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State of Nevada

STATE CONSERVATION COMMISSION

Capitol Complex

Carson City, Nevada 89710

Phone 775-687-6977

Best Management Practices Handbook

FOREWARD

In 1978, through the leadership of the Nevada Division of Conservation Districts, the Conservation Commission, and the Nevada Division of Environmental Protection, the first Handbook of Best Management Practices was developed as part of the water quality management planning process for addressing nonpoint sources of pollution in the nondesignated area in Nevada. The nondesignated area includes the entire state with the exception of Washoe and Clark counties, the Lake Tahoe Basin and the Carson River Basin. This 1994 revision, which was developed through a coordinated effort between these same groups, is applicable for remediating and eliminating nonpoint sources of pollution throughout the entire state.

Nonpoint sources of pollution, which include agriculture, grazing, silviculture, construction, hydrologic and habitat modification, mining, urban runoff and waste disposal, are now recognized as the major causes of water quality degradation in the nation's streams and rivers. It is also recognized that the most effective means of reducing nonpoint source pollution is through a grass root level, voluntary approach in implementing best management practices and through the cooperative efforts of all those affected by the water quality problems.

In Nevada, the Conservation Districts have provided leadership in soil and water conservation programs for many years and are now in a unique position to spearhead and coordinate programs aimed at reducing nonpoint pollution. By working in cooperation with the Nevada Division of Environmental Protection, National Association of Conservation Districts, U. S. Soil Conservation Service, Agriculture Stabilization Conservation Service and other federal land management agencies, Conservation Districts can develop and implement water quality management plans which incorporate best management practices.

As the statewide population continues to increase in both urban and rural areas demands placed on our limited surface and ground water resources also increase. Through a cooperative effort to develop water quality management plans which include the implementation of best management practices, it is hoped that the quality of Nevada's water resources can be improved and maintained. It is also hoped that this Handbook of Best Management Practices will serve as a useful guide toward meeting that goal.

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Approval Letter – State Environmental Commission

December 7, 1994

Mr. Christopher Freeman
Executive Secretary
Nevada State Conservation Commission
Capitol Complex
Carson City, Nevada 89710

Mr. Wendell McCurry, Chief
Bureau of Water Quality Planning
Nevada Division of Environmental Protection
123 W. Nye Lane
Carson City, Nevada 89710

Dear Sirs

The purpose of this correspondence is to notify you that the Nevada State Environmental Commission on November 9, 1994 conducted a public hearing and adopted without amendment the revised 1994 edition of the Handbook of Best Management Practices.

The Environmental Commission's action to adopt follows the Nevada State Conservation Commission's action of adoption on September 21, 1994. The Environmental Commission acted in accordance with Nevada Administrative Code 445.230 "State Handbook of Best Management Practices," subsequently replaced by 445A.336 in November 1994 by the Legislative Counsel Bureau.

If you have any questions regarding the Environmental Commission's action, please feel free to contact me at 702-687-4670 ext. 3118.

ACKNOWLEDGEMENTS

This revision of the Handbook of Best Management Practices represents a combined effort of the Nevada Division of Environmental Protection and the Nevada Division of Conservation Districts. Most of the material presented herein is not original but was developed from many sources including best management practice handbooks and technical guides from the U.S. Environmental Protection Agency, U.S. Soil Conservation Service, U.S. Forest Service, U.S. Bureau of Land Management and the Tahoe Regional Planning Agency.

Special thanks to Chris Heppe of the Environmental Protection Agency Region IX, Chris Freeman of the Nevada Division of Conservation Districts, Pat Murphy of the Nevada Division of Forestry and Dan Greenlee of the U.S. Soil Conservation Service for their preliminary reviews and comments on the document. All Division staff must be acknowledged for their dedication and extra effort devoted to completing the project.

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PURPOSE AND USE

This Handbook of Best Management Practices is intended as a general guidance and information resource to assist agencies, entities and individuals in water quality management activities aimed at reducing or preventing nonpoint source pollution. The handbook is intended to provide the framework for soil and water conservation programs for water quality improvement throughout the State, including areas where waters are not part of major basins or stream systems. The ring binder format is designed to allow for inserting updates and revisions as deemed appropriate by the Nevada Division of Environmental Protection, the Nevada Nonpoint Source Task Force cooperators and the public.

U.S. Environmental Protection Agency (EPA) guidelines define Best Management Practices (BMPs) as "methods, measures or practices to prevent or reduce water pollution, including but not limited to, structural and non-structural controls, operation and maintenance procedures and scheduling and distribution of activities. Usually BMPs are applied as a system of practices rather than a single practice. BMPs are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility".

Nevada Administrative Code 445.200 defines "Best Practices" as "measures, methods of operation or practices which are reasonably designed to prevent, eliminate or reduce water pollution from diffuse sources and which are consistent with the best practices in the particular field under the conditions applicable. This term is intended to be equivalent to the term "best management practices" as used in federal statutes and regulations".

In general, BMPs are site specific actions taken to prevent or reduce water pollution from nonpoint sources. Examples of operational BMPs include constructing water bars across roads or skid trails, spreading grass seed on exposed soil, placing jute matting or other types of temporary cover on cut or fill slopes and identifying or designating stream-side management zones. Organizational BMPs include scheduling activities to avoid wet seasons, incorporating water quality protection measures into contract provisions, requiring road locations on ridge lines rather than valley bottoms, reviewing project implementation documents to insure protection methods and measures are incorporated and inspecting project sites to insure protection measures are in place.

Effective BMPs must be based on consideration of all existing site specific conditions and must be cost effective. Factors which need to be considered include the occurrence and movement of surface and ground water, geology, soil type, climate, topography and habitat. Scheduling and timing are important, as are adequate design and application. BMPs should be designed and developed on a site specific basis by qualified professionals. Technical assistance needed for BMP installation and cost estimates for farms and ranches can be provided by the Soil Conservation Service.

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In general BMPs are not meant to be minimum standards, nor are they meant to be used as a cookbook approach in lieu of good professional management experience and judgement; however, the BMPs outlined in this manual are considered as the minimum criteria in 404 certification and mining reclamation permits, although the use of other more specific BMPs as developed by other agencies such as the Soil Conservation Service (SCS), United States Forest Service (USFS), Bureau of Land Management (BLM), EPA, and the Army Corp of Engineers can be proposed. The BMPs presented here are expected to be compatible with requirements such as restrictions on pesticide application or building and zoning regulations. BMPs are expected to be planned and implemented with full consideration for existing water rights, including those based on return flows. Not all situations are covered in this Handbook, nor are the potential risks to water quality during the installation of some practices. Such issues should be evaluated during the resource or site specific planning process. The planning process should also consider economics and compatibility with existing operations.

The BMPs presented in this Handbook can be used to remediate or prevent pollution from numerous nonpoint source categories including construction, agriculture, grazing, silviculture, resource extraction, urban runoff, waste management activities and atmospheric deposition. The BMPs are written in general format; more detailed guidelines and specifications for BMP installation are included in the Appendices. Additional information for resource planning and BMP implementation can be obtained from the agencies listed in the section titled Sources of Assistance. The section on Selection of Best Management Practices contains an easy reference table for determining appropriate BMPs for specific nonpoint source pollution categories.

Nonpoint source pollution, whether natural or man-made, is a key factor in the degradation of Nevada's limited water resources. It is hoped this Handbook will be a useful resource for the voluntary implementation of best management practices in order to mitigate existing and prevent further nonpoint source pollution.

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SELECTION OF BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) can be utilized by an individual or agency to control a water quality problem caused by nonpoint source pollution. The BMP concept is based on the premise that individuals and agencies should take the most practical and feasible approach prevent the release of pollutants into the surface and ground waters of the State.

The diffuse and intermittent nature of nonpoint source pollution makes identification of these sources difficult at times. Section 445.203 of the Nevada Administrative Code defines diffuse source as:

1. Agricultural activity, including return flows from irrigation;
2. Silvicultural activity;
3. Mining activity;
4. Construction of buildings, roads, dams, utility lines or other improvements of facilities;
5. Runoff from roads, streets and railroads;
6. Construction or use of recreational trails;
7. Modification of water courses or stream channels; and,
8. Runoff from urban areas.

The Nevada Diffuse Source regulations were adopted in 1982. In 1987, the Federal Clean Water Act was amended to address nonpoint sources of pollution. The U.S. Environmental Protection Agency (EPA) has identified additional categories and subcategories of nonpoint sources of pollution which encompass a wide range of activities.

The following is a summary of the major activities recognized by the State and EPA with the potential for generating nonpoint source pollution in Nevada.

1. Construction
2. Hydrologic Modification
3. Habitat Modification
4. Irrigation and Drainage
5. Cropland
6. Livestock Grazing
7. Feedlots/Animal Holding Units
8. Silviculture
9. Resource Extraction
10. Urban Runoff
11. Land Disposal
12. Waste Management Activities
13. Atmospheric Deposition

Best Management Practices can effectively eliminate or reduce the introduction of

pollutants into receiving waters when applied either before, during, or after pollution producing activities.

The main criteria which should be considered when selecting BMPs to improve water quality are the type of pollutant(s) being generated and the category of pollution generating activity; however, the following factors must also be considered: site-specific physical characteristics, cost-effectiveness, landowner acceptance, public interest and support, legal authority, and agency limitations.

Thus, the selection of BMPs for application to a particular nonpoint source (NPS) pollution problem will be site-specific and modifications may be required to tailor the BMPs to the characteristics of the problem area. However, some general guidelines for BMP selection can be provided based upon the activity which is generating the pollution.

The following is a brief description of the activities and conditions that are potential nonpoint pollution sources. Recommended BMPs for controlling nonpoint source pollution from each category are summarized in Tables VII-1 through VII-8 for easy reference.

1. Construction

Sediment is the primary pollutant generated at construction sites. Runoff from construction and industrial activities potentially generates more sediment per unit acre than from any other land use. In response to this common cause of water quality impairment, EPA promulgated regulations (55 CFR 47990) on November 16, 1990, requiring the permitting of stormwater generated pollution under the National Pollutant Discharge Elimination System (NPDES). The Nevada Division of Environmental Protection (NDEP) has been delegated the authority to administer these federal regulations and has adopted state regulations to administer an NPDES Stormwater program. (For additional information on the Stormwater program, see Category 4. Urban Runoff.)

Pursuant to these federal regulations, an operator must obtain a General Permit under the NPDES Stormwater Dischargers Program for all construction activities five (5) acres or greater. The General Permit requires the implementation of BMPs to reduce pollutant loadings into waters of the State.

Although stormwater permits are not required for construction related activities smaller than five acres, runoff and erosion can be minimized at these sites by implementing the following BMPs:

- diversion structures designed to channel runoff away from disturbed surfaces;
- structures designed to collect, retain and/or treat any water that contacts disturbed surfaces;
- permanent stabilization of exposed surfaces once construction is complete;

- locating roads and access where the effect on water quality will be the least;
- the implementation of good housekeeping practices such as proper storage and spill prevention to prevent runoff from paints, solvents, fuels, etc.; and,

- properly designing, constructing, and maintaining commercial, residential and industrial properties in a manner that will minimize contribution of pollutants to the water.

Nonpoint source pollution loads from construction sites are also controlled through federal, state and local building codes, standard engineering designs, and standardized plans and specifications which are enforced by building, health and public works departments.

2. Hydrological Modification

Hydrological modifications such as streambank modification/destabilization, channelization, dredging, dam construction, flow regulation/modification, and bridge construction may contribute large amounts of sediment to waters of the State.

Hydrological modifications can result from natural conditions or can include activities directed by man such as straightening, widening, deepening, or relocating existing stream channels and clearing or snagging operations. These forms of hydromodification are intended to result in more uniform channel cross sections, steeper stream gradients and reduced average pool depths. These activities are usually overseen by the Army Corp of Engineers 404 permitting process.

Whether natural or man-made, hydrological modifications can increase sediment loadings, decrease or interfere with surface water contact to overbank areas, and destroy riparian areas and wildlife habitat.

3. Habitat Modifications

In the context of this manual, habitat modification is a general term used to describe the loss of riparian habitat due to hydrologic modifications, trampling and overgrazing by all forms of livestock, and silvicultural and mining activities.

Riparian zones are lands adjacent to streams where the vegetation is strongly influenced by the presence of water. The loss of riparian vegetation increases runoff and erosion by exposing soils to the drying effects of wind and sunlight, reduces the water storage capacity of the riparian area, reduces shade which increases in-stream water temperature and reduces the filtration of sediment necessary for building streambanks, wet meadows and floodplains. Theses factors typically result in degraded water quality, lost of livestock forage, reduced numbers and diversity of fish and wildlife, reduced property

values and increased potential for severe flooding.

4. Irrigation and Drainage

Return flows, runoff and leachate from irrigated lands may transport sediment, organic solids, nutrients, pesticides, salts, metals, bacteria, viruses and other microorganisms to surface or ground water systems. The manner in which irrigation and drainage water is managed may determine whether these pollutants actually reach waters of the State.

The 1985 Farm Bill requires all ranchers to have and implement Farm Plans that address water quality and soil erosion problems associated with irrigation and other farming\ranching practices. The plans are written by the Soil Conservation Service and approved by the Conservation Districts.

5. Cropland

Hay dominates crop production in Nevada and occupies the largest amount of irrigated land. Nonpoint source pollutants associated with crop production are similar to those produced from irrigation and drainage activities. Preventing and mitigating nonpoint source pollution from cropland and other associated agricultural activities is overseen through educational activities and policies directed by the Soil Conservation Service, and Conservation Districts. The Army Corp of Engineers and the Bureau of Reclamation also work in conjunction with irrigation districts on projects to improve water quality.

6. Livestock Grazing

The impacts of overgrazing in riparian areas are discussed in Section 3 (Habitat Modification). Improper upland grazing and maintenance of pasture lands can cause reduced water infiltration and accelerated runoff and erosion resulting in the formation of rills and gullies and the loss of soil and wildlife habitat.

The development of management plans for both riparian and upland areas is useful for protecting water quality and habitat. The plans may include the development of livestock water facilities away from streams to protect riparian areas.

Management plans for grazing lands should at a minimum consider livestock density, and livestock location--especially access to riparian areas and bodies of water, and ensure
adequate forage and ground cover with diverse, native species. For any grazing management system to work, it must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, and particular type of operation involved.

7. Feedlots\Animal Holding Units

Livestock containment facilities are structures built or used to hold livestock including but not limited to corrals, cattlelots, feedlots and other similar structures. The following pollutants may be contained in manure, associated bedding materials, runoff and process wastewater: sediments, bacteria, viruses, and other microorganisms; oxygen-demanding substances; nitrogen, phosphorus, and other major and minor nutrients or other deleterious materials; organic solids; and salts.

Nevada Administrative Code (NAC) 445.140 exempts operators from obtaining an NPDES discharge permit for discharges of pollutants from agricultural and silvicultural activities, including irrigation return flow and runoff from orchards, cultivated crops, pastures, rangelands and forest lands. This exclusion does not apply to the following:

- Discharges from facilities which confine animals if the facilities contain, or at any time during the previous 12 months contained, for a total of 30 days or more, any of the following types of animals at or in excess of the number listed for each type of animal:

--slaughter and feeder cattle	1,000
--mature dairy cattle (whether milkers or dry cows)	700
--swine weighing over 55 pounds	2,500
--horses	500
--sheep	10,000
--turkeys	55,000
--laying hens and broilers, if the animal confinement facility has continuous overflow watering	100,000
--laying hens and broilers, if the animal confinement facility has liquid manure handling system	30,000
--ducks	5,000

- Discharges from facilities which confine animals if such facility or facilities contain, or at any time during the previous 12 months contained, for a total of 30 days or more, a combination of animals such that the sum of the following numbers is 1,000 or greater:

  --the number of slaughter and feeder cattle multiplied by 1.0, plus the number of mature dairy cattle multiplied 1.4, plus the number of swine weighing over 55 pounds multiplied by 0.4, plus the number of sheep

multiplied by 0.1, plus the number of horses multiplied by 2.0.

As previously stated, facilities containing fewer than the number of head listed above are not required to obtain an NPDES discharge permit. The goal of implementing BMPs at feedlots is to minimize the discharge of contaminants in both facility wastewater and in storm runoff.

8. Silviculture

Forestry operations may degrade several water quality characteristics in waterbodies receiving drainage from forest lands. Sediment concentrations can increase due to accelerated erosion. Water temperatures can increase due to removal of overstory riparian shade. Slash and other organic debris can accumulate in waterbodies, depleting dissolved oxygen. Organic and inorganic chemical concentrations can increase due to harvesting and fertilizer application. These potential increases in water quality contamination are usually proportional to the severity of site disturbance.

Silvicultural activities related to runoff and erosion control are regulated through a permit program operated by the Nevada State Forester Firewarden under the Nevada Forest Practice Act. These regulations also mandate that environmental concerns be properly addressed before major silvicultural activity takes place.

9. Resource Extraction (Including gas, oil, and geothermal)

Several activities associated with mining operations including exploration projects, mine access and haul roads, waste rock dumps, ore stockpiles, landfills, and product storage areas have the potential to be sources of nonpoint pollutants such as sediment, salts, metals and organic compounds.

Nonpoint source discharges associated with mining activities are addressed by federal, state, and in certain situations, local governments through special use permits and county bond requirements. The State Mine Reclamation regulations (NAC 519A.260) require all exploration projects to submit a detailed plan on the measures which will be taken to minimize the sedimentation of surface waters during the life of the project and after the site is closed. Mining operations must comply with the requirements specified in NAC 519A.270 which require, in part, that the mining operation identify, 1) all surface water bodies within one-half-mile down gradient of the operation which may be impacted by excess sedimentation; 2) the technical criteria used to determine the final gradient and stability of slopes created or affected by the mining operation; 3) the measures which will be used to minimize sediment loading to surface waters during operation and reclamation; 4) and a description of reclamation which is necessary because of instream mining.

Federal land management agencies require reclamation plans as specified in the

Code of Federal Regulations (CFR). The NDEP has entered into a Memorandum of Understanding with both the Bureau of Land Management and the U.S. Forest Service which provides for a multi-agency review and permitting process for all exploration and mining operations in the State affecting greater than five acres.

Nevada Administrative Code, 445.242 through 445.24388, specifies the regulations governing design, construction, operation and closure of mining operations. These regulations
contain provisions to insure the immobilization of pollutants from process components and waste rock dumps after the cessation of mining.

Additionally, pursuant to federal regulations, an operator must obtain a General Permit under the NPDES Stormwater Dischargers Program if mining is being conducted at any size facility for copper, lead, zinc, gold, and/or molybdenum. The General Permit requires the implementation of BMPs to reduce pollutant loadings into the waters of the State.

10. Urban Runoff

In 1987, the Clean Water Act was amended to mandate EPA to establish regulations for permitting requirements for stormwater discharges under the National Pollutant Discharge Elimination System (NPDES). EPA promulgated regulations (55 CFR 47990) on November 16, 1990. NDEP was delegated this program and has subsequently adopted applicable regulations.

Under this program, permits must be obtained for stormwater runoff associated with industrial activity and medium and large separate storm sewers (serving a population of greater than 100,000 or 250,000 people, respectively). A stormwater discharge permit may also be required if the State determines that a storm water discharge contributes to the violation of water quality standards or is a significant contributor of pollutants to waters of the United States.

The NPDES permitting program requires the medium and large municipalities to develop and institutionalize stormwater management programs. The pollutant discharges from municipal storm sewers are highly intermittent and are usually characterized by very high flow rates occurring over relatively short time intervals. The nature and extent of pollutants in discharges from municipal systems is also variable and depends on the activities occurring on the lands which contribute runoff to the system. Potential pollutants include sediment, nutrients, salts, organic materials and compounds, and metals. Thus, management programs will have a wide variety of structural and non-structural BMPs.

Identified industrial discharges (specified Standard Industrial Codes [SIC]) are also required to obtain a General Permit. The General Permit outlines BMPs which need to be

implemented to reduce pollutant loading.

Smaller municipalities and some activities are presently not covered by the NPDES permit requirements such as construction activities on sites that result in the disturbance of less than 5 acres.

11. Land Disposal (Runoff/Leachate/Infiltration)

Sludge disposal, wastewater, leachate from unlined landfills, industrial land treatments and hazardous waste spills are potential sources of pollutants such as nutrients, salts, metals and organic compounds to both surface and ground waters. On-site wastewater systems (i.e. septic tanks) can cause problems if the density is too great in a given area.

State and federal laws regulate the design, operation and maintenance of wastewater treatment facilities and landfills. Sludge, effluent application and rapid infiltration basins are also regulated.

12. Waste Management Activities

Improperly designed waste storage structures, leaking underground storage tanks, highway maintenance and runoff, and spills are sources of pollutants such organic compounds, metals, salts and nutrients to surface and ground waters.

13. Atmospheric Deposition

Airborne sediments can not only directly affect water quality, but can affect productive capability of the land, air quality, and health and safety.

Table VII-1

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 1-1	BMP 1-2	BMP 1-3	BMP 1-4	BMP 1-5	BMP 2-1	BMP 2-2	BMP 2-3	BMP 2-4	BMP 2-5
Construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hydrologic Modification	✓	✓	✓	✓		✓	✓	✓	✓	✓
Habitat Modification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Irrigation and Drainage	✓	✓	✓	✓		✓	✓	✓	✓	✓
Cropland	✓	✓	✓	✓		✓	✓	✓	✓	✓
Livestock Grazing			✓							✓
Feedlots / Animal Holding Units	✓	✓	✓	✓		✓	✓	✓		
Silviculture	✓	✓	✓	✓		✓	✓	✓		
Resource Extraction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban Runoff	✓	✓	✓			✓			✓	
Land Disposal (runoff/leachate/infiltration)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste Management Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Atmospheric Deposition	✓	✓	✓	✓	✓	✓				

BMP 1-1: DEVELOPMENT SITE PLAN (pg 1-2)

BMP 1-2: GRADING SEASON & PRACTICES (pg 1-4)

BMP 1-3: ACCESS ROADS (pg 1-5)

BMP 1-4: DUST CONTROL (pg 1-8)

BMP 1-5: TOPSOIL MANAGEMENT (pg 1-10)

BMP 2-1: EROSION & SEDIMENT CONTROL STRUCTURES (pg 2-2)

BMP 2-2: RUNOFF INTERCEPTOR TRENCH OR SWALE (pg 2-5)

BMP 2-3: DIVERSION DIKE (pg 2-8)

BMP 2-4: DIVERSION DAM (pg 2-11)

BMP 2-5: LEVEL SPREADER (pg 2-14)

Table VII-2

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 2-6	BMP 2-7	BMP 2-8	BMP 2-9	BMP 2-10	BMP 2-11	BMP 2-12	BMP 2-13	BMP 2-14	BMP 3-1
Construction	✓	✓		✓	✓	✓	✓		✓	✓
Hydrologic Modification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Habitat Modification	✓	✓	✓	✓		✓		✓		✓
Irrigation and Drainage		✓	✓	✓	✓	✓	✓	✓	✓	✓
Cropland						✓		✓	✓	✓
Livestock Grazing						✓		✓		✓
Feedlots / Animal Holding Units				✓	✓					
Silviculture	✓	✓	✓	✓	✓		✓			✓
Resource Extraction	✓	✓	✓	✓	✓	✓	✓		✓	✓
Urban Runoff	✓	✓		✓	✓	✓	✓	✓	✓	✓
Land Disposal (runoff/leachate/infiltration)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Waste Management Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Atmospheric Deposition						✓	✓			✓

BMP 2-6: SILTATION OR FILTER BERMS (pg 2-17)
BMP 2-7: FILTER OR SILT FENCE (pg 2-20)
BMP 2-8: FILTER STRIPS (pg 2-23)
BMP 2-9: SEDIMENT BARRIERS (pg 2-27)
BMP 2-10: SEDIMENT BASINS (pg 2-31)
BMP 2-11: GRASSED WATERWAYS & OUTLETS (pg 2-34)
BMP 2-12: ROCK LINED DITCH OR SWALE (pg 2-36)
BMP 2-13: WATERSPREADING (pg 2-39)
BMP 2-14: PERMANENT WATERWAY (pg 2-41)
BMP 3-1: SEEDING PRACTICES (pg 3-2)

Table VII-3

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 3-2	BMP 3-3	BMP 3-4	BMP 3-5	BMP 3-6	BMP 3-7	BMP 3-8	BMP 4-1	BMP 4-2	BMP 4-3	BMP 5-1
Construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydrologic Modification	✓	✓	✓		✓			✓	✓	✓	✓
Habitat Modification	✓	✓	✓			✓	✓	✓			
Irrigation and Drainage	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Cropland				✓							✓
Livestock Grazing				✓							✓
Feedlots / Animal Holding Units				✓							✓
Silviculture	✓	✓	✓		✓	✓	✓	✓		✓	✓
Resource Extraction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban Runoff					✓	✓	✓	✓	✓	✓	✓
Land Disposal (runoff/leachate/infiltration)	✓	✓	✓		✓	✓	✓	✓		✓	✓
Waste Management Activities	✓	✓	✓	✓	✓	✓	✓			✓	✓
Atmospheric Deposition	✓	✓	✓		✓	✓	✓			✓	

BMP 3-2: WATTLING (pg 3-5)
BMP 3-3: BRUSH LAYERING (pg 3-9)
BMP 3-4: BRUSH MATTING (pg 3-11)
BMP 3-5: WINDBREAKS (pg 3-13)
BMP 3-6: ROCK & GRAVEL MULCHES (pg 3-17)
BMP 3-7: WOOD CHIP, STRAW & BARK MULCHES (pg 3-19)
BMP 3-8: JUTE & SYNTHETIC NETTING (pg 3-21)
BMP 4-1: SLOPE SHAPING (pg 4-2)
BMP 4-2: RETAINING STRUCTURES (pg 4-4)
BMP 4-3: ROCK RIPRAP (pg 4-8)
BMP 5-1: INFILTRATION TRENCH OR BASIN (pg 5-2)

Table VII-4

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 5-2	BMP 5-3	BMP 5-4	BMP 6-1	BMP 6-2	BMP 6-3	BMP 6-4	BMP 6-5	BMP 6-6	BMP 7-1	BMP 7-2
Construction	✓	✓	✓	✓	✓	✓	✓	✓			
Hydrologic Modification			✓	✓	✓	✓	✓	✓	✓	✓	
Habitat Modification			✓	✓	✓	✓			✓		✓
Irrigation and Drainage	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Cropland			✓	✓	✓	✓				✓	✓
Livestock Grazing			✓	✓	✓	✓			✓		
Feedlots / Animal Holding Units											
Silviculture			✓	✓	✓	✓			✓		
Resource Extraction			✓	✓	✓	✓	✓	✓			
Urban Runoff	✓	✓		✓	✓	✓	✓	✓			
Land Disposal (runoff/leachate/infiltration)	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Waste Management Activities	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Atmospheric Deposition			✓		✓	✓					

BMP 5-2: DRY WELL (pg 5-6)
BMP 5-3: FRENCH DRAIN (pg 5-7)
BMP 5-4: WETLANDS (pg 5-9)
BMP 6-1: CRITICAL AREA PROTECTION (pg 6-2)
BMP 6-2: CRITICAL AREA STABILIZATION (pg 6-4)
BMP 6-3: STREAM PROTECTION & STABILIZATION (pg 6-7)
BMP 6-4: FLOODWATER RETARDING STRUCTURE (pg 6-10)
BMP 6-5: FLOODWATER DIVERSION (pg 6-12)
BMP 6-6: PRESCRIBED USE OF FIRE (pg 6-15)
BMP 7-1: IRRIGATION WATER MANAGEMENT (pg 7-2)
BMP 7-2: IRRIGATED CROPLAND MANAGEMENT (pg 7-6)

Table VII-5

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 7-3	BMP 7-4	BMP 7-5	BMP 7-6	BMP 7-7	BMP 7-8	BMP 7-9	BMP 7-10	BMP 7-11	BMP 8-1
Construction										✓
Hydrologic Modification										
Habitat Modification					✓	✓	✓			✓
Irrigation and Drainage	✓	✓	✓	✓	✓					
Cropland	✓	✓	✓	✓	✓	✓	✓			
Livestock Grazing	✓	✓	✓			✓	✓	✓		
Feedlots / Animal Holding Units			✓			✓	✓		✓	
Silviculture					✓					✓
Resource Extraction					✓					
Urban Runoff										
Land Disposal (runoff/leachate/infiltration)	✓		✓	✓						
Waste Management Activities			✓	✓						
Atmospheric Deposition		✓		✓						✓

BMP 7-3: NATIVE MEADOWLAND IRRIGATION MANAGEMENT (pg 7-9)

BMP 7-4: PASTURE & HAYLAND MANAGEMENT (pg 7-11)

BMP 7-5: SALINITY CONTROL (pg 7-13)

BMP 7-6: CHISELING OR SUBSOILING (pg 7-16)

BMP 7-7: SOIL AMENDMENT, FERTILIZER & PESTICIDE MANAGEMENT (pg 7-17)

BMP 7-8: PLANNED GRAZING SYSTEM (pg 7-21)

BMP 7-9: PROPER GRAZING USE (pg 7-25)

BMP 7-10: RANGE IMPROVEMENTS (pg 7-27)

BMP 7-11: LIVESTOCK FACILITIES (pg 7-30)

BMP 8-1: ACCEPTED FOREST PRACTICES (pg 8-2)

Table VII-6

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 8-2	BMP 8-3	BMP 9-1	BMP 9-2	BMP 9-3	BMP 9-4	BMP 9-5	BMP 9-6	BMP 10-1	BMP 10-2
Construction	✓	✓		✓	✓		✓		✓	✓
Hydrologic Modification			✓	✓	✓	✓	✓	✓	✓	✓
Habitat Modification	✓	✓	✓	✓		✓		✓		
Irrigation and Drainage					✓		✓	✓		
Cropland										
Livestock Grazing		✓								
Feedlots / Animal Holding Units										
Silviculture	✓	✓			✓					
Resource Extraction			✓	✓	✓	✓	✓	✓	✓	✓
Urban Runoff					✓				✓	✓
Land Disposal (runoff/leachate/infiltration)				✓	✓	✓	✓	✓	✓	✓
Waste Management Activities			✓	✓	✓	✓	✓	✓	✓	✓
Atmospheric Deposition	✓			✓		✓	✓			

BMP 8-2: WILDLAND/URBAN INTERFACE MANAGEMENT (pg 8-4)
BMP 8-3: FUELS MANAGEMENT (pg 8-7)
BMP 9-1: MINERAL EXPLORATION (pg 9-2)
BMP 9-2: EXCAVATION STABILIZATION (pg 9-4)
BMP 9-3: SURFACE RUNOFF MANAGEMENT (pg 9-8)
BMP 9-4: WASTE ROCK DUMP MANAGEMENT (pg 9-11)
BMP 9-5: IMPOUNDMENT MANAGEMENT (pg 9-12)
BMP 9-6: RECLAMATION (pg 9-15)
BMP 10-1: STREET RUNOFF COLLECTION (pg 10-2)
BMP 10-2: STORM DRAINAGE STRUCTURES (pg 10-7)

Table VII-7

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 10-3	BMP 10-4	BMP 10-5	BMP 10-6	BMP 10-7	BMP 10-8	BMP 10-9	BMP 10-10	BMP 10-11	BMP 10-12
Construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydrologic Modification	✓	✓					✓			✓
Habitat Modification				✓						
Irrigation and Drainage		✓	✓		✓	✓	✓	✓		✓
Cropland			✓		✓	✓				
Livestock Grazing										
Feedlots / Animal Holding Units										✓
Silviculture		✓								
Resource Extraction		✓					✓	✓		✓
Urban Runoff	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Land Disposal (runoff/leachate/infiltration)		✓		✓	✓	✓	✓	✓	✓	✓
Waste Management Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Atmospheric Deposition				✓						

BMP 10-3: SANDBAG CURB INLET SEDIMENT BARRIER (pg 10-11)
BMP 10-4: CULVERTS (pg 10-13)
BMP 10-5: IRRIGATION (pg 10-16)
BMP 10-6: LANDSCAPING (pg 10-18)
BMP 10-7: FERTILIZER MANAGEMENT (pg 10-20)
BMP 10-8: PESTICIDE/HERBICIDE MANAGEMENT (pg 10-22)
BMP 10-9: SNOW DISPOSAL PRACTICES (pg 10-25)
BMP 10-10: ROAD SALT STORAGE & RELATED PRACTICES (pg 10-27)
BMP 10-11: STREET CLEANING PRACTICES (pg 10-29)
BMP 10-12: WELLHEAD PROTECTION (pg 10-31)

Table VII-8

Best Management Practices (BMPs) Related To Activities And Conditions That Are Potential Pollution Sources

Pollution Source	BMP 11-1	BMP 11-2	BMP 11-3	BMP 11-4	BMP 11-5	BMP 11-6	BMP 11-7	BMP 12-1	BMP 12-2
Construction	✓	✓	✓	✓	✓	✓		✓	✓
Hydrologic Modification								✓	✓
Habitat Modification									
Irrigation and Drainage								✓	✓
Cropland									
Livestock Grazing									
Feedlots / Animal Holding Units		✓	✓	✓	✓	✓		✓	
Silviculture									
Resource Extraction		✓	✓	✓	✓	✓		✓	✓
Urban Runoff	✓	✓					✓		
Land Disposal (runoff/leachate/infiltration)	✓	✓	✓	✓	✓	✓		✓	
Waste Management Activities	✓	✓	✓	✓	✓	✓		✓	
Atmospheric Deposition									

BMP 11-1: UNDERGROUND STORAGE TANKS (pg 11-2)

BMP 11-2: WASTE MANAGEMENT SYSTEMS (pg 11-4)

BMP 11-3: RURAL WASTE DISPOSAL MANAGEMENT (pg 11-6)

BMP 11-4: WASTE TREATMENT LAGOON (pg 11-8)

BMP 11-5: WASTE STORAGE POND (pg 11-10)

BMP 11-6: WASTE STORAGE STRUCTURE (pg 11-12)

BMP 11-7: HOUSEHOLD HAZARDOUS WASTE MANAGEMENT (PG 11-13)

BMP 12-1: IMPERVIOUS SEALS (pg 12-2)

BMP 12-2: WATER STORAGE RESERVOIR (pg 12-5)

TEMPORARY VERSUS PERMANENT BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) are utilized to minimize erosion and sedimentation before, during and after development, construction, mining or agricultural projects. Temporary BMPs are designed for relatively short periods of time, before and during a specific project or until permanent BMPs are installed. Permanent BMPs are designed, constructed and maintained to function the entire life of the project and may be retained after the life of the project.

Temporary BMPs are typically designed for periods of up to one year or one winter and spring runoff season and may require a significant amount of maintenance depending on the extent of the surface disturbances and the intensity of precipitation and storm events which occur during the life of the project.

The primary difference between temporary and permanent BMPs is the construction materials and the design life. While a straw bale sediment barrier will function well on a temporary basis, a more permanent barrier or sediment basin would be required for long term or permanent installation. Most large scale development, mining or construction projects install permanent BMPs initially because the life of the project, or the magnitude of the surface disturbance warrants such an approach. A single family dwelling under a construction schedule of nine months, for example, would probably not require permanent BMPs. The specific conditions of the site, the project schedule and the proposed amount of surface disturbance typically govern the number and type of BMPs necessary to prevent nonpoint source pollution.

While any permanent BMP can function as a temporary BMP, temporary BMPs will not function as permanent BMPs. The BMPs contained within this Handbook have not been categorized by "temporary" and "permanent"; rather those BMPs that are temporary are so noted. The reader is directed to specific BMPs for his or her need (i.e. Erosion & Sediment Controls, Soil Stabilization Practices, etc.).

CHAPTER 1

ROAD & CONSTRUCTION SITE PRACTICES

BMP 1-1	DEVELOPMENT SITE PLAN
BMP 1-2	GRADING SEASON & PRACTICES
BMP 1-3	ACCESS ROADS
BMP 1-4	DUST CONTROL
BMP 1-5	TOPSOIL MANAGEMENT

BMP 1-1
DEVELOPMENT SITE PLAN

DEFINITION

A site plan identifies the physical features of the site, the location of proposed development, and the location of temporary and/or permanent BMPs.

PURPOSE

The development site plan provides basic information about the physical characteristics of the site including: topography, access, surface water courses, etc.. By utilizing a development site plan the proposed development can be situated to minimize impact to natural resources, the land, and to enable water quality protection measures and runoff conveyance measures to be properly located.

APPLICABILITY

Site plans are required in a variety of situations, especially when development results in a land disturbance.

PLANNING CRITERIA

The first step in development site planning is to identify the physical features of the site.

1. Topography - A topographic map that shows the existing topography and site conditions at a scale appropriate to the project.

2. Drainage - The topographic map will help indicate which way water will flow across the site. On the map identify points where runoff will enter and leave the site. Mark all existing streams and drainageways on the map. Perform a drainage analysis for the site as it exists before development.

3. Vegetation - Show the existing locations of the trees and shrubs on the map.

4. Identify land capability boundaries, including boundaries of stream environment zones, flood plains, and other natural hazards.

5. Identity significant features such as rock outcrops, survey monuments, existing roads or other impervious coverage.

METHODS AND MATERIALS

After the physical features of the site have been identified, locate the proposed development in order to minimize land disturbance.

1. Minimize earth movement - Fit development to the terrain. Minimize cuts and fills.

2. Minimize impervious coverage - Make paved areas, such as driveways and parking pads consistent with other design and regulatory requirements.

3. Minimize vegetation removal - Preserve trees, grass, and other native vegetation in order to maintain site stability and reduce BMP costs. Locate structures and driveways to minimize the need for site clearing.

4. Avoid steep slopes - Confine construction activities to the least critical parts of the site. Once these areas are disturbed by construction, the resulting erosion may be very difficult to stop. In addition, any construction activities on steep slopes will require installation of costly BMPs.

5. Align roads and driveways along slope contours - Locate driveways parallel to slope contours rather than up and down slopes. Runoff down long or steep driveways tends to channelize flows and can cut deep gullies along the driveway.

6. Retain the natural drainage system - Avoid confining any natural drainage system by placing it in a buried culvert or forcing it to a new location on-site. Accommodate all drainages entering the site, whether natural or established by man.

After the proposed developments have been located, identify the erosion and sediment control measures (BMPs) to be installed both during and after construction.

MAINTENANCE

The development site plan should be updated and kept current based upon any physical changes to the site. Periodic reviews of the site plan should be conducted.

BMP 1-2
GRADING SEASON & PRACTICES

DEFINITION

The grading season is determined by the local climate conditions. All grading, clearing, and excavation work should be conducted during this period in order to avoid climatic conditions that could increase the chances for erosion.

PURPOSE

To coordinate grading and construction activities such that bare and disturbed soil exposure is minimized during the winter snow and rainy seasons.

APPLICABILITY

For construction or development projects which occur in a location where there is an opportunity for snow or rain to occur to the extent that soils become saturated and surface soil erosion is possible.

PLANNING CRITERIA

Many counties and communities have established specific grading and construction seasons applicable to their local environment. Coordination with the local building department or public works department will clarify any regulatory requirements applicable to the development project.

METHODS AND MATERIALS

The best time to begin construction is after the snow has melted. All grading and excavation work should be completed prior to the setting in of winter. At that time, all building sites should be winterized. Grading should not take place during storm events, rain or snow, and for the following period of time when the site is covered with snow or the soil is in a wet, saturated, muddy or unstable condition.

BMP 1-3
ACCESS ROADS

DEFINITION

Roads to provide needed access to an area should be constructed in such a way that the quality of runoff water is preserved.

PURPOSE

To provide a route for vehicle travel, for moving equipment, supplies and products, and for providing access for proper operation and management of conservation enterprises without disturbing the quality of runoff water.

APPLICABILITY

Where roads are needed to provide access from a county, state or federal highway or to provide planned travelways within an area.

PLANNING CRITERIA

1. **Location**: Roads should be located to serve the purpose intended and to facilitate the control and disposal of surface water.

2. **Gradient, Vertical and Horizontal Alignment**: The gradient and alignment should be adapted to the development of which it is a part.

3. **Width**: The recommended minimum width of the road bed is 14 feet for one-way traffic and 20 feet for two-way traffic. The tread width for two-way traffic should be increased approximately five feet for trailer traffic. The recommended minimum shoulder width is two feet on each side of the tread width. Widths less than recommended minimums may be used where topography or other natural conditions restrict the width.

4. **Side Slopes**: All cuts and fills should have side slopes that are stable for the soil or soil material involved. Typically side slopes should not be steeper than 2:1 (50% slope).

5. **Drainage**: Culverts, bridges, or grade dips should be provided at all natural drainageways. **Design of these structures should be conducted by a qualified engineer in keeping with sound engineering practices for the class of vehicle or equipment used on the road.**

Roadside ditches should be adequate to provide surface drainage for the roadway and deep enough to serve as outlets for subsurface drainage.

6. **Erosion Control Measures**: Erosion control measures should be provided for road ditches, cut slopes, fill slopes, and cross drains.

7. **Surfacing**: Access roads should be given a wearing course or surface treatment when required for traffic needs, climate, erosion control, or dust control. The type of treatment will depend on local conditions, available materials and the existing road base. Where these factors and the volume of traffic are not a problem, no special treatment of the surface is required. **Sound engineering practices must be followed to insure that the road will meet the requirements for its intended use**.

8. **Intersection with Public Highways**: Traffic safety should be a prime factor in selecting the angle of intersection with public highways. Any access roads that connect to a state highway must be approved by the State Highway Department.

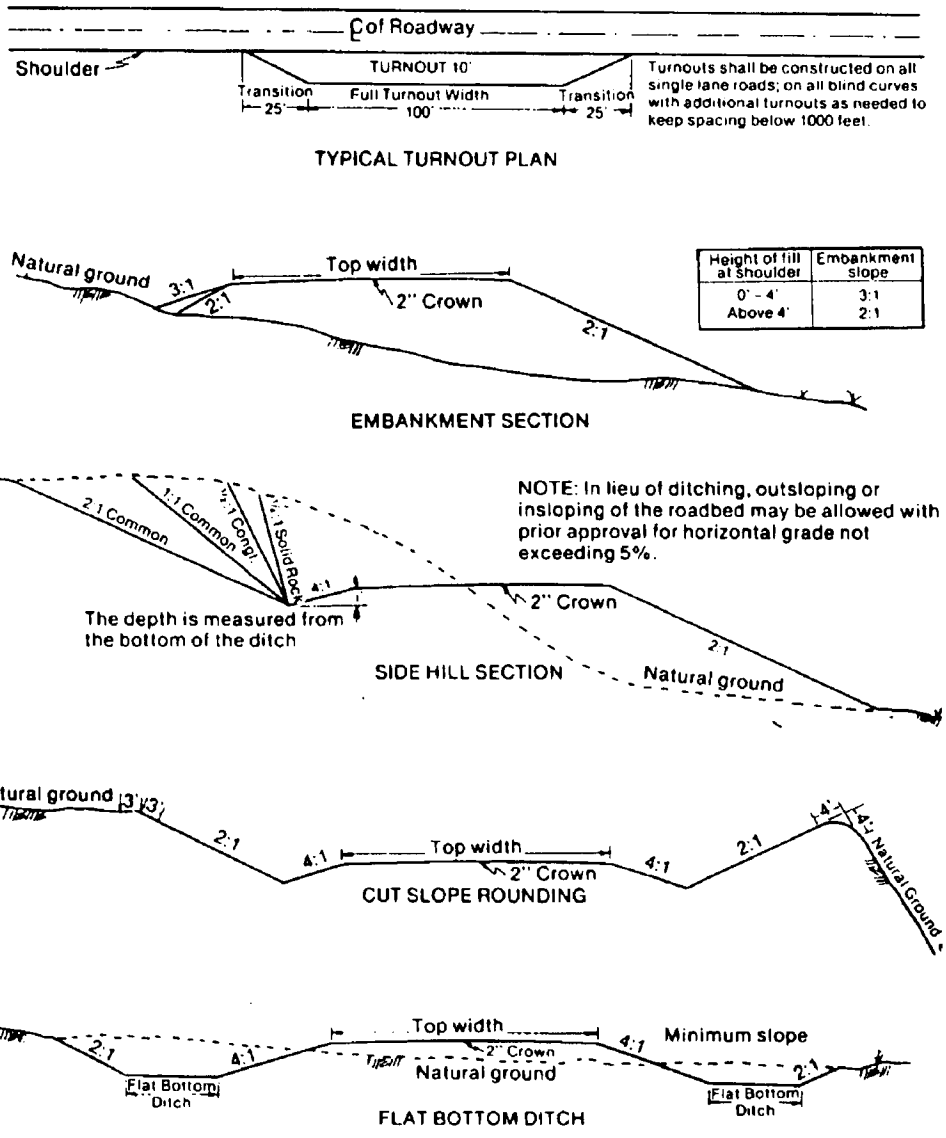
MAINTENANCE

Roadways, drainage structures and erosion control facilities must be maintained on an as needed basis given the site specifics of the access road to keep them operational. Proper and regular maintenance will minimize soil erosion and the degradation of surface and ground water resources.

EFFECTIVENESS

Proper installation and maintenance of access roads can be effective in reducing soil erosion and minimizing impacts to water quality.

TYPICAL ACCESS ROAD CROSSECTIONS
FIGURE 1-1



BMP 1-4
DUST CONTROL

DEFINITION

The control of windblown soil or other materials to reduce dust.

PURPOSE

To prevent excess movement of soil or other materials by wind, to reduce on-site and off-site damage, and to reduce health and traffic hazards.

APPLICABILITY

This practice applies to open areas subject to wind erosion, including cropland, hay and pastureland, construction sites, surface disturbance areas such as mine sites, waste dumps and mill tailings, livestock concentration areas and similar sites.

PLANNING CRITERIA

1. In construction, mining and land development work, plan and schedule work to open the least amount of land possible at one time. Surface disturbances should be stabilized or reclaimed before additional land is disturbed.

2. Plan and install temporary erosion control measures during construction, mining or development operations.

3. Install permanent erosion control measures as soon as construction, mining or development work is completed.

4. For new agricultural lands, or surface disturbances the irrigation water supply should be developed before land is opened so that water is available for establishing crops or cover crops.

5. When possible, schedule farming, construction, mining and development operations during months with the least wind erosion hazard. This is usually during late summer through fall.

METHODS AND MATERIALS

1. Stone and gravel mulches can be used for stabilization of surface disturbances.

2. Irrigation - Irrigate as needed to keep the surface moist but not saturated for temporary control of dust.

3. Vegetative Cover - Establish cover using native and adapted plant species.

4. Barriers - Establish temporary and permanent barriers as nearly as possible at right angles to the prevailing winds. The barrier(s) should be located upwind of the site in the best location(s) to retard the majority of the prevailing winds. Depending upon the specifics of the site and wind behavior the number and height of wind barriers should be considered. Board fences, snow fences, burlap, plastic netting, bales of hay or straw or earth ridges can be used for barriers. Use hedges of tall grasses, or shrubs; or tree and shrub windbreaks for barriers (See BMP-3-5 Windbreaks).

5. Emergency Tillage - Tillage to roughen the soil surface can be used for temporary control. Tillage should be at right angle to prevailing winds and performed to leave a ridged, cloddy surface.

MAINTENANCE

Regular maintenance is critical to effective dust control, whether temporary or permanent measures are being utilized. Regular water applications are necessary given specific site conditions. Mulches should be replaced or reapplied as necessary. Vegetative cover should be established and maintained on surface disturbance areas. Keep windbreaks and barriers in good condition by repairing or replanting any openings. Protect sensitive areas from additional surface disturbance.

EFFECTIVENESS

Dust control will reduce sediment delivery by runoff waters, control degradation of water in nearby streams and lakes from windblown sediments and minimize the loss of topsoil.

BMP 1-5
TOPSOIL MANAGEMENT

DEFINITION

The salvaging, stockpiling and reapplication of topsoil or other selected materials to be used as growth medium in the reclamation of surface disturbances.

PURPOSE

To re-establish the stability and productivity of lands subject to surface disturbances through proper soils management.

APPLICABILITY

Proper topsoil or soils management is critical to successfully reclaiming surface disturbances resulting from agricultural, mining, construction or development activities. Surface disturbances of all sizes require that available topsoil or selected replacement material, which will be utilized for growth medium, be managed in a proper manner.

PLANNING CRITERIA

The following elements should be considered when developing a topsoil management plan for a specific project.

1. The amount and quality of existing topsoil or growth medium.

2. The amount of surface disturbance (area), which will receive topsoil or growth medium and the required depth of application.

3. Methodology to be utilized for topsoil or growth medium salvage.

4. Storage location, the duration of storage of salvaged soils and the protection of stockpiled soils to prevent erosion.

5. The feasibility of direct replacement of the salvaged soils.

6. Availability of additional growth media to supplement topsoil replacement.

METHODS AND MATERIALS

1. **Conduct a site specific soil survey of the project area as a part of baseline investigations.** The soil survey will identify the soils suitable for salvaging, their depth and amount prior to disturbance.

2. All suitable topsoil and suitable material to be utilized in reclamation of the surface disturbance should be salvaged wherever feasible and stockpiled for reapplication.

3. If conditions permit, or if project schedules can accommodate, topsoil or growth medium should be applied directly to recontoured disturbance areas.

4. Stockpiled soils should be properly stored and revegetated to protect from erosion. Long term storage of soils may result in the loss of vital organisms within the soil, thus jeopardizing revegetation or landscaping success.

5. Soil replacement depths are determined by several factors including: pre-disturbance soil depths, vegetation types and the physical and chemical properties of the material being covered. Generally speaking, the poorer the physical and chemical properties of the spoil or waste material the greater the required depth of replacement soil. Soil testing, (nutrients, pH and toxicity factors), of the replacement soils and the materials to be covered should be completed prior to reapplication.

MAINTENANCE

Topsoil stockpiles require periodic maintenance to prevent erosion. Based upon the anticipated length of time the soils will be stockpiled, the piles should be covered with plastic or another substrate to protect from wind, rain and erosion. If storage will be for a long period of time, the stockpiles should be seeded with either annual or perennial grasses. This will stabilize the stockpiles surface. Other mechanisms may include covering stockpiles with plastic or canvas tarps or rock mulches.

EFFECTIVENESS

Proper topsoil management will result in successful revegetation of surface disturbances, reduce soil erosion, and initiate the restoration of the surface disturbance areas stability and productivity.

CHAPTER 2

EROSION & SEDIMENT CONTROL STRUCTURES

STRUCTURES
BMP 2-1 EROSION & SEDIMENT CONTROL STRUCTURES

DIVERSIONS
BMP 2-2 RUNOFF INTERCEPTOR TRENCH OR SWALE
BMP 2-3 DIVERSION DIKE
BMP 2-4 DIVERSION DAM
BMP 2-5 LEVEL SPREADER

SEDIMENT RETENTION
BMP 2-6 SILTATION OR FILTER BERMS
BMP 2-7 FILTER OR SILT FENCE
BMP 2-8 FILTER STRIPS
BMP 2-9 SEDIMENT BARRIERS
BMP 2-10 SEDIMENT BASINS

CONVEYANCE
BMP 2-11 GRASSED WATERWAYS & OUTLETS
BMP 2-12 ROCK LINED DITCH OR SWALE
BMP 2-13 WATERSPREADING
BMP 2-14 PERMANENT WATERWAY

STRUCTURES

BMP 2-1
EROSION AND SEDIMENT CONTROL STRUCTURES

DEFINITION

Erosion and sediment control structures encompass a host of specific structures that are designed to control a variety of surface drainage, erosion and sediment problems.

PURPOSE

Erosion and Sediment Control Structures protect the watershed and natural resources in a number of ways, for example:

* By preventing the formation of, or the advancement of rills and gullies;
* Reducing the flow velocity in watercourses or providing structures capable of with-standing high flow velocity;
* Stabilizing the grade and controlling head cutting in natural or artificial channels;
* Conveying water from one elevation to another;
* Diverting water away from unstable slopes; and
* By filtering and retaining sediment.

APPLICABILITY

These practices are applicable on sites where:

1. Flow velocity is such that structures are required.
2. Excessive grade or overfill conditions occur.
3. Water needs to be moved from higher to lower elevations.
4. Critical slopes have sheet erosion problems.
5. Vegetative cover is being established.
6. Concentrated runoff from unstabilized areas can be diverted onto stabilized areas.
7. There is a sedimentation or an erosion problem.

METHODS AND MATERIALS

Erosion and Sediment Control Structures include the following:

1. Chute Spillway
2. Flume
3. Pipe Drop
4. Straight Drop Spillway
5. Drop Inlet Spillway
6. Box Inlet Spillway
7. Check Dam
8. Waterbreaks or Waterbars
9. Retaining Walls

The location, design and installation of erosion and sediment control structures should be based on site requirements using qualified engineering assistance.

Material selection for construction should be made with consideration for economic feasibility, durability, and aesthetic values.

See Appendix A - Erosion and Sediment Controls for sample illustrations.

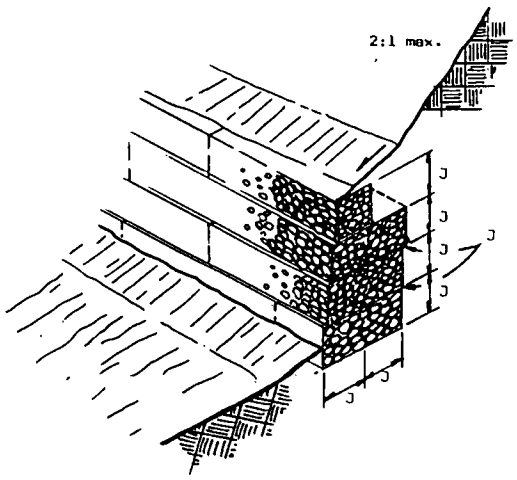
MAINTENANCE

Erosion and sediment control structures require regular inspection, maintenance and repairs given the specifics of the project site. During periods of runoff (i.e. spring snow melt, etc.) and precipitation events (i.e. snow, rain, thunderstorms, etc.), maintenance activities may require expansion. Erosion and sediment structures which are not properly maintained may not function and potentially risk failure, resulting in additional resource degradation.

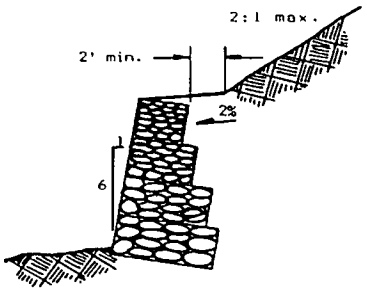
EFFECTIVENESS

Properly designed, installed and maintained, erosion and sediment control structures will effectively reduce the transport of sediments, minimize erosion and the degradation of water resources and reduce negative impacts to natural resources (i.e. vegetation, wildlife, etc.).

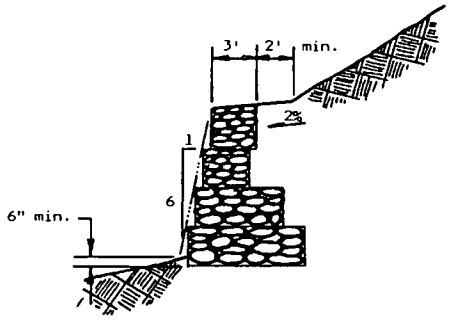
GABION RETAINING WALLS
FIGURE 2-1



3-DIMENSIONAL



SECTION



SECTION

GABION RETAINING WALLS

DIVERSIONS

BMP 2-2
RUNOFF INTERCEPTOR TRENCH OR SWALE

DEFINITION

A trench or swale designed and constructed along the contour of a slope to intercept surface runoff.

PURPOSE

To decrease the uninterrupted slope length, store and divert surface runoff from the slope face and to reduce the erosion potential from concentrated surface runoff.

APPLICABILITY

Used on slopes with comparatively gentle gradients (3:1 or less), but having long uninterrupted slope lengths; e.g., abandoned dirt roads, easements, and gently sloping cuts and fills.

PLANNING CRITERIA

1. Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways.

2. **Depending on the magnitude of the project and the expertise of the proponent, utilize a qualified engineer to design the size, capacity, length and location of the runoff interceptor trench or swale.**

3. Identify and include in the design adequate runoff conveyance and discharge areas to receive the surface runoff captured by the trench or swale.

METHODS AND MATERIALS

Construct the trench along the slope contour including a conveyance to outlet flow to a level spreader or other stabilized discharge. Excavated materials should be placed on the downslope side of the trench or swale and spread to conform with the natural slope. The trench or slope and the surrounding disturbance area should be stabilized and revegetated immediately after construction.

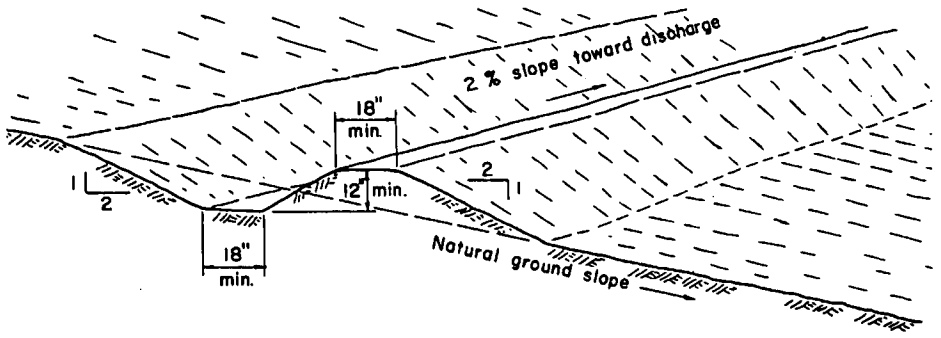
MAINTENANCE

Inspections should be conducted for damage after each major precipitation or runoff event. Repair damage immediately as required.

EFFECTIVENESS

Properly designed, installed and maintained a runoff interceptor trench or swale will effectively convey surface runoff, minimize soil erosion resulting from surface runoff and reduce the degradation of receiving water resources.

RUNOFF INTERCEPTOR TRENCH OR SWALE
FIGURE 2-2



ISOMETRIC SECTION
not to scale

BMP 2-3
DIVERSION DIKE

DEFINITION

A runoff interceptor designed and constructed at the top of a cut or fill slope to divert surface flow.

PURPOSE

To divert overland runoff flow away from slopes, reduce the potential for surface erosion and reduce uninterrupted slope length.

APPLICABILITY

All slopes, cut or fill, which may receive runoff from upslope areas.

PLANNING CRITERIA

Diversion dikes should be designed and constructed to intercept all runoff flow from above cut and fill slopes and upon benches on large slope faces to prevent collected runoff from flowing onto slope faces below.

1. Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways.

2. Diversion dikes should be engineered and designed such that diverted runoff does not overtop the dike.

3. The outlet of the diversion dike should be designed to dissipate energy via dense and durable vegetation, or artificially stabilized with rock, matting or other material. Runoff flow can also be conveyed to a downdrain, chute or flume for conveyance down slope.

4. Discharge - Discharge should be to an area, mechanically and/or vegetatively stabilized, or to an established drainage system.

5. **Depending on the magnitude of the project and the expertise of the proponent, utilize a qualified engineer to design the size, capacity, length and location of the diversion dike.**

METHODS AND MATERIALS

The diversion dike consists of a trench and a dike. The trench may be constructed using mechanized equipment or hand tools. The dike should be compacted as specified in the engineering design. The trench, dike and the surrounding disturbance area should be stabilized and revegetated immediately after construction.

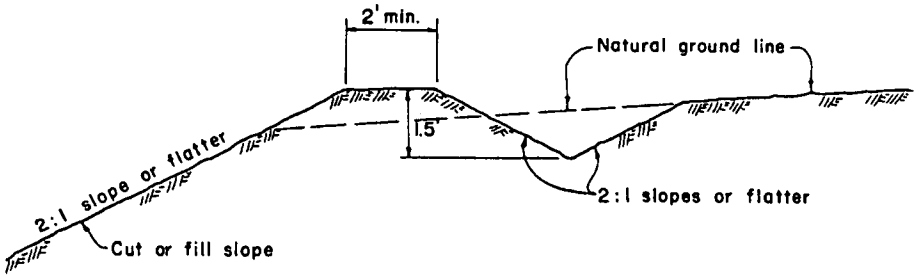
MAINTENANCE

Inspect after each major precipitation or storm event to identify any damaged areas. Repairs should be completed before the next storm. Any channel obstructions should be removed.

EFFECTIVENESS

Properly designed, installed and maintained a diversion dike will effectively reduce the transport of sediments, minimize erosion resulting from surface runoff and reduce the degradation of receiving water resources.

DIVERSION DIKE
FIGURE 2-3



SECTION
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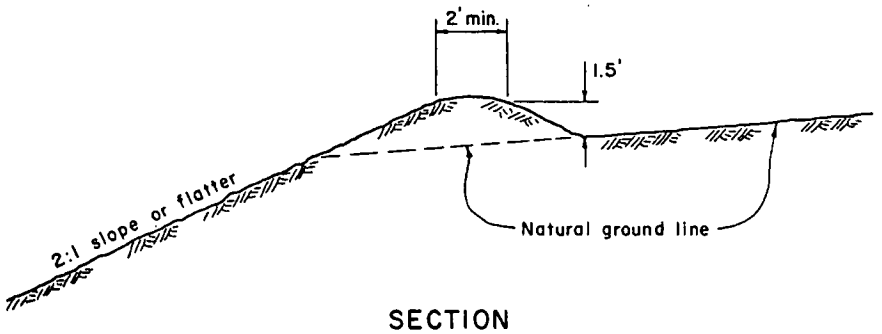


SECTION

Dike constructed by dozer moving soil upslope and dumping at top of slope.

BMP 2-4
DIVERSION DAM

DEFINITION

A structure built to divert part or all of the water from a waterway or stream into a different watercourse, an irrigation canal or ditch, or a waterspreading system.

PURPOSE

The purpose of a diversion dam is:

1. To divert part or all of the water from a waterway in such a manner that it can be controlled and applied to a beneficial use; or
2. To divert periodic damaging flows from a watercourse to another watercourse having characteristics which reduce the damage potential of the flows and thus protect the watershed.

APPLICABILITY

This BMP includes structures of a permanent nature, constructed of materials having an expected life span consistent with the purpose for which the structure is designed. It does not include Floodwater Diversion, Floodwater Retarding Structure or Erosion and Sediment Control Structures. The BMP applies:

1. Where a diversion dam is needed as a integral part of an irrigation system or for a water spreading system which has been designed to facilitate the conservation of soil and water resources.

2. Where it is desirable to divert water from an unstable watercourse to a stable watercourse.

3. Where the water supply available is adequate for the purpose for which it is to be diverted.

4. Where the construction of a dam and the diversion of water are permitted by applicable federal, state, and local statutes and regulations.

PLANNING CRITERIA

1. Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways. Baseline soils data should be gathered and analyzed for stability and erodability.

2. Materials - All materials to be used in construction of the diversion dam and appurtenances should have the strength, durability and workability required to meet the installation and service conditions at the site.

3. Outlet works - Where partial diversions are required, the outlet works should provide for positive control of both maximum and minimum diversions consistent with the purpose for which the diversions are made. Where all the flow is to be diverted, the outlet works should provide for safe diversion of all expected flows based on site conditions.

4. By-pass works - The by-pass works should be capable of passing all flows needed to satisfy downstream priorities and all flows in excess of diversion requirements. This may require a combination of orifices, and gates designed to meet the requirements of the site.

5. Special purpose works - Where debris or sediments are present under flow conditions subject to diversion, provision should be made to bypass or remove those materials which may be detrimental to the functioning of the outlet works, to other portions of the works, or areas to which diversion is made. This may involve the use of settling basins, debris traps, trash guards of sluiceways depending on the site conditions.

6. Federal, State, & Local Laws - Laws concerning water use must be complied with.

7. **Depending on the magnitude of the project and the expertise of the proponent, utilize a qualified engineer to design the size, capacity, length and location of the diversion dam.**

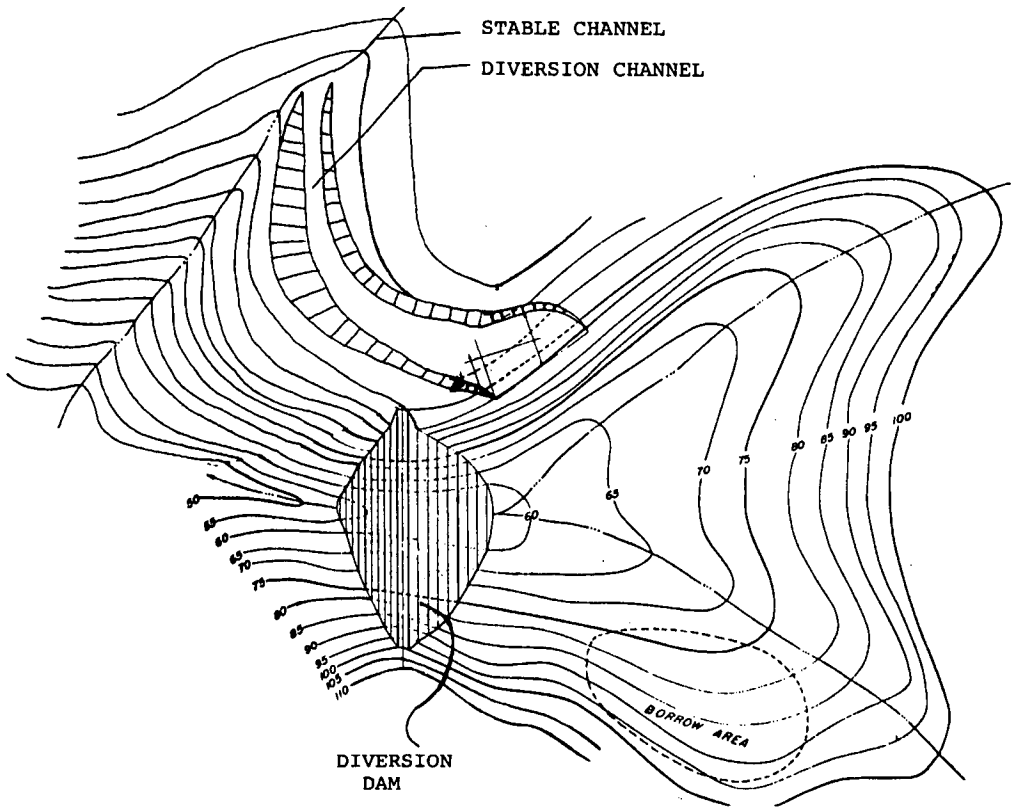
MAINTENANCE

A regular inspection schedule is necessary to insure that the structure has not developed any faults and that sediments or debris are not interfering with its functioning. Inspections should also occur after precipitation or runoff events and identified repairs made before the next storm event.

EFFECTIVENESS

Use of diversion dams are effective in diverting surface water flow when properly designed, installed, operated and maintained.

DIVERSION DAM
FIGURE 2-4



BMP 2-5
LEVEL SPREADER

DEFINITION

An outlet constructed at zero grade across a slope to disperse concentrated runoff.

PURPOSE

To convert concentrated flow into sheet flow for surface application at non-erosive velocities onto stabilized areas.

APPLICABILITY

Used at locations where concentrated runoff from unstabilized areas can be diverted onto stabilized areas under sheet flow conditions; e.g., at diversion dike or runoff interception trench outlets.

PLANNING CRITERIA

Detailed design is not required, but extreme care must be used during construction to ensure that the outlet lip is exactly level and uniform from end to end. Failure to meet these requirements will cause concentrated flow and consequent erosion of the stabilized area. The excavation for the spreader should be on well stabilized soils (vegetated or rock armored).

1. Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways. Baseline soils data should be gathered and analyzed for erodability.

2. Level spreaders should not be located on slopes steeper than 3:1.

3. General criteria include:

    a. Material - Must be constructed in undisturbed soil and must outlet into a stabilized area.
    b. Inflow - Runoff to the spreader should be from areas which have been stabilized to eliminate sediment buildup in the spreader.
    c. Discharge - When discharge is to a slope steeper than 3:1 or the soil is highly erodible, the length of the spreader should be increased.

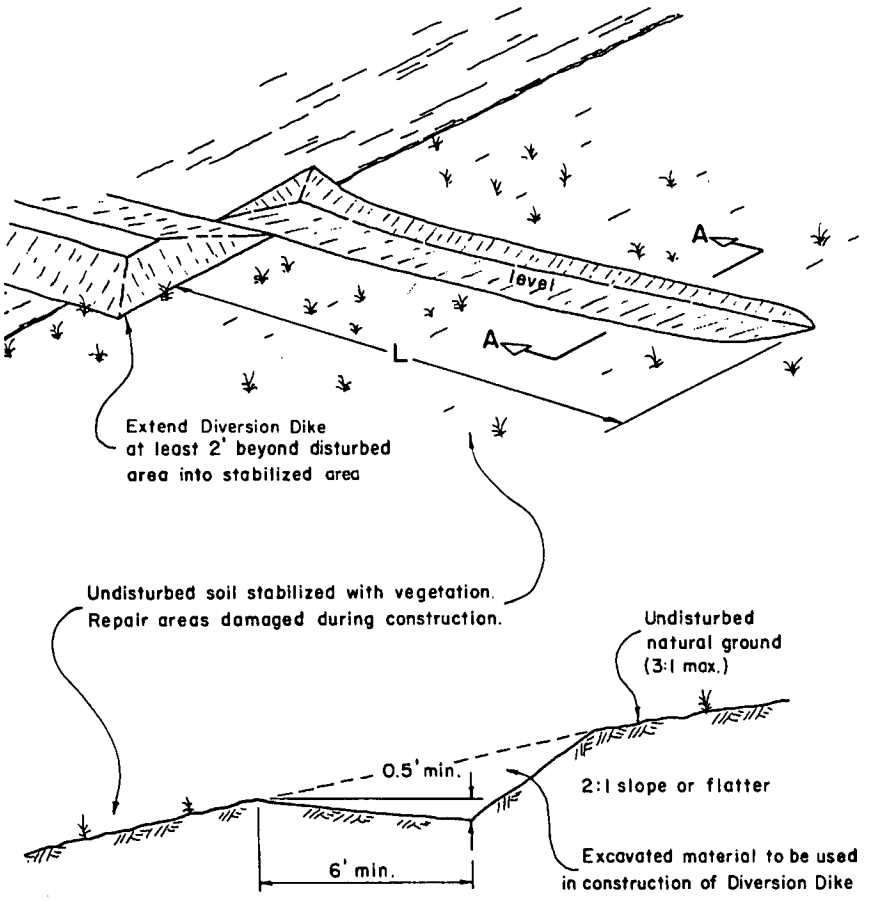
MAINTENANCE

Inspect for damage after each precipitation or storm event and repair as required before the next storm event. Remove sediment as necessary, given the specifics of the site.

EFFECTIVENESS

Level Spreaders are effective for surface runoff dispersion if they are designed, constructed and maintained properly. Maintenance is critical to the effectiveness of the spreader.

LEVEL SPREADER
FIGURE 2-5



SECTION A-A
no scale

LEVEL SPREADER

SEDIMENT RETENTION

BMP 2-6
SILTATION OR FILTER BERMS

DEFINITION

Siltation or filter berms are utilized in conjunction as temporary barriers and filters constructed across access roads or highways, and around or within development, mining and construction sites.

PURPOSE

To capture and retain runoff from construction sites or roadways, to allow sediments to settle out, and to direct runoff water through filter berms at outlets to stabilized drainage ways.

APPLICABILITY

The siltation or filter berms are applicable to relatively flat construction sites and should be installed on the downslope sides of the disturbed areas.

PLANNING CRITERIA

Impervious siltation berms are used to capture and retain runoff from construction sites. The berms should be sized to contain the runoff water from a design storm per applicable regulations. The sediments in the runoff water are allowed to settle out and the water is directed through permeable filter berms located at points leading to stable drainage ways.

METHODS AND MATERIALS

To construct a siltation berm a ridge of gravel or crush rock (.75- to 1.5-inches) should be mounded along the contour of the slope at the downhill side of the construction site. The height of the ridge should be sufficient to contain the specified volume of runoff. The height of the ridge should be at least 1 1/2 feet. The side slopes of the ridge should not exceed 2:1. Plastic sheeting (six mil thick) is placed over the berm. The sheeting width should be wide enough to cover the berm and allow at least one foot of additional sheeting on each side of the berm to allow anchoring. The sheeting is anchored by placing gravel or crushed rock on the edges to a depth of at least three inches and width of at least eight inches.

Filter berms should be constructed of well graded gravel or crushed rock (.75 to 3 inches). The material should be compacted to dimensions of up to: 1 1/2 to 2 feet in height, top width of three to five feet with side slopes of 3:1 slope. Filter fabrics are available which can be incorporated into the top layer of the berm and are very effective, particularly on sites which slope.

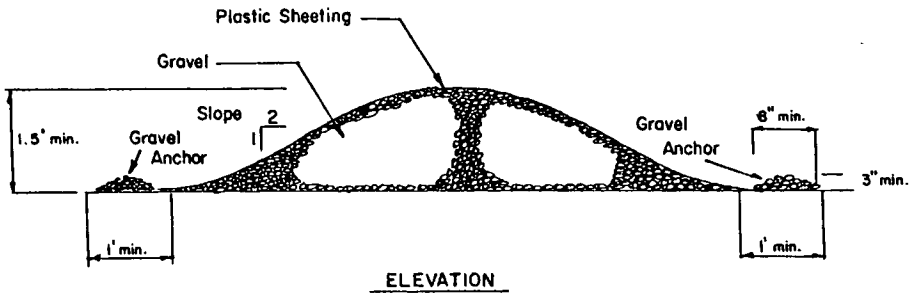
MAINTENANCE

Siltation and filter berms should be inspected periodically, especially after each precipitation or storm event, and maintained to keep functional. The plastic sheeting should be replaced as necessary in order to retain runoff water and sediments on-site. Sediments must be removed regularly, given the specific of the site to maintain functionality.

EFFECTIVENESS

Siltation berms and filter berms can be effective if they are properly installed and maintained on relatively flat sites. Filter fences are more effective in most situations, except where runoff needs to be directed to certain discharge points.

SILTATION OR FILTER BERM
FIGURE 2-6



ELEVATION

BMP 2-7
FILTER OR SILT FENCE

DEFINITION

Filter or silt fences are a sediment barrier consisting of a pervious sheet of synthetic polymer filter fabric attached to wire mesh fencing and supported by fence posts.

PURPOSE

Filter or silt fences are constructed to intercept and capture sediment by decreasing the velocity of surface runoff.

APPLICABILITY

All development, mine, construction sites, areas of erosion, reclamation sites, etc. may utilize filter or silt fence to reduce sediment transport. These barriers are temporary in nature and are limited to slowing and filtering sediment associated with surface stormwater runoff, not concentrated, heavy flows.

PLANNING CRITERIA

Filter or silt fences are designed to intercept surface runoff on slopes of varying degree. Barriers should be constructed in series depending on the size of the contributing drainage area. A rule of thumb is approximately 100 feet of fence for every 0.25 acre of drainage area. Fences require regular maintenance to maintain functionability so access is necessary. Average usable life of filter or silt fences is six months to a year.

METHODS AND MATERIALS

Construction of filter or silt fences involves attaching filter fabric to wire mesh fencing and steel T-Bar fence posts. Depending upon the specifics of the site, fence posts should be placed on three to six foot centers. A trench is constructed along the base of the fence and approximately eight inches of the filter fabric is buried both vertically and horizontally to "toe in" the fabric. The wire mesh and the filter fabric are securely attached on the uphill side of the fence posts. The trench is then backfilled and soil is compacted against the filter fabric.

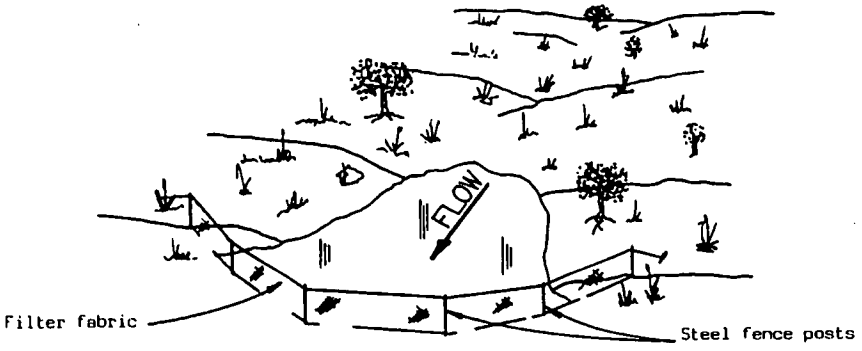
MAINTENANCE

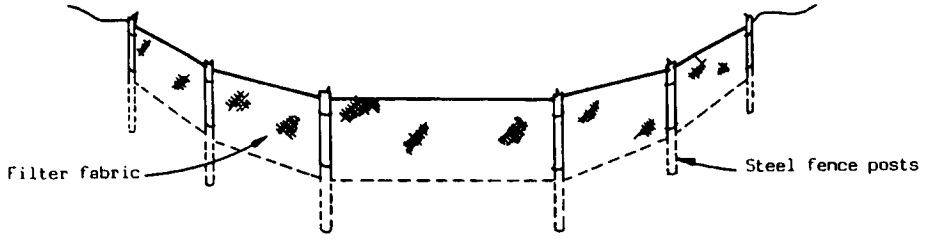
The filter or silt fence should be thoroughly inspected after each precipitation or storm event and immediately repaired. Sediment should be removed regularly to keep the barrier functional. Sediment should not be allowed to reach one-half the height of the fence. Excavated material must be disposed of properly, off site and never placed down slope.

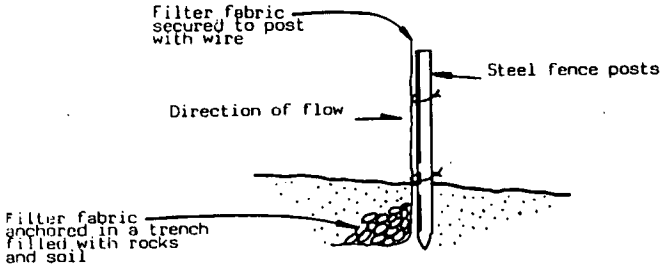
EFFECTIVENESS

The effectiveness of filter or silt fences is excellent if they are installed properly and maintained regularly. Fence barriers will last longer than straw bale lines due to their greater strength and durability.

SILT FENCE/FILTER FENCE
FIGURE 2-7







SECTION

SILT FENCE/FILTER FENCE

BMP 2-8
FILTER STRIPS

DEFINITION

Strips of close growing vegetation located to receive runoff from diffuse sources, waterways, drains and intermittent streams before the water enters a stream, drainage, pond or lake.

PURPOSE

To provide desilting areas to remove sediments from runoff waters before they enter streams, drainages, ponds or lakes.

APPLICABILITY

Applies to all land uses where topography, soils and moisture supplies are suitable for establishment of filter strips.

PLANNING CRITERIA

1. The runoff water should be spread as it enters the filter strip either by natural topography or by installation of level spreader ditches.

2. Use strips or areas of existing vegetation wherever possible.

3. Width of the filter strip should be adequate to allow settlement of the sediments. The width will vary depending on slope, type of vegetation and quantity of anticipated runoff water.

METHODS AND MATERIALS

1. In silviculture or rangeland brush management work, leave undisturbed strips of vegetation adjacent to streams, ponds and lakes.

2. On grazing lands, fence areas adjacent to streams, ponds and lakes where runoff waters enter.

3. Plant strips of adapted grasses, legumes, and other vegetation along the lower edge of cropland fields as filter strips for irrigation drainage runoff.

4. On constructed ponds and reservoirs, plant filter strips of adapted grasses and legumes at the upper end of the storage area wherever the topography is suited to the use of filter strips. Use species that tolerate inundation and deposition of sediment such as reed canary grass, creeping foxtail, beardless wildrye and common reedgrass. Protect filter strips from grazing during establishment.

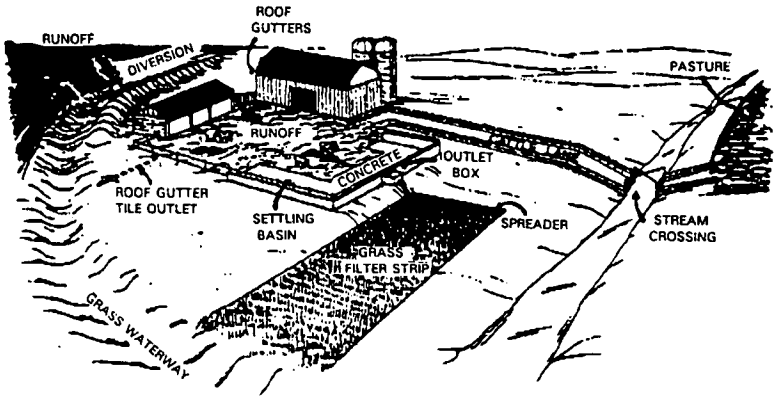
MAINTENANCE

Manage filter strips to maintain good vegetative cover. Protect filter strips from grazing or graze lightly after plants have matured seed. Where channels develop in the filter strips, install diversions to spread the water.

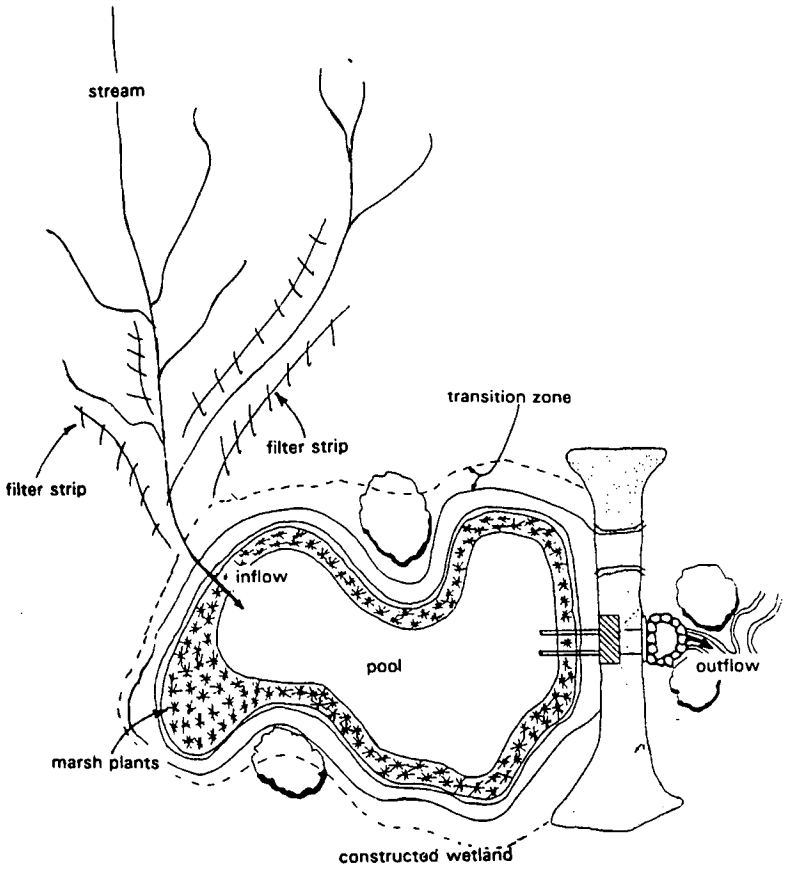
EFFECTIVENESS

Where installed and maintained properly, filter strips can significantly reduce sediment delivery into streams, ponds and lakes.

FILTER STRIPS
FIGURE 2-8



FILTER STRIPS B
FIGURE 2-9



BMP 2-9
SEDIMENT BARRIERS

DEFINITION

Barriers constructed to retain sediments.

PURPOSE

During periods of high runoff sediment barriers retain sediments by retarding flow and filtering.

APPLICABILITY

Usable in areas that have erosive soils and have a history of high sediment load during runoff. Sediment barriers are also applicable to development, mining, construction and reclamation sites.

PLANNING CRITERIA

Barriers are useful at storm drain inlets, across swales and ditches, drainages, as restraining dikes and berms, along property lines, and for other applications where the structure is of a temporary nature until permanent surface stabilization treatments are in place.

METHODS AND MATERIALS

1. Sandbag sediment barriers - berms to direct or divert runoff flows, or as barriers to collect and store runoff. The following information pertains to the installation of sandbag sediment barriers.

    a. Install so that flow under or between bags is prevented.
    b. The sandbags should be stacked in an interlocking fashion to provide additional strength for resisting the force of flowing water.
    c. Sandbags should not be stacked more than three high without broadening the foundation using additional sandbags, or providing addition stability.
    d. Sandbag sediment barriers should store the expected runoff.

2. Straw Bale Sediment Barriers - The following information applies to the installation of straw bale sediment barriers.

a. The service life of the barrier can be prolonged by using wire or nylon-tied bales rather than those tied with twine.
b. Bales should be laid on their sides and staked in place. At least two metal stakes should be driven through each bale and into the ground at least one foot. The first stake should be angled toward the previously placed bale and driven through both the first and second bale.
c. Piping is a major cause of failure. The possibility of piping failure should be reduced by setting the straw bales in a trench excavated to a depth of at least six inches and by firmly tamping soil along the upstream face of the barrier.
d. The functionality of straw bales can be increased by incorporating filter fabric or utilized with a filter or silt fence.

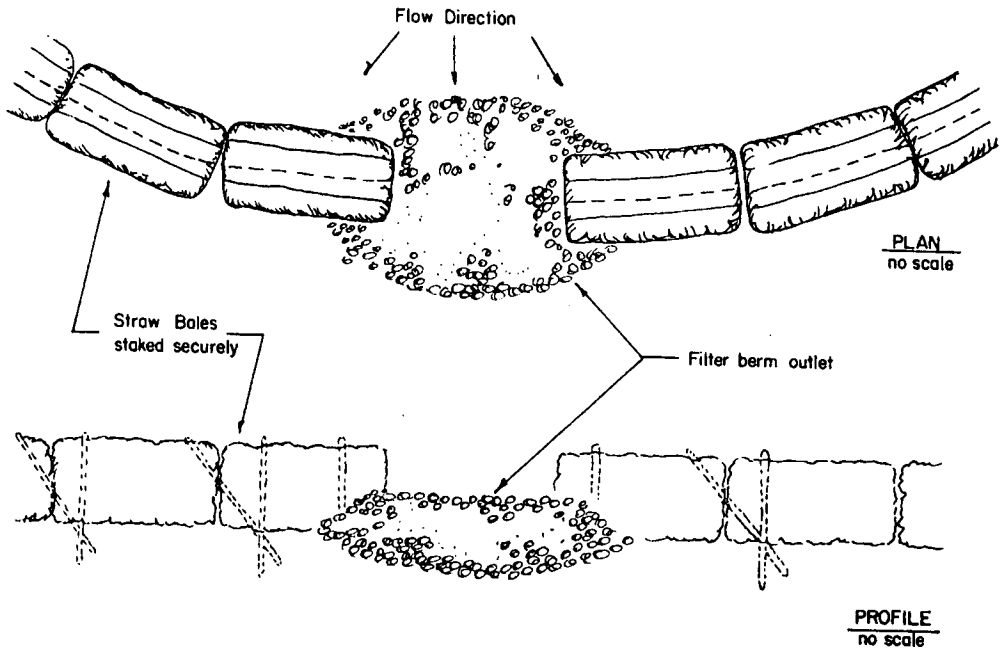
MAINTENANCE

Inspect sediment barriers after every precipitation or storm event and replace damaged bags or bales. Straw bales are often a target for vandals and frequent inspection is usually required. They should be replaced when rotten or disintegrating. Remove deposited sediment from structures after each precipitation or storm event and dispose of the sediment off site.

EFFECTIVENESS

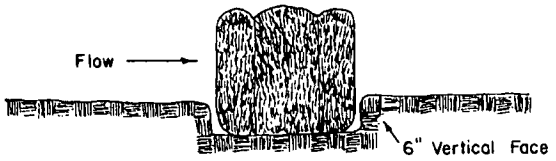
Sandbag or strawbale barriers are effective for temporary structures but require proper installation, regular maintenance and frequent repair.

STRAW BAIL SEDIMENT BARRIER
FIGURE 2-10

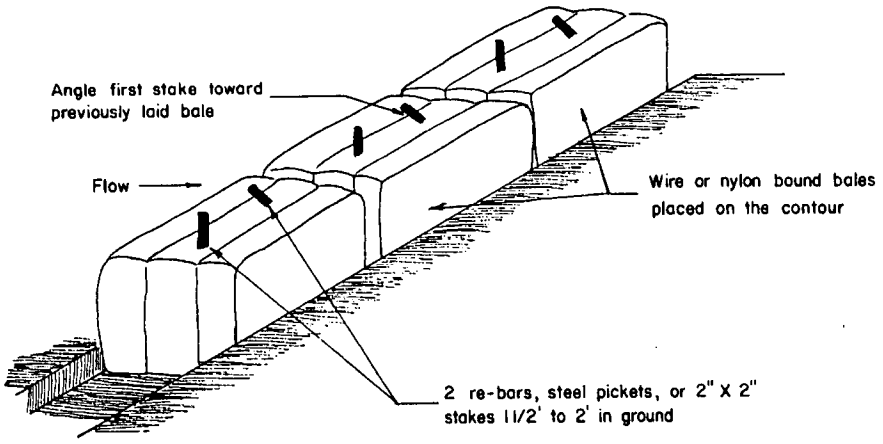


Semi-pervious barrier of straw bales with more pervious embankmen of sand and gravel for spillway

STRAW BAILS
FIGURE 2-11



EMBEDDING DETAIL



ANCHORING DETAIL

BMP 2-10
SEDIMENT BASINS

DEFINITION

A barrier or dam constructed across a waterway or other suitable location to form a silt or sediment basin.

PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways, and streams; to prevent undesirable deposition on bottom lands and developed areas; to trap sediment originating from mining operations, gravel pits and construction sites; and to reduce or abate water pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes, and other debris.

APPLICABILITY

This practice applies where the physical conditions, soils, topography and disturbance area require. Sediment basins may be utilized in conjunction with erosion control measures installed at the source of the sediment or where a sediment basin offers the most practical solution to the problem. Development, mine, construction and any surface disturbing activity may utilize sediment basins to control the transport of sediment.

PLANNING CRITERIA

A qualified engineer should be utilized to design the size, capacity, length and location of the sediment basin.

The capability of a sediment or debris basin should equal the volume of sediment expected to be trapped at the site during the planned useful life of the structure or the improvements it is designed to protect. Where it is determined that periodic removal of debris will be practicable, the capacity may be proportionately reduced.

The design of dams, spillways and drainage facilities should be in accordance with the standard engineering principles as appropriate for the class and kind of structure being considered. Less conservative requirements may be used for small, temporary basins that will be in place only during a short development or construction period and conditions so warrant.

In urban and built-up areas the means of draining and maintaining a dry pool between periods of use should be incorporated in the plans.

Safety measures to protect the public from the hazards of soft sediment and floodwater are to be established as conditions dictate. Installations must consider water rights and comply with State statutes and regulations.

METHODS AND MATERIALS

See Appendix A-2 for guidelines for sediment basins.

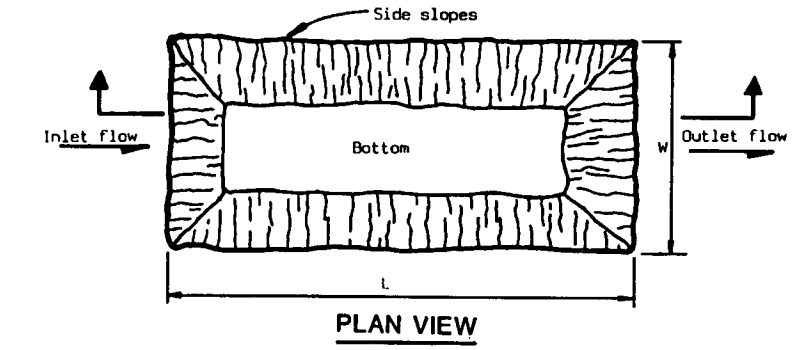
MAINTENANCE

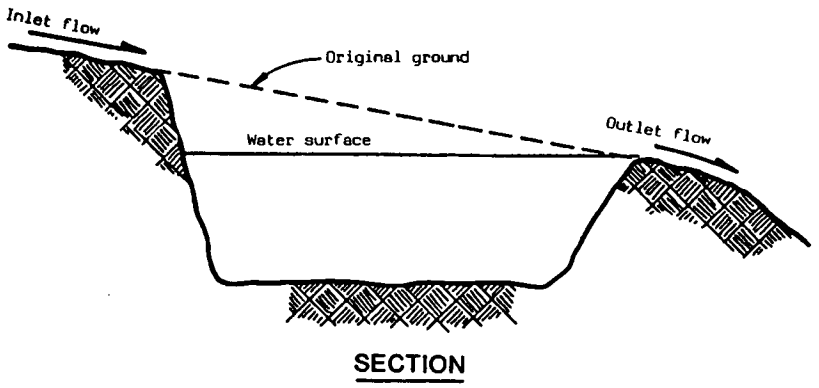
Sediment basins should be regularly cleaned to retain their storage capacity and to maintain their effectiveness. Maintenance requirements should be based upon the specifics of the site.

EFFECTIVENESS

Sediment basins are effective in reducing water pollution from silt, sand, gravels, and other debris. The proper design, construction and maintenance is critical to the effectiveness of the basin.

SEDIMENT TRAPS OR CATCH BASINS
FIGURE 2-12





SEDIMENT TRAPS OR CATCH BASINS

CONVEYANCE

BMP 2-11
GRASSED WATERWAYS AND OUTLETS

DEFINITION

A natural or constructed waterway or outlet with a vegetative cover of adapted grasses for safe disposal of runoff water without erosion.

PURPOSE

Grassed waterways are established to provide economical disposal channels for excess runoff waters for desilting and erosion control.

APPLICABILITY

This practice applies to all land uses where site specific conditions warrant and where soil and site conditions are suitable for establishing adequate grass cover. May be used for disposal of runoff water from diversions.

PLANNING CRITERIA

1. Grassed waterways and outlets must be installed in accordance with plans and designs specific for the site.

2. Moisture from natural precipitation or irrigation must be adequate to establish and maintain good grass cover.

3. Select grass species adapted to the area.

METHOD AND MATERIALS

1. Channels should be constructed with minimum side slope, 3:1 or flatter.

2. Fills and embankments must be firmly compacted.

3. The capacity of the waterway should be adequate.

4. Install grade control structures in waterways where grades are too steep for erosion control by vegetative cover alone.

5. It may be necessary to temporarily divert water from the area while grass cover is being established.

6. Protect grass seeding from erosion during establishment.

MAINTENANCE

1. Protect waterways from excessive grazing and vehicle use.

2. Keep waterway clear of debris, brush and excess growth.

3. Fertilize as needed to maintain grass stand and plant vigor.

4. Reseed any damaged or open areas in the grass cover.

EFFECTIVENESS

Properly designed, installed and maintained grassed waterways and outlets will effectively reduce sediment delivery from runoff waters.

BMP 2-12
ROCK LINED DITCH OR SWALE

DEFINITION

A rock lined ditch or swale is an excavated ditch or swale lined with rock.

PURPOSE

A rock lined ditch or swale conveys surface runoff from other erosion control structures to an off site drainage, stream, pond or lake. It can also be utilized between and in conjunction with other erosion control structures conveying runoff down slope.

APPLICABILITY

This type of conveyance can be utilized anywhere site conditions warrant. Typical application includes development, mine, and construction sites.

PLANNING CRITERIA

1. Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways.

2. **Depending on the magnitude of the project and the expertise of the proponent, utilize a qualified engineer to design the size, capacity, length and location of the rock lined ditch or swale.**

3. Identify and include in the design adequate erosion control and discharge areas to receive the surface runoff conveyed by the ditch or swale.

METHODS AND MATERIALS

Construct the rock lined ditch or swale along the slope contour per the site specifics of the project design including a stabilized discharge. Excavated materials should be placed on the downslope side of the ditch or swale and spread to conform with the natural slope. The ditch or swale is then lined with rock per design specifications. (NOTE: Angular rock is better than rounded rock due to it being more stable.) Depending on the design specifics, a fabric base is sometimes required to prevent under cutting of the rock. The fabric is layed into the ditch, anchored along the top edge, "toe in", then the rock placed on top. The rock should be applied thick enough to completely cover the ditch. The surrounding disturbance area should be stabilized and revegetated immediately after construction.

MAINTENANCE

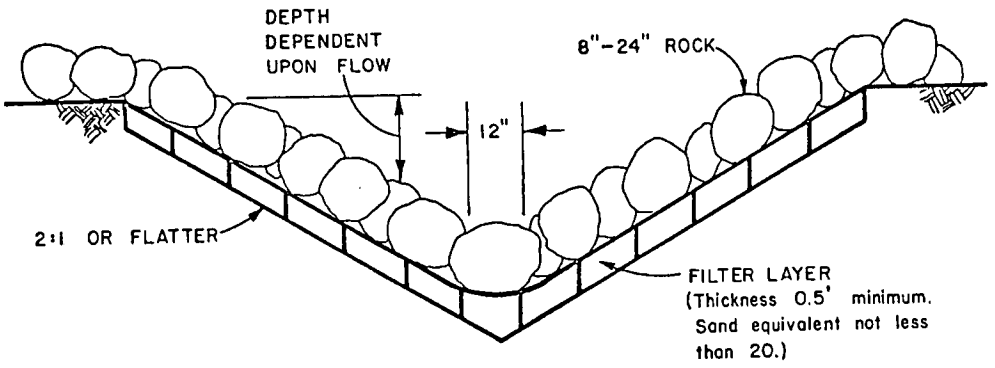
Inspections should be conducted for damage after each major precipitation or runoff event. Repair damage immediately as required.

EFFECTIVENESS

Properly designed, installed and maintained a rock lined ditch or swale will effectively convey surface runoff.

ROCK LINED CHANNEL
FIGURE 2-13

ROCK LINED CHANNEL



TYPICAL SECTION
no scale

BMP 2-13
WATERSPREADING

DEFINITION

Diverting runoff from natural channels or gullies by means of a system of dams, dikes, or ditches and spreading it over relatively flat areas.

PURPOSE

To provide extra moisture for improved cover and forage production on rangeland, pastureland, native hayland and reclamation projects and to disperse floodwaters to reduce sediment and damage to watershed areas.

APPLICABILITY

Applies to locations where climate, topography, soils and runoff conditions are suitable for installation and operation of a waterspreading system.

PLANNING CRITERIA

All applicable state laws or water rights must be complied with in design, layout, construction and operation of the system.

The topography of the spreading area should be relatively flat, smooth and free of gullies or channels that would tend to concentrate the spread waters. Soils should have a moderate to high water holding capacity. The combination of soils, slopes and plant cover should be such that spreading of floodwaters will not create erosion problems. Sites without adequate plant cover should be properly revegetated.

The diversions and conveyance systems should ordinarily be designed to operate automatically during runoff periods. Where runoff periods extend for a day or more, some manual controls may be used. The works must be capable of safely bypassing peak flood flows.

METHODS AND MATERIALS

Ditches, dike diversions and water control structures such as drops, checks and outlet gates are used as needed for installation of the system. Guidelines and specifications for these components are in other BMPs or in Appendix F-1 or F-2.

MAINTENANCE

Ditches, dikes and diversion works should be inspected after each precipitation or storm runoff period and repaired as needed. The entire system should be inspected prior to the runoff season and repaired as needed for proper function.

EFFECTIVENESS

Properly installed waterspreading systems will reduce sediment delivery by trapping sediments in the spreading area and are highly effective in improving vegetative cover and forage production.

BMP 2-14
PERMANENT WATERWAYS

DEFINITION

A permanent waterway is a man-made drainage channel designed, engineered and constructed to convey surface runoff.

PURPOSE

To convert sheet flow to channel flow, to convert pipe flow to channel flow, and to convey concentrated runoff water at non-erosive velocities to permanent storm drainage systems or natural streams without causing erosion.

APPLICABILITY

Applicable to all drainage systems which collect, concentrate, and convey surface runoff at the ground surface. Can be used to convey runoff both to and from permanent underground storm drainage systems. Permanent vegetated waterways can provide the entire stormwater conveyance system where space and steep slopes are not a problem.

PLANNING CRITERIA

Permanent waterways are man-made channels designed to convey surface runoff for many years. They are also referred to as drainageways. The term diversion is sometimes used to describe temporary drainageways installed during the construction period. Permanent waterways lined with concrete or asphalt are commonly referred to as paved swales while those lined with rock are called rock-lined ditches or riprap channels. Permanent waterways can be lined with grass. Grass-lined waterways offer several advantages over paved or rock structures, but they do require more space and are not suitable on steep slopes.

A qualified engineer should be utilized to design the size, capacity, length, location and construction of the permanent waterway. Permanent waterways must be designed in accordance with two primary criteria. First, the channel must have sufficient capacity to convey the peak flow from the design storm event. Second, the channel must be resistant to erosion at the design peak flow. Permanent waterways must always be lined or vegetated regardless of slope. Channel linings have several secondary functions that influence the choice of lining material. Permeable lining materials permit infiltration of water into the soil, and that encourages plant growth. On the other hand, impermeable materials prevent infiltration, and that would be desirable on unstable cut and fill slopes. A smooth lining increases flow velocities. A lining that slows velocity reduces peak flows by spreading the flow over a longer time period. Thus, the choice of lining material must be evaluated in terms of flow velocities, cost, aesthetics, slope, desirability of infiltration, and maintenance.

The permeable lining materials include grass and rock, used separately or together. Impermeable materials include grouted riprap, concrete, gunite, and asphalt. Grass lined waterways are the most aesthetically pleasing and probably do the best job of filtering sediments and nutrients. Sediment traps, if needed, can be incorporated into waterway design by installation of small check dams at regular intervals. These drop structures can trap sediment at locations where cleanout is possible and thus keep the riprap channel relatively clean.

METHODS AND MATERIALS

Permanent waterways must be designed and installed by qualified professionals. Small riprap channels can be installed as follows:

1. Size the channel to hold the peak flow for the design storm.

2. Place a layer of filter fabric in the channel and up to at least 0.5 feet above the designed waterline.

3. Place a layer of riprap on top of the filter fabric.

4. **The proper rock size must be determined by qualified professionals in order to provide surface protection from erosion during the peak design velocities**. The rocks must be large enough so that they are not moved during the peak flow.

MAINTENANCE

If properly installed in accordance with the design criteria, maintenance will not be a problem because design velocities should keep the waterways clean. However, waterways, especially rock-lined ditches, can fill up with sediment very rapidly if located adjacent to roadsides or in flat areas. The cleaning of riprap channels is labor intensive unless specialized vacuum equipment is available. Paved swales require little maintenance other than regular sweeping. Grass-lined ditches adjacent to roadways can be cut if vegetation gets too high.

EFFECTIVENESS

Permanent waterways are very effective in conveying storm water runoff if properly designed and installed as part of a drainage system. High maintenance costs can reduce the cost-effectiveness of riprap channels. Grass-lined ditches are the most effective in trapping sediment and nutrients and are the most aesthetically pleasing.

CHAPTER 3

SOIL STABILIZATION PRACTICES

VEGETATIVE

BMP 3-1 SEEDING PRACTICES
BMP 3-2 WATTLING
BMP 3-3 BRUSH LAYERING
BMP 3-4 BRUSH MATTING
BMP 3-5 WINDBREAKS

NON-VEGETATIVE

BMP 3-6 ROCK & GRAVEL MULCHES
BMP 3-7 WOOD CHIP, STRAW & BARK MULCHES
BMP 3-8 JUTE & SYNTHETIC NETTING

VEGETATIVE

BMP 3-1
SEEDING PRACTICES

DEFINITION

Seeding practices include a variety of techniques which result in the sowing or planting of seeds. Common practices include broadcast seeding (hand or mechanical), drill seeding, aerial seeding and hydroseeding.

PURPOSE

The primary purpose of seeding a site is for soil stabilization through the establishment of a vegetative cover. Related objectives include: to reduce raindrop impacts and surface water flow, to reduce erosion from wind and water and to enhance aesthetics and the natural environment.

APPLICABILITY

Seeding practices are applicable to any surface disturbance site requiring revegetation or reclamation. Slopes must be mechanically stabilized prior to seeding as vegetation alone will not stabilize a slope. Drilling seeding is typically limited to slopes of 3:1 or flatter, but it is the most successful practice. Hydroseeding is most effective in steep slope situations which have little or no access (e.g. road cut or fill slopes, mine waste dumps, etc). Broadcast seeding is less expensive but requires approximately twice the amount of seed over drill seeding. Aerial seedings are typically applied on large areas with no access, such as forest or rangeland fires.

PLANNING CRITERIA

The establishment of vegetation is the most efficient and cost effective form of erosion control and soil stabilization. Once established vegetation absorbs raindrop impact and prevents the mobilization of soil particles. Vegetation prevents erosion while other treatments such as filter fabric, sediment basins or filter strips only treat the sediment mobilization process.

Seeding practices should be selected based upon the specifics of the site and the expertise of a qualified professional should be consulted. Typically economics, site topography and/or access are controlling factors in the selection process. Seeding practices should also be tailored to the plant material seed being applied (i.e. grasses, forbs, shrubs). Tree species are typically planted from container stock after establishment of a grass/forb/shrub cover. Seeding practices are usually incorporated within a combined structural and vegetative approach to soil stabilization. Vegetation alone will not stabilize a slope. Other nonvegetative techniques are also utilized to enhance the success of a seeding such as mulches, netting, matting and chemical tacifiers.

Irrigation will assist in achieving a good seed/soil contact and is critical to plant establishment on dry sites. Over watering will cause washing and runoff, thus potentially transporting seed down gradient.

METHODS AND MATERIALS

Vegetation or reclamation specialists should be consulted regarding mulch application rates, plant species selection, seeding rates, etc. to ensure a successful project.

Broadcast seeding (hand or mechanical): Broadcast seeding can be accomplished by hand held seeders or a mechanically driven seeder typically mounted on a tractor or ATV vehicle. The seed mix is placed in a hopper, adjustments are made for the size of the seed and rate of application, and the seeder is operated by a hand crank or motor while walking or driving over the areas to be seeded. Broadcast seeding typically requires twice the amount of seed to cover the same given area as a drill seeder due to wind drift, wildlife consumption and lack of good soil to seed contact.

Drill seeding: Drill seeding requires the use of a Range drill or equivalent depending on the condition of the site. Drill seeders are pulled behind a tractor or bulldozer and actually place the seed to a pre-determined depth. The seed is then covered by the drill mechanism or a chain drag is utilized to cover the seed behind the drill. Drill seeding provides the best seed to soil contact and correspondingly the highest success rate.

Aerial seeding: Aerial seeding is conducted by helicopter or fixed wing aircraft and can cover large areas of inaccessible terrain. It is the most efficient method for large disturbance areas such as forest or rangeland fires. Germination success is usually low given wind drift, soil conditions, and poor seed to soil contact, but application timing can greatly improve success. If seeding can occur shortly after a wildland fire and before a soil crust is formed, success is greatly improved.

Hydroseeding: The wood fiber and water mixture are well agitated in a large tank and then blown through a hose and nossel by compressed air. The apparatus is typically truck or trailer mounted and has sufficient capacity to complete several acres at a time. Mulch application rates and/or seeding rates depend upon the site specifics of the project area and the project goals. Typically irrigation is necessary to successfully establish a vegetative cover with hydroseeding.

MAINTENANCE

Seeded areas require regular inspection and potentially reapplication if necessary. The treatment areas should be protected from foot or vehicle traffic until vegetation is well established. This may require fencing, barriers and signing.

EFFECTIVENESS

Selection of the appropriate seeding practice for a specific site coupled with proper plant material selection, application rates, application timing and maintenance will result in the most effective method of soil stabilization. Coupled with other revegetation techniques seeding and the resulting vegetation will provide long term soil stability.

BMP 3-2
WATTLING

DEFINITION

Wattling is a revegetation technique consisting of placing bundles of willow cuttings in shallow trenches, on the contour of either cut or fill slopes.

PURPOSE

To stabilize cut or fill slopes, to stabilize the soil surface, to reduce the velocity of surface runoff, to trap sediment, to increase infiltration, and to establish vegetation.

APPLICABILITY

Applicable to surface disturbances involving cut or fill slopes. Slope lengths can be interrupted by rows of wattling. Wattling is not applicable to excessively steep slopes. As a type of revegetation, wattling is applicable on moist sites or seeped areas.

PLANNING CRITERIA

Wattling is a valuable method to help achieve surface stability on a cut or fill slope which is near its angle of repose, but continues to erode due to surface runoff. Wattling bundles can vegetatively root and sprout and continue to stabilize slope surfaces as a revegetation planting. Rooting and sprouting will occur if adequate moisture is available at the time of placement and the first growing season. Temporary irrigation can be very effective during establishment. In addition to sprouting and revegetating the site, the placement of the wattling bundles along the contours can reduce slope lengths which can provide long, uninterrupted paths for surface runoff. The rows of wattling bundles act as small sediment traps and increases the amount of infiltration on site. Thus, wattling should not be prescribed as a treatment on cut banks with shallow soils. The increased infiltration will saturate the subsoil and may lead to soil slippage and landslides.

METHODS AND MATERIALS

The following steps for preparing and placing the wattling bundles are recommended:

1. Wattling bundles should be prepared from living branches of willow (Salix spp.) within or near the project area. Willow is the ideal material because it sprouts and roots easily, branches are long, straight, and flexible. Wattling material can be cut with lopping shears, chain saws, or power brush cutting saws.

2. Wattling bundles may vary in length, depending on the material available. Bundles 5 feet long are the easiest to work with. Bundles shall taper at the ends and shall be 1 to 1/2 feet longer than the average length of stems used to achieve this taper. The butts of individual stems shall not vary more than one half inch in diameter.

3. Stems shall be placed alternately (randomly) in each bundle so that approximately one-half of the butt ends are at each end of the bundle.

4. When compressed firmly and tied, each bundle shall be approximately eight inches in diameter.

5. Bundles shall be tied on not more than 15 inch centers with two wraps of binder twine or heavier tying material with a nonslipping knot.

6. Bundles shall be prepared in advance of placement and kept covered and wet. They may be prepared up to seven days in advance of placement.

7. Grade for the wattling trenches shall be staked with an Abney level, or similar device, and shall follow slope contours (horizontal).

8. Trenches shall be three feet vertical spacing (or such other spacing specified. Economics may dictate wider placement).

9. Bundles shall be laid in trenches dug to approximately one-half the diameter of the bundles, with ends of bundles overlapping at least 12 inches. The overlap shall be as long as necessary to permit staking as specified below.

10. Bundles shall be staked firmly in place with vertical stakes on the down-hill side of the wattling. Vertical stakes should be spaced not more than 18 inches on center and diagonal stakes through the bundles on not more than 20 inch centers (See Figure 3-1). Where bundle overlap occurs between previously set bottom or guide stakes, an additional bottom stake shall be used at the midpoint of the overlap. Bundle overlaps shall be "tied" with a diagonal stake through the ends of both bundles.

11. Stakes may be made of live wattling material greater than 1 1/2 inches in diameter or they may be construction stakes (1" x 2" x 24" or 1" x 2" x 36"). Reinforcing bar may be substituted only as specified below.

12. All stakes shall be driven to a firm hold and a minimum of 18 inches deep. Where soils are soft and 24 inch stakes are not solid (i.e. if they can be moved by hand), 36 inch stakes shall be used. Where soils are so compacted that 24 inch stakes cannot be driven 18 inches deep, 3/8 - 1/2 inch steel reinforcing bar shall be used for staking.

13. Work shall progress from the bottom of the cut or fill toward the top and each row shall be covered with soil and packed firmly behind and on the uphill side of the wattling by tamping or by walking on the wattling as the work progresses or by a combination of these methods.

14. The downhill "lip" of the wattling bundle shall be left exposed when staking and covering are completed. However, the preceding specification must be rigorously adhered to.

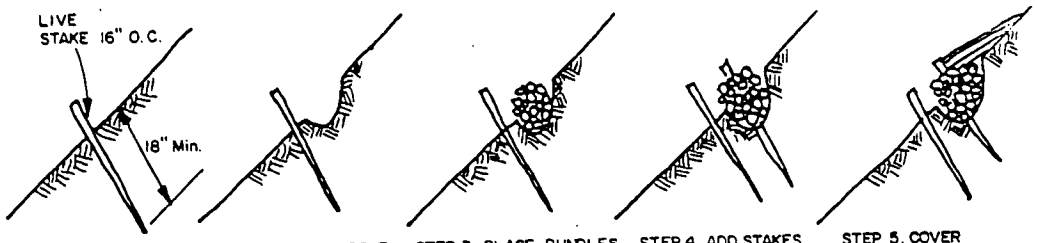
MAINTENANCE

Regular inspection and maintenance of wattling installations should be conducted, especially during the first year and after each precipitation or storm event. Any stakes or bundles which have worked out of the ground should be repaired immediately. Some areas of the slope may slough and lead to gully formation. Immediate repair of any failures is essential to prevent major problems from developing.

EFFECTIVENESS

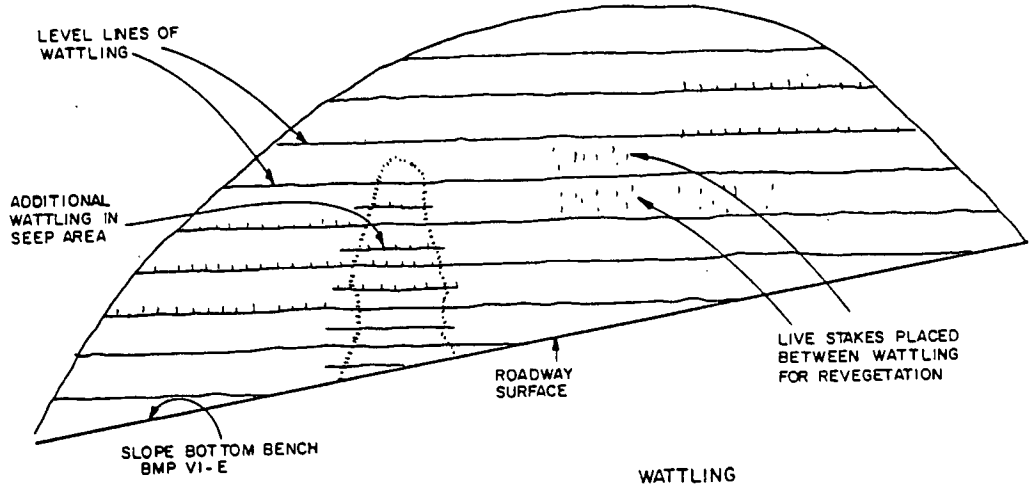
Wattling is very effective if properly installed according to the design criteria. The wattle bundles will sprout and root, binding the soil with roots and protecting the surface with the above-ground parts. Wattling is a labor intensive practice.

WATTLING
FIGURE 3-1



NOTE: 1. WORK FROM BOTT TO TOP OF CUT OR FILL
2. WALK ON BUNDLES TO COMPACT OVERLAY SOIL
3. STAKES SHOULD BE LIVE WATTLING MATERIAL
4. SPACING OF ROWS SHALL BE DETERMINED BY BMP IV-8

PREPARE WATTLING: CIGAR-SHAPED BUNDLES OF LIVE BRUSH WITH BUTTS ALTERNATING, 8-10" DIA., TIED 12-15" O.C. SPECIES WHICH ROOT ARE PREFERRED.



WATTLING

BMP 3-3
BRUSH LAYERING

DEFINITION

Brush layering consists of embedding tree branches of shrub or tree species, preferably those that will root, such as willows, on horizontal rows or contours in the face of a slope.

PURPOSE

To stabilize cut or fill slopes, to stabilize the soil surface, to reduce the velocity of surface runoff, to trap sediment, to increase infiltration, and to establish vegetation.

APPLICABILITY

Applicable to newly constructed cut or fill slopes or as a reclamation measure for seriously eroded and barren slopes. Slope lengths can be interrupted by rows of brush layering. The method is not applicable on very steep slopes. As a type of revegetation, brush layering is most applicable on moist sites or seeped areas.

PLANNING CRITERIA

Brush layering is a valuable method to achieve slope stabilization on cut or fill slopes or to reclaim seriously eroded or barren slopes. The method can be viewed as a combination of vegetative and mechanical means for slope stabilization. The brush layers can root and vegetatively stabilize the soil surface as a revegetation planting. The woody branches are also used as the soil stabilizing and reinforcing material. The placement of the brush layering along the contours can reduce slope. The rows of exposed branches act as small sediment traps and increase the amount of infiltration on site.

Brush layering has been used successfully in repairing partial fill slope failures. The slope angle may have to be decreased to the angle of repose, and the toe of the slope reconstructed with properly designed retaining structures.

METHODS AND MATERIALS

The following steps for brush layering are recommended:

1. Obtain willow cuttings from on-site or as close to the site as possible.

2. The brush branch (cutting) length should be three to five feet long.

3. The cuttings should be 3/4 to 2" in diameter.

4. The cuttings should be placed perpendicular to the slope and more or less randomly with some criss-crossing of stems.

5. The butt ends of the cuttings should angle down slightly into the slope.

6. The tips should be allowed to protrude beyond the face of the slope at least 1/4 the length of the cutting. For example, cuttings of four feet would have three feet buried and one foot exposed.

7. Vertical spacings between rows of brush layering are dictated by the erosion potential of the slope. In general, the spacings are closer at the bottom and increase up the slope. For example, spacings of four feet near the bottom could increase to eight feet at the top of the slope.

MAINTENANCE

Regular inspection and maintenance of brush layering installations should be conducted, especially during the first year and after any precipitation or storm event. Any slump areas need to be repaired immediately in order to prevent gully formation.

EFFECTIVENESS

Brush layering is very effective if properly installed according to the design criteria. The cuttings will sprout and root, binding the soils, filtering sediment from slope runoff, holding sediment on slope, and protecting the surface. Brush layering is usually more costly than wattling because of the larger amount of excavation, but is the better alternative on old fills or eroding slopes.

BMP 3-4
BRUSH MATTING

DEFINITION

Brush matting is a mulch of hardwood brush species, preferably those that will sprout and root, such as willows, and fastened down with stakes and wire.

PURPOSE

To provide bank protection along streams.

APPLICABILITY

Applicable as a stream bank protection measure. It is usually used in conjunction with other erosion control measures, such as bank reconstruction, rock riprap, and planting.

PLANNING CRITERIA

Brush matting can provide a certain amount of stream bank protection and erosion control. It is usually used in conjunction with other measures. Like brush layering, the method can be viewed as a combination of vegetative and mechanical means for bank stabilization. The brush mats can sprout and vegetatively stabilize the bank surface as a vegetation planting. The mats can also serve as reinforcing material to stabilize the banks.

Brush matting is usually installed above the low-water line. The toe of the bank may be riprapped and the mats placed above. The seasonal water will promote rooting and sprouting of the mats, whereas if the mats are submerged they will not usually sprout.

METHODS AND MATERIALS

The following steps for brush matting are recommended:

1. Obtain willow cuttings from on site or as close to the site as possible.

2. The cuttings should be at least one inch thick.

3. The brush mat should be placed over exposed banks as soon as any bank reconstruction or grading is completed.

4. If the design calls for planting, it is preferable to plant first and then place the brush mats.

5. The brush is laid shingle-fashion with the but-ends pointed upstream. The brush should be trimmed, if necessary, to lie flat on the bank forming a tight mat.

6. The brush mat should be 4 to 18 inches thick, depending on stream discharge and bed load.

7. The brush mat must be secured so that it will not float away. Stakes and/or netting may be necessary.

MAINTENANCE

Regular inspection and maintenance of brush matting installations should be conducted especially during the first year and after any precipitation events. Areas where scouring or undercutting have occurred must be repaired immediately. Any floating material must be removed in order to prevent downstream plugging.

EFFECTIVENESS

Brush matting can be very effective if properly installed according to the design criteria. The mats will sprout and root, binding the soil with roots, filtering sediment from the stream flow, and protecting the soil surface. Brush matting is labor intensive, but may be more cost effective than pure mechanical treatments.

BMP 3-5
WINDBREAKS

DEFINITION

Windbreaks are barriers used to reduce and redirect wind, typically consisting of trees and shrubs, but may also consist of perennial or annual crops, grasses, fences, or other structures.

PURPOSE

To reduce or redirect wind speed which results in a modification of the environmental conditions or microclimate in the sheltered zone.

APPLICABILITY

Windbreaks are applicable wherever a reduction or redirection of winds is desired. The resulting reductions in wind speed lead to microclimate changes which create desirable environments for growing crops, raising livestock, reducing snow drifting and protecting living and working areas. Windbreaks decrease wind speeds which reduces heating fuel costs in the winter and provide shade in summer reducing cooling costs.

PLANNING CRITERIA

The planning of an effective wind break involves the windbreak height, the density of the windbreak, orientation and the effective length. Windbreaks should be designed to meet the specifics of the site, the goals and proposed uses within the resulting protected area and associated planting and maintenance costs. While vegetative plantings, utilizing trees, shrubs and grasses provide additional benefits besides functioning as a windbreak, the specifics of the site may require a structural approach such as fences or walls. Vegetative plantings may be utilized in conjunction with structural approaches in an effective manner.

On the windward side of a windbreak, wind speed reductions are measurable upwind for a distance of 2 to 5 times the height of the windbreak. On the leeward side, wind speed reductions occur up to 30 times the height of the windbreak, downwind of the barrier. Windbreak density is the ratio of the solid portion of the barrier to the total area of the barrier. Wind flows through the open portions of a windbreak, thus the more solid a windbreak, the less wind passes through. By adjusting density different wind flow patterns and areas of protection are established (Table 3-1). A windbreak density of 40 to 60 percent provides the greatest downwind area of protection and provides excellent soil erosion control.

The number of rows, the distance between trees, and species composition are factors controlling windbreak density. Increasing the number of windbreak rows or decreasing the distance between trees increases density and provides a more solid barrier to the wind. Windbreaks with four or five rows are commonly used to protect farmsteads or livestock. Greater width may be necessary in northern climates for wildlife protection. For example eight row windbreaks have been utilized for wildlife protection in Minnesota and one to three row windbreaks are commonly use farther south in areas such as the Texas panhandle.

Windbreaks are most effective when oriented at right angles or perpendicular to prevailing winds. The purpose and design of each windbreak is unique, thus the orientation of individual windbreaks depends on the design objectives. Although the height of a windbreak determines the extent of the protected area downwind, the length of a windbreak determines the amount of total area receiving protection. For maximum efficiency, the uninterrupted length of a windbreak should exceed the height by at least 10:1. This ratio reduces the influence of end-turbulence on the total protected area.

Plant species selection is also important and proper selection will result in not only a functional windbreak but a more natural look and provide excellent wildlife habitat. A row of short shrubs on the outside windward side will trap snow and improve wind protection near the ground. Alternate trees, both large deciduous and conifers with taller shrubs in slightly staggered rows depending upon the density desired. Typically, conifers should occupy windward side with large deciduous in the middle and then tapering down with small deciduous to shrubs on the leeward side.

METHODS AND MATERIALS

A successful windbreak planting depends on proper establishment and care during the first few years after planting. Time spent in site preparation, weed control, and replanting is repaid many times during the lifetime of the windbreak. Each windbreak is unique and your windbreak should be designed for your site and objectives. Assistance in windbreak design and installation is available from the Nevada Division of Forestry, the USDA Soil Conservation Service and the University of Nevada Extension Service. The primary components of designing and installing a windbreak include the following.

1. The windbreak design should be customized to the actual site including buildings, roads, fields, ditches, and utilities.

2. Proper site preparation includes soil types and testing, existing vegetation, rodent control, erosion hazards and weed control.

3. Proper plant material selection includes suitability for the soils of the site, environmental extremes, available moisture and/or irrigation, disease and insect resistance, and purchasing of stock from a reliable source. **Professional expertise is recommended**.

4. Utilize proper planting techniques which meet the needs of the selected plant materials size and location.

5. Maintenance of a windbreak requires weed control, prevention of livestock and/or wildlife damage, insect and disease prevention, adequate irrigation and replanting.

MAINTENANCE

Regular inspection and maintenance should be conducted throughout the plant material establishment period, especially during the first few growing seasons. Irrigation systems and fencing should be well maintained. Replanting should be conducted as necessary.

EFFECTIVENESS

Windbreaks, when properly designed, installed and maintained are effective means for creating microclimates conducive to many human activities. Windbreaks will increase relative humidity, reduce evaporation and heat loss, increase energy efficiency, improve air quality and reduce soil erosion.

TABLE 3-1

OPEN WIND SPEED 20 MPH DECIDUOUS 25%-35% DENSITY

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	10	13	16	17	20
% of open wind speed	50%	65%	80%	85%	100%

OPEN WIND SPEED 20 MPH CONIFER 40%-60% DENSITY

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	6	10	12	15	19
% of open wind speed	30%	50%	60%	75%	95%

OPEN WIND SPEED 20 MPH MULTI ROW 60%-80% DENSITY

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	5	7	13	17	19
% of open wind speed	25%	35%	65%	85%	95%

OPEN WIND SPEED 20 MPH SOLID FENCE 100% DENSITY

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	5	14	18	19	20
% of open wind speed	25%	70%	90%	95%	100%

NON-VEGETATIVE

BMP 3-6
ROCK & GRAVEL MULCHES

DEFINITION

The application of gravel or crushed rock as a mulch.

PURPOSE

To stabilize soils during construction activities, for other temporary periods, and for permanent erosion control on a variety of surface disturbance areas.

APPLICABILITY

On construction sites, dirt roads, driveways, other areas of light vehicular activity, and surface disturbance areas. (See Mulch-Guide in Appendix C-1.)

PLANNING CRITERIA

Slopes steeper than thirty percent, (3:1), may require additional sediment and erosion control structures depending on the specifics of the site. Installation and maintenance of gravel or rock mulches require heavy equipment so access should be well planned.

METHODS AND MATERIALS

1. Gravel or rock of approximately 3/4 inch to 1 1/2 inch diameter may be used interchangeably. At least 50 percent of the material should be larger than 3/4 inch in diameter. Apply material in a uniform covering.

2. Application rates should be at least 100 tons per acre, with a minimum acceptable surface coverage of 90 percent. If the material used does not supply 90 percent coverage at 100 tons per acre, the application rate should be increased.

3. Upon completion of activities on the site, the gravel or stone mulch may be left in place during revegetation operations.

4. When used for driveways or dirt roads, a filter blanket should be placed under the gravel.

MAINTENANCE

After the gravel or rock is applied, construction or other traffic may move over it. Areas which become compacted or depressed should be remulched to the same level as the remaining area to prevent flows from becoming channelized into these depressions.

EFFECTIVENESS

Rock or gravel mulches retain their effectiveness indefinitely if properly applied, protected from compacting traffic and regular maintenance is conducted.

BMP 3-7
WOOD CHIP, STRAW & BARK MULCHES

DEFINITION

Wood chips, straw and bark mulches are used as mulch in landscape areas as ornamental decoration, soil stabilization and areas recently seeded.

PURPOSE

To protect the soil surface from raindrop and irrigation impact, to create a micro-environment, to increase infiltration, to conserve moisture around tree and shrub plantings, to prevent soil compaction or crusting, and to decrease runoff.

APPLICABILITY

Bark and wood chip mulches are applicable to any landscape area where trees and shrubs have been planted. Straw mulch is utilized in new seedings to create a micro-environment, protect the soil surface and improve seed germination.

PLANNING CRITERIA

Wood chips can be produced on-site by processing tree trunks, limbs, and branches in a wood chipper. Chips should range in size from 1/2 to 3-inches in length, 1/2 to 1-1/2-inches in width, and 1/3 to 1/2-inch in thickness. Chips produced from tree trimmings with significant quantities of leaves or small twigs are not effective as mulch. Straw mulches are widely used in revegetation projects. Straw must be anchored to the soil by one or more of the following methods to prevent wind blowing.

- Crimping, rolling, disking, or punching;
- Covering with netting; or
- Spraying with a chemical or tackifier.

The steeper the slope or in wind prone areas, the greater the need for anchoring the straw. Bark requires a large tree source for on site processing or it can be purchased in varying sizes. The larger sizes, greater than six inches, withstands wind and is not as likely to move.

METHODS AND MATERIALS

Wood or bark chips may be processed from any clean, green, soft wood. A permeable landscape cloth should be placed over the soil surface and the chips blown or spread by hand to a uniform thickness which fully covers the project area. Excess chips can be safely returned to the undisturbed forest floor to supplement existing organic cover. Chips should not be used on decomposed granite slopes over 30%.

Only clean wheat, barley, oat or rice straw should be utilized to prevent the spread of noxious weeds. Straw can be blown on or applied by hand to a uniform depth of approximately two inches or approximately two tons per acre. The straw must be anchored by an appropriate method immediately after application. Slopes steeper than 3:1 and areas adjacent to streams or drainages should be netted to prevent sliding of material and material entering the water course.

MAINTENANCE

Mulched areas must be regularly inspected for damage and remulched as necessary. Inspections and repairs should also be conducted after precipitation or storm events.

EFFECTIVENESS

Wood chip and bark mulches deteriorate slower than the wood fiber in hydromulches and, therefore, retain their effectiveness longer. Wood chips and bark are heavier than straw and less subject to removal by wind. Straw mulch is very effective if it is applied, anchored and maintained properly.

BMP 3-8
JUTE & SYNTHETIC NETTING

DEFINITION

Netting manufactured from a variety of materials typically comprised of squares, approximately one inch in size.

PURPOSE

The primary purpose of nettings is to anchor mulch in place on varying topography or in wind prone areas. Netting provides stability to surface disturbances and reduces the soil erosion potential.

APPLICABILITY

Netting is applicable to any situation that straw or wood chip mulch is utilized. Typical applications include: revegetation of surface disturbances, road cut and fill slopes, ski slopes, mine reclamation sites, etc.. Netting can be utilized in both temporary and permanent applications.

PLANNING CRITERIA

Jute netting is manufactured from heavy jute fiber yarn and woven into approximately one inch square netting. Synthetic netting are manufactured from a variety of plastics and nylon materials with varying strengths. The appropriate netting should be selected for the specifics of the project site. Nettings require anchoring to the slope with either wood stakes or "U"-shaped wire staples per the manufacturers specifications. Netting is quite versatile and can be used on steep slopes, can be seeded, fertilized and hydromulched through, it can stabilize bare soil and sand and can secure mulch or containerized plantings.

METHODS AND MATERIALS

1. Seed and/or mulch the disturbed area.

2. Starting above the mulched and/or seeded area, anchor the top end of the netting by burying it in a trench at least four inches deep by eight inches wide; backfill and compact the excavated material into this trench.

3. The netting should extend beyond the edge of the mulched or seeded area at least one foot on the sides, and three feet at the top and bottom. Fasten with a row of wire staples on one foot centers.

4. Roll the netting out, perpendicular with the slope and secure with staples on three foot centers. The "U"-shaped staples should be six inches to ten inches long, with a one inch crown. Longer staples should be used in loose or sandy soils.

5. Overlap netting at least one foot on the sides and secure with staples on one foot centers along the overlap.

6. Overlap the lower end of the uphill strip over the downhill strip at least one foot and secure with staples on one foot centers.

7. Continue adding strips of netting until the entire mulched area is covered and secured with staples.

8. The netting should be cut to fit around protruding rocks or other large objects, and tucked in around smaller rocks or objects to prevent "bridging".

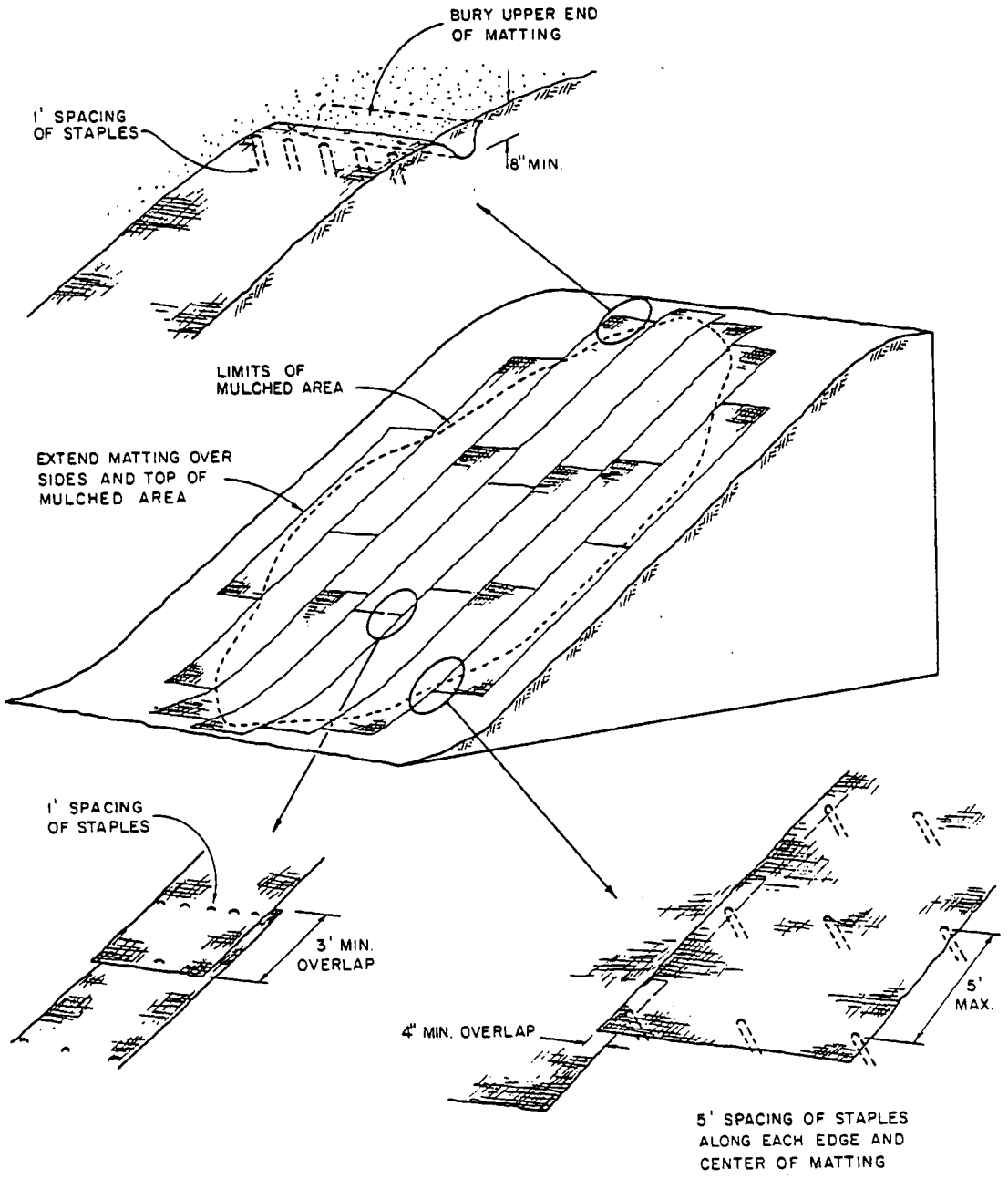
MAINTENANCE

If the netting is properly installed, little maintenance is required. The netted areas should be periodically inspected, particularly after precipitation and storm runoff events. Damaged netting should be repaired and restapled immediately.

EFFECTIVENESS

When installed and maintained properly, nettings are very effective in soil stabilization, revegetation and securing mulches.

JUTE MATTING
FIGURE 3-2



JUTE MATTING

BMP 3-9
SLASH MANAGEMENT

DEFINITION

The scattering of downed and dead tree limbs, shrubs and other woody materials for soil stabilization applications.

PURPOSE

To stabilize the soil surface of disturbed sites of less than 3:1 slope, to reduce the velocity of surface runoff, to trap sediment, to increase infiltration and moisture retention, and to improve seeded vegetation.

APPLICABILITY

Applicable to new surface disturbances where woody vegetation remains or is readily available. The method is not advised on slopes steeper than 3:1. Slash management can also be utilized in conjunction with other reclamation treatments for eroded or barren slopes.

PLANNING CRITERIA

Slash or woody plant materials can be utilized as an effective means of soil stabilization. The practice must consider the specifics of the site including slope, aspect, soils, elevation and precipitation. Generally the practice is most effective on flat grades to gentle slopes. Slash piles should be well scattered to minimize shading and increase effectiveness. Exposed branches will act as small sediment and moisture traps which will increase infiltration. Highly erodible soils and/or steep slopes may result in slash movement, thus compromising its effectiveness. The potential for wildland fire, given the amounts of slash, should also be considered.

METHODS AND MATERIALS

Based upon the specifics of the site, reclamation and/or revegetation treatments proposed and the amount of slash available determine a quantity to be applied. Slash should consist of woody plant materials, typically tree limbs and shrubs. Whole trees should be cut up into manageable pieces, approximately 3 to 5 feet long and no larger than 6 inches in diameter. Larger pieces should be removed from the treatment area.

Slash must be scattered evenly, avoiding excessive ground shading or piles. Slash should be kept out of stream or runoff channels. Butt ends of limbs should angle down slope and be scattered

randomly. Additional information regarding the utilization and disposal of slash associated with timber operations is contained in Appendix H, Forest Resource Management or by contacting the Nevada Division of Forestry.

MAINTENANCE

Regular inspection, monitoring and maintenance is critical to the success or failure of slash applications, particularly after precipitation or storm events. Identified damage or concerns should be addressed immediately and appropriate remedial measures taken as necessary.

EFFECTIVENESS

The use of slash has proven effective under specific natural resource management situations. When properly planned, designed, implemented and followed up, slash management is an effective soil stabilization tool which can, in some situations, reduce long term erosion and sediment transport and improve revegetation efforts.

CHAPTER 4

SLOPE STABILIZATION PRACTICES

BMP 4-1 SLOPE SHAPING
BMP 4-2 RETAINING STRUCTURES
BMP 4-3 ROCK RIPRAP

BMP 4-1
SLOPE SHAPING

DEFINITION

Slope shaping is comprised of designing and modifying cut or fill slopes to reduce the soil erosion and runoff potential. Slope shaping activities include: pre-disturbance planning and design, terraces, benches, serrations, and steps.

PURPOSE

The goals of slope shaping include: reducing steep and unstable slopes; reducing velocity and surface runoff; and increasing the distance of overland flow which results in increased infiltration and sediment collection. Additionally, slope shaping is required to create a stable environment for the establishment of plant species.

APPLICABILITY

Slope shaping activities are applicable to any cut of fill slope and should be considered up front in the planning and design phase of a surface disturbance project (i.e. development, mining, construction, etc.).

PLANNING CRITERIA

The design of slope shaping activities is typically done by qualified engineers during the design phase of a project. Slope shaping is utilized in conjunction with other sediment and erosion control structures or treatments. Slope stability and the stability of the soils or excavated materials is critical to the design of appropriate slope shaping activities. Contributing watershed, length of slope, stability, drainageways, etc. all must be considered in the design. Slopes greater than 3:1 typically required stair-stepping or terraces to create shorter, gentler slope lengths. Permanent establishment of vegetation slopes greater than 3:1 is difficult and requires comprehensive planning.

METHODS AND MATERIALS

A qualified engineer should be consulted for the design, location and construction of slope shaping treatments. The following discussion identifies the basics of slope shaping treatments.

Terraces reduce the slope length, allow for drainage, sediment control and create flat areas for vegetation establishment. Terraces are comprised of benches, steps and serrations. Benches generally refer to wide horizontal, level or slightly reverse sloping terraces. Benches range from 10 to 20 feet wide and accommodate construction equipment and drainage conveyance.

They also provide access for maintenance activities until vegetation establishment. Steps are usually horizontal and range from two to four feet. They are typically cut into a slope by heavy equipment as a road is constructed. Serrations are typically ten inches wide and are cut by a special attachment on a bulldozer or grader.

MAINTENANCE

Regular maintenance is important to the functionablity of slope shaping activities. Inspections should be conducted on a regular basis, particularly after precipitation or storm runoff events. Accumulated sediment must be collected and removed. Sloughing is possible so those areas should be watched carefully and repaired as necessary.

EFFECTIVENESS

Slope shaping activities are effective if applied correctly given the site specific soils and conditions of the site.

BMP 4-2
RETAINING STRUCTURES

DEFINITION

Retaining structures are walls comprised of wood, rock concrete or other material, constructed at the toe of a slope.

PURPOSE

Retaining structures stabilize a slope against mass movement, protect the slope face or toe from scour and erosion from storm runoff, and allow reduction in the degree of slope for revegetion efforts, (i.e. plant material establishment).

APPLICABILITY

Applicable to all cut or fill slopes which can not be regraded due to specific site conditions. Retaining structures are typically utilized at the base of slopes, adjacent to roadways, structures, or drainageways. Retaining structures are always utilized in conjunction with other reclamation, revegetation and erosion control treatments to stabilize the affected slope.

PLANNING CRITERIA

The expertise of qualified professionals is required, as a variety criteria and data is needed to properly design and install retaining structures. The specifics of a given project area will guide the type and design of a retaining structure.

METHODS AND MATERIALS

Retaining structures can be built from a variety of materials, both natural and artificial. Natural materials include: rock, stone timber and earth. Artificial materials include steel and concrete which is stronger but more expensive. Combinations of both natural and artificial materials are also utilized such as gabion walls and welded wire walls. Retaining structures include:

- Gravity Walls
- Reinforced Earth
- Wood Walls
- Tie-Back Walls
- Crib or Bin Walls
- Gabions and Welded Wire
- Pile Walls
- Cantilever and Counterfort Walls

Structures can be designed specifically for the site in a manner which is both structurally sound and aesthetically pleasing.

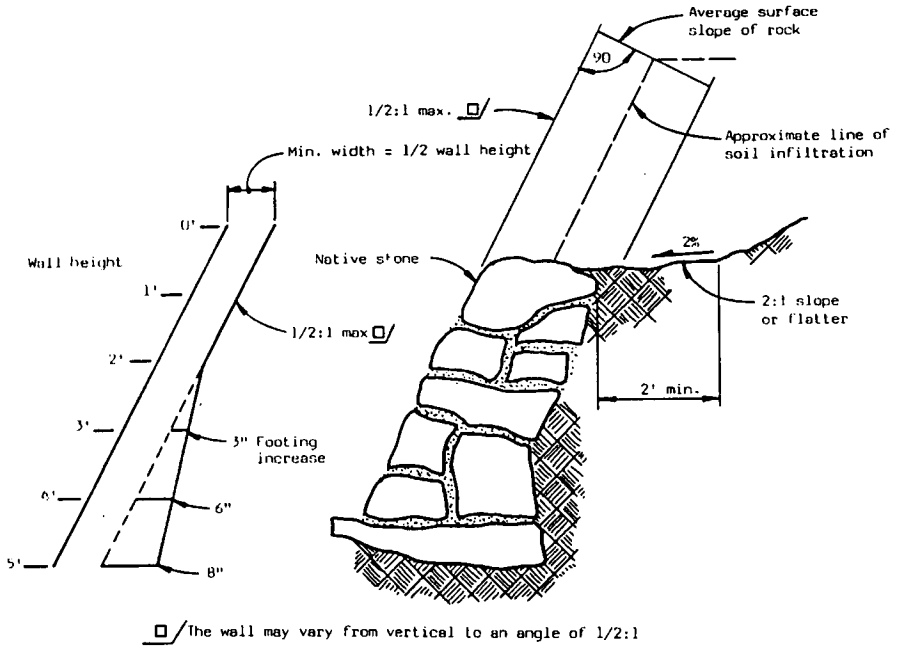
MAINTENANCE

If properly installed, retaining structures require little maintenance unless damaged. Periodic inspections should be made and repairs conducted immediately.

EFFECTIVENESS

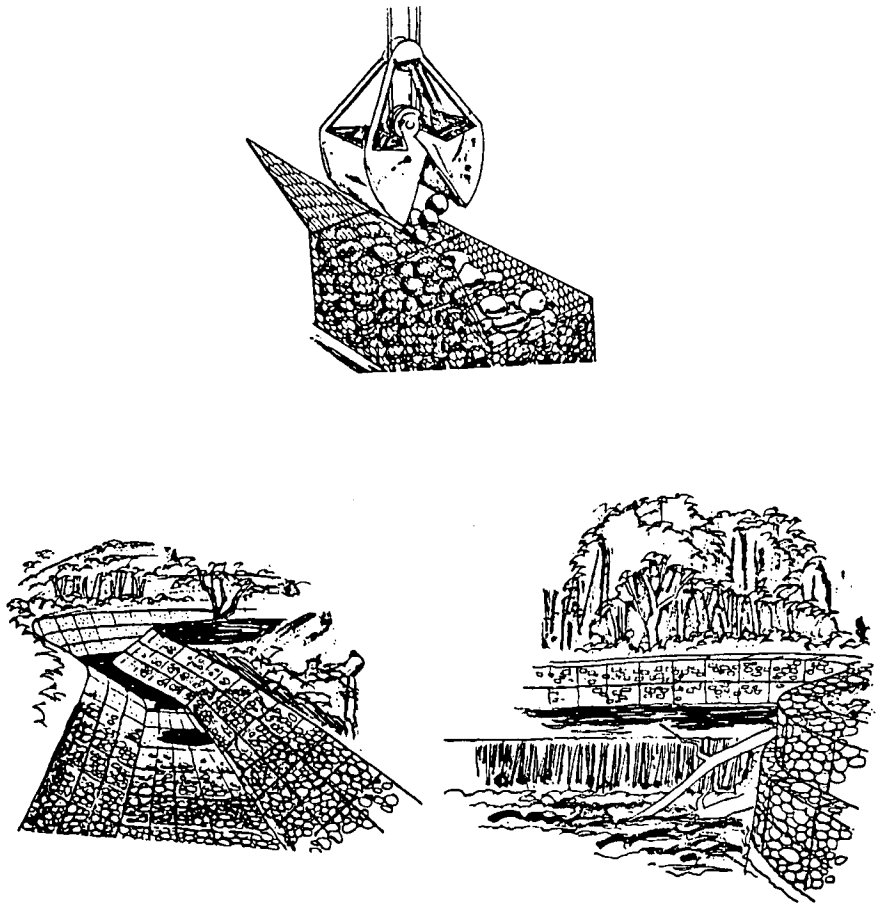
Retaining structures are very effective for controlling soil erosion and providing slope stability when properly designed and installed. They are most effective when utilized in conjunction with revegetation practices.

NATIVE ROCK RETAINING WALL
FIGURE 4-1



NATIVE ROCK RETAINING WALL

RETAINING WALLS
FIGURE 4-2



Gabions usefull to stabilize channels and for retaining walls.

BMP 4-3
ROCK RIPRAP

DEFINITION

Rock riprap is a layer of loose rock placed over an erodible soil or surface disturbance.

PURPOSE

To protect the soil surface, to provide for slope stabilization on steep slopes and to reduce soil erosion within a project area.

APPLICABILITY

Rock riprap is primarily utilized in drainage stabilization projects such as channel and ditch linings and energy dissipators. Rock riprap is used on steep, difficult slopes where vegetation has not been successful. Seed, shrubs and trees have been incorporated with rock riprap by interplanting.

PLANNING CRITERIA

A source of rock riprap of the appropriate size and the associated transportation costs are the primary planning criteria. Depending upon the application, rock riprap can be utilized with revegetation efforts but the establishment of permanent vegetation is preferred for long term stability and maintenance. Rock riprap applied to active drainageways or channels usually requires an underlining of matting or fabric to prevent erosion.

METHODS AND MATERIALS

The rock riprap should be sound, dense and durable rock with a specific gravity of not less than 2 1/2 and greater than 12 inches in diameter. Seeding should occur prior to rock placement. If to be used within an active drainage channel, a synthetic mat or fabric should be installed prior to rock placement. Depending on the specifics of the site rock riprap can be placed by hand or by equipment. Existing trees and vegetation should be protected and rock riprap placed by hand in these areas. Rocks should be securely bedded and homogeneous in the layering. Depth of application depends upon the size of the drainageway, slope degree and length and the other specifics of the site.

MAINTENANCE

Little maintenance is required when rock riprap is installed properly. Periodic inspections should be made and any dislodged rocks replaced as required.

EFFECTIVENESS

Rock riprapping is an effective means of reducing soil erosion in channels and drainageways. Steep slope applications should be done in conjunction with revegetation practices. Rock riprap can be expensive depending upon the source and transportation costs.

CHAPTER 5

INFILTRATION SYSTEMS

BMP 5-1 **INFILTRATION TRENCH OR BASIN**
BMP 5-2 **DRY WELL**
BMP 5-3 **FRENCH DRAIN**
BMP 5-4 **WETLANDS**

BMP 5-1
INFILTRATION TRENCH OR BASIN

DEFINITION

A shallow rock or gravel filled trench located at the drip line of roofs or adjacent to other impervious surfaces such as paved driveways and parking areas.

PURPOSE

To infiltrate and percolate runoff from impervious surfaces and to prevent erosion.

APPLICABILITY

Applicable to most sites with impervious surfaces such as roof tops, driveways, parking areas and other paved surfaces; however, since runoff from parking lots and other paved surfaces may contain oils, greases, metals, salts or other pollutants, site specific conditions such as soil characteristics and depth to ground water must be carefully considered to prevent shallow ground water contamination.

PLANNING CRITERIA

Infiltration trenches should be designed and constructed to intercept all runoff from impervious surfaces where erosion may be a problem or where surface runoff must be reduced (as in reducing flows to a storm drain). The sizing of infiltration trenches is dependent on the design storm, soil type and permeability, and the area of impervious surface.

Infiltration trenches placed at the dripline of structures can reduce surface erosion but must be designed so that water infiltrating will not damage foundations or seep into basements. French drains can be used to convey runoff to an infiltration trench away from the structure. Infiltration trenches which are used to drain paved areas, especially parking lots, should incorporate a sediment or grease trap, or replaceable sand filter.

The storage capacity of infiltration trenches decreases as the slope of the trench increases. Infiltration trenches are ineffective on slopes steeper than 15 percent unless modification to the design are made. Trenches on slopes greater than 15 percent can be stepped using baffles or headers in order to provide the design storage capacity.

Where an infiltration trench is located below a disturbed area, a sediment barrier to remove the sediment before it reaches the trench should be installed. Removing sediment from the runoff will increase the efficiency of the infiltration system and reduce maintenance costs.

Infiltration trenches and other infiltration structures should be designed by a qualified professional.

METHODS AND MATERIALS

The location, design and installation of infiltration trenches should be based on site requirements using qualified engineering assistance.

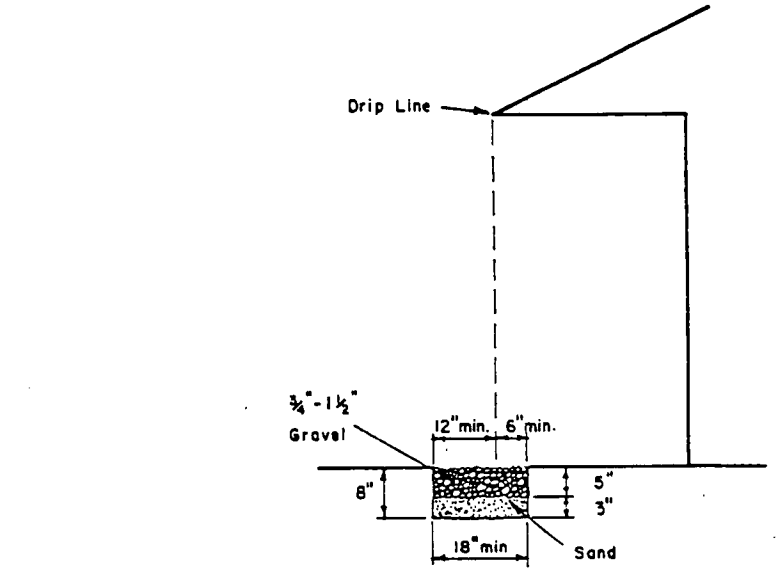
MAINTENANCE

Infiltration trenches require regular maintenance. Accumulated debris and sediment should be removed periodically. The use of the filter cloth for sediment capture can reduce maintenance costs.

EFFECTIVENESS

Properly designed and maintained infiltration trenches can reduce surface runoff and erosion. These structures are not effective in areas where shallow ground water is present.

FIGURE 5-1 (Dripline.pcx)
INFILTRATION TRENCH-A



SECTION
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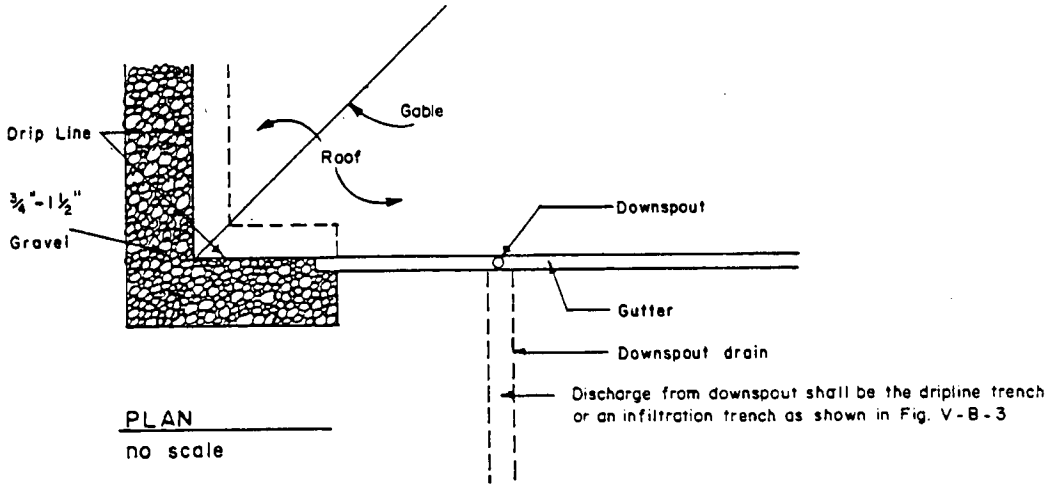

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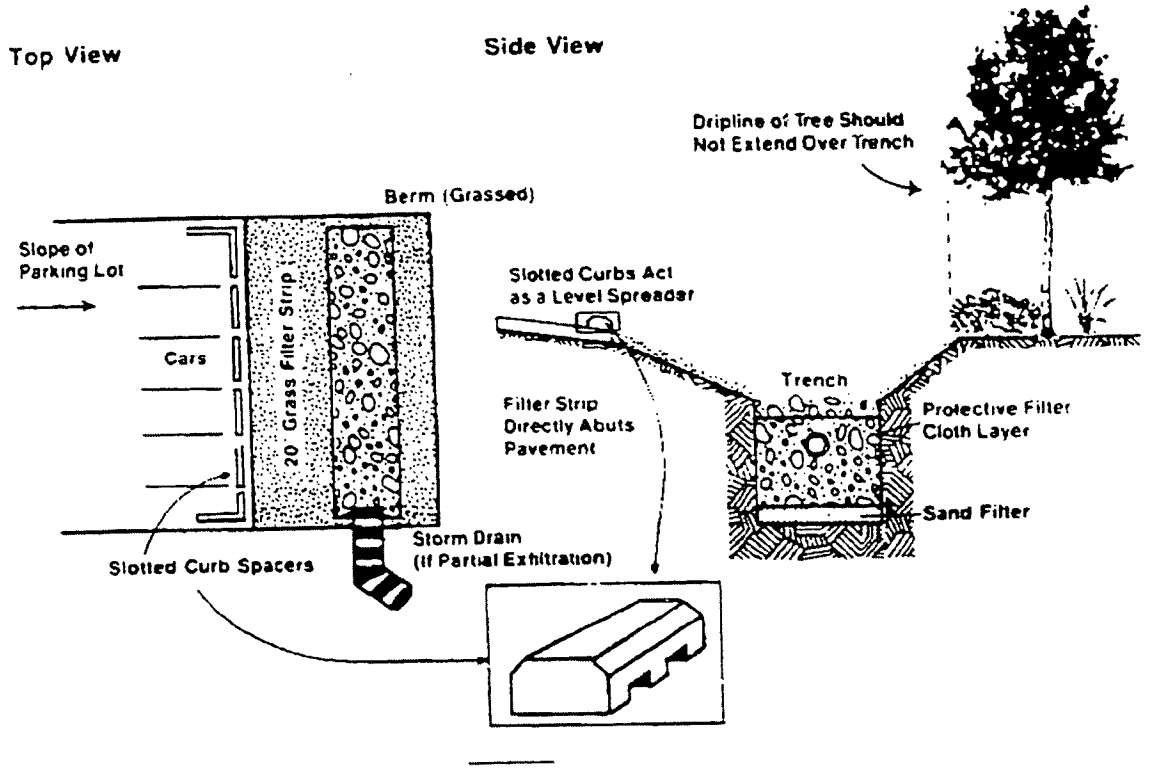
DRIPLINE TRENCH

INFILTRATION TRENCH-B
FIGURE 5-2



BMP 5-2
DRY WELL

DEFINITION

A stone or gravel filled pit, deeper than it is wide.

PURPOSE

To infiltrate and percolate runoff from impervious surfaces with no direct discharge to surface waters.

APPLICABILITY

Applicable to sites requiring additional storage capacity for runoff from impervious surfaces or as an alternative to infiltration trenches on steeper slopes.

PLANNING CRITERIA

The sizing of dry wells is dependent on the design storm, soil type, soil permeability, depth to ground water and/or bedrock, and the area of impervious surface. **Dry wells should be designed by a qualified professional. NOTE: A permit is required for the design, construction and operation of dry wells--permits are not issued for dry wells if the potential for ground water degradation exists.** Contact the Nevada Division of Environmental Protection, Bureau of Water Pollution Control for additional information.

BMP 5-3
FRENCH DRAIN

DEFINITION

A trench containing a perforated drainage pipe surrounded by gravel and located at the dripline of roofs or adjacent to other impervious surfaces, such as driveways and parking areas.

PURPOSE

To infiltrate and collect runoff from impervious surfaces and convey the excess to other infiltration structures.

APPLICABILITY

Applicable on steep slopes where the storage capacity of infiltration trenches is limited and excess water must be conveyed to a different location; also used to convey roof top runoff away from foundations.

PLANNING CRITERIA

The final design of a french drain is dependent on site characteristics and should be completed by a qualified professional.

METHODS AND MATERIALS

A perforated pipe is placed on a layer of small gravel in an excavated trench and backfilled with gravel. Filter cloth can be used to reduce sediment accumulation in the trench.

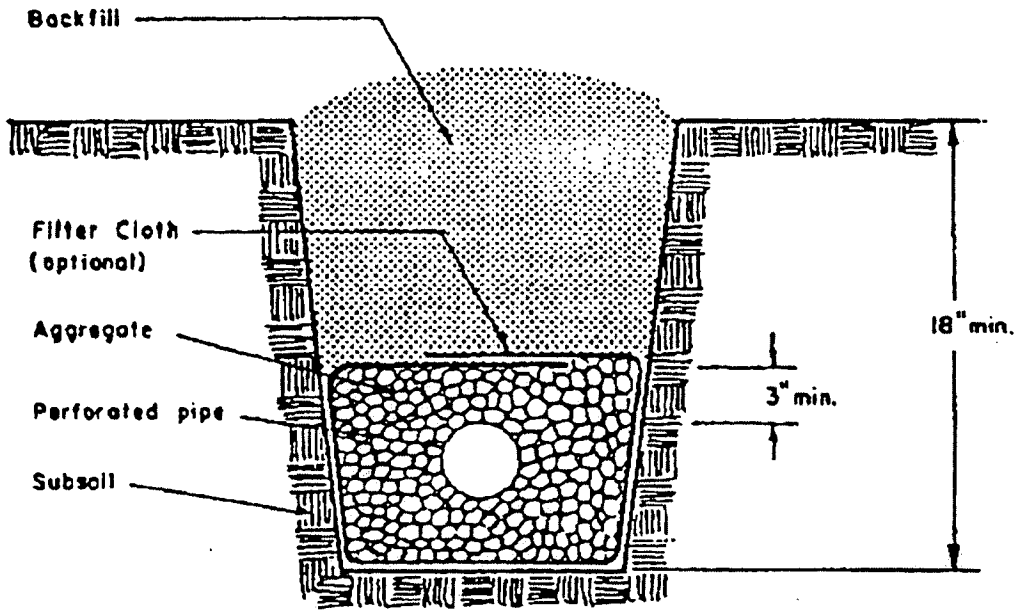
MAINTENANCE

French drains require regular maintenance. Accumulated debris must be removed periodically. The gravel may need to be removed, reworked, or replaced in order to remove accumulated sediments. Filter cloth is useful for preventing clogging.

EFFECTIVENESS

French drains, when properly installed and maintained in accordance with the design criteria, can effectively transport water away from foundations or to alternative sites for infiltration.

FRENCH DRAIN
FIGURE 5-3



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BMP 5-4
WETLANDS

DEFINITION

Natural or constructed 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.

PURPOSE

To improve water quality, remove sediment, reduce soil erosion and prevent flooding.

APPLICABILITY

Natural or constructed wetlands can be utilized where there is a need to 1) reduce pollutants, including nutrients, pesticides, bacteria and sediment, in surface waters; 2) reduce soil erosion along downstream watercourses by slowing overland flow; or 3) reduce flooding by providing temporary storage capacity.

PLANNING CRITERIA

Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to require and issue permits for dredge and fill activities in the nation's waters which include wetlands, mudflats, vegetated shallows and riffle and pool complexes. Other federal, state and local agencies may also need to be included in the planning and permitting process.

To utilize either natural or man-made wetlands for reducing nonpoint source pollution, a thorough knowledge of the water, soil and plant characteristics is necessary. The wetlands area must be protected from degradation by the pollutants entering the wetland system. A constructed wetlands requires an engineered design which considers site specific criteria.

EFFECTIVENESS

Wetlands and riparian areas can play a critical role in reducing nonpoint source pollution by intercepting surface runoff and subsurface flow; however a definite range of operational conditions must be maintained in order for the wetland system to effectively remove pollutants and to prevent degradation of the system itself. When hydrologic changes or nonpoint source pollutants exceed the natural assimilative capacity of these systems, the wetland areas can become degraded or destroyed.

CHAPTER 6

WATERSHED MANAGEMENT

BMP 6-1	CRITICAL AREA PROTECTION
BMP 6-2	CRITICAL AREA STABILIZATION
BMP 6-3	STREAM PROTECTION & STABILIZATION
BMP 6-4	FLOODWATER RETARDING STRUCTURE
BMP 6-5	FLOODWATER DIVERSION
BMP 6-6	PRESCIBED USE OF FIRE

BMP 6-1
CRITICAL AREA PROTECTION

DEFINITION

Protection of critical erosion areas from damaging use by grazing animals, people and vehicular traffic.

PURPOSE

To manage the land use of critical erosion areas in a manner which reduces wind and water erosion and improves the quality of surface runoff waters.

APPLICABILITY

Protection of critical areas is applicable to road cut and fill slopes, dams, borrow pits, development or construction sites, drainage ways, stream channels, mined areas, mine and mill wastes, burned range and forest lands or other surface disturbance areas.

PLANNING CRITERIA

Evaluate the site specific conditions, drainage and potential erosion hazards of the target area and the revegetation requirements. Determine if temporary or permanent protection is needed to achieve a stabilized site. Most steep slopes, fragile soil areas and mine wastes that contain toxic materials may require long term (multiple years) protection. Other areas such as rangeland burns or construction sites may need protection only until vegetation is well established. Revisions to land use plans and ordinances may also be necessary to further protect critical areas and to avoid a repeat of the situation.

METHODS AND MATERIALS

1. Control access to the project area by fencing or other means of restricting access. (See Fencing guidelines and specifications in Appendix G-6.)

2. For large areas such as rangeland burns, fencing may not be required if the area can be protected by deferred grazing or animal control until the vegetation is well established. Electric fences can be used where only temporary protection is needed.

3. Construct surface water diversions where needed to direct runoff water around the site.

4. **Determine with the assistance of qualified professionals, the necessary steps to stabilize and reclaim the disturbance area.**

MAINTENANCE

Periodically inspect and repair fences or barriers as needed to maintain functionability. Review land use management strategies and revise as necessary. On grazable sites, evaluate grazing use during the grazing season. Manage land use activities to maintain adequate plant cover for soil protection.

EFFECTIVENESS

Protecting critical areas from overuse by grazing animals, people and vehicular traffic will aid revegetation and stabilization of these areas and will result in reduced erosion and sediment delivery.

BMP 6-2
CRITICAL AREA STABILIZATION

DEFINITION

Development of a plan of action to stabilize critical erosion sites. This includes natural sites as well as those created by man's activities.

PURPOSE

To stabilize and reclaim the surface disturbance area, reduce soil erosion, and control runoff and sediment delivery from critical erosion sites.

APPLICABILITY

On surface disturbance areas where soil and vegetation has been disturbed by activities such as housing, industrial developments, roads, highways, pipelines, powerlines, dams, oil, gas, and geothermal exploration, mining, recreation, wildfires, and animal overgrazing. Stabilization treatments are applicable for all topographical, elevational and climatic situations encountered.

PLANNING CRITERIA

1. Soils - It is essential to know the types of soils that exist on the project site and the characteristics of these soils that will affect construction and erosion control treatments. **Soils information may be obtained from published soil surveys, from conservation district offices or may have to be gathered in the field by qualified professionals.**

2. Surface drainage and topography - Base maps of the project area should be developed at sufficient detail to address the site specifics of the area. A comprehensive drainage plan and sediment/erosion control plan should be developed. All the necessary components should be designed and specified by a qualified engineer.

3. Vegetation - The natural vegetation should be protected and maintained wherever possible. Surface disturbances should be coordinated with the construction schedule and only the surface area that is essential for completion of the project should be disturbed. Plans for revegetating the disturbance areas should be included.

4. Slope Gradients - Cuts and fills should be minimized and slopes reduced to the extent possible given the specifics of the site. Available soil survey information and reports for soil stability characteristics should be utilized in the project design. Where it is not feasible to flatten slopes to the desired grade, it may be necessary to use structural measures such as retaining walls.

METHODS AND MATERIALS

There are numerous sediment and erosion control structures and treatments which may be required given the specifics of the site. The majority of these are referenced in other sections of this handbook. **It should be emphasized that a qualified professional should be consulted regarding design and construction requirements (See Appendix A-2).**

MAINTENANCE

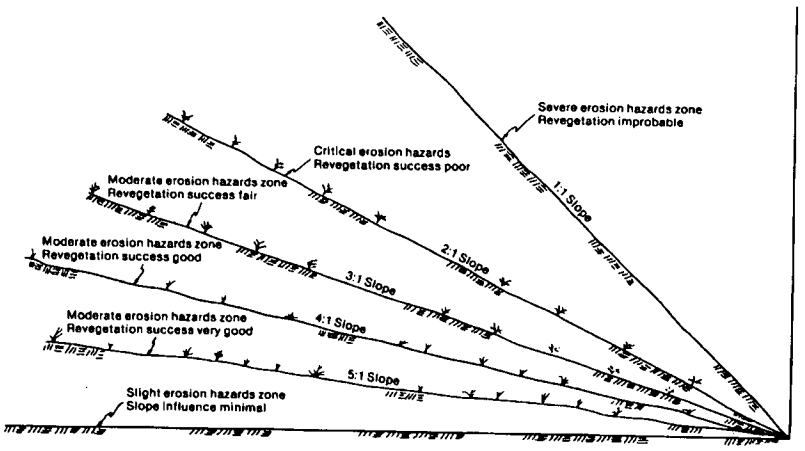
Structural measures are to be maintained in a condition to adequately perform their designed function. Vegetation should be replanted on areas where initial plantings fail to establish.

Fertilize and irrigate vegetation as needed if these treatments are included in the plan. Continue to protect the area from grazing animals, pedestrians, vehicle traffic and fire.

EFFECTIVENESS

Proper installation and maintenance of critical area stabilization is a highly effective method for reducing unnatural sediment loads in runoff waters from these sites and in reducing total runoff.

FIGURE 6-1 (BMP 1)
EROSION HAZARD ZONE



BMP 6-3
STREAM PROTECTION & STABILIZATION

DEFINITION

Structural and vegetative treatments to stabilize stream channels and streambanks.

PURPOSE

To reduce erosion and sediment loads, improve fish and wildlife habitat, maintain channel capacity, and prevent damage to land, utilities, roads, buildings or other facilities adjacent to the stream.

APPLICABILITY

Applies to natural streams or excavated channels where stream channels and/or streambanks are experiencing erosion.

PLANNING CRITERIA

Streambank Protection - Each reach of a stream is unique, so streambank protection measures must be installed according to a plan adapted to the specific site. Hydrology of the entire stream above and below the site must also be considered. Streambank protection will generally require a combination of vegetation and sediment and/or erosion control structures.

1. Streambank protection should start and end at stabilized or controlled areas within the stream. Treatments are planned and implemented based upon a comprehensive analysis of the entire stream.

2. Channel clearing to remove debris, stumps and fallen trees is often the initial required treatment but must be done in a coordinated manner with considerations for the other resources. In most instances only loose debris should be cleared and debris that is cemented into place should be left. Branches, trunks, etc. sticking out of the sediment can be cut off, thus removing the obstruction without disturbing the sediment and/or stream banks. Preservation of fisheries and their associated habitat is a priority.

3. Bank sloping is sometimes needed to reduce the slope and provide suitable conditions for the installation of structures and revegetation. Before bank sloping is initiated consideration for impacts to fisheries and their associated habitat must be analyzed.

4. The channel grade must be stabilized by natural or artificial means before permanent bank protection can be successfully installed.

5. Changes in channel alignment should be made only after a thorough evaluation of the effect of the change on land use, hydraulic characteristics and existing structures and facilities.

6. Structural measures must be designed to withstand floods without serious damage, maintain functionability while aesthetics are incorporated.

7. Protect existing vegetation and revegetate disturbed areas. Natural revegetation, depending upon the specifics of the site, can provide stable channels while preserving both wildlife and fisheries habitat. Control the use of herbicides near streambanks.

Stream Channel Stabilization - Channels may aggrade or degrade during a given storm or over a short period of time. A channel can be considered stable if the channel bottom remains at essentially the same elevation over an extended time. Consideration should be given to the following points:

1. Character of materials (i.e. rock, soils, etc.) that comprise the stream bottom.

2. The quantity and characteristics of sediments entering the channel or that have the potential to enter the channel. A comprehensive analysis should be conducted based upon present conditions and potential changes which may result from changes in land use, surface treatments, upstream improvements and structural measures.

3. A comprehensive watershed hydrological analysis including peak stream flow, flow velocities and volumes at various frequencies.

4. Effects of installation of grade control structures.

5. Measures and construction methods that improve fish and wildlife habitat to the extent needed and practical.

6. Structural design and installation to meet approved engineering standards. Structures must be designed specifically for the site.

7. Construction carried out in a manner that will create the least disturbance to existing vegetation. Surface disturbance areas should be revegetated.

METHODS AND MATERIALS

The following are utilized to stabilize stream channels and are usually designed to function together. The goal of stream protection and stabilization is to recreate the naturally stable channel conditions which includes an appropriate shape, pattern and gradient for the materials, watershed and land form. **A qualified professional should be consulted regarding proper design and construction of stream stabilization treatments.**

1. Grade Stabilization Structures - Installed to stabilize the grade and control channel erosion.

2. Riprap - Placed or dumped heavy stone to provide protection for the streambank (See BMP 4-3, Chapter 4-pg 4-8).

3. Revetments - Pervious or impervious structures built on a parallel to the stream at the base of the streambank to prevent bank erosion. These structures prevent scouring resulting from high streamflow velocities.

4. Jetties - Deflectors constructed of posts, piling, fencing, rock, brush or other materials which project into the stream to protect the streambank on curves and other reaches subject to high velocity flows. Utilization of wood or brush should be followed with permanent vegetation as wood will decompose.

5. Fencing - Fencing is often needed to protect streambanks from damage by grazing animals and vehicular traffic.

6. Revegetation - Planting streambanks and surface disturbances within the stream channel with native and/or adapted plant species. See Appendix E-2 for guidelines and specifications for streambank plantings.

MAINTENANCE

Maintain all structures and fences so they adequately perform the function intended. Protect streambanks from overuse by grazing animals, vehicles and people.

EFFECTIVENESS

Stabilization of stream channels and streambanks is an effective treatment to reduce sediment loading, control erosion and land damage. Great care needs to be taken when using engineered structures so that these structures do not aggravate the situation. For example in flat alluvial settings, streams naturally meander and change courses. Trying to keep such a stream channel in one particular location may be futile and counter productive.

BMP 6-4
FLOODWATER RETARDING STRUCTURE

DEFINITION

A single-purpose structure providing for the temporary storage and controlled release of floodwater.

PURPOSE

Floodwater retarding structures are installed to reduce flood damages downstream by controlling the release rate from flood flows of predetermined frequencies. They protect the watershed and may also permit the use of more economical channel improvements or stabilizing structures in the channel downstream.

APPLICABILITY

The construction of a floodwater retarding structure requires qualified professional engineering and natural resource expertise. A site may be considered for a structure if it meets all of the following minimum conditions:

1. The construction of the floodwater retarding structure is permitted by applicable state statutes and regulations.

2. Topographic, geologic and soil conditions at the proposed site are satisfactory for the development of a feasible dam and reservoir.

3. **The sediment yield at the site is not excessive as determined by a qualified professional engineer**.

PLANNING CRITERIA

Floodwater retarding structures must be fully investigated, designed and installed by qualified professional engineers. Plans, designs and installations must consider water rights and meet the requirements of the laws of the State of Nevada and be cleared by the state engineer. An environmental analysis should be conducted which identifies all potential impacts to existing natural resources (i.e. fisheries, wildlife, vegetation, etc.). Long term considerations should identify impacts associated with downstream degradation from sediment starvation, upstream aggradation from raising the base level of the stream and other related impacts.

MAINTENANCE

A comprehensive inspection and maintenance plan should be developed to insure functionablity of the structure for the design life. Periodic inspection is necessary to assure that the structure has not developed any problems and to determine if the sedimentation rate is in keeping with initial estimates. If a problem is identified, appropriate remedial measures should be undertaken.

EFFECTIVENESS

Floodwater retarding structures are effective in regulating floodwater runoff if they are designed, installed and maintained properly. A reduction in flood damage and sediment delivery can be expected from floodwater retarding structures.

BMP 6-5
FLOODWATER DIVERSION

DEFINITION

A channel with a supporting embankment or dike constructed on the down slope side which will divert floodwaters from one area to another.

PURPOSE

This treatment will divert floodwater from lowland areas or from specific areas within the floodplain requiring protection. Floodwater diversions will protect the land, surface improvements and the watershed by reducing erosion and sediment delivery to receiving waters.

APPLICABILITY

This practice is applicable where:

1. Floodwater which originates up gradient from the lowland area to be protected and is causing, or has the potential to, damage agricultural land, crops or other land uses.

2. An adequate outlet for the design flow is available, either by gravity flow or by pumping. The outlet should be suitable for the quality and quantity of water and sediment to be disposed of, and consideration should be given to possible damages above or below the point of discharge. The outlet may be a floodway or natural channel, river or lake.

3. Lands to be protected are suitable for the planned use within their capabilities after installation of required conservation practices.

This practice does not include dams constructed to divert floodwaters to a waterspreading system, irrigation canal or storage facility for beneficial use. A Diversion Dam may discharge in a Floodwater Diversion.

PLANNING CRITERIA

The design and installation of floodwater diversions should be under the supervision of a qualified professional engineer.

Location - The floodwater diversion should be located to protect the maximum area of lowland, consistent with economic limitations, topographic requirements, and the desired slope of the hydraulic gradeline. These structures must meet applicable federal, state and local laws.

Hydraulic Gradeline - The hydraulic gradeline of the floodwater diversion should tie into the elevation of water in the outlet expected for the frequency storm selected for design and should be established with due regard for damages which may occur on the opposite side of the floodwater diversion from the supporting embankment. It should have a slope in the direction of flow which will result in a velocity that will not cause excessive erosion or sedimentation.

Velocity - The maximum permissible design velocity should be based on site conditions. A desirable minimum velocity is 1 1/2 feet per second. On flat grades where the design velocity is below this value, the cross section should be adjusted to obtain the most efficient section that depth and maintenance methods permit. Consideration must be given to the increased shear stress in channels carrying water that would have dissipated energy over a floodplain.

Berm and Embankment - The minimum berm width between channel and embankment should be based on depth of channel. The embankment may be constructed from the channel excavation or from suitable borrow. The design height of the embankment should be the design water depth plus a freeboard of at least two feet. The constructed height should be the design height plus an allowance for settlement based on consideration of soil material and the anticipated compaction during construction.

METHODS AND MATERIALS

Floodwater Diversions should be designed and constructed by a qualified professional engineer. The following generally describes the installation process.

Site preparation - The entire width of the site for the floodwater diversion, including channel, berm, and embankment should be cleared of all trees, stumps, roots, brush, boulders and debris. All channel banks and sharp breaks should be sloped no steeper than 1:1 unless such sloping would likely result in changing a stable slope into an unstable slope. Topsoil which is high in organic matter should be removed. The ground surface where the embankment is to be placed should be thoroughly scarified before placement of the embankment material.

Excavation and Construction of Embankment - Excavation of the channel and placement of spoil in the embankment should progress simultaneously from the outlet upstream. The channel is excavated and the embankment constructed per the dimensions specified in the engineering plans.

Vegetative Cover - An adequate vegetative cover or non-vegetative slope stabilization BMP should be implemented on the embankment where it is necessary to protect against erosion by flood flows, wave action, or from rainfall and runoff on the embankment.

MAINTENANCE

Periodic inspection of the embankment is required, particularly after precipitation or storm events. Identified damage should be repaired immediately or the appropriate remedial measures taken as necessary.

EFFECTIVENESS

Floodwater Diversions are effective in diverting floodwater when they are designed, installed and maintained properly.

BMP 6-6
PRESCRIBED USE OF FIRE

DEFINITION

The prescribed use of fire is defined as the deliberate and planned use of fire in a controlled manner to achieve or accomplish specific natural resource management prescriptions.

PURPOSE

Prescribed fire is utilized in the following general natural resource management fields; silviculture, range management, watershed management, fire prevention and control, land clearing, pathological and entomological uses and wildlife management.

APPLICABILITY

This practice is applicable on sites which are compatible to the prescribed use of fire, where the benefits are larger than the risks associated with utilizing fire as a management tool, and within the auspices of an overall watershed or "holistic" resource conservation plan.

PLANNING CRITERIA

The design and utilization of prescribed fire requires the expertise of a multi-disciplinary natural resource team and a coordinated effort among federal, state and local agencies. **Under no circumstances is a layman to initiate or implement the prescribed use of fire. The Nevada Division of Forestry should be contacted prior to the development of any fire prescription.**

Fire can be used in a variety of situations throughout the watershed from improvement of the overall condition of a watershed to specific applications for vegetation manipulation. Fire is often the most efficient means of forest regeneration including seedbed preparation, opening of cones, reduction of vegetative competition and a fertilizing effect from mineral nutrients released in the ashes. Vegetation cover types and/or species composition can be changed or modified through the use of prescribed fire. Vegetation type manipulation must be based upon sound ecological knowledge of natural successional trends coordinated with other watershed, resource and land use goals.

Vegetation type and cover manipulation can result in economic benefits such as: improved forage for livestock, more valuable commercial timber stands, retained naturalness where historic fire prevention is changing vegetation, prevention of less frequent but more damaging catastrophic wildfires, improved wildlife habitat in support of public hunting and in controlling certain insects and/or diseases. Prescribed fire can also be utilized in certain specific situations to improve the overall surface stability of a watershed resulting in reduced soil erosion and improved water quality.

METHODS AND MATERIALS

As stated above, the design and utilization of prescribed fire requires the expertise of a multi-disciplinary natural resource team and a coordinated effort among federal, state and local agencies. A variety of federal, state and local permits may be required including a comprehensive environmental impact analysis. **Any prescribed use of fire in Nevada requires approval from the Nevada Division of Forestry among others.** Site specific data gathering activities would potentially include, soils information, surface and ground water resources, vegetation, topography, climate, existing and proposed land uses wildlife and fisheries and other related information.

Primary components of a fire prescription include:

1. Baseline data gathering and inventorying of the watershed.
2. Development of a comprehensive watershed plan in a coordinated manner with all effected entities.
3. Conducting an environmental analysis of the watershed plan.
4. Upon approval to initiate a prescription the following activities are necessary.

    - Area and boundary selection
    - Firebreaks and fire control
    - Sediment and erosion controls
    - Defining the prescription window, or set of weather, fuel loading and fuel moisture conditions
    - Preparation of fuel
    - Burning plan
    - Fire crews, equipment, communications & support
    - Weather information during burn period
    - Burn execution
    - Follow-up, monitoring and analysis.

MAINTENANCE

Regular inspection, monitoring and maintenance is critical to the success or failure of a prescribed burn, particularly after precipitation or storm events. Identified damage or concerns should be addressed immediately and appropriate remedial measures taken as necessary.

EFFECTIVENESS

The prescribed use of fire has proven effective under specific natural resource management situations. When properly planned, designed, implemented and followed up, prescribed fire is an effective watershed management tool which can, in some situations, reduce long term erosion and sediment transport.

CHAPTER 7

AGRICULTURE

FARMING

BMP 7-1 IRRIGATION WATER MANAGEMENT
BMP 7-2 IRRIGATED CROPLAND MANAGEMENT
BMP 7-3 NATIVE MEADOWLAND IRRIGATION MANAGEMENT
BMP 7-4 PASTURE AND HAYLAND MANAGEMENT
BMP 7-5 SALINITY CONTROL
BMP 7-6 CHISELING OR SUBSOILING
BMP 7-7 SOIL AMENDMENT, FERTILIZER, & PESTICIDE MANAGEMENT

LIVESTOCK

BMP 7-8 PLANNED GRAZING SYSTEM
BMP 7-9 PROPER GRAZING USE
BMP 7-10 RANGE IMPROVEMENTS
BMP 7-11 LIVESTOCK FACILITIES

FARMING

BMP 7-1
IRRIGATION WATER MANAGEMENT

DEFINITION

A broad system or scheme for controlling, applying, and removing irrigation water on the farm in a planned and efficient manner. The elements of an irrigation water management system may include:

1. **Water Measuring Devices** - Structures, such as weirs, flowmeters, flumes and open pipe discharges to measure flows.

2. **Water Control Structures** - Permanent structures, such as diversion boxes, checks, turnouts, pipes, or drops which provide positive control of in-system diversion of the irrigation stream.

3. **Regulating Reservoirs** - Relatively small basins constructed at the head of the irrigation system to regulate a fluctuating supply or for temporary storage to provide a larger, more efficient flow of water for irrigation. Regulating reservoirs can be used as desilting basins when operated in conjunction with a tailwater recovery system.

4. **Tailwater Recovery System** - A system of channels, sumps or small reservoirs, pipelines, and/or pumps which will return the drainage water (surface or subsurface) to the irrigation distribution system for reapplication.

5. **Land Grading** - Reshaping of the land surface to provide a uniform or complex slope for efficient, uniform surface irrigation and drainage.

6. **Land Smoothing** - Removing land surface irregularities, such as small ridges and closed depressions, to provide complete drainage of the land surface.

7. **Surface Irrigation System** - A system of facilities designed and constructed for the efficient distribution of irrigation water to the cropland by surface methods such as corrugations, furrows, border checks, basin, contour checks, ditches, wildflooding, drip irrigation, sprinkler and underground pipe. The system should be designed for the most efficient irrigation flow and optimum irrigation run.

PURPOSE

Efficient, economical control of the irrigation and drainage water on the farm is done to: satisfy crop irrigation and soil leaching requirements; maintain soil conditions for suitable plant growth; and prevent degradation of surface and ground water quality. The principal water quality parameters to be considered are suspended solids, dissolved solids, nutrients, biocides, pesticides, herbicides, biological oxygen demand, temperature, pH, and coliform bacteria.

APPLICABILITY

Applies to all irrigated land on which a conservation irrigation system has been developed.

PLANNING CRITERIA

In planning for irrigation water management, consideration should be given to other BMPs, including salinity control, water conveyances, and appropriate conservation crop production elements.

Planning criteria include the following:

1. All facilities and their use, including the diversion and discharge of irrigation water, must conform to the applicable federal, state and local water laws and environmental regulations.

2. General irrigation system design considerations include: soil (agricultural and foundation) characteristics, crop water requirements, topography, material availability, irrigation and drainage water flow paths, farm management capabilities and a cost benefit analysis.

3. Specific determinations are necessary for proper irrigation water management including: water application amount and rate, leaching requirement, system capacities, optimum slopes and/or hydraulic gradients, facility sizes and configuration, time of irrigation set, and uniformity of application.

4. Know the amount that should be applied. Schedule irrigations to meet crop requirements plus a minimum leaching fraction. This will result in improved irrigation efficiencies.

5. Apply water as infrequently and for as long a duration as proper irrigation scheduling will allow. This will minimize total erosion and runoff.

6. Apply water uniformly. This will involve flow measurement, careful land grading (slope), optimum length of run and good design and operation for sprinkler and drip systems.

7. Avoid applying fertilizers, biocides, or amendments in the irrigation water when runoff cannot be confined to the farm.

8. Develop a tailwater recovery system including an adequate drainage system.

9. Utilize sediment retention basins. These can be specific basins, regulating reservoirs, or small basins created by checks in the drain ditches.

10. Utilize vegetated buffer strips or drainageways. Another alternative is to use runoff from row crops to irrigate close growing crops.

11. Since land varies in requirements for irrigation water management, consideration should be given to the identified irrigation land treatment groups described in the Appendix F.

METHODS AND MATERIALS

Since irrigation water management is defined, in effect, as a system of physical facilities for water control, it is necessary that the facilities be constructed of dependable materials and installed properly for proper operation. The materials should be native and/or fabricated which have been determined acceptable by previous experience, testing, or warranty.

A principal objective of irrigation water management is control of the water quality in the downstream receiving waters. The methods suggested in this section for achieving water quality control involve the use of appropriate elements of the system. The design considerations for these elements are discussed in Appendix F.

The degradation of receiving waters is a result of, or associated with, surface runoff from the farm. Following are management methods for controlling this runoff. The degree of control will depend upon the extent and/or practicability of their implementation.

1. **Sprinkler Irrigation System** - A designed and constructed system for the efficient application of irrigation water under pressure through pipelines and above ground nozzles or orifices.

2. **Drip Irrigation** - A designed and constructed system for the efficient application of irrigation water to the land at a low pressure and rate to individual or groups of plants, at or near the soil surface, through a system of pipelines and emitters.

3. **Surge Irrigation/Corrugation** - A system designed to do repeated wetting of irrigated lands in surges and thus reducing the potential for field runoff.

MAINTENANCE

A regular inspection and maintenance program should be developed and implemented to keep the irrigation system or systems operating at its optimum. Repairs and the replacement of system components should be completed as required.

EFFECTIVENESS

Each of the elements and methods of this practice are effective. The degree of total effectiveness will depend upon the extent that they are properly implemented and managed.

BMP 7-2
IRRIGATED CROPLAND MANAGEMENT

DEFINITION

The use of irrigated cropland for crop production and management of soil and water resources.

PURPOSE

To provide for sustained production of agricultural crops, protect the soil from erosion and maintain or improve water quality.

APPLICABILITY

Applies to all irrigated cropland.

PLANNING CRITERIA

The specifics of the site will govern the development of an irrigated cropland management system. Consideration should be given to soil characteristics, topography, surface drainage, farm management capabilities and the relative cost effectiveness of various management techniques.

METHODS AND MATERIALS

The following are suggested cropland management techniques which may be tailored to the specifics of the site.

1. **Conservation Cropping System** - A cropping system that includes crops that produce plant residue adequate to maintain organic matter and soil tilth. Perennial legume or grass-legume, hay or meadow crops in the system are very effective conservation treatments. Close growing small grain crops and mulching can sometimes be substituted for hay or pasture in a cropping system.

2. **Minimum Tillage** - A tillage system that leaves the crop residue on the soil surface or partially incorporated into the surface soil. Use subsurface tillage equipment and till only enough for weed control and seedbed preparation. Special planting equipment designed for planting in residue may be needed for some crops. Grass-legume crops may be seeded directly into small grain stubble with no tillage if weed control has been adequate in the grain crop. Cultivate intertilled row crops only as needed. The proper use of herbicides for weed control will reduce the need for tillage. Additional nitrogen fertilizer above normal application rates may be needed for residue decomposition.

Care must be taken to avoid over fertilization to the extent that runoff or excessive leaching occurs. Fertilizer amounts and application timing should be well planned to minimize the potential for surface or ground water contamination.

3. **No Till** - A tillage system that leaves the crop residue on the soil surface for maximum protection against soil erosion.

4. **Cover Crops** - Plant cover crops to protect the soil from wind and water erosion following clean tilled row crops, on land laid bare by land leveling, or on development of new lands prior to establishment of the initial crop or cropping system. In development of new land irrigation water should be available for establishing cover crops.

   Small grains are good cover crops. Rapid developing grasses and legumes like ryegrass and annual sweetclover can also be used. On soils where it is adapted, sudangrass is a good cover crop plant for summer seedings. Fertilize and irrigate as needed for rapid development of the cover crop. Use minimum tillage procedures to work down cover crop residue.

5. **Green Manure Crops** - Green manure crops are used when the cropping system does not produce adequate plant residue for soil protection or to maintain soil tilth. Hairy vetch, common vetch, sweetclover, rye or other small grains make good green manure crops. If possible, green manure crops should be worked down with minimum tillage procedures.

6. **Mulching** - The application of plant residues not produced on the site, barnyard manure, or other suitable materials to cropland for erosion control during critical periods. These are usually applied only on small critical areas such as ridgetops or blowouts. Hay straw, manure, cornstalks or other plant residues can be used. Application rates should be adequate to provide the needed soil protection. Hay and straw mulches should be anchored by punching them into the soil surface.

7. **Fertility Management** - Apply fertilizer based on soil tests, agency recommendations and local practice. Excess fertilizer may cause nutrient pollution by runoff or deep percolation.

8. **Pest Control** - Use a combination of cultural, biological and chemical control measures. Apply pesticides in accordance with labeled instruction registered with the Nevada Department of Agriculture or in accordance with specific regulations of the department. Always read the label on the pesticide container before using the material.

9. **Diversions** - Install diversion dikes or ditches to divert excess offsite runoff waters away from cropland to suitable drain outlets. (See Appendix A - Erosion and Sediment Controls.)

10. **Grassed Waterway** - Install grassed waterways where needed to conduct runoff water through cropland. (See BMP - 2-11 "Grassed Waterways and Outlets").

11. **Irrigation and Drainage Systems** - Install adequate irrigation and drainage systems adapted to soils and crops. (See Appendix F - Agriculture - Farming).

12. **Irrigation** - Use irrigation water management specific for the soil and crops grown. (See BMP - 7-1 "Irrigation Water Management").

MAINTENANCE

Maintenance of the cropland management system will be done through normal tillage and crop culture operations. Additional maintenance will be required to keep irrigation and drainage systems in effective operating condition.

EFFECTIVENESS

Application of a cropland management system that includes the necessary components for the specific soils and crops will maintain the soil resource for sustained crop production and maintain or improve water quality.

BMP 7-3
NATIVE MEADOWLAND IRRIGATION MANAGEMENT

DEFINITION

A planned irrigation system where all necessary water control structures have been installed for the efficient distribution of irrigation water by surface means. Determining and controlling the rate and amount of irrigation water application to soils for crop water requirements in a planned and efficient manner.

PURPOSE

To effectively utilize available irrigation water in managing and controlling the moisture requirements of native hay and pastures; to promote the desired growth response; to minimize soil erosion and loss of plant nutrients; to control undesirable water loss, and to protect water quality.

APPLICABILITY

This practice is adapted to all native meadowlands that are suitable for irrigation and that have a water supply of suitable quality and quantity.

PLANNING CRITERIA

The layout of a ranch irrigation system should provide for the conveyance and distribution of irrigation water without sustaining soil erosion. All ditches should be located on non-erosive gradients and include the necessary water control structures. Land shaping for proper water distribution should be done in a manner that will least disturb the meadow vegetation. Disturbed areas should be reseeded. Ditches and other structures must be designed and constructed to allow delivery of required quantities of water. They should be designed for the maximum flow conditions that are to be expected.

Irrigation delivery systems should be located out of muck and silt areas to less erosive soil types on higher ground. Stream channels should be re-located only after careful planning. The channels should be re-shaped so that the banks can be stabilized with vegetation.

Identification of existing stable channels in the area is a good guide for shaping and layout of new channels.

Maintaining fisheries within stream channels should be a high priority and irrigation diversions should be designed to maintain an instream flow that will support fish requirements.

METHODS AND MATERIALS

Native meadowland irrigation management is defined, in effect, as a system of physical facilities for water control; therefore, it is necessary that the facilities be designed and constructed properly. A principal objective is the control of the water quality in the downstream receiving waters. The methods suggested in this section for achieving water quality control involve the use of appropriate elements of the system. The design considerations for these elements are discussed in the Appendix F - Agriculture - Farming.

MAINTENANCE

Snag and debris removal from creek beds and ditches is usually an annual project which helps to maintain water in the channels and alleviate uncontrolled surface flow and soil erosion. Snag and debris removal must be conducted in a manner which does not impact the fisheries and wildlife values of the creek. Please refer to BMP 6-3 for additional information.

EFFECTIVENESS

Irrigation management will maintain meadow production, control soil erosion and improve water quality.

BMP 7-4
PASTURE & HAYLAND MANAGEMENT

DEFINITION

The use of haylands and pasturelands for improved forage production and management of soil and water resources.

PURPOSE

To provide for sustained forage production, protect the soil from erosion and maintain or improve water quality.

APPLICABILITY

Applies to all lands used for the production of hay and/or pasture.

PLANNING CRITERIA

Develop a management system for sustained forage production and land treatment practices suited to soil and site conditions.

METHODS AND MATERIALS

1. **Hay and Pasture Planting** - Plant hay and pasture lands to adapted forage species. Follow joint recommendations of the University of Nevada Agricultural Extension Service, U.S.D.A. Soil Conservation Service and other cooperating agencies. Lands cleared for pasture and hayland development must be treated as needed for erosion.

2. **Harvest Management** - Cut hay crops when plants are at the proper growth stage for high yields and good quality. Defer grazing of new pasture seedings until plants are well established. Allow adequate plant growth in the spring before starting grazing (six to ten inches of growth). Use a rotation grazing system with adequate regrowth time between grazing periods. Always leave sufficient plant residue to protect the soil from erosion and excessive runoff. Scatter manure with harrow or brush drag.

3. Fertilize according to agency recommendations, soil tests, and plant species requirements. Excess fertilizer may cause nutrient pollution in surface runoff or ground water.

4. Install irrigation and drainage systems adapted to the soil, site and water supply. (See Appendix F - Agriculture - Farming)

5. Control shrub invasion on native pasture and haylands.

6. Install diversion dikes or ditches as needed to divert excess irrigation runoff.

7. Install grassed waterways where needed to carry runoff waters.

8. Use no till seeding whenever possible.

MAINTENANCE

Manage grazing, harvesting, irrigation and fertilization to maintain a healthy plant community and a stable site.

EFFECTIVENESS

Using lands for production of hay or pasture under proper management will significantly decrease runoff and sediment delivery. Proper fertilizer practices will not adversely affect water quality.

BMP 7-5
SALINITY CONTROL

DEFINITION

The design and implementation of land and water management practices with the objective of reducing salt concentration in surface runoff and ground water.

PURPOSE

To maintain soil conditions suitable for plant growth while preventing degradation of downstream surface and ground water quality by excessive salt concentration.

APPLICABILITY

Applies to all irrigable land. However, the applicability to land with a high water table will be dependent on establishment of adequate surface drainage and the development of an acceptable drainage effluent disposal system.

PLANNING CRITERIA

In planning for salinity control, consideration should be given to other BMPs, including irrigation water management and appropriate conservation crop production elements.

Specific site characteristics that should be considered are:

1. Quality of receiving waters (stream and/or ground water).
2. Quality of irrigation water.
3. Salt content throughout soil profile.
4. Soil water-holding capacity and cation exchange capacity.
5. Topography.
6. Presence of a high water table.
7. Potential use of receiving waters.
8. Subsurface drainage.

METHODS AND MATERIALS

Since the purpose of salinity control is non-degradation of downstream water quality, the amount of salts leaving the site should be minimized. This means the principal treatment for excess salts is to leach the salts into the soil profile area below the rooting depth of the crop. However, in the instance where a high water table exists, requiring subsurface drainage and where continued reuse of the effluent builds salts in the soil close to the tolerance of even salt-tolerant crops, increased salt discharge will be unavoidable.

Practices that will effect some degree of salinity control are listed below. The greatest control will most often be achieved by a combination of practices. Two situations are considered: non-high water table areas and high water table areas. (High water table means the existence of a water table in the normal rooting zone of the crop.)

Non-High Water Table Areas

1. Adopt some form of irrigation scheduling. Apply only enough water to satisfy the crop irrigation requirement plus a calculated amount necessary to move excess salts below the root zone but not into the ground water.

2. Develop or modify the irrigation system so that the best possible water control and distribution can be achieved. The type of system will depend upon the topography, soil characteristics, and crop types.

3. Develop a tailwater recovery system. The extent of reuse and/or discharge will have to be compatible with receiving stream water quality and applicable water rights.

4. Develop a cropping system compatible with salinity control objectives. Factors of importance include amount of crop residue, rooting characteristics, nutrient requirements, and relative salt tolerance.

5. Where sodium-affected (greater than 15 percent of cations) or high pH soils occur, the appropriate soil amendment should be applied and incorporated into the soil. Amendments may include gypsum, soil sulphur, sulfuric acid, and organic material. The appropriate amendment and rate will be determined by soil analysis, local practice, and technical recommendations.

6. A minimal quality monitoring program, including receiving stream, surface runoff, and soils would be beneficial. This may be more practical on an area wide basis using "typical" cooperators.

High Water Table Areas

The practices mentioned above are appropriate for the high water table situations except for the type of drainage system and the management approach taken in utilizing irrigation scheduling. A subsurface drainage system may be developed in conjunction with the tailwater recovery system.

In high water table areas, irrigation scheduling concepts may be used to reduce the water applied to a crop by using a portion of the ground water to meet crop needs. Crop tolerances to salt will dictate how much applied water can be reduced and the degree of salinity control possible.

The amount of reuse will be determined by the extent of long term salt buildup in the unsaturated soil zone and in the drain effluent. At some point in time, discharge of the drain effluent may be necessary. This discharge should occur prior to the time that the salt concentration in the drain effluent exceeds that in the receiving stream, and/or off season leaching could be performed with direct discharge into the stream during high flows.

MAINTENANCE

Design and implement a regular preventive maintenance program for all facilities to ensure good, dependable operating conditions. Repair and replace facilities and system components as necessary. Periodically sample soils, drainage waters, and receiving streams. Regularly re-evaluate farm operation management including facilities and cropping patterns based upon monitoring data.

EFFECTIVENESS

The level of effectiveness will depend upon the extent that the practices are implemented. A high degree of downstream water quality control can be achieved by using all applicable practices at the specific site.

ASSISTANCE

Assistance in irrigation scheduling can be obtained from the U.S. Soil Conservation Service, and the Cooperative Extension Service.

BMP 7-6
CHISELING OR SUBSOILING

DEFINITION

Breaking up shallow, impervious layers in soils.

PURPOSE

To improve water infiltration, plant root penetration, and for protection from wind erosion.

APPLICABILITY

Applies to soils on cropland, hayland, or pastureland having impermeable layers.

PLANNING CRITERIA

Chiseling is used on soils with shallow impervious layers. Subsoiling is usually needed with deeper impervious layers. For maximum benefit, the penetration must extend completely through the impervious layers.

METHODS AND MATERIALS

Heavy duty equipment with sturdy shanks long enough to reach the desired depth is required along with a tractor of adequate power.

MAINTENANCE

It may be necessary to repeat the operation periodically, especially on clay soils that tend to flow back together. Proper cultivation can prevent the reforming of plowpans.

EFFECTIVENESS

Breaking up of impervious soils will improve water penetration and plant growth. Proper chiseling will effectively reduce surface erosion.

BMP 7-7
SOIL AMENDMENT, FERTILIZER & PESTICIDE MANAGEMENT

DEFINITION

Application of soil amendments, fertilizers and pesticides to cropland, hay and pastureland, rangelands or forest land for increased production and/or control of pests.

PURPOSE

To supply nutrients and/or biological or chemical soil amendments to promote optimum forage and crop yields, minimize entry of nutrients and chemicals to surface and ground water, and to control pests.

APPLICABILITY

This applies to lands where soil amendments and/or fertilizers are applied to increase productivity. Pesticides are applied for pest control.

PLANNING CRITERIA

1. Evaluate water quality standards and designated use limitations that exist locally or statewide in managing nutrients to protect the quality of water resources.

2. Evaluate sources and forms of nutrients available for plant growth and production and how they affect the nutrient budget for the proposed crop and target yield.

3. Consider the effects of the seasonal water budget on nutrient balance and on potential loss from the plant environment to surface or ground water. These effects will be the basis for developing the nutrient management plan for the practice application.

4. Consider legume cover crops or green manure crops, where feasible, to provide a nitrogen source for the next crop. Be sure to consider these effects in the nutrient budget.

5. Develop soil erosion control practices to reduce soil loss, runoff, and leaching of dissolved and attached nutrients.

6. Consider adjustments to rate, timing, placement, method of application, and nutrient form to meet seasonal variations in plant uptake needs, reduce soil fixation, and to avoid excessive soil-water solution nutrient concentrations that could leach out of the root zone when capacity is exceeded.

7. Consider induced deficiencies of nutrients due to excessive levels of other nutrients, the affect of soil pH on the availability of both soil and applied sources of plant nutrients and the optimum pH range of the crop to be grown.

8. Consider soil tilth and organic content in relation to plant nutrient absorption and root development should be considered.

9. Consider cover crops following crop harvest, where appropriate, to take up residual nutrients.

10. Consider practices such as crop rotations, selection of crop varieties, waste utilization, etc., that enhance efficiency of nutrient uptake and improve soil water conditions.

11. Consider waste storage and treatment needs to meet application timing as well as land area requirements for proper waste utilization.

12. Evaluate the effect of water table management or controlled drainage on availability and movement of nutrients.

13. Apply only those pesticides specifically approved for the crop, animal, or site specified on the label in accordance with labeled instructions registered with the Nevada Department of Agriculture. Always read the label on the pesticide container before using the pesticide.

14. Use pest control techniques that utilize Integrated Pest Management (IPM) systems. These include the use of pest predators or parasites, pest resistant plants, the use of insect pheromones, and the use of bacterial insecticides, to name a few. Utilizing this type of IPM approach could reduce reliance on the amount of pesticides used on a per acre basis.

15. Properly locate chemical mixing and equipment rinsing stations relative to potential for contamination of ground or surface water. Extreme care must be taken to follow loading and mixing procedures. Provide for managing accidental spills.

16. Properly rinse equipment and re-use rinse water for subsequent batches of the same pesticide or herbicide, where possible.

17. Store pesticides in original containers in a locked, well ventilated, weather resistant building. Post warning signs on or around the building. Locate the building so that accidental spills will create minimal environmental effects. Dispose of pesticide containers according to label directions and adhere to local or state regulations.

18. Provide emergency wash stations for personnel who might be accidentally exposed to chemicals, and formulate a safety plan complete with information about locations of emergency treatment centers for personnel exposed to chemicals.

19. Ensure that backflow prevention devices are installed and operating properly on irrigation systems used for applying pesticides.

METHODS AND MATERIALS

1. Nutrient rates applied to agricultural land shall be based on soil test results, where applicable. Frequency of soil tests and/or plant tissue tests shall be specified.

2. Establish realistic yield goals based on soils, available moisture, historical yield data, climatic conditions, and the level of management necessary to minimize potential nutrient loading of surface water and ground water.

3. Develop a nutrient management plan for the crops to be grown. Account for the residual amount of nutrients in the soil and crop residue, add estimated nutrients from anticipated organic waste applications, and then determine the amount of chemical fertilizer needed to meet the nutrient needs of the proposed crop and target yield. Specify the crop, crop rotation, the type, source, and amount of plant nutrients that will be used to meet the crop fertility needs.

4. If non-farm organic waste is to be used, it shall be analyzed for content and applied as prescribed by federal, state, or local regulations. Appropriate documentation of the amounts applied should be maintained.

5. Livestock waste shall be analyzed prior to land application to establish nutrient credits and application rates.

6. Credit for nitrogen contributions from legume crops in rotation shall be consistent with current land grant university recommendations.

7. Develop a water budget that will describe the seasonal distribution of water resources under the appropriate soil-crop-management system.

8. Use the "Leaching Index for Soluble Nutrients" procedure or other detailed guidelines from land grant universities to evaluate groundwater pollution potential in conjunction with the water budget for the location.

9. All specifications will be consistent with the water and local regulations.

10. When using pesticides, follow all label directions. If assistance is necessary in choosing a particular pesticide ask a pesticide supplier and/or a technical assistance agency for their recommendations. **Follow any county specific limitations on pesticide use. Use only pesticides that are registered for use in the State of Nevada by the Nevada Division of Agriculture.**

MAINTENANCE

Follow up fertilizer applications may be needed to maintain fertility on cropland, hayland and pastureland. Site specifics may dictate additional soil amendments, fertilization and pesticide application.

EFFECTIVENESS

Using recommended rates and application procedures for fertilizers and pesticides will provide improved forage and crop production with little or no detrimental effects on water quality.

LIVESTOCK

BMP 7-8
PLANNED GRAZING SYSTEM

DEFINITION

A livestock/wildlife grazing system in which two or more grazing units are alternately deferred or rested from grazing in a planned sequence over a period of years. The rest period may vary in duration given the specifics of the grazing area (i.e. season, year, etc.).

PURPOSE

1. To maintain or improve plant cover, plant composition and forage production while properly using the forage on all grazing units.

2. To improve efficiency of grazing by uniform use of all parts of each grazing unit.

3. To provide a supply of forage throughout the grazing season.

4. To improve the quality of forage available to animals during specific seasons.

5. To protect watersheds, reduce runoff and sedimentation for the improvement of surface and ground water quality.

6. To improve wildlife habitat.

APPLICABILITY

Applies to native grazing lands, including those treated by spraying, seeding, etc., grazable woodlands and grazed wildlife lands. Grazing management may be applied to a single grazing unit and may be adequate to meet water quality objectives where proper grazing use and uniform distribution can be obtained.

PLANNING CRITERIA

The grazing system plan should:

1. Consider the climate, soils, range sites, present vegetative conditions, topography and other ecological conditions.

2. Allow forage use allocation for livestock and wildlife.

3. Be coordinated among all effected interests and natural resources. A "watershed" view should be established to identify all of the resources and interests. The coordinated approach should include federal land management agencies, state agencies, private land owners, other grazing users and applicable special interest groups. A variety of Resource Management and/or grazing systems are available given the specifics of the site including Holistic Resource Management, Coordinated Resource Management, and Savory Grazing Systems, to mention a few.

4. Consider specific management measures to alleviate livestock distribution problems such as concentrated use of riparian areas or other critical areas.

5. Should consider the kinds of livestock and the operator's objectives in conjunction with the federal land management objectives if the plan involves public lands.

6. Allow for practical application of the system and be flexible enough to meet the needs of key plant species and communities in relation to climatic fluctuations.

7. Consider the facilities needed for proper distribution and uniform use of grazing units such as fences, stock water developments, stock trails, access roads, salt, and supplemental feeding stations.

8. Provide for prolonged drought or other unusual circumstances. A monitoring plan should be included which monitors plant species use and condition with respect to the desired condition.

9. Consider economic costs in relation to the benefits expected from the entire system.

METHODS AND MATERIALS

1. **Grazing Management Systems** - Appropriate grazing management systems ensure proper grazing use by adjusting grazing intensity and duration to reflect the availability of forage and feed designated for livestock uses, and by controlling animal movement through the operating unit of range or pasture. Practices that accomplish this include:

   A. Deferred grazing - usually is defined as the postponing or resting of livestock grazing on an area for a prescribed period to provide for plant reproduction, establishment of new plants, or restoration of vigor to existing plants.

   B. Deferred-rotation grazing - Provides for a systematic rotation of deferment among two or more units.

C. Rest-rotation grazing - Provides for adequate rest to restore and maintain plant vigor, reduced trampling of mature seeds after plant maturity, and establishment of seedlings. Grazing and rest are systematically rotated until all pastures within the system have received treatment. Rest periods may be throughout the year, during the growing season of key plant species or may include one full year of rest.

2. **Livestock Distribution** - Proper distribution of livestock is needed for the efficient and uniform use of each grazing unit. A livestock operator can implement the management practice of herding or moving livestock when the desired plant use has been attained in a given area:

A. Fencing - Fences are usually required for livestock control and to divide ranges into grazing units of near equal capacity. Fences are also needed to exclude livestock from sensitive or critical areas. (See Appendix G-5 for fencing guidelines and specifications)

B. Stockwater Developments - It is essential to provide adequate water for livestock within reasonable distance of the grazing areas. Implementation of an improved grazing system often concentrates livestock requiring development of new or higher capacity watering facilities. In some applications water alone can be controlled to move livestock from one area to another.

There are several methods of developing stock water, including:

(1) Spring developments - Improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities.

(2) Wells - Constructed or improved to meet the needs of livestock and wildlife.

(3) Stockwater ponds and dugouts - A water impoundment made by constructing a dam or an embankment, or by excavation of a pit or dugout.

(4) Pipelines, trough or tank - Pipeline to convey water to areas with no water source and a trough or tank for storage.

(5) Photovoltaic pumping systems.

(6) Ram pumps.

(7) Windmills.

C. Stock Trails - May be needed where natural or man-made barriers limit access and movement of grazing animals. (See Appendix G-4 for guidelines and specifications for stock trails)

D. Salt, Mineral and Feed Supplement Locations - These need to be properly placed for good distribution of grazing animals throughout each grazing unit. They may be placed in light use areas away from water.

3. **Access** - It is necessary to have good access to all grazing areas for livestock management and to service and maintain facilities. Refer to NRS.535.010 on permit requirements for stock watering ponds and dams.

MAINTENANCE

Proper grazing use will maintain enough live vegetation and litter cover to protect the soil from erosion; will achieve riparian and other resource objectives; and will maintain or improve the quality, quantity and age distribution of desirable vegetation. Maintain fences and other facilities for efficient operations. Follow proper grazing use, that is, grazing at an intensity that will maintain plant cover and maintain or improve the quantity and quality of desirable vegetation. Adjust system plans based on inspection and records of utilization.

EFFECTIVENESS

A properly operated grazing system provides for efficient use of forage and is an effective means of maintaining a plant cover that will reduce runoff and sediment delivery. How effective grazing management will be is dependent upon both the quality of the design in relation to the land and the skill utilized to implement, monitor and adjust management to meet objectives.

BMP 7-9
PROPER GRAZING USE

DEFINITION

Utilizing grazing practices at an intensity which will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation.

PURPOSE

To improve or maintain the condition of a plant species or community; to improve vegetative ground cover; and to maintain or improve the quality of surface runoff water on upland areas. In riparian areas, the purpose is to provide minimum vegetation stubble height to slow runoff, trap sediment, and ensure adequate root mass to hold banks during spring run off events.

APPLICABILITY

On all rangeland, woodland, pasture land, wetlands, riparian areas, and cropland utilized for livestock or wildlife grazing.

PLANNING CRITERIA

Specific grazing or allotment plans should consider the following:

1. Grazing frequency;
2. Stocking rates and distribution;
3. Class and age of livestock, wildlife or free roaming horses or burros;
4. Season of forage use and the duration of each rest and grazing period;
5. Historic and/or prior livestock distribution problems including areas with concentrated use or overuse and areas where forage has remained unused.
6. Manager preferences for plant species, the abundance of those species and the forage use allocation for livestock, wildlife or free roaming horses and burros;
7. The grazing system being used;
8. Physical terrain limitations, access and water sources;

9. Desired vegetation in riparian and/or critical areas is of significant importance to wildlife, fisheries and watershed function.

10. Other public land users.

The importance of climate and weather patterns must also be recognized with a certain flexibility provided for extreme variations in amounts of forage from year to year.

The best measure of proper use and management is the response of the range over a period of time to a comprehensive management system. An experienced range manager can recognize the signs of response and the range trend. Management decisions should then be based upon sound scientific data and analysis.

METHODS AND MATERIALS

Consult with a qualified range management professional in either the private or public sector before establishing a grazing management system. The following are key elements for proper grazing use.

1. Use a comprehensive data form that provides a use record of key forage species each year or grazing season.

2. Keep a record for each grazing unit and make evaluations of use in representative areas of each unit based on species composition and normal grazing patterns in the unit (See Appendix G-3).

3. Maintain a photographic record of range conditions at established photo points.

MAINTENANCE

Maintain proper use by adjusting grazing as indicated by plant response and trend in range condition.

EFFECTIVENESS

Proper grazing use will improve range production and vegetative cover to reduce runoff and sediment delivery.

BMP 7-10
RANGE IMPROVEMENTS

DEFINITION

Improving the existing rangeland through specific treatments including seeding, planting, prescribed burning, and brush/weed management.

PURPOSE

To improve watershed quality, conserve soil and water resources and reduce sediment delivery; produce forage for livestock and wildlife; improve plant species diversity; and improve recreation, wildlife and the natural resource values of the land.

APPLICABILITY

Applies to grazing lands: where the land does not have enough desired plant species diversity to recover in a reasonable period by management alone; where existing vegetation would out compete introduced plant materials; following wildfires or brush management treatment, and where soil, climate, and topography are suitable for establishment of the desired plant community.

PLANNING CRITERIA

Compile the necessary base line data to determine the specific range improvement best suited for the site. Consultation with a qualified range management professional in the private or public sector is recommended.

1. Determine site suitability for seeding or containerized planting - slope, soils, elevation, available moisture, etc.

2. Select species for seeding or planting that are adapted to the site. Mixtures of grasses, forbs, shrubs, etc. are better than single species plantings on most sites.

3. Determine the requirements for acceptable methods of site preparation, soil amendments, planting or seeding.

METHODS AND MATERIALS

The following practices can be utilized to improve rangelands (See Appendix G).

Pasture and Hayland Plantings - Establishing and reestablishing long-term stands of adapted species of perennial, biannual, or reseeding forage plants.

Range Seeding - Establishing adapted plants by seeding on native grazing land.

1. On tillable land, the soil should be tilled with a rangeland plow, chisel plow, or one-way disk. Depth should be as shallow as possible while still eliminating competing vegetation. Double plow if necessary. Perform operations across the slope or on the contour.

2. Pitting or contour furrowing may be used in special situations where complete tillage is not practical or desired, or where other tillage methods would create serious erosion hazards. Chain drags can be used where plowing is not feasible.

3. Tillage operations should leave as much plant residue on the soil surface as possible for seedling protection, moisture conservation and erosion control.

4. Seed with a rangeland drill or, on well-prepared seed beds, a grain drill equipped with agitator and depth regulators. Broadcast seed only on areas that are too rocky or where seeding is not practical for other reasons.

5. Fall or early winter seedings are best. Spring seedings can be used on small areas or sites that remain wet and cold into late spring. (See Cooperative Extension Publication C - 183 for species, mixtures, and seeding rates.)

Critical Area Planting - Planting vegetation, such as trees, shrubs, vines, grasses or legumes on highly erodible or critically eroding areas.

Brush and Weed Management - Managing and manipulating stands of brush and weeds on range, pasture and other areas by mechanical, chemical, biological means or by prescribed burning (See Appendix G-7).

Prescribed Burning - Applying fire to predetermined areas when the intensity and spread of the fire are controlled. (See BMP 6-6, "Prescribed Use of Fire").

MAINTENANCE

1. Seedings must not be grazed until the plants are well established. Usually it is necessary to protect seedings from grazing for one full year and through the growing season of the second year. Some seedings established during adverse weather cycles may need protection for a longer period.

2. After seedings are established, follow established grazing management practices. (See BMP - 7-9 - "Proper Grazing Use" and BMP - 7-8 - "Planned Grazing System")

EFFECTIVENESS

Well established and managed range seedings protect watersheds from excessive runoff, reduce runoff, reduce erosion and sediment delivery.

BMP 7-11
LIVESTOCK FACILITIES

DEFINITION

Livestock containment facilities are structures built or used to hold livestock, including but not limited to: corrals, holding pens, feed lots, barns and sheds.

PURPOSE

To reduce the degradation of surface runoff water quality and the potential to contaminate ground water resources resulting from the confinement of livestock.

APPLICABILITY

Applicable to areas where livestock are concentrated, such as horse corrals, feed yards, and holding pens. Runoff and leachate from these facilities can be high in nutrients from animal feed and manure and create water quality problems especially if located near a streamside management area (SMA) or areas with a high water table.

PLANNING CRITERIA

The siting and construction of livestock containment facilities is important and sites should be carefully chosen based on the following guidelines.

1. Facilities should not be located in or near a SMA .

2. Facilities should not be located in areas subject to overland surface flow or flooding from upslope areas.

3. Facilities should be located on gently sloping to flat land (5% slope or less).

4. Facilities should not be located in areas which have less than four feet from the soil surface to the ground water table at any time of the year or areas having a high leaching potential.

In addition to the proper location of livestock confinement facilities, the following guidelines should be followed:

1. Surface runoff and related discharges from livestock containment facilities should be limited by:

* Storing both the facility wastewater and the runoff from confined animal facilities that is caused by storms up to and including a 25-year, 24 hour frequency storm. Storage structures should:

    a. Have a compacted clay seal or plastic membrane lining, or
    b. Be constructed with concrete, or
    c. Be a storage tank.

* Managing stored runoff and accumulated solids from the facility through an appropriate waste utilization system.

2. Surface runoff from these facilities or animal waste stockpile should not be allowed to flow into a SMA.

3. Stockpiling of animal wastes should be thoroughly investigated for the potential to degrade the soil profile and ground water resources. Any runoff or drainage from animal waste stockpiles or the facility area should be routed to the runoff storage system.

4. Manure storage or animal waste piles should be protected from precipitation and surface runoff.

5. When applied to agricultural lands, manure, stored runoff water, stored facility wastewater, and accumulated solids from the facility are to be applied utilizing appropriate nutrient management measures. An appropriate waste utilization system to minimize impacts to surface water and to protect ground water may be achieved through implementation of the SCS Waste Utilization Practice (633).

6. Anaerobic ponds can be used to reduce odors and solids, improve water quality and generate methane gas.

METHODS AND MATERIALS

Livestock confinement facilities should be located, designed, and constructed under the direction of qualified professionals. If the facility is to be served by vehicle, the site should have loading-unloading areas that are outside of SMAs.

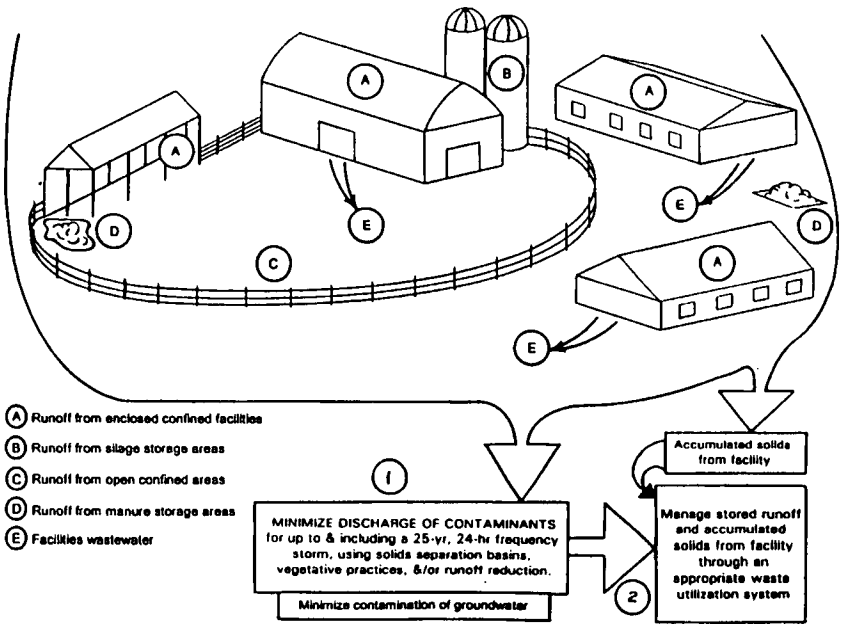
MAINTENANCE

A comprehensive inspection and maintenance program should be developed based upon the specifics of the site. Inspections should be conducted regularly, particularly after precipitation or storm events and repairs made as required.

EFFECTIVENESS

Properly maintained and operated facilities can be effective in preventing the discharge of degraded surface runoff and minimize ground water quality degradation.

FIGURE 7-1 (DAIRY 1)
CONTAMINATION CHART



CHAPTER 8

FOREST RESOURCE MANAGEMENT

BMP 8-1 ACCEPTED FOREST PRACTICES
BMP 8-2 WILDLAND/URBAN INTERFACE MANAGEMENT
BMP 8-3 FUELS MANAGEMENT

BMP 8-1
ACCEPTED FOREST PRACTICES

DEFINITION

The incorporation of the Amended Forest Practice Rules consist of Protect, and Preservation of Timber Land, Trees and Flowers of NRS 527.010-527.300 and Forest Practices Act of 1955, NRS 528.010-528.090. Timber resources in Nevada are the responsibility of the Nevada Division of Forestry (NDF) and other federal land management agencies, the US Forest Service and the USDI Bureau of Land Management.

PURPOSE

To protect, preserve and enhance forest resources through forest health management; providing for water quality, reduce soil erosion and the control of runoff and sediment delivery from forestlands.

APPLICABILITY

On sites affected by silvicultural activities such as timber harvesting, stand improvement, firebreaks and related access construction; also riparian zones directly or indirectly affected by such activity.

PLANNING CRITERIA

1. **Timber Harvesting Plan** - Through use of a timber harvesting plan, it is essential to provide for water quality as well as future continuous timber growth and protection of other resources on timberlands.

2. **Silvicultural Methods** - Every timber operator should exercise due diligence in the management and operation of felling, yarding, and loading of timber or other related activity to prevent unnecessary damage to residual trees, riparian vegetation and water quality.

3. **Erosion Control** - Timber operators should conduct operations in a manner to protect soil resources from unnecessary damage and erosion. Tractor roads, skid trails, landings, logging roads, and firebreaks should be located, constructed and left after logging so that water flow thereon and water flow in natural water courses do not contribute to excessive erosion of soil and degradation of water quality. Waterbreaks should be installed on tractor roads, skid trails, landings, logging roads and firebreaks.

Following silvicultural activity, natural water courses should be opened where permanent culverts and bridges have not been constructed and seeding or other practical measures should be taken to meet the objective of preventing excessive soil erosion and the degradation of water quality.

4. **Riparian Zone Protection** - Careful consideration should be given to ensure the protection of water quality and the biological capacity of streams and lakes. Further consideration should be given to minimizing erosion of stream beds and lake banks during timber operations. Streams should be kept free of slash, debris, side cast and other materials and accidental deposits should be expeditiously removed. Trees harvested within the zone of influence of the stream or lake should be removed in such a manner as to minimize erosion and maintain water quality. Discharge of soil, bark, slash or the organic and inorganic material from any logging, construction, or associated activity into any lake or stream in quantities deleterious to fish, wildlife, or other beneficial uses of water should be prevented.

5. **Hazards Reduction** - Special provisions should be made to reduce fire hazard. Accelerated erosion may occur after a fire.

Pesticide use in Nevada is regulated by the Nevada Division of Agriculture (DOA). DOA has developed a State Management Plan for the use of pesticides and should be contacted in conjunction with NDF regarding the types and amounts of pesticides proposed for use.

METHODS AND MATERIALS

See Practices in Appendix H-1.

MAINTENANCE

Structural measures such as bridges, culverts and water bars are to be maintained in a condition that will adequately perform their designated function. Vegetation should be replanted in revegetated areas that fail to establish. Protection of revegetated areas from livestock, vehicle or foot traffic and fire should be continued.

EFFECTIVENESS

The use of the Amended Forest Practice Rules as a base for more site specific planning can be a highly effective method for reducing sediment loads in runoff water from these sites.

BMP 8-2
WILDLAND/URBAN INTERFACE MANAGEMENT

DEFINITION

The management of the area where urban development meets wildlands, which is defined as the wildland/urban interface.

PURPOSE

Vast areas throughout Nevada and the United States now contain high value urban development intermingled with flammable native and adapted vegetation, the "wildland/urban interface". Structural fire losses are increasing, and the threat of major loss of life has become a reality. Recent devastating wildfires have occurred within the wildland/urban interface areas of Nevada which identifies the need to manage the wildland/urban interface in an attempt to minimize the threat of wildfire.

APPLICABILITY

To all areas where urban development has encroached upon wildlands or urban areas which have heavy, extensive landscaping susceptible to wildfire.

PLANNING CRITERIA

Basic planning criteria should include developing the necessary baseline data required to implement a comprehensive wildland/urban interface management program. Primary base line data is governed by the specifics of the management area but, at a minimum should include topography, vegetation, climate/weather, land use, access/escape routes, infrastructure, suppression capabilities and emergency services.

METHODS AND MATERIALS

The following items should be considered when developing a management plan for a wildland/urban interface area.

1. **Prevention Programs -** A prevented fire requires no suppression and results in no damage.

   Education: Development of a fire prevention program to motivate the public to be fire safe by teaching simple precautions.

   Regulations: Developing rules and regulations which control specific land uses and the publics actions within the wildland/urban interface.

Law Enforcement: The enforcement of fire laws and regulations is essential to effectively prevent wildfires.

2. **Presuppression Programs -** The reduction of highly flammable fuels through fuels management.

   Fuelbreaks: Fuel density is reduced or a vegetation type is converted to a less hazardous, more fire retardant type in a strategically located, easily accessible strip of land. Fuelbreaks serve as a line of defense, break up large uniform areas of fuel, save lives and reduce suppression costs. Primary methods include: herbicide application, mechanical application, livestock grazing, and prescribed burning (See BMP 8-3 , "Fuels Management").

   Planning, Zoning and Development Regulations: Urban development proposed for wildland areas must address planning for fire protection, fire access requirements, fire safe building practices, water supplies and property clearing and maintenance for ongoing fuels management. Fire hazard risk assessments should be conducted by all state and local governments to identify upfront those areas prone to wildfire. Urban development should be restricted or extensively controlled in these areas.

   Greenbelts: The use of greenbelts has been successful in providing safety from wildfire. A greenbelt is designed to provide a buffer zone between the highly flammable wildland vegetation and the urban environment. Typical greenbelts include: golf courses, parks, cemeteries, reservoirs and agriculture.

3. **Suppression Activities -** Wildfire suppression or wildland fire control is at best one of the most hazardous activities ever undertaken by man. The following elements comprise effective and systematic wildfire suppression activities.

   Advanced Fire Planning: The development of initial attack plans for specific areas including the deployment of men and equipment, tactics, and evacuation.

   Fire Communication Systems: Reliable communications and the application of the nationally recognized Incident Command System (ICS) is critical.

   Fire Transportation Systems: Transportation systems provide the means and facilities for moving men and equipment to and from the fire area. Effective transportation systems save valuable time and improve initial attack on the wildfire.

   Manpower & Equipment: Well trained and well equipped wildfire crews are essential to successful wildfire suppression. Equipment requirements include hand tools, mechanized equipment and aircraft resources.

Cooperative Agreements: Cooperative agreements and/or mutual aid agreements reduce the need for duplication of efforts, improve coordination, and minimize funding constraints. Effective wildfire suppression relies heavily on mutual aid agreements, given the shear magnitude of wildland fire.

4. **Rehabilitation Activities -** Activities to promote the recovery and reestablishment of adapted and native plants destroyed by wildfire, to reduce accelerated soil erosion and to do so as quickly as possible. Primary rehabilitation activities include: seedling planting, drill seeding, broadcast seeding, sediment and erosion control structures and soil stabilization treatments (See BMP's 2-1 through 3-8).

MAINTENANCE

A wildland/urban interface management plan requires ongoing maintenance activities in several areas. The management plan should be updated annually or whenever there is a significant change in land use or a component of the plan. A fuels management plan should be developed (BMP 8-3, "Fuels Management"), and on going maintenance provided to continue the effectiveness of the treatment.

EFFECTIVENESS

The development and maintenance of a wildland/urban interface management plan will be highly effective if it is regularly reviewed and updated.

BMP 8-3
FUELS MANAGEMENT

DEFINITION

Management and manipulation of vegetation by mechanical, chemical, or biological means, or by controlled burning on forestland, rangeland, native pasture, pastureland, and public or private land (Includes reducing excess brush stands through selective and patterned control methods to protect the soil and maintain or improve the quality of runoff water).

PURPOSE

To maintain or reduce a level of vegetation to minimize the threat of wildland fire.

APPLICABILITY

The term "fuels" as used in the practice, includes woody half-shrubs, shrubs, and trees (alive, dead or dying) which invade lands on which they are not part of the natural (climax) plant community or which occur in amounts significantly in excess of that which is natural to the site.

PLANNING CRITERIA

A fuels management plan requires the careful integration of vegetation treatments to all components of the vegetative community. Effective fuels management requires the reduction and/or removing and disposing of ground, overstory and ladder overstory fuels. Components of a fuels management plan are driven by the vegetation of the site and may include the following.

1. Timber harvesting, thinning, and pruning.

2. Brush removal, pruning, and trimming.

3. Debris removal utilizing lopping and scattering, burying, piling and burning, and chipping.

Fuels management also requires consideration of site specific factors such as slope, aspect, species diversity, horizontal and vertical continuity, and proximity to improvements. While these factors are highly variable, and the number of combinations are unlimited, criteria and guidelines for implementation of fuels management programs have been developed by forestry and wildland fire professionals such as the Nevada Division of Forestry.

METHODS AND MATERIALS

Please refer to Appendix H-3.

1. Mechanical
   a. Plowing
   b. Chaining
   c. Harvesting, thinning, trimming
   d. Mowing, chipping, logging, and beating

2. Burning

3. Chemical (Herbicides)
   (See Appendix H-3 for specifications and guidelines)

MAINTENANCE

1. Follow best management practices including proper grazing use.

2. Follow up treatments will be required on most fuels management areas. Length of time between treatments will depend on the effectiveness of the vegetation kill in the initial treatment and species of trees and shrubs involved.

EFFECTIVENESS

Fuels management is effective in improving watershed conditions for better water infiltration, reduced runoff and lower sediment delivery and for wildland fire protection.

CHAPTER 9

MINING

BMP 9-1	MINERAL EXPLORATION
BMP 9-2	EXCAVATION STABILIZATION
BMP 9-3	SURFACE RUNOFF MANAGEMENT
BMP 9-4	WASTE ROCK DUMP MANAGEMENT
BMP 9-5	IMPOUNDMENT MANAGEMENT
BMP 9-6	RECLAMATION

BMP 9-1
MINERAL EXPLORATION

DEFINITION

Best Management Practices (BMPs) utilized in the management of exploration or development drill sites.

PURPOSE

To minimize erosion, sedimentation and other environmental pollution which is generated during mineral exploration or development drilling operations.

APPLICABILITY

Applicable to all mineral exploration or development drilling activities where a surface disturbance occurs.

PLANNING CRITERIA

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation regulates mineral exploration and mining operations within the state of Nevada. Federal land management agencies and some local governments also regulate mineral exploration and mining operations. **Before any mineral exploration is initiated, the appropriate federal, state and local permits should be obtained**. The Nevada Division of Water Resources regulates drilling and drill hole plugging activities. Specific regulations govern these activities and any proposed mineral exploration project should review the applicable requirements. Drill holes are potentially direct conduits to ground water sources and as such, represent a significant threat to ground water quality. The proper closure and abandonment of drill holes is a high concern.

Selection of BMPs for mineral exploration or development drilling are governed by the specifics of the site (i.e. topography, elevation, precipitation, vegetation, etc.). Activities typically involved in exploration projects may include: road building, drainage crossings, drill pad construction, trenching, mud pit construction, and heavy equipment transport and use. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems

* Watershed Management
* Waste Management
* Miscellaneous

Proper mineral exploration or development drilling activities require comprehensive pre-disturbance planning, project engineering design and installation specifications, a conscientious commitment to proper maintenance and reclamation practices. Project management scheduling and management typically lend themselves to concurrent reclamation as phases of the drilling are completed.

METHODS AND MATERIALS

A qualified professional should be selected to assist in the project design through reclamation phases. Close coordination with the applicable federal, state and local agencies is necessary. BMPs selected should be properly designed and installed per the engineering specifications.

MAINTENANCE

A site specific maintenance and repair program should be developed with a mineral exploration or development project. Proper maintenance is critical to the effectiveness of selected BMPs and the minimization of erosion and sedimentation.

EFFECTIVENESS

A well planned, designed, implemented and reclaimed mineral exploration project can be successfully completed with minimal impacts to surface and ground water quality.

BMP 9-2
EXCAVATION STABILIZATION

DEFINITION

Stabilization of mined surfaces to prevent erosion, sedimentation and the degradation of surface and ground water quality.

PURPOSE

To prevent discharge of sediments or other pollutants into stream channels, drainage ways or waters of the state.

APPLICABILITY

Stabilization practices are applicable to surface disturbances resulting from mining activities that are subject to forces of erosion.

PLANNING CRITERIA

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation regulates mineral exploration and mining operations within the state of Nevada. Federal land management agencies and some local governments also regulate mineral exploration and mining operations. **The applicable agencies must be contacted and coordinated with before initiating mineral excavations within the state of Nevada.**

Nonpoint source impacts to surface and ground water quality from mine excavation activities may be prevented or minimized by properly designing and implementing stabilization and reclamation practices. The majority of potential water quality impacts can be averted by upfront planning before land disturbance is initiated. Planning elements to consider include: design and siting of the mine site, facilities, haul and access roads; mining operations and maintenance; design and implementation of sediment and erosion controls prior to surface disturbances; proper mine closure procedures; and for concurrent and final reclamation activities consistent with federal and state regulations.

Various methods are available for stabilizing mine surfaces. Decision as to the appropriate type should be based on careful consideration of the specifics of the site including: magnitude of problem, installation requirements, local conditions, and future maintenance requirements. Topsoil should be stockpiled in conjunction with any disturbance to assist in reclamation efforts.

METHODS AND MATERIALS

General BMPs for mine excavations are described below. Site specifics may require more detailed design and engineering. **A qualified professional engineer should be consulted where appropriate**. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems
* Watershed Management
* Waste Management
* Miscellaneous

1. Open Pit Backfilling & Stabilization

Depending upon the type of deposit, the geochemistry of the rock, and water (if present) in the pit, backfilling or partial backfilling, can be a viable means for stabilization and reclamation. Backfilling will typically be compatible with post-mining land uses and management objectives, reduce visual impacts and minimize the impoundment of surface water.

There are three types of backfilling which can be accomplished concurrently or at the end of mining.

Total Backfilling - Potentially extends the duration of the project and may not be economically feasible, but this is balanced against returning the landform more nearly to its original configuration.

Partial Backfilling or Screen Slope Backfilling - This practice is typically done to modify or conceal visual impacts and to increase slope stability of the pit walls. Sometimes utilized as a compromise to total backfilling.

Concurrent Backfilling - Commonly done at mine sites with multiple pits where production schedules can accommodate direct placement of waste rock in an open pit. This method is advantageous because it is cost effective, reduces the size, extent and reclamation of waste rock dumps and allows for a productive post-mining land use.

2. **Highwall Stabilization**

The configuration of a highwall including: the highwall, the overall slope angle, and the bench heights/widths should be designed based upon site specific factors such as rock alteration(s), rock types(s), structure, rock competency and the individual weathering characteristics of each lithologic unit. Slopes created by a mining operation are required by Nevada state law, to be in a stable condition at final reclamation.

The stabilization or reclamation of pit highwalls may range from leaving the highwall stand, to scaling it down or backfilling it to some extent. Fencing or berming is typically incorporated into final reclamation to protect the safety of the public.

3. **Trenches & Bladed Areas**

The stabilization of trenches and bladed areas includes the following elements.

* Topsoil should be stockpiled separate from any subsoil or bedrock materials.

* Utilization of mechanical hoes results in less surface disturbance than bulldozers.

* Trenches should be reclaimed immediately or stabilized by reducing the slope of the walls. If the trench is not immediately reclaimed sediment and erosion control measures should be implemented, and hazards to people, livestock and wildlife addressed.

* The reclamation of trenches and bladed areas includes backfilling, regrading to the original slope and contour, spreading of the stockpiled topsoil and revegetating the disturbed area.

4. **Placer Operations**

Placer operations typically involve the disturbance of stream management areas, including the stream bed. The control of sediment and erosion becomes more difficult and requires the design and installation of sediment and erosion control structures, usually in series. Impacts to riparian and aquatic vegetation, fisheries and wildlife habitat all become concerns which must be addressed. **Coordination with federal, state and local regulating agencies is necessary. Qualified professionals are recommended for the design and implementation of placer operations**.

MAINTENANCE

A comprehensive maintenance program should be developed for all mine excavation operations. Regular maintenance is necessary throughout the life of the mine, design, development through closure and reclamation. The project area must be left in a stable condition for long term recovery as required by state and federal law.

EFFECTIVENESS

When properly designed, installed and maintained mine excavation and stabilization practices should be an effective means to control erosion, prevent soil loss, and protect water quality.

NOTE:

For specific guidance on excavation stabilization refer to U.S. Soil Conservation Service Technical Guides, U.S. Forest Service Handbooks, U.S. Department of the Interior - Bureau of Land Management Mining Regulations and handbooks, and the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation.

BMP 9-3
SURFACE RUNOFF MANAGEMENT

NOTE

Nevada is an authorized National Pollutant Discharge Elimination System state, and its stormwater program covers all active and inactive mine sites with a general stormwater permit; as such, mines are treated as point sources for purposes of the permit.

Areas **NOT** covered by this program are: haul roads constructed of conventional materials and not subject to spillage, parking lots, reclaimed areas released from bond, grassy areas, office buildings, and areas released from bond that are inadequately reclaimed.

Stormwater coming in contact with "industrial" areas of mine sites will be permitted. Examples of industrial areas include: industrial buildings, haul roads constructed of waste rock or spent ore or which are used to transport industrial materials, milling, concentrating and processing areas, waste rock dumps, spent ore dumps, chemical and fuel storage areas, and truck wash areas.

NPDES and stormwater general permits do not apply once the mining site has met closure and reclamation requirements.

BMPs should be implemented on all mining and mining related sites to prevent, control and minimize nonpoint source pollution and to protect water quality. BMPs throughout this manual are provided as guidance and should be selected and applied on a site specific basis appropriate to the goals and objectives of the project, existing environment and site management requirements.

DEFINITION

BMPs utilized to manage surface or stormwater runoff from mine sites and all ancillary facilities including areas being reclaimed, areas covered by NPDES permits and sites not subject to permit requirements.

PURPOSE

To prevent and control nonpoint source pollution impacts to surface and ground water from mine site stormwater runoff.

APPLICABILITY

Surface or stormwater runoff management practices are applicable to all mining industry related sites, active, inactive, temporarily closed or reclaimed.

PLANNING CRITERIA

Surface or stormwater management practices should be incorporated into permit requirements as per regulation, and should be accepted protocol for mining related sites, operations, designs and project planning. A mine site which had or has the potential for acid rock drainage, metal leaching or related water quality concerns should be particularly concerned with surface water management.

A risk identification and assessment of the potential pollution or contaminant sources should be completed. Data should be gathered for each contaminant source including: type, quantity, characteristics, toxicity, mobility and the potential for release to surface or stormwater flows. A contingency plan should also be developed which addresses each of the existing or potential contaminant sources. Monitoring may also be a necessary component to stormwater management. The gathering and compiling of baseline data on stormwater quality will clarify agency concerns and protect all involved.

Employee training on the components of the stormwater runoff management program, practices, good housekeeping and maintenance related to those practices should be implemented on a timely basis.

METHODS AND MATERIALS

The development of a stormwater runoff management program may require the expertise of a qualified professional engineer. Coordination with the appropriate federal and state regulatory agencies is also necessary. A variety of BMPs may be required as described in the following sections of this document.

* Road and Construction Site Practices
* Erosion and Sediment Controls
* Soil Stabilization Practices
* Slope Stabilization Practices
* Infiltration Systems
* Watershed Management
* Waste Management
* Miscellaneous

MAINTENANCE

A comprehensive maintenance plan should be developed and incorporated into the stormwater runoff management program. Regular maintenance particularly after contaminant spills, precipitation and storm events is necessary. Identified problems should be repaired immediately, prior to the next storm event.

EFFECTIVENESS

Stormwater runoff management practices when designed, installed and maintained properly are effective methods to treat nonpoint source pollution and minimize impacts to surface and ground water quality.

BMP 9-4
WASTE ROCK DUMP MANAGEMENT

DEFINITION

The management, handling and construction of waste rock dumps comprised of waste rock generated by mining activities.

PURPOSE

To provide guidance for waste rock management for the expressed purpose of preventing and controlling erosion, improving slope stability and reclamation success, and minimizing impacts to surface and ground water quality.

APPLICABILITY

Mine waste rock management and waste rock dump construction practices are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure.

PLANNING CRITERIA

The proper management and handling of waste rock and the proper design and construction of waste rock dumps has a direct effect on slope stability, closure and reclamation success. Generally speaking, a reduction in the degree of waste rock dump fill slopes results in improved slope stability and improved revegetation potential. **Mining operations and associated waste rock dumps are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NAC 445.242 to 445.24388 and NAC 519A).** Final waste rock configurations, stability and revegetation are all components of the mining operations reclamation permit as defined by NAC 519A. Waste rock should be sampled and characterized for acid generation potential, reactivity, metals and other parameters that might be of concern, so the material can be handled, stored, disposed and reclaimed successfully.

Upon completion of waste rock characterization the selective placement and construction of waste rock dumps must be considered. This should be completed during the mine planning, design and environmental analysis or pre-disturbance phase of the project. The design and construction of waste rock dumps should consider topography, drainage ways or streams, slope stability, dump surface drainage, reclamation and revegetation aspects. Waste rock dumps should blend with the existing topography to minimize visual impacts. Waste rock can also be utilized to backfill open pits, construct mine roads or haul roads and other areas where material may be needed.

METHODS AND MATERIALS

The management and handling of waste rock, including the design and construction of waste rock dumps requires the expertise of a qualified professional mine engineer. There are also numerous publications regarding mining and mine waste rock available from the federal land management agencies, mineral research centers and universities.

The most common types of mine waste rock dumps include: Head of Valley Fills; Cross Valley Fills; Side Hill Dumps; and Flat Land Pile Dumps.

MAINTENANCE

Mine waste rock area management and mine dump design and construction should be included within the overall mine site maintenance program. Regular inspections are necessary, particularly after precipitation or storm events and repairs should be made immediately. Surface and ground water quality monitoring is recommended and often a permit is required.

EFFECTIVENESS

When properly designed, installed and maintained, mine waste rock management practices are effective means of reducing or preventing erosion, sedimentation and contaminant mobilization, improving reclamation success and reducing public safety risks.

BMP 9-5
IMPOUNDMENT MANAGEMENT

DEFINITION

The management of tailings ponds and dams, fresh water impoundments, dewatering infiltration ponds and impoundments, and any other mining facility impoundment.

PURPOSE

To design, install and manage mining impoundments in a manner which prevents erosion and sediment mobilization, controls surface runoff and minimizes pollution impacts to surface and ground water quality.

APPLICABILITY

Proper impoundment design, installation and management practices are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure. **Mining operations and mineral exploration projects are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NRS Chapter 445 and NAC Chapter 445.242 through 445.24388. Additionally dams designed and constructed within the state, water wells and related drilling practices are regulated by the Division of Water Resources, State Engineers Office.**

PLANNING CRITERIA

The design, construction and management of an impoundment requires the expertise of a qualified professional engineer. Additionally, comprehensive site specific investigations are necessary including: geological, hydrogeological, soils, hydrologic and related environmental analysis.

Depending upon the specifics of the site, surface water diversions are typically designed and constructed in conjunction with the design and construction of an impoundment facility. Surface diversions are utilized to decrease the amount of runoff water entering the impoundment and to reduce the potential for stormwater or a storm event damaging the facility. Surface diversion BMPs include: diversion dikes/berms, interceptor dikes/berms, interceptor trenches and related sediment and erosion control treatments.

Ground water related concerns include the migration of impoundment fluids into the ground water and the seepage or incursion of ground water into the impoundment area. Practices to prevent these potential concerns include the following:

1. Installation of a liner or liners to prevent leachate and/or process chemicals from coming into contact with ground water. Liners may include recompacted soils, impervious clay, synthetic materials (i.e. polyvinyl chloride-PVC, high-density polyethylene- HDPE, etc.) or a combination there of.

2. Installation of a drainfield and/or collection system under the liner to prevent seepage from building up between the liner and saturated soil underneath the impoundment.

Air quality concerns regarding fugitive dust are a common problem with tailings impoundments which are in temporary closure, closure or abandonment. NDEP, Bureau of Air Quality is responsible for fugitive dust management (NAC 445.734 Fugitive Dust). Typical treatments to control fugitive dust include the application of water and/or chemical tacifiers, compaction, or covering the site with larger size material such as waste rock.

Typical management practices for impoundments include the following components.

* Routine inspections
* Established monitoring as required by permit
* Regular maintenance as specified in a comprehensive maintenance program
* Erosion prevention and control measures
* Dust management
* Controlled access through fencing or other measures
* Emergency contingency plans
* Concurrent reclamation and revegetation

METHODS AND MATERIALS

Impoundments and tailings ponds must be designed, installed and maintained according to approved engineering plans and specifications specific to the site. **Engineering plans and specifications should be prepared by a qualified professional engineer**. Throughout the construction phase regular inspections and documentation is necessary. As built plans which accurately represent the final project, should also be prepared.

MAINTENANCE

A comprehensive maintenance program should be developed in conjunction with the project. The impoundment facilities must be inspected and maintained on a regular basis, particularly after precipitation or storm events. Identified problems must be repaired immediately, prior to the next storm event.

EFFECTIVENESS

Appropriate management practices developed site specifically for impoundments and tailings ponds are a very effective means of pollution prevention, erosion control and surface and ground water quality protection.

BMP 9-6
RECLAMATION

DEFINITION

The reclamation of surface disturbances associated with mineral exploration and extraction including the practices of planning, designing, engineering, grading, stabilization, growth medium application, and revegetation. Reclamation provides for physical stabilization of the land surface, but does not include the chemical stabilization of mined lands which is addressed in mine closure activities.

PURPOSE

To prevent, control and minimize erosion and sedimentation, stabilize affected or created slopes, restore surface drainage ways, revegetate surface disturbances, prevent and minimize impacts to surface and ground water quality and to meet post mining land use objectives of the site (i.e. wildlife, recreation, livestock grazing, etc.).

APPLICABILITY

BMPs for the reclamation of surface disturbances associated with mineral exploration and extraction activities are applicable to all active, inactive, or potential mine sites and mine sites in temporary closure. **Mining operations and mineral exploration projects are regulated by the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NRS and NAC Chapter 519A).**

PLANNING CRITERIA

Mineral exploration and extraction activities should not be the final use of the land. A goal for reclamation activities is to incorporate reclamation into all phases of a mining project, from planning and permitting through closure, to return the subject lands to a safe, stable productive post mining land use consistent with land management objectives. In Nevada a regulatory and permit process is in place for mineral exploration projects and mining operations to ensure that: reclamation is accomplished concurrently, or as soon as possible; exposed soil surfaces, soil loss and erosion are minimized; surface and ground water quality is not degraded; the land is returned to a condition of productivity, consistent with its pre-mining land use and land use objectives; public safety is maintained and visual impacts are minimized; and the costs of reclamation are secured through a surety process.

The following are generally recognized principals of reclamation that should be utilized as guidance for the mineral industry:

a) Reclamation should be incorporated into mineral activities up front and throughout the life of a project, not as an after thought.
b) Contaminants or hazardous/toxic materials should be controlled to prevent impacts to the environment.
c) Surface and ground water quality should be protected.
d) Topsoil or growth medium should be stockpiled and conserved so it can be utilized in the reclamation of disturbed areas.
e) The reclamation of disturbed areas should occur concurrently or as soon as possible to minimize exposed soil surfaces, soil loss, erosion and water quality impacts. Interim reclamation should be incorporated for projects lasting more than one growing season.
f) Final project site grading and shaping should be designed prior to initiating surface disturbances, consistent with sound watershed principles and the productive post-mining land use.
g) The final land morphology should be physically stable to prevent further soil loss, erosion, storm runoff damage and to provide an environment for successful revegetation.
h) A holistic or "watershed" approach should be utilized to analyze the physical, chemical and climatic characteristics of the site to formulate the reclamation plan. Test plots should be developed to test reclamation practices and procedures proposed for the site.
i) The proper equipment should be selected for the site based upon the site specific characteristics (i.e. soils, slope gradients, access, etc.).
j) Successful revegetation requires completion of several primary components including: seed bed preparation, appropriate plant species selection (native, adapted, diversity criteria) which meets post mining land use goals, proper seeding methodology for the site, available moisture or irrigation, and site protection until seedling establishment.

METHODS AND MATERIALS

The field of disturbed site reclamation is evolving rapidly as research and field trials expand. A variety of technical manuals are available from the federal land management agencies, agricultural research agencies, plant materials centers and western universities. The Bureau of Mining Regulation and Reclamation, Division of Environmental Protection can also provide technical assistance and guidance.

A qualified professional should be consulted regarding the design, development and implementation of a comprehensive mine reclamation plan. The following discussion outlines the primary phases of a reclamation plan, but depending on the specifics of the site, additional data collection and analysis may be necessary.

Pre-Disturbance Planning -
The first step is tied closely to the federal and state permitting process and environmental analysis. Given the fact that the vary nature of mineral exploration and recovery varies significantly as drilling information is gathered, a project may evolve significantly over time both in physical size, location and magnitude. While a "best guess" mine plan is the starting point to build a reclamation plan, changes in the mine plan over time require that the reclamation plan be a dynamic tool and regularly updated. Baseline data must be gathered on the project site including but not limited to: topography, soils, geology, surface and ground water quality and quantity, vegetation, wildlife, precipitation, existing land uses and post mining land uses. The baseline data is then utilized to develop a reclamation plan which can be implemented concurrently with the mine plan in a coordinated and economically feasible manner.

Growth Medium/Topsoil Management -
The future productivity and success of disturbed area reclamation is strongly influenced by the amount and quality of growth medium or "topsoil" salvaged. In the arid west many areas have little or no "topsoil" but many subsoils do provide adequate growth medium. Soils must be tested and salvaged accordingly. Depending upon the specifics of the site the management or stockpiling of growth medium may vary significantly to keep the growth medium biologically viable. The initiation of test plots upfront can not be overemphasized to determine the best methods for revegetation.

Sediment, Erosion and Stormwater Control Measures -
The basic activities of mineral exploration and mining operations involve significant surface disturbances and the creation of dumps, impoundments and other exposed slope surfaces. Exposed soils and subsurface materials are primary sources of sediment. The proper control of sediment, erosion and the management of stormwater is critical to prevent and minimize degradation of surface and ground water quality and air quality. **Designed, engineered, constructed and maintained sediment and erosion control structures by qualified professionals is a necessity prior to surface disturbances**.

Shaping and Grading -
Topographic compatibility is necessary between pre-mining and post-mining land forms for several reasons including physical stability, public safety, revegetation and visual aesthetics. The final land form configuration should be designed up front, prior to surface disturbance and designed in such a manner to be consistent with existing topography, facilitate and improve revegetation efforts, minimize surface and ground water quality impacts, control surface drainage and provide for the overall stability of the site. Graded slopes should include a plan or design for water harvesting. Water harvesting techniques include contour furrows, moonscaping, terracing or "cat tracks" along the contours. Pre-planning will significantly improve the economic viability of the project.

Revegetation -
Revegetation activities are comprised of growth medium/soils testing, plant species selection, seed bed preparation, seeding, fertilizing, mulching, irrigation and site protection.

Growth medium/soils testing - The growth medium or soils proposed for reapplication should be tested for viability, toxic constituents, nutrients, pH and productivity. Test results will guide selection of the type and quantity of soil amendments.

Plant species selection - The selection of proper native and adapted plant species is critical to revegetation success and the productivity of post-mining land use. Close coordination is necessary with the federal land manager or the private land owner to select plant species which meet land use objectives, stabilize the surface, are compatible with the growth medium and the specifics of the site, and prevent sedimentation and erosion. Pre-mining vegetation diversity should be a primary component in plant species selection. Plant species with rhizomatous root systems are proven effective in controlling surface erosion.

Seed bed preparation - Surface disturbances and created slopes should be recontoured to approximate the original landform preserving natural drainages or reestablishing them. Final graded surfaces should be ripped to relieve compaction and growth medium reapplied to the maximum depth possible. Seeding should immediately follow, but if it is not possible, the surface may have to be disced or tilled depending on the amount of surface crusting that occurs. Ideally, seed bed preparation will immediately proceed seeding during the fall to early winter of the year.

Seeding - The proper seeding methodology must be selected based upon the specifics of the site, the size, type and depth requirements of the seed and the other revegetation components utilized. Typical seeding methodologies include: broadcast seeding, drill seeding, and hydroseeding. Each has specific requirements, benefits and constraints which should be evaluated. Seeds must be drilled to the proper depth or covered with soil and/or mulch to prevent wind migration and consumption by avians. The most favorable time to seed in Nevada and the arid west is the fall to early winter. Seeds lay dormant until spring until soil moisture and temperatures are optimal for germination and growth.

Fertilizing - Fertilizer and/or soil amendments should be added to the growth medium given the specifics of the site, soil testing results and plant species requirements. Slow release fertilizers haven proven very effective and minimize the potential for over application.

Mulching - Mulching has proven effective in improving reclamation success. Mulching assists in erosion control and soil stabilization, creates a micro climate which moderates temperatures and retains moisture, and it protects seedlings until plant establishment (See Soil Stabilization - Chapter 3). Straw mulches are the most commonly used in revegetation and are either blown on mechanically or spread by hand at approximately

two tons per acre. Mulches must be crimped into the soil, utilized under netting or applied with tackifiers, otherwise they are subject to wind migration.

Irrigation - While not commonly utilized in mining applications, temporary irrigation is by far the best method for ensuring plant species establishment. Temporary irrigation can provide plant species germination and establishment water requirements when nature may not. While temporary irrigation represents additional costs, the benefits of improved plant germination and establishment, rapid soil and slope stabilization and earlier return of sureties out weigh costs. Irrigation water application, (amount and timing), must also be carefully planned to the fall and early winter seasons. Seeding and irrigating earlier in the season is feasible as long as irrigation continues throughout the growing season. If not applied correctly there is a potential for plant growth and die off due to poor weather conditions and lack of water.

Site protection - Revegetation areas must be protected from disturbance until plant species establishment. Site protection is typically provided by fencing, berming and signing to prevent intrusion by livestock, wildlife, motor vehicles and the public.

It is important to emphasize that individual components of a mining operation or exploration project may require specifically designed reclamation treatments. Reclamation must be closely coordinated with closure activities to address potential chemical, hazardous or toxic conditions. Chemical stabilization and closure must occur prior to revegetation efforts so plant species are not negatively impacted.

MAINTENANCE

Maintenance is a primary component of any reclamation plan no matter what the size. A maintenance program must be comprehensive and address all aspects of reclamation throughout the life of the mining plan or exploration project. Maintenance inspections and repairs should be conducted regularly and after all precipitation or storm events. Surface drainage ways, sediment and erosion controls, site protection facilities and revegetation components all require maintenance. Revegetation areas may require reseeding, fertilizing and mulching depending upon the adequacy of the initial treatments.

EFFECTIVENESS

A well designed, implemented and maintained reclamation plan will significantly reduce impacts to existing natural resources, control sediment and erosion and minimize impacts to surface and ground water quality.

CHAPTER 10

URBAN RESOURCE MANAGEMENT

BMP 10-1	STREET RUNOFF COLLECTION
BMP 10-2	STORM DRAINAGE STRUCTURES
BMP 10-3	SANDBAG CURB INLET SEDIMENT BARRIER
BMP 10-4	CULVERTS
BMP 10-5	IRRIGATION
BMP 10-6	LANDSCAPING
BMP 10-7	FERTILIZER MANAGEMENT
BMP 10-8	PESTICIDE/HERBICIDE MANAGEMENT
BMP 10-9	SNOW DISPOSAL PRACTICES
BMP 10-10	ROAD SALT STORAGE & RELATED PRACTICES
BMP 10-11	STREET CLEANING PRACTICES
BMP 10-12	WELLHEAD PROTECTION

BMP 10-1
STREET RUNOFF COLLECTION

DEFINITION

Concrete or asphalt structures for the collection of surface runoff from paved roadway surfaces, parking lots, or other impervious surfaces.

PURPOSE

To prevent erosion of roadside shoulders and adjacent roadway slopes from surface runoff. To direct street runoff to collection and conveyance systems off of the street.

APPLICABILITY

To be used for collection of surface runoff from paved surfaces.

PLANNING CRITERIA

Street runoff collection systems should be designed by a qualified professional engineer. Systems should be designed to the specifics of the site including: topography, elevation, soils, climate and the proposed discharge area.

METHODS AND MATERIALS

1. Roadways should be designed to drain from the roadway surface into lateral runoff collection facilities such as curb and gutter or roadside ditches.

2. Paved roadways to be used as streets in residential or commercial areas should be complete with curbs, gutters, and appropriate infiltration and drainage facilities.

3. Paved roadway shoulders should be constructed along all existing paved roadways which do not meet the above standards. They should be constructed wherever roadside drainage facilities are required to reduce erosion or other surface runoff management problems.

4. In steep areas with cross slopes in excess of 15 percent and where the roadway is bounded by a fill slope, the roadway should be constructed to drain away from the fill slope.

5. Curbs and gutters should be designed to the specifications and requirements of the specific area.

6. Curb design should be incorporated into roadway slope stabilization structures to eliminate concentrated surface flows along the toe or over the top of slopes.

7. Asphalt-concrete dikes should be used in limited situations where damage from vehicular traffic is not likely to occur. Acceptable uses include incorporation into slope toe stabilization along roadways and along parking lots which are not bordered by fill slopes.

8. Asphalt-concrete dikes should not be used along crowned roadways above adjacent fill slopes where damaged sections could allow concentrated runoff flows off the roadway onto the fill slope face. Dikes should not be utilized in areas of snow accumulation as snow plows will damage them.

9. Construction materials should satisfy minimum requirements of the appropriate state and local regulatory agencies.

MAINTENANCE

The following standards apply to the maintenance of roadway surfaces, curb and gutter drainage facilities, and infiltration facilities associated with paved streets.

1. All roadway and parking surfaces should be kept clean and free from substances which will deteriorate the quality of runoff waters from these surfaces.

2. All roadways should be swept with a vacuum sweeper. Any time an exceptional buildup of litter, sediment material, or debris is present, the surface should be swept, regardless of the schedule.

3. All drainage and infiltration facilities associated with roadways must be maintained to serve the originally intended purposes.

4. Curbs and gutters should be inspected regularly for damage from snowplows or other road maintenance equipment.

5. Drainage systems and infiltration facilities should be inspected during each major storm or snowmelt for clogging, damage or signs of deterioration. Repair and cleaning should be accomplished as quickly as possible.

6. All major street repairs should incorporate infiltration and drainage facilities to prevent roadway deterioration caused by inadequate drainage.

EFFECTIVENESS

Street runoff collection systems are highly effective in minimizing erosion and sediment transport if the system is designed, installed and maintained properly.

FIGURE 10-1 (22A)
TYPICAL STREET CROSS-SECTION

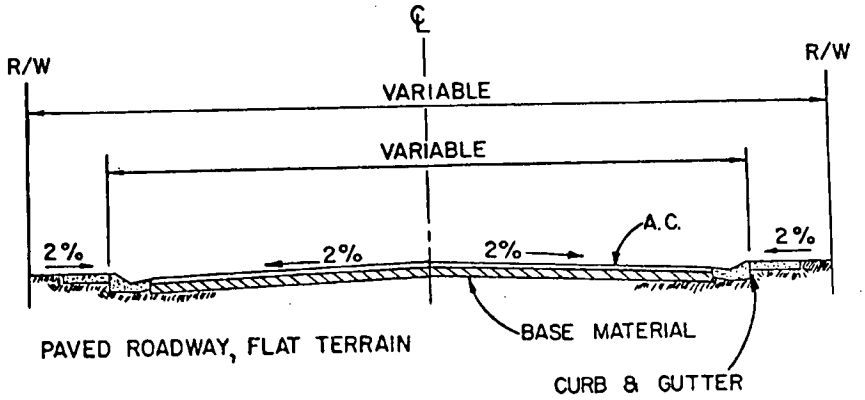
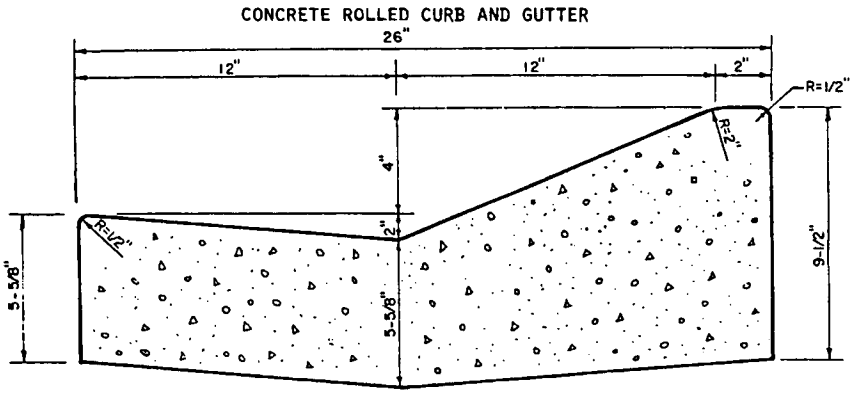
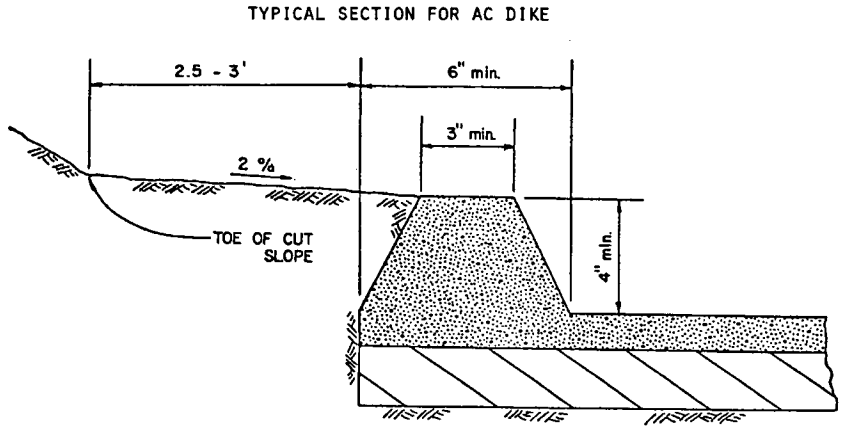


FIGURE 10-2 (22B)
CURB & GUTTER





BMP 10-2
STORM DRAIN STRUCTURES

DEFINITION

Pipes, channels, drop inlets, slotted drains, grease and oil traps, or other facilities used to collect and/or convey surface runoff.

PURPOSE

To convey surface runoff in non-erodible conduits or channels so gutter or ditch flow capacity is not exceeded and to dissipate energy.

APPLICABILITY

For conveyance of surface runoff concentrated by natural drainageways, streets, curb and gutter, or other runoff collection facilities where a storm drainage system is installed to a stable discharge point.

PLANNING CRITERIA

All natural drainageways originating outside the project area should enter and leave the project area at the original horizontal and vertical alignment. Storm drainage facilities (excluding cross-culverts) should be parallel with the street centerline wherever possible.

Large angular changes in the alignment of any drainage facilities should be avoided. Vegetation should be established and street surfaces repaired in all disturbed areas immediately after drainage system construction. Depending on the location of the storm drain, grease and oil traps may be needed.

Closed Conduits - Underground pipe systems are preferred to surface systems in heavily developed commercial or residential areas.

Debris control measures such as trash racks should be incorporated into drainage system design in those locations where system failure from clogging could cause damage from flooding or erosion.

Perforated pipe encased in a gravel-filled trench may be used as soil conditions permit to promote infiltration of surface runoff and to reduce surface flows.

Sediment retention and flow detention basins may be incorporated into storm drainage systems wherever possible to reduce peak flows and keep sediment materials from clogging downstream drainage facilities.

Periodic inspection and repair are required to keep all runoff conveyance systems operable. Regular street sweeping is recommended to prevent the deposition of large solids in pipes, ditches, and inlet structures, and to prevent clogging.

METHODS AND MATERIALS

Storm drainage structures and systems must be designed and installed under the guidance of a qualified professional engineer. The standards and specifications of the local, state, or federal agency having jurisdiction shall be followed.

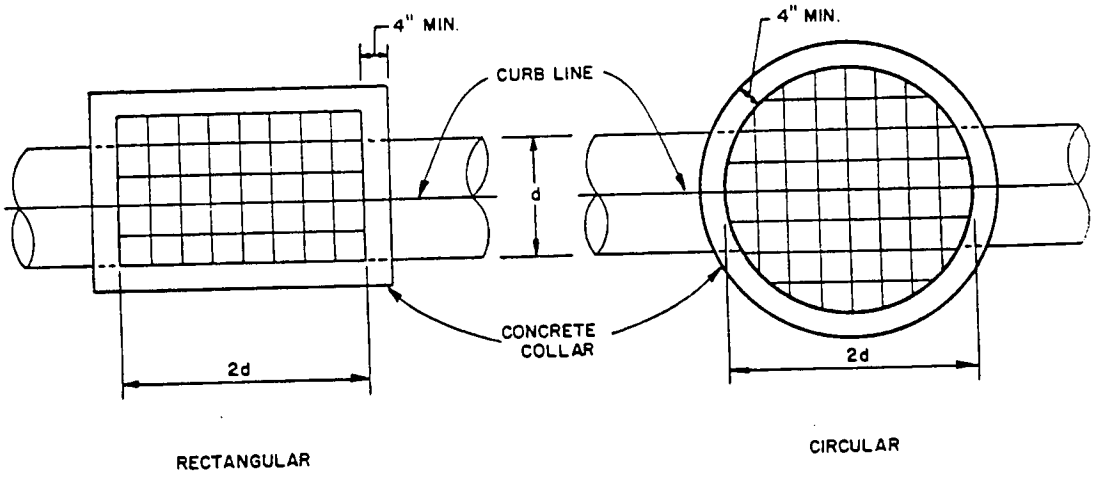
MAINTENANCE

Storm drainage structures must be inspected and maintained on a regular basis per the schedule of a comprehensive maintenance program. Inspections and maintenance should occur after precipitation or storm events and repairs completed prior to the next storm. Debris control devices must be cleaned out to keep the system operable.

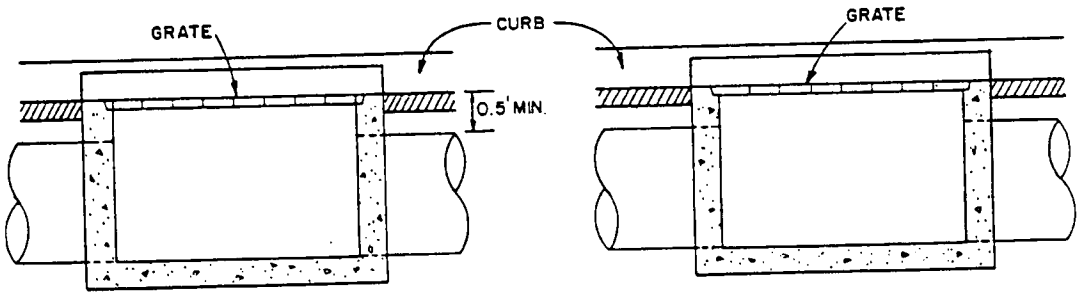
EFFECTIVENESS

Storm drainage structures are only effective if they are properly installed in accordance with the design criteria. The effectiveness is lost once the storm drains are clogged with debris or filled with sediment. Regular street sweeping increases the effectiveness of storm drains and reduces the overall maintenance costs.

FIGURE 10-3 (Drop.pcx)
DROP INLET



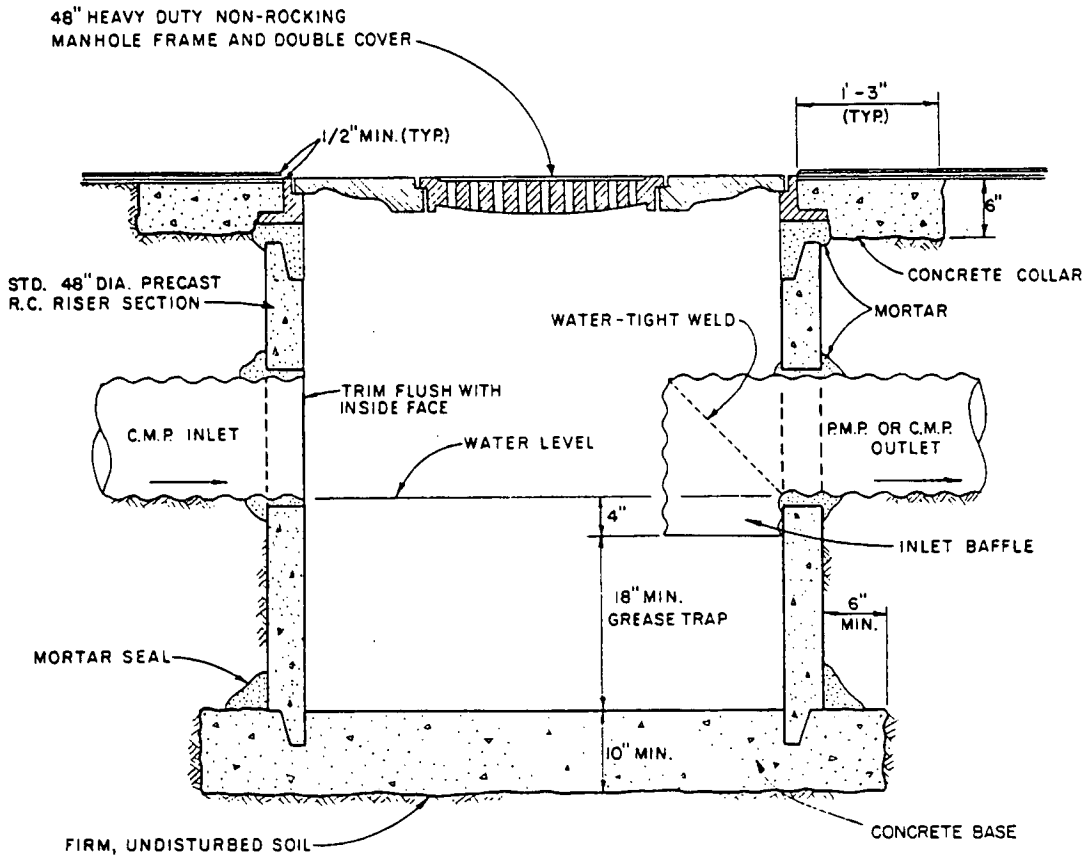
PLAN
NO SCALE



ELEVATION
NO SCALE

DROP INLET

FIGURE 10-4 (Grease.pcx)
GREASE AND OIL TRAP



ELEVATION
no scale

GREASE AND OIL TRAP

BMP 10-3
SANDBAG CURB INLET SEDIMENT BARRIER

DEFINITION

Sandbag curb inlet barriers are temporary sediment barriers consisting of sandbags placed on the uphill side of the inlet and overlapping onto the curb.

PURPOSE

Curb inlet sediment barriers are used to prevent sediment from entering the storm drain system in paved areas.

APPLICABILITY

Applicable to all construction sites where the roads are already paved with the curb inlets in place. The sandbag barriers are useful on streets which receive runoff flows of less than 0.5 cubic feet per second (cfs).

PLANNING CRITERIA

The sandbag curb inlet sediment barriers are for drainage areas of less than one acre. They are designed to keep sediment out of the storm drain system when the roads are already paved. There is a small area of sediment storage behind the sandbags.

METHODS AND MATERIALS

The sandbag should be of plastic woven material rather than burlap. Burlap bags rot and deteriorate, and as a result, can cause more problems if broken. Clean washed sand should be used to fill the bags. The sandbags should be placed in a curved row from the top of the curb at least three feet into the street. The row should be at least six feet from the inlet and curved at the ends which should be pointing uphill. Several layers of bags should be overlapped and packed tightly together in order to eliminate any spaces between the bags. Leave a 6 inch gap in the middle of the top row of sandbags to serve as the spillway.

MAINTENANCE

The curb inlet barriers should be checked after each storm and repaired to keep them functional. Sediment which has accumulated should be removed and placed where it will not enter the storm drain. Additional sediment storage capacity can be obtained by constructing a series of sand bag barriers along the curb and gutter so that each barrier traps a small amount of sediment.

EFFECTIVENESS

Sandbag barriers can be effective if they are inspected and maintained regularly throughout their application. Sediment must be removed and damaged bags replaced to maintain effectiveness.

BMP 10-4
CULVERTS

DEFINITION

A culvert is a conduit used to provide free passage of surface drainage water under a highway, street, roadway or driveway.

PURPOSE

To provide an uninterrupted drainage pattern for surface and/or ground water flows.

APPLICABILITY

Applicable to all areas where roads or driveways cross surface drainage systems or intercept ground water flows.

PLANNING CRITERIA

Culverts should be designed at drainage swales, roadside ditches, streams, and any drainage system so that the natural drainage pattern is not interrupted or abruptly changed when a permanent roadway or driveway is installed. The factors to consider in the design of culverts are contributing watershed, culvert alignment, culvert grade, type of material, inlet structures, culvert size, debris control, and energy dissipation. Failure to properly consider these factors is the primarily cause for culvert failure. **The design and installation of culverts should be conducted by a qualified professional engineer**.

Special consideration regarding culvert design and siting is required if the subject stream supports a fishery and related aquatic ecosystems. Culvert design should insure safe fish passage and not become a barrier. Impacts to existing stream habitat should be minimized and fully revegetated after culvert installation.

METHODS AND MATERIALS

Culverts should have the same alignment as the drainage channel and provide the runoff water with a direct entrance and a direct exit. Sharp turns at the inlet should be avoided because it may cause erosion or blocking of the inlet by debris. The culvert grade should be at least one or two percent more than the waterway entering the culvert. Generally, a ten percent grade will prevent deposition of sediment. Culverts must be sized to handle the peak flow during a heavy storm. Size and material for culverts must conform to the standards of the local, state, or federal agency having jurisdiction. Culverts draining roadside ditches shall be designed for the 20-year, one-hour storm. Culverts for stream crossings must be designed for the 50-year, one-hour storm. A qualified professional engineer must design the culvert as well as the inlet and outlet protection. Headwalls, wingwalls, or aprons should be used for protection against scour. Erosion frequently

occurs at culvert inlets. The culvert should be installed with its inlet flush to the embankment. The edge of the culvert should be rounded or flared to improve flow into it. Rocks can be placed around the inlet to prevent scour. The culvert outlet should always be at ground level, not suspended above the ground. Because culverts increase the flow velocity, outlet protection is usually required. A rock apron should be installed below the outlet. Culverts must discharge to stabilized drainageways. Culverts requiring fishery and aquatic ecosystem considerations should be designed by a qualified professional. Debris control devices can become an obstacle to fish movements and should be considered carefully.

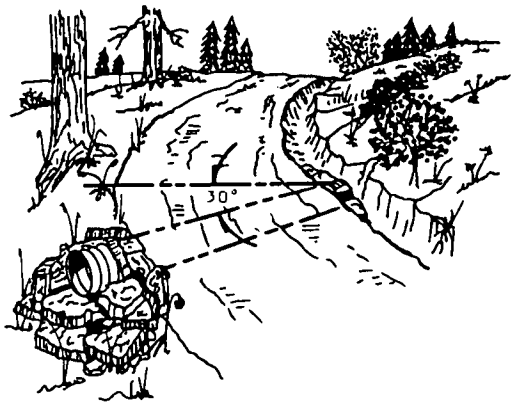
MAINTENANCE

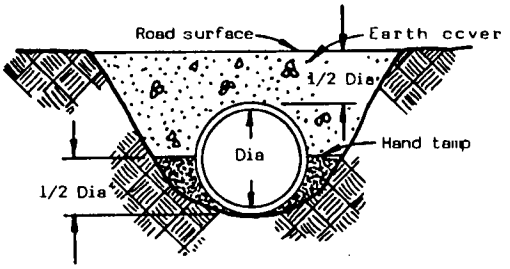
Culverts must be inspected periodically and cleaned out if necessary. If heavy debris is expected, a debris control device should be considered based upon fishery and related aquatic resources. If heavy sediment is expected, a culvert riser should be installed to trap sediment.

EFFECTIVENESS

Culverts are only effective if they are properly installed in accordance with the design criteria. The effectiveness is lost once the culverts are clogged with debris or filled with sediment. Regular street sweeping increases the effectiveness of culverts and reduces the maintenance costs.

FIGURE 10-5 (Culvert.pcx)
CULVERTS





SECTION

BMP 10-5
IRRIGATION

DEFINITION

Irrigation is the application of water to newly seeded areas, planted trees and shrubs.

PURPOSE

To improve plant establishment and growth, to insure plant survival during the growing season and periods of drought and for revegetation of disturbed sites.

APPLICABILITY

Applicable to most seeding and planting operations. It should be noted that previous BMPs recommend the use of native and adapted species. By nature, these species require less water than most exotic species. Thus, by proper species selection and careful watering practices, water conservation can be achieved.

PLANNING CRITERIA

The use of irrigation will significantly improve the growth, survival, and establishment of plant material during the growing season. Nevada's climate during the growing season is hot and dry. Little precipitation, if any, falls during the summer months. On most sites, the increase survival rate is well worth the additional costs of irrigation, particularly for revegetation of disturbed sites.

The frequency and quantity of irrigation is a function of plant species, site conditions, and precipitation. Deep watering is more effective than shallow watering and helps to conserve water supplies. Water should percolate at least two inches below the root zone during each watering. Thus, watering must be conducted as needed, and not restricted to specific quantities or schedules. Coordinate watering with weather predictions to avoid over watering, which can cause erosion.

Many types of irrigation systems are available. Permanent underground and above ground systems can be installed at a reasonable expense. Above ground systems may be conventional sprinklers, dripline systems or water collars around trees and shrubs. Hand watering using hoses connected to water trucks or hydrants can be used along roadside revegetation projects. Be sure to use the correct nozzle when applying water under high pressure.

METHODS AND MATERIALS

Irrigation systems must be designed for the specifics of the project area, proposed plant species, available water source and related factors. **A qualified professional should be consulted for irrigation system design.**

MAINTENANCE

If properly installed, permanent irrigation systems require little maintenance. They should be checked periodically and repaired as necessary. Erosion caused by over watering must be corrected immediately.

EFFECTIVENESS

Irrigation is a very cost effective way to establish vegetation. The decision to irrigate or not is usually based on economics. However, the damage which could occur if an area is not immediately revegetated is more costly than the cost of irrigation. For sites where water is not available on site, large tanks can be temporarily used for the irrigation season.

BMP 10-6
LANDSCAPING

DEFINITION

A process utilized to alter the land through designing, grading, seeding and planting of native, ornamental and adapted plant species to create an environment which is aesthetically pleasing.

PURPOSE

To stabilize disturbed sites in a manner which controls surface drainage and soil erosion, provides for vehicle and pedestrian access, visual effect, noise abatement and creates an environment which is beneficial and enjoyable.

APPLICABILITY

Applicable to both urban and rural residential, commercial and industrial settings. Landscaping can be utilized for virtually all development applications.

PLANNING CRITERIA

A qualified professional should be consulted regarding the design, installation and maintenance of landscaping projects. The following elements should be considered in developing a landscaping plan.

1. Topography, drainage ways, length of slopes.
2. Soils, elevation, climate, precipitation.
3. Existing vegetation (See BMP 8-2).
4. Irrigation systems which emphasize water conservation.
5. Landscape theme or goal consistent with the existing environment.
6. Maintenance requirements.
7. Economic practicality.
8. Applicable state and local regulations and ordinances.

METHODS AND MATERIALS

Landscaping should be designed given the advantages and disadvantages of the existing environment. Compatibility with the specifics and conditions of the project site will result in a successful landscape. **A qualified professional with experience in the existing environment should be consulted regarding plant species selection, seeding and planting specifications, surface drainage, fertilizer and pesticide application, irrigation systems and maintenance requirements (See Appendix I-1).**

MAINTENANCE

A comprehensive maintenance program should be developed to maintain the landscape and keep the irrigation and drainage systems functional. Identified repairs should be completed as required.

EFFECTIVENESS

A properly designed, installed and maintained landscape will control erosion, reduce sediment mobilization, conserve water and provide an aesthetically pleasing environment.

BMP 10-7
FERTILIZER MANAGEMENT

DEFINITION

Fertilizer management is the careful application of fertilizers based upon plant nutritional requirements to prevent any excess from reaching surface or ground waters.

PURPOSE

To establish plants when revegetating or landscaping, to maintain the health and vigor of vegetation, promote nutrient uptake by plants, and prevent excess nutrients from reaching surface and ground waters.

APPLICABILITY

Fertilizer management is applicable to revegetation projects and existing vegetation where fertilization is necessary. Fertilizers are commonly applied as part of the routine maintenance of most landscaped sites, especially around commercial and residential structures. Golf courses and other areas of grass lawns especially need to manage and regulate fertilizer rates in order to meet water discharge standards. Fertilizers should not be used in or near stream channels or in shorezone areas.

PLANNING CRITERIA

Many soils are frequently deficient in nitrogen, phosphorus, and sulfur and, as a result, need additional fertilizer in order to maintain good plant health and vigor. Plant material in poor vigor is often attacked by disease and insect pests. Permanent vegetation is the best form of erosion control and must be healthy and vigorous. However, overuse of fertilizer can cause serious impacts on water quality.

Criteria that should be evaluated include: the type of fertilizer, rate of application, timing, and type of vegetation. There are three types of fertilizers commonly used: conventional or fast release, slow release and organic materials. Conventional fertilizers release their nutrients rapidly, making them available for immediate growth but do not provide the plant with a sustained supply of nutrients. Conventional fertilizer is usually added annually and as a result, over-fertilizing can be a problem in many areas. Slow release fertilizers release their nutrients slowly over a longer period of time, so there is less chance of them being leached out during watering or rainstorms. Organic fertilizers, such as animal manure or composted plant material, can provide some nutrients. However, the concentration of nutrients varies widely, and deficiencies can occur when organic fertilizers are used alone. Organic materials actually tie up nutrients, especially nitrogen, during the decomposition process. Thus, the best use of organic fertilizers is as soil conditioners and amendments along with other types of fertilizers.

These fertilizers add organic matter to the soil and increase water holding capacity. Organic fertilizers must be worked into the soil and not applied as a mulch because surface runoff can transport this material to permanent waterways and streams. These fertilizers must be decomposed by soil microorganisms before the nutrients are released and can be absorbed by plant material.

METHODS AND MATERIALS

The type of fertilizer and rate of application depend largely on the type of vegetation. Fast release fertilizers are commonly used with grass seeding operations, whereas slow release fertilizers are used with tree and shrub plantings. A conventional, fast release fertilizer should be broadcast immediately after germination of the grasses and each spring. Two hundred fifty pounds of ammonium-phosphate-sulfate (16-20-0) per acre will provide the necessary nutrients, including sulfur. This is about six pounds per 1000 square feet. Maintenance fertilization rates should be cut in half, or about three pounds per 1000 square feet. On sites which will not receive maintenance applications, both slow and fast release fertilizers should be applied at rates of 100-150 pounds each per acre.

The use of native and adapted species for revegetation and landscaping reduces the need for heavy fertilizer applications. These plants are normally adapted to the local soil conditions.

MAINTENANCE

Maintenance applications of fertilizers should be made when loss of vigor or slow growth indicates a possible nutrient deficiency. At lease one additional application is required following the original grass seeding and should be applied in the spring. Soil testing is recommended to determine actual nutrient deficiencies.

EFFECTIVENESS

The use of fertilizer is usually necessary to achieve early and complete establishment of plants when revegetating or landscaping. Overuse is harmful. Fertilizer management is extremely effective in reducing the input of nutrients to surface or ground water systems.

BMP 10-8
PESTICIDE/HERBICIDE MANAGEMENT

DEFINITION

Application of pesticides to urban vegetation for the control of pests.
Note: Herbicides are defined as pesticides and weeds are defined as pests.

PURPOSE

To develop a pest management program consistent with selected urban landscape goals that is environmentally acceptable.

APPLICABILITY

Pesticides apply to all land uses where increased pest control is needed.

PLANNING CRITERIA

Planning Considerations

1. Integrated pest management principles should be used, some major features of which, are incorporated in subsequent items.

2. Consider the use of plant varieties resistant to the target pest(s), and adjust planting dates to help control weed, insect, and disease problems.

3. Mechanical cultivation and biological controls should be considered, where appropriate.

4. Consider the affect of adequate plant nutrients and soil moisture, favorable pH, and good soil condition to reduce plant stress and improve plant vigor.

5. Consider use of hand weeding for small, isolated areas, or on larger areas where labor costs are not prohibitive. Spot spraying rather than full-coverage spraying is another alternative.

6. Minimize exposure to chemicals, wear protective clothing, and use safety equipment as appropriate.

7. Properly locate chemical mixing and equipment rinsing stations relative to the potential for contamination of ground or surface water. Extreme care must be taken to follow loading and mixing procedures. Provide for managing accidental spills.

8. Properly rinse equipment and re-use rinse water for subsequent batches of the same pesticide or herbicide, where possible.

9. Store pesticides in original containers in a locked, well ventilated, weather resistant building. Post warning signs on or around the building. Locate the building so that accidental spills will create minimal environmental effects. Dispose of pesticide containers according to label directions and adhere to local or state regulations.

10. Provide emergency wash stations for personnel who might be accidentally exposed to chemicals, and formulate a safety plan complete with information about locations of emergency treatment centers for personnel exposed to chemicals.

11. Ensure that backflow prevention devices are installed and operating properly on irrigation systems used for applying pesticides.

METHODS AND MATERIALS

The selection and application of pesticides and herbicides requires professional knowledge and certification except for those chemicals available for sale to the public. Consumers should read and follow all label instructions explicitly to avoid health hazards or environmental contamination.

1. Identify the target pest(s) and the life cycle periods when it is most vulnerable to control. For weeds, identify the species. Determine the best mechanical, biological, or chemical control method or combinations of control and list limitations on use.

2. Specifications for any pest management measure will be described and consistent with state and local regulations. Appropriate land grant university publications concerning pesticide use should be maintained and updated as part of the field office technical guide. All recommendations for specific chemicals, rates of application, level of plant tolerance, and effectiveness ratings shall be in accordance with these publications.

3. A reference section should be included at the end of the specifications that contains those sources used in developing these specifications to provide easy access to more in-depth technical information.

4. All specifications will be consistent with the state and local regulations.

MAINTENANCE

Reapplication of pesticides will be needed to maintain the landscape at the desired level.

EFFECTIVENESS

Using recommended rates and application procedures will provide control of the targeted pest(s) and have little or no effect on water quality.

BMP 10-9
SNOW DISPOSAL PRACTICES

DEFINITION

Snow disposal practices are those practices which move snow out of the way of human activity.

PURPOSE

To permit snow to be disposed of economically but with minimal effect on water quality.

APPLICABILITY

Applicable mainly to areas such as parking lots, where large amounts of snow are concentrated on-site or removed off-site, and roads and highways where snow is stockpiled or trucked away to disposal sites.

PLANNING CRITERIA

Many state and county highway authorities have a policy of maintaining bare pavement to protect lives and promote safety. Thus, ice and snow are removed as quickly as possible from roads, driveways, and parking areas. The most common treatments include sodium chloride, calcium chloride and sand mixes for preventing icy conditions. The use of an abrasive alone often is not sufficiently effective. With normal highway or roadway snow removal practices, the snow is blown or plowed to the side or center of the roadway. The main concern from a water quality standpoint is the in corporation of deicing compounds, sediment, and debris into the snow, slush, and ice which is picked up and moved to areas where it can degrade water quality or is allowed to melt in place.

Local codes may require that all commercial, tourist accommodation, public service, recreation, and multi-residential projects provide snow storage areas of adequate size to store snow removed from parking, driveway and pedestrian access areas or have arrangements to remove and store accumulated snow off-site. The melting snow in snow disposal areas can be a significant source of sediments, nutrients, hydrocarbons, metals and debris. If not properly planned, these materials can be discharged directly into waterways and streams. Therefore, snow storage or disposal areas should not be located in or adjacent to, stream management areas (SMA).

METHODS AND MATERIALS

Snow disposal areas should be designed and installed by qualified professionals. The location of such areas must be carefully evaluated in terms of site criteria, especially drainage patterns.

These areas should not be located in or adjacent to SMAs. If the area is paved, drop inlets with grease and oil traps should be designed. Infiltration trenches may be required. If unpaved, the operation of the site should be such that vehicles operate on gravel or 12" of packed snow. Drainageways should be protected from direct discharge of snow from trucks or loaders by berms of snow, straw bales, or other barriers.

MAINTENANCE

Snow disposal areas should be inspected after snow melt periods and cleaned of trash if necessary. Occasionally sand/salt deposits may accumulate and need to be removed.

EFFECTIVENESS

If properly designed and located out of SMAs, snow disposal areas can effectively prevent the discharge of degraded melt water. Regular sweeping of areas to be plowed prior to the snow season can improve the appearance of these areas by eliminating the accumulation of trash.

BMP 10-10
ROAD SALT STORAGE & RELATED PRACTICES

DEFINITION

Road salt must be properly stored in order to prevent degraded runoff or leachate from reaching surface or ground waters.

PURPOSE

To reduce the problem of degraded runoff resulting from the storage of de-icing chemicals.

APPLICABILITY

Applicable to areas where de-icing salts are stored and located.

PLANNING CRITERIA

The location of salt storage areas is important and sites should be chosen that are accessible, well drained (but not on an aquifer recharge area), and not subject to overland runoff from upslope areas. A structurally sound and waterproof concrete base and an ample loading area are essential. Concrete pads should be treated with a sealant. Covering techniques for salt piles include:

1. Permanent structure with doors;
2. Structure with open face away from prevailing wind; and
3. Three sided bunker with permanent or temporary cover.

During loading, minimize the area of the heap that is uncovered at any one time, and following loading, make sure the loading pad is thoroughly swept.

The specific material and application rates on roads and highways should also be considered. This includes checking the calibration and rates of spreader trucks, the possible use of liquid calcium chloride for premelting salts, the proper mixes of abrasive and salts, adopting maintenance policies which consider various weather conditions, and evaluating use of alternative de-icing agents.

Alternative de-icing process have been researched in response to environmental concerns. These include ground heat pipes, electrical resistance heat, incorporation of snow melting chemicals into pavement during construction, and solar heating. The use of these methods is limited due to cost; however, Calcium Magnesium Acetate (CMA) is proving to be a promising alternative to sodium and calcium chlorides. Twice as much CMA must be used to get the same results as sodium chloride but it is neither corrosive nor harmful to the environment.

METHODS AND MATERIALS

Salt storage facilities shall be designed and installed under the direction of qualified professionals. Salt and slag/sand mixtures shall be stored on paved surfaces in a structure with at least three sides. Piles shall be covered during periods when the material is not being loaded or unloaded.

MAINTENANCE

If properly designed, little maintenance is required other than cleanup of spills.

EFFECTIVENESS

Properly maintained salt storage facilities are very effective in preventing the discharge of degraded runoff.

BMP 10-11
STREET CLEANING PRACTICES

DEFINITION

Street cleaning practices consist of sweeping operations conducted by broom or vacuum type sweepers.

PURPOSE

To remove litter, sediment, and other contaminants from streets and roadways in order to prevent degraded runoff from paved areas.

APPLICABILITY

Applicable to all paved areas, especially streets, highways, and parking lots.

PLANNING CRITERIA

Street sweeping is effective for removing litter and other contaminants from streets, including components of vehicle bodies (such as glass, rubber, rust, and metal), pollutants resulting from vehicle operation (hydraulic fluids and particulate exhaust emissions), atmospheric dustfall, de-icing chemicals, and particles from industrial operations. There are two types of street sweepers.

1. Brush-type. These are designed to loosen surface contaminants and push them to a conveyer which deposits the material into a hopper. These units propel larger particles into the collection bin, but often fail to collect the fine, pollutant-laden dust and dirt. (Research has determined that the major portion of polluting substances reaching the street attach themselves to the very fine particles already deposited there.) Studies have found these sweepers to be relatively inefficient in collecting material smaller than 400 microns, which, though a comparatively small volume, are a major factor in the oxygen demand of runoff pollutants.

2. Vacuum-type. These operate using both a broom for loosening and moving the street contaminants and a vacuum system to collect them. These units are much more efficient in the capture of fine material, when the pavement is dry.

Estimates of the efficiency of street sweepers in removing the tail dust and dirt load on paved surfaces are that vacuum sweepers are about 90% efficient and brush sweepers about 50% efficient, assuming a smoothly paved surface and no interference from parked vehicles. Particles which remain, mostly finer material, will have a high polluting potential.

Street sweeping effectiveness is also a function of sweeping frequency, number of passes per sweeping, equipment speed, and pavement conditions. Contaminants on street surfaces build up

rapidly following sweeping or flushing by rain. The average sweeper will cover approximately 25 curb-miles per day. Studies have shown that nearly 90% of the contaminants will accumulate within 12 inches of the curb; only one sweep is needed. Operators of street sweepers should be made aware of the importance of collecting fine solids; this would improve their efficiency, including the speed at which they operate the equipment. Concrete streets have been found to be generally cleaner than asphalt streets, but this is not a basis for recommending the use of the former. However, broader concrete gutters could lead to greater street cleaning efficiency. Porous pavements should not be used in areas susceptible to heavy loads of contaminants unless sweeping can be performed each day. Damaged pavement is impossible to clean effectively and should be resurfaced.

Roadside ditches, rocklined ditches, culverts, drop inlets, sediment retention basins, and storm drains also need to be cleaned out periodically. Vacuum-type equipment is also available for this type of maintenance. The "Vactor" type truck is available to maintain these erosion control structures. The use of a "Vactor" type truck is much better than the annual use of a grader to clear roadside ditches along streets and highways without curbs. The grader operator usually digs into the toes of the slopes, thus removing material and ensuring continued annual erosion.

METHODS AND MATERIALS

Sweeping should be scheduled based upon the specific conditions of the site. Based upon the amount of sediments and contamination generation, sweeping frequency should be increased or decreased. The seasons of the year may effect the sweeping frequency with spring and fall typically the greatest. Sweepings should be disposed of in approved locations.

EFFECTIVENESS

Regular street cleaning practices are very effective in maintaining the continuing effectiveness of other roadside erosion control facilities and in minimizing dust conditions caused by constant stirring up of dust particles on streets and parking lots.

BMP 10-12
WELLHEAD PROTECTION

DEFINITION

Preventative actions by which communities or public drinking water supply purveyors can protect their current and future drinking water supply from contamination.

PURPOSE

To protect and maintain the quality of the public drinking water supply now and in the future through the development of a comprehensive Wellhead Protection Program.

APPLICABILITY

Wellhead protection is applicable to any well which provides drinking water for human consumption.

PLANNING CRITERIA

There are seven elements which comprise the state of Nevada's Wellhead Protection Program.

1. Identify roles and responsibilities of all affected entities and formation of a Wellhead Protection Program team.

2. Delineation of Wellhead Protection Areas (WHPA) for each well or well field.

3. Inventory and identify existing and potential contaminant sources within the WHPAs.

4. Develop and implement WHPA management strategies.

5. Develop contingency plans for emergencies.

6. Plan for the siting of new wells.

7. Encourage and involve public participation.

The basic concept of wellhead protection is to determine the land surface area or WHPA, that should be managed in order to protect the ground water being pumped from a well. After identifying and mapping existing and potential contaminant sources, various management options can be developed and implemented. Wellhead protection programs also contain contingency plans to deal with accidents and emergencies. Public participation and education are key elements of wellhead protection.

METHODS AND MATERIALS

A Wellhead Protection Program should be designed by the local community or utility company, as management of WHPAs will be the responsibility of the community. The Nevada Division of Environmental Protection, Bureau of Water Quality Planning can provide guidance and technical assistance to communities and utilities in the development and implementation of a wellhead protection program.

MAINTENANCE

Successful wellhead protection programs require long term maintenance and management at the local level. Funding and maintenance requirements vary significantly depending upon the specifics of the community. Technical assistance is available from the state for maintenance of a wellhead protection program.

EFFECTIVENESS

A community wellhead protection program which is developed consistent with Nevada's State Wellhead Protection Program will be very effective in ensuring a good quality public drinking water supply into the future.

FIGURE 10-6 (Cone.pcx)
GROUND WATER MOVEMENT WITH PUMPING:
THE ZONE OF CONTRIBUTION, ZONE OF INFLUENCE,
AND CONE OF DEPRESSION.

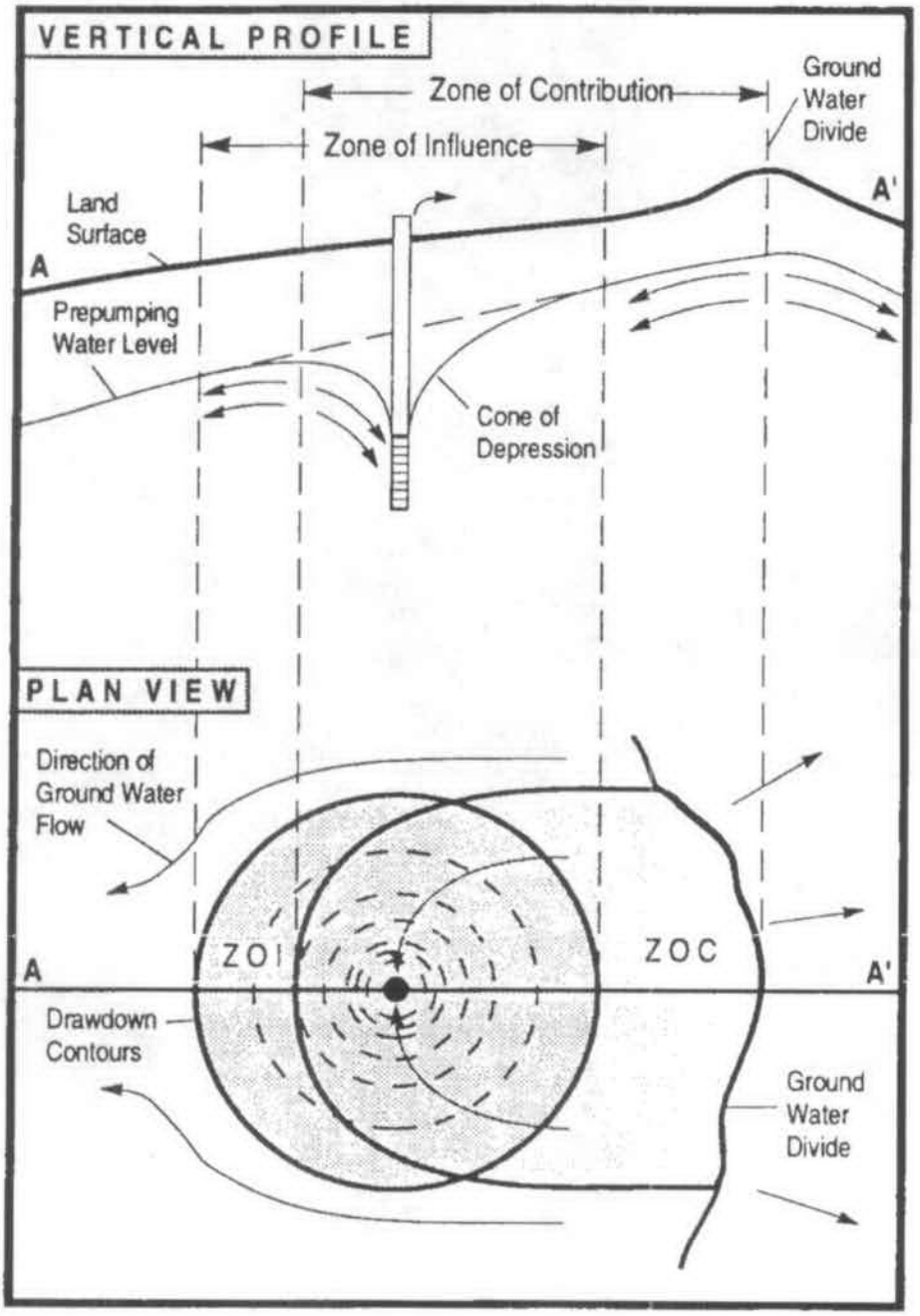
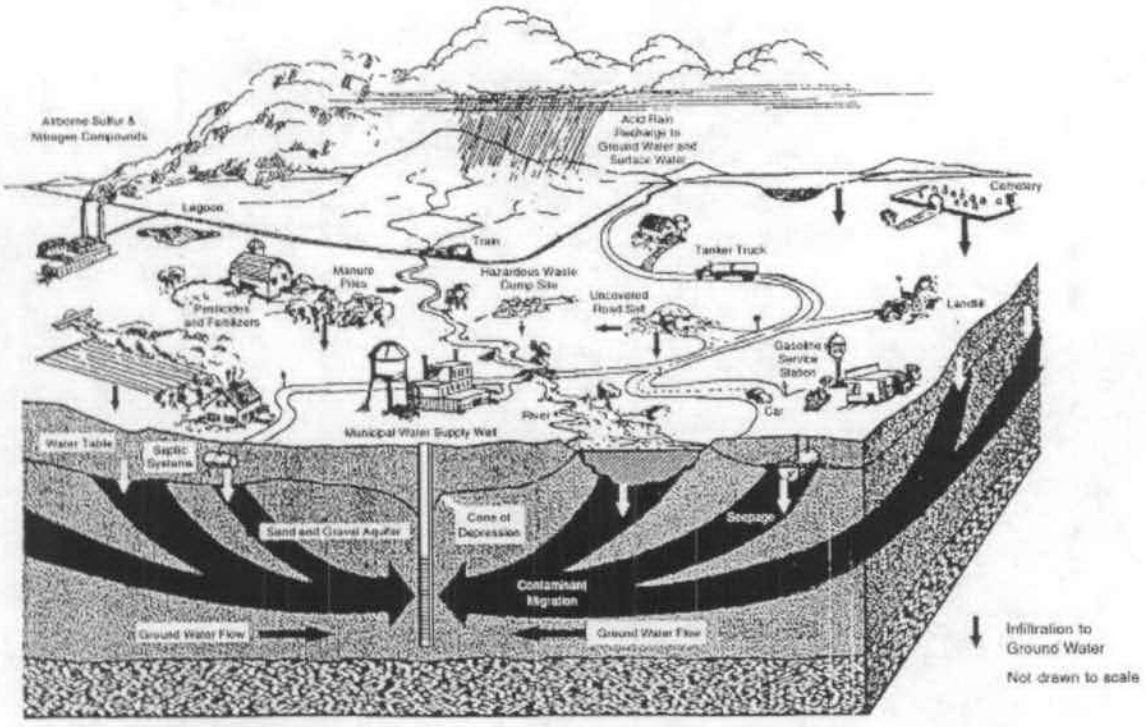


FIGURE 10-7 (Ground.pcx)
POTENTIAL SOURCES OF GROUND WATER CONTAMINATION



Some potential sources of ground water contamination.

CHAPTER 11

WASTE MANAGEMENT

BMP 11-1 UNDERGROUND STORAGE TANKS
BMP 11-2 WASTE MANAGEMENT SYSTEMS
BMP 11-3 SOLID WASTE DISPOSAL MANAGEMENT
BMP 11-4 WASTE TREATMENT LAGOON
BMP 11-5 WASTE STORAGE POND
BMP 11-6 WASTE STORAGE STRUCTURE
BMP 11-7 HOUSEHOLD HAZARDOUS WASTE MANAGEMENT

BMP 11-1
UNDERGROUND STORAGE TANKS

DEFINITION

An underground storage tank is defined as any tank with at least 10 percent of its volume buried below ground. Underground tanks are potential sources of ground water contamination because they are commonly used for the storage of sewage, motor fuels, or other potentially hazardous materials. (Note: The UST program does not cover residential septic tanks.)

PURPOSE

To prevent the discharge of degraded water to ground or surface water supplies.

APPLICABILITY

Applicable to any business or agency, such as, gas stations, marinas, utility maintenance yards and farms which store liquids in underground tanks.

PLANNING CRITERIA

The design and installation of new storage tanks and the repair and maintenance of existing tanks must be in compliance with local, state and federal regulations. There has been an increase in the number of leaking underground tanks. These leaking tanks can degrade water quality. Underground tanks which are no longer in use must be removed and disposed of properly or else left in place and filled with an acceptable inert material depending on the applicable state or local laws. Prior to any installation, repair, removal, or closure of underground tanks, secure the necessary permits from the proper authorities. **Consult with the respective County Health Department and the Nevada Division of Environmental Protection, Bureau of Corrective Actions (UST/LUST/Petroleum Claims branch).** These agencies have compiled an extensive manual geared specifically for owners/operators of tanks.

METHODS AND MATERIALS

The installation, repair, removal or closure of underground tanks must be conducted by qualified professionals. For tanks that are leaking or are suspected of leaking, samples of the soil, ground water, or surface water must be gathered to determine the release of a hazardous substance (including petroleum products) and would have to be accomplished by or overseen by someone with certification as a Environmental Manager under the NDEP Certification Program. Temporary BMPs must be installed and in place during all underground tank activities involving any soil disturbance. The ordinances and statutes of the state and county within which the tank is located shall be complied with.

MAINTENANCE

Underground storage tanks should be tested and monitored periodically in order to detect any leaks.

EFFECTIVENESS

If properly installed and monitored, underground tanks will not cause degradation of water quality.

BMP 11-2
WASTE MANAGEMENT SYSTEMS

DEFINITION

A planned waste management system designed for solid and/or liquid waste containment, management and disposal in a manner which does not degrade the environment. Waste management systems are utilized for livestock wastes, municipal waste treatment plant effluent and sludges, agricultural processing wastes and industrial processing wastes.

PURPOSE

Waste management systems are implemented to manage agricultural, municipal and industrial wastes in a manner which minimizes impacts to the air, soil, surface and ground water resources, and to protect the public health and safety. Systems are specifically designed to preclude discharges to the environment and to the fullest extent practicable, recycle wastes through soil and vegetation.

APPLICABILITY

Each waste management system must be designed, engineered, constructed and maintained by a qualified professional for the complete management of the specific type of waste, given the specific site conditions. Industry standards, federal, state and local regulations, and waste treatment technology establish the minimum acceptable standards for waste management systems.

PLANNING CRITERIA

Design criteria must be in accordance with applicable federal, state and local regulations, industry standards and completed by a qualified professional engineer. Typical components of waste treatment systems include, but are not limited to:

Sediment/Debris Basins or Other Settling Facilities
Dikes, Diversions or Terraces
Disposal Lagoons, Aerated Lagoons, Oxidation Ditches
Drainage Field Ditches, Drainage Land Grading
Grassed Waterways or Ditches
Waste Storage Facilities
Irrigation Systems
Effluent Land Application
Subsurface Drains
Pumping Plants
Waterspreading Facilities

All system components should be consistent with accepted engineering practices and protect public health and safety. Surrounding land uses should be incorporated into the waste management system development review process and mitigation measures installed to minimize off site impacts.

METHODS AND MATERIALS

A waste management system must be designed, engineered, constructed and maintained as a system. Individual components should not be constructed without an overall waste management plan approved. Public health and safety, wildlife and livestock should all be protected from potential hazards through the installation of safety devices and management practices. A comprehensive operations and maintenance plan should be developed for the system to ensure proper day to day operations.

MAINTENANCE

The operation of a waste management system will require ongoing inspection and maintenance to keep the system functioning. A comprehensive maintenance plan should address all system inspection and maintenance needs, including contingency and emergency response issues.

EFFECTIVENESS

A properly designed, constructed and maintained waste management system will function effectively while minimizing impacts to the environment.

BMP 11-3
SOLID WASTE DISPOSAL MANAGEMENT

DEFINITION

A management system for the proper disposal of domestic, commercial, agricultural and industrial solid wastes. Includes all landfill sites which must meet current federal, state and local regulations.

PURPOSE

To provide for the proper disposal of solid waste materials in a manner which will control pollution of surface and ground waters in accordance with applicable federal, state and local regulations.

APPLICABILITY

Applies to all entities within the State of Nevada disposing of solid waste including: communities, farms, ranches, recreation sites, commercial and industrial enterprises, mining operations, mineral exploration projects and the public.

PLANNING CRITERIA

The State of Nevada, Division of Environmental Protection has adopted statutes and regulations affecting municipal solid waste landfills and industrial solid waste disposal sites and has implemented a permit program for such facilities. Any solid waste landfill, irrespective of size or quantity, that receives household waste is a Municipal Solid Waste Landfill (MSWLF). There are three classes of disposal sites:

CLASS I MSWLF-	Receives 20 tons or more per day on annual average.
CLASS II MSWLF-	Receives less than 20 tons per day on annual average and has not caused ground water contamination, is located in an area that receives 25 inches or less of precipitation annually, and serves a community that has no practicable alternative for managing its solid waste.
CLASS III -	Receives only industrial solid waste.

The state regulations require that owners and operators meet specific criteria and obtain a permit based upon their disposal site classification. An individual landfill (i.e. farm, ranch, industrial, mining operation, etc.), is no longer allowable without a permit. Entities without a permitted landfill should be transporting their solid waste to a permitted landfill.

BMP 11-4
WASTE TREATMENT LAGOON

DEFINITION

An impoundment made by constructing an excavated pit, dam, embankment, dike, levee, or combination of these for biological treatment of organic waste. This practice does not include holding ponds and tanks.

PURPOSE

Lagoons are constructed to biologically decompose organic waste by aerobic or anaerobic organisms or a combination of both. The production of methane gas can be a by product of anaerobic activity and could be used to offset local energy costs.

APPLICABILITY

This BMP is applicable to lagoons located to serve predominantly rural or agricultural areas where there is a need for a facility to process concentrated organic waste, reduce sources of pollution, minimize health hazards and improve the local environment. Typically, there are no economically feasible alternatives to treatment by any other means.

PLANNING CRITERIA

Each waste treatment lagoon must be designed, engineered, constructed and maintained by a qualified professional for the complete management of the specific type of waste, given the specific site conditions. Industry standards, federal, state and local regulations must be adhered to. The State of Nevada, Division of Environmental Protection (NDEP) has statutes and regulations governing the design, construction, operation and maintenance of waste treatment facilities, including lagoons, through a permitting process. For additional information please contact the NDEP, Bureau of Water Pollution Control.

METHODS AND MATERIALS

A qualified professional engineer should be retained to design, engineer, construct, operate and maintain a waste treatment lagoon.

MAINTENANCE

A comprehensive maintenance plan should be developed in conjunction with the design and construction of a waste treatment lagoon. Lagoons require regular inspection and maintenance to ensure safe operations and effectiveness.

EFFECTIVENESS

A properly designed, constructed and maintained waste treatment lagoon will function effectively while minimizing impacts to the environment.

BMP 11-5
WASTE STORAGE POND

DEFINITION

An impoundment made by constructing an excavated pit, dam or embankment for the temporary storage of livestock or other agricultural wastes, waste water, and/or polluted runoff. Depending on the design, waste storage ponds can be aerobic or anaerobic or a combination of both.

PURPOSE

Waste storage ponds are utilized to store liquids, solid wastes and polluted runoff from concentrated livestock or waste areas until they can be safely utilized, evaporated, or otherwise disposed of.

APPLICABILITY

This practice applies generally in predominantly rural or agricultural areas, where there is a need for facilities to temporarily store agricultural wastes or polluted runoff, reduce pollution, minimize health hazards and improve the environment in predominantly rural or agricultural areas. Waste storage ponds must be designed and constructed to all applicable federal, state and local regulations.

PLANNING CRITERIA

Waste storage ponds should be designed, engineered and constructed by a qualified professional engineer. All federal, state and local laws, rules and regulations governing waste management, pollution abatement, public health and safety and environmental protection shall be strictly adhered to. A lining may be required if the potential for ground water contamination exists. The owner and operator is responsible for securing all required permits or approvals and for performing in accordance with such laws and regulations.

METHODS AND MATERIALS

A qualified professional engineer should be retained to design, engineer, construct, operate and maintain a waste storage pond.

MAINTENANCE

A comprehensive maintenance plan should be developed in conjunction with the design and construction of a waste storage pond. Storage ponds require regular inspection and maintenance to ensure safe operations and effectiveness.

EFFECTIVENESS

A properly designed, constructed and maintained waste storage pond will function effectively while minimizing impacts to the environment.

BMP 11-6
WASTE STORAGE STRUCTURE

DEFINITION

A fabricated structure for the temporary storage of animal or other agricultural wastes. Agricultural waste storage facilities typically include holding tanks and manure stacking facilities.

PURPOSE

These structures are a storage component of an agricultural waste storage system. They are constructed to temporarily store liquids, slurry or solid livestock manure, and other agricultural wastes until they can be treated, utilized, recycled or otherwise disposed of in an environmentally safe manner.

APPLICABILITY

Waste storage facilities are utilized where there is a need for fabricated structures to temporarily store agricultural wastes, reduce pollution of surface and ground waters, minimize public health and safety hazards and improve the environment. All federal, state and local laws, rules and regulations governing waste management, pollution abatement, public health and safety and environmental protection shall be strictly adhered to. The owner and operator is responsible for securing all required permits or approvals and for performing in accordance with such laws and regulations.

METHODS AND MATERIALS

A qualified professional should be retained to design, engineer, construct, operate and maintain a waste storage structure.

MAINTENANCE

A comprehensive maintenance plan should be developed in conjunction with the design and construction of a waste storage structure. Structures require regular inspection and maintenance to ensure safe operations and effectiveness.

EFFECTIVENESS

A properly designed, constructed and maintained waste storage structure will function effectively while minimizing impacts to the environment.

BMP 11-7
HOUSEHOLD HAZARDOUS WASTE MANAGEMENT

DEFINITION

The proper management of hazardous household products from the time of purchase, through application, to final disposal.

PURPOSE

Numerous household products contain solvents, caustics, petroleum products, heavy metals and other hazardous chemicals. The proper management of these products will reduce surface and ground water pollution impacts, threats to public health and safety and minimize impacts to the environment.

APPLICABILITY

The proper management of hazardous household products is applicable to every household utilizing the involved products. It is also important to the overall reduction of environmental pollution associated with Nevada's solid waste landfills.

PLANNING CRITERIA

Hazardous household products include, but are not limited to the following list:

Motor Oils, & Lubricants
Brake Fluids & Automatic Transmission Fluid
Batteries
Antifreeze
Solvents & Degreasers
Pesticides, Herbicides, & Fungicides
Household Cleaners
Wood Preservatives
Oil Based Paints
Lacquers and Thinners
Polishes, Waxes, & Spot Removers

The chemical components of these products have the potential to poison, corrode, burst, and contaminate various areas of the environment including the air, soil, surface and ground water, vegetation, fisheries and wildlife. Many of these products will also interfere with the operations of septic tanks and sewer treatment plants. When hazardous products are discarded improperly they become household hazardous wastes.

METHODS AND MATERIALS

There are several ways to minimize or eliminate hazardous household wastes. Many products now have environmentally safe counterparts which accomplish the same task. In certain circumstances the environmentally safe product not only eliminates a hazardous waste, it works more effectively. It is important for the consumer to know exactly what he or she is trying to accomplish and then select the appropriate product to complete the task. Reading the product label fully before purchase will provide clear understanding of what the product will do and how to properly dispose of it. Purchase only the products you need in quantities to complete the job, as waste is usually created by purchasing excess quantities. If you are unable to use all of the product, then give it to someone else who can utilize it instead of disposing of it.

Key rules to follow when utilizing or disposing of any hazardous household waste include the following:

* Follow label instructions for proper product application, clean up and disposal.
* Never bury hazardous household waste or products.
* Do not dump hazardous household wastes along roadways, in storm drains, sewer systems or septic tanks.
* Never dispose of hazardous household wastes in streams, creeks, lakes, ponds or drainages.
* Avoid utilizing or applying hazardous household products in or around drinking water wells or within a Wellhead Protection Area.

Recycle as many hazardous household products as possible. The local recycling center, community landfill or sanitation department can provide the consumer with current recycling information. Hazardous waste collection days are becoming very popular in most communities. Consumers are urged to safely store their household hazardous wastes until a scheduled collection day, then bring them to a central location for proper disposal.

MAINTENANCE

All household products should be stored and maintained per the product labels. Failure to maintain products in a proper manner may result in explosion, fire, environmental contamination or risk to personal health and safety.

EFFECTIVENESS

If a consumer reads and follows hazardous household product labels and disposes of the hazardous waste in the specified manner, household hazardous waste management is very effective in minimizing contamination of the environment.

CHAPTER 12

MISCELLANEOUS

BMP 12-1 IMPERVIOUS SEALS
BMP 12-2 WATER STORAGE RESERVOIR

BMP 12-1
IMPERVIOUS SEALS

DEFINITION

A method to prevent infiltration of pollutants into surface water or ground water and to seal ponds for water storage.

PURPOSE

To prevent infiltration of pollutants into surface water or ground water by use of impervious seals.

APPLICABILITY

Suitable wherever the potential exists for pollutants to enter ground water basins and for sealing ponds for water storage.

PLANNING CRITERIA

Various methods are available for use in preventing ground water infiltration. The overall practicability of the method should be given careful consideration, along with economic factors, aquifer vulnerability, magnitude of the potential problem, installation requirements, local conditions, acceptability by operators, and future maintenance requirements.

METHODS AND MATERIALS

1. **Clay Seals** - Is a technique to reduce or retard the infiltration of pollutants into ground water. Where good quality clay is available locally, pollutant intrusion into ground water can be reduced by the placement of a compacted zone of clay between the pollutant and the ground water.

   Use of clay is dependent on availability and cost of transport to the treatment site. Consideration must be give to equipment available for placement and compaction. The clay sealant must be laid in a uniformly thick layer of sufficient depth to minimize opportunities for leakage of pollutants.

   Clay can be placed using various methods. Front end loaders, pull scrapers, belly and end dump trucks, cranes and power shovels could all be used successfully depending on site conditions.

Compaction of clay is also done by several methods. Hand-held "Jitterbug" vibrating compactors are usable for small-scale work. Large roller, vibratory roller and sheepsfoot roller compactors are suited for large areas. Travel of heavy rubber tire equipment over clay surface is often used to compact the clay zone.

Bentonite or montmorillonite is highly suitable due to good sealing characteristics.

2. **Gunite** - Seals the ground surface by pneumatically placed concrete. High application cost allows use only where limited area requires treatment and a strong durable sealer is needed. Use is restricted to sealing small ponds, channels, and tanks. Work should be done by contractors who specialize in gunite application.

   A low slump, high strength concrete is used to allow the sealant to be place pneumatically on irregular, vertical, or overhead surfaces. Acids and other chemicals may attack the surface and cause leaking. Where possible, cements resistant to expected fluid-type should be used.

3. **Asphalt Seals** - Used where lower cost clay is not available and the area to be treated is not large. Most applications require outside services of a contractor specialized in asphalt paving work. Mixing and placement equipment is usually not available to operators. A firm earthen base is needed to allow placement of asphalt since heavy rolling compactors are utilized to lay the sealant. Asphalt is a good choice as a sealant except where fuels, acetates, alcohols, and other similar type materials exist in substantial amounts. Only cold mix type asphalts are considered satisfactory as a sealant. High-cost precludes hot mix asphalt from consideration unless the site is very small and a mixing plant is close by.

4. **Plastic Sheeting Seals** - Are useful as a sealant where resistance is needed from attack by most chemicals and acids. High temperature may result in breakdown of sealant. Manufacturing representatives should be sought for advice on specific applications.

   Limited areas, such as small collection reservoirs, are ideally suited for plastic sheet seals. High initial cost may prevent this practice from being used. The surface area where applied must be carefully prepared with sand or soft dirt to prevent cuts from sharp rocks or other rough material. Polyethylene sheeting is the most commonly used plastic. The material is sometimes installed as a solid sheet or in overlapping strips. Heavier strips can be fused by welding in place.

MAINTENANCE

Frequent inspections are recommended with repairs or modifications made when necessary. A comprehensive maintenance program is necessary to ensure integrity of the seal.

EFFECTIVENESS

Effectiveness will be based on proper selection, design, installation and regular maintenance.

BMP 12-2
WATER STORAGE RESERVOIR

DEFINITION

A water storage reservoir made by constructing a dam or an embankment.

PURPOSE

Storage reservoirs are constructed to conserve water by holding it in storage for later beneficial use. Uses include irrigation, domestic water, mining, industrial applications, recreation, wildlife, flood control and streamflow regulation.

APPLICABILITY

Applies to sites that meet the following criteria:

1. There is a need for stored water for beneficial use.

2. Water for storage is available from surface runoff, streamflow or pumped ground water.

3. Topographic, geologic and soil conditions for construction of a dam or earthen embankment and storage reservoir.

PLANNING CRITERIA

Water storage reservoirs must be fully investigated, designed and installed under supervision of qualified professional engineers. Plans, designs and installation must meet the requirements of all applicable state statues and regulations including water rights.

MAINTENANCE

A comprehensive maintenance program should be developed for the water storage reservoir. Regular inspections of the dam or earthen embankment and other facilities are necessary. Any deficiencies must be immediately corrected.

EFFECTIVENESS

Storage provides water for use during low flow periods and aids in flood control, regulating stream flow and sediment reduction.

APPENDICES

APPENDIX A - EROSION & SEDIMENT CONTROLS

A-1 SUGGESTIONS FOR TEMPORARY EROSION AND SILTATION CONTROL MEASURES

A-2 EROSION AND SEDIMENTATION CONTROL STRUCTURES

Appendix A-1

Edited From:

SUGGESTIONS FOR TEMPORARY
EROSION AND SILTATION
CONTROL MEASURES

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Region One

Acknowledgement

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SUGGESTIONS FOR TEMPORARY EROSION AND SILTATION CONTROL MEASURES

Introduction

This booklet has been prepared to assist highway designers, construction field personnel, and contractors by providing some ideas and suggestions for controlling erosion and sediment pollution during highway construction. Many of the control measures are considered temporary, intended to serve during construction or until permanent controls are installed and become effective.

Most of the features discussed and shown have been successfully employed on highway construction projects. In some states, they have been incorporated into design plans and specifications. State highway departments are encouraged to incorporate these temporary features, along with other erosion and siltation control measures, into their designs. It is also necessary to establish an adequate maintenance schedule of temporary controls during construction.

Where temporary erosion control features are not included in the plans, it is expected that construction field personnel and contractors will anticipate possible problems and provide timely and adequate controls to prevent or at least minimize adverse effects.

These ideas and suggestions should also be of value to contractors in developing erosion control schedules as required on all federal aid projects.

Discussion

The most effective erosion and siltation control that can be exercised on any highway construction project is early treatment of the slopes - both cut and fill. Early treatment means treating cut slopes as excavation progresses and fill slopes as embankment construction proceeds. Slope treatment varies from state to state but generally consists of mulchseeding, and in some instances topsoil application. Stone blankets and other special treatments may be needed in problem areas. The temporary control measures discussed and shown in this booklet should not be considered in lieu of early slope treatment, but rather for use in conjunction with early slope treatment.

It is also presumed that proper excavation and embankment construction operations will be performed including items such as: early installation of interceptor and toe of slop ditches, adequate roadway crowning to allow lateral drainage in both cuts and fills, maintaining side ditches in cut areas as a lower elevation than the main body of the cut, and proper

embankment compaction. In general, control measures should not be constructed in existing watercourses. If at all possible, erosion and siltation control should be accomplished before runoff reaches the main watercourse.

Sedimentation Pools

Major siltation control features which are being included in many highway designs are sedimentation pools, stilling basins and sediment dams. Figures A-1, A-2 and A-3 (pages A-11, A-12, and A-13, respectively). Large sedimentation pools should be considered during the design stages and incorporated into the construction plans. They may be added to a project during construction but must be subjected to a formal design procedure based on site conditions. These pools should be located at ponds and lakes. This type of sedimentation pool can be permanent, to remain in place after project completion. These pools should be constructed early in grading operations and all runoff from the contributing construction area controlled to enter the pool before reaching a stream or adjacent watercourse. Periodic cleaning is necessary in order to maintain their effectiveness.

There are also many locations on a highway construction project where stilling basins or sediment dams can be constructed as a temporary measure. Figure A-2 and A-3 illustrate structures that can be used to effectively control pollution until permanent controls are installed.

Special care must be exercised in building and maintaining all sediment dams and basins. If these impoundments pond much water, a failure could result in extensive damage.

Berms and Slope Drains

Temporary berms serve as an effective measure in controlling runoff and preventing erosion. Figure A-4 (page A-14) shows the use of temporary berms along the top of a fill slope. The berms should be large enough to control heavy runoff and prevent washout. The earth berms shown in Figure A-4 are approximately two feet wide by one foot high and should be compacted by the wheel or track of construction equipment. Earth berms can easily be constructed at the end of each day's embankment operations to provide positive erosion control during construction stages. Another type of temporary berm which has been used successfully is a long burlap sleeve filled with sand. This type is effective when installed on essentially completed embankments. The sand filled burlap sleeve remains in place to allow grass to become established before the burlap rots and the sand disperses. Temporary berms can also be placed along the top of cut slopes where runoff might cause erosion along the cut face.

In using temporary berms, it is important to recognize that the runoff collected must be periodically outleted to prevent severe erosion. Figure A-4 shows a temporary slope drain installed for this purpose. An end section should be placed on the inlet of the pipe and a crescent shaped earth berm constructed to channel runoff into the slope drain. Sumped stone protection may be necessary to prevent erosion at the drain outlet.

Figure A-5 (page A-15) shows the installation of a flexible downdrain. The collapsible pipe is about 20 inches in diameter and can be connected to an 18 inch pipe and section. It is held in place by pinning or staking. Flaps with grommets are provided every 20 feet for this purpose. This type of temporary downdrain system can be easily removed while addition embankment is being placed and reinstalled at the end of each embankment operation. Also, the location of the outlet can be easily changed when desired. Outlet protection is needed and the pipe should be inspected for clogging after each storm.

Toe of Slopes

Another problem area where some form of temporary erosion control should be provided is along the toe of embankment slopes. Where plans call for toe of slope ditches, they should be constructed early in the grading operations. However, ditches in themselves may not offer the type of protection needed and additional controls should be installed.

Figures A-6a through A-6d (pages A-16 through A-19) show the plan details for brush barriers, silt and check dams. These devices are useful where brush is plentiful and can be allowed to remain in place.

Figures A-7, A-8 and A-9 (pages A-20 through A-22) show the use of hay bales along the toe of a slope. Hay bales can be effectively used in many locations as a temporary measure to control erosion and prevent siltation. For long lengths of this type of barrier and at low points where runoff will accumulate, overflow outlets should be provided as shown in Figure A-7. Bales should be embedded in the ground 4 to 6 inches to prevent water from flowing under them. Figures A-8 and A-9 show the manner in which bales are to be placed depending on whether the exiting ground slopes toward or away from the embankment. Bales can remain in place until they rot, or be removed after they have served their purpose. Replacement of damaged or silted bales may be necessary.

Figure A-10 (page A-23) is a composite picture indicating various temporary control measures that can be employed during embankment construction.

Cut-to-Fill Slope

Generally, a major problem area is created when grading operations begin. The problem area starts at the cut to fill transition and extends along the toe of the embankment slope. Figure A-11 (page A-24) shows this area and suggests some possible temporary controls that should be installed. Controls in this area should be provided at an early stage of grading and maintained throughout excavation embankment operations and until permanent controls are installed.

Ditches

Newly excavated ditches may be highly susceptible to erosion and often contribute to the siltation of waterways. Although desirable, it is not always practical to provide necessary ditch lining immediately after excavation. Consequently, timely installation of temporary erosion and siltation control measures is important.

Figure A-12 (page A-25) shows a typical situation involving side and median ditches or swales. Dumped stone, jute mesh, or sod can be used to effectively minimize erosion of ditch bottoms and sides. Hay bales can be used as temporary check dams to assist in controlling erosion and minimizing siltation. In providing the protection shown in this figure, the width of the lining or dam should extend far enough up the ditch slope to effectively contain the runoff and prevent erosion and washout at the edges.

Figure A-13 (page A-26) illustrates the use of temporary dams for use in wider ditches or small streams. These types of dams are generally used where flow must be maintained by providing a spillway opening. As a word of caution, careful consideration should be given to temporary dams constructed of graded stone to assure that the size of the stone selected is large enough to withstand the force of the flowing water. A number of temporary stone dams have been constructed utilizing two inch stone, while they have been quite effective during the periods of low flow, they have failed during periods of heavy rain. As a rule of thumb, about 50% of the stone should be 6 inches or larger for dams in small streams.

Waterway Crossings

Most highway construction projects cross some form of a waterway--a stream, river, pond, etc. These are highly critical areas that must be protected from siltation.

For smaller streams, where temporary dams can be used without causing upstream damage, a log and hay erosion check dam can be used. Figures A-14A and B (pages A-27 and A-28) show the general plan details of this type of dam. These dams can be constructed from readily available native material and should be placed on the downstream side of the construction area.

Figure A-15 (page A-29) shows a method of installing a temporary board dam at the inlet of a culvert. This method can be used in those locations where space is not available at the outlet end to install adequate temporary measures. Also, many locations are usually available where this method can be used to temporarily pond runoff in medians and ramp loop areas. The basin created by this dam should be periodically cleaned. Hay bales may be used in conjunction with the boards if adequate measures (such as staking) are taken to prevent them from clogging the culvert.

At larger stream or river crossings, temporary dams in the channel are generally not feasible or practical, except under special conditions. In these instances, eroded materials should be intercepted before they reach the waterway. Figure A-16 (Page A-30) shows three types of protection that can be installed to trap sediment. Dumped stone or riprap protection is also needed between the outlet and the waterway.

Ditch Junctions

Most highway plans show the location of ditches and include a typical cross section detail. However, no special details are generally included for those locations where ditches join and in many cases the junctions are indicated as 90 degree intersections. At junctions, heavy concentrations of flow may result in the water leaving the ditch and eroding the adjacent earth. Ditch junctions should therefore, be designed and constructed to accommodate the runoff and side slope at junctions should be steepened to more effectively direct the flow.

Drainage Inlets

Unprotected drainage inlets, catchbasins, and other minor structures often times empty silt laden runoff directly into waterways or ditches leading to waterways. Runoff should be intercepted before it reaches these drainage structures and the silt and other materials removed. Figures A-17 and A-18 (pages A-31 and A-32) suggest methods that can be used to minimize the amount of sediment entering these structures. Periodic cleaning is necessary to maintain their effectiveness and all accumulated silt must be removed before constructing the pavement structure.

Pipe Outlets

When water is discharged from a pipe, erosion often results. While permanent splash pads, energy dissipators, or other special treatment may be required, often times they are not constructed until some time after the pipe is installed. In these situations, dumped stone should be used as shown in Figure A-19 (page A-33) for temporary or permanent erosion control. The quantities of stone required should be determined depending on conditions such as the anticipated discharge and velocity.

Consideration should be given to including provisions in the contract requiring stockpiling of stone during the early stages of construction for use at pipe outlets, ditches and other locations where erosion problems may develop.

Diversion Channels

Temporary diversion channels are used when it is necessary to divert water around an area where a culvert is to be constructed. Often times the raw erodible slopes of these channels contribute to siltation. Figure A-20 (page A-34) suggests using stone linings with gravel foundations for erosion control in large diversion channels and gravel lining for smaller channels. On those projects where rock excavation is encountered, ledge fragments should be stockpiled for use in lining channels, ditches, pipe outlets, and for constructing haul roads across streams. Temporary stone or hay bale check dams placed in the diversion channel can also effectively minimize siltation.

Haul Roads

Hazardous conditions can be created not only by the hauling activities but also from the silt laden runoff that is discharged from the haul road onto the local street. Quite often sediment is deposited in street drainage systems and ultimately carried to a nearby waterway.

Temporary erosion and siltation controls should be included at these locations. One method that can be employed is to construct a sag in the haul road profile, install a temporary pipe under the road and direct runoff to a temporary sediment pool. Similar structures can be constructed at stream and river crossings.

Summary

The ideas and suggestions presented in this booklet depict many of the temporary measures that have been used successfully in minimizing soil erosion and water siltation related to highway construction activities. In some instances, these temporary controls are being included in the project plans.

The features shown in this booklet will apply to other conditions besides those discussed. There are many situations which occur on a typical highway construction project where erosion and pollution problems become evident and some type of temporary control should be provided. The features discussed in this booklet are just some of the items that have been successful and should be considered. Bridge construction, borrow pits, waste areas and haul roads off the right-of-way are some other areas where the features discussed in this booklet could be used effectively.

ILLUSTRATIONS OF STRUCTURAL CONTROLS TO CONTROL EROSION AND SILTATION

(Figures A-1 through A-20)

FIGURE A-1 (App10.pcx)
SEDIMENTATION POOL

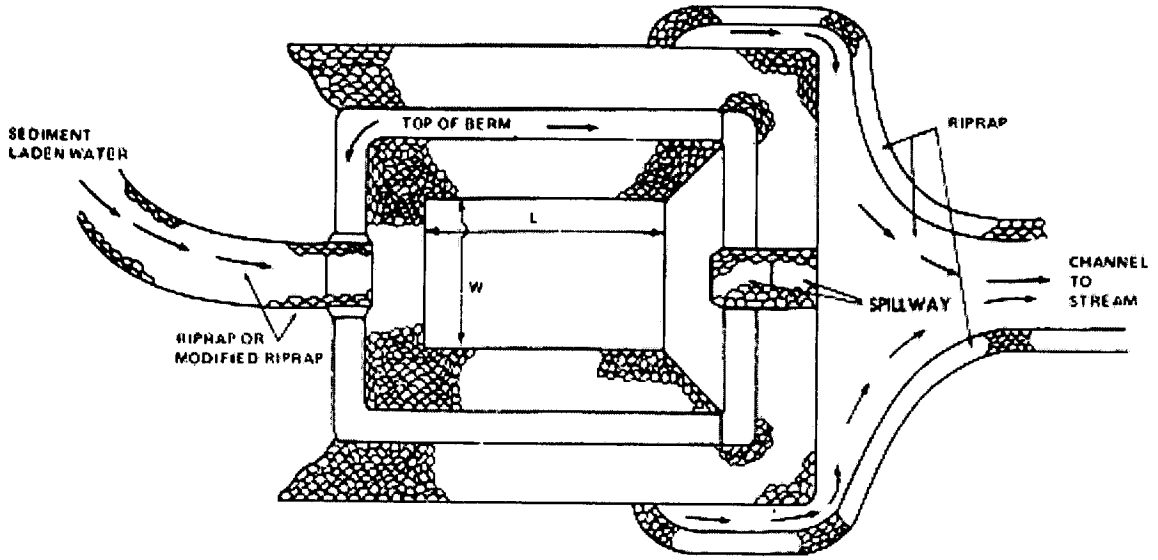


FIGURE A-2 (APP11.PCX)
TEMPORARY EROSION CONTROL STILLING BASIN

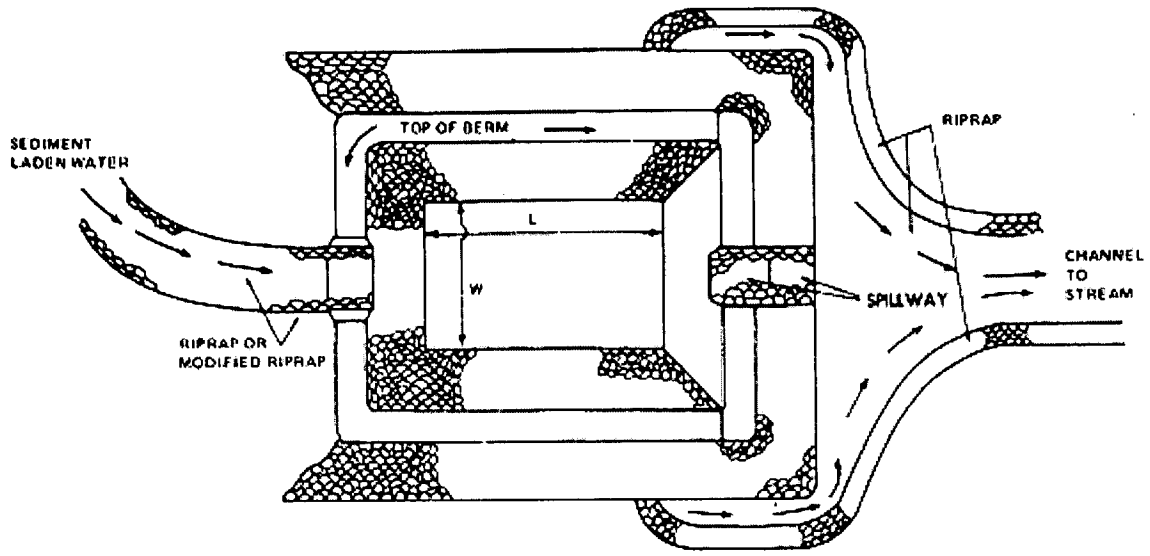
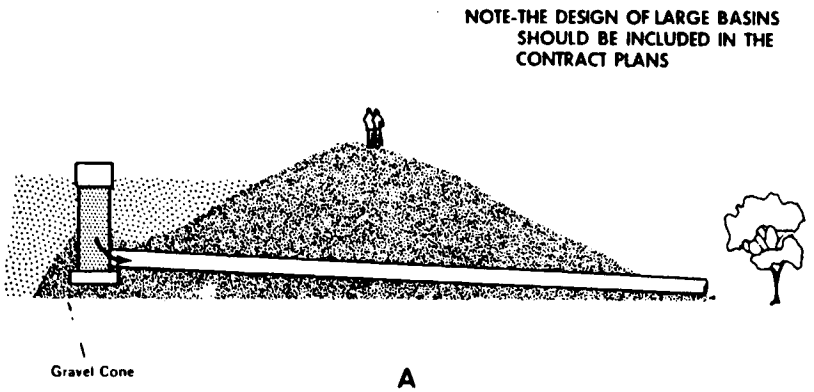
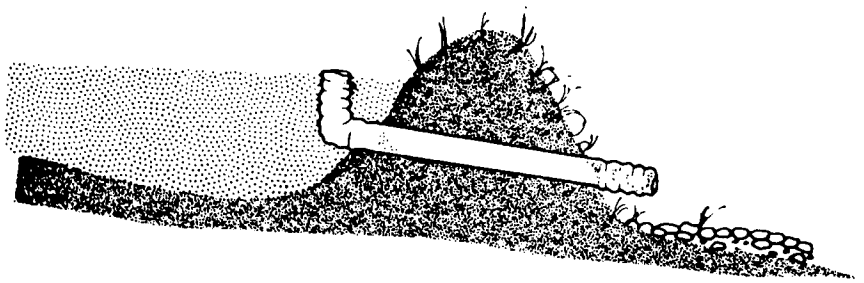


FIGURE A-3 (APP12.PCX)
SEDIMENT DAMS



A

LARGE-SEDIMENT POOL INSTALLATION

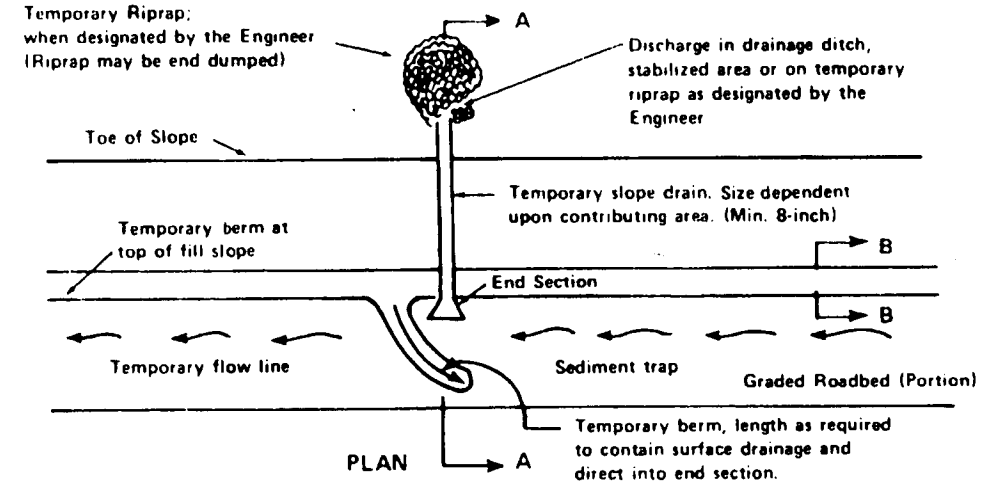


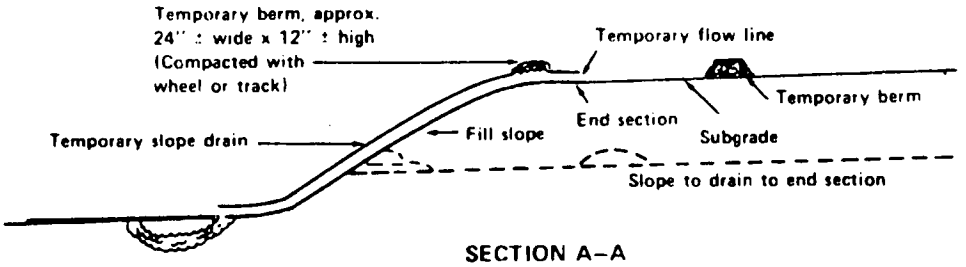
B

SMALL - TEMPORARY INSTALLATION

SEDIMENT DAMS

FIGURE A-4 (APP13.PCX)
TEMPORARY BERMS & SLOPE DRAIN





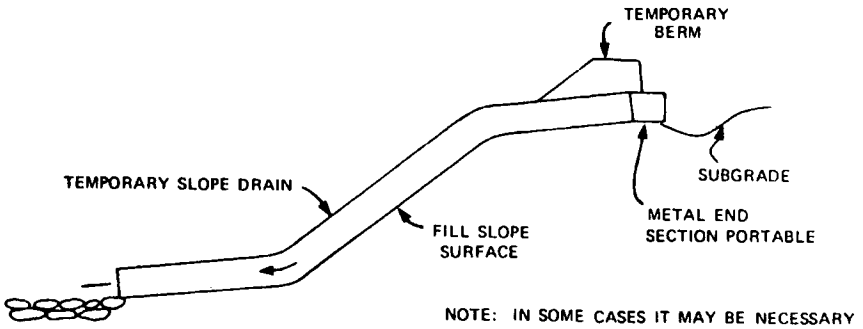
SECTION A–A

TEMPORARY SLOPE DRAIN, BERM AND RIPRAP
(FOR FILL SLOPES)

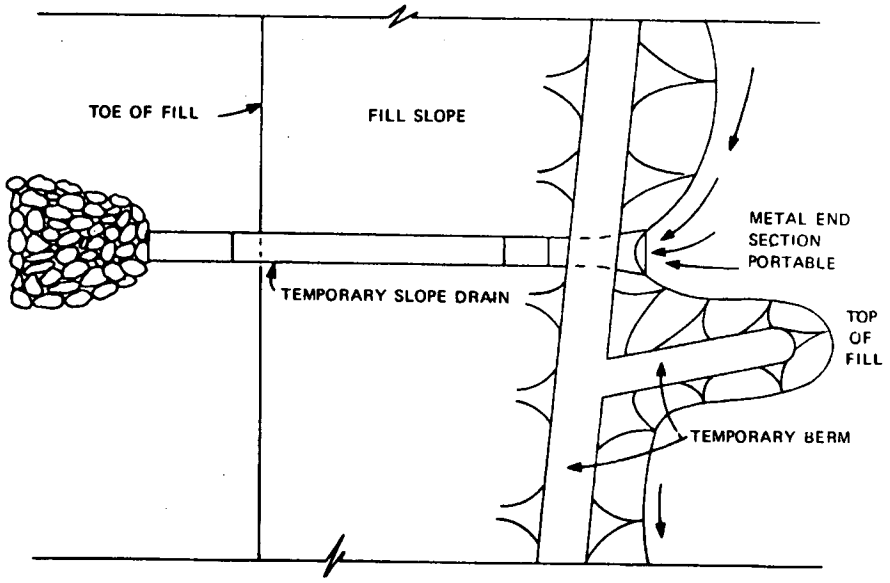
SECTION B–B

TEMPORARY BERMS & SLOPE DRAIN

FIGURE A-5 (APP14.PCX)
TEMPORARY SLOPE DRAIN (FLEXIBLE)



END VIEW

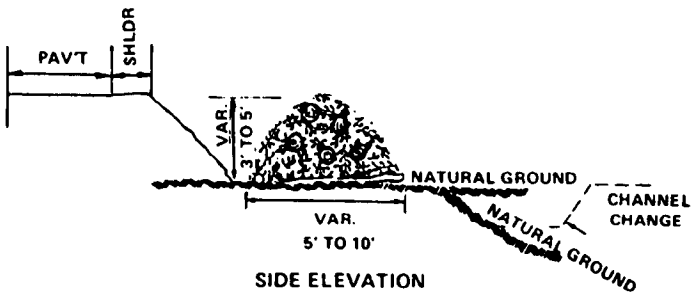


PLAN VIEW

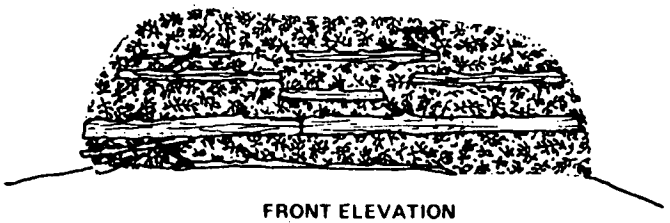
TEMPORARY SLOPE DRAIN (FLEXIBLE)

FIGURE A-6A (APP15.PCX)
DETAIL OF BRUSH BARRIER

NOTE: BRUSH BARRIER TO BE USED WHEN NATURAL GROUND IS LEVEL OR SLOPING AWAY FROM PROJECT.



SIDE ELEVATION



FRONT ELEVATION

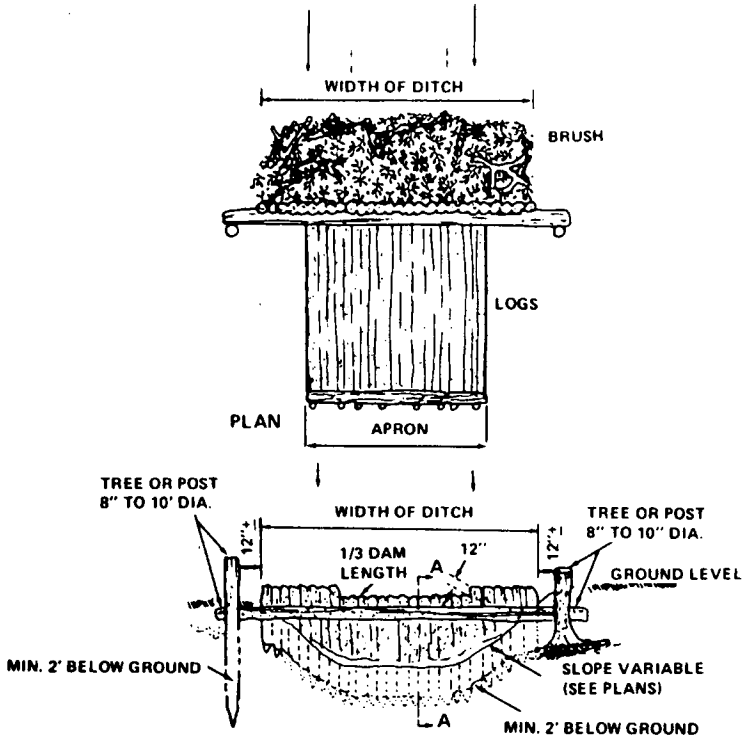
PLACE BRUSH, LOGS AND TREE LAPS APPROXIMATELY PARALLEL TO TOE OF FILL SLOPE WITH SOME OF THE HEAVIER MATERIALS BEING PLACED ON TOP TO PROPERLY SECURE THE BARRIER AS DETAILED ABOVE AT LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY THE ENGINEER.

TO ALLOW WATER TO FILTER THROUGH BRUSH BARRIER, INTERMINGLE THE BRUSH LOGS AND TREE LAPS SO AS NOT TO FORM A SOLID DAM.

THE BRUSH BARRIERS MAY BE CONSTRUCTED WITH MECHANICAL EQUIPMENT.

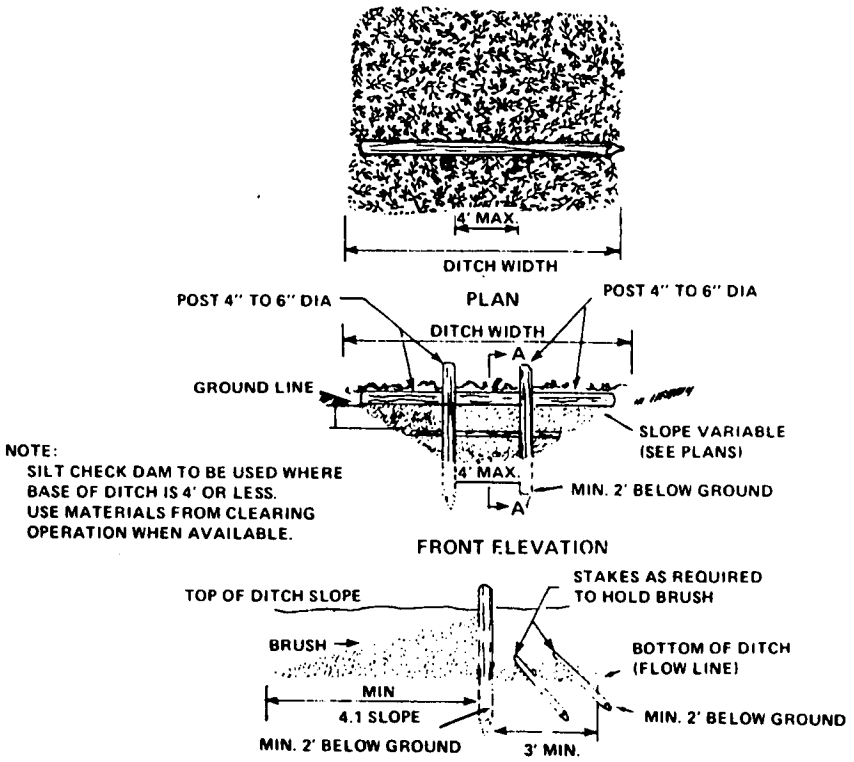
DETAIL OF BRUSH BARRIER

FIGURE A-6B (APP16.PCX)
DETAIL OF SILT CHECK DAM TYPE A



DETAIL OF SILT CHECK DAM TYPE A

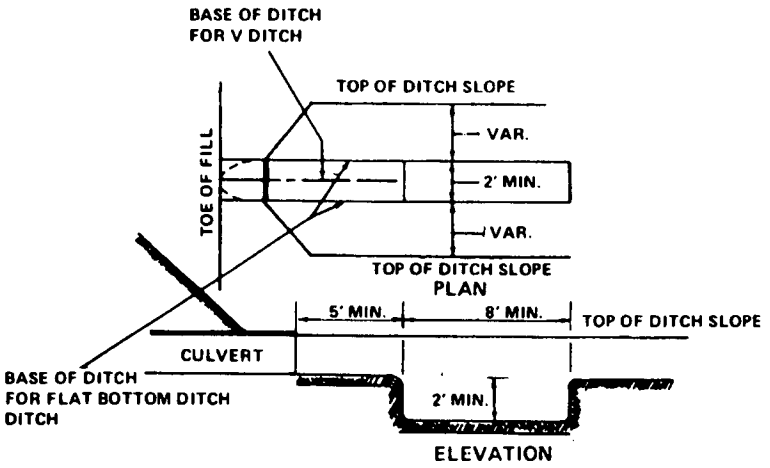
FIGURE A-6C (APP17.PCX)
DETAIL OF SILT CHECK DAM TYPE B



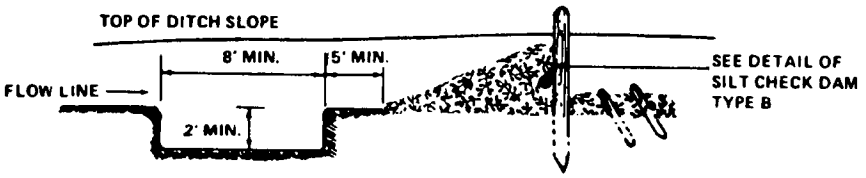
WHERE LOGS ARE NOT AVAILABLE, WOVEN WIRE FENCE MAY BE USED TO RETAIN WOODS LITTER FOR BRANCH FILTER. IF WOVEN WIRE FENCE IS USED, THE WIRE SHALL BE ANCHORED SECURELY AND TO THE SATISFICATION OF THE ENGINEER PRIOR TO PLACING THE LITTER AND FOLIAGE FILTER MATERIALS.

DETAIL OF SILT CHECK DAM TYPE B

FIGURE A-6D (APP18.PCX)
DETAIL SHOWING COMBINATION OF SILT CHECK DAM TYPE B AND SILT BASIN TYPE B



DETAIL OF SILT BASIN TYPE B



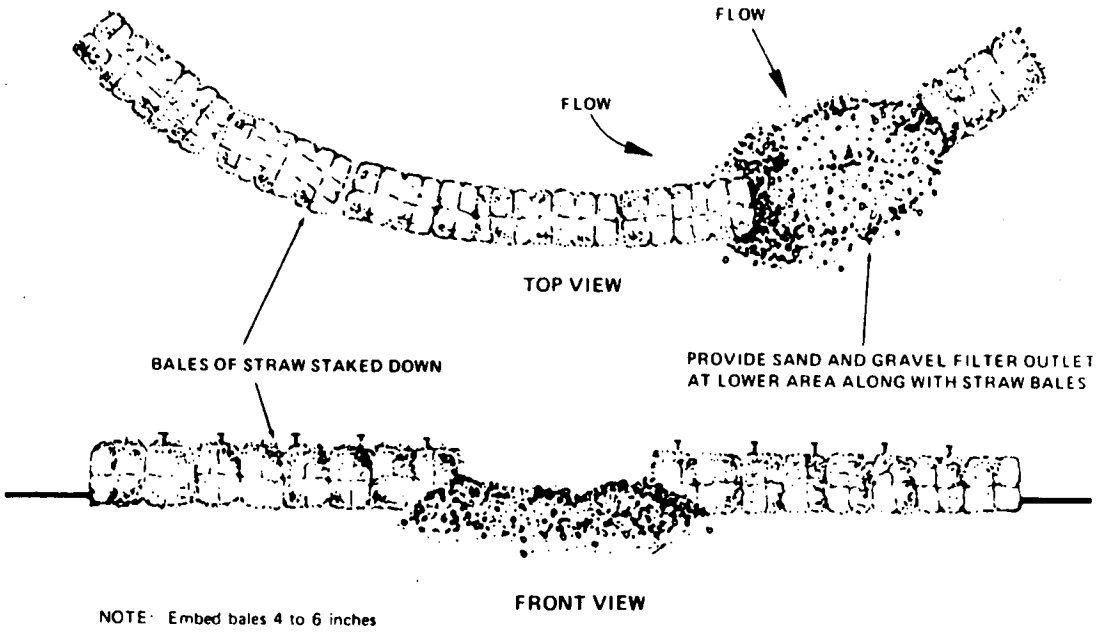
NOTE:

SMALL SILT BASIN TO BE USED AS NEEDED AT PIPE INLET AND OUTLETS PARALLEL ROADWAY DITCHES AND AT OTHER LOCATIONS AS DIRECTED BY THE ENGINEER.

LENGTH, WIDTH AND DEPTH AS REQUIRED TO CONTROL SILT IN FLOW LINE'

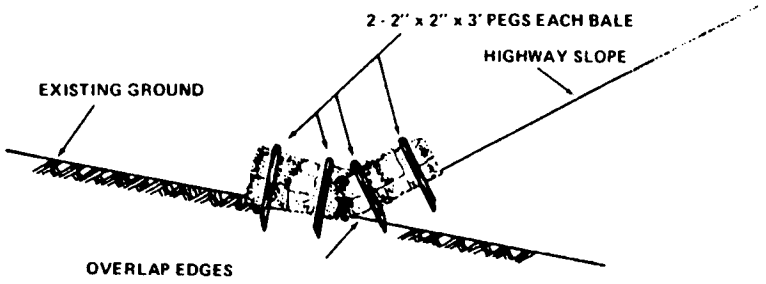
DETAIL SHOWING COMBINATION OF SILT CHECK DAM TYPE B AND SILT BASIN TYPE B

FIGURE A-7 (APP19.PCX)
HAY BALE DAMS USED ALONG TOE OF SLOPE



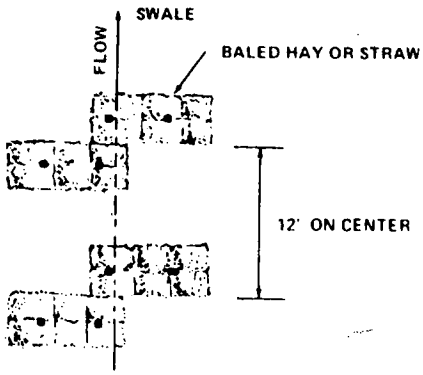
HAY BALE DAMS USED ALONG TOE OF SLOPE

FIGURE A-8 (APP20.PCX)
TYPE A--BALED HAY OR STRAW EROSION CHECKS



ELEVATION

NOTE: Embed bales 4 to 6 inches



PLAN

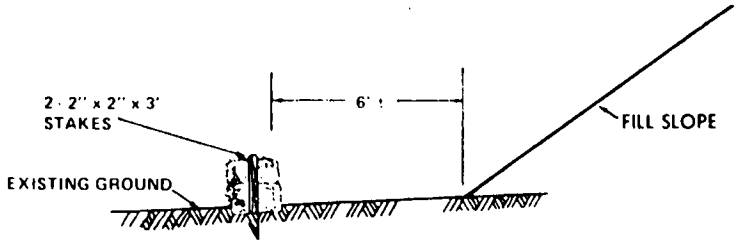
TO BE USED WHERE THE EXISTING GROUND SLOPES TOWARDS THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.

MEASUREMENT AND PAYMENT WILL BE BY THE BALE IN PLACE. BALES WILL BE ALLOWED TO ROT IN PLACE SO THERE WILL BE NO REMOVAL ITEM. THERE WILL BE NO PROVISIONS FOR MAINTENANCE OTHER THAN REPLACEMENT OF A BALE IF REQUIRED.

TYPE "A"

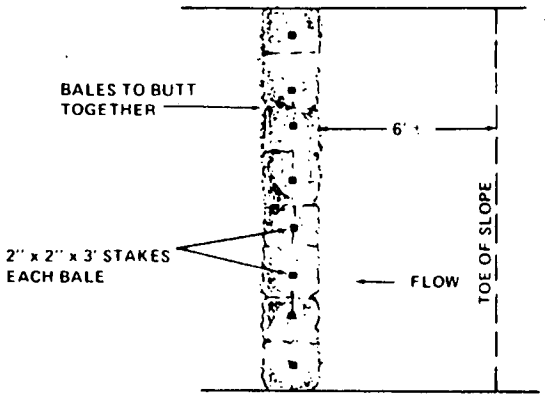
BALED HAY OR STRAW EROSION CHECKS

FIGURE A-9 (APP21.PCX)
TYPE B--BALED HAY OR STRAW EROSION CHECKS



ELEVATION

NOTE - Embed bales 4 to 6 inches



PLAN

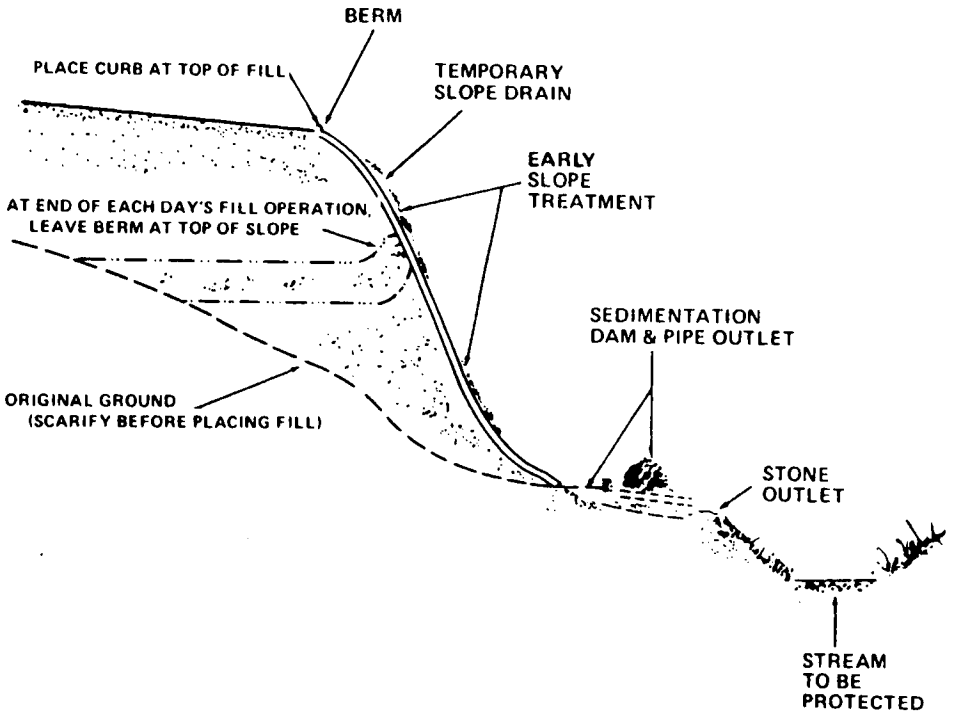
TO BE USED WHERE THE EXISTING GROUND SLOPES AWAY FROM THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.

MEASUREMENT AND PAYMENT WILL BE BY THE BALE IN PLACE. BALES WILL BE ALLOWED TO ROT IN PLACE SO THERE WILL BE NO REMOVAL ITEM. THERE WILL BE NO PROVISIONS FOR MAINTENANCE OTHER THAN REPLACEMENT OF A BALE IF REQUIRED.

TYPE B

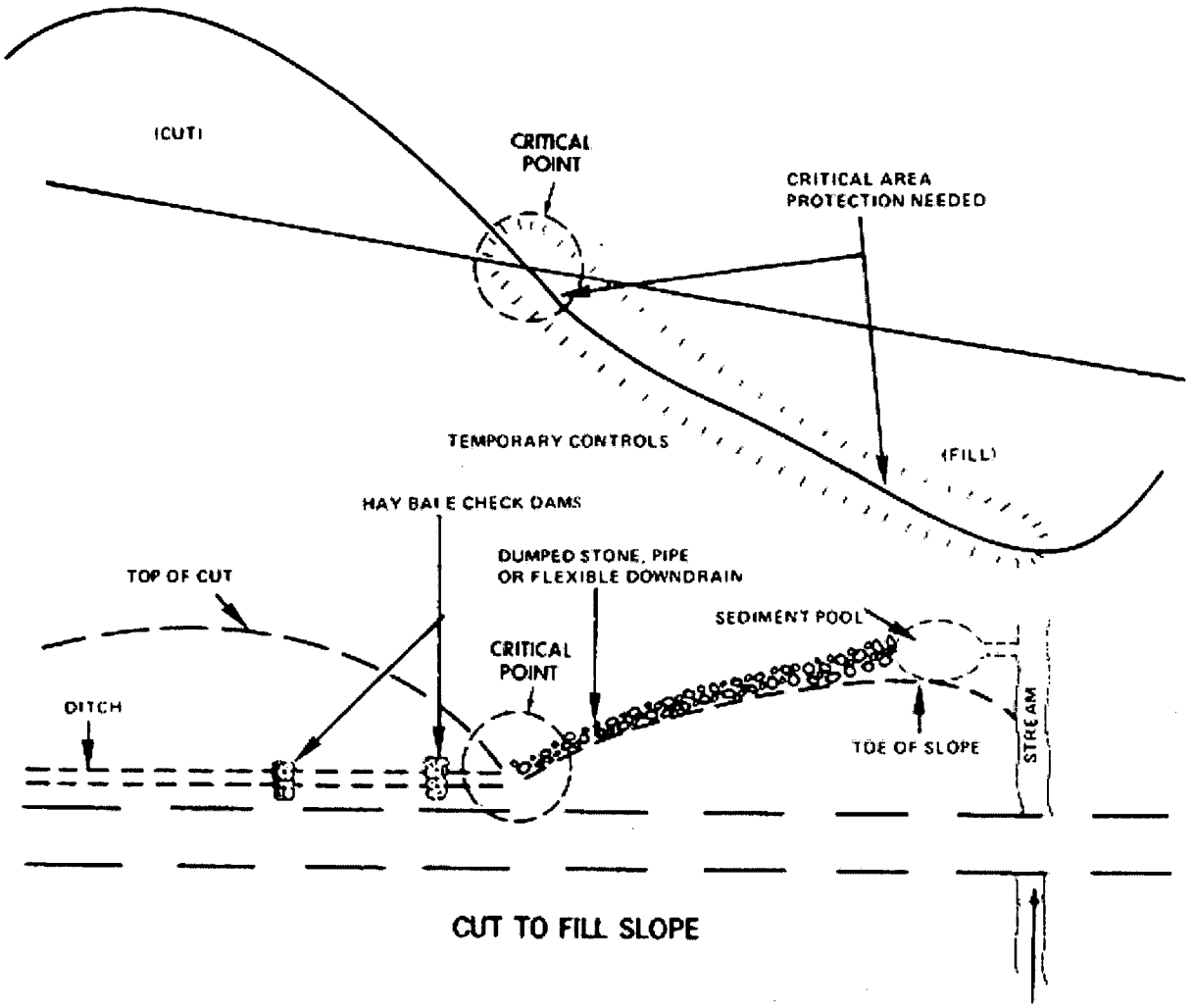
BALED HAY OR STRAW EROSION CHECKS

FIGURE A-10 (APP22PCX)
EMBANKMENT CONSTRUCTION UTILIZING SILTATION CONTROLS



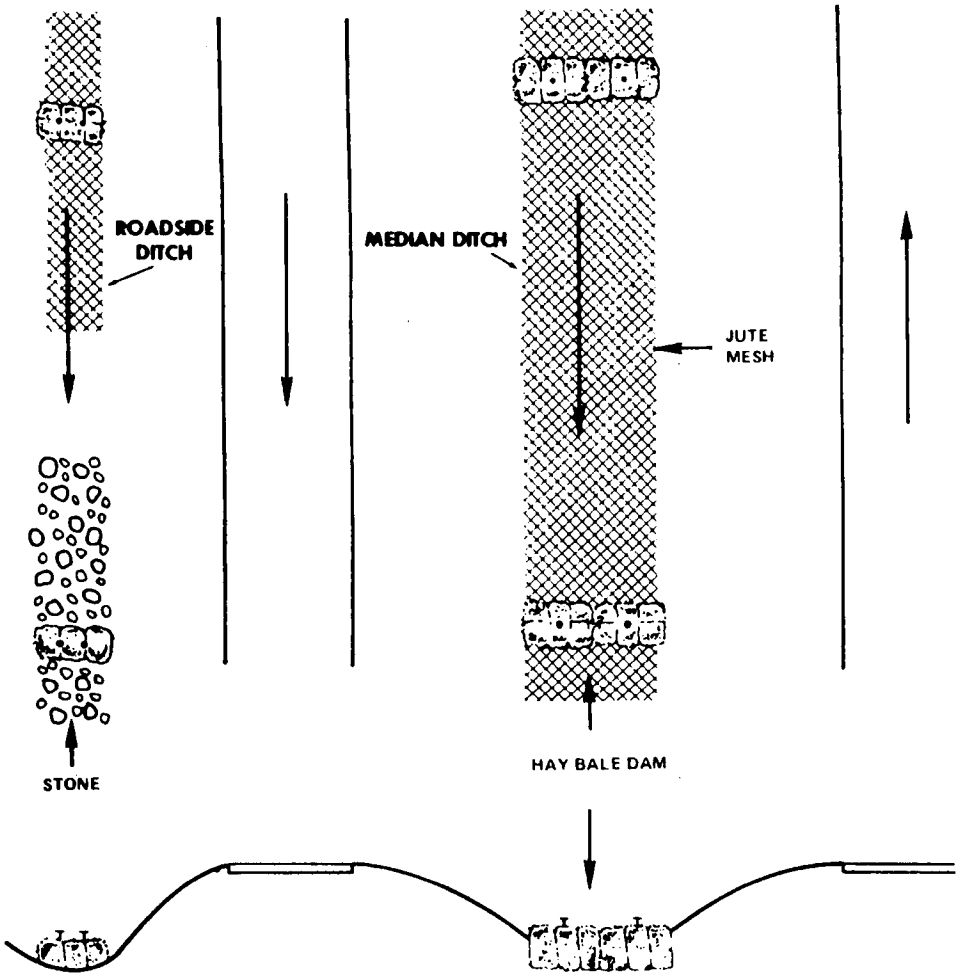
EMBANKMENT CONSTRUCTION UTILIZING SILTATION CONTROLS

FIGURE A-11 (APP23.PCX)
CUT TO FILL SLOPE



CUT TO FILL SLOPE

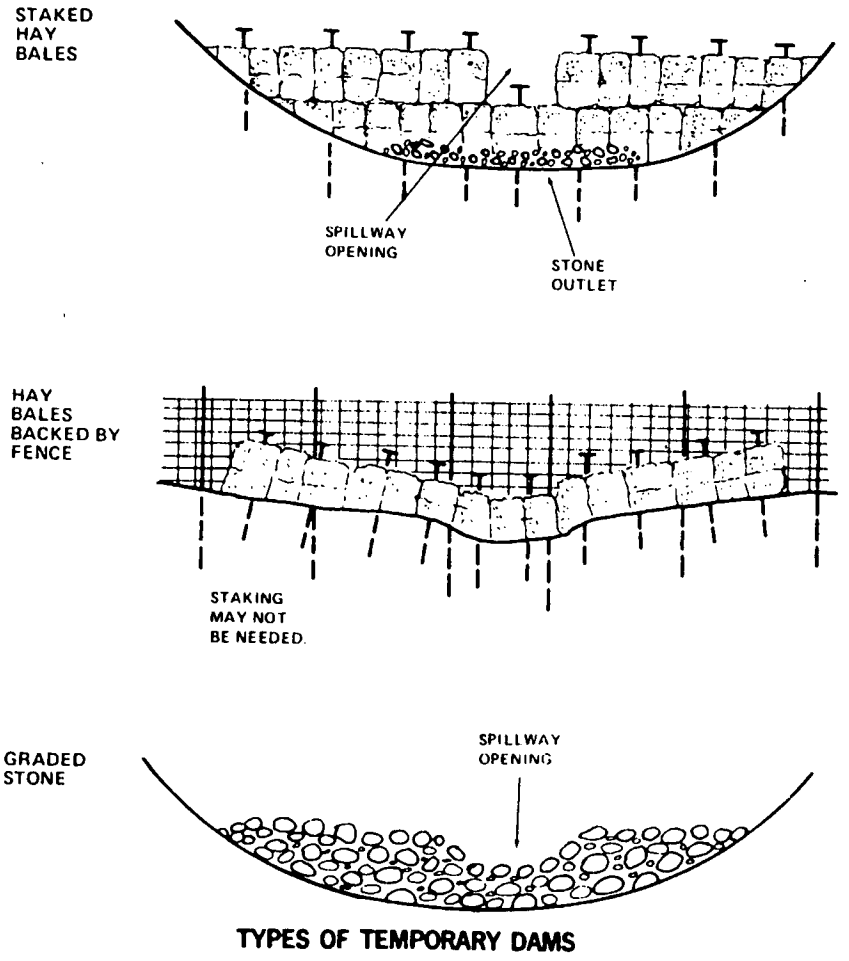
FIGURE A-12 (APP24.PCX)
HAY BALE DAMS USED IN DITCHES



HAY BALE DAMS
USED IN DITCHES

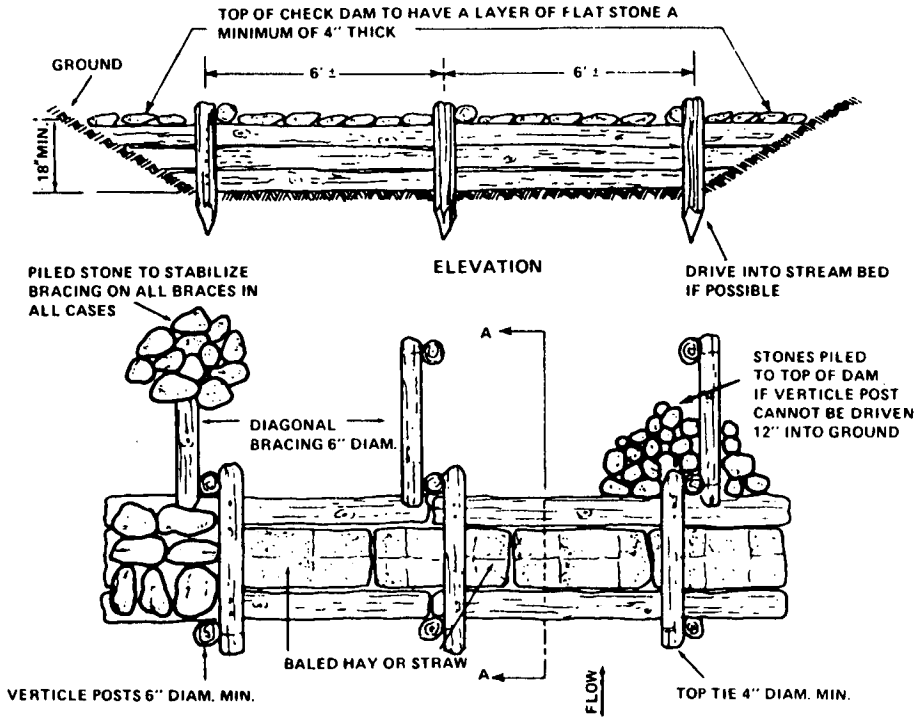
FIGURE A-13 (APP25.PCX)
TYPES OF TEMPORARY DAMS

NOTE: Dam should extend far enough up ditch side slopes to effectively pond the runoff and prevent erosion and washout.



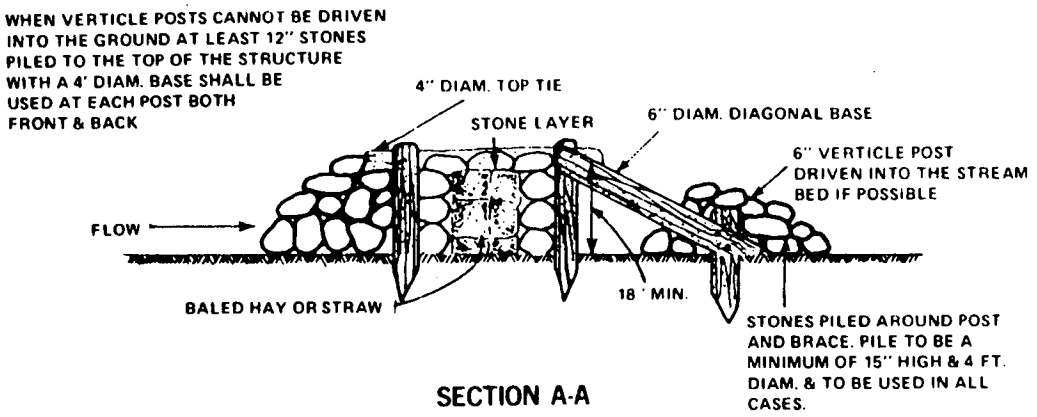
TYPES OF TEMPORARY DAMS

FIGURE A-14A (APP26.PCX)
LOG AND HAY EROSION CHECK DAM



LOG AND HAY EROSION CHECK DAM

FIGURE A-14B (APP27.PCX)
LOG AND HAY EROSION CHECK DAM

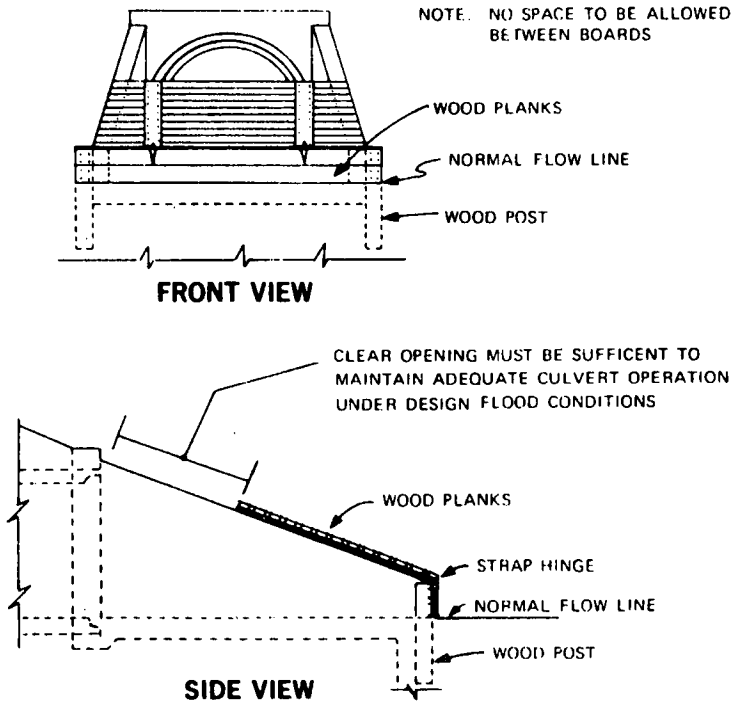


SECTION A-A

DAM TO BE CONSTRUCTED OF NATIVE LOGS OBTAINED FROM CLEARING OPERATION. ALL LOGS TO BE SPIKED WITH BOAT & DOCK OR WIRE SPIKES OR BOLTED TOGETHER. EXISTING TREES, BOULDERS OR LEDGE MAY BE USED IN PLACE OF THE VERTICLE POSTS AT THE DISCRETION OF THE ENGINEER. WHEN VERTICLE POSTS CANNOT BE DRIVEN INTO THE STREAM BED, STONES SHALL BE USED TO BRACE THE STRUCTURE. DAM TO BE PAID FOR BY THE LINEAR FOOT IN PLACE. REMOVAL OF DAM TO BE PAID FOR BY THE UNIT "EACH" FOR EACH TIME THE POOL IS CLEANED. INCLUDING ALL LABOR AND SMALL SIZE EQUIPMENT. NO LARGE EQUIPMENT WILL BE ALLOWED IN THE AREA. ALL EQUIPMENT AND METHODS OF OPERATIONS SHALL HAVE THE WRITTEN APPROVAL OF THE ENGINEER BEFORE ANY WORK IS DONE ON EITHER THE CONSTRUCTION OR MAINTENANCE

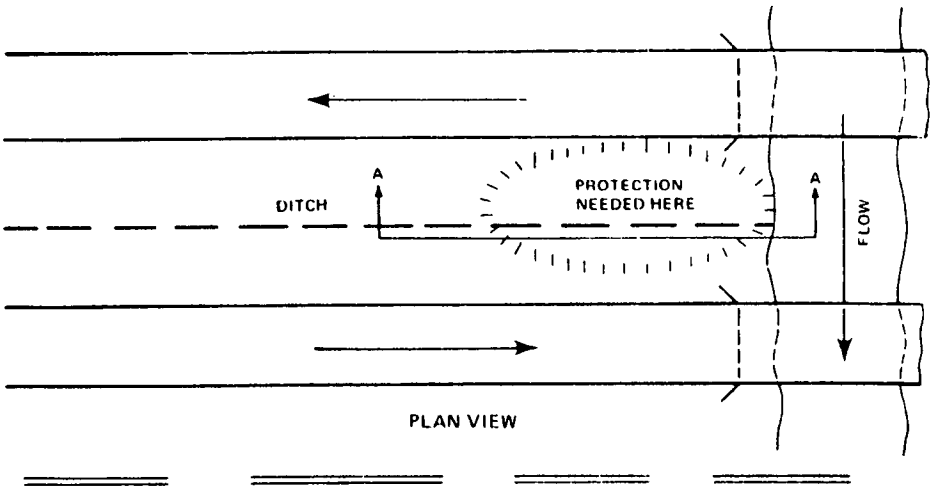
LOG AND HAY EROSION CHECK DAM

FIGURE A-15 (APP28.PCX)
CULVERT SEDIMENT TRAP

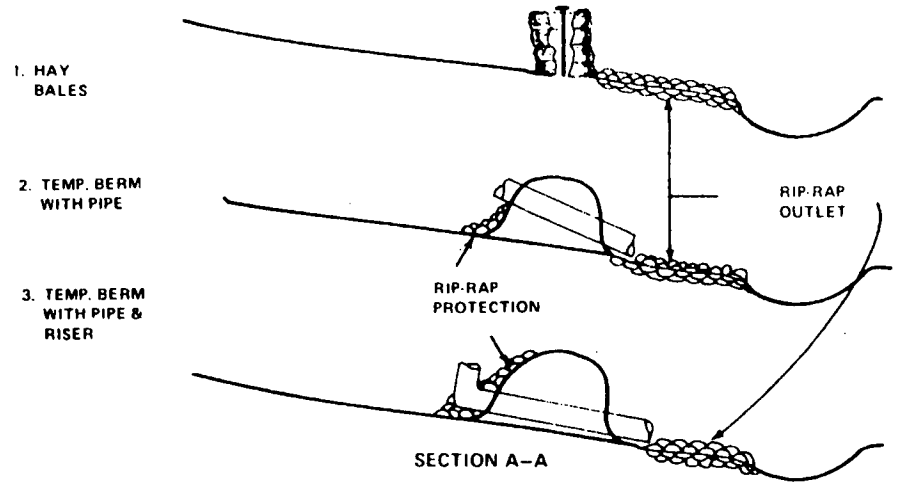


CULVERT SEDIMENT TRAP

FIGURE A-16 (APP29.PCX)
PROTECTION AT STREAM CROSSING MEDIAN & SIDE DITCHES

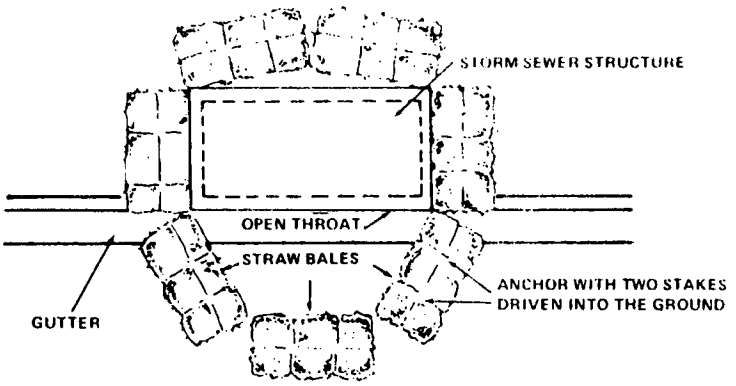


3 TYPES OF PROTECTION

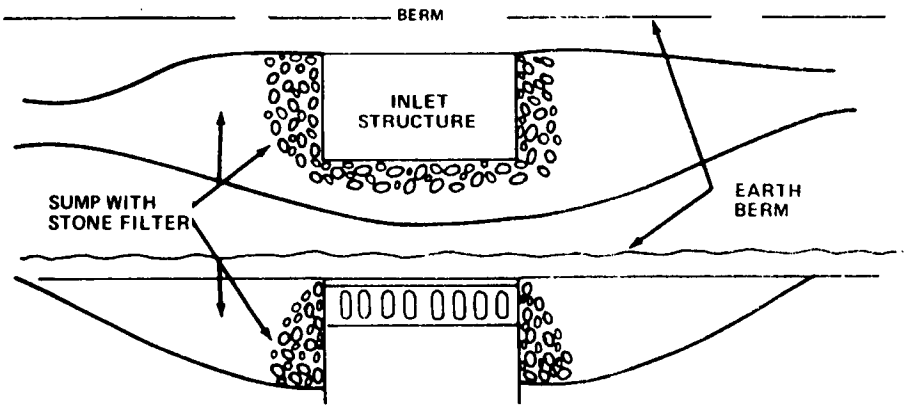


PROTECTION AT STREAM CROSSING MEDIAN & SIDE DITCHES

FIGURE A-17 (APP30.PCX)
TEMPORARY SUMP - STONE FILTER INLET SEDIMENT TRAPS

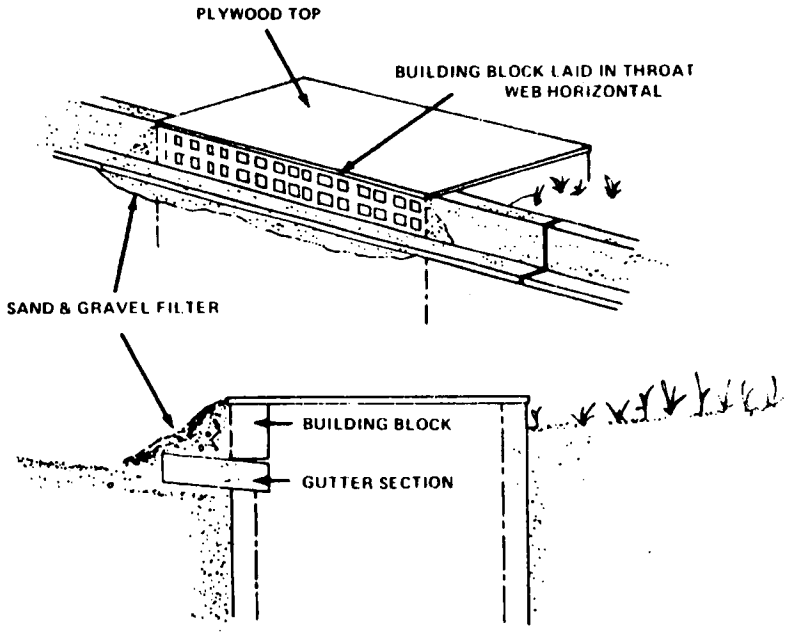


TEMPORARY BARRIER - HAY BALES



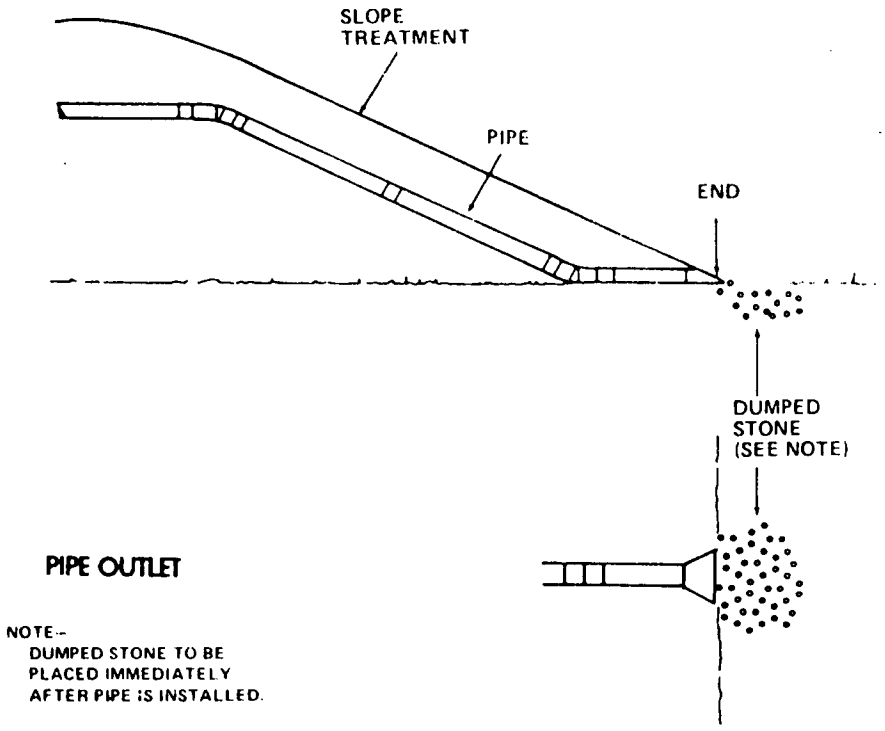
TEMPORARY SUMP - STONE FILTER
INLET SEDIMENT TRAPS

FIGURE A-18 (APP31.PCX)
SAND AND GRAVEL FILTER INLET SEDIMENT TRAP



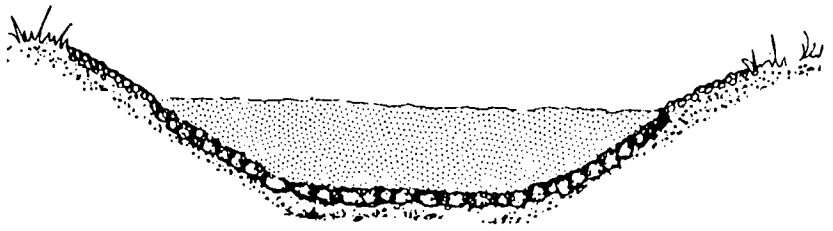
SAND AND GRAVEL FILTER
INLET SEDIMENT TRAP

FIGURE A-19 (APP32.PCX)
EROSION PROTECTION AT PIPE OUTLET



EROSION PROTECTION AT PIPE OUTLET

FIGURE A-20 (APP33.PCX)
DIVERSION CHANNELS



LARGE CHANNELS – USE STONE
LINING WITH GRAVEL FOUNDATION.

SMALL CHANNELS – USE
GRAVEL.

DIVERSION CHANNELS

Appendix A-2

EROSIONS AND SEDIMENT CONTROL STRUCTURES

Sediment basins are dams constructed across a waterway or other suitable location to form a sediment storage basin (See Figure A-21, page A-37). A pipe spillway is generally used for sediment/debris basins. Design layout and construction are generally the same as for grade stabilization structures with principle spillways.

The site selected should provide for storage of not less than 0.5 inches of sediment per acre of drainage area. Volume for trap efficiency should be the volume below the pipe spillway crest. Sediment basins should be cleaned out whenever the effective sediment storage capacity drops below 0.2 inches per acre of drainage area. (Storage of 0.5 inches per acre is about 67 cubic yards per acre and 0.2 inches per acre is about 27 cubic yards per acre).

Earth Embankment

Top Width - Minimum top width for settled fill height up to 15 feet should be 10 feet, for fill heights over 15 feet, the minimum top width should be 12 feet.

Freebord - The settled fill should be a minimum of two feet above the emergency spillway crest.

Side Slopes - Constructed side slopes should not be steeper than 2 1/2 feet horizontal to one foot vertical.

Compaction - A high degree of compaction is required.

Spillways

Principle Spillway - The principle spillway system should provide for a gradual drawdown of the stored runoff after each storm. The principle spillway should consist of a vertical pipe or box-type riser and a conduit through the embankment. The riser should be perforated to provide for gradual drawdown. Metal risers should be perforated with one inch diameter holes spaced eight inches vertical and 10 to 12 inches around the riser. One inch wide by four inches high slots that provide an equivalent area of opening can also be used. Box type risers should have ports throughout their height that will provide drawdown equivalent to that listed for pipe risers. The spillway risers should have a cross-sectional area at least 1.5 times that of the conduit through the embankment. The base of the riser should have sufficient weight to prevent flotation.

Pipe Conduit - Any pipe used for conduit through the embankment must be capable of withstanding the external loading. Aluminum pipe should not be used on soils with pH values less than 4.0 or greater than 9.0. Anti-seep collars should be installed on pipe conduits.

Trash Racks and Safety Guards - All drop inlet risers should be equipped with trash racks. Where debris basins are excavated below ground level or fills are less than five feet high, alternative principle spillway systems can be used. They should provide for sediment storage, runoff drawdown, and protection to the embankment.

Emergency Spillway - A natural or constructed emergency earth spillway should be provided. The capacity of the emergency earth spillway should be adequate to pass the peak outflow anticipated during the effective life of the structure.

Fencing - Fencing may be necessary for safety reasons or to protect the facility from traffic.

Vegetation - The exposed embankment, earth spillway, borrow area, and other disturbed area of permanent or semi-permanent debris basins should be revegetated (See Appendix B-1).

Examples of different erosion and sediment control structures are depicted in Figures A-21 through A-39 (pages A-37 through A-55).

FIGURE A-21 (FIGGL.PCX)
SEDIMENT BASIN

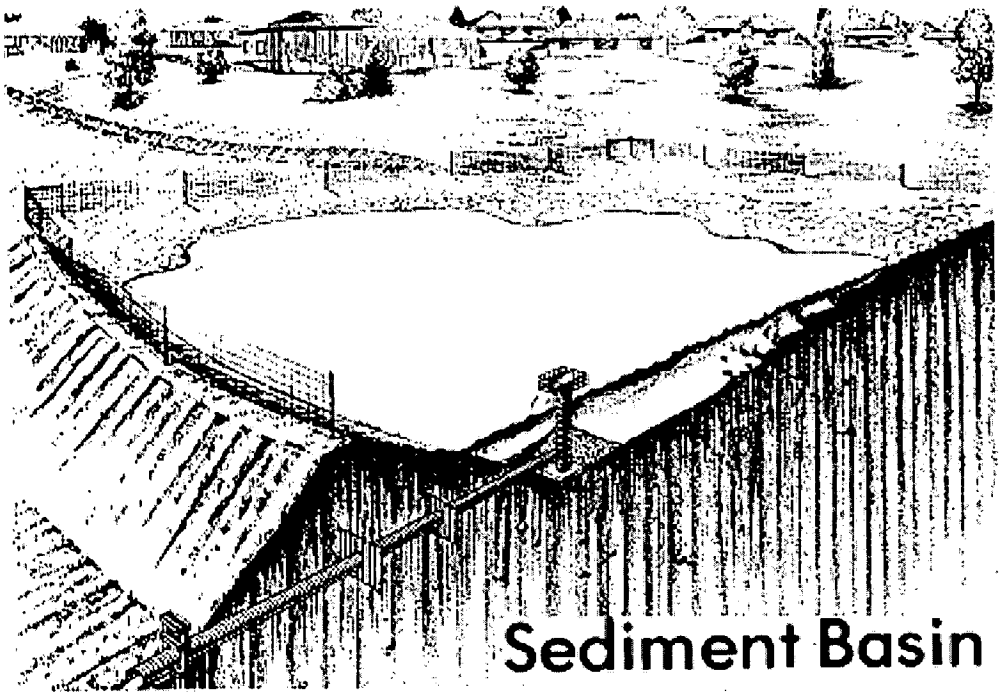
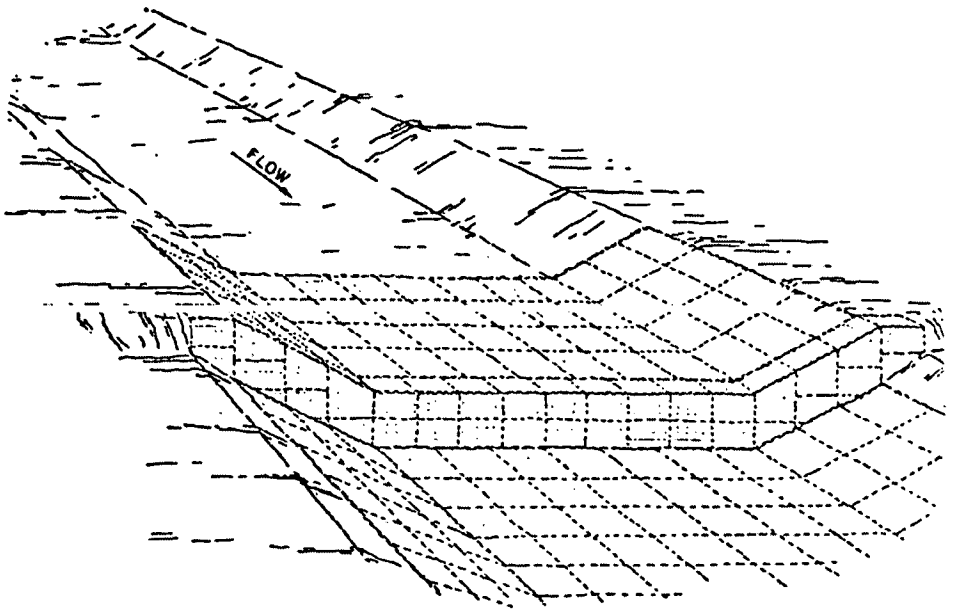


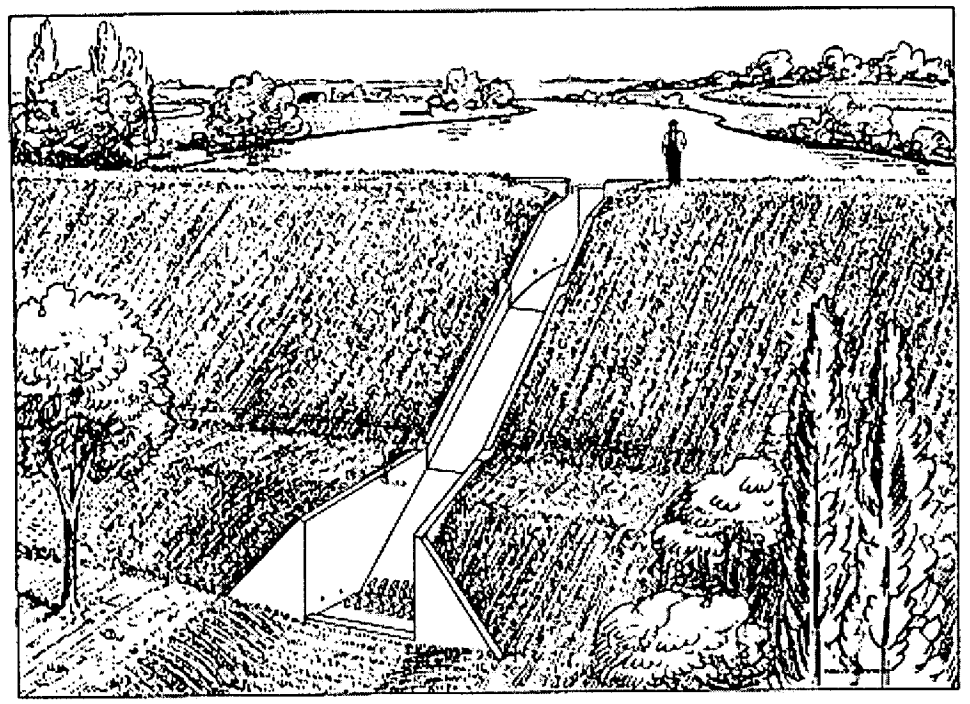
FIGURE A-22 (APPF2.PCX)
DROP STRUCTURE

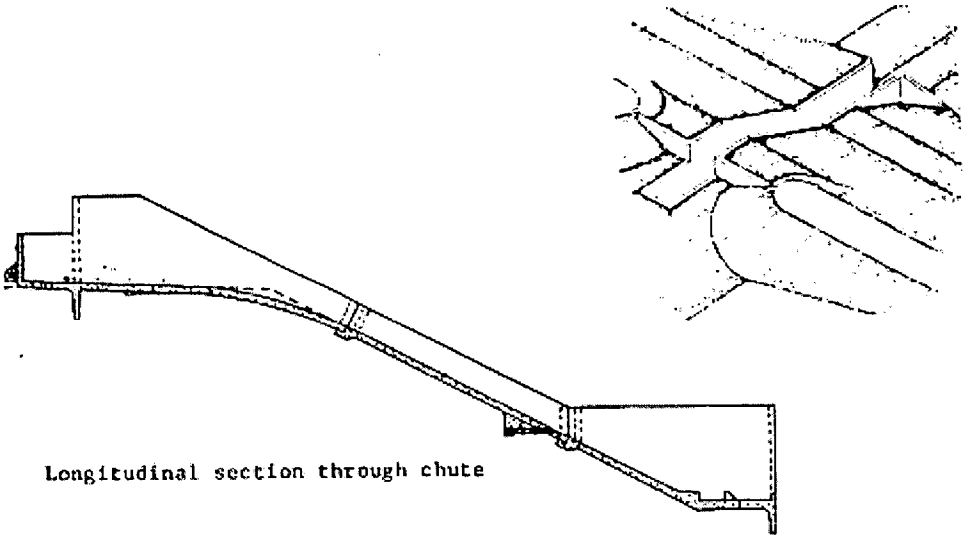
DROP STRUCTURE



ISOMETRIC
no scale

FIGURE A-23 (APPF3.PCX)
REINFORCED CONCRETE CHUTE SPILLWAY





Reinforced concrete chute spillway

FIGURE A-24 (APPF4.PCX)
CHUTE OR FLUME

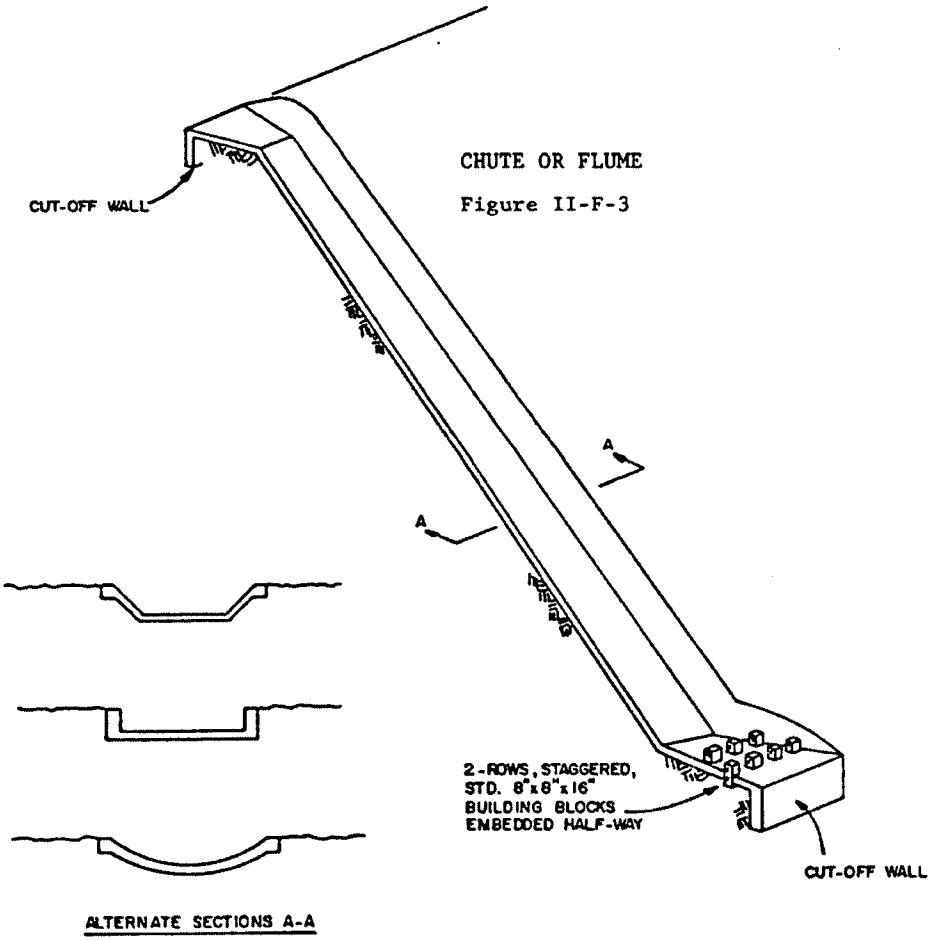


FIGURE A-25 (APPF5.PCX)
PIPE DROP

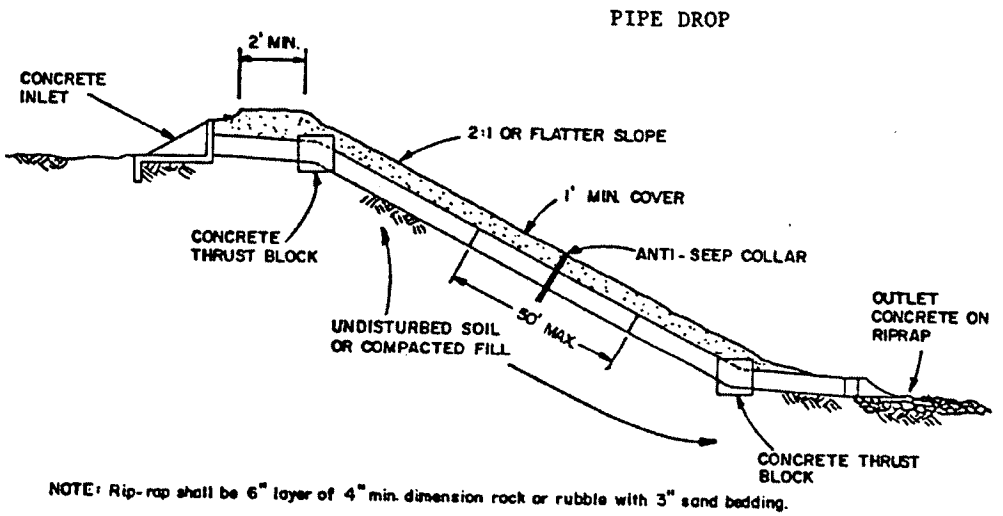
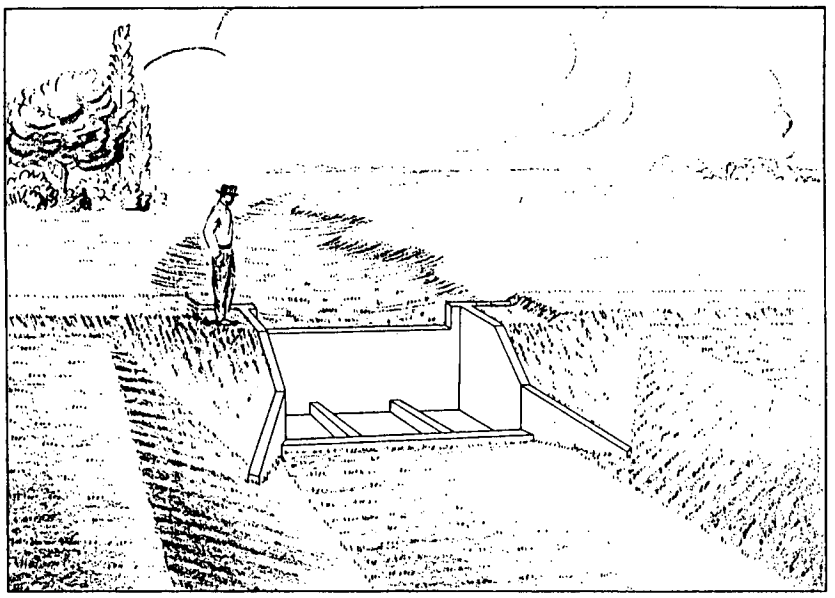
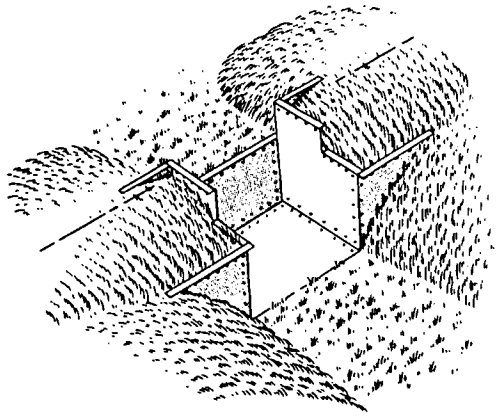


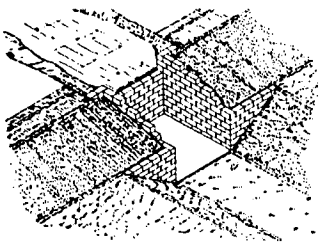
FIGURE A-26 (APPF6.PCX)
REINFORCED CONCRETE



Reinforced concrete



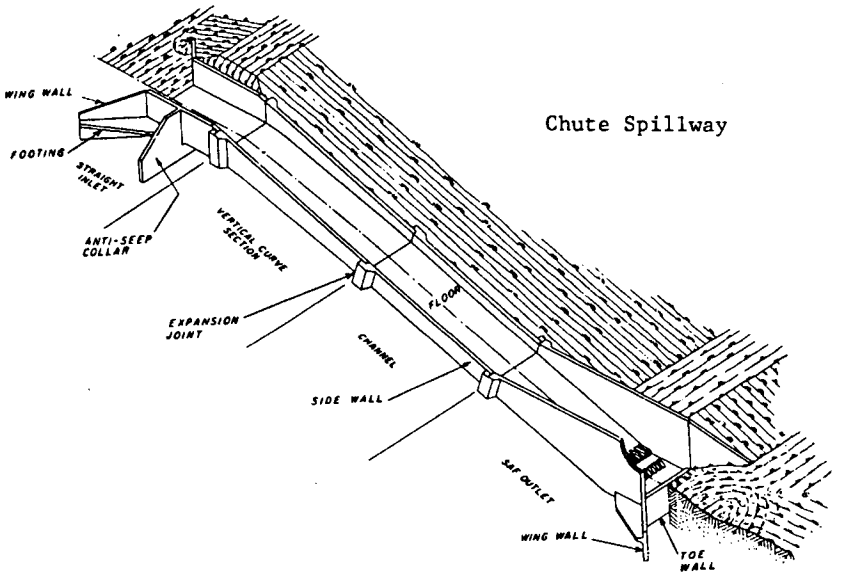
Prefabricated metal



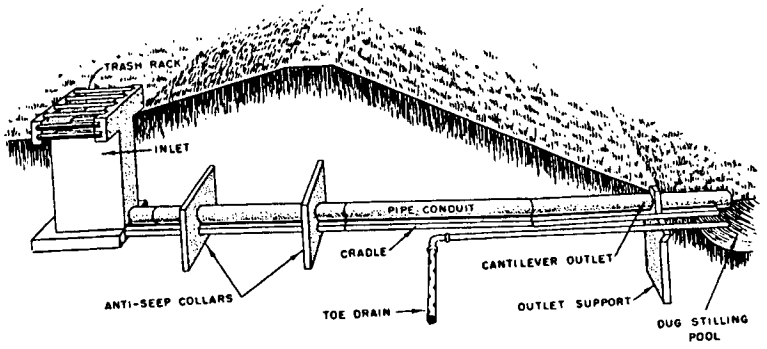
Concrete block

Straight drop spillways

FIGURE A-27 (APPF7.PCX)
DROP & CHUTE SPILLWAYS

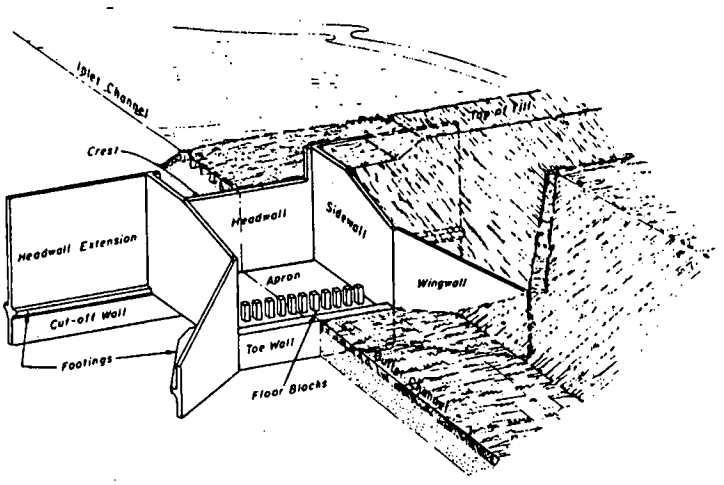


Chute Spillway

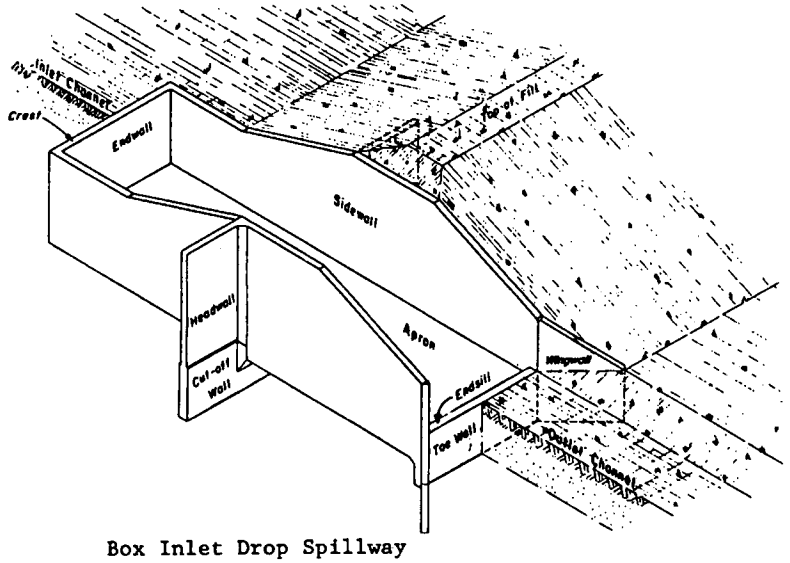


Drop Inlet Spillway

FIGURE A-28 (APPF8.PCX)
BOX & STRAIGHT SPILLWAYS

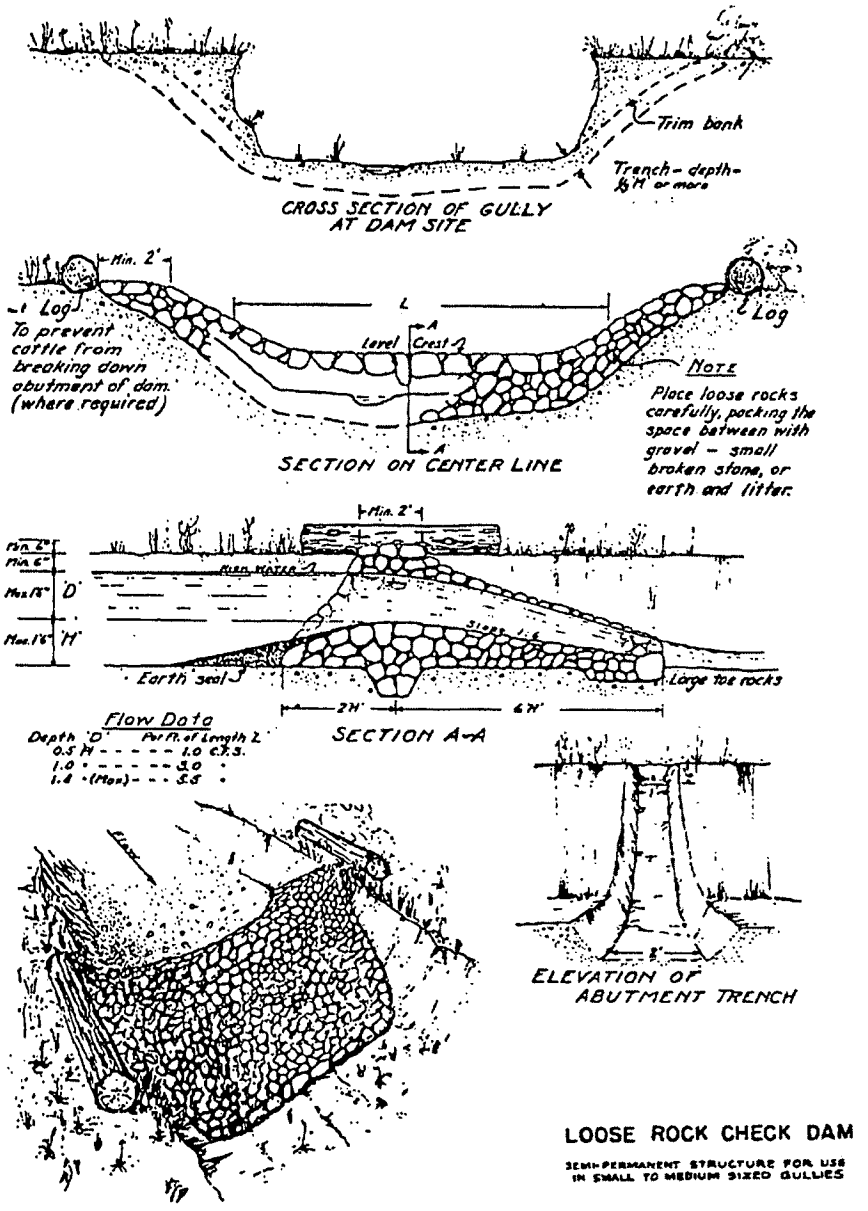


STRAIGHT DROP SPILLWAY



Box Inlet Drop Spillway

LOOSE ROCK CHECK DAM
FIGURE A-29



LOOSE ROCK CHECK DAM

SEMI-PERMANENT STRUCTURE FOR USE IN SMALL TO MEDIUM SIZED GULLIES

FIGURE A-30 (APPF10.PCX)
BRUSH CHECK

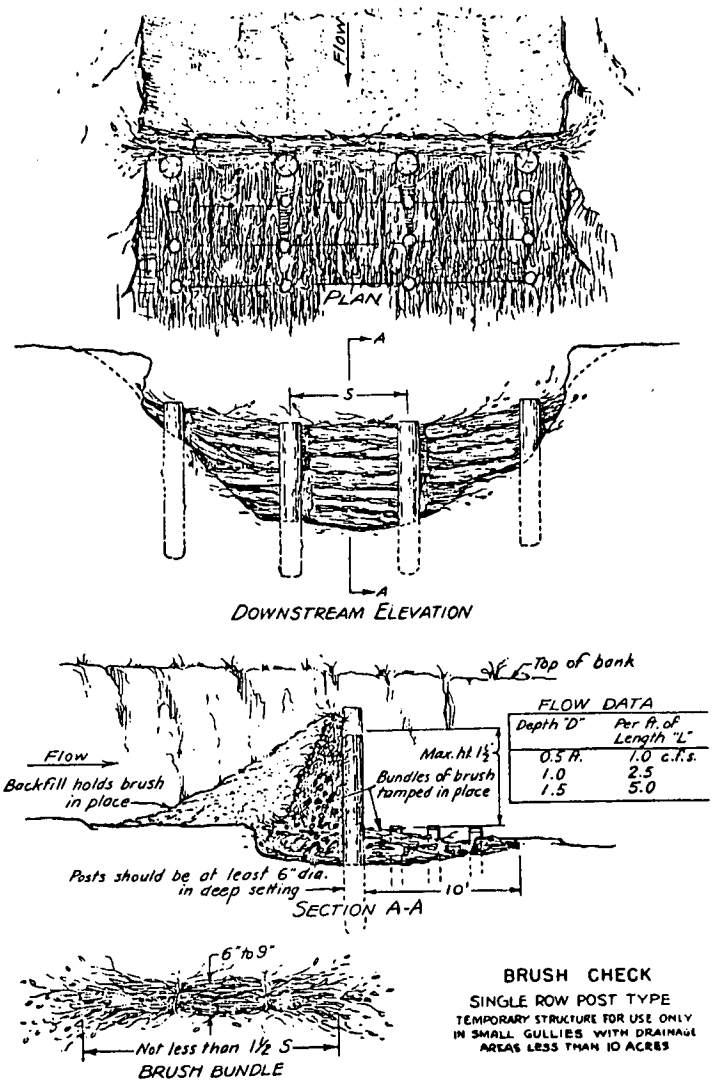
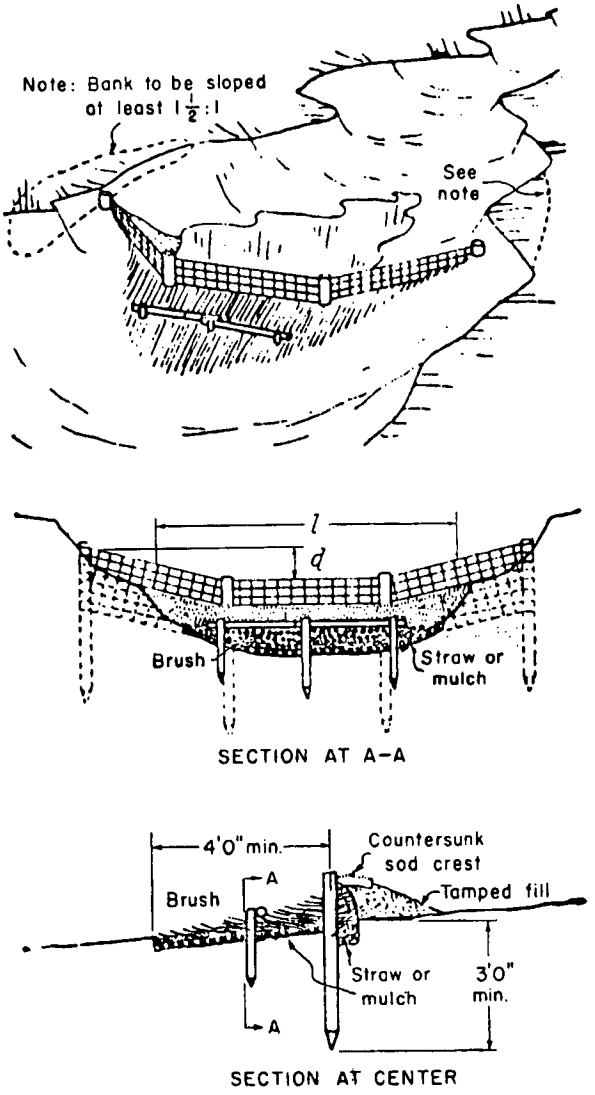


FIGURE A-31 (APPF11.PCX)
WOVEN WIRE DAM



WOVEN WIRE DAM

FIGURE A-32 (APPF12.PCX)
WIRE FENCE CHECK

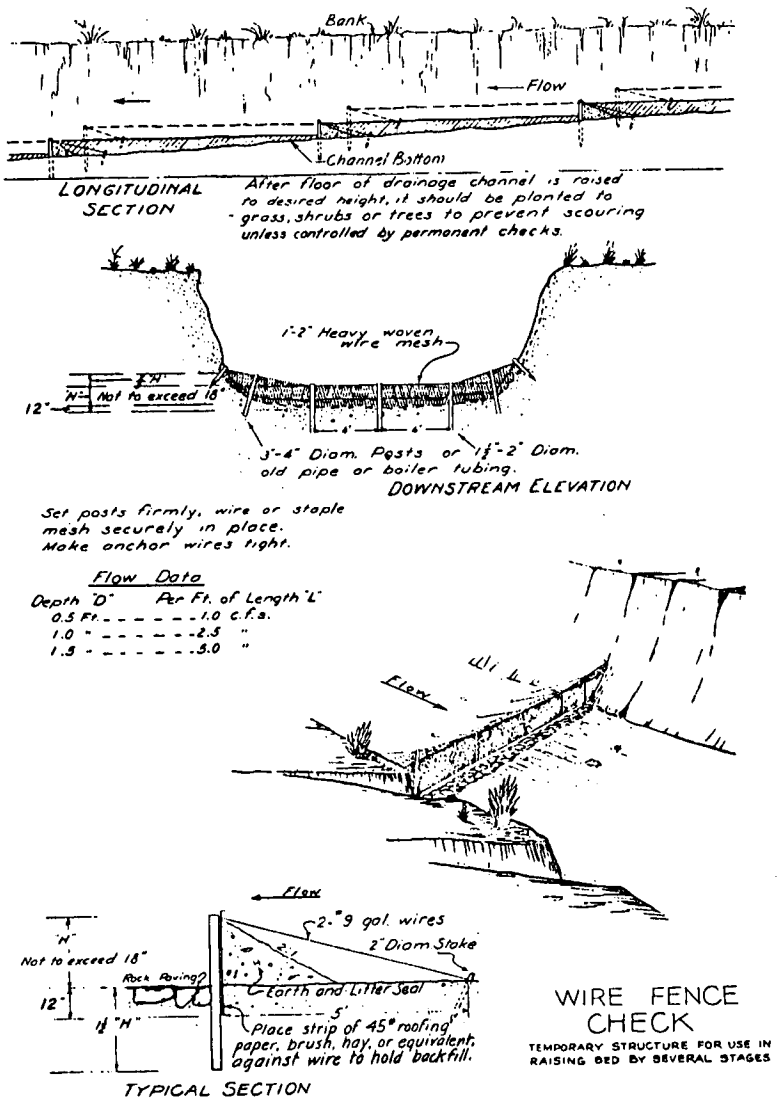


FIGURE A-33 (APPF13.PCX)
RUBBLE MASONRY CHECK

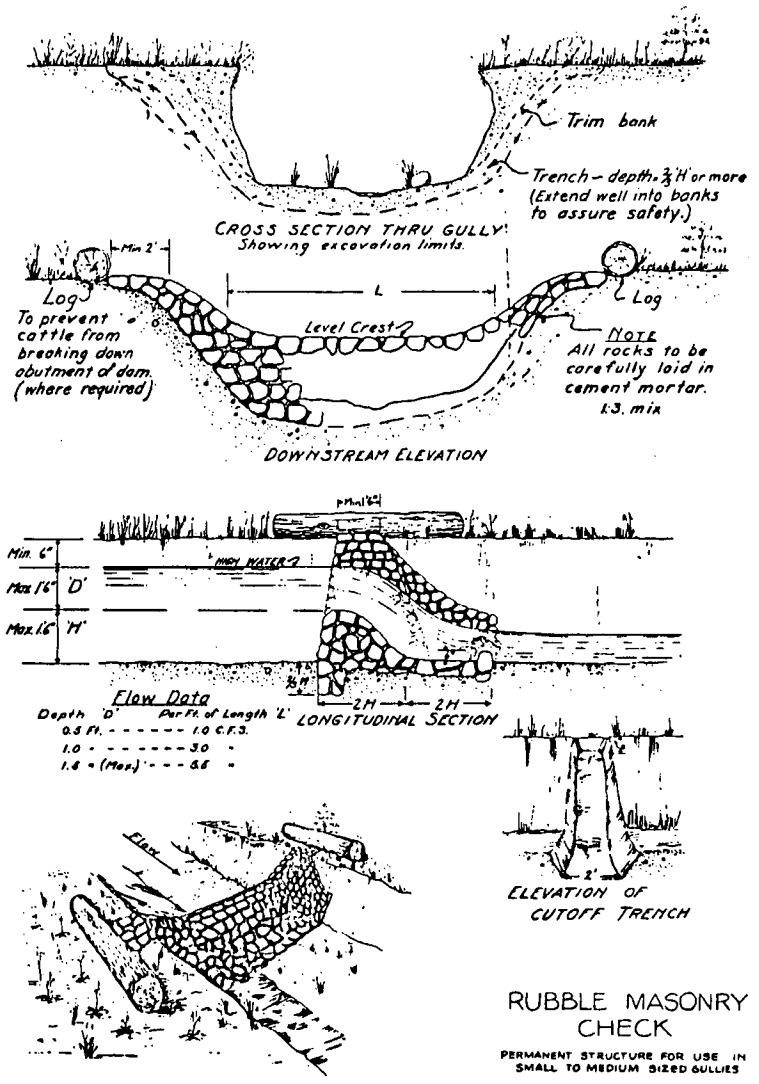
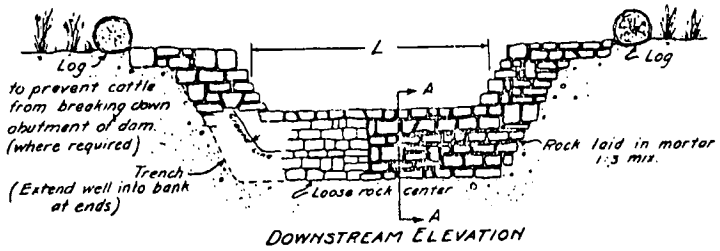
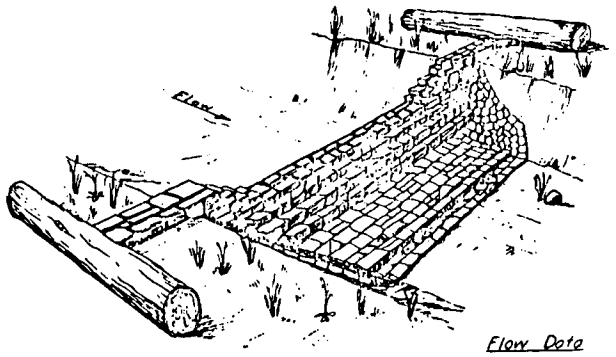


FIGURE A-34 (APPF14.PCX)
LOOSE FLAT ROCK DAM WITH RUBBLE MASONRY FACING

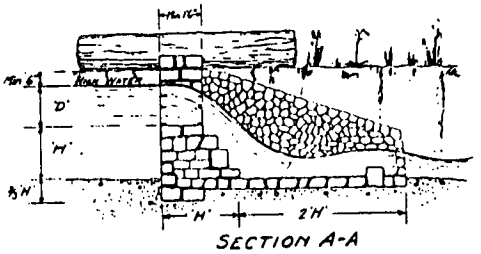


DOWNSTREAM ELEVATION



Flow Data

Depth 'D'	Per ft of Length 'L'
0.5 Ft.	1.0 CFS
1.0 "	3.0 "
1.5 "	5.5 "
2.0 "	8.5 "
2.5 "	12.0 "

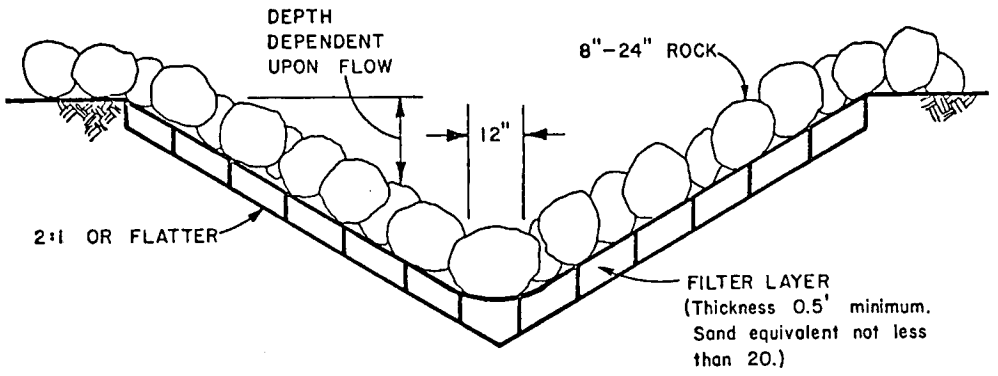


SECTION A-A

LOOSE FLAT ROCK DAM WITH RUBBLE MASONRY FACING
PERMANENT STRUCTURE FOR CONTROL IN ANY GULLY

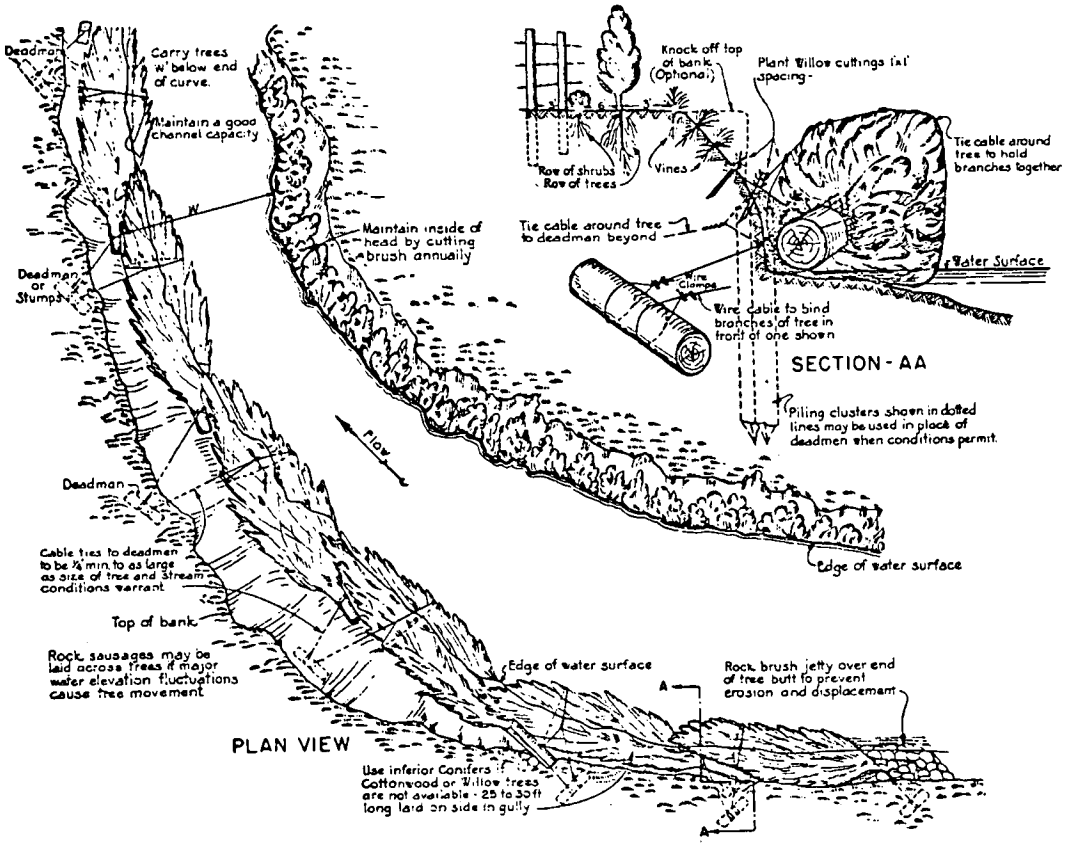
FIGURE A-35 (APPF15.PCX)
ROCK LINED CHANNEL

ROCK LINED CHANNEL



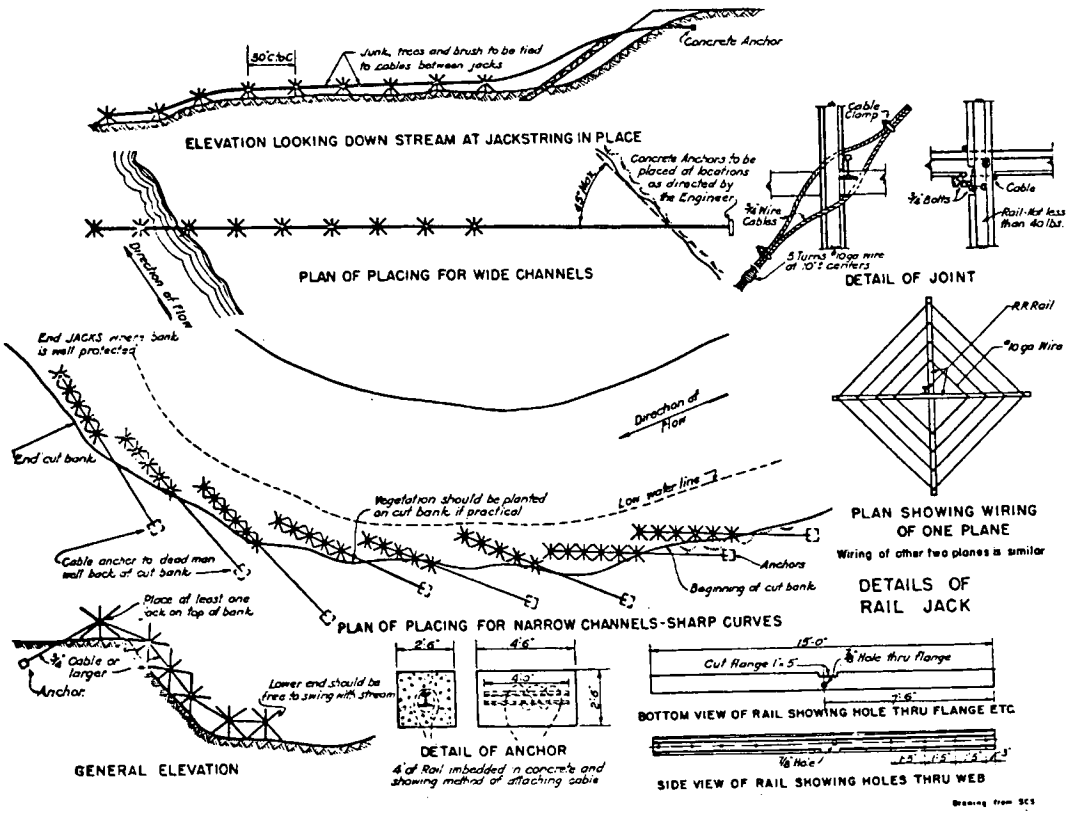
TYPICAL SECTION
no scale

FIGURE A-36 (APPF16.PCX)
ANCHORED CUT TREE REVETMENT



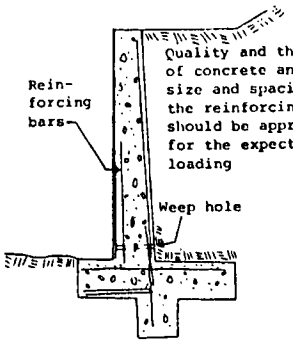
Anchored Cut Tree Revetment

FIGURE A-37 (APPF17.PCX)
RAIL JACK STRING DEFLECTORS

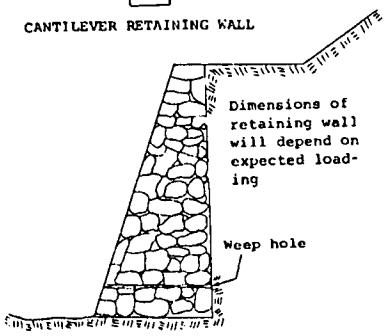


Rail Jack String Deflectors
(Bed Load Streams)

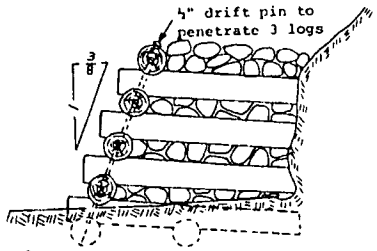
FIGURE A-38 (APPF18.PCX)
RETAINING WALLS



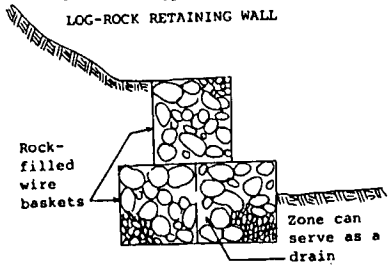
CANTILEVER RETAINING WALL



RUBBLE MASONRY RETAINING WALL



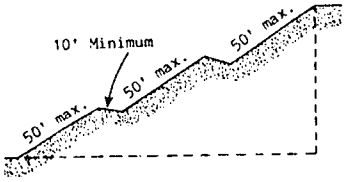
LOG-ROCK RETAINING WALL



GABION RETAINING WALL

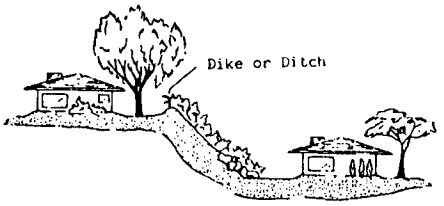
Terraces or Benches - Properly spaced terraces or benches will provide additional protection on long slopes and aid in the establishment of vegetation.

Each bench or terrace should be at least 10 ft. wide, but if this is not possible narrower benches spaced closer can be used. In dry areas the benches hold moisture and aid in plant growth and establishment.

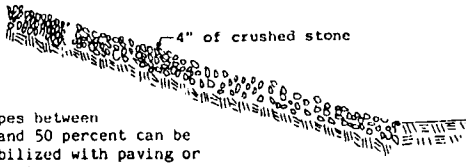


Diversions - Excess water from higher areas spilling over a slope or fill creates difficult erosion problems.

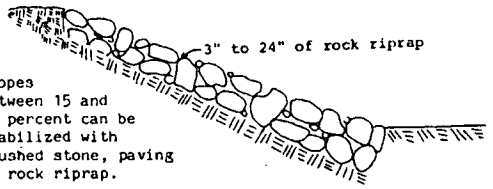
These problems can be avoided by placing a ditch or dike diversion at the top of the slope to intercept the runoff water and lead it to a safe place of disposal.



Structural Treatment - In addition to the use of retaining walls other structural treatments can be used for slope stabilization. Paving, gravel, crushed stone, or rock riprap can be used to stabilize slopes.



Slopes between 30 and 50 percent can be stabilized with paving or rock riprap.

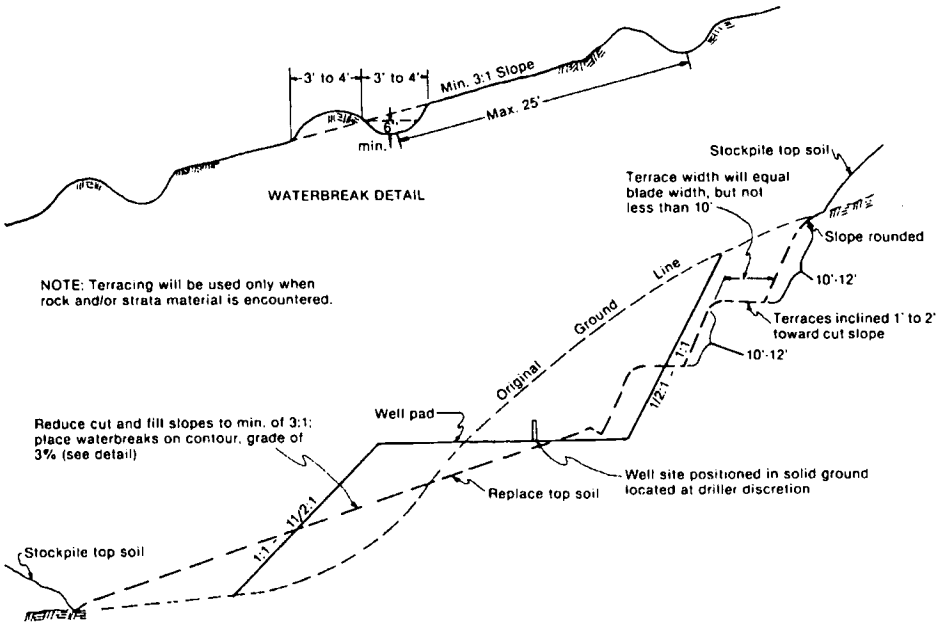


Slopes between 15 and 30 percent can be stabilized with crushed stone, paving or rock riprap.

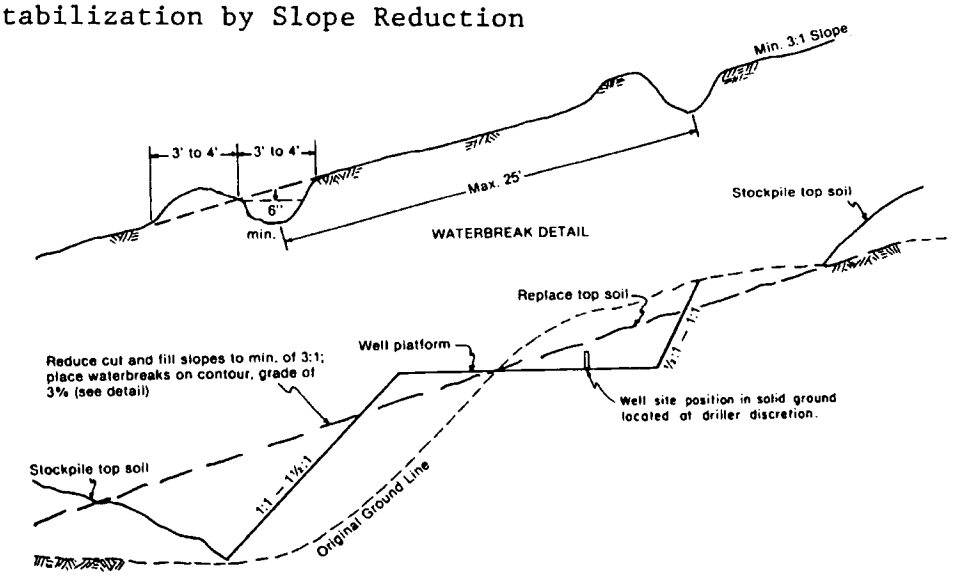
Retaining Walls

FIGURE A-39 (APPF19.PCX)
STABILIZATION

Stabilization by Terracing Cut Slopes



Stabilization by Slope Reduction



APPENDIX B - VEGETATIVE MEASURES FOR SOIL STABILIZATION PRACTICES

B-1 VEGETATIVE MEASURES
B-2 SUGGESTED FLOWER, LEGUME, GRASS, SHRUB & TREE PLANT SPECIES
B-3 "100% - A GUIDE TO SUCCESSFUL RESTORATION"

Appendix B-1

VEGETATIVE MEASURES

Broad Principles Involving Vegetation in Non-Agricultural Areas

1. Disturb as little of the site as possible.
2. Retain and protect trees and other natural plants wherever possible.
3. Avoid burning of vegetative cover. Burned areas are vulnerable to erosion immediately following a fire.
4. Avoid creating steep slopes so plant establishment is successful and maintenance is reduced.
5. Stockpile topsoil to apply on sites that are otherwise unsuited for establishing vegetation.
6. Do not bury construction debris in fills.
7. Apply needed ground cover on exposed areas before fall rains start and immediately on sites subject to wind erosion. If construction is interrupted, temporary erosion control measures need to be applied and the areas should be seeded, covered with plastic, or mulched without delay.
8. Select species that are adapted to the site and to the goals of the planting.

Criteria For Establishing Vegetation

In non-agricultural developments, soils to be revegetated are potentially of the B and C horizons, low fertility, poor in structure and aggregation, with little or no organic matter and little biological activity. Such soils are easily eroded.

Successful plant establishment is obtained by the following principles: (1) Provide for adequate water control of the planted area; (2) Prepare a seedbed or site that will provide soil stability during plant establishment; (3) Use proper planting techniques at the proper season; (4) Mulch to protect soil and provide a better environment for plant growth; and (5) Fertilize and apply soil amendments as needed.

Adverse pH, lack of water, saline or alkaline soils, and low fertility are common problems found in establishing plant cover in non-agricultural areas. Soil tests can identify these conditions and corrective measures can usually be applied. In the absence of soil tests, use local expertise for treating the soil.

Grasses and Legumes

Grasses and legumes may be established from seed, seed bearing hay, plants, sprigs, or sod. Seeding is much less expensive than other planting methods. The cost of labor and materials makes the use of clones, plugs or sod the most expensive. These are used less than seed, but can be the best method of establishing vegetation on some sites.

Sodding is done in three forms: (1) spot; (2) strip; and (3) solid sodding. Spot sodding is planting small pieces of sod (plugs) at more or less regular intervals. Grass will grow and fill the blank spaces. It is practiced with grass species that spread rapidly. Sod must be rolled into the seedbed to insure good contact of sod roots with new soil.

Strip sodding is laying parallel strips of sod at prescribed intervals. This is done occasionally on slopes. Spaces between strips may be seeded or sprigged to the same species to hasten a complete ground cover. Solid sodding, which is the most expensive method of sodding, is complete coverage of an area. This method may be used on critical areas such as around drop inlets, on bottoms of grassed waterways and on steep slopes.

Sprigging is a method of propagating stolon-type grasses. Sod of stolon-type grasses are lifted, chopped or shredded to provide sprigs six to eight inches long. These are set properly in well prepared, moist seedbeds. Caution must be used to prevent drying or heating between lifing and planting.

Mulching

Mulching is important in establishing vegetation on critical areas. Mulch protects the surface from erosion; holds seed, fertilizer and soil amendments in place; keeps soil temperature more uniform; holds moisture and slows evaporation. It should be applied uniformly and maintained in place until vegetation is established but should not be applied in quantities that will prevent emergence and growth of plants.

Trees, Shrubs and Woody Ground Covers

Shrubs and trees are planted from bare root stock, plant bands or potted stock. Ground cover is usually established from cuttings, plant bands or potted stock. The site should be prepared by removing competition from sod or other plants and providing a bare area for each seedling. Bare areas should be mulched to reduce erosion. Never plant directly in sod or other dense growth. Apply fertilizer and water based upon soils analysis for vigorous establishment.

CATEGORIES
RELATING TO VEGETATION THAT REQUIRE SPECIAL TREATMENT

Topsoiling for Grasses and Legumes

If the soil on a site is too shallow, gravelly or otherwise unsuited for vegetation, it may be necessary to top dress with good soil from outside the area. This may be too expensive to consider for large areas. Stockpiling existing topsoil from the area being disturbed is much more desirable and less expensive than bringing in new soil. A study of the local soil profile characteristics should be made to determine the treatment needed. Subsoil or parent materials may be suitable for planting without top dressing after applying needed fertilizers and/or soil amendments.

Where topsoil is required, it should consist of natural surface soil, friable, and loamy in character. It should be free of large brush or stumps, objectionable weeds, large stones or rocks and substances toxic to plants. A pH range of 6.0 to 7.5 is most desirable. Soluble salts should not exceed 500 ppm.

The depth of topsoil needed is dependent on its characteristics of the material to be covered. Ordinarily three to six inches after settling is sufficient with adequate irrigation for establishing grasses and legumes. A six inch depth of loose soil will settle an inch or two. An important part of topsoiling is obtaining a good bond between the imported topsoil and the material being covered. The surface, if possible, should be scarified before topsoil is applied. The topsoil should be disked and smoothed into place to obtain an even depth and good bonding to the underlying surface.

Volume of Topsoil Required for Application to Various Depths

Table B-1

Depth (Inches)	Cubic Yards Per 1,000 Square Feet	Cubic Yards PerAcre
1	3.1	134.4
2	6.2	268.9
3	9.3	403.3
4	12.4	537.8
5	15.5	672.2
6	18.6	806.7

Considerations for Establishing Grasses and Legumes on Modified Slopes

Cut and fill slopes created on construction sites often present an erosion hazard from runoff or wind unless the surface is protected by vegetating or mulching.

Climate and rainfall, soil permeability, surface runoff, soil productivity, soil structure and dispersion characteristics are all factors which influence the preparation of seedbeds, soil amendments and plant establishment.

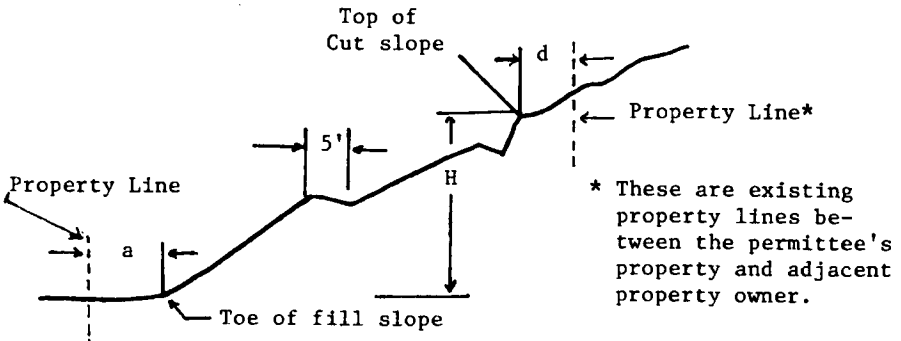
Slope stabilization may also be a serious problem on some sites and may require structural measures. Slopes must be stabilized, and sediment and erosion control measures installed before revegetation is initiated. Information contained in geologic, engineering, and soil survey reports can serve as guides in the planning and design of stable slopes. Local governments often impose restrictions on slopes, berms, setbacks, etc., and these agencies should be consulted. Figure B-1 (page B-6) suggests some typical setback distances for slopes steeper than 4:1. Table B-2 (page B-7) illustrates recommended minimum and maximum site slope limitations for steep slopes.

FIGURE B-1 (FIGB1.PCX)
SUGGESTED SETBACK REQUIREMENTS

SUGGESTED SETBACK REQUIREMENTS
For Slopes Steeper Than 4:1
(Check Local Building Codes and Ordinances)

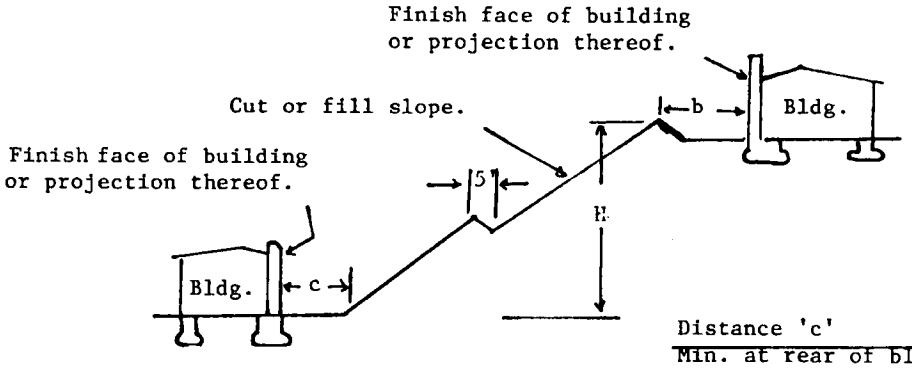
Slope Setback from Property Line

Figure II-B-1



H in feet	Toe of fill from property line	Toe of cut from property line	Building from top of slope
	a	d	b
0 - 10	4'	2'	10'
10 - 30	8'	4'	15'
over 30	12'	6'	20'

Building Setback



Distance 'c'	Preferable	Absolute
Min. at rear of bldg.	15'	10'
Min. at side of bldg.	10'	5'

FIGURE B-2 (TABB2.BMP)
SITE SLOPE LIMITATIONS

Steep slopes ordinarily require structural measures in addition to vegetation to conduct runoff downslope without erosion.

Table B-2 - Site Slope Limitations

Feature	Recommended Maximum	Minimum
Distance to slope ground away from building	---	10'
Slope away from building	7" in 10'	5" in 10'
Yards or lawns	---	2%
Terraces, slopes or banks, 1 or 2 unit residences	3:1	---
Terraces, slopes or banks, all other	2:1	---
Side slope of swale	12" in 10'	6" in 10'
Longitudinal slope of swale	2%	1%
Slope patios, paved walks, etc., away from building	2%	1%
Driveways and leadwalks	10%	1%
Parking pads and stalls	5%	1%

Steep slopes make establishing vegetation difficult. Slopes for seeding grasses and legumes with tractor drawn equipment are 3:1 or flatter. Slopes steeper than 3:1 usually require hydroseeders, mechanical mulchers or hand labor. Vegetation will not provide protection from slips on unstable soils.

Grassed Waterway or Outlets

A vegetated waterway may be used to carry runoff water to a disposal point without erosion. Natural drainage ways are most easily reshaped and vegetated for waterways. On many sites, it may be necessary to excavate a waterway of sufficient size to carry the anticipated runoff.

In selecting adapted grasses for a waterway, those that establish quickly and grow rapidly are desirable. Fast establishment is needed to avoid rilling of the waterway bed and washing out of seeds and seedlings. Sod grasses (rhisomatious), are preferred over bunchgrasses or annuals for waterways.

Dense and uniform sod reduces turbulence and is more resistant to breaking lose. The grass should also withstand inundation and sedimentation. Grassed waterways may be established by seeding, sprigging or sodding. Sprigging and sodding are more effective methods which facilitate successful establishment on the more critical sites.

Irrigation is usually required for successful establishment of grassed waterways in Nevada and needed to maintain adequate cover.

If exposed material is not suited for planting, topsoil should be stockpiled and replace uniformly over the surface of the constructed waterway. Mulch and netting over a seeding or sprigging will help protect plant materials from splash erosion and heavy runoff. Solid sodding down the center of a waterway to contain flows may be needed for successful establishment on some sites.

Protecting Trees Against Damage

Protecting suitable trees during construction can often provide some combination of aesthetic value, erosion control, shade, wildlife enhancement, screening, or windbreak protection which is needed in a new development. Tree protection is determined by location, species, size, age, vigor, cost, work involved in preserving the trees, and their adaptability to environmental changes. Tree species vary in suitability for developed sites, and this must be considered carefully in selecting trees to be saved. Old or large trees may not adapt to significant environmental changes as well as young trees of the same species.

Trees need to be protected from equipment damage during construction and any significant grade changes that raise or lower the ground line at their base.

To protect a tree against mechanical injury, construct a temporary fence or other barrier around it of sufficient size to protect the roots. Any changes in grade will affect the air, water and minerals available to tree roots. Fills - six inches or less in depth - may do no harm if the fill soil is fertile, has good tilth, and is not subjected to excessive compaction.

Major grade increases usually require gravel layers and tile drain systems. Tiles are laid on original grade in the form of the spoke of a wheel. The "spokes" open into a dry well built around the tree trunk. The dry well acts as the hub of the tile system and holds fill away from the tree trunk. The air system must be designed for each tree so that water drains away from the tree trunk. Protecting a tree from a lowered grade is usually achieved by terracing the grade.

If space is available, the tree may be preserved unharmed by letting it remain on a gentle sloping mound. If space is limited, a tree may be saved by building a retaining wall between it and the lower grade. If underground utility lines cannot be planned to avoid a tree, tunneling under it may be necessary. In tunneling, cut as few roots as possible, sever roots that must be cut smoothly. Backfill the trench as soon as possible to minimize drying.

There may be occasions when the only way to save a tree is to move it. It is best to move trees when they are dormant. Roots must be kept moist at all times. Trees are moved either bare root, or by balling and burlapping. Trees may be moved bare root if they are small and dormant and protected by applying wet material such as peat moss to their roots immediately after digging. When trees are balled and burlapped for moving, the balls of earth should enclose a majority of the root system.

Appendix B-2

SUGGESTED FLOWER, LEGUME, GRASS, SHRUB & TREE PLANT SPECIES

FLOWER AND LEGUME SPECIES

Flower and legume species include native and adapted herbaceous plants other than grasses. Flowers and legumes are often added to erosion control seed mixes because they add color to the landscape and provide significant wildlife and livestock forage. In addition, the ability of legumes to make their own nitrogen makes them a valuable addition to infertile soils commonly encountered in revegetation sites. Flowers and legumes are less effective than grasses in terms of the initial soil protection. Flower and legume seed is commonly added to grass and shrub seed mixes. It is important to select the appropriate species in the appropriate quantities to achieve compatablity. Flower seedlings are slow-growing and, as a result, poor competitors. Legume seed should be inoculated with the correct bacteria immediately before seeding in order to promote normal, healthy growth. Uninoculated seed produces stunted seedlings which cannot compete or survive on harsh sites.

Descriptions of Flower and Legume Species

1. Yarrow (Achillea millefolium) - Yarrow is a vigorous growing perennial which is readily available. It is widely adapted and has white flowers.

2. California Columbine (Aguilega formosa) - This is a beautiful native species with yellow-orange flowers. It grows on sunny-shaded, moist sites with well-drained soils.

3. Balsam Root (Balsamprhiza sagitata) - Balsam root is a drought tolerant plant found on sunny sites with well-drained soils. The yellow flowers bloom early.

4. California Poppy (Eschscholzia californica) - This is an annual which is native to lower elevation but does well in higher elevations. It has orange flowers and spreads quickly. It does best in full sun and sandy soils.

5. Sulphur Flower Buckwheat (Eriogonum umbellatum) - Sulphur flower buckwheat is a shrubby plant which is excellent for erosion control. It reproduces by seed and from shoots and is drought tolerant. It grows on sunny-partly shady sites with sandy soils.

6. Blanket Flower (Gaillardia aristata) - This is a drought tolerant plant with yellow-red daisy-like flowers. It grows in sunny to partly-shady sites with well-drained soils.

7. Utah Sweet-Vetch (Hedyasrum boreale) - This is a Great Basin native legume. It is drought tolerant and nitrogen fixing. It grows best in full sun with sandy soils.

8. Lewis Flax (Linum lewisii) - Lewis flax is a widely adapted, drought tolerant plant which works well in mixes. It grows best in sunny, exposed sites with well-drained soils.

9. Lupin (Lupinus spp.) - Lupin are nitrogen-fixers, deep-rooted, and excellent for erosion control. The flowers are mostly blue or purple, a few white or pink and they grow on a variety of sites.

10. Butter and Eggs (Linnarea vulgaris) - This is a vigorous plant which spreads rapidly in sunny to partly shady sites. The flowers are a cream to yellow color.

11. Scarlet Monkey Flower (Mimulus cardinalis) - This is a common plant found in wet environments.

12. Common Monkey Flower (Mimulus guttatus) - This flower is a natural invader in moist sites. It grows in moist to wet, sunny sites and has yellow flowers.

13. Mountain Pride Penstemon (Penstemon newberryi) - This is a drought-tolerant plant which is excellent on unstable, sandy slopes. It does have limited availability; however, the rose to purple color flowers are popular with hummingbirds. It can be found in sunny sites with sandy, well-drained soils. There are many species of Penstemon.

GRASS SPECIES

Grass species include native and adapted perennial grasses and can be planted to provide both short and long-term stabilization. Grass seedings can be utilized on all cleared, graded, or disturbed sites which are mechanically stabilized. Short-term vegetative practices can be used to winterize a construction site. Long-term vegetative practices are used to establish permanent vegetation after the construction activity is completed.

Grass is the most rapidly growing type of plant that will produce an adequate ground cover in a short period of time. Grasses can be grouped into bunch grasses and sod-forming grasses. Bunch grasses are quick to establish and are usually quite persistent. Most important are orchard grass, Sherman big bluegrass, and crested wheatgrass. To obtain a quick ground cover, at least one of these should be included in all seed mixes. Dura hard fescue is a very short bunchgrass which is best seeded alone in situations requiring a uniformly short, fine-textured cover. Sod-forming grasses are desirable because of their ability to spread by rhizomes. A good sod-forming grass is Luna pubescent wheat-grass. It produces fairly short

top growth and maximum root growth. This provides good soil protection and minimum fuel production, which is important where wildfire is a hazard. Tegmar intermediate wheatgrass also produces short top growth.

Lawn areas and ornamental vegetation should be confined to areas near houses or buildings. This way, a transition zone to more-native vegetation can be accomplished. If a total native look is desired, the erosion control species, such as the wheatgrasses, can be used. These grasses provide excellent soil stabilization and require little or no maintenance.

A qualified professional plant materials specialist should be consulted to select a seed mix to match the specific conditions (i.e. soils, precipitation, elevation, etc.) of the project site.

Description of Grass Species

1. **Canby bluegrass (Poa canbyi), Canbar (variety)** - This is a Great Basin native grass that greens up early and goes dormant early. It can be found on dry, sandy soils. It makes a good filler grass and is long lived.

2. **Big bluegrass (Poa ampla), Sherman (variety)** - This grass can be found on moist to dry sites and sandy to heavier soils with good drainage. It has early spring growth.

3. **Mountain brome (Bromus marginatus), Bromar (variety)** - This type of brome is a fast growing, short-lived, native perennial bunchgrass. It is moderately drought tolerant and is found on moist to dry sites with well-developed to coarse, soils.

4. **Smooth brome (Bromus inermis), Manchar, Lincoln, Carlton, and Bromar (varieties)** - This grass originated in north and central Europe. Its habitat is moist, deep, fertile soils and can be found in meadows along creeks.

5. **Tall fescue (Festuca elatior var. Arundinacea)** - Tall fescue is a deeply rooted grass generally used for turf fields. It grows well in wet as well as dry sites and is quite drought tolerant. This would be a good grass for areas that receive heavy foot traffic and use.

6. **Hard fescue (Festuca longifolia), Dura (variety)** - This is an excellent species for harsh, dry sites which receive heavy foot traffic. It is a low growing, drought tolerant, low maintenance grass and can be used in lawn mixes. It grows on dry sites with coarse, well-drained soils.

7. **Red fescue (Festuca rubra), Pennlawn and Dawson (varieties)** - Red fescue is also called creeping fescue because it propagates by underground stems. This fescue is good for bank erosion control. It has a deep green color, is low growing and shade

tolerant and is found on moist sites. This grass is a good substitute for Kentucky Bluegrass for lawns.

8. **Chewings fescue (Festuca Rubra var. Commutata)** - Chewings fescue is a cool-season grass used primarily for lawns and general purpose turf. It is especially adapted to shaded, dry sites.

9. **Sheep Fescue (Festuca ovina) Covar (variety)** - Sheep fescue is shorter lived than hard fescue but is very cold and drought tolerant. It grows on dry sites with coarse to sandy soils. At heavy seeding rates this grass can be used as a low water use, low maintenance lawn.

10. **Meadow foxtail (Alopecurus pratensis) Garrison (variety)** - This is a tall grass found on wet sites and is good for stream bank restoration. It is frost tolerant and long-lived. Foxtail spreads slightly, has slow seeding development, but strong rhizomes once established.

11. **Hairgrass (Deschampsia caespitosa)** - Hairgrass is a native wet meadow bunchgrass which is available from native stands. It is found on moist sites and is a beautiful species useful in bank erosion control.

12. **Indian ricegrass (Oryzopsis hymenoidis), Nezpar and Paloma (varieties)** - This grass is a Great Basin native which does best when planted alone. It is a very ornamental grass and has excellent potential for landscaping. The dense root system provides resistance to wind and water erosion. It is very drought tolerant and can be found on dry, sunny sites with sandy, well-drained soils.

13. **Orchardgrass (Dactylis glomerata), Potomac and Paiute (varieties)** - Paiute is a new release used in arid areas but has not been tested in the Basin. Potomac has been tested and proven in the Basin. It greens up early, maintains growth through the season, and is low growing. Orchardgrass appears well-adapted to dry to moist sites.

14. **Perennial ryegrass (Lolium perenne)** - Perennial ryegrass is used in mixtures for pastures, lawns, and erosion control.

15. **Squirreltail (Sitanion hystrix)** - Squirreltail is a native invader of disturbed sites. Its habitat is dry, sunny area with sandy soils and rocky slopes. This grass is commercially available but very expensive and should only be use on extremely harsh sites.

16. **Timothy (Phleum pratense)** - Timothy is long lived on cool, moist sites, and is winter hardy. It grows well on moist sites and is good for erosion control. It is not drought tolerant.

17. **Bluebunch Wheatgrass (Agrophyron spicatum)** - Secar (variety) - Bluebunch wheatgrass is a Great Basin native. It works well in mixes and is potentially useful as an ornamental grass. This grass greens up early and is drought tolerant. It is found in dry and rocky areas with sandy soils.

18. **Intermediate Wheatgrass (Agropyron intermedium)** - Tegmar, Oahe, and Greenar (varieties) - Inter-mediate wheatgrasses have excellent seeding vigor and establishment. Intermediate wheatgrasses are found on moist to drier sites, but are not as drought tolerant as pubescent wheatgrass. Tegmar was introduced from Europe and works well for erosion control.

19. **Slender Wheatgrass (Apropyron trachycaulum) Revenue and Primar (varieties)** - This grass establishes fairly rapidly, and is short-lived. It is a native grass of the intermountain region.

20. **Pubescent Wheatgrass (Agropyron tricophorum), Luna and Topar (varieties)** - This grass is widely adapted, and does well on dry to moist sites with coarse textured soils. It is a drought tolerant, long-lived, tall non-native grass.

21. **Desert Wheatgrass (Agropyron descrtorum), Nordan (variety)** - This is an introduced, early-maturing, perennial bunchgrass. It grows 2-3 feet high on well-drained soils.

SHRUB SPECIES

Shrub species include native and adapted shrubs for Nevada's varied climate and provide long-term, permanent stabilization. Shrub seed can be mixed with grass, flower and legume seed to provide diversity. Woody plants, such as trees and shrubs, require time to develop sufficient size to control erosion adequately. Although woody species can be seeded by broadcast seeding or spot seeding, woody plants are best established by transplanting containerized seedlings. Planting is limited to seasons in which adequate moisture is present, usually late fall or early spring. Spring planting has been somewhat more successful because fall planted seedlings are often subject to frost-heaving. Once established, shrubs stabilize the soil and are desirable as permanent landscaping. Shrubs are frequently used in combination with other mulches, such as wood chips or bark, to provide permanent erosion control and landscaping around structures.

As previously stated, **a qualified professional plant materials specialist should be consulted to select a seed mix to match the specific conditions (i.e. soils, precipitation, elevation, etc.) of the project site.**

Description of Shrub Species

1. **Mountain Maple (Acer glabrum)** - This is a fast growing, somewhat drought-tolerant shrub species. It grows best on sunny, moist to drier slopes and has beautiful fall colors.

2. **Western Serviceberry (Amelanchier alnifolia)** - The serviceberry is a native species which is currently available. It grows on sunny moist to dry slopes and well drained soils. It has a white flower.

3. **Pinemat Manzanita (Arctostophylos nevadensis)** - Pinemat manzanita is an excellent shrub for erosion control since it forms a low mat and is drought-tolerant. It is difficult to establish, however, and has limited availability. It requires sandy, well-drained soils and is found on sunny, dry aspects.

4. **Greenleaf Manzanita (Arctostophylos patula)** - This manzanita is a slow-growing, drought tolerant plant that has wide altitudinal range. It is found on sunny, dry aspects and sandy to rocky, well-drained soils and outcrops. Greenleaf manzanita has white flowers and red bark and is available in limited quantities.

5. **Big Sagebrush (Artemisia tridentata)** - This shrub is a common sagebrush in the basin and is found on sunny, dry slopes and flats. It is very drought tolerant and has aromatic, gray leaves.

6. **Whitethorn (Ceanothus cordulatus)** - Whitethorn is a thorny, spreading shrub native to this area. It is found in sunny, dry areas and has white flowers.

7. **Squawcarpet (Ceanothus prostratus)** - Squaw carpet is another low-growing shrub excellent for erosion control. Unfortunately, it has limited availability and is difficult to establish. It grows best in shady to partly sunny, dry areas and has purple flowers.

8. **Tobaccobrush (Ceanothus velutinus)** - The seeds of tobaccobrush are stimulated to germinate by fire. The shrub is found on sunny, dry to moist, open slopes. It has white flowers and limited availability.

9. **Rabbitbrush (Chrysothanmus nauseous)** - Rabbitbrush is an excellent shrub for revegetation. It is very drought-tolerant and grows best on sunny aspects with sandy, well-drained soils. Rabbitbrush has late-blooming yellow flowers. This plant is a high reactor for allergy prone individuals.

10. **Creek Dogwood (Cornus stolonifera)** - This is a fast-growing shrub used for bank stabilization. It grows best on sunny, moist to wet sites and has bright red stems, white berries, and white flowers.

11. **Bittercherry (Prunus emarginata)** - Bittercherry is a good plant for wildlife and grows on sunny, moist to dry sites. It has white flowers, red berries and a yellow fall color.

12. **Chokeberry (Prunus virginiana var. emissa)** - The chokecherry grows best on moist, deep, fertile loam soils. It is well adapted for ornamental use and for erosion control as well. The flowers are white and the dark purple grape-like clusters of fruit appear in the fall.

13. **Bitterbrush (Purshia tridentata)** - This shrub is very drought-tolerant, easily established from seed, readily available, and also provides deer browse. It grows best on sunny, dry sites with well-drained soils. It has yellow flowers.

14. **Huckleberry Oak (Quercus vaccinifolia)** - Huckleberry oak is found on sunny, dry sites with sandy soils. The acorns provide wildlife food. However, this oak has limited availability.

15. **Golden Currant (Ribes aureum)** - This shrub can be found in sunny to partly shady, moist sites. It has yellow flowers and beautiful fall colors.

16. **Wax Currant (Ribes cereum)** - This is a drought-tolerant shrub found on sunny to partly shady sites. It has white to pinkish flowers with red fruit.

17. **Sierra Currant (Ribes nevadense)** - This type of currant has pink flowers and grows on sunny, moist to dry sites.

18. **Wood's Rose (Rosa Woodsii)** - Wood's rose is a thorny, very hardy, fast-growing shrub with light pink flowers. It grows best on sunny to partly shady, moist to dry sites. It is widely adapted.

19. **Thimbleberry (Rubus Parviflorus)** - Thimbleberry has large, maple-like leaves, white flowers, and red berries. It is found on sunny to partly shady, moist sites and provides good wildlife habitat.

20. **Willow (Salix spp.)** - There are several native (lemmonii and scourleriana) and adapted species of willow available. Willows are excellent bank stabilizers, are fast-growing and easy to propagate. They grown on sunny, wet to moist sites.

21. **Western Blue Elderberry (Sambuscus caerulea)** - This is a spreading, fast growing shrub with white flowers and blue berries. It grows in sunny, dry openings and provides good wildlife habitat.

22. **Red Elderberry (Sambucus microbotrys)** - Red Elderberry grows on sunny, moist sites and has white flowers and red berries.

23. **Mountain Spiraea (Spiraea densiflora)** - Spiraea is a very ornamental shrub with good fall colors. It has rose to pink flowers and grows on sunny to partly shady, moist sites.

24. **Creeping Snowberry (Symphoricarpos mollis)** - Snowberry is a very good species for ornamental planting and for erosion control. The tube or bell-shaped flowers appear in small clusters and are white or pink in color. The berries are white. Snowberry is adapted to many soil types, ranging from deep loams to shallow and moderately deep soils. They grow best on sunny to partly shady moist sites.

25. **Mountain Snowberry (Symphoricarpos vaccinoides)** - Mountain snowberry has pink flowers with white berries and is found on sunny, dry, rocky slopes.

26. **Ninebark (Physocarpus capitatus)** - The name Ninebark comes from peeling bark which often shows several layers. The clusters of tiny, white flowers make this a very ornamental shrub. It grows best on sunny to partly shady sites.

TREE SPECIES

Tree species used for plantings should consist of native or adapted trees which provide long-term, permanent stabilization. Trees, like shrubs, are not as effective as grasses for the initial erosion control because not enough of the disturbed soil is protected. At maturity, however, trees provide the best soil stabilization because the well-developed canopy absorbs the raindrop impact while the tree litter, fallen leaves and needles, protect the soil surface.

Trees are slow growing and require time to develop sufficient size to control erosion adequately. After stabilizing slopes with grass, trees can be inter-planted at the desired spacing. Trees are usually established by planting containerized stock or bare root seedlings. Planting is limited to seasons in which adequate moisture is present, usually late fall or early spring. Although larger containerized stock may be planted during the summer if irrigation is available, survival and establishment is better with spring or fall plantings because optimum soil temperature and moisture promote rapid root growth and development. Once established, trees stabilize slopes and are desirable as permanent landscaping. Trees are frequently used in combination with other mulches, such as wood chips or bark, to provide permanent erosion control and landscaping around structures.

Tree plantings should be irrigated during the first season in order to increase the rate of establishment. Once established, trees require little maintenance.

Tree Lists

For a list of trees that will work best for your area, contact the U.S.D.A. Soil Conservation Services, U.S. Forest Service, Bureau of Land Management, Extension Service or Nevada State Forestry Plant Material Centers.

Other Sources

A recently published plant materials handbook titled, "Conservation Plantings for Natural Resources Management", University of Nevada Cooperative Extension and the USDA Soil Conservation Service (BE-92-01), is an excellent source for selection of plant species recommended for Nevada.

Appendix B-3

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A GUIDE TO SUCCESSFUL RESTORATION

EVERY SHORTCUT HAS A PRICE.....

...A FEWER PERCENTAGE SURVIVAL

...A FEW INCHES GROWTH

THIS PLAN WAS DEVELOPED BY THE USFS CARSON RANGER DISTRICT
AND REVISED BY PAT MURPHY NEVADA DIVISION OF FORESTRY

ACCLIMATIZATION OF BAREROOT SEEDLINGS

A. Tell what you are going to tell them
   1. 16 steps
      a. Identify each step as it comes up
      b. Tell it to them
      c. Show it to them

STEPS	TASKS	FACTORS TO EMPHASIZE
1. Erect work tent and acclimation tent or use existing facilities.	1. Locate site convenient to the planting site and seedling storage area. 2. Select shelter site	1. Planting site is preferred as this is the equalization point 1. 20% crown cover 2. Protect seedlings from wind, day-night temperature fluctuations, especially freezing.
2. Install work bench	1. Construct to optimum size for rapid work. 2 Identify 12" root length line from edge of bench.	1. Measure and mark the line for permanent use.
3. Prepare burlap	1. Cut to size 2. Trim tattered strings 3. Soak in water or vermiculite slurry	1. 20"X30" 1. Thoroughly saturate. New burlap may take up to 24 hours.
4. Mix vermiculite with water	1. Use 5-gallon container or larger 2. Mix to a consistency of cereal 3. Allow solution to age 4. Retain premixed solution on hand	1. Use clean water 1. Approx. 2 1/2 water to vermiculite 1. 2 to 3 hours

ACCLIMATION OF BAREROOT SEEDLINGS (Continued)

5.	Remove packaged seedlings from storage	1. Do not handle frozen trees. Do not awaken from dormancy	
6.	Open packages of seedlings	1. Inspect for mold	1. White mold on roots may be beneficial mycorrhizal fungus
		2. Inspect for new root bud growth and shoot bud swell or burst.	1. Yellowish-white enlongation at tip ends of roots 2. Root bud enlongation with shoot bud swelling or burst o.k. to keep if roots do not need pruning. 3. Discard trees with shoot bud swelling or burst that require pruning.
7.	Lay out water-soaked burlap on top of work bench	1. Lay burlap out with long axis parallel with length of the table 2. Place top edge evenly along the premarked 12-inch root line 3 Drape excess end of burlap over the edge of the table	

ACCLIMATION OF BAREROOT SEEDLINGS (Continued)

8.	Take up a handful of seedlings and dip the roots into the vermiculite slurry	1. Use both hands so that roots can be spread apart for good coverage 2. Dip roots into the slurry 3. Gently agitate and swirl roots in mixture 4. Keep remaining seedlings covered 5. Keep vermiculite mixture stirred	1. Limit to desired number of seedlings per roll usually 50-100 1. Up to the root collar 1. Do not wash mycorrhizae off 2. Thoroughly coat roots
9.	Spread dipped seedlings out on the burlap	1. Spread seedlings parallel to the short axis of the burlap 2. Leave a 6-inch wide portion of the burlap unoccupied by seedlings on the left 3. Cull substandard size seedlings	1. Root collars even with the top edge of the burlap
10.	Trim roots	1. Use grass shears or large scissors and cut the roots that extend past the edge of the table	
11.	Fold flap end of burlap over the roots		1. Do not curl roots. Curled roots at this stage stay curled and are planted that way

ACCLIMIZATION OF BAREROOT SEEDLINGS (Continued)

STEPS	TASKS	FACTORS TO EMPHASIZE
12. Roll burlap	1. Start from the right side and roll to the left toward the 6-inch outer edge that is unoccupied with seedlings	
13. Pin the roll	1. Use a 3-inch nail 2. Pin outer edge of burlap to the roll, inserting the nail from top to bottom and out again	
14. Stack "jelly rolls"	1. Stack on platform 2. Stack in a single row with roots inward and shoots outward (stack in crates)	1. Avoid tree contact with ground 2. Do not stack more than 6 layers high
15. Cover rolls	1. Cover top layer root zone with wet burlap to prevent drying 2. Cover all seedlings with light canvas	1. Canvas should not be in contact with shoots 2. Do not use petroleum treated canvas 3. Do not use non-porous covers such as plastics

ACCLIMATIZATION OF BAREROOT SEEDLINGS (Continued)

STEPS	TASKS	FACTORS TO EMPHASIZE
16. Acclimatize seedlings	1. Store platform inside tent or other structure	1. Protect from fluctuating outdoor temperatures and drying winds 2. Do not water shoots except to protect seedlings from freezing
	2. Acclimatize until root mass and soil temperatures are near equilibrium	1. Soils should be no cooler than 37 degree F. at 10 inch depth at time of planting. Optimum soil temperature is 0 degree F. 2. Acclimatize no longer than 48 hours 3. Do not return trees to cache or cooler after acclimatized 4. Do not root prune after acclimatized
	3. When overnight temperatures fall below root mass temperatures, cover with insulation blankets	

HAND SITE PREPARATION

A. Tell them what you are going to tell them
   1. 5 steps
      a. Identify each step as it comes up
      b. Tell it to them
      c. Show it to them

STEPS	TASKS	FACTORS TO EMPHASIZE
1	Determine size of scalps	1. 24"X24" standard 2. Less than standard size may be used on clean-burn areas or mechanically cleared areas 3. Where fire has singed surface of competing vegetation but had no effect on roots, full size scalp is needed
2.	Select proper tool, (Mcleod is standard tool, hazel hoe good for heavy grass)	

HAND SITE PREPARATION (Continued)

SITE	TASKS	FACTORS TO EMPHASIZE
3. Select location of scalp		1. Wide hoe-type tools are best 2. Heavy tool for grass sod
		1. Downhill side of logs, stumps, rocks, etc. to protect from moving materials 2. Locate 12" from stumps, burned logs or chunks to reduce drying influence 3. Plant on west side of stumps on ease aspects to protect from frost damage (Douglas Fir) 4. Locate in light concentrations of slash to reduce air movements, temperature fluctuations, and animal travel 5. Avoid the following areas: wet, snow, rotten logs, live vegetation, and areas of stunted growth 6. Maintain spacing proximity

HAND SITE PREPARATION (Continued)

SITE	TASKS	FACTORS TO EMPHASIZE
4. Remove vegetation, duff, ash and debris to expose mineral soil	1. Scalp to a depth that removes vegetation root crowns	1. Vegetation removes available moisture 2. Site preparation removes trash that gets into planting holes 3. Trash carries pathogens that transmit diseases
	2. Scalp to selected size standards	
5. Construct escape route	1. Break open berms on the lower end of scalp	1. Allows water and debris movement out and away from the seedling

AUGER PLANTING HOLE CONSTRUCTION

STEPS	TASKS	FACTORS TO EMPHASIZE
1. Mark desired depth on auger shaft		1. 14" or 2" deeper than root length
2. Start auger engine		
3. Grasp handles firmly		1. Position of hands should be against the auger force
4. Center auger bit on planting spot		1. At an angle between the vertical and perpendicular to the slope
5. Accelerate engine and penetrate soil to premarked spot on auger shaft		1. Do not fight rocks as you will damage or break auger bit
6. Slow engine and extract auger	1. Careful not to kick dirt into hole	1. 1/2 entry speed or less to reduce slinging of soil
7. Obliterate false holes	1. Drag soil into false hole with boot	1. If soil is rocky, extra holes are needed to provide planting dirt
8. Move on to next planting spot	1. Repeat steps 3-7	2. False holes are invitation to planters. Kick them in

BAR PLANTING

STEPS	TASKS	FACTORS TO EMPHASIZE
1. Insert bar blade into soil		1. 2" deeper than root length
2. Push bar forward		1. To 45 degree angle
3. Pull bar forward		1. To 45 degree angle
4. Push blade down full length		1. Because steps 2 & 3 have raised the blade
5. Push bar forward to vertical position		
6. Insert bar into soil adjacent to hole		1. 4"
7. Insert seedling into hole	1. Hold seedling in place	1. Root collar even with round line
8. Pull bar back		1. To firm soil against roots
9. Push bar down and forward		1. To fill hole
10. Insert blade		1. 8" from trees, full length
11. Push bar forward		
12. Smooth surface		1. Use hands 2. Fill remaining depressions

APPENDIX C - NON VEGETATIVE MEASURES FOR SOIL STABILIZATION PRACTICES

C-1 MULCHING GUIDE

Appendix C-1

MULCHING GUIDE

Mulching is the application of plant residues or other suitable materials to the soil surface. Mulching is effective in conserving moisture, reducing runoff and erosion, assists in establishing plant cover, controls weeds and prevents crusting of the soil surface.

SPECIFICATIONS

A. Mulching critical areas to aid in the establishment of vegetation.

1. Site preparation - The site should be cleared of debris and smoothed to fill any rills or gullies. Compacted soils should be scarified to a depth of 2" to 4". Operations should be at right angles to the slope whenever possible. A disk, chisel plow, ripper or similar implement may be used for scarification.

2. Mulching materials and rates - (See Tables C-1 and C-2) The preferred mulching material is grass hay or grain straw at 1-1/2 to 2 tons per acre.

3. Distribution - Spread or mechanically "blow" mulch evenly over the area. Avoid thick clumps that will curtail seed germination and smother seedlings.

4. Vegetative mulches such as hay, straw and similar materials must be anchored to the ground surface to prevent them from washing or blowing away. (See Table C-3 for methods of anchoring mulches).

5. Apply mulches immediately after seeding/planting is completed.

B. Mulching critical areas for erosion control.

1. Mulch materials and rates: Gravel or crushed stone - nine cubic yards per 1000 square feet; rock four inches to six inches diameter - 150 tons per acre; asphalt emulsion concentrate - 600 - 1200 gallons per acre; wood chips - 10 to 15 tons per acre; hay or straw - two to three tons per acre; manure - eight to ten tons per acre.

2. Compacted sites should be scarified to loosen soil to a depth of two inches to four inches before mulch is applied.

C. Mulching to conserve moisture and/or improve water infiltration.

1. Irrigated land - Apply mulch material evenly over the area. Some mixing of mulch with the surface soil is usually necessary but the mulch should not be buried. Manure or plant residue mulches are best.

2. Woody plants or ornamentals. Place mulch around individual plants. Wood chips, bark, crushed stone or gravel are good mulches for this purpose.

Mulches areas shall be check periodically and immediately after severe storms for damage. Damaged areas of mulch or tie down material should be repaired as needed.

THE NEXT THREE PAGES REPRESENT TABLES

ALL TABLES ARE IN REFERENCE TO MULCHING

TABLE C-1

MULCHING

Guide to Mulch Materials, Rates, and Uses

		Application Rates			
Mulch Material	Quality Standards	per 1000 sq. ft.	per acre	Depth of Applica -tion	REMARKS
Asphalt Emulsion	SS-1 SS-K SM-K SM-2	14-28 gal.	600 to 1200 gal.	-----	Use as a film on seeded areas without additional mulch. Requires special equipment to apply. Application rate critical -- too much prevents seedings from penetration and too little prevents erosion control. Has not been very satisfactory for establishing seedings in arid areas. Good for stilling sand.
Compost or manure	Well shredded, free from ex- cessive coarse material	400 - 600 lbs.	8 - 10 tons	-----	Use a strawy manure where erosion control is needed. May create problems with weeds. Excellent moisture conserver. Resistant to wind blowing.
Cornstalks or Sorghum stover, shredded or chopped	Air dried, shredded into 8" to 12" lengths	150 - 300 lbs.	4 - 6 tons	-----	Effective for erosion control, relatively slow to decompose. Excellent for mulch on crop fields. Has about the same value as a cover crop. Resistant to wind blowing.
Gravel, Crushed Stone or Slag	Washed: Size 2B or 3A	9 cubic yards	-----	3"	Excellent mulch for short slopes and around woody plants and ornamentals. Use 2B where subject to foot traffic. (Approximately 2,000 lbs. per cu. yd.)
Grass Hay or Grain or Straw	Air-dried, free from undesirable seeds and coarse materials	75 - 100 lbs., 2 -3 bales	1.5 - 2.5 T., 90 - 120 bales	Lightly covers 75 to 90% of surface	Given good results in the establishment of critical area seeding. Subject to wind blowing unless kept moist or tied down. Most common and widely used mulching material. Good for erosion control in critical areas.
Peat Moss	Dried, compressed, free from coarse materials	200 - 400 cubic ft.	-----	2" 4"	Most effective as a mulch around ornamentals. Subject to wind blowing unless kept wet. Packaged in 100 lb. bales (6 cu. ft.). Excellent moisture holding capacity.
Sawdust, Green or Composted	Free from objectionable coarse materials	83 - 500 cubic ft.	-----	1" - 7"	Most effective as a mulch around ornamentals, small fruits, and other nursery stock. Application rates--fruit trees 5-7"; vegetables and flowers, 2-3"; blackberries & rasberries, 4-7"; straw- berries, 3". Good resistance to wind blowing. Requires 30-35 lbs. N/ton to prevent N deficiency while decaying mulch. Cu. ft. weighs 24 lbs.
Wood Chips	Green or air dried. Free from objec- tionable coarse materials	500 - 900 lbs.	10 - 15 tons	2" - 7"	Has about the same use and application as sawdust, but requires less N/ton (10-12 lbs.). Resistant to wind blowing. Decomposes slowly.
Wood Excelsior	Green or air dried burred wood fibers .024" x .042" x 4"	90 lbs. (1 bale)	2 tons	-----	Effective for erosion control. Tie-down needed on windy sites. Decomposes slowly. Packaged in 80 - 90 lb. bales.
Wood Fiber Cellulose (Partly digested wood fibers)					When used for erosion control of critical areas double application rate. Apply with hydro-mulcher. No tie- down required. Packaged in 100 lb. bags. Has not been very satisfactory for establishing seedings or arid sites.

TABLE C-2

MULCHING

Guide to Mulch Materials, Rates, and Uses

		Application Rates			
Mulch Material	Quality Standards	Unit Size	Unit & Weight	Area Covered Per Unit	REMARKS
Mats & Netting					
Twisted Kraft Paper Yarn	Plain weave, warp 7 per inch, filling 4 per inch selvage edge with polypropylene filament	45" x 250 yards	Roll 100 lbs.	312½ sq. yards	Use to hold seed and aid in germination without mulch. Tie down according to manufacturing specifications. Not effective in seed- ing establishment on arid sites. Use for irrigated lawn and turf planting.
Twisted Kraft Paper Yarn	Fungicide treated warp 1.1 pairs/in. filling 2.5 /in.	45" x 250 yards	Roll 80 lbs.	312 sq. yards	Use over bare soil or sod to prevent erosion and hold seed. Good for waterways and critical ditch bottoms. Tie down with staples as per manufacturing specifications.
Jute, Twisted Yarn	Undyed, unbleached plain weave. Warp 78 ends/yd. Weft 41 ends/yd.	45" x 50 yds. or 48" x 75 yds.	Roll 60 lbs. 90 lbs.	60 sq. yds. 100 sq. yds.	Use without additional mulch. Tie down as per manufacturing specifications. Effective for erosion control in waterways and ditches.
Excelsior Wood Fiber Mats	Interlocking web of excelsior fibers w/ mulch net backing on one side only.	36" x 30 yards	Roll	16½ sq. yds.	Use without additional mulch. Tie down as per manufacturing specifications. Good for establishing seedings on critical areas.
Glass Fiber	1/4" thick, 7/16"dia., holes on 1" centers	72" x 30 yards	Roll 56 lbs.	100 sq. yds.	Use without additional mulch. Tie down with T bars as per manufacturing specifications.
Plastic	2 - 4 mils	Variable up to 50' wide	-----	-----	Use black for weed control, use white for seeding establishment without organic mulch. Release plastic after seeding is established. Effective moisture conservation & weed control for small fruits.

* All mulches will provide some degree of erosion control, moisture conservation, weed control and reduction of soil crusting.

TABLE C-3

MULCHING

Mulch Anchoring Guide

Anchoring Method of Material	Kind of Mulch to be Anchored	How to Apply
Manual Methods		
Peg and Twine	Hay or straw, corn stalks	After mulching, divide areas into blocks approximately 1 sq. yd. in size. Drive 4 - 6 pegs per block to within 2" to 3" of soil surface. Secure mulch to soil surface by stretching twine between pegs in a criss-cross pattern on each block. Secure twine around each peg with two or more turns. Drive pegs flush into soil where mowing and maintenance is planned.
Mulch Netting	Hay or straw, corn stalks, compost, wood shavings, "tanbark"	Staple light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations.
Soil and Stones	Plastic	Plow a single furrow along edge of area to be covered with plastic, fold about 6 inches of the plastic into the furrow and polw furrow slice back over the plastic. Use stones to hold plastic down in other places as needed.
Slit	Hay or straw, corn stalks	Cut mulch into soil surface with a square-edged spade. Make cuts in contour tows spaced 18" apart.
Mechanical Methods		
Commercial sticking compounds	Sompost, wood ships, wood shavings, hay, straw, or cornstalks	See listing of "Mulching Products and Materials" for application methods and rates.
Pick chain	Hay or straw, corn stalks, manure, or compost	Use on slopes steeper than 3 to 1. pull across slopes with suitable power equipment.
Mulch anchoring tool or disk (smoothed or disked)	Hay or straw, corn stalks, manure	Apply mulch and pull a mulch anchoring tool over mulch. When a disk (smooth) is used, set in the straight position and pull across the slope with suitable power equipment. Mulch materials should be "tucked" inot the soil surface about 3 inches.
Sheepsfoot roller or packer	Hay or straw, corn stalks, manure	Pull sheepsfoot roller over the area after mulch is applied. Can be operated up and down slope.

APPENDIX D - US ARMY CORPS OF ENGINEERS
404 CRITERIA & GUIDELINES

404 GUIDANCE FOR THE NONPOINT SOURCE PROGRAM

I. BACKGROUND

The Clean Water Act (CWA) establishes a national goal of restoring the physical, chemical, and biological integrity of the nation's waters through the elimination of discharges of pollutants. Section 319 of the Act provides funding mechanisms to establish State programs to control nonpoint sources of pollution, with emphasis on development of watershed management programs. Section 404 of the CWA establishes that the U.S. Army Corps of Engineers (COE) regulates the discharge of dredged or fill material into the nation's waters and that (in addition to other oversight activities) EPA develop the regulations under which permits may be granted. With the exception of nationwide general permits and regional permits, the emphasis of the 404 program has been, by default, on a permit-by-permit basis. The Nonpoint Source Management Programs provide substantial flexibility in the techniques a State may choose to adopt in nonpoint source management. Section 404, on the other hand, operates under strict regulations promulgated in 1980. As such, potential conflicts between the two programs is likely unless the requirements and flexibility within each are incorporated into the planning and operations of each program.

A. REQUIREMENTS OF SECTION 404 REGULATIONS.

The 404(b)(1) Guidelines (40 CFR 230) were adopted on December 24, 1980, and are the substantive regulations that determine what discharges of dredged or fill material are permitable. The COE has also promulgated regulations indicating how the 404 program is administered (33 CFR 320-330). These regulations cover discharges into "waters of the United States", as they are broadly defined, including, but not limited to, the territorial sea, rivers, streams, tributaries, lakes, ponds, and wetlands adjacent to such water bodies. In addition, hydrologically-isolated waters and wetlands are also subject to regulation if their use or destruction would affect interstate or foreign commerce.

In particular, these regulations identify particular types of "waters" as being of particular concern because of their functions and values; these "special aquatic sites" include 1) Wetlands; 2) Mudflats; 3) Vegetated shallows; 4) Riffle and pool complexes; 5) Coral reefs; and 6) Sanctuaries and refuges. Loss or degradation of such areas are considered to be among the most severe environmental impacts covered by the regulations [40 CFR 230.1(d)]. As such, the regulations establish restrictions to discharge [40 CFR 230.10(a)] that place a particularly high priority on avoidance of discharges into "special aquatic sites", where such avoidance is "practicable".

B. NONPOINT SOURCE MANAGEMENT MEASURES INVOLVING 404 DISCHARGES.

Efforts to reduce or control nonpoint source pollution may include alternatives that would result in discharges of dredged or fill material into "waters of the United States", including into "special aquatic site", such as riparian wetlands. Such alternatives are likely to require authorization from the COE (a permit pursuant to Section 404 of the CWA and/or Section 10 of the Rivers and Harbors Act). More importantly, perhaps, the alternative may conflict with the regulations pursuant to 40 CFR 230, and/or may be perceived as resulting in net losses of wetlands or other special aquatic sites. In such cases, EPA and other federal and/or State agencies reviewing the permit application may seek to have the proposed project modified or may recommend that the permit be denied; this may create awkward situations, particularly if EPA has facilitated or funded the proposed project as part of a larger watershed protection effort through the Section 319 program (in order to control a significant source of agricultural runoff, for example).

II. GUIDANCE ON SECTION 319 AND 404 PROGRAM COORDINATION

In order to minimize instances where efforts to control nonpoint-source pollution conflict with the goals and/or regulations pursuant to the Section 404 and EPA's wetlands programs, the following guidance has been developed by EPA's Wetlands and Coastal Planning Section in coordination with EPA's Nonpoint Source Pollution Control Section. This guidance should also serve to alert entities addressing nonpoint source pollution problems of the types of potential activities that may require prior authorization from the COE.

A. ACTIVITIES REGULATED PURSUANT TO SECTION 404 OF THE CWA.

Presently, activities that would result in the discharge of dredged or fill material into "waters of the United States", including wetlands, require authorization from the COE.

1. A DISCHARGE.

Actions that constitute a **discharge** have been interpreted broadly. Of course, the deposition of dredged spoils within waters of the United States constitutes a regulated 404 discharge. In addition, however, simply changing the bottom contours of a "water" or regulated wetland by use of a point-source discharge (such a bulldozer) may be subject to regulation, even if no material is actually added to a site (i.e., the re-distribution of existing soils in a land-clearing operation). In one extreme case, the bottom sediment that was suspended and redeposited by tugboat propellers working in shallow waters was determined to constitute a point-source discharge of dredged or fill material (see United States v. M.C.C. of Florida, Inc.).

In addition, the Federal Government has issued proposed rules in the Federal Register (June 16, 1992) that would regulate mechanized landclearing, ditching, channelization, and other **excavation** activities as **"discharges"** under Section 404 "when such activities have or would have the effect of destroying waters of the United States, including wetlands" (Federal Register, Vol. 57, No. 116, Page 26894); these proposed regulatory changes implement a court settlement agreement in North Carolina Wildlife Federation v. Tulloch.

2. DREDGED OR FILL MATERIAL.

The Clean Water Act defines fill materials as "pollutants" and includes clean dirt as a pollutant. However, the full range of materials that constitute dredged or fill material remains somewhat open, in spite of the long-awaited Memorandum of Understanding (MOU) between EPA and the Army that was signed in 1985 regarding the definition of "fill" material; the need for this MOU had been an outgrowth of continuing disputes between EPA and the Army as to whether certain discharges should be regulated as solid waste discharges pursuant to Section 402 of the CWA (an EPA responsibility) or as fill material pursuant to Section 404 (a COE responsibility). For example, the MOU clarified that discharges associated with sanitary landfills would generally be regulated by the COE as a 404 discharge, but that mining wastes would generally be regulated by EPA as a 402 discharge. The MOU established several criteria that could be used to determine whether the material was fill including consideration of the primary purpose of the discharge (i.e., for 404 the purpose might be to change the level of the land). The primary impacts of the discharge (i.e., 402 might be release of water-borne chemicals as opposed to 404 that might be smothering of benthic organisms) and other similar criteria.

However, the MOU is sufficiently ambiguous to allow EPA and the Army to disagree on which agency should regulate certain discharges, and it is this ambiguity that has left somewhat open the issue of what constitutes fill material (i.e., under 404, the COE has refused to regulate some sanitary landfills, and has agreed to regulate some mining wastes in spite of the fairly clear contrary direction given by the MOU).

3. WATERS OF THE UNITED STATES.

"Waters of the United States" are broadly defined [40 CFR 230.3(s)(1-7)]. They include the territorial sea, traditionally navigable waters to the ordinary high water (or high tide) mark, tributary streams, inter- and intra-state lakes and streams, and wetlands adjacent to navigable waters. Furthermore, these waters include those hydrologically-isolated waters and wetlands, the use, degradation, or destruction of which could affect interstate or foreign commerce; in this latter regard, it is the legal opinion of the EPA (which has been upheld in legal challenges within the Ninth Circuit Court of Appeals) that this commerce connection includes "local waters which may provide habitat to migratory birds and endangered species" [Leslie Salt Co. v. United States, 896 F.2d 354, 369 (9th Cir. 1990) -- emphasis added].

Areas that constitute "waters of the United States" need not be always covered with water to be "waters". Particularly in the arid west, regulated "waters" may seasonally be dry, and therefore, hard to recognize. It is particularly important to be aware of this difficulty in order to minimize the chances of initiating activities that may result in an unauthorized discharge. In addition, the COE and EPA are proposing a regulatory change that would de-regulate certain wetland and aquatic areas that have been subject to farming practices since before 1985 such that they meet specific definitions of "prior-converted cropland". It may be very difficult in some cases, therefore, to know whether "waters of the United States" are involved without a formal determination by the COE or EPA.

The COE, the EPA and the USDA, Soil Conservation Service (SCS) are the only agencies that can formally determine the geographic extent of "Waters of the United States". The SCS is responsible for delineation of wetlands on agricultural lands, except rangelands. There are several methods available to help determine whether a proposed activity will take place in regulated "waters". For example, the U.S. Fish and Wildlife Service maintains an inventory of wetlands and aquatic areas for much of the United States in its National Wetlands Inventory (NWI) Maps. Although the areas designated on these maps do not constitute determinations of Clean Water Act jurisdictional areas (the maps, in fact, carry a disclaimer to the contrary, because the NWI designations are often more extensive than the areas that would actually be subject to CWA regulation) these maps can assist greatly in determining the likelihood that a proposed project site involves regulated "Waters of the United States". These NWI maps are available from:

U.S. Fish and Wildlife Service
Portland Regional Office
Attn: National Wetlands Inventory
911 N.E. 11th Avenue
Portland, OR 97232-4181
Phone: (503) 231 -6154
Fax: (503) 429-6243

Also, there are consulting firms that have training in delineation of the geographic extent of Clean Water Act jurisdiction and that can assist is evaluating a particular project or project site, particularly if an assessment is needed quickly and the COE, EPA or SCS are unable to respond in a timely manner to a request to delineate a site. In any event, however, the COE should be contacted if there is a question that "Waters of the United States" may be involved.

4. THE NEED FOR A PERMIT.

Activities that result in movement of earth (including some methods of vegetation removal), sediment removal, placement of rip rap, construction of breakwaters, levee construction or maintenance, filling, ditching, draining, land-leveling, or the like within any regulated "Waters of the United States", may be subject to regulation pursuant to Section 404 of the CWA. (Refer to Figure D-3, page D-11.) Failure to attain prior authorization risks enforcement action by the COE or EPA, and may be subject to substantial financial penalties. In the case of knowing violations, criminal penalties including imprisonment may be assessed.

Often, the COE can arrange a pre-application meeting in which prospective permit applicants can present their proposed project to the COE, as well as other federal and State agencies that would be likely to review and comment on the formal permit application to the COE. These meetings can serve to reduce delays in the permitting process by identifying any possible problems up-front so that these problems can be lessened or resolved before the application goes out for public review. In addition, the COE can determine whether the proposed activity may already be authorized under a nationwide general permit, or may, in some cases, be exempt from regulation as normal farming or silvicultural activities pursuant to Section 404(f)(1) of the CWA.

B. RESTRICTIONS TO DISCHARGE.

The regulations place significant restrictions on proposed discharges of dredged or fill material into "Waters of the United States".

1. Consideration of Alternatives.

No discharge may be permitted if there is a less environmentally-damaging practicable alternative to achieve the basic purpose of the proposed project. (Refer to Figure D-4, page D-12.) In other words, if it is cost-effective to achieve the basic purpose of a proposed project in a way that results in less harm to the aquatic system than the way that the project is proposed, no permit may be issued for the proposal. Alternatives that may be considered can include other sites, including those not presently owned by the applicant, if those sites could be obtained, used, expanded, or managed in order to achieve the basic purpose of the applicant's proposal. A discussion of the 404(b)(1) alternatives analysis and how it has been applied within EPA, Region IX, has been published [Yocom, T.G., R.A. Leidy, and C.A. Morris. 1989. Wetlands protection through impact avoidance: A discussion of the 404(b)(1) alternatives analysis. Wetlands 9(2): 283-298.].

For projects whose purpose is environmental enhancement, the alternatives analysis may not require off-site analysis. However, if the environmental enhancement is to upland resources at the expense of aquatic resources, the analysis of alternatives that do not cause the loss or degradation of aquatic resources may be required.

2. Water Quality Standards, Endangered Species, and Marine Sanctuaries.

No discharge may be permitted if it would violate any applicable State Water Quality Standard (State 401 Certification or a waiver of same is required) or violate any applicable toxic effluent standard or prohibition under Section 307 of the CWA. (Refer to Figure D-5, D-13.) Furthermore, no discharge may be permitted if it would jeopardize the continued existence of a species listed as endangered or threatened under the Endangered Species Act of 1973 or results in the destruction or adverse modification of endangered species critical habitat. Finally, no discharge may be permitted if it violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary.

3. Significant Degradation of the Waters of the United States.

The regulations [40 CFR 230.10(c)] prohibit a permit from being issued if the discharge of dredged or fill material would cause or contribute to significant degradation of the aquatic ecosystem (emphasis added). The regulations identify impacts to fish, shellfish, municipal water supplies, wildlife, and recreation as uses whose loss of degradation could be considered as "significant degradation". In areas such as California, which has already lost more than 90% of its historical wetlands base, even relatively minor incremental losses may "contribute to" significant degradation; for this reason, it has become increasingly more difficult to comply with this portion of the regulations and obtain permits to fill in portions of the remaining aquatic ecosystem.

If an applicant has already shown that it is not practicable to avoid discharging dredged or fill into waters of the United States under 40 CFR 230.10(a) and that the discharge is not likely to violate State Water Quality Standards or jeopardize federally-listed threatened or endangered species, it is typical for the COE and EPA to evaluate the significance of the project impacts in light of proposed mitigation measures (i.e., a determination of "significant degradation" will generally take into account the degree to which mitigation/compensation proposals of the applicant will offset unavoidable project impacts to the aquatic ecosystem).

4. Mitigation Requirements.

The regulations [40 CFR 230.10(d)] require that reasonable and practicable measures be implemented to minimize impacts of the discharge of dredged or fill material for all permitted discharges. As guidance on the extent of mitigation, the regulations state that the post-project ecological state should be higher than the pre-project ecological state.

C. THE CORPS' PUBLIC INTEREST DETERMINATION.

In addition to determining compliance with the 404(b)(1) Guidelines, the COE makes an independent determination of whether a proposed project is in the public interest. This determination considers economics, safety, public need, and several other factors. A project that does not comply with the 404(b)(1) Guidelines cannot receive a permit, but under no circumstances will the COE grant a permit that is contrary to the public interest (33 CFR 323.6).

III. APPLYING FOR A PERMIT.

The COE is the regulatory authority that issues permits pursuant to Section 404 of the Clean Water Act, as well as Section 10 of the Rivers and Harbors Act. COE District offices that operate within EPA, Region IX, are geographically divided by watersheds (See Figures D-1, page D-9). Information about how to apply for a permit can be obtained from the appropriate Corps District Office. The Figure D-2 (page D-10) includes addresses, phone and fax numbers for the regulatory offices within each District.

A. The South Pacific Division.

The Sacramento District covers Nevada, the California Central Valley, and Northern Sierra Nevada drainages. The Los Angeles District covers Arizona and southern California, and the San Francisco District covers the California coastal drainages from the Oregon border to San Luis Obispo, as well as the San Francisco Bay drainages upstream to the confluence of the Sacramento and San Joaquin Rivers. These three Districts are all overseen by the South Pacific Division, whose office is in San Francisco.

B. The Pacific Ocean Division.

The State of Hawaii and Pacific islands (Guam, Northern Marianas, American Samoa, and Palau) are covered by the Honolulu District office which also houses the Pacific Ocean Division which oversees the District's operations.

C. EPA's Wetlands Permits and Enforcement Section.

Within EPA, Region IX, the Wetlands Permits and Enforcement Section (see Figure D-6, page D-14) reviews applications for individual permits that are subject to public notices from the COE Districts. EPA also attends pre-application meetings to assist prospective applicants in understanding how to comply with the 404(b)(1) regulations. This section of EPA also enforces against unauthorized discharges of dredged or fill material into waters of the United States. EPA's Wetlands Permits and Enforcement Section can be contacted at the following address:

Wetlands Permits and Enforcement Section (W-7-2)
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105-3901

Phone: (415) 744-1962
Fax: (415) 744-1078

FIG. D-1

U.S. ARMY CORPS OF ENGINEER GEOGRAPHIC RESPONSIBILITIES

SAN FRANCISCO DISTRICT

CALIFORNIA
- NORTH COAST DRAINAGES
- SAN FRANCISCO BAY DRAINAGES
- SOUTH COASTAL DRAINAGES TO SAN LUIS OBISPO

SACRAMENTO DISTRICT

CALIFORNIA
- CENTRAL VALLEY DRAINAGES
- SIERRA DRAINAGES SOUTH TO OWENS VALLEY

NEVADA (ENTIRE STATE)

LOS ANGELES DISTRICT

CALIFORNIA
- COASTAL DRAINAGES SOUTH OF SAN LUIS OBISPO
- SIERRA DRAINAGES OWENS VALLEY SOUTH

ARIZONA (ENTIRE STATE)

HONOLULU DISTRICT

- HAWAII
- GUAM
- PALAU
- AMERICAN SAMOA
- NORTHERN MARIANAS

FIGURE D-2

CORPS PERMIT OFFICES

SAN FRANCISCO DISTRICT

DISTRICT ENGINEER, S.F. AREA
U.S. ARMY CORPS OF ENGINEERS
SAN FRANCISCO DISTRICT
211 MAIN STREET
SAN FRANCISCO, CA 94105-1905

REGULATORY FUNCTIONS
PHONE: (415) 744-3036
FAX: (415) 744-3320

SACRAMENTO DISTRICT

DISTRICT ENGINEER
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
REGULATORY SECTION
1325 J STREET
SACRAMENTO, CA 95814-2992

REGULATORY FUNCTIONS
PHONE: (916) 557-5252
FAX: (916) 557-7943

LOS ANGELES DISTRICT

DISTRICT ENGINEER
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
P.O. BOX 2711
LOS ANGELES, CA 90053-2325

PHONE: (213) 894-5606
FAX: (213) 894-5312

HONOLULU DISTRICT

DISTRICT ENGINEER
U.S. ARMY CORPS OF ENGINEERS
HONOLULU DISTRICT
FT. SHAFTER, HI 96858-5440

PHONE: (808) 438-9258
FAX: (808) 438-4060

FIGURE D-3

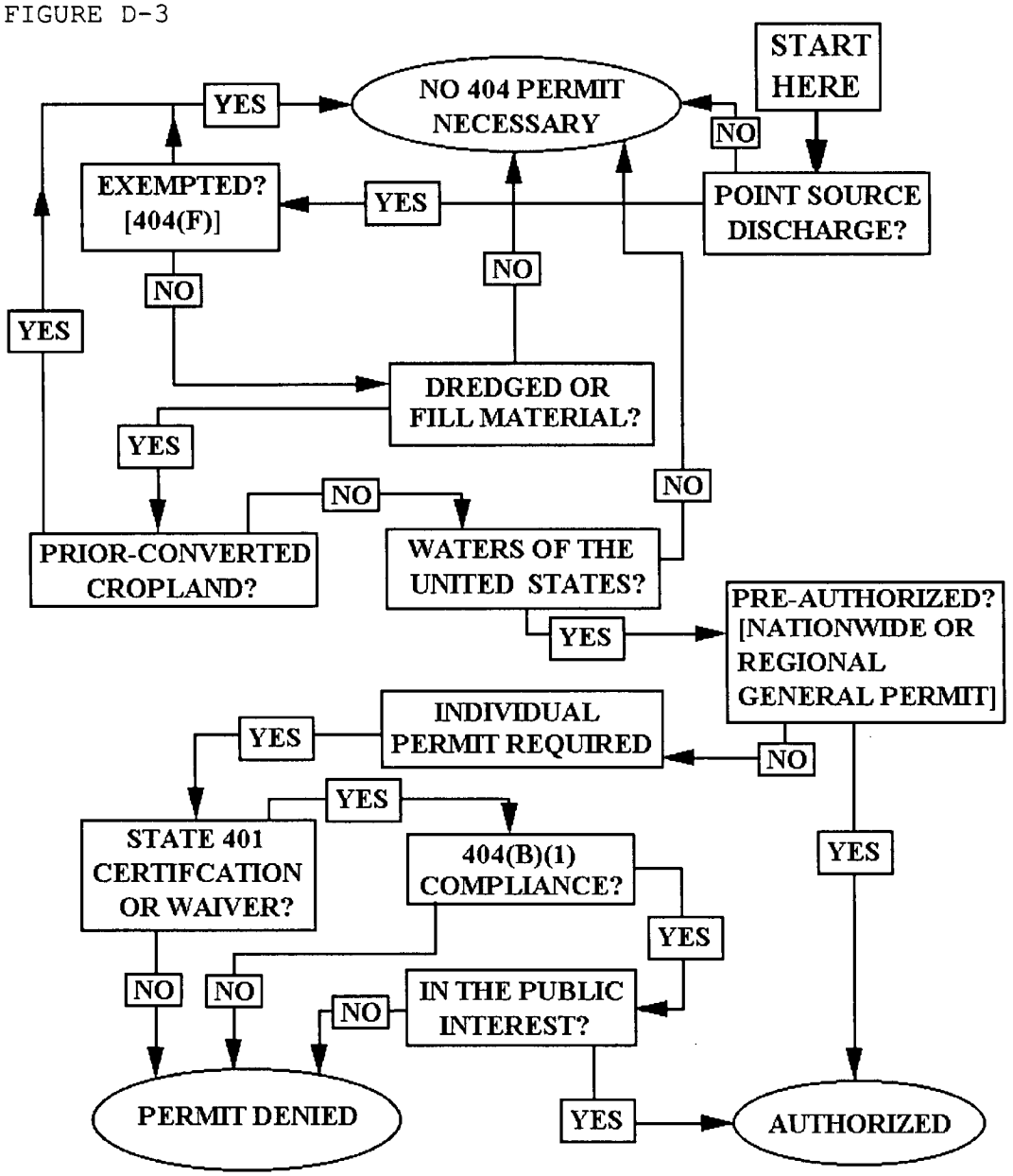
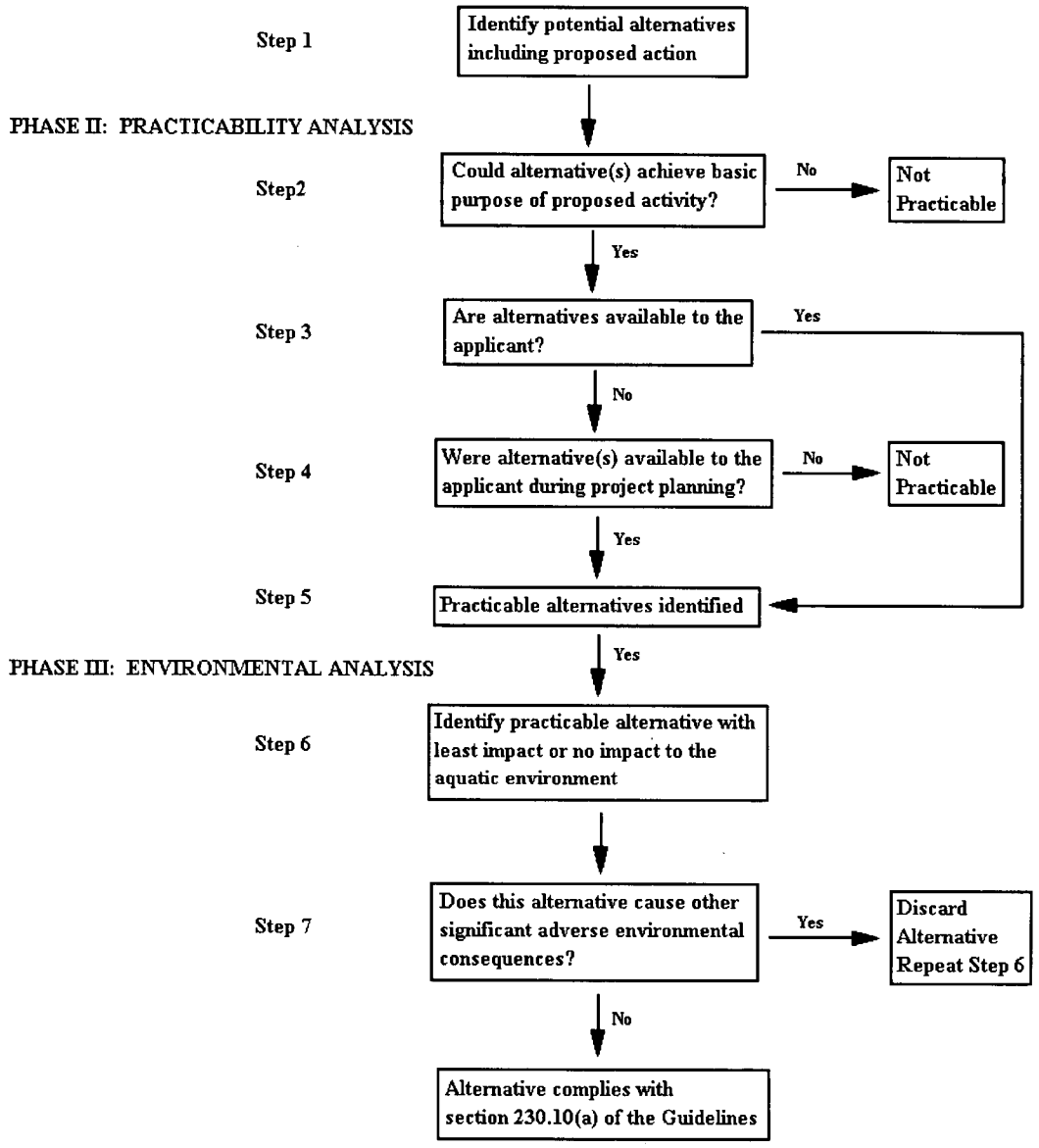

START HERE
NO 404 PERMIT NECESSARY
YES
NO
POINT SOURCE DISCHARGE?
EXEMPTED? [404(F)]
YES
NO
YES
NO
DREDGED OR FILL MATERIAL?
YES
NO
NO
PRIOR-CONVERTED CROPLAND?
WATERS OF THE UNITED STATES?
YES
PRE-AUTHORIZED? [NATIONWIDE OR REGIONAL GENERAL PERMIT]
INDIVIDUAL PERMIT REQUIRED
YES
NO
YES
STATE 401 CERTIFCATION OR WAIVER?
404(B)(1) COMPLIANCE?
YES
YES
NO
NO
NO
IN THE PUBLIC INTEREST?
PERMIT DENIED
YES
AUTHORIZED

FIGURE D-4

OVERVIEW OF SECTION 404 ALTERNATIVE ANALYSIS
40 CFR 230.10(a)



Notes

1. The permit applicant must demonstrate compliance with all requirements of the section 404(b)(1) guidelines. In the absence of sufficient information, i.e. determine compliance, a permit should be denied pursuant to section 230.12(a)(3).

FIGURE D-5

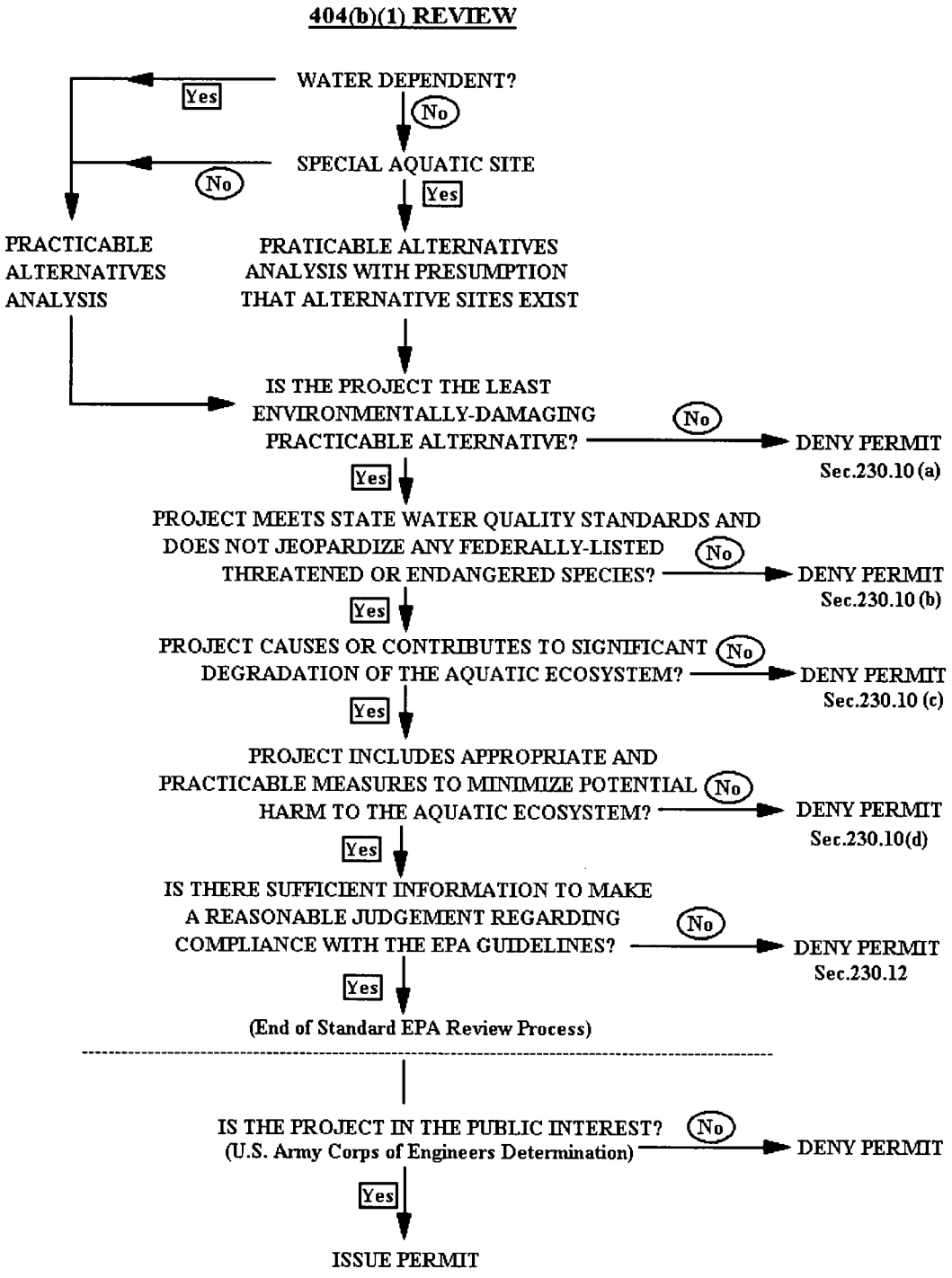

404(b)(1) REVIEW
WATER DEPENDENT?
Yes
No
SPECIAL AQUATIC SITE
No
Yes
PRACTICABLE ALTERNATIVES ANALYSIS
PRATICABLE ALTERNATIVES ANALYSIS WITH PRESUMPTION THAT ALTERNATIVE SITES EXIST
IS THE PROJECT THE LEAST ENVIRONMENTALLY-DAMAGING PRACTICABLE ALTERNATIVE?
No
DENY PERMIT Sec.230.10 (a)
Yes
PROJECT MEETS STATE WATER QUALITY STANDARDS AND DOES NOT JEOPARDIZE ANY FEDERALLY-LISTED THREATENED OR ENDANGERED SPECIES?
No
DENY PERMIT Sec.230.10 (b)
Yes
PROJECT CAUSES OR CONTRIBUTES TO SIGNIFICANT DEGRADATION OF THE AQUATIC ECOSYSTEM?
No
DENY PERMIT Sec.230.10 (c)
Yes
PROJECT INCLUDES APPROPRIATE AND PRACTICABLE MEASURES TO MINIMIZE POTENTIAL HARM TO THE AQUATIC ECOSYSTEM?
No
DENY PERMIT Sec.230.10(d)
Yes
IS THERE SUFFICIENT INFORMATION TO MAKE A REASONABLE JUDGEMENT REGARDING COMPLIANCE WITH THE EPA GUIDELINES?
No
DENY PERMIT Sec.230.12
Yes
(End of Standard EPA Review Process)
IS THE PROJECT IN THE PUBLIC INTEREST? (U.S. Army Corps of Engineers Determination)
No
DENY PERMIT
Yes
ISSUE PERMIT

FIGURE D-6

U.S. ENVIRONMENTAL PROTECTION AGENCY
75 HAWTHORNE STREET
SAN FRANCISCO, CA 94105-3901
PHONE NUMBER: 415-74X-XXXX

REGION 9 WETLANDS PERSONNEL

WATER MANAGEMENT DIVISION (W-1)	4-1078 (FAX) 4-2125
WETLANDS, OCEANS AND ESTUARIES BRANCH (W-7)	4-1078 (FAX) 4-1953
WETLANDS PERMITS & ENEORCEMENT SECTION (W-7-2)	4-1078 (FAX) 4-1962
PERMITS AND EIS REVIEW	4-1969
ENFORCEMENT	4-1970
WETLANDS AND COASTAL PLANNING SECTION (W-7-4)	4-1078 (FAX) 4-1971
PLANNING, STRATEGIES & STATE PROGRAMS	4-1976
NATIONAL WET LANDS EXPERT	4-1975
WETLANDS AARPS	4-1956

APPENDIX E - WATERSHED MANAGEMENT

E-1 CRITICAL AREA PLANTING GUIDE
E-2 GUIDELINES AND SPECIFICATIONS FOR STREAMBANK PLANTING

Appendix E-1

CRITICAL AREA PLANTING GUIDE

It is important to establish vegetation on roadsides, dams, open pits, waste dumps, ditchbanks, and areas disturbed by construction or mining activity. Vegetative cover will minimize erosion, improve appearance, and help control noxious weeds. Selection of fire resistant and low fuel volume plants will aid in fire prevention on these sites. For the best results, plantings should be made as soon as possible after construction is completed.

Planning - The first step in the installation of a critical area planting is to develop a plan specifically for the site in question. Each critical area is different and the conditions that exist will dictate specific treatments needed. Where possible the plan should be initiated prior to the construction that creates the critical area. **The expertise of a qualified professional should be utilized in the formulation of a site specific plan**. Items to be considered in the plan are:

1. Types of structural work required (diversions, benching, terracing, chute drop or other water control structures, retaining walls, etc.).

2. Seedbed preparation requirements and methodology.

3. Soil testing and analysis.

4. Fertilizer and/or soil amendment requirements.

5. Plant material selection.

6. Seeding or planting procedures.

7. Types of mulch to be utilized and the application procedure.

8. Irrigation requirements and methodology.

9. Plans for livestock/wildlife exclusion, if necessary. All sites should be protected from disturbances until the planting is well established.

10. Determination of site maintenance requirements and development of a comprehensive maintenance plan, including a schedule.

Site Preparation - The needs for site preparation will depend on the specifics of the project area and types of vegetation treatment to be made, herbaceous, woody or a combination of both. Plant material selection should be diverse, similar to the pre-disturbance vegetation type. All seedings shall include grasses for rapid surface disturbance stabilization and establishment of an initial ground cover, even if woody plant cover is the final objective. The developed reclamation plan should be implemented as designed.

1. Smooth and shape the area and remove any stumps, large rocks or debris left by construction.

2. Shape banks to slopes no steeper than 3:1. Slopes must be physically stable before revegetation efforts are initiated. Where it is not feasible to regrade slopes to a 3:1 other physical treatments are required (i.e. retaining walls, toe buttressing, terracing, etc.).

3. Install diversions, terraces, drop chutes, or other structures needed for water control.

4. Loosen or scarify compacted areas. Perform these operations across the slope as near to the contour as possible.

5. Topsoil - Apply two to four inches of stockpiled topsoil to the area after scarification. Stockpiling the topsoil should be included in the construction plans. Replacing the topsoil not only provides a better medium for plant establishment and growth but it may also contain native seed, rhizomes, roots and sprigs that will grow and aid in establishing plant cover. Stockpiling and reapplication of topsoil is proven effective and is a practical way to establish vegetation in the Great Basin environment.

6. Fertilizer - These areas are typically low in fertility and will need some fertilizer. Fertilizer needs can best be determined by soil tests. Fertilizers are available in both slow release and direct uptake forms (liquid or granular). Some additional nitrogen may be needed the first two years after planting. In some instances there may be a need for other soil amendments such as gypsum, lime or sulfur. Fertilizer and soil amendments should be applied prior to planting and worked into the soil wherever possible.

Planting - Select plant species and varieties adapted to the area. Grasses, legumes and other herbaceous plants provide the best ground cover and erosion control but shrubs and trees may be needed for the final vegetative cover on some sites. Use plants that are native in the area whenever possible.

1. Use a drill for seeding on all sites where normal farm equipment can be operated. Steep slopes can be seeded by broadcasting or with a hydroseeder. On sites to be broadcast or hydroseeded, the last site preparation operation should leave the surface slightly roughened with pockets or grooves and furrows across the slope to trap and hold the seed. Broadcast seeding rates should be double that determined for drill seedings.

2. Usually trees or shrubs will have to be hand planted as will sprigs or grasses and legumes. A mechanical tree planter may be used on sites suitable for operation of this type of equipment. Either bare root or container grown plants may be used. However, container grown plants normally survive better than bare root plants, especially evergreen species. Bare root plants should always be dormant when planted. Remove the container from plants when planting. Slow release fertilizer may be placed in the planting hole. Be sure the hole is large enough and deep enough to accept the plant without bending or curling the roots. Tap the soil firm around the plants to seal any air pockets. The plants should be watered immediately after planting. Plants should be planted in a random arrangement rather than rows. Plants may be planted in rows across the slope if they are staggered so they do not form rows up and down the slope. If several species are used, it is usually best to mix the species rather than planting them in blocks of single species. This, of course, would not be true when one species is used on a wet area and another on a dry portion because of their adaptation to those conditions.

3. Sod - A rapid cover can be established by using sod. Kentucky bluegrass, tall fescue or a combination of these two species are suited to most Nevada conditions. Riparian sites can be treated by lifting sod from adjacent undisturbed areas in a random manner. Site preparation for sod is about the same as for seeding. Some additional smoothing may be required to remove irregularities that could interfere with sod placement. Sod strips should be laid across the slope, never up and down, starting at the bottom of the slope and working up. On steep slopes the use of ladders will facilitate the work. Place the sod strips so that the joints are snug and even. Stagger the joints across the slope. Roll or tap the soil immediately after placement to insure solid contact of the root mat and the soil surface. On sloping sites secure sod to the soil with staples or wooden pegs. Water thoroughly immediately after placement and continue watering as needed to maintain optimum moisture for two weeks, then water as needed to maintain growth.

Mulching - Mulching is desirable on all seeded sites and is essential on any slope three to one or steeper. Serious consideration should be given to mulching for all critical area plantings, both herbaceous and woody. Mulch not only aids in plant establishment but, properly selected and applied, will protect the area from erosion until plant cover is established.

Straw or hay at one and one half to two tons per acre has been the best mulching material for plant establishment. It can be applied by hand or with a straw blower or spreader. Hay or straw mulch must be anchored either mechanically with a mulch anchoring machine, with twine, netting or a sticking compound. Wood fibers, wood chips, rock gravel, jute matting or other mulching materials can be used. If hydromulching is used it should be applied as a separate operation after seeding, not with the seed.

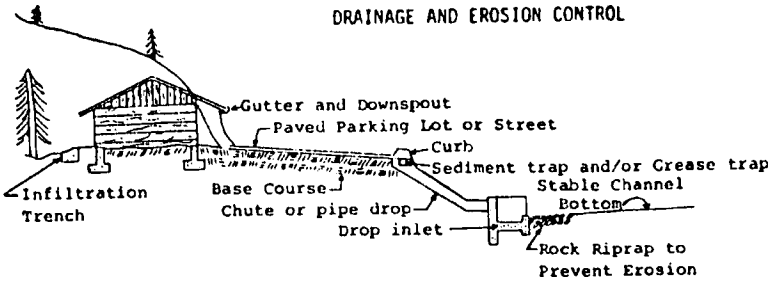
Well anchored straw or hay mulch will persist and aid in establishment of volunteer native plants as well as the seeded species. There have been instances where mulching with grass hay has resulted in the establishment of good plant cover without any seeding. A good mulching job may be the single most important practice in the treatment of critical areas.

Structural Aids - The figures on the following pages show some examples of structural practices that can be used to aid and supplement plantings in critical area stabilization.

Critical areas containing steep slopes with erosive slopes that are subject to melting snow require special treatment to protect the area from erosion or other environmental deterioration. Areas requiring special treatment for protection from erosion include cut and fill slopes, residence lots, public utilities, commercial sites and rights-of-way. Structures should be designed for stability and to control surface erosion. Saturated conditions should be considered in the expected loading. All structures should be designed in accordance with sound engineering practice. Where possible, applicable types of vegetation should be included in the design to beautify or blend the structures into the surrounding landscape.

Figures illustrating drainage and erosion control and slope stabilization by mechanical means are depicted in Figures E1-E3 (pages E-6 through E-8), respectively.

FIGURE E-1 (FIGC1.PCX)
DRAINAGE AND EROSION CONTROL



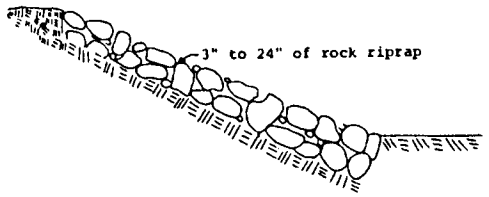
Provide for surface and subsurface drainage. This should include roof drainage and paved areas. The disposal of runoff should be made without causing erosion.

FIGURE E-2 (FIGC1A.PCX)
SLOPE STABILIZATION BY MECHANICAL MEANS-A*

SLOPE STABILIZATION BY MECHANICAL MEANS*

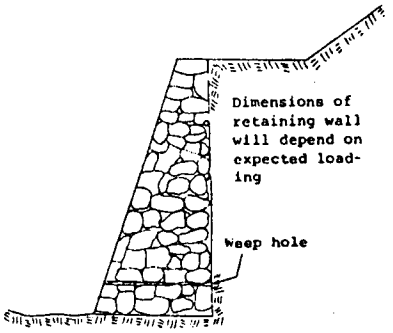
Slopes between 15 and 30 percent can be stabilized with crushed stone, paving or rock riprap.

Slopes from 30 to 50 percent (3.3:1 to 2:1)



Slopes between 30 and 50 percent can be stabilized with paving or rock riprap.

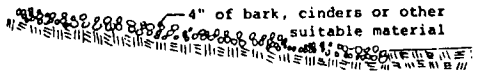
* Slopes less than 2:1 may also be stabilized with vegetation.



RUBBLE MASONRY RETAINING WALL

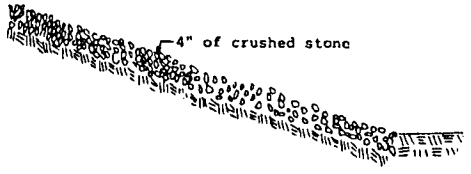
Slopes greater than 50 percent should be stabilized with the use of structural controls.

Slopes less than 15 percent (6.7:1)

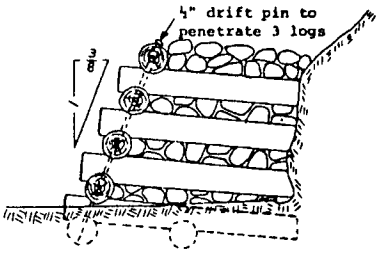


Slopes flatter than 15 percent can be stabilized with crushed stone, permanent mulch (bark, cinders, etc.), paving or rock riprap.

Slopes from 15 to 30 percent (6.7:1 to 3.3:1)

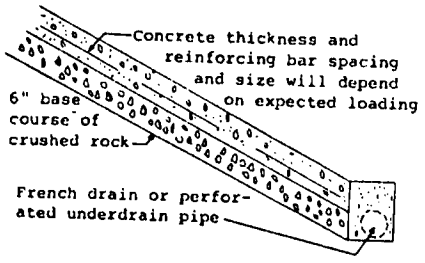


Slopes greater than 50 percent (Steeper than 2:1)

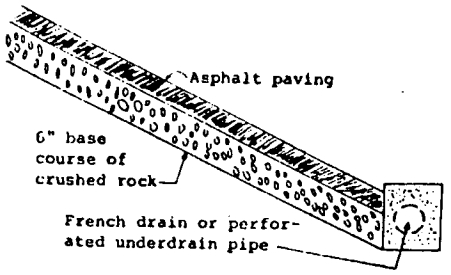


LOG-ROCK RETAINING WALL

FIGURE E-3 (FIGC1B.PCX)
SLOPE STABILIZATION BY MECHANICAL MEANS-B*

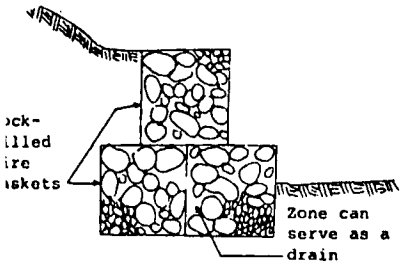


CONCRETE PAVING

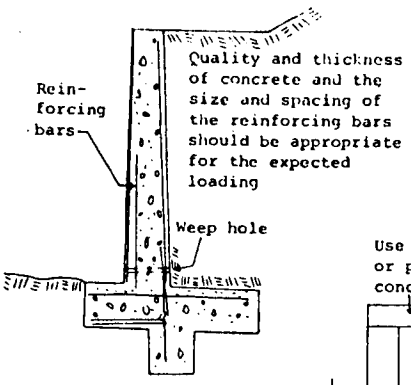


ASPHALT PAVING

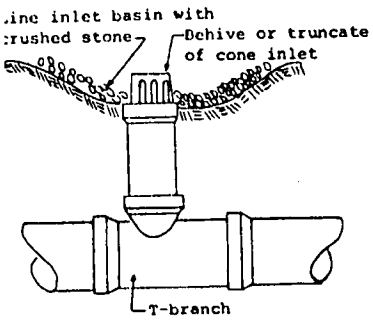
Where paving is subject to automotive traffic it should be designed to withstand a wheel load of at least 4,000 pounds



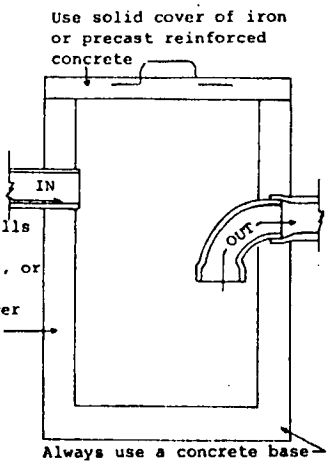
GABION RETAINING WALL



CANTILEVER RETAINING WALL



SURFACE INLET



SEDIMENT TRAP

Appendix E-2

GUIDELINES AND SPECIFICATIONS FOR STREAMBANK PLANTING

Either herbaceous or woody plants or a combination of both can be used in streambank plantings. Most areas disturbed by construction should be planted to grass to provide immediate ground cover. If needed, woody plants can be interplanted into the area.

Herbaceous Plantings

1. Seedbed preparation - Disturb the stream bank as little as possible. Where the areas have been disturbed by construction, leave slopes no steeper than 2:1 and preferably 3:1 or flatter. Extreme care must be taken when regrading steep streambanks as this can result in large amounts of sediment being introduced into the water. Prepare the best seedbed possible and practical under existing conditions. Pre-plan construction to stockpile topsoil for replacement on the area to be planted. A conventional seedbed as used for hay or pasture planting should be specified wherever possible.

2. Fertilization - Rapid establishment is important. Fertilize according to soil tests or apply about 40 pounds each of available N and P_2O_5 per acre. Some maintenance fertilizer may be needed for a year to two years after establishment. Different plant species have different fertility requirements which also should be considered.

3. Planting procedures - Where possible the seed should be drilled. If slopes or rough terrain make it impossible to use a drill the seed may be broadcasted or seeded with a hydroseeder. Seeding rates for broadcast or hydroseeder seedings should be double that used for drill seedings.

4. Species - Moisture conditions on stream banks may vary from very wet near the shoreline to very arid on the upper portions of the bank. Stream bank plantings on live streams usually require the use of water loving species such as reed canary grass near the shoreline while the bank above the area affected by beneficial moisture from the stream may require the use of very drought tolerant species. Most plantings will therefore require a mixture of species. **The assistance of a qualified plant material specialist is recommended**.

   Some suggested species are listed below but plantings are not limited to these species.

   Species

   Smooth bromegrass
   Sand dropseed

Hard fescue
Tall fescue
Garrison foxtail
Reed canary grass
Burmudagrass
Perennial ryegrass
Crested wheatgrass
Desert wheatgrass
Tall wheatgrass
Intermediate wheatgrass
Pubescent wheatgrass
Streambank wheatgrass
Western wheatgrass

5. Mulching - Mulch all seedings immediately after seeding. Mulching will be beneficial on all seedings regardless of slopes. (See Appendix C-1 Mulching Guide).

6. Seeding Dates - Seed when recommended for the project area. In Nevada, fall seedings or early spring seedings are the most opportune times of the year. Try to coordinate completion of any construction activities with recommended seeding dates. In some instances it may be necessary to plant a cover crop of small grain or sudangrass for temporary protection until the proper time for seeding the permanent species.

7. Irrigation - Irrigate as needed until the stand is well established, typically one to two growing seasons.

Woody Plantings

Generally species native to the area will be superior to exotic or introduced species. Usually shrubs are preferred to trees as they stay anchored better and will spread by root sprouts.

1. Species Selections (Suggested) - Plantings not limited to species listed:

Shoreline Area

Redosier dogwood	Root sprouting
Shrub willows	Root sprouting
Purple osier	Root sprouting
Sandbar	Root sprouting
Silky dogwood	Root sprouting
Snowberry	Root sprouting

Area Above Shoreline But Affected By Moisture From The Stream

Chokecherry	Root sprouting shrub or small tree
American Plum	Root sprouting shrub or small tree
Buffaloberry	Root sprouting shrub or small tree
Siberian Crabapple	Small tree
Golden Willow	Tall tree
Cottonwoods or Poplars	Tall trees
Green Ash	Tall tree

Dry Upper Bank Area

Atriplex Species Quailbrush	Native shrub - salt tolerant
Fourwing Saltbrush	Native shrub - salt tolerant
Buffaloberry	Root sprouting shrub or small tree
Creeping Juniper	Native shrub - spreads and roots down
Desert Willow	Root sprouting native shrub - Southern Nevada only
Tatarian Honeysuckle	Shrub
Pomegranate	Shrub or small tree -
Southern Nevada only	
Russian Olive	Shrub or small tree
Black Locust	Medium tree
Skunkbush Sumac	Native shrub

2. Planting

Use rooted cuttings, container grown plants or bare root seedlings. Containerized plants will give best survival.

Do not attempt to plant in rows, stagger the plants to provide even cover. Space shoreline shrubs about two feet x two feet, other shrubs three feet x three feet, small trees four feet x four feet, and tall trees six feet x six feet.

Plant tall trees at least 12 feet from the stream bank.

Plant at the time recommended for other tree and shrub plantings.

Follow standard procedures for care of planting stock and planting woody plants.

3. Irrigation

Irrigate as needed to establish the plants the first two growing seasons. Do not use species that require continued irrigation for maintenance except in special situations.

4. Maintenance

Replant dead plants at the beginning of the second season.

Do not prune, except that some species may be clipped back to promote spreading.

Maintain fencing to protect the planting from livestock, wildlife and vehicle traffic.

Provide fire protection.

APPENDIX F - AGRICULTURE

FARMING

F-1 SURFACE IRRIGATION SYSTEMS
F-2 WATER CONTROL STRUCTURES
F-3 WATER MEASURING DEVICES
F-4 DRAINAGE FOR IRRIGATED LAND
F-5 LAND LEVELING FOR SURFACE IRRIGATION
F-6 LAND SMOOTHING

Appendix F-1

SURFACE IRRIGATION SYSTEMS

DESIGN CONSIDERATIONS

A well designed surface irrigation system should uniformly apply water to a crop root zone before soil water is depleted beyond certain limits. The available stream size, length of run, and grade of the land units should be combined to meet the optimum timing and amount of irrigation water determined. Flexibility and positive water control should be incorporated into the system, since the optimum timing and amount of irrigations will not always mean replenishing the root zone reservoir upon reaching a fixed depletion. The system should achieve the desired results without excessive labor inputs, water waste, erosion and inconvenience to the farming operations.

Preliminary design considerations should include an evaluation of general topography, soils, planned cropping programs, farming practices, and available financing. This should allow the selection of one or more types of surface irrigation systems including corrugations, furrows, low pressure sprinklers, border checks, basins, contour checks or ditches, or wild flooding. Selection and design should be based on detailed information regarding water, soils and topography, crops, and other factors. **The assistance of a qualified professional may be necessary.**

Water - The design should be based on the cost, amount, and availability of water allocated to the area under consideration with special importance on the water supply during periods of peak crop water use.

Soils and Topography - Soils data required include depth of potential root zone, water-holding capacity, available water in the root zone reservoir, chemical analyses, variations in soil type and texture, intake characteristics, leaching requirement, and drainage capacity. The topographic data necessary includes slope of the land, degree of land leveling or smoothing, point of water delivery, and surface drainage potential.

Crops - The design should be based on specific crop data for existing and planned cropping programs. This includes rooting depths, growth and water use characteristics, peak water use requirements, field restrictions required to grow and harvest the crop, and germination requirements.

Other Factors - The availability and cost of labor and energy inputs, financial resources required, and the required operation and maintenance programs are additional design considerations.

Materials Used

A wide variety of materials is available for the components of surface irrigation systems. Where conditions dictate, the conveyance and distribution facilities may need to be constructed from something other than soil.

Open conveyance and distribution facilities can be lined with concrete, plastic, asphalt, soil cement, or bentonite clay to minimize seepage and erosion. Special attention must be given to the required water surface elevations, hydraulic forces on the lining from inside and outside the channel, adequate freeboard, channel velocities, and the degree of wetting and drying encountered in the channel.

Pipelines are frequently used to convey and distribute water for surface irrigation systems. Common materials include PVC, aluminum, concrete, and cement. Selection of a pipe material will usually depend on availability, cost, design requirements, and grower's preference.

Many alternatives exist for the actual distribution of water. Included are soil notches, concrete notches, spiles, siphon tubes, gated pipe, and risers with alfalfa valves on pipelines. The final design should also include an evaluation and incorporation of automation where appropriate.

Final Considerations

The design of surface irrigation systems following selection of a system type should be based on the predicted advance and recession curves for a given land unit. Consideration should be given to achieving a uniform irrigation without excessive runoff or deep percolation losses. The use of tailwater recovery systems may allow higher application rates and thus shorten advance times to achieve uniform irrigations since the runoff water can be reused. Irrigation streams should be sized to be nonerosive.

The final surface irrigation system design should provide an integral combination of land grading and smoothing, water measurement and control structures, conveyance facilities, surface distribution facilities, and provisions for removal and/or reuse of drainage water. For example, a surface irrigation system comprised of a buried plastic conveyance pipeline, alfalfa valves, a gated pipe distribution system with 1/8 mile runs, proper stream size, and a tailwater recovery system will achieve high irrigation efficiencies.

DESIGN SPECIFICATION

Surface irrigation systems should be designed by qualified professionals. Criteria and specifications for the actual design can be found in the following references:

Hagan, R. M., Haise H. R., and Edminister, T. W., 1967, **Irrigation of Agricultural Lands.** Number 11 in the series, Agronomy. American Society of Agronomy, Madison, Wisconsin.

Soil Conservation Service. **SCC National Engineering Handbook, Section 15.** United States Department of Agriculture, Washington, D.C.

Soil Conservation Service. **Irrigation Guide.** United States Department of Agriculture.

Appendix F-2

WATER CONTROL STRUCTURES

DESIGN CONSIDERATIONS

Surface irrigation requires control of the irrigation stream to reach all lands to be watered. Control structures are necessary in the conveyance system to drop water to a lower elevation and to divide or divert the flow to the appropriate farm ditch. The structure must also protect the channel sides and bottom from erosion at the structure site. The dimensions of the structure will depend on its use, water flow, and soil erodability. All structures should be installed plumb and level and at the proper elevation relative to the channel and desired water level. The materials used for construction will depend on cost, availability, ease of installation, and desired life. Typical materials are concrete, wood and metal.

The structure required will depend upon the needed function: drop, distribution, or application.

Drop Structures

Drop structures are used where an elevation change is necessary or where the slope of a ditch creates an erosive velocity. There are two general types of drops: Open Drop and Pipe Drop.

Open Drop: The open drop structure usually consists of an upstream cutoff wall, a drop chute, and a downstream cutoff wall. The downstream cutoff wall should include a splash section extending above the chute bottom creating a stilling basin for energy dissipation. The top of the splash section should be at the elevation of the ditch bottom. The upstream cutoff wall can be fitted with splash boards to double as a check. A side chute can be added for division or diversion of the flow.

Pipe Drop: A pipe drop is used when the change in elevation is at a roadway or other embankment. It consists of an inlet box and a pipe chute extending vertically from the inlet box and then horizontally under the embankment to the receiving ditch.

Distribution Structures

Distribution structures are used for division or diversion of water in a ditch system. Typical distribution structures are headgates, division boxes, and checks.

Headgates: Used to divert water into the farm distribution system. Headgates can be a headwall and pipe outlet or open structure with a shutoff gate and are often calibrated as a measuring device. Headgates should have cutoff walls. A closed pump box, constructed with a bottom and outlet chutes, is a special adaption of a division box.

Checks: Used to control the upstream water level in a head ditch to divert the water from the ditch. Permanent checks can be a single headwall where nonerodable soils exist or with a chute where erosion may endanger the structure. These are usually equipped for flashboards. Canvas or plastic sheets can be used as a temporary check.

Application Structures

Application structures are used for controlling the flow of water from the head ditch onto the field. Typical application structures are turnouts, siphons, and gated pipe.

Turnouts: Concrete, metal or wooden boxes and concrete or metal pipes through the ditch bank. Boxes should be equipped for flashboards or with a gate. An exception would be spiles which operate by overpouring with the rise of the water in the ditch. The elevation of the pipes, especially spiles, in the ditch bank is critical.

Siphons: Plastic or aluminum curved pipes which deliver water over the ditch bank to the field. Downstream end of siphon must be lower than the level of the water in the ditch. Good for use with temporary ditches. Also, permanent ditches remain unobstructed for cleaning.

Gated Pipe: Portable pipe (rigid or flexible) with many small gates or outlets through which water is applied to the field. Can be used in place of, or in conjunction with, the head ditch.

DESIGN SPECIFICATIONS

The design and construction specifications should be prepared by a qualified professional, experienced in irrigation system layout and design. The following reference is a source of design specifications for small water control structures. Specifications and drawings can also be obtained from Soil Conservation Service offices.

Aisenrey, A.J., J., et al, 1974. **Design of Small Canal Structures**. United States Department of Interior, Bureau of Reclamation, Denver, Colorado

Appendix F-3

WATER MEASURING DEVICES

DESIGN CONSIDERATIONS

The measurement of irrigation water allows the irrigator to become more efficient by knowing how much he is applying. Measurement is also important to ensure proper distribution according to water rights, shares, or quantity ordered, and to maintain efficient performance of wells and pumps.

The type of measuring device used will be determined by one or more of the following conditions:

Ease of Use
Desired Accuracy
Type of Flow (open channel or pipe)
Frequency of Measurements Desired (structure permanency)
General Size of Flow
Economics

Common types of measuring devices are:

1. Collecting Water in a Container of Known Volume: For a measured period of time. Used for small flows through spiles from head ditch and from sprinkler nozzles. Good accuracy. Inconvenient for frequent measurements. Economical and easy to use.

2. Commercial Water Meters: Used in a closed pipe system or a constantly submerged pipe outlet. Usually has a dial showing accumulated volume of water. Good accuracy. Constant reading. Low to moderate flows.

3. Timing a Floating Object: Or tracer of dye or salts as it floats through a measured channel distance. Easy and economical. Relatively low accuracy. Channel cross section should be uniform. Moderate to large flows.

4. Current Meter: Used in open channels. Measures velocity through known cross-sections. Reasonable accuracy possible. Moderate to large flows. Inconvenient for frequent measurements.

5. Pipe Trajectory: Used on open discharges from pipes. Easy and economical. Moderate accuracy. Moderate to large flows.

6. Pitot Tube: Used primarily for flow in pipes. Good accuracy. Inconvenient for frequent measurements. Economical (after original equipment purchase).

7. Weirs: Used in open channels. Usually permanent installation. Good accuracy and easy to use. Low to large flows. Economical. Critical installation requirements.

8. Parshall Flume: Used in open channels. Permanent installation. Good accuracy with low to large flows. Easy to use. Critical installation requirements.

9. Orifices: Can be free flowing or submerged in open channels. Good accuracy with low to moderate flows. Easy to use and economical.

10. Commercial or Farm-Constructed Headgates: Must be calibrated. Used in open channels. Moderate accuracy. Dual use. Permanent installation. Low to large flows.

DESIGN SPECIFICATIONS

The design and construction specifications should be prepared by a qualified professional experienced in hydraulics. The following references are sources for design specifications and flow charts:

Bureau of Reclamation, 1975. **Water Measurement Manual,** United States Department of Interior, Washington, D.C.

Scott, Vern H. and Clyde E. Houston, 1959. **Measuring Irrigation Water.** Circular 473, California Agricultural Experiment Station, University of California, Davis.

Soil Conservation Service, 1962. **SCS National Engineering Handbook, Section 15, Chapter 9.** United States Department of Agriculture, Washington, D. C.

Appendix F-4

DRAINAGE FOR IRRIGATED LAND

DESIGN CONSIDERATIONS

Drainage itself cannot protect downstream water quality, but since it is normally necessary for maintenance of productivity, the farm drainage system can be designed to minimize its impact on downstream quality.

Surface Drainage Considerations

Surface drainage on the farm is usually for removal of irrigation water runoff, but other purposes are intercepting surface water from higher land and removing precipitation runoff. Considerations for surface drainage include:

Topography: Land leveling or smoothing provides an even path for surface water to leave the field without soil erosion. On unleveled fields, natural swales may have to be developed as drainage channels.

Soils: Consideration should be given to the potential for silting for the surface drains. Also, the drains must be designed to minimize ditch erosion.

Inlets to Ditches: Where structures are used, proper location and type must be considered (See Appendix F-2 on Water Control Structures). Vegetated buffer areas may be appropriate to improve runoff water quality.

Outlets: Ditches should have adequate fall into a definite natural or constructed channel outlet or a sump from where the water can be pumped. Downstream water quality can be protected if the surface drainage water is recirculated in a tailwater recovery system.

Maintenance: Access must be provided for regular maintenance including cleaning, spraying, and repairs.

Subsurface Drainage Considerations

Subsurface drainage on the farm using tile or open drains is for removal of excess water from the soil to maintain an unsaturated crop root zone and/or to maintain a favorable salt balance in the soil. Considerations for subsurface drainage include:

Sources of Subsurface Drainage Water: Relief of water table originating on the farm and the interception of ground water flows from on or off the farm will affect the design of subsurface drainage systems.

Topography: Broad flat fields may be better suited for relief drainage while benches and swales may call for interceptor type drains. Pumping for drainage may be preferable with basin type topography underlain with good aquifer material.

Soils: Permeability, which is affected by soil texture, stratification, and structure, will affect the depth and spacing of drains. Wider spacings may allow use of open channels for subsurface drainage.

Crops: Sensitivity to salts and rooting depths of crops will affect depth and spacing of drains, in addition to soil factors.

Outlets and Conveyance: Subsurface drainage outlets should be designed to handle the maximum discharge of drainage water. Open channels and buried tile or pipeline systems are options for removing drainage water. Where elevations dictate, sumps may be used to provide adequate outlet of drainage water.

As with surface drainage systems, the downstream water quality can be protected by incorporating a tailwater recovery system into the design. Local regulations and drainage water quality may sometimes allow the return of drainage water to the stream without degradation.

DESIGN SPECIFICATIONS

The investigation for, and design of, surface and subsurface drainage systems is site specific and should be performed by experienced qualified professionals. References for drainage investigation and design criteria include:

Houston, C. E., 1967. **Drainage of Irrigated Land**. Circular 504, California Agricultural Experiment Station, University of California, Davis, California

Luthin, J. N. (editor), **Drainage of Agricultural Lands,** No. 7 in the series, Agronomy. American Society of Agronomy, Madison, Wisconsin.

Soil Conservation Service, USDA, 1973. **Drainage of Agricultural Land.** Water Information Center, Port Washington, New York.

Appendix F-5

LAND LEVELING FOR SURFACE IRRIGATION

DESIGN CONSIDERATIONS

Surface irrigation requires land over which water can flow evenly without causing erosion and which has a soil environment suitable for the planned crops. This normally requires land leveling. There are three general areas of consideration in planning and designing land leveling for surface irrigation: Site Suitability, Land Leveling Preparation, and Land Leveling Operation.

Site Suitability

1. Soil Permeability: Soils with excessive permeability, such as very sandy or gravelly soils with intake rates greater than three to four inches per hour, may not be suitable for surface irrigation and, leveling because of potentially low application efficiencies.

2. Soil Depth: The soil after leveling must be of sufficient depth to support good crop growth. In some instances, ripping, slip plowing, deep plowing, and/or the addition of organic matter and soil amendments will modify the resultant depth to where it may be satisfactory.

3. Topography: Rough topography may increase earth-moving costs to where it is impractical to level.

4. Drainage: Very permeable soils with a high water table lying within closed basins or floodways constitute serious limitations to the advisability of leveling the land.

5. Water Supply: Low available flows are not suggested for surface irrigation on very permeable soils which make the advisability of leveling questionable.

Land Leveling Preparation

1. Timing: Earthmoving should not be undertaken when the soil is moist. If it is, compaction may occur.

2. Clearing: All brush and trees should be removed. Stumps and roots should be grubbed to a depth of about six inches. It is often advisable to disk down all vegetation.

3. Rough Grading: Where relatively sharp irregularities exist, such as ditches, ridges, and hummocks, they should be reduced within reason with a dozer. This will increase the accuracy of the earthwork calculations.

4. Staking: The area should be staked on an even grid, usually 100 foot spacings, and oriented relative to the longest straight side of the field. The first row of stakes should be one-half the grid spacing from this field side. Where a sharp break in topography occurs, it would be advisable to place at least one additional stake, usually at half the grid spacing, in the grid at the topographic break.

5. Surveying: The relative elevations of all grid corners must be determined by surveying or laser methods. The spot for rod readings should be selected to represent the average elevation near the stake.

6. Base Map: A base map should be prepared showing field boundaries, all grid stations, and the original and final elevations and cut or fill at each station. Contours should be drawn at reasonable intervals.

7. Areas of Separate Leveling: If the entire field should not be leveled as a unit, as determined by inspection from the base map considering relatively sharp changes in topography, the separate units should be identified on the base map.

8. Earthwork Calculations: The depth of cut or fill at each grid station is calculated by conventional methods or with a computer. Factors to be considered are irrigation slope, cross slope, appropriate cut-fill ratio, amount of borrow necessary to fill any large depression, and amount of waste necessary to build a roadway or ditch pad. The slope factors are determined by the soil limitations and the planned crop. The cut-fill ratio is estimated considering the soil type and type of equipment to be used. The waste and/or borrow is estimated or calculated.

9. Posting: The cut or fill is posted on each grid stake. The level for fill is indicated with blue crayon or paint from the ground surface, and the depth of cut is indicated with red crayon or paint from the top of the stake. A station at finish grade elevation should be indicated by a red or blue circle.

Land Leveling Operation

1. Selection of Contractor: The contractor selected should be one with experience and the proper type and amount of equipment to accomplish the leveling operation in a timely and dependable manner. A written contract stating all requirements should be executed. (Note: Laser Leveling is also a widely used practice on irrigated fields.)

2. Grade Tolerance: The grade tolerance at each grid station should be 0.1 foot for finish slopes less than two percent and 0.2 foot for slopes greater than two percent. All construction work should be checked prior to acceptance.

3. Planning: After land leveling is completed, the leveled surface should be planed in both diagonal directions, and finally, in the direction of irrigation.

DESIGN SPECIFICATIONS

The design specifications should be prepared by an experienced qualified professional. An experienced person should also perform the inspection during construction. The following references are sources for design specifications:

Marr, James C. 1957. **Grading Land for Surface Irrigation.** Circular 438, California Agriculture Experiment Station, University of California, Davis.

Soil Conservation Service, 1970. **SCS National Engineering Handbook, Section 15, Chapter 12.** United States Department of Agriculture, Washington, D.C.

Appendix F-6

LAND SMOOTHING

DESIGN CONSIDERATIONS

Land smoothing may be appropriate for surface or sprinkler irrigation. It is often necessary prior to land leveling. The important considerations for land smoothing are indicated in the following steps:

1. Clearing: The areas to be smoother should be cleared of brush and trees and grubbed of stumps and large roots.

2. Construction: The gullies and closed depressions should be filled and ridges reduced to a uniform topography so that complete surface drainage is achieved without concentration of runoff water. A dozer or earthmover will probably be required.

3. Planning: Finish land planning or floating should be performed following smoothing. If a landplane can be used, the size (length) will be determined by the height and areal extent of the remaining ridges.

APPENDIX G - AGRICULTURE

LIVESTOCK MANAGEMENT

G-1 RIPARIAN IMPROVEMENT GRAZING STRATEGY
G-2 SAMPLE GRAZING SYSTEMS
G-3 PROPER GRAZING USE GUIDELINES
G-4 GUIDE FOR CONSTRUCTING STOCK TRAILS
G-5 STOCKWATER DEVELOPMENT GUIDELINES
G-6 FENCING GUIDELINES
G-7 BRUSH MANAGEMENT GUIDELINES

Appendix G-1

RIPARIAN IMPROVEMENT GRAZING STRATEGY

The following is designed to provide information on how to develop a grazing strategy to improve your riparian and wetland areas.

No one knows better than the people who move the stock that grazing western rangelands is a complicated business. The more one learns about livestock ecological inter-relationships the more complex it gets. However, complexity should not impeed business, the repair of riparian and wetland areas, or the protection of water quality.

The kind and degree to riparian and wetland grazing problems vary from site to site. However, there are a few simple common denominators which apply universally. These denominators are:

Livestock follow the green;

Riparian vegetation typically is quite different than plants on adjacent uplands; and,

Grazing strategies targeted exclusively on grasses may result in severe overgrazing of riparian areas and conversely too little upland vegetation in a riparian pasture may also result in overgazing.

These are two principles which must be followed to protect and/or restore wetland and/or riparian areas. These are:

1) exclude livestock from the riparian area with stream corridor fencing; or,

2) use other grazing strategies to limit the season, duration, and intensity of grazing on riparian areas. (i.e. develop alternate water sources; alter pastures, etc.)

The first step in developing a riparian improvement grazing strategy is establishing an objective. If rangeland watersheds are overstocked they will be overgrazed. Long-term productivity will deteriorate, no matter how well you manage your livestock. From a riparian/water quality perspective, how many head can be less important than where, when and for how long as livestock tend to concentrate in and overuse riparian areas at certain times of the year.

Management options to protect your riparian/wetland areas include stream corridor exclosures, riparian pasture management; and livestock management on both riparian and upland pastures. Each management option may require increasing levels of expertise.

However, any successful riparian grazing strategy will at minimum:

Limit grazing intensity and season of use to provide sufficient rest to encourage plant vigor, regrowth, and energy storage;

Ensure sufficient vegetation during periods of high flow to protect streambanks, dissipate stream energy and trap sediments;

Control the timing of grazing to prevent damage to streambanks when they are most vulnerable to trampling.

A basic grazing strategy can be derived by answering a few simple questions:

1) Which plants will grow and reproduce on each site? Which plants do you want to encourage; when do they put on new growth, produce shoots or seeds, store energy, become dormant?
2) When livestock are in the riparian areas, what plants do they prefer at different times of the year? When livestock are not in the riparian area, where are they and what plants do they prefer? When livestock are in the riparian area, are they under-utilizing upland vegetation?
3) What time(s) of the year are streambanks and riparian areas under most stress from high flows? When are streambanks most vulnerable to damage by livestock trampling?

The answers to these questions will get your thought process going, and help narrow options to those most likely to help you achieve your specific riparian improvement objectives.

Appendix G-2

SAMPLE GRAZING SYSTEMS

The idea of three pasture rest-rotation grazing is to put a number of cattle into a unit, graze it uniformly, move the cattle and progress accordingly to the other units. This is one of the most popular generic rangeland grazing strategies. Typically, rest rotation grazing provides for grazing a pasture in spring the first year, summer the second and no grazing the third year.

The basic theory is to graze cool season grasses early and heavy the first year and then give them the summer to recover, produce seed, and store energy in roots. The second year, the grasses are rested until after the seed ripens, then grazing is initiated. The third year the unit is rested.

Warm season grasses are grazed lightly early the first year, heavy the summer of the second year, with total rest the third year. With attention to the degree of plant utilization, this grazing strategy has produced good results for upland grasses. A full year's rest the third year allows cool and warm season grasses to build root reserves and litter.

Generally practiced, this strategy is good for sedge-rush-grass communities. It often is detrimental to riparian tree seedlings and brushy species, especially willows. Livestock can consume two or three years growth in one summer grazing period. Close attention to woody species utilization generally is necessary for this grazing strategy to result in improved condition of brushy riparian vegetation especially where willows are limited.

Grazing plans as shown in system #1-#3 are good management practices.

System #1: Two Unit - Summer Range - Alternate year rest.

1st Year		2nd Year	
Unit #1	Unit #2	Unit #1	Unit #2
Rest	Graze	Graze	Rest

Begin Grazing the unit when key vegetation* is ready. Remove livestock when proper range utilization is attained and provide total growing season rest for grass species every other year. Spring grazing may help ailing riparian woody vegetation while summer and fall grazing is potentially harmful to riparian shrubs and tree seedlings. Under proper management, this grazing strategy may maintain or improve low gradient grass/sedge riparian areas, but depending upon

duration and timing it may be detrimental to reestablishment of shrubs and woody vegetation. Repeat, beginning with the first year to make the two pasture rest system continuous.

*Key vegetation includes the plant species to be managed for in the unit.

System #2: Three Unit - Summer Range - Rest every third year.

	Unit #1	Unit #2	Unit #3	
1st year	Rest	1st	2nd	Begin grazing when the key vegetation* has sufficiently developed which may vary by plant species.
2nd year	2nd	Rest	1st	Unit #1 is rested for the entire first year and during the first half of the second year.
3rd year	1st	2nd	Rest	Move livestock when proper use of vegetation is reached in the units.
4th year	Rest	1st	2nd	Repeat beginning with 1st year to make system continuous.

Generally when the soil is firm plants have had an opportunity to make good growth. Early maturing grasses should have seed heads and others should be at least six inches tall.

*Key vegetation includes the plant species to be managed for in the unit.

System #3: Four Unit - Rest one year of four

	Unit #1	Unit #2	Unit #3	Unit#4
1st Year	Rest	Graze Spring	Graze summer	Graze Fall
2nd Year	Graze Fall	Rest	Graze Spring	Graze Summer
3rd Year	Graze Summer	Graze Fall	Rest	Graze Spring
4th Year	Graze Spring Summer	Graze	Graze Fall	Rest

Spring - Allow vegetation readiness - four to six inches high depending on species managed.

Summer - Vegetation possibly mature and in seed head.

Fall - Vegetation at seed maturity.

Analysis of the four pasture system indicates that after each pasture is rested, the next two years allow for grazing when vegetation is mature. A four pasture system should meet all livestock and vegetation requirements. Five pastures are even better, allowing for seed maturity and new seedling development. One of the hazards of spring and early summer grazing is the trampling and the displacement of new seedlings by livestock.

Rest-Rotation grazing systems work best where the units are nearly equal in carrying capacity. At a minimum, each unit must have enough capacity to feed the number of cattle over its required part of the grazing season. Each unit should reach vegetative readiness at approximately the same time or each pasture should have enough early feed to hold until higher elevation vegetation has a chance to develop to the state of range readiness.

Early Grazing

Graze early during the grass growing season; early spring in cool season areas, early summer in warm season areas. This strategy usually results in good dispersal of cattle and minimizes use of riparian woody plants. Additionally, herbaceous plants are allowed to rest during most of the critical late growing period which promotes plant vigor, seed production and energy storage in roots. It is important to note that early foliage growth is from root reserves and heavy grazing every year at this time can seriously damage preferred plants.

The early grazing strategy has potential to improve riparian wood vegetation. Utilization of grasses must be carefully controlled. In may areas, wet streambanks may be susceptible to trampling damage under this grazing strategy; potential may be minimized due to good dispersals of cattle.

Riparian Exclosures/Irrigated Pastures

Repairing damaged riparian areas within intensively managed irrigated pastures presents a special management challenge. A typical approach is to place the riparian area in a separate pasture with special management standards, or to exclude livestock from the riparian area. Corridor fencing can be integrated into a new system of pastures to allow better management and increased livestock forage, while improving water quality and the aesthetic and future economic values of the ranch.

References

Soil Conservation Service, USDA, 1976, **"National Range Handbook"**, Washington, D.C. **Livestock Grazing on Western Riparian Areas**, U.S. Environmental Protection Agency 1993.

Appendix G-3

PROPER GRAZING USE GUIDELINES

Key Grazing Areas and Key Species

Each pasture or grazing enclosure is a management unit for grazing land. Every unit has different characteristics of soil, topography, size, location of water, etc. that will influence distribution of grazing. While it is not practical to prescribe grazing use for all parts of a grazing unit, key grazing areas within each unit should be selected for planned grazing in order to meet the needs of the plants in the key areas. When the key grazing areas are properly grazed, the pasture as a whole will not be excessively used as long as key grazing areas in each grazing unit have been properly selected.

Most plant communities in a pasture consist of several plant species in varying densities. The entire plant community is of concern to proper management, but it is not practical to obtain desired use of all plants. It is more practical to select a single species to serve as a guide for utilization of the entire plant community. If key species are properly utilized, the entire plant community will not be excessively grazed, although minor constituents may.

Selecting Key Grazing Areas

1. Key grazing areas should be selected after careful evaluation of the current pattern of grazing in the pasture.

2. The areas selected should provide a significant amount of the available forage in the unit but not necessarily the major amount.

3. Key areas should be representative because of factors such as topography, nearness to water, and other favorable factors that influence grazing distribution. Areas of concentration, such as around watering facilities, shade or salt, should not be selected as key areas, nor should areas remote from water or with limited accessibility.

4. It may be necessary to select new key grazing areas when the grazing pattern is significantly altered by changes in season of use, class or kind of livestock, water developments, fencing or other factors that affect grazing distribution. Distribution of livestock use can be altered by providing expanded watering sources using solar and ram pumping systems.

Selecting Key Species

1. Key species should be palatable during the planned grazing season and preferred over associated species by the type of animals being grazed.

2. Key species should provide 15% or more of the readily available forage in the key grazing area. A species providing less than 15% of available forage can be used as a key species if it has a potential for greater production or is critical to the needs of the grazing animals.

3. Key species selected must be consistent with the management objectives for the plant community. These might include: (a) Maintaining a near-climax plant community; (b) Restoring near-climax conditions; or (c) Perpetuating a plant cover somewhat different from near-climax conditions. For (a) and (b), the key species should be a major component of the climax plant community.

Degree of Grazing Use

The objective of grazing management is to maintain or improve the plant community for protection of soil and water resources and to maintain or increase production of renewable forage resources through proper grazing use. The proper degree of use for key plant species is a guideline or reference point to be used in evaluating the condition of the plant community. Determining the trend in condition of the plant community is the major concern.

1. Specifications for the proper degree of use of native species should be based on locally adapted research data or local experience.

2. Research and experience indicate that the amount of grazing use that native plants can tolerate varies according to the kind of plant, season of use, soil, climate, plant vigor and amount of use to which competing plants are subjected. In general, research and experience show that most native herbaceous forage plants remain vigorous and productive if 50% by weight of the annual production remains at the end of the growing season.

3. If grazed during the dormant season, use should generally not exceed 60% by weight of the annual growth of key grasses and forbs.

4. Generally not more than 65% by weight, of the current year's growth of browse species should be used.

5. A significantly greater percentage of annual growth may be safely removed from some native plant species if pastures are grazed at high intensity for short periods and completely rested for longer periods.

6. The degree of use should be changed by managers if range condition trends indicate a need for more or less use.

The use of record forms (pages G-12 through G-17) like, or similar to, those on the following pages provide a means of recording degree of use for key plants and are helpful management tools in carrying out a program of proper grazing use.

RIPARIAN GRAZING USE

In planning riparian use some common sense observations are:

Each watershed, stream, stream reach, and riparian area has unique characteristics that must be accounted for in developing a grazing strategy to improve degraded riparian conditions and water quality.

No one grazing strategy fits all conditions. Any off-the-shelf grazing strategy likely will have to be modified to fit your specific condition, and updated as conditions change.

A grazing strategy is only as good as the management that goes into it. A high level of management can make almost any grazing strategy work. A low level can make almost any strategy fail.

Riparian exclosures and riparian pastures reduce management complexity and enhance the odds and speed of achieving riparian improvement objective.

When grazing riparian areas within upland pastures, one or both of the following management techniques probably will have to be added to your grazing strategy to improve degraded riparian areas:

1. Provide water, salt, supplemental feed away from riparian areas.

2. Herd to limit livestock use of riparian areas.

3. Initiate grazing when upland vegetation is palatable.

4. Grazing with a large herd for a short time may increase distribution.

MONITORING RESULTS

It's important to monitor on a continuous basis the effects of changes in grazing management to check progress toward long-term objectives.

Some riparian and wetland areas will recover fast while some sites will be slow to recover. Responses important from a water quality perspective may be gradual and only become obvious over time.

Ranchers typically keep detailed records on animal performance from year to year. Therefore, it would not be difficult for the rancher to record how key plant species, the overall riparian area and stream, and key upland plants respond to changes in grazing management.

Another method to monitor results is to take annual photographs of the same representative areas. Establish a few photo points (easily accessible, easily recognizable, permanent landmarks) from which to shoot each years photos. Supplement to photo albums with notes on your observations of the condition and trend of riparian vegetation, streambanks and stream channel. Don't forget to do the same for key upland sites.

Over time these records will clearly reveal progress or lack of it, toward long term objectives that may not be readily apparent at any given point in time.

References

Soil Conservation Service, USDA, 1976, **"National Range Handbook"**, Washington, D.C. **Livestock Grazing on Western Riparian Areas**, U.S. Environmental Protection Agency 1993.

INSTRUCTIONS

PROPER GRAZING USE - GRASSES AND FORBS

Grazing Unit: Enter in this column the name or number of the pasture or field.

Acres: Enter in this column the acreage of the grazing unit.

Species of Grazing Animal: Enter in this column the species and class of livestock being grazed such as: dry cows, cow-calves, ewes and lambs, yearling cattle, two year steers, yearling sheep, goats, deer, and horses.

Season of Use: Enter in this column the season that the unit will be grazed, such as: fall, winter, spring, summer, or by month: September-October, November-March, etc.

Location of Key Grazing Area: Enter in this column a description of the key grazing area. This may be a range site or it may be a portion of a site, or possibly a particular location within the grazing unit such as: South West portion of grazing unit starting about 200 yards from pond to fence.

Key Plant(s) for Judging Proper Grazing Use: Enter in this column the species by common name on which proper grazing use will be judged. There may be occasions when you will select two species; in that case enter the name of both species.

Planned Use of Key Species at End of Grazing Period: Enter in this column the percent by weight of the current year's growth of the key species that should be left ungrazed at the end of the grazing season.

Estimated Use of Key Species by Weight: Enter in this column by calendar year the estimate of the actual use the grazing unit received. This estimate should be based on the key species on the key grazing area, at or near the end of the grazing period, or on year-long grazing, just prior to the next growing season.

FIGURE G-1 (GRAZING.USE)
PROPER GRAZING USE

JUDGING UTILIZATION, TREND AND CONDITION OF BROWSE PLANTS

REPRODUCTION

1. For Key Species Three categories as follows:

Adequate:	Sufficient seedlings and young plants to maintain or increase status of species in the community.
Some but Inadequate:	Some seedlings and young plants present, but not enough to maintain status of species in the community.
Little or None:	The species is not reproducing. Plants mostly mature or decadent. Few or no seedlings and/or young plants.

2. For Low Quality Species Three categories as follows:

Excessive:	More seedlings and young plants than required to maintain species in the community. Species obviously increasing.
Adequate:	Sufficient seedlings and young plants to approximately maintain status of species in the community. Stable population.
Little or None:	Very few seedlings or young plants becoming established. Species is declining in the community.

INSTRUCTIONS FOR JUDGING UTILIZATION OF BROWSE PLANTS

CURRENT GROWTH

1. Utilization during the growing season: Proper use is when 50 percent by weight or less of the available twigs, leaves, and fruits have been removed during the growing season.

2. Utilization during the dormant season: Proper use is when 65 percent by weight or less of available twigs of deciduous species, or twigs and leaves of evergreen species have been removed.

(NOTE: These percentages could be used unless local research indicated otherwise. The above percentages are determined on the basis of weight of current year's growth as determined by ocular estimates or a combination of harvest and estimates.)

CHECKING TREND AND CONDITION OF BROWSE PLANTS

EVIDENCE OF PAST YEAR'S USE

1. Hedging Three categories as follows:

Not Evident	Little or no evidence of hedging of plants.
Moderate	Up to half the plants plainly show evidence of hedging.
Severe	More than half the plants plainly show evidence of hedging.

2. Browse Line Three categories as follows:

Not Evident	No browse line distinguishable from a distance. Production on lower twigs similar to that of twigs beyond reach of animals.

	Moderate	Browse line apparent from a distance, but lower twigs still reasonably productive.
	Very Apparent	Browse line strikingly evident. Little or no production on twigs within reach of animals.

Bitterbrush (NOTE: Browse lines may be permanent with some species such as Antelope and may actually reflect historical grazing management.)

FIGURE G-2 (FIG J2.PCX)
JUDGING UTILIZATION, TRENCH, AND CONDITION OF BROWSE PLANTS

Appendix G-4

GUIDE FOR CONSTRUCTING STOCK TRAILS

Stock trails are often needed to obtain better livestock distribution and to provide access to water where steep slopes, rimrocks, rock slides or other obstacles impede livestock movement.

Guidelines and Specification

1. Do not construct trails through critical erosion areas.

2. Trails should be at least two feet wide.

3. Bridges crossing gullies should be at least six feet wide.

4. Maximum grade for trails should be 20% except for short distances to bypass barriers or danger areas. Every effort should be made to keep trails less than 20%, particularly in areas of live streams or canyon crossings.

5. Locate trails to avoid switchbacks if possible.

6. Install waterbars, drains or other structures as needed to control runoff and erosion.

7. Avoid canyon bottoms or draws where possible.

8. Revegetate critical areas created by construction. (See Critical Area Planting Guide)

Appendix G-5

STOCKWATER DEVELOPMENT GUIDELINES

Spring Development

Fracture and Tubular Springs: Where water issues from fractures, the individual openings should be cleaned and enlarged as needed to provide an increase in flow. The water from these individual openings should be collected and conveyed to a central sump or spring box by means of a tile or perforated pipeline or by a gravel filled ditch. The collection works should be below the elevation of the openings to permit free discharge.

Where water issues from a single opening, such as solution channels found in rock formations or tunnels in lava, the opening should be cleaned or enlarged as needed. A collection system usually will not be needed, but a spring box or sump should be installed. The spring box or sump should be low enough to prevent ponding over the spring opening.

Perched or Contact Springs: Perched or contact springs occur where an impermeable layer outcrops beneath a water-bearing permeable layer. These springs should be developed by intercepting and collecting the flow from the water bearing formation. Collection trenches are used for developing these types of springs.

Artesian Springs: Artesian springs should be developed by removing obstructions, cleaning or enlarging joints or fractures, or by lowering the outlet elevation. Sumps and spring boxes should be located so as to hold ponding over the spring outlet to a minimum.

Spring Collection Systems: Where a collection trench along the outcrop of the waterbearing formation is to be used, the trench should be excavated into the pervious layer.

An impervious cutoff wall of well tramped clay, masonry, concrete or other suitable material should be constructed along the downstream side of the trench where needed to direct the flow into the collection system.

The collection system should consist of a drain tile, perforated pipe, or a wood box drain enclosed in a sand-gravel filter. A crushed rock or gravel backfill, not less than 12 inches deep, can be used in lieu of these types of drains. The collection system should outlet into a spring box.

Spring Boxes: Spring boxes should be made of durable material and have a tight, removable cover. The boxes should have a minimum cross sectional area of 1-1/2 square feet.

The floor of the spring box should be at least six inches below the outlet of the collection system.

Spring boxes for perched springs should be floored with concrete or other stable impervious material unless the natural underlying material is solid and impervious.

Spring Outlets: The outlet pipe from a spring box should be placed about six inches above the floor of the box to provide a sediment trap. The outlet should not be high enough to create a head on the spring that would reduce flow. The outlet pipe should be installed with a watertight connection to the spring box. Measures required to protect the development from damage by freezing, flooding, sedimentation, contamination and livestock should be included in the design. The water should be piped into tanks or troughs suitable for livestock use.

Natural Resource Considerations: With any spring development natural resource considerations should be incorporated into the project design. Sufficient water should be left at the spring to maintain riparian vegetation and for wildlife resources. If the spring will only be used a portion of the year for livestock watering the spring development should be designed to allow water to remain at the spring site during periods of non-use. All livestock watering troughs should be constructed in a manner which provides wildlife escape routes. Spring developments must be well maintained and periodically inspected.

Wells

The feasibility of development and type of well installed should be based on reliable local experience or on detailed investigations including test wells and geologic and hydraulic analysis. All well development must be conducted in accordance with federal, state and local regulations.

Casing and Materials: Wells should be cased, except that the lower section of a well passing through consolidated strata does not require casing. Installation and construction must comply with county codes and state water laws.

Screens: All wells finished in unconsolidated aquifers should be equipped with manufactured screen sections, well points or field perforated sections. The screen openings for aquifer material of near uniform size should be slightly smaller than the average diameter of the aquifer material. For graded aquifer materials (of non-uniform gradation), the screen openings should be such that 25 to 40 percent of the aquifer material is larger than the screen openings. In wells using a gravel pack envelope, the screen should have openings of a size that will exclude at least 85 percent of the gravel pack material. The length of the screen should be sufficient to maintain the entrance velocity of water into the well at an acceptable level.

The position of the screen in the well will be governed by the depth of the aquifer below the ground surface and the thickness of the aquifer penetrated by the well. Where practical, the top elevation of the screen should be below the lowest water level expected during pumping and located opposite the most permeable areas of the water bearing strata.

Gravel Pack: Filter packs should be used in wells developed in strata composed of fine material of relatively uniform grain size to prevent aquifer materials from passing through the well screen or perforated casing. The pack should be 3 to 12 inches thick and should be composed of sand or gravel material with a grain size 5 to 12 times that of the strata material.

Well Installation Requirements

Alignment: Drilled wells should be round, plumb and aligned so as to permit satisfactory installation and operation of a pump of the desired size and type, at the grids anticipated depth of setting.

Casing Installation: In consolidated formations, the casing should extend from the ground surface through the overburden material to an elevation at least two feet into the consolidated foundation.

In unconsolidated formations, the casing should extend from the ground to the screen. For artesian aquifers, the casing should be sealed into the overlying impermeable formations to retain the artesian pressure.

When a formation bearing water of poor quality is penetrated, the formation should be sealed off to prevent the infiltration of poor quality water into the well and the developed aquifer.

Plastic well casing should be equipped with a steel driving shoe and be placed with as little driving as possible.

Protection: All wells should be sealed at the ground surface to exclude the entrance of surface and near surface water. The State of Nevada has regulations which govern water wells and related drilling. These regulations are administered by the Division of Water Resources, State Engineers Office (NRS Chapter 534). Water should be piped to tanks or troughs suitable for livestock use.

Ponds: When free flowing springs are not available and the ground water situation is such that well drilling is not feasible it may be possible to develop stockwater with ponds in draws or canyon bottoms. The general types of ponds are used, embankments ponds and excavated ponds. An embankment pond is created by constructing a dam across a stream or waterway. An excavated pond is created by digging a pit or dugout. On some sites a combination of excavation and dam construction is used. Ponds often supply water only for seasonal use. **(Note: If the pond will impound greater than or equal to 20 acre feet of water, a permit may be necessary. Contact the State Engineers Office.)**

Embankment Ponds

1. **Dams should be designed by a qualified engineer and must meet requirements of State statutes and recognized water rights.**

2. The pond site should be located so excess runoff can be safely passed through a natural or constructed spillway.

3. Topography and soils of the site should permit storage of water at a depth and volume adequate to meet needs of the intended use. Soils should be impervious or of a type that sealing is practical.

4. Water should be piped through the dam to livestock troughs or tanks and the dam and pond area fenced.

5. Where precipitation is adequate, the dam and disturbed areas should be revegetated. (See Appendix E-1, "Critical Area Planting Guide".)

6. Where surface runoff is the main source of water, the pond should be located where the contributing drainage area is large enough to yield sufficient runoff to meet the intended use.

Excavated Ponds

1. Excavated ponds may be fed by surface runoff or ground water aquifers.

2. Ponds fed by surface runoff can be located on almost any type of topography, but are most satisfactory in areas of comparatively flat terrain in broad natural drainage ways.

3. Excavated ponds fed by ground water are located where shallow underground water exists or where there is a permanent water table within a few feet of the surface.

4. Excavated ponds fed by surface runoff should be located on relatively impervious soils. Ponds on porous soils must be sealed.

5. Locations with favorable discharge conditions for overflow waters should be selected. Sites where overflow escapes through natural drainageways are desirable.

6. Excavated ponds can be constructed in almost any shape but a rectangular shape is usually most efficient.

7. Pond size should be adequate to provide the amount of storage needed for the intended use.

8. Side slopes should normally be 2:1, but certain soils may require flatter slopes. A ramp with

a slope of 4:1 or flatter should be provided at one or both ends for livestock access. The ramps should be designed to minimize soil erosion and damage to the structure by livestock.

9. Excavated material should be placed where it will not endanger stability of pond side slopes or be washed back into the pond.

10. Except for access, ramps, the pond area should be fenced. Where feasible, excavated material should be revegetated. (See Critical Area Planting Guide)

Pipelines

Pipelines can be used to convey water from an established source to parts of the range without a water supply. With an adequate water supply, a number of watering facilities can be placed along a pipeline. Where possible, facilities should be located about one mile apart. If water from the pipelines is likely to be used for human consumption, the installation must meet requirements of State and County health agencies.

1. Pipelines should have the capacity to provide a minimum of 12 gallons of water per day per head for beef cattle or horses, and 1 1/2 gallons per head for sheep and goats at each facility serviced by the pipeline.

2. Pipelines should be placed so they are protected from traffic hazards, farm operations, freezing or soil cracking.

3. Trenches for plastic pipe should be free of rocks. The pipe should be placed in a snakelike fashion.

4. Valves should be placed at low points so the line can be drained as needed.

5. Vents are usually required for removing air from the system.

6. Watertight joints should have a strength equal to the pipe. Couplings should be of material similar to the pipe or well insulated.

7. Pipelines should be tested for several days after installation and all visible leaks repaired.

8. Properly designed tanks and troughs for livestock watering should be located at each facility.

Hydraulic Rams

A hydraulic ram is a pump operated by water power. It uses the power developed by a given quantity of falling water to force a much smaller quantity to an elevation above the source of supply. Hydraulic rams can be used for livestock water facilities along streams where livestock access to the stream is difficult or where streambanks must be protected from livestock due to critical erosion problems, or other sources of continuous supply.

The following data is needed to design a hydraulic ram installation:

1. Fall in feet from source of supply to the site of the ram.
2. Pipe length to conduct water from source to the ram.
3. Height in feet water is to be raised - vertical distance between the ram and the delivery point.
4. Supply of water available to the ram in gallons per minute.
5. Length of pipe required to conduct water from the ram to the delivery point.
6. Volume of water required in gallons per day.

The following data is needed to design a solar pumping system:

1. Well depth or description of water source.
2. Depth to water surface: Does it vary? If so, how much?
3. Yield of well estimated in gallons (or liters) per minute.
4. Total vertical lift from water surface to storage tank or pipe outlet.
5. Size of well casing (inside diameter).
6. Quality of water: Is it clear, silty or mineralized?
7. Water requirements in gallons (liters) per day, according to season.
8. Application for water: Home? Livestock? Irrigation?
9. Is pressure required for home, sprinkling?

10. Can a storage tank be easily located higher than the point of use?

11. Is the pump to be located near a home/battery system? Distance?

12. Elevation above sea level (to determine suction limitation).

13. Geographical location of system.

14. Solar access is unobstructed sunlight available near water source? If not how far?

15. Complex terrain? Draw map or diagram.

16. Describe existing equipment for pumping, distribution, storage, etc.

17. Is this system to be the only source of water available.

Guide to Estimating Water Requirements:

Large Livestock (Cattle):	10 gallons (40 liters) per day in dry weather.
Small Animal:	1/4 gallon per day per 25 lbs of body weight (1 liter per 10 kg.).
Poultry:	6-12 gallons (20-50 liters) per day hundred birds per day.
Young Trees:	15 gallons (55 liters) per day in dry weather.
NOTE:	These figures will vary with ambient temperature.

Appendix G-6

FENCING - GUIDELINES

Fences are needed in a number of land treatments for water quality management:

1. To exclude livestock, wildlife and federal horses from critical erosion areas, areas of toxic wastes from mining or other industry, and from critical riparian zones.

2. To control access of vehicles and people to critical erosion areas and danger zones.

3. To subdivide grazing lands and regulate grazing use.

4. To protect revegetation planting during the establishment period.

PLANNING CRITERIA

1. Design fence to meet the specific objectives of the project.

2. Where legal fences are needed, they must meet the requirements of State Statues of Nevada and the Federal land manager.

3. Select fencing materials on the basis of availability, cost, soil conditions, and objectives of the fence.

4. Where possible, avoid snowdrift areas, erosive soils, steep slopes and game migration routes.

5. Make maximum use of natural barriers.

6. Avoid creating livestock and wildlife traps; fences should not point in at sharp angles to other fences or natural barriers.

7. Fence lines should be clear of brush and trees.

8. Special provisions should be made where wildlife crossings are needed. Consult game management specialists.

STANDARD GUIDELINE SPECIFICATIONS

1. Space posts a maximum of 20 feet apart (wood posts for suspension fences a maximum of 120 feet).

2. Post sizes - wood posts six feet long with a three inch top diameter (corner posts seven to eight feet long with a five inch top); steel posts 5-1/2 feet long; 1-1/3 pounds per foot and with anchor plate. Wood posts, except juniper, should be butt-treated. Set posts 1-1/2 to two feet deep. Where higher fences are needed, longer posts will be required.

3. Brace post assemblies should be placed:

   (a) 1320 feet apart in a straight line fence on moderate terrain.
   (b) At each gate.
   (c) At each turn of 15 degrees or more.
   (d) At each point of change in the vertical angle of 10 degrees or more.

4. Barbed wire should be heavy duty galvanized, minimum gauge 12-1/2 with a minimum of four wires spaced 12 inches apart, top wire a minimum of 42 inches above the ground and bottom wire a maximum of 12 inches above the ground, except where passage of wildlife under the fence is desired.

5. Woven wire should be heavy duty galvanized with a minimum of one strand of barbed wire on top at a minimum of 42 inches above the ground. Chain-link fencing can also be used. High fences may be needed for certain uses.

6. Staples should be nine gauge or heavier, 1-1/2 inches long (2-1/2 inches for suspension fences.)

7. Use wire stays spaced 10 to 16 feet apart between posts on suspension fences. Special metal clips can be used in lieu of staples on suspension fences.

8. Electric fences can be used where temporary exclusion of livestock is needed, such as in range seedings.

9. Consider the use of solar electric fences when temporary fencing is needed to restrict use in critical riparian zones.

Appendix G-7

BRUSH MANAGEMENT GUIDELINES

Mechanical, chemical and biological procedures and controlled burning are used singly or in combinations depending upon the site specific factors of the treatment area. Site specific factors may include land use, topography, woody plant species (sprouters or non-sprouters), treatment hazards, plant species size, density and distribution, treatment objectives and costs.

The use of non-chemical treatments is advised whenever it is feasible and practicable. The amount of land disturbance and resulting sediment transport should be considered. Phenological development of the plant species being controlled and of the plants being favored is of prime importance. Select the time when plants to be controlled are most vulnerable to the specific treatment. For growth regulating chemicals, this is a time of most active growth. Mechanical treatment is most successful just prior to seed maturity when root reserves are lowest.

Brush Management Planning Techniques -

* Defer grazing prior to brush management activities that are designed to improve the resident forage species.

* Tailor grazing management to favor the key species following brush management.

* Leave sufficient herbaceous plants, shrubs and trees to maintain desirable wildlife habitat, migration and escape routes.

* Provide for preservation of natural beauty to the fullest extent possible. This could include strategically located and irregularly shaped patches, avoiding rectangular shapes.

* Provide view barriers of untreated land 100 to 200 feet wide along major roads and perennial streams.

Brush Management Treatments -

Plowing -

* Adaptation: Low shrubs on sites planned for seeding.
* Equipment: Disk or moldboard plow; heavy offset disk, root plow.
* Dates: Late spring to early fall before shrubs have matured seed. Soil should be dry enough to prevent regrowth of partly covered plants.
* Operation: Plow below root crown. Operate disk at a sharp angle. Repeat as necessary.

Chaining -

* Adaptation: Pinyon, juniper, or sagebrush stands that are predominantly mature and brittle. Less effective on young, limber plants or those that resprout. Adapted to sites that will be seeded or for improvement of native range with less than a full stand of forage plants.
* Equipment: A 70 to 90 pound anchor chain, modified by welding rails to each link and installing swivels on each end.
* Dates: Same as for plowing.
* Operation: Pulled between two tractors, twice over in opposite or diagonal directions. May be broadcast or drill seeded between operations.

Beating -

* Adaptation: Stone-free sites with low shrubs that do not readily resprout. Not adapted to rabbitbrush, snowberry, silver sagebrush, three-tip sagebrush or Anderson peachbrush. Adapted to sites that will be seeded or managed for natural improvement.
* Equipment: Flair beaters or circular cutters.
* Dates: Same as for plowing.
* Operation: Cut as near ground level as possible. Adjust travel speed to brush conditions.

Controlled Burning - **NOTE: Please see BMP 7-2**

* Adaptation: Big sagebrush or other non-sprouting brush or trees on sites planned for seeding. Heavy stands of nonsprouting shrubs or trees with good understory of desirable forage plants.
* Equipment: Farming or land grading machinery to prepare firebreaks; weedburners.
* Dates: Brush should be burned in mid or late summer after understory is dry but before brush seed has been dispersed. Grass root reserves should be high after seed maturity. Cheatgrass should be burned in late spring just prior to seed maturity. NOTE: It is imperative that the necessary state and local burning permits are obtained prior to burning activities.
* Seeding: Seed burned areas as soon as possible after burning.

Chemical -

* Use only approved chemicals as regulated by the Nevada Division of Agriculture.
* Apply in accordance with pesticide labeled use registered with the Nevada Division of Agriculture. Always read the label on the pesticide container before using the material. **NOTE: Please see BMP 7-7 and BMP 10-8.**

Biological -

* Introduction and fostering of the target plant species natural enemies and competitor's.

APPENDIX H - FOREST RESOURCE MANAGEMENT

H-1 STANDARD FOREST PRACTICES RULE
H-2 WILDLAND/URBAN INTERFACE MANAGEMENT
H-3 FUELS MANAGEMENT

Appendix H-1

AMENDED FOREST PRACTICE RULES

Standard Forest Practice Rules

ARTICLE 1. INTRODUCTION

1.0 Statement of Purposes: The purpose of these rules is to establish standards in accordance with the policies set forth by the Nevada Revised Statutes. Rules promulgated herein apply to all timber lands and are to be used with exceptions for the zone where practice is to be applied. The rules are not intended to result in taking of private property for public use without payment of just compensation.

ARTICLE 2. DEFINITIONS OF TERMS

2.0 Definition of Terms: In these rules the following definitions shall apply, unless the context clearly requires otherwise:

2.1 Basal Area Per Acre. "Basal Area Per Acre" means the sum of the cross-sectional areas of the tree measured at 4.5 above the ground (dbh) diameter per acre.

2.2 Commercial Species: "Commercial species" means the following: Ponderosa Pine (Pinus Ponderosa), Jeffrey Pine (Pinus Jeffreii), Pinyon Pine (Pinus Monophylla), White Fir (Abies Concolor), Douglas Fir (Pseudotsuga Menziesii), Utah Juniper (Juniperus Osteosperma), Tamarisk (Tamarisk sp.), Sugar Pine (Pinus Lambertiana), Red Fir (Abies Magnifica), Western White Pine (Pinus Monticola), Mountain Hemlock (Tsuga Mertensiana), Incense Cedar (Libocedrus Decurrens), Western Juniper (Juniper Occidentalis), Aspen (Populus Tremuloides), Cottonwood (Populus sp.), Limber Pine (Pinus Flexilus), White Bark Pine (Pinus Albicaulus), Bristle Cone Pine (Pinus Aristata), Engleman Spruce (Picia Englemanii), Sub Alpine Fir (Abies Lasiocarpa), One Seed Juniper (Juniperus Monosperma).

2.3 Commercial Timberland: "Commercial timberland" is that forest land which is capable of and available for producing successive crops of commercial wood and generally capable of producing in excess of 20 cubic feet per acre of annual growth.

2.4 Countable Tree: "Countable tree" means:

(a) The tree must be in place at least two growing seasons.
(b) The tree must be alive and healthy.
(c) The tree must have at least one-third of its length in live crown.
(d) The tree must be a commercial species from a local seed source or a seed source which the State Forester's representative determines will produce commercial trees physiologically suited for the area involved.

2.5 Diameter or D.B.H: "Diameter or D.B.H." means the average diameter of a tree, outside the bark, at a point 4.5 feet above the ground level on the high side of the tree.

2.6 Erosion Potential: The "erosion potential" of an area should be estimated by considering the following factors:

2.6 TABLE FOR ESTIMATING EROSION POTENTIAL:

TABLE H-1

EROSION POTENTIAL RATINGS

FACTORS	1	2	3	4
Parent Rock	basic igneous basalt gabbro	sedimentary / metamorphic	sedimentary / metamorphic	acid igneous (granite)
Soil Texture	fine-medium clay/clay loam	fine-medium clay & loam	sandy sandy/loam loamy sand	sandy decomposed granite
Soil Depth	40" +	20" - 40"	20' - 40" clay subsoil	20" or less clay subsoil
Precipitation	heavy snow light rain	mainly snow some rain	mainly snow some rain	rain
Vegetative Cover	plant/litter 70% cover	plant/litter 50-70% cover	plant/litter 30-50% cover	plant/litter 30% or less
Slope	less than 20%	20 - 30%	30 -50%	55% +

USE OF TABLE FOR ESTIMATING EROSION POTENTIAL:

Add the rating factors for parent rock, soil texture, soil depth, precipitation, and vegetative cover. Multiply the sum by the rating factor for slope.

EXAMPLE:

Parent rock is granite	4	
Soil texture is sandy loam		+3
Soil depth is 20" - 40"	+2	
Precipitation is mainly snow, some rain		+2
Vegetative cover is 30 - 50%	+3	
Multiply sum by slope rating	14 x 3 = **42**	

Using the following guide the example area would have HIGH erosion potential:

EROSION POTENTIAL FORMULA RESULT

Less Than 20	Low
20-39	Moderate
40-59	High
More Than 59	Extremely High

2.7 Fire Protection Zone: "Fire Protection Zone" means that portion of the logging area within 100 feet, as measured along the surface of the ground, from the edge of the travelled surface of all public roads and railroads; and within 200 feet, as measured along the surface of the ground from permanently located structures currently maintained for human habitation.

2.8 Fuelbreak: "Fuelbreak" means a strip of modified fuel to provide a line from which to work in the control of a fire.

2.9 Lake: "Lake" means a permanent body of water, isolated from the sea, either natural or artificially impounded, and having an area of open water of sufficient depth and permanency to prevent complete coverage by rooted aquatic plants.

2.10 Logging Area: "Logging Area" means that area on which timber operations are being conducted as shown on the map accompanying the Timber Harvesting Plan, and within 100 feet as measured on the surface of the ground, from the edge of the travelled surface or appurtenant roads owned or controlled by the timber operator and being used during the harvesting of the particular area.

2.11 Logging Road: "Logging Road" means a road other than a public road used by trucks going to and from landings to transport logs and other forest products.

2.12 Lopping: "Lopping" means severing limbs from the exposed sides of unutilized portions of trees so that portions of the severed limbs are in contact with the ground.

2.13 Meadows and Wet Areas: "Meadows and Wet Areas" means those areas which are moist on the surface throughout most of the year and/or support aquatic vegetation, grasses and forbs as their principal vegetative cover.

2.14 Public Road: "Public Road" means a road open to the general public which is (a) in the state or county road system, or (b) a road on which a public agency has deeded unlimited easement.

2.15 Reproduction: "Reproduction" means young trees of commercial species that are less than two inches D.B.H., i.e., seedlings and saplings.

2.16 Seed Tree: "Seed Tree" means a firm coniferous tree with full crown now capable of producing seed.

2.17 Site Classification: "Site Classification" means the classification of productive potential of commercial timberland into one of five classes by board regulation, consistent with normally accepted forestry practices. Site I shall denote sites of highest productivity potential, Site II and III shall denote sites of intermediate productivity potential, and Site IV and Site V shall denote sites of lowest productivity potential.

2.18 Slash: "Slash" means split product material, branches, limbs or stems of any species left in the harvest area as a result of current timber harvesting.

2.19 Snag: "Snag" means a standing dead tree or standing section thereof, regardless of species.

2.20 Special Treatment Areas: "Special Treatment Areas" means specific areas that have been legally designated and described by the appropriate public agency or commission as: wild and scenic rivers, scenic highways, historical and archaeological sites (excepting old logging sites, abandoned railroad grades, mills or towns), ecological reserves, key habitat areas of endangered species of plants and animals; national, state, regional, county and municipal parks; and those areas within 200 feet, as measured along the surface of the ground from the established boundaries of such areas or the edge of the travelled surface of such highways.

2.21 Stream: "Stream" means a natural watercourse as designated by a solid line or dash and three dot symbol shown in blue on the most recently published United States Geological Survey 7 1/2 minute series topographic map.

2.22 Stream and Lake Protection Zone: Certain activities prohibited near bodies of water; exceptions:

1) No felling of trees, skidding, rigging or construction of tractor or truck roads or landings, or the operation of vehicles, may take place within 200 feet, measured on the slope, of the high water mark of any lake, reservoir, stream or other body of water unless a variance is first obtained from a committee composed of the State Forester Firewarden, the Director of the Division of Wildlife and the State Engineer.

2) The committee may grant a variance authorizing any of the activities prohibited by subsection one within a 200-foot buffer area if the committee determines that the goals of conserving forest resources and achieving forest regeneration, preserving watersheds, reaching or maintaining water quality standards adopted by federal and state law, continuing water flows, preserving and providing for the propagation of fish life and stream habitat and preventing significant soil erosion will not be compromised.

3) In acting on a request for such variances the committee shall consider the following factors:

(a) The extent to which such requested activity is consistent with good forestry management for the harvesting of timber.

(b) The extent to which such requested activity significantly impedes or interrupts the natural volume and flow of water.

(c) The extent to which such requested activity significantly affects a continuation of the natural quality of the water pursuant to state and federal water quality standards.

(d) The extent to which such requested activity is consistent with the prevention of significant soul erosion.

(e) The extent to which such requested activity may significantly obstruct fish passage, cause sedimentation in fish spawning areas, infringe on feeding and nursing areas and cause variations of water temperatures.

(f) The filtration of sediment-laden water as a consequence of timber harvesting on adjacent slopes.

2.23 Stream and Lake Transition Line: The "Stream and Lake Transition Line" means that line closest to the stream or lake where riparian vegetation is permanently established.

2.24 Tight-Lining: "Tight-Lining" means the moving of the main line from one tail block location to another and tightening the cable to pull the main line to the new position.

2.25 Thrifty Trees: "Thrifty Trees" means trees with usually long, full, pointed tops and lower limbs frequently dead, but containing very few dead limbs in the upper green portion of the crown. Such trees usually fall within Dunning's tree classes 1 and 2, and Keen's tree classes 1a, 1b, 2a, and 2b.

2.26 Timberland: "Timberland" means land, other than land owned by the federal government, which is available for, and capable of, growing a crop of trees of any commercial species used to produce lumber and other forest products, including Christmas trees.

2.27 Timber Operations: "Timber Operations" means the cutting or removal or both of timber or other solid wood forest products, including Christmas trees and firewood from timberlands for commercial purposes. Together with all the work incidental thereto, including, but not limited to, construction and maintenance of roads, fuelbreaks, firebreaks, stream crossing, landings, skid trails, beds for the felling of trees, and fire hazard abatement, (but excluding preparatory work such as tree-marking, surveying) or roadflagging. Removal or harvest of incidental vegetation from timberlands, such as berries, ferns, greenery, mistletoe, herbs and other products, which action cannot normally be expected to result in a threat to forest, air, water or soil resources, does not constitute timber operations.

2.28 Timber Operator: "Timber Operator" means any person who is engaged in timber operations or who contracts with others to conduct such operations on his behalf, except a person who is engaged in timber operations as an employee as his sole compensation.

2.29 Timber Owner: "Timber Owner" means any person who owns commercial timber, timberland, cutover land, or timber rights, including Christmas tree rights, on lands of another except a federal agency.

2.30 Tractor Roads and Skid Trails: "Tractor Roads and Skid Trails" means constructed trails or established paths where the vegetation or ground cover has been removed and which are used by tractors or other yarding or skidding vehicles in harvesting forest products.

2.31 Waterbreak: "Waterbreak" means a ditch, dike or dip, or a combination thereof, constructed across tractor roads, skid trails, firebreaks and roads, diagonally where feasible, so that water flow is effectively diverted therefrom.

ARTICLE 3. SILVICULTURAL METHODS

3.0 Silvicultural Methods: The objective of this article is to provide for future continuous timber growth and to protect other resources on timberland, which will be at or near the productive capacity for the soil, timber site, and species present.

The Timber Harvesting Plan shall designate one or a combination of silvicultural methods. If some other silvicultural method other than those described below is to be applied, it shall be described and defined in the Timber Harvesting Plan. The timber operator or owners' representative shall state the objective of the harvesting method in the Timber Harvesting Plan. The selection of a silvicultural method should be determined by consideration of timber stand conditions, topography, land stability, erosion potential, slash treatment and visual aspects.

Lands on which Christmas trees, fuelwood, minor timber operations, or dead, dying or diseased trees are harvested may be exempt from these silvicultural methods by order of the State Forester. Each timber operator shall conduct his timber operations in accordance with the silvicultural method or methods described in the Timber Harvesting Plan filed with the State Forester.

Some of the most commonly used silvicultural methods are listed below:

3.1 Thinning Method: The "Thinning Method" provides for cutting and removing trees in a timber stand to increase the rate of timber growth, foster quality timber growth, and/or improve species composition, or recover and use timber that would otherwise be lost to mortality.

3.2 Selection Method: The "Selection Method" provides for the removal of timber usually covering a variety of age classes, either as single trees or in small groups, at relatively short intervals of time, commonly 5 to 20 years, repeated indefinitely, by means of which continuous establishment of natural reproduction is encouraged and an uneven-aged stand is maintained.

3.3 Shelterwood Method: The "Shelterwood Method" shall provide for the removal of mature timber in a series of cuttings, which extend over a period of years equal usually to not more than one-quarter and often not more than one-tenth of the time required to grow the crop to harvestable age. In this method, the establishment of natural reproduction under the partial shelter of seed trees is encouraged.

3.4 Seed Tree Method: "The Seed Tree Method" provides for the removal of timber in one cut except for the seed trees to be left to restock the logged area. An average of at least ten mature trees, with a minimum of five trees of each logged area shall be more than 500 feet from the nearest seed tree as measured along the surface of the ground. Seed trees should be left in groups of at least three trees at least one of which is for each dominant species.

3.5 Clear-Cutting Method: The "Clear-Cutting Method" provides for harvesting of the entire timber stand in one cut on an area (clear-cut areas shall not exceed forty (40) acres in any one block). No clear-cutting shall be done on an area contiguous to a previously clear area in the same ownership until that area has been adequately revegetated. The boundaries of the clear-cut area should, where practical, follow the topography rather than section lines to make them irregular in shape to blend with the natural landscape. The cut areas shall not exceed 600 feet in width unless explained in the Timber Harvesting Plan.

3.6 Sanitation Salvage Cutting Method: The "Sanitation Salvage Cutting Method" provides for the cutting and removal of only those trees which are dead, dying, or deteriorating because of damage from fire, wind, insects, disease, flood, age, or other injurious agents.

3.7 Special Treatment Areas: Special consideration in "Special Treatment Areas" will be given to selection of a silvicultural method compatible with the objectives for which the special area was established. Such areas shall be identified in the Timber Harvesting Plan.

To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, the timber land owner or his designated representative and the State Forester may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas.

When a significant archaeological discovery is made during timber operations, it should be reported to the proper authorities. Timber operations should stop on that specific site to protect it for future evaluation.

3.8 Riparian Vegetation: All non-commercial riparian vegetation found along streams and lakes and within meadows and wet areas shall be retained and protected insofar as practical.

3.9 Protection of Wildlife Habitat: Trees should be retained on areas designated as deer migration corridors, holding areas, or key ranges when consistent with good forestry practices. Also trees within meadows, wet areas and other areas should be designated in order to retain these areas for wildlife. These areas are to be shown on the Timber Harvesting Plan.

Live trees as designated with visible evidence of use as nesting sites by endangered bird species will be left standing and unharmed.

Live trees with visible evidence of use as nest sites by eagles or ospreys as designated by the Department of Wildlife are urged to be retained. These trees may be felled only during the time of year when such nest sites are not being used for breeding or other purposes. This period is normally from August 15th to February 1st.

3.10 Emergency Salvage Cutting: On timberlands which the State Forester has determined to have been substantially damaged by fire, insects, disease, wind, flood, air pollution, or substantial damage caused by an Act of God, the timber operator may remove all dead and dying, insect-infested and diseased timber, and other timber on the area so damaged after a harvest plan has been submitted and approved by the State Forester or his designee.

3.11 Exceptions: The requirements of this Article shall not prohibit the timber operator from cutting or removing trees for purposes of clearing the right-of-way, log landings, campsites, or firebreaks necessary for the conduct of timber operations. The harvesting of Christmas trees and construction of an integral part of a public fire protection agency fuelbreak are also permitted.

ARTICLE 4. LOGGING PRACTICES

4.0 Logging Practices: Every timber operator shall exercise due diligence in the management and operation of felling, yarding, and loading of timber or any activity connected therewith, to prevent unnecessary damage to residual trees, reproduction, riparian vegetation, and water quality, and to maintain the productivity of the forest land.

4.1 Felling Practices: Timber felling shall be done in such a manner as to protect the residual trees, reproduction, riparian vegetation, and trees left for wildlife benefits from unnecessary damage, and to minimize breakage in merchantable timber, insofar as topography, safety consideration, lean of trees, obstructions, openings and land locations permit.

4.2 Stump Height: Stumps shall be kept to a height of twelve inches or less on the side adjacent to the highest ground level, except where safety, imbedded metal, or unmerchantable wood make this impractical.

4.3 Landings: "Landings" shall be kept to a minimum size and number consistent with safe and efficient logging operations. Landings shall be no larger than one-half acre in size unless the reason for a larger size is explained in the Timber Harvesting Plan. Landings shall not be placed within a stream and lake protection zone or in meadows or wet areas unless specifically explained in the Timber Harvesting Plan, and approved by the variance committee as specified in N.R.S. 528.053.

4.4 Tractor Yarding: Every timber operator shall locate, construct and use tractor roads and skid trails so as to minimize damage to residual timber and reproduction. Skid trails shall be limited in number and width consistent with safe and efficient logging practice.

Tractor yarding equipment shall not be operated on known potential or active slide areas unless satisfactory protective measures are specified in the Timber Harvesting Plan.

Timber harvesting shall not be conducted under ground conditions which, due to excessive moisture, result in unreasonable soil compaction or accelerated erosion.

Tractor logging shall not be conducted on areas having average slopes in excess of (30%) unless a variance is obtained from the State Forester.

4.5 Cable Yarding: Cable lines shall be installed, hung, and operated so as to minimize damage to residual timber and reproduction.

4.6 Tight Lining: Tight-lining, when changing location of lines, is prohibited if such practice will damage or destroy residual trees or reproduction.

4.7 Rigging: Guy lines and other rigging shall not be hung on residual trees, unless said trees are protected from damage by effective protective devices.

4.8 Refuse, Litter, Trash, and Debris Disposal: In Special Treatment Areas, and within 200 feet of public roads, refuse, litter, trash, and debris, other than natural wood or vegetation resulting from timber operations in connection therewith, shall be disposed of concurrently with the conduct of timber operations, in accordance with State and local laws and regulations.

4.9 Servicing of Logging Equipment: Timber operations shall not operate or service any machinery or equipment in such a manner as to allow grease, oil, or fuel to pass into lakes or streams during or after operations.

ARTICLE 5. EROSION CONTROL

5.0 Erosion Control: Every timber operator shall conduct operations in such a manner as to protect soil resources from unnecessary damage and erosion. Tractor roads, skid trails, landings, logging roads and firebreaks shall be located, constructed and left after logging that water flow thereon and water flow in natural water courses shall not contribute to excessive erosion of soil. Following the use of tractor roads, skid trails, landings and temporary logging roads, and construction of firebreaks, and prior to the removal of logging equipment, waterbreaks shall be installed, natural water courses shall be opened where permanent culverts and bridges have not been constructed, and seeding or other practical measures shall be taken to meet the objective of preventing excessive soil erosion.

5.1 Waterbreaks: Waterbreaks shall be installed on all skid trails and landings as follows (See page H-12), based on slopes and erosion potential as stated in the Timber Harvesting Plan (See N.R.S. 528.0551).

TABLE H-2

MAXIMUM DISTANCE BETWEEN WATERBREAKS IN FEET
(SEE NRS 528.0551)

EROSION POTENTIAL	Land Slope Percent			
	10 or less	11 - 25	26 - 50	Over 50
Low	300	200	150	100
Medium	200	150	100	75
High	150	100	75	50
Extreme	100	75	50	25

The foregoing erosion control measures shall be completed on the following schedule:

(a) Within 30 Days, but not later than September 30th, after completion of seasonal or final use of tractor roads, skid trails, landings, and temporary logging roads when such use is concluded before September 30th of the current year.

(b) Concurrently with final or seasonal use of tractor roads, skid trail landings and temporary logging roads when such use occurs after September 30 of the current year.

(c) Concurrently with construction of firebreaks.

Waterbreaks shall be cut into the firm roadbed, skid trail or firebreak surface and shall provide for unrestricted discharge at the lower end of the waterbreak so that water is discharged and spread onto the adjacent area. Logging roads may be similarly drained by rolling dips.

(d) Revegetation work should not be done on areas where natural reproduction of native species will effectively bind the soil. Grass seeding must be supplemental to other soil stabilization measures such as mulching, pitting, scarification, water bars, or dips and cross ditching. Grazing must be excluded from areas where erosion control work has been performed until the vegetation is established.

5.2 Logging Roads: Roads shall be constructed and maintained in accordance with the following:

(a) Logging roads shall be located and constructed to utilize to the fullest extent practicable the general contours of the land in order to avoid excessive cuts, fills and road grades. Unless indicated in the Timber Harvesting Plan, roads shall be constructed to single lane width with turnouts at reasonable intervals. Both roads and turnouts shall be no wider than necessary to permit safe passage of logging trucks and equipment. Logging roads shall not exceed a grade of 15%, except that pitches of up to 20% will be allowed, not to exceed 500 continuous feet in length. These percentages and distances may be exceeded only where there is not other feasible access for the harvesting of timber, or the use of gradient in excess of 20% will serve to reduce soil disturbance. Said road will be indicated in the Timber Harvesting Plan.

The degree of gradient to which a particular road may be safely built from a watershed management standpoint varies with local conditions. The critical gradient is that grade beyond which it is uneconomical to provide for the a stabilized road prism and adjacent water disposal areas. The critical gradient is affected by rainfall intensity pattern of precipitation, soil types, ground cover on intercepting surfaces, class of road use, and plans and facilities for maintenance. In all cases, special drainage provisions will be made on logging roads regardless of gradient.

Minimum drainage will be required on those of little gradient and maximum protection given those of steeper gradient, taking into full account those factors affecting the critical grade.

(b) Logging roads shall be constructed with no overhanging banks.

(c) Any tree with more than 40 percent of its root system exposed by reason of road construction shall be felled.

(d) All permanent drainage ditches, rolling dips, culverts or other facilities needed to control erosion shall be installed concurrently with construction of the road.

(e) Road construction should avoid soil with highly erodible characteristics. Roads will be located where soils can be stabilized.

(f) All permanent structures shall be shown on the map accompanying the Timber Harvesting Plan. In bridge location, plan to avoid relocation of the stream channel. Where the stream must be changed, use rip rap to reduce soil movement into streams.

(g) Any side cast materials from road construction which has unimpaired access to a stream or lake shall be treated or intercepted to prevent it from entering the stream or lake.

(h) Culvert outflow shall not be discharged on erodible fill material unless rocks, downspouts or other suitable structures are placed so that the water velocity will be dissipated to minimize erosion. Culverts should be of adequate size and properly installed with a suitable bed and grade in the drainage channels. Avoid changes or disturbance of stream channels as much as possible.

(i) Berms shall be removed from logging roads except on fills and where necessary to deflect water to the drainage facility upon completion of logging or before September 30th of the current year so that water may freely flow off the road surface.

(j) No significant amount of woody material shall be incorporated into fills.

(k) During timber operations, road running surface in the logging area shall be maintained to prevent excessive loss of road surface material.

(l) Cross-Ditches: (Rolling dips). Cross-ditches (See Figure H-2, page H-16) are used to supplement outsloping and built-in drainages such as culverts, grade breaks, and dips. They should be constructed in such a manner that a vehicle will roll rather than bounce over them. Guides for cross-ditch construction:

1. Slope diagonally out and downgrade at a minimum angle of 60 degrees with the center line of the road. The ditch should be tied securely to the upper bank.

(See Figure H-2, page H-16)

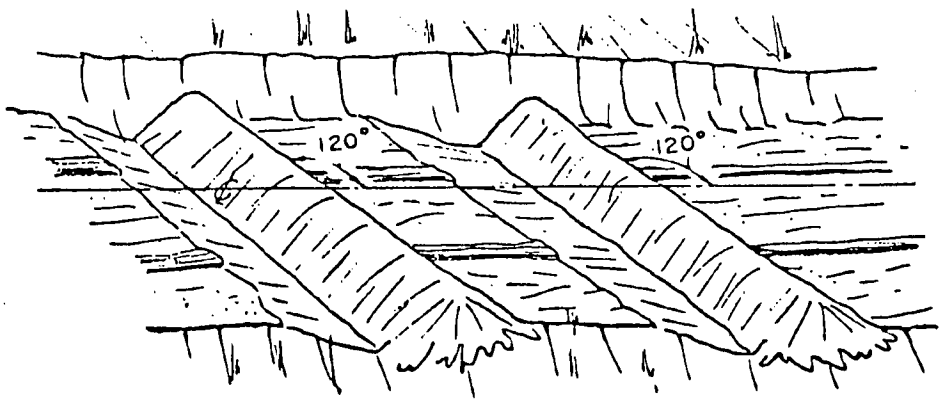
2. The ditch is bulldozed or cut with a grade blade into the roadbed to a depth of at least 12 inches on the road shoulder.

(See Figure H-3, page H-17)

3. Excavated material should be scattered below the ditch so that no dike or barrier is noticeable.

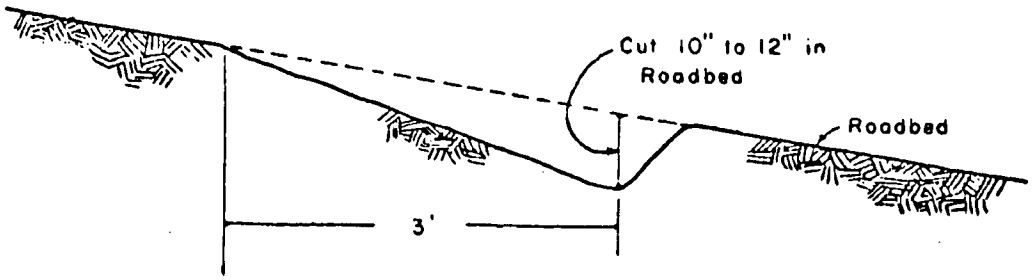
4. Handwork is required to open the ditch and to secure the needed outsloping.

FIGURE H-2 (FIGH1.PCX)
VIEW OF COMPLETED CROSS-DITCH



View of Completed Cross-Ditch

FIGURE H-3 (FIGH2.PCX)
CROSS SECTION OF CROSS-DITCH



CROSS SECTION
OF CROSS-DITCH

(m) Location of Cross-ditches. Cross-ditch locations will be flagged or staked in advance of construction of ditches. This will be done by the timber operator in charge of the sale or by other qualified persons.

1. Locate the cross-ditch to take advantage of dips, changes in grade and natural barriers wherever possible.

2. Ditches should be located directly below water courses, draws, intercepting skid trails and roads, below outcurves and above incurves.

3. Locate so that outlet does not discharge onto long, loose fills. Discharge on rocks, accumulation of wood, on flats and on other places where water can be spread rather than concentrated.

4. Place cross-ditches on each end of all fill sections.

5. The spacing of surface drainage structures will vary with soil type, with grade, and width of road. Maximum spacing of cross-ditches is as follows:

Spacing in feet for relative Erosion Hazard is depicted in Figure H-4 (page H-19).

FIGURE H-4

SPACING IN FEET FOR RELATIVE EROSION HAZARD

Road Gradient (percent)	Extreme	High	Moderate	Low
5 or less	100	240	480	720
5 to 9	75	170	340	520
10 to 15	50	100	200	500

ARTICLE 6. STREAM AND LAKE PROTECTION
(Refer to: N.R.S. 528.053)

6.0 Stream and Lake Protection: The purpose of this Article is to insure the protection of beneficial uses that are derived from the physical form, water quality, and biological capacity of streams and lakes.

It is the further purpose of this Article to minimize erosion of stream and lake banks and beds during the conduct of timber operations.

In order to prevent unreasonable adverse effects on the beneficial uses of streams and lakes, each timber operator shall do the following:

(a) Below the stream and lake transition line, the streams will be kept free of slash, debris, side cast and other materials from logging operations. Accidental deposits shall be removed as soon as practicable. Trees cut within 50 feet of the surface of the ground shall be felled as nearly as possible at right angles away from the stream or lake, or in such a manner as to minimize erosion and maintain water quality.

(b) The timber operator shall prevent the discharge of soil, silt, bark, slash or other organic and earthen material from any logging, construction or associated activity into any stream or lake in quantities deleterious to fish, wildlife or other beneficial uses of water.

(c) When logging skid trails must cross a live stream, a prepared crossing shall be used.

(d) The timber operator shall not use beds of streams as landings, roads, or skid trails, except at prepared crossings.

(e) At all road crossings of live streams, install suitable structures of sufficient size to allow for the full surface flow of the stream throughout the entire period of timber operations. All structures shall be placed to allow unrestricted fish passage.

(f) All temporary stream crossing structures not designed for the normal maximum flow of the stream shall be removed prior to the normal maximum flow of the stream. All temporary structures shall be removed upon completion of logging.

6.1 Protection of Water Quality and Wildlife Habitat: To minimize erosion and protect water quality and fish and wildlife habitat within the stream and lake protection zone, adjacent to perennial streams and lakes, riparian vegetation, residual timber and other soil-protecting and shade producing vegetation will be protected from unnecessary damage.

Felled trees shall be end-lined to the edge of the stream and lake protection zone and tractors on skidding equipment will not be operated within the zone except on existing roads of where less damage will result from the use of such equipment.

Within the stream and lake protection zone, enough trees or shrubs of any species shall be left so that 50% or more of the shade-producing canopy before timber operations shall remain after timber operations are completed. When explained and justified, the Timber Harvesting Plan may provide for a lesser percentage of remaining shade-producing canopy where it is necessary to achieve stocking standards or if it can reasonably be expected there will not be substantial adverse effects on soil erosion, wildlife, aquatic life, or unreasonable effects on the beneficial uses of water because of one or more of the following reasons:

(a) The remaining canopy or streamside shrubs will still provide adequate protection;

(b) A stream is oriented with a northerly or easterly facing slope such that the aspect substantially reduces the amount of solar radiation;

(c) The depth and narrowness of the canyon at stream level is such that removal of additional percentage of canopy does not adversely affect the water or substantially increase erosion;

(d) The combination of inherent temperature, depth, rate of flow and volume of water is such as to prevent significant heating or temperatures higher than normally required for the survival of fish;

(e) The length of stream affected by canopy decreased is less than 200 feet.

Only sanitation salvage cutting may be done in future harvests within the stream and lake protection zone until such time that the canopy has become sufficiently reestablished to prevent substantial adverse effects on soil erosion, wildlife, aquatic life, or the beneficial use of water.

In the event the State Forester disagrees with the judgement exercised by the timber landowner or his designated representative and the plan is rejected following an on-the-ground inspection which may be requested by either party, the person who submitted the plan may appeal to the Board of Forestry.

6.2 Soil Treatment - Stream and Lake Protection Zone: Areas exceeding 800 square feet in size within the stream and lake protection zone, where bare mineral soil is exposed by timber operations and pose a threat to a stream or lake, shall be treated to keep the soil from entering the stream or lake, shall be treated to keep the soil from entering the stream or lake.

Treatment shall be done prior to October 15th, except that such bare areas created after October 15th shall be so treated within ten days.

ARTICLE 7. HAZARD REDUCTION

7.0 Hazard Reduction: The purposes of this Article are to provide for the treatment of snags, logging slash and other debris in the logging area in order to reduce the fire hazard associated with timber operations, to protect the timber resources from wildfire and potential insect and disease attack, and to prepare the area for natural or artificial reforestation.

7.1 Snag Disposal: All snags over 20 feet in height within the logging area shall be felled concurrently with the timber operations, except as provided below:

(a) In the salvage of fire-killed timber, the operator shall only be required to fell such snags within 200 feet of the edge of the traveled surface of all roads which traverse the burned area and within 200 feet of places of habitation and within a strip 200 feet wide whose exterior boundary is the perimeter of the burn, such distances to be measured along the surface of the ground.

(b) Due consideration should be given to leaving snags less than 50 feet in height which exhibit wildlife values and/or exhibit visible evidence of use as nesting sites by eagles, hawks, owls, waterfowl, or any rare or endangered species. Other specifications may be required in the forest harvest plan that are site specific.

(c) Exception to height and location may be made for the protection of wildlife for specific snags showing evidence of active wildlife use not to exceed one snag per 20 acres of timber operating area when designated in writing and marked for leave by the authorized representative of the timberland owner and the State Forester.

The above provisions in no way shall exempt any person from federal and state safety laws and regulations that require the felling of snags.

7.2 Treatment of Logging Slash: Limbs shall be lopped from the unutilized portions of felled trees and all trees felled or pushed over in road construction. Lopping shall be done concurrently with the timber operation.

7.3 Slash Disposal Within Fire Protection Zones: All slash created by road construction or timber operations, including trees knocked down, within the fire protection zone shall be treated by lopping and scattering so that generally none will be more than twenty-four (24) inches above the ground or by piling and burning, chipping, burying, or by removal from the zone.

7.4 Piling and Burning: As an alternative to lopping, the operator may pile and burn the slash and other logging debris. Such piling and burning shall be done in the following manner:

(a) Slash and debris shall be piled and burned in a location and manner which will not excessively damage the residual trees or reproduction.

(b) Piles shall be sufficiently free of earth and other non-combustible material for effective burning. Piles shall be hand piled or pushed into a pile with equipment that has a brush rake attachment.

(c) The piled slash shall be burned at a safe time during the first wet fall or winter weather, or other safe period following piling and according to laws and regulations. Piles that fail to burn clean shall be further treated for disposal. All reasonable precautions shall be taken to confine such burning to the piled slash.

(d) Piles shall not be burned within 50' of a stream as defined by N.R.S. 528.0255.

7.5 Broadcast Burning: Slash may be broadcast burned. No broadcast burning shall be permitted within the stream and lake protection zone. The local representative of the State Forester shall be notified in advance of the time and place of burning and all burning shall be done in a manner provided by law.

ARTICLE 8. FIRE PROTECTION

8.0 Fire Protection: When burning permits are required by the State Forester, every timber operator shall have a fire protection plan and program for prevention and suppression of fires in his logging areas.

8.1 Fire Plan Filing: Every timber operator shall prepare in writing a fire prevention and control plan. He shall file a copy of such a plan with the State Forester by no later than April 1st of each year, or if his operations commence for that year later than April 1st, then the plan shall be submitted not later than ten (10) days prior to the date of the beginning of such operations. Such filing to be made to the nearest headquarter's office of the Nevada Division of Forestry as follows:

OFFICE LOCATION	FIRE PLAN FOR:
Western Area 885 Eastlake Boulevard Carson City, Nevada 89710 (702) 849-2500	Washoe, Pershing, Lyon Churchill, Mineral, Douglas, Carson City Storey Counties

Northern Area P.O. Box 1507 Elko, Nevada 89801	Elko, White Pine Eureka, Lander Humboldt Counties
(702) 738-3454	
Southern Area 4747 West Vegas Drive Las Vegas, Nevada 89158	Esmeralda, Nye, Lincoln, Clark Counties
(702) 486-5123	

8.2 Fire Plan Contents: Timber operators' written fire prevention and fire control plan shall include, but not limited to, the following information:

(a) The name, address and 24 hour telephone number so a responsible person and an alternate who have authority to act for the operator in fire suppression operations.

(b) Location and number of men available for fire fighting duties.

(c) Kind, type and location of tools and equipment, including bulldozers, and water tank trucks suitable for fire fighting purposes.

(d) The plan shall set forth the general procedure which will be followed for the detection, control, and suppression of uncontrolled fires.

(e) Sketch map and land subdivision description of logging areas upon which timber operations may currently be conducted or are anticipated of being conducted during the ensuing forest fire season.

8.3 Roads to be Kept Passable: Timber operators shall keep all logging truck roads in a passable condition during the dry season for fire truck travel until snag and slash disposal has been completed.

8.4 Smoking and Matches: Timber operators shall make and enforce rules prohibiting persons employed, or otherwise engaged by them in timber operations, from smoking on timberland belonging to, or under the control of, the timber operator; with the following exceptions subject to any law or ordinance prohibiting, or otherwise regulating smoking, such rules may allow smoking when persons engaged in such operations are not moving about and are confined to cleared landings and areas of bare soil at least three feet in diameter. Burning materials shall be extinguished in such areas of bare soil before discarding.

8.5 Lunch and Warming Fires: Timber operators shall make and enforce rules for setting, maintenance, or use of warming or other fires used for the comfort or convenience of employees or other persons engaged in timber operations. Rules and rule enforcement for fires shall be subject to terms of written permission from the land owner and to any law or ordinance regulating or prohibiting fires. The rules made by the timber operator shall require clearance of ten feet or more from the perimeter of such fires of flammable vegetation or other substances conducive to the spread of fire. Rules shall require warming fires to be in a depression in the soil to hold the ash created by such fires. Timber operators shall not allow such fires to be left unattended unless totally extinguished and the fire site covered with soil.

8.6 Posting Fire Rules: Timber operators shall post notices which set forth the fire prevention rules they have prescribed in connection with their timber operations and such notices shall be posted in sufficient quantity and location throughout their logging areas so that all employees or other persons engaged by them to work therein shall be informed of such rules; and timber operators shall provide for diligent supervision and enforcement of fire prevention rules throughout their operations.

8.7 Blasting and Welding: Timber operators shall provide for a diligent fire watchman service at the scene of any blasting or welding operations conducted on tier logging areas to prevent and extinguish fires resulting from such operations. Blasting and welding permits must be obtained before such activity commences.

8.8 Inspection for Fire: Timber operators shall daily provide diligent inspection to detect and report fires in all parts of their logging areas where men or equipment have been working. Inspection shall be made no sooner than one hour after such operations have ceased for the day.

8.9 Cable Blocks: During the declared fire season, all tail and side blocks on a cable shall have a cleared area to mineral soil at least 15 feet in diameter. A shovel and an operational full five-gallon back pump must be located within 25 feet of such block prior to yarding.

8.10 Glass Container: Timber operators shall prohibit the use of uncovered glass containers on their logging areas.

ARTICLE 9. FOREST INSECT AND DISEASE PROTECTION PRACTICES

9.0 Insects and Diseases: Every timber operator shall provide reasonable protection against forest insects and diseases.

9.1 Prevention Practices: Timber operations shall be conducted in a manner that will minimize the build-up of destructive insect population or the spread of insect disease.

9.2 Locating and Reporting: Timber operators and timber owners shall assist the State in determining the location of insect and disease outbreaks, and report such outbreaks to the state Forester or his representative.

ARTICLE 10. INFRACTIONS OF RULES PRIOR TO CHANGES

10.0 Infractions of Rules Prior to Changes: Amendment, modification or repeal of rules shall not, unless otherwise provided, bar action on prior infractions of rules as they stood at the time of infraction.

Appendix H-2

WILDLAND/URBAN INTERFACE MANAGEMENT

The wildland/urban interface is the area where urban development, typically residential homes, meets the wildland or native vegetation. This area is characterized by heavy vegetation (i.e., shrubs, and trees) surrounding structures, with limited access. The populations desire to "live in the country", particularly in the western states, has resulted in extensive development in wildland areas previously unoccupied. Additionally, some areas of the west have incorporated extensive amounts of landscaping and adapted plant materials into their communities, so that they have in effect, created a wildland/urban interface. During the hot summer months and periods of drought the vegetation dries out becomes a major fuel source.

A significant conflict for fire management agencies occurs when fire suppression efforts are directed to the protection of structures at the expense of natural resources. Vast acerages of high value watershed has been destroyed resulting in extensive erosion and sedimentation, a loss of wildlife habitat and forage resources and impacted the economic health of many communities.

Development in the wildland/urban interface has inevitably increased the risk of fire as only in recent years has planning for fire protection been incorporated into the development review process. Nevada has been somewhat of a leader in wildland/interface management through the development of the Sierra Front Wildfire Cooperators. Extensive development along the eastern front foothills of the Sierra Nevada range and in the Mt. Charleston area of southern Nevada, Coupled with several major wildfires during the 1980's, resulted in a cooperative effort between fire and land management agencies at the local, state and federal level. Significant accomplishments have been made in the areas of building material controls, land use controls, access, communications, fire suppression resources, fuels management and pre-incident planning.

The following management tools are general but should guide local communities, real estate developers and individual homeowners in developing mechanisms for the management of the wildland/urban interface.

* **Prevention:** Prevention is the primary first line of defense against wildfire. A prevented fire requires no suppression and results in no damage. The three primary prevention categories are:

  Education Programs - To motivate and educate people to be fire safe through the media, schools, special events and signing.

Regulations - The development of federal, state and local ordinances and laws to manage peoples activities and actions. Regulations could include land use controls, access controls, burning laws, and building codes.

Law Enforcement - Fire laws must be enforced to be effective. Enforcement activities should be coordinated at the federal, state and local levels.

* **Presuppression:** While prevention efforts attempt to address human caused wildfire ignitions, mother nature cannot be totally predicted or controlled. Because lightning caused wildfires are unavoidable, and highly flammable fuels (vegetation) continue to grow annually, presuppression activities are needed to reduce the wildfire hazard.

Pre-planning - Formulate a team of all the affected persons, agencies and governmental entities (i.e. fire departments, land managers, local governments, property owners, etc.). **A qualified professional should identify high fire hazard areas utilizing industry standards (i.e. topography, vegetation, access, exposure, weather patterns, etc.).** Identified high fire hazard areas should then be mapped and incorporated into the county/community development review process. High fire hazard areas are then analyzed for key issues which include:

Existing Vegetation (Fuels);
Existing and Proposed Land Uses;
Access;
Topography;
Utility Infrastructure - Water, Electrical, etc.;
Fire Suppression Resources;
Existing Structures - Type and Construction Materials;
Existing Land Use, Zoning and Planning Ordinances; and
Building Codes and Construction Material Regulations.

Every site is unique and as such, may require that additional issues and/or conditions be assessed. The gathered information is then utilized to develop a comprehensive wildland/urban interface management plan. The plan should address the primary issues and identify management options and/or solutions for each high fire hazard area. Modification of existing regulations or the development of new regulations should be fully explored. It is very important that the public is involved and commits to the management plan. A public commitment will ensure a workable plan.

Fuels Management - Fuels management, (See Appendix H-3, "Fuels Management Guidelines") involves the reduction in fuels density or the conversion of a vegetation type to a more fire retardant type. Fuelbreaks are the commonest form of fuels management and typically consist of a linear strip where existing vegetation is removed and replanted with fire resistant grass species. Fuelbreaks should be incorporated into identified high fire hazard areas and illustrated on project mapping within the plan. Fuelbreaks are strategically located and are easily accessible by fire suppression equipment. Fuelbreaks serve as a line of defense during a wildfire and are proven to save structures, human lives and in reducing suppression costs. All fuels management techniques require maintenance to maintain their effectiveness.

Planning and Development Regulations - Development within the wildland/urban interface is very popular and is here to stay. The key to safety is to design and construct wildland/urban interface developments in a manner which minimizes the risk of wildfire. This requires the development of specific development regulations for high fire areas which address the issues identified in the pre-planning section. Numerous states and communities throughout the west have completed comprehensive development regulations for the wildland/urban interface. This information is available through the Nevada Division of Forestry, State Foresters Office.

Implementation - The final step in the wildland/urban interface management planning process is implementation. The plan should be presented through the media, at all levels, to all age groups. Annual review of the plan is a key component, which should include public involvement. At the beginning of every fire season, special effort should be made to re-educate the public on all aspects of wildfire prevention and presuppression.

* **Suppression:** Wildland fire suppression activities are handled by professionals who are extensively trained in fire science. From a home owners stand point it is best to leave the fire fighting to the professionals and not unnecessarily risk human lives.

A properly designed, implemented and maintained wildland/urban interface plan, whether at an individual property owner level or at the community level will greatly reduce the devastating effects of wildland fire. Additional information is available at your local fire department or the Nevada Division of Forestry.

Appendix H-3

FUELS MANAGEMENT GUIDELINES

GENERAL

Fuels management has become an important component for the wildland/urban interface dweller. Fuels management is defined as reducing the fuel density and/or the replacement of a vegetation type with a more fire resistant type. For the wildland/urban interface dweller fuels management is critical to maintaining the surrounding vegetation to minimize the threat of wildland fire. The application and maintenance of proper fuels management techniques greatly improves the ability of fire fighters to control a wildfire and protect a structure, slows the spread of wildfire and may result in improved wildlife habitat. A reduction in wildfires and the corresponding natural resource damage (watershed values, wildlife, etc.) will equate to reduced sedimentation and erosion.

Fuels management must be tailored to the specifics of the site and can vary significantly in magnitude as well as methodologies. Mechanical, chemical and biological procedures and controlled burning are used singularly or in combinations depending upon many factors, including:

(1) Type Of Land Use (Site);
(2) Topography and Elevation;
(3) Species of Plants - Whether They Are Root-sprouters or Non-sprouters;
(4) Size, Abundance and Distribution Of Woody Plants;
(5) Hazards Of Treatment, If Any;
(6) Objectives Of The Land User;
(7) Costs In Relation To Expected Benefits; and
(8) Access.

The objectives, methodologies and maintenance of a fuels management project should be developed and incorporated into a comprehensive fuels management plan. Fuels management requires ongoing maintenance to be effective. **The assistance of qualified professionals should be obtained in developing a fuels management plan.**

Non-chemical methods of fuels management should be used whenever feasible and where land disturbance and resulting sediment delivery can be minimized. Phenological development of the plants being controlled and of the plants being favored is of prime importance. Select the time when plants to be controlled are most vulnerable to the specific treatment. For growth regulating chemicals, this is a time of most active growth. Mechanical treatment is most successful just prior to seed maturity when root reserves are lowest.

Techniques Associated with Fuels Management

1. Defer grazing prior to fuels management activities that are designed to improve the resident forage species.

2. Tailor grazing management to favor the key species following fuels management. Grazing can be utilized as a fuels management tool.

3. Leave sufficient herbaceous plants, shrubs and trees to maintain desirable wildlife habitat, migration and escape routes. Surface stability should not be jeopardized by removing too many herbaceous or woody plants.

4. Provide for preservation of natural beauty to the fullest extent possible. This could include strategically located and irregularly shaped patches, usually in a contiguous manner. Avoid square patterns.

5. Incorporate fuel breaks into existing topographical and physical features such as roadways, stream zones or meadows.

6. Elimination of "ladder" fuels to prevent the growth of a ground fire to a crown fire.

7. Reseeding with fire resistant plant species.

METHODS AND MATERIALS

1. Mechanical

   a. Plowing

      (1) Adaptation: Low shrubs on sites planned for seeding.

      (2) Equipment: Disk or moldboard plow; heavy offset disk, root plow.

      (3) Dates: Late spring to early fall before shrubs have matured seed. Soil should be dry enough to prevent regrowth of partly covered plants.

      (4) Operation: Plow below root crown. Operate disk at sharp angle. Repeat at later date if necessary for satisfactory kill.

b. Chaining

(1) Adaptation: Pinyon, juniper, or sagebrush stands that are predominantly mature and brittle. Less effective on young, limber plants or those that resprout. Adapted to sites that will be seeded or for improvement of native range with less than a full stand of forage plants.

(2) Equipment: A 70 to 90 pound anchor chain, modified by welding rails to each link and installing swivels on each end.

(3) Dates: Same as for plowing.

(4) Operation: Pulled between two tractors, twice over in opposite or diagonal directions. May be broadcast or drill seeded between operations.

c. Beating/Cutting

(1) Adaptation: Stone-free sites with low shrubs that do not readily resprout. Not adapted to rabbitbrush, snowberry, silver sagebrush, three-tip sagebrush or Anderson peachbrush. Adapted to sites that will be seeded or managed for natural improvement.

(2) Equipment: Flair beaters or circular cutters.

(3) Dates: Same as for plowing.

(4) Operation: Cut as near ground level as possible. Adjust travel speed to brush conditions.

d. Controlled Burning

(1) Adaptation: Big sagebrush or other non-sprouting brush or trees on sites planned for seeding. Heavy stands of non-sprouting shrubs or trees with good understory of desirable forage plants.

(2) Equipment: Farming or earthshaping machinery to prepare firebreaks; flamethrowers or weedburners.

(3) Dates: Brush should be burned in mid or late summer after understory is dry but before brush seed has been dispersed. Grass root reserves should be high after seed maturity. Cheatgrass should be burned in late spring just prior to seed maturity. It is necessary to obtain the required burning permits.

(4) Seeding: Seed burned areas as soon as possible after burning.

e. Thinning

(1) **Design and develop a timber harvest plan utilizing a qualified professional and coordinated with the appropriate federal, state and local agencies.**

(2) Equipment: Logging equipment, (i.e., yarders, skidders, chain saws, etc.) helicopters, trucks and chippers.

(3) Dates: Timber harvesting or thinning operations typically occur during the spring, summer and fall months depending upon elevation, topography, snow, soil moisture, and other specifics of the site.

(4) Seeding: Surface disturbances associated with timber harvesting should be graded and revegetated immediately upon completion of the activity.

f. Chemical

(1) Use only approved chemicals, Follow agency recommendations for materials, rates and application procedures.

(2) Apply in accordance with pesticide labeled use registered with the Nevada Division of Agriculture. Always read the label on the pesticide container before using the material.

(3) If herbicides are handled or applied improperly, or if unused portions are not disposed of safely, they may injure humans, domestic animals, desirable plants, and fish or other wildlife, and may contaminate nearby crops, other vegetation and the watershed. Follow the directions and heed all precautions on the container label. Herbicides should not be used over or directly adjacent to ponds, lakes, or streams.

g. Maintenance

(1) An ongoing maintenance plan should be developed inconjunction with the fuels management plan. Maintenance activities should be implemented on an annual basis to maintain the effectiveness of the shrub and tree treatments.

(2) Equipment: Typically annual maintenance will require hand labor involving pruning, trimming, and general clean up.

(3) Dates: Maintenance activities typically occur during the spring and fall, before or after the fire season.

APPENDIX I - URBAN RESOURCE MANAGEMENT

I-1 LANDSCAPING IN THE GREAT BASIN
I-2 WELLHEAD PROTECTION GUIDELINES

Appendix I-1

LANDSCAPING IN THE GREAT BASIN

Landscaping residential, commercial or industrial areas in the Great Basin environment is quite different than many areas of the west which benefit from higher amounts of precipitation. Nevada's annual precipitation varies from as low as four inches in the south to approximately twenty inches in the northeast. Western Nevada is subject to a rain shadow effect from the Sierra Nevada Range which greatly reduces our annual precipitation compared to the western slope of the Sierras. The wise use of water in landscaping is critical given our limited supplies, growing population and periods of drought. The following basic principals of landscape design and irrigation management will ensure Great Basin residents of an aesthetically pleasing landscape while getting the most benefit from existing water supplies.

PLANNING

The first step in designing and developing a landscape is to plan. The goals of the landscape should be clearly defined. For example are large turf areas needed for outdoor play or is the purpose of the landscape to screen an industrial site. After determining the landscape goals a design should be developed on paper which is drawn to scale accurately. The design should clearly illustrate the topography of the site, structures, walkways and driveways, the water source, elevation, north arrow and any other features or unique conditions of the site. All impervious surfaces should be clearly illustrated and the soils of the site should be tested for fertility. The actual landscape design can then be based upon this information. **The assistance of a qualified professional may be necessary given the specifics of the site.**

PLANT MATERIAL SELECTION

In conjunction with the design phase the selection of plant materials which are native or adapted to the Great Basin environment and to the goals of the landscape is important. The wise use of water resources hinges on the plant materials selected. Plant materials should be selected upon the following criteria.

* Topography and Soils;
* Climatic Conditions - Wind, Temperature and Exposure;
* Elevation;
* Mature Height, Spread and Water Requirements;
* Growth Characteristics - Flower, Fruit, Shape and Growth Rate;
* Texture and Color;

Over planting is one of the single most common mistakes made in developing a landscape. The landscape should be designed for plant material maturity with room for plant materials to grow. Overcrowding results in plant mortality, wasted water and an unhealthy landscape.

Turf grasses are one of the most important components of the landscape and one of the most misused plant materials. Turf grasses should be selected for their intended use and not over planted. The benefits of turf grass are numerous including erosion control, ground water recharge, lowering of surface temperatures and reduced surface water runoff. Selecting the appropriate turf grass for the area does not require large amounts of irrigation water or fertilizer. A significant amount of maintenance may be necessary for turf grass depending upon the site. Turf grass areas require separate irrigation from trees and shrubs.

IRRIGATION

An appropriately designed irrigation system will meet the needs of the selected plant materials without overwatering. Turf areas should be designed to minimize over spraying of impervious surfaces, trees and shrubs. To avoid overwatering, turf grasses should be irrigated in zones utilizing spray sprinklers. Trees, shrubs and flowers should be irrigated with a drip system and micro-sprays. Each zone of the irrigation system should be independently controlled via an automated controller. This flexibility will ensure a healthy landscape without waste of irrigation water. As Great Basin winters almost always include freezing temperatures for extended periods of time, the irrigation system should be installed with automatic drains in the distribution lines and manual drains at the valves and backflow preventer. Every irrigation system should include a backflow prevention device to insure that the drinking water supply is not contaminated.

MULCHES

The used of both organic and inorganic mulches is one the best methods of conserving water and creating microclimates conducive to plant growth. Organic mulches include: bark, compost, sawdust, leaves and grass clippings. Organic mulches should be placed in planting beds and around plant materials. Inorganic mulches include rock, crushed stone and gravel. Storage areas, foot traffic areas and in areas where plants are not desired can all receive inorganic mulches. Weed control can be achieved by utilizing one of the many fabrics which allow water infiltration yet prevent weed growth.

MAINTENANCE

Maintenance of a landscape can be a full time job if the landscape is not properly designed. The selection of the appropriate plant materials and not over watering the landscape will greatly reduce maintenance requirements. Regular inspections of the irrigation system including the spray sprinklers and the drip emitters will also minimize maintenance and plant material loss. Fertilizing turf grasses in only the spring and fall will ensure a health lawn with minimal thatch build up.

Appendix I-2

WELLHEAD PROTECTION GUIDELINES

As mandated by the 1986 Amendments to the Safe Drinking Water Act (SDWA) the Nevada Division of Environmental Protection, Bureau of Water Quality Planning (NDEP-BWQP) has developed a Wellhead Protection Program (WHP) for Nevada. The program is contained in the document "State of Nevada Wellhead Protection Program", dated December 1993 and is available to the public at NDEP-BWQP offices in Carson City, Nevada. Primary components of Nevada's Wellhead Protection Program (NWHPP) are summarized in the following discussion.

The primary goal of WHP in Nevada is the protection of public drinking water supplies through the implementation of contaminant source controls at the community level. To achieve the State's goal the NWHPP has been developed and implemented at both the State and local level. Present activities at the state level are designed to achieve the following objectives.

* Generate Interest and Participation in WHP Activities Through Public Outreach and Education;

* Place Responsibility For WHP on at the Local Level;

* Develop Program Guidelines Which Will Facilitate Community Involvement in all Aspects of Wellhead Protection; and

* Provide Technical Assistance as Requested.

WHP programs must be developed and administered by those governments having jurisdiction (i.e., county commission, city council, town board) in conjunction with the public water suppliers (public or private entities). WHP in Nevada is voluntary and the NWHPP allows for flexibility in developing WHP activities. This is important given the vary diverse urban and rural communities within the State.

A complete WHP program which is endorsed by the State and the U.S. Environmental Protection Agency (EPA) will include the following seven core elements:

* Roles and responsibilities of the state agencies, local governments, and the water supply providers;

* Delineation of WHP areas;

* Contaminant source inventories;

* WHP area management options;

* Siting of new wells;

* Contingency planning; and

* Public participation.

While the NWHPP is non-regulatory, the State will encourage and assist those communities which commit to the development and implementation of a complete WHP program. Both technical and financial assistance will be prioritized and provided based upon the commitment of the community to a complete WHP program. Of the seven program elements, the delineation of WHP areas, the identification of existing and/or potential contaminant sources and the development of wellhead protection area management options are the most important to the communities.

Delineation of Wellhead Protection Areas (WHPAs): A WHPA is defined as the surface and subsurface area surrounding a water well or well field which supplies a public or private water system through which contaminants are reasonably likely to move toward and reach such water well or well field. There are numerous methodologies utilized for the delineation of WHPAs which are selected based upon the specifics of the site and available data.

NDEP-BWQP is developing a guidance document to assist local governments and public water suppliers in their delineation efforts. It is also important to note that in Nevada the recharge area for many water supply wells may be some distance away or include a very large area. This may pose some difficulty in coordination between landowners and land managers and under scores the need for cooperative efforts at all levels of government.

Identification of Contaminant Sources: The inventorying of existing and/or potential contaminant sources within the delineated WHPA is critical to the effectiveness of the WHP program. The inventory serves as the basis for development of management strategies. The state is also conducting a statewide inventory of contaminant sources which will be made available to communities for WHP activities.

Wellhead Protection Management Strategies: Typical management strategies include both regulatory and non-regulatory mechanisms. Land use controls, zoning/master plan ordinances and special use permits are some commonly used regulatory tools. Land purchases, acquisitions and donations are examples of non-regulatory tools.

WHP programs have been initiated in seven Nevada communities to date and interest is growing rapidly. WHP simply makes sense as the clean up of a contaminated water supply well can potentially be very expensive or not possible at all. The importance of maintaining a quality drinking water supply can not be over emphasized. Additional information on NWHPP is available from the NDEP-BWQP.

SOURCES OF ASSISTANCE

1. FEDERAL AGENCIES

Federal programs and assistance are important in the planning, implementation and evaluation of BMPs. Several federal agencies have programs which offer financial, technical, regulatory and/or educational assistance to private landowners and landowner associations who seek to improve NPS-related water quality problems. The assistance available from the majority of federal agencies in the State is summarized in Table S-1. A brief description of some of the more pertinent programs follows.

U.S. Department of Agriculture

- Agricultural Stabilization and Conservation Service (ASCS)

Nevada State ASCS Office
1755 E. Plumb Lane, Suite 202
Reno, Nevada 89502-3207
(702) 784-5411

Elko ASCS Office
2002 Idaho Street
Elko, NV 89801-2627
(702) 738-6445

Ely ASCS Office
744 E. North Industrial Way
Ely, NV 89301
(702) 289-4990

Fallon ASCS Office
111 Sheckler Road
P.O. Box 1205
Fallon, NV 89406-1205
(702) 423-5127

Las Vegas ASCS Office
3301 W. Charleston Blvd.
Suite A
Las Vegas, NV 89102-8609
(702) 388-5311

Lovelock ASCS Office
11th & Cornell St.
Suite 1
P.O. Box 1070
Lovelock, NV 89419-1070
(702) 273-2922

Minden ASCS Office
1694 County Road
Minden, NV 89423-1329
(702) 883-2623

Winnemucca ASCS Office
1200 Winnemucca Blvd., E
Winnemucca, NV 89445-2920
(702) 623-5025

Yerington ASCS Office
28 N. Main Street
P.O. Box C
Yerington, NV 89447-0803
(702) 463-2855

The Agricultural Conservation Program (ACP) administered by the ASCS, provides financial and technical assistance to farmers, ranchers and non-industrial landowners who wish to apply soil, water and wildlife habitat conservation BMPs of long-term benefit to their land. The program emphasizes projects which control soil erosion and nutrient runoff from agricultural lands. Program monies are allocated to states and subsequently to county ASCS offices. County offices establish annual or long-term (3 to 10 years) cost-share agreements with landowners. Assistance under ACP may provide up to 80% of the costs for the conservation practice. Group projects involving more than one landowner are eligible for up to $10,000 annually. ACP special projects may be conducted at the state and/or county level. State/county level projects tend to promote interagency cooperation and may take the form of demonstration projects which provide long-term environmental benefits to the community in the treatment area. Other programs under the auspices of the ASCS include the: Conservation Reserve Program, Sodbuster, Swampbuster, Conservation Compliance, Water Bank Program and the Rural Clean Water Program. ASCS field offices are located strategically to serve all of Nevada.

- Farmers Home Administration (FmHA)

State Office
1390 S. Curry Street
Carson City, NV 89703
(702) 887-1222

Elko County Office
2002 Idaho Street
Elko, NV 89801
(702) 738-8468

Ely County Office
744 E.N. Industrial Way
Ely, NV 89315
(702) 289-8100

Fallon County Office
111 Sheckler Road
Fallon, NV 89406
(702) 423-7541

Las Vegas County Office
2357-A Renaissance Drive
Las Vegas, NV 89119
(702) 262-9047

Minden County Office
1694 County Road
P.O. Box 1300
Minden, NV 89423
(702) 782-3661

Winnemucca County Office
1200 Winnemucca Blvd., East
Winnemucca, NV 89445
(702) 623-4461

The Farmers Home Administration (FmHA) makes grants and loans to individual farmers and ranchers to develop water and soil conservation practices and pollution abatement measures on their lands. Loans are also available to landowner associations for irrigation improvements and other soil and water conservation projects. Loans obtained from FmHA may be used to supplement USDA cost-share projects developed through Watershed Protection and Flood Prevention and Resource Conservation and Development Programs.

- Soil Conservation Service (SCS)

Battle Mountain Field Office
113 Carson Road, 153-9
Battle Mountain, NV 89820
(702) 635-2650

Caliente Field Office
360 Lincoln Street
P.O. Box 8
Caliente, NV 89008
(702) 726-3101

Elko Field Office
2002 Idaho
Elko, NV 89801
(702) 738-8431

Ely Field Office
744 East N. Industrial Way
Ely, NV 89315
(702) 289-4065

Eureka Sub-Office
Sentenial Building
P.O. Box 323
Eureka, Nevada 89316
(702) 237-5251

Fallon Field Office
111 Sheckler Road
Fallon, NV 89406
(702) 423-5124

Las Vegas Field Office
2357-A Renaissance Drive
Las Vegas, NV 89104
(702) 388-6426

Lovelock Field Office
City of Lovelock Building
400 14th Street
P.O. Box 860
Lovelock, NV 89419
(702) 273-2134

Minden Field Office
1694 County Road
P.O. Box 517
Minden, NV 89423
(702) 782-3661

Nevada State Office
5301 Longley Lane
Bldg. F, #201
Reno, NV 89511
(702) 784-5863

Reno Field Office
1201 Terminal Way
Suite 222
Reno, NV 89502
(702) 784-5408

Tonopah Field Office
P.O. Box 1147
Tonopah, NV 89049
(702) 482-5506

Winnemucca Field Office
1200 Winnemucca Blvd., East
Winnemucca, NV 89445
(702) 623-5025

Yerington Field Office
215 West Bridge Street
Suite 11-A
Yerington, NV 89447
(702) 463-2265

Carson-Walker Resource
Conservation & Development Office
705 N. Plaza, Room #107
P.O. Box 3543
Carson City, NV 89702
(702) 463-2265

Conservation technical assistance is the core of the SCS programs. Technical assistance is provided in the form of on-site development and application of individual conservation plans. SCS personnel perform site-specific investigations of soil, plant, water and other physical conditions and interpret soil survey data to identify alternative land use and land treatment systems. Assistance also includes design and installation of conservation practices. The primary focus of the program has been to respond to farmers who voluntarily seek technical assistance in development and application of conservation plans. Other programs under the auspices of the SCS include: Watershed Protection and Flood Prevention (PL 566), Resource Conservation and Development, and River Basins Studies.

- U.S. Forest Service (USFS)

Austin Ranger District
50 S. Main at 5th
P.O. Box 130
Austin, NV 89310
(702) 964-2671

Bridgeport Ranger District
Highway 395
P.O. Box 595
Bridgeport, CA 93517
(619) 932-7070

Carson Ranger District
1536 S. Carson
Carson City, NV 89701
(702) 882-2766

Ely Ranger District
350 8th Street
P.O. Box 539
Ely, NV 89301
(702) 289-3031

Humboldt National Forest
976 Mountain City Highway
Elko, NV 89801
(702) 738-5171

Inyo National Forest
873 W. Main Street
Bishop, CA 93514
(619) 873-5841

Jarbidge Ranger District
1008 Burley Avenue
Buhl, ID 83316
(208) 543-4129

Las Vegas Ranger District
550 E. Charleston
Las Vegas, NV 89104
(702) 477-7782

Mountain City Ranger District
Mountain City, NV 89831
(702) 763-6691

Ruby Mountain Ranger District
301 South Humboldt
P.O. Box 246
Wells, NV 89825

Santa Rosa Ranger District

1200 Winnemucca Blvd. East
Winnemucca, NV 89445
(702) 623-5025

Toiyabe National Forest

1200 Franklin Way
Sparks, NV 89431
(702) 331-6444

Tonopah Ranger District
1400 S. Erie Main
P.O. Box 3940
Tonopah, NV 89049
(702) 482-6286

The U.S. Forest Service is a public land management agency responsible for the conservation of the Nation's forest resources for sustained yields of wood, water, forage, minerals, wildlife, and recreation, and for the conservation of environmental values of the

forests and rangelands.

In 1990, the Forest and Rangeland Renewable Resources Planning Act (RPA) Program was developed to address future resource demands, conflicts and concerns. The U.S. Forest Service has a special legislative mandate to implement multiple-use management for greatest resource benefits (timber, minerals, wilderness, soil and water, air, forage, fish and wildlife, recreation, cultural resources) and environmental sensitivity. Through a "Forest Plan," the Forest Service has implemented a Nonpoint Source Management Program for water quality protection and watershed improvement; in addition, the USFS has developed BMPs to address these concerns. Through cooperative efforts with other agencies and landowners, cumulative affects of land activities (NPS impacts) will be addressed by implementation of Best Management Practices on federal, state, and private lands.

Landowners with forest leases or with lands adjacent to U.S. Forests can cooperate with the USFS to solve common resource problems. Forest Service District Offices are located in Austin, Carson City, Elko, Ely, Fallon, Las Vegas, Mountain City, Tonopah, Wells and Winnemucca, and Bishop, California (Inyo Natl. Forest) and Buhl Idaho (Humboldt Natl. Forest).

U.S. Department of Commerce

- National Oceanic & Atmospheric Administration (NOAA)
  National Weather Service Office
  601 S Rock Blvd.
  Reno, NV
  (702) 784-5402

  NOAA maintains meteorological data and mapping for the country. The National Weather Service can also provide data which may be necessary to design certain structural BMPs (i.e. impoundments, detention/retention basins) to meet specific criteria such as the 100 year storm event.

U.S. Department of Defense

- U.S. Army Corps of Engineers (Corps)

  Sacramento District
  1325 J Street
  Sacramento, CA 95814-2992

  Nevada Regulatory Office, Room 2120
  300 Booth Street
  Reno, NV 89509

(916) 551-2268 (702) 784-5306

The U.S. Army Corps of Engineers is directly concerned with all aspects of water-resources development including conservation for municipal and industrial uses, flood zone mapping, flood control, navigation, hydroelectric power, recreation, fish and wildlife enhancement, irrigation, water quality control, waste water disposal, preservation of esthetic and ecological values and all other ecological values and other related land and water uses. The Corps administers laws pertaining to protection and preservation of navigable waters and is responsible for the issuance of 404 permits and wetland mapping.

U.S Department of Health and Human Services

- Indian Health Service (IHS)
  Reno District Office
  1395 Greg Street
  Sparks, NV 89431
  (702) 784-8522

  The IHS provides services to all tribes on a specific project basis. Services include water systems, waste water systems, soil testing and surveys, water quality and engineering and design. Residential subdivisions and support functions are their primary focus.

U.S Department of Interior (USDI)

- Bureau of Indian Affairs (BIA)

  Western Area Office
  1677 Hot Springs Road
  Carson City, NV 89706
  (702) 887-3551

  Eastern Area Office
  P.O. Box 28
  Elko, NV 89801
  (702) 738-5156

  Southern Area Agency
  P.O. Box 986
  Cedar City, UT 84720
  (801) 586-1121

  BIA administers the following programs: tribal management; real estate; leases, contracts and agreements; fiscal management; loan programs; surveying and mapping; tribal policies; housing; education and training; and social programs.

- Bureau of Land Management (BLM)

Nevada State Office
850 Harvard Way (89502-2055)
P.O. Box 12000
Reno, NV (89520-0006)
(702) 785-6500

Battle Mountain District
50 Bastian Road
P.O. Box 1420
Battle Mountain, NV
89820-1420
(702) 635-4000

Tonopah Detached Area Office
Tonopah Resource Area
Bldg. 102, Old Radar Base
P.O. Box 911
Tonopah, NV 89049-0911
(702) 482-7800

Carson City District
1535 Hot Springs Road
Suite 300
Carson City, NV
89706--638
(702) 885-6000

Elko District
3900 E. Idaho Street
P.O. Box 831
Elko, NV 89803-0831
(702) 753-0255

Ely District
702 North Industrial Way
HC33 Box 33500
Ely, NV 89301-9402
(702) 289-4865

Las Vegas District
4765 W. Vegas Drive 89108-2135
P.O. Box 26569
Las Vegas, NV 89126-0569
(702) 647-5000

Caliente Detached Area
Office
P.O. Box 237
Caliente, NV 89008-0327
(702) 726-8100

Winnemucca District
705 E. 4th Street
Winnemucca, NV 89445-2807
(702) 623-1500

National Wild Horse &
Bureau at Palomino Valley
P.O. Box 3270
Sparks, NV 89432-3272
(702) 475-2222

The BLM is responsible for administration of nearly 48 million acres of public lands in Nevada. These lands are managed for multiple-use benefits including mining, rangeland, grazing, recreation, fish and wildlife, woodland, etc. Resource Management Plans and Management Framework Plans are developed for pubic lands. The objectives of these management plans are to stabilize watersheds, to protect soil, water and air resources, and to develop and improve watershed conditions. Although the primary responsibility is public lands management, the BLM also works with public land users and adjacent landowners to solve resource problems of common concern to both.

- U.S. Geological Survey (USGS)
  Water Resources Division
  District Office
  333 W. Nye Lane
  Carson City, NV 89701
  (702) 887-7600

  As a federal agency with water quality and quantity concerns, the USGS has the capability to assist federal, state and local agencies through a variety of technical, coordination and management, financial, data management and other programs. One of the primary tasks of the USGS is the maintenance and collection of hydrological data. This data from streams, canals, drains and springs, lakes and reservoirs, and observation wells provide the hydrological information needed by state, local, and federal agencies and the private sector for developing and managing our Nation's land and water resources.

- U. S. Fish & Wildlife Service
  4600 Kietzke Lane
  Bldg C
  Reno, NV 89502
  (702) 784-5227

  The mission of the U.S. Fish and Wildlife Service is to provide leadership in achieving a national net gain of fish and wildlife and the natural systems which supports them.

- U.S. Bureau of Mines
  Reno Research Center
  1605 Evans Avenue
  Reno, NV 89502
  (702) 334-6600

  The Bureau of Mines is responsible for Nevada mining operations, mineral resources and associated statistical data. Research programs for mine processing technology are also conducted.

- U.S. Bureau of Reclamation (BOR)

  Lahontan Basin Projects Office
  P.O. Box 640
  Carson City, NV 89701
  (702) 887-3436

  Lower Colorado Regional Office
  P.O. Box 427
  Boulder City, NV 89005

  The Bureau of Reclamation administers a variety of programs that provide financial and technical assistance to irrigation districts for project operation and improvements such as

(control of sediment, erosion, and nonpoint source pollution) on BOR irrigation project lands. Additionally BOR can provide technical and financial assistance to state and federal agencies for basic water quality investigations, monitoring and planning (especially for irrigation return flow water quality).

U.S. Environmental Protection Agency

- U.S. Environmental Protection Agency (EPA)

  Region IX
  75 Hawthorne Street
  San Francisco, CA 94105
  (714) 744-1972

  The EPA was established in 1970 by Presidential Executive Order to bring together various government agencies involved with the control of pollutants. EPA provides numerous grants to states to promote the preservation of natural resources and to regulate potentially adverse environmental impacts. The EPA has primacy over the Nonpoint Source Pollution Program and provides technical assistance and monies for demonstration projects.

FEDERAL AGENCIES THAT PROVIDE ASSISTANCE *											
	USFS	SCS	Ag S	FHA	CORPS	EPA	USFWS	USGS	BLM	BOR	NWS
General Planning	✓	✓			✓				✓		
Aerial Photography		✓	✓		✓	✓		✓			
Topographic Maps	✓				✓			✓	✓		
Air Quality		✓				✓					
Land Use	✓	✓	✓		✓				✓	✓	
Land Ownership	✓	✓	✓						✓	✓	
Solid Waste Management		✓				✓					
Energy Resource									✓	✓	
Recreation	✓	✓			✓				✓	✓	
Geology	✓	✓						✓	✓		
Soils	✓	✓				✓		✓	✓		
Fish & Wildlife	✓	✓			✓		✓		✓		
Vegetation	✓	✓	✓						✓		
Critical Area Planning	✓	✓				✓		✓	✓		
Surface Water Quantity					✓	✓		✓	✓		
Surface Water Quality					✓	✓		✓	✓		
Ground Water Quantity						✓		✓	✓		
Ground Water Quality					✓	✓		✓	✓		
Wetlands						✓			✓		
Flood Hazard		✓			✓	✓		✓			✓
Water Use and Ownership	✓	✓				✓		✓	✓		
Financial Assistance			✓	✓							
Land Value	✓	✓							✓		
Engineering									✓		

* Abbreviations - USFS - Forest Service; SCS - Soil Conservation Service; Ag S - Ag. Stabilization & Conservation Service; FHA - Farmer's Home Administration; CORPS - Army Corps of Engineers; EPA - Environmental Protection Agency; USFWS - Fish & Wildlife Service; USGS - Geological Survey; BLM - Bureau of Land Management; BOR - Bureau of Reclamation; NWS - National Weather Service

TABLE S - 1

2. STATE AGENCIES

The following is a synopsis of State agencies that can provide assistance in the planning, implementation and evaluation of BMPs. The assistance available from State agencies is summarized in Table S-2. A synopsis of the assistance available from the University and Community College System is detailed in Section 3 and Table S-3.

Department of Conservation and Natural Resources

- Division of Conservation Districts (SDCD)
  333 West Nye Lane
  Carson City, NV 89710
  (702) 687-6977

  The Nevada Division of Conservation Districts provides staff services to the State Conservation Commission, which assists, guides and regulates the operations of Nevada's Conservation Districts. The SDCD maintains a current directory of the state's twenty-nine locally elected conservation district chairman.

  The authorities and responsibilities of the Commission and the Division are set forth in NRS 548. The Commission has promulgated NAC 548: Regulations Governing the Operations of Conservation Districts.

  Pursuant to the regulations, each conservation district is required to:

  - Meet at a regularly scheduled time and place in accordance with the Open Meeting Law, and file agendas and minutes with the Division.
  - Meet at least three times annually.
  - Adopt an annual work plan and budget for each fiscal year and submit same to the Division.
  - Complete an annual report and financial statement at the end of each fiscal year and submit same to the Division.
  - Hold elections during the first ten days of November in each even-numbered year, as set forth in the statutes.

- Division of Forestry (NDF)
  123 West Nye Lane
  Carson City, NV 89710
  (702) 687-4350

The Division of Forestry manages and coordinates all forestry, nursery, endangered plant species and watershed resource activities on certain public and private lands and is responsible for protecting community and natural resources by fire prevention and protection. NDF also provides planning assistance to private landowners for management and conservation of woodland and riparian areas. Several offices are located throughout the State.

Programs administered by the Division of Forestry, include but are not limited to:

FOREST PRACTICES - The Nevada Forest Practice and Reforestation Act (Nevada Revised Statutes [NRS] 528) establishes minimum standards of forest practice and requires compliance by every timber owner or operator in order to promote sustained productivity of forests in Nevada and to preserve the natural water supply in the interests of the economic welfare of the State.

WATER AND SOIL CONSERVATION - The establishment and preservation of vegetative cover in forests and watersheds is mandated in NRS 472. The purpose of this law is to conserve water and soil and to prevent destructive floods.

Nevada's Forest Protection Act (NRS 527) provides protection of forested lands, and trees and flora on all lands of the State of Nevada.

LOGGING - NRS 528 outlines logging permit and application requirements. The statutes also require: 1) logging plans depicting all roads, landings etc.; 2) the volume of timber to be removed; 3) performance bonds; and, 4) specifies cutting practices.

ACTIVITIES NEAR WATER - NRS 528 prohibits certain activities near bodies of water. No felling trees, skidding, rigging or construction of tractor or truck roads or landings, or the operation of vehicles may take place within 200 feet of any lake, reservoir, stream or other body of water unless a variance is first obtained from the State Forester, Director of Wildlife and the State Engineer.

TIMBERLAND CONVERSION CERTIFICATE - NRS 528 outlines the requirements to convert timber lands to other uses.

ENVIRONMENTAL EDUCATION - Provides environmental education material and training to teachers through 14 hour workshops; using trees and the forest as a "learning window" into the environment. Student/classroom programs utilize Smokey Bear, Project Learning Tree, and Nature Scope materials.

FOREST STEWARDSHIP PROGRAM AND STEWARDSHIP INCENTIVE PROGRAM - provides technical assistance and cost-share funding to Non-Industrial Private landowners to assist them with the management of their natural resources.

URBAN AND COMMUNITY FORESTRY - NRS 528.098 - Urban Forestry is thescience of developing, caring for and or cultivating conservation plant materials in an urban environment to enhance air quality, provide shade, stabilize soils, reduce noise and dust levels, maintain water quality and improve esthetics.

This program provides technical and cost share assistance to cities, communities, volunteer groups and citizens.

NURSERIES - To aid agriculture, conserve water resources, renew the timber supply, promote erosion control, beautify urban areas, educate the public, improve natural forests, deserts, wildlife habitation, and in other ways advance the general welfare and bring about benefits resulting from reforestation and the establishment of windbreaks, wood lots, greenbelts, open space, parks and arboretums on lands in the State of Nevada, NRS 528 authorizes the State Division of Forestry to negotiate and enter into cooperative agreements with the U.S. government or other state or local governments for the purpose of securing and establishing nursery sites.

The purpose of the nursery is to propagate and sell conservation grade plant material for all of the conservation purposes mentioned above. Plant materials range from harsh desert natives to riparian species. Plant material sales are restricted to landowners living outside of the city limits and owning 1 or more acres of land. This promotes planting for conservation purposes rather than general landscaping.

- Division of State Lands
  333 West Nye Lane
  Carson City, NV 89710
  (702) 687-4363

  The Division of State Lands authorizes all uses of state-owned lands, including the beds of navigable bodies of water, with the exception of lands held by the University systems, the Department of Transportation, and the Legislature. Nevada Revised Statutes 321 and 322 set forth the authority for the leasing of state lands and issuance of easements and rights-of-way and other authorizations. Activities at Lake Tahoe are governed by NAC 445.040 through 445.064: Regulations governing pier construction, deposit of fill, dredging or alteration of Lake Tahoe Shoreline.

- Division of Wildlife (NDOW)
  P.O. Box 10678
  Reno, NV 89520
  (702) 688-1500

The Division of Wildlife was established to preserve, protect, manage and restore the wildlife resources of Nevada. NDOW consists of six divisions and three Regions. The Board of Wildlife Commissioners was created to establish policies and regulations for the protection, propagation, restoration, transplanting, introduction and management of wildlife in the State. The goals of NDOW are to: 1) maintain all species of the State's wildlife and their habitats for their intrinsic and ecological values as well as their direct and indirect benefits to man, 2) provide for the diversified recreational use of the State's wildlife resource, 3) provide for an economic contribution from the wildlife resources in the best interests of the people consistent with the long-term welfare of these resources, and 4) provide for scientific, educational and aesthetic uses of the State's wildlife resources.

Environmental pollution, including nonpoint source pollution of water, degrades wildlife habitat and restricts production and propagation and is, therefore, inconsistent with the goals and objectives of NDOW. Divisions within NDOW can offer technical and educational, and, at times, financial assistance in NPS pollution management programs and projects.

Game Bureau - The Game Division is responsible for management of the State's big game, upland game, furbearers, waterfowl and nongame resources. In addition, the Division's duties include development, operation and maintenance of State-owned or uncontrolled wildlife management areas. The Division has the potential to assist in NPS Pollution management through the acquisition and protection of sensitive wildlife habitat areas which also have beneficial water quality functions (ie. wetlands and riparian areas) and through monitoring for metal, toxic chemical and other contamination of biota from water pollution.

Fisheries Bureau - The Fisheries Division is responsible for the protection, restoration, transplanting, introduction, and management of the fisheries resources within the State of Nevada. The Division provides financial, technical and research assistance for evaluating and resolving problems, including water pollution, affecting the resources.

Conservation Education Bureau - The objective of the Conservation Education Bureau (CEB) is to disseminate information about the Division of Wildlife and its programs, projects and activities through a multi-media approach designed to achieve public understanding of the need for the wise use of wildlife resources. The Division encompasses four major programs including Public Affairs, Hunter Education, Boating Safety Education, and Environmental Education. Project WILD, an environmental education program sponsored by the Department, presents teachers with methods for instruction of basic principles of conservation. The program is a potential mechanism for providing assistance to NPS educational programs.

Habitat Bureau - The Habitat Division is responsible for maintenance, protection, and enhancement of Nevada's fish and wildlife resources and habitats. The Division provides input relative to fish and wildlife concerns during the development of resource management plans and other action plans in addition to reviewing and evaluating proposed land and water uses that may effect fish and wildlife resources. The Division can offer technical, financial and data-management assistance in NPS pollution programs.

◆ Division of Water Resources
123 West Nye Lane
Carson City, Nevada 89710
(702) 687-4380

The Division of Water Resources is responsible for the appropriation of all surface and ground waters of the State, and regulates the construction of water wells. Nevada statutes exempt wells drilled before March 25, 1939 and those for single family household use up to 1, 880 gallons per day. The State Engineer is authorized to designate basins when administration of the basin is required to conserve ground water. Within designated basins, the State Engineer can establish preferred uses and limit withdrawals as needed. The following activities are regulated by the State Engineer through a permit process:

- appropriation of public waters;
- changing existing water rights;
- issuance of temporary changes of existing water rights;
- primary storage and use of secondary waste water;
- construction, reconstruction or alteration of dams;
- recharge, storage and recovery of water projects;
- claims of vested rights;
- subdivision review (permit not required but signature is); and,
- assignment of ownership of water rights (acknowledgement only, no permit required).

The State Engineer also licenses all well drillers and water right surveyors, maintains well logs from the drilling of all wells, and develops and enforces standards for well construction and closure. The goals of Nevada's water law is to protect the health and safety of Nevada's citizens, wildlife and fisheries, to preserve the quality of life and to protect the existing water rights of beneficial users.

The Division of Water Resources has the following information booklets available:

- Summary of Statutory Procedure in Making Application for a Water Right and Fee Set by Statute.

- Regulations Concerning Preparation of Maps under Applications to Appropriate

Water and Proofs of Appropriation.

- Nevada Administrative Code - Regulations for Water Well and Related Drilling.
- Common Methods of Measuring Water as Practiced in Western States.
- Assignments of Water Rights (Guidelines).

◆ Division of Environmental Protection
Nevada Division of Environmental Protection
333 West Nye Lane
Carson City, Nevada 89710
(702) 687-4670

The Division of Environmental Protection (NDEP) is responsible for implementation of statutory and regulatory provisions for the control of air and water (including point and nonpoint source) pollution and solid and hazardous waste management. NDEP has a variety of programs which directly or indirectly address NPS pollution issues and may offer assistance in NPS pollution control programs.

Bureau of Air Quality - The Bureau of Air Quality has responsibility for the issuance of air quality construction and operating permits. The purpose of the permits is to ensure, through enforceable permit conditions, that adequate air pollution control equipment is used in industrial processes to protect the ambient air quality standards and public health and safety, prevent injury to plant and animal life, prevent damage to property, and preserve visibility, scenic, aesthetic and historic values within the State.

Bureau of Mining Regulation and Reclamation - The Bureau of Mining Regulation and Reclamation has the responsibility for protecting the environment from adverse impacts associated with mining activities. Permits for the design, construction, operation and closure of mining facilities are issued under the authority of NAC 445.242 through NAC 445.24388. The purpose of the permits is to protect waters of the State from unauthorized discharges from process components. These regulations do not apply to facilities involved solely in the mining and processing of sand and gravel, cinders, diatomaceous earth, slate, shale, gypsum, clay or crushed stone.

Permits for the reclamation of exploration projects and mining operations are issued under the authority of NAC 519.A. the purpose of these permits is to ensure: 1) the return of the land to a safe, stable condition consistent with the establishment of a

productive post-mining use; and 2) the safe abandonment of a facility in a manner which ensures the public safety as well as the encouragement of techniques which minimize the adverse visual effects.

Bureau of Water Pollution Control - Bureau of Water Pollution Control is responsible for issuing ground water discharge permits, under the authority of Nevada Revised Statutes, Chapter 445. The purpose of the permit is to prevent ground water pollution and to protect the environment. Permits are required for any activity such as waste treatment plants, etc., which would or could result in a discharge of pollutants having the potential to adversely impact ground water.

This Bureau also issues National Pollution Discharge Elimination System (NPDES) permits. The purpose of these permits is to regulate discharges into surface waters to prevent water pollution, protect the environment and to preserve the beneficial uses that have been designated for those waters. Stormwater discharge permits are also issued under this program.

Underground Injection Control (UIC) permits are also obtained from this Bureau. The purpose of the permits is to regulate underground injection in order to prevent ground water pollution and protect the environment. Examples of activities which require a UIC permit include:

- Injection of fluids produced in conjunction with oil and gas production;
- Spent geothermal fluids;
- Ground water recharge projects; and
- Remediation projects if water or another substance is injected.
- Note: Injection of radiological and hazardous wastes are prohibited.

The Bureau of Water Pollution Control also permits all sewage disposal systems with a capacity of more than 5,000 gallons of effluent per day.

Bureau of Waste Management - The Bureau of Waste Management issues permits for the operation of landfills under the authority of Nevada Revised Statutes. The purpose of the permits is to ensure proper operation of such systems, in order to protect public health and the environment.

The Waste Management Bureau is also authorized to regulate hazardous wastes and to issue Resource Conservation and Recovery Act (RCRA) permits under authority of Nevada Revised Statutes (NRS) 459.400 through 459.600. Hazardous waste regulations and permits ensure proper management of hazardous wastes by generators, transporters, and treatment, storage, and disposal facilities.

Bureau of Water Quality Planning - The Bureau of Water Quality Planning develops, reviews and revises beneficial uses and water quality standards for surface water, develops the total maximum daily loads of pollutants which can be introduced into a waterbody to meet in-stream water quality standards, manages the Wellhead Protection Program, the Comprehensive State Ground Water Protection Program, and conducts statewide surface water monitoring. This Bureau also manages the Nonpoint Source program. The focus of the program is to 1) identify categories of NPS pollution which contribute significantly to water quality degradation and are not adequately addressed or controlled by existing programs; 2) describe a strategy for managing these categories of NPS pollution; and 3) develop a schedule for achieving program goal and objectives.

Bureau of Federal Facilities - The Bureau of Federal Facilities oversees permitting and remediation activities on lands owned by the Department of Energy and the Department of Defense.

Bureau of Corrective Actions - The Bureau of Corrective Actions regulates underground storage tanks and provides regulatory oversight on remediation of leaking underground storage tanks (UST/LUST programs), provides oversight for RCRA corrective action cases, provides Certification of Remediation Consultants and UST personnel, and administers the Superfund programs.

Department of Business and Industry

- Division of Agriculture
  350 Capitol Hill Avenue
  P.O. Box 1209
  Reno, NV 89504
  (702) 688-1180

The Nevada Division of Agriculture has primacy to administer the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in the state. The primary responsibility is to regulate the registration, use, storage, transportation and disposal of canceled and suspended pesticides. A State Management Plan for pesticides is being developed with the goal of protecting ground water from pollution.

The Nevada Pesticides Act (NRS 586.401) requires that all pesticides used in the state be registered with the Division of Agriculture which publishes an annual list of all registered pesticides, by their EPA registration Number.

The DOA is required to eliminate from use in the state any pesticides that endanger the agricultural or nonagricultural environment. To accomplish this, the Division of Agriculture continuously evaluates all registered pesticides, and those pending registration.

Less hazardous pesticides, but ones that still require careful use so as to avoid injury to man or the environment, are classified by the DOA as restricted-use pesticides. These pesticides are regulated by the Department and all applicators must pass a test prior to licensing.

- Division of Minerals (DOM)
  400 W. King Street
  Suite 106
  Carson City, NV 89710

The Division of Minerals regulates exploration for and production of oil, gas, and geothermal energy. In issuing permits for geothermal production and exploration wells, DOM is required to consult with and adhere to the policies and regulations administered by the Divisions of Environmental Protection, Water Resources, and Wildlife.

The DOM oil and gas regulations mandate that surface and subsurface formations of fresh water will be protected from pollution as a result of drilling or plugging a well or as the result of the escape, release, or injection of oil, gas, or brine from any well. Wells used to inject gas, air, water, or other fluids into a producing formation must be cased in such a way that leaks or damage to oil, gas, or fresh water are prevented.

Department of Human Resources

- Division of Health (DOH)
  Bureau of Health Protection Services
  505 E. King Street
  Carson City, NV 89710
  (702) 687-4150

The Division of Health, Bureau of Health Protection Services (BHPS), Nevada Department of Human Resources, is the primary enforcement authority for the supervision of public water systems as authorized under the Federal Safe Drinking Water Act. The BHPS is responsible for the monitoring and regulation of public water supplies throughout the state, with the exception of Washoe and Clark counties. The DOH is also responsible for permitting all individual domestic waste disposal (septic) systems (typically systems with less than 5,000 gallons per day), except in those health districts where a board of health has adopted such regulations. The District Health Departments have regulatory primacy in Washoe and Clark Counties.

Department of Transportation (NDOT)

1263 South Stewart St.
Carson City, NV 89710
(702) 687-5440

The role of the State Highway Department is to build and maintain roads throughout Nevada. Water quality problems evolving from highway and right-of-way runoff, maintenance procedures and road de-icing, are resolved by the Nevada Department of Transportation in cooperation with other state and federal agencies such as SCS, BLM, Nevada Division of Forestry, USFS, NDEP, Bureau of Indian Affairs, and others. All major Nevada Department of Transportation highway construction projects involve an EIS, Clearinghouse review and a water pollution control plan which includes appropriate BMPs. NDOT also is involved in interlocal Stormwater NPDES Permits in Washoe and Clark Counties. District offices are located at Las Vegas, Elko, Ely, Tonopah, and Winnemucca.

STATE AGENCIES THAT PROVIDE ASSISTANCE *										
	NDOA	NDEP	NDF	NDSP	NDSL	NDWR	NDWP	NDOW	NDOT	NHP
General Planning				✓		✓				
Aerial Photography				✓	✓					
Topographic Maps				✓						
Air Quality									✓	
Land Use	✓			✓	✓	✓	✓		✓	
Land Ownership	✓			✓	✓		✓			
Solid Waste Management									✓	
Energy Resource										
Recreation			✓	✓				✓		
Geology				✓						
Soils										
Fish & Wildlife					✓			✓		
Vegetation	✓	✓			✓			✓		
Critical Area Planning		✓	✓							
Surface Water Quantity					✓	✓				
Surface Water Quality			✓	✓	✓	✓		✓	✓	
Ground Water Quantity					✓	✓				
Ground Water Quality				✓	✓	✓			✓	
Wetlands					✓	✓		✓		
Flood Hazard					✓	✓				
Water Use and Ownership	✓				✓	✓				
Financial Assistance										
Land Value	✓	✓				✓				
Engineering					✓	✓				

* Abbreviations - NDOA - NV Department of Agriculture; NDEP - NV Division of Environmental Protection; NDOF - NV Division of Forestry; NDSP - NV Division of State Parks; NDSL - NV Division of State Lands; NDWR - NV Division of Water Resources; NDWP - NV Division of Water Planning; NDOW - NV Division of Wildlife; NDOT - NV Department of Transportation; NHP - Natural Heritage Program

TABLE S - 2

3. UNIVERSITY AND COMMUNITY COLLEGE SYSTEM

The following is a synopsis of programs in the University and Community College System which can provide educational and technical information for the general public regarding land use alternatives and treatments. Assistance in the planning, implementation and evaluation of BMPs is also available. As these agencies are quasi-public, the level of gratis assistance must be determined on a case-by-case basis.

The University and Community College System of Nevada has established programs which include:

- Agricultural Experiment Stations - (702) 784-6237
- Cooperative Extension Service - (702) 784-1614
- Desert Research Institute - (702) 673-7300
- Harry Reid Center for Environmental Studies - (702) 739-3094
- Nevada Small Business Development Center - (702) 784-1717
- Nevada Bureau of Mines and Geology - (702) 784-6691
- University of Nevada Library System - (702) 784-6533

The services provided by each of the above referenced programs is summarized in Table S-3. Each program can be contacted for more detailed information on the services provided. The following discussion will only focus on the services provided by the Cooperative Extension Service (CES) as CES has a mandate to work with agriculture, families, small communities, and decisions makers.

The Cooperative Extension Service has a primary role of public education (educational outreach and technology transfer), utilizing the technical expertise of specialists from the University of Nevada-Reno and elsewhere for field assistance when necessary. Assistance is provided through local extension staff who, in turn, work closely with other agencies. Information is provided in BMPs addressing water quality and quantity issues, and other traditional topics including: crop information, economics, seeding recommendations, pesticide use, etc.

Nevada Cooperative Extension areas and office locations are summarized below:

Central Area		**Southern Area**	
Fallon	423-5121	Las Vegas	731-3130
Winnemucca	623-6304	Logandale	397-2604
Yerington	463-3341	Tonopah	482-6794
Lovelock	273-2923	Caliente	726-3109
		Pahrump	727-5532

Northeast Area	
Elko	738-7291
Eureka	237-5326
Battle Mt.	635-5565
Ely	289-4459

Western Area	
Reno	784-4848
Carson City	887-2252
Gardnerville	782-9960
Incline Village	832-4150
Pahrump	727-5532

	UNIVERSITY & COMMUNITY COLLEGE SYSTEM THAT PROVIDES ASSISTANCE *							
	DRI	AES	BMG	RNR	HRCES	SBDC	CES	LS
General Planning								
Aerial Photography								
Topographic Maps								
Air Quality								
Land Use				✓			✓	
Land Ownership				✓				
Solid Waste Management								
Energy Resource				✓			✓	
Recreation								
Geology			✓					
Soils		✓		✓			✓	
Fish & Wildlife								
Vegetation		✓		✓			✓	
Critical Area Planning	✓							
Surface Water Quantity								
Surface Water Quality							✓	
Ground Water Quantity								
Ground Water Quality								
Wetlands								
Flood Hazard								
Water Use and Ownership			✓					
Financial Assistance								
Land Value							✓	
Engineering	✓							

* Abbreviations – DRI – Desert Research Institute (UNR); AES – Agriculture Experiment Station (UNR); BMG – Bureau of Mines & Geology (UNR); RNR – Renewable Natural Resources (UNR); HRCES – Harry Reid Center for Environmental Studies; SBDC – Small Business Development Center; CES – Cooperative Extension Service; LS – University of Nevada Library System

TABLE S – 3

4. LOCAL AGENCIES

The general services provided by regional and local agencies and business is summarized in Table S-4. Individual agencies and consulting firms should be contacted for specific information and applicable fees.

Conservation Districts

Conservation planning an technical assistance is available to landowners and manager through Nevada;s 29 Conservation Districts. The Districts consist of locally elected boards which provide guidance for the USDA soil conservation Service. This relationship provides access to the latest technology and knowledge available in a wide range of environmental disciplines.

Conservation Districts encourage Best Management Practices (BMPs) through public outreach efforts, demonstration projects and student education. Conservation District identify problems and provide solutions through voluntary programs.

Additional information on Conservation Districts can be obtained form the Nevada division of conservation Districts. (687-6977)

Consultants

Consulting firms are based throughout the State, and provide services such as resource inventory and planning, engineering, soils testing, etc. Some businesses marketing irrigation supplies or erosion control products, etc., also have specialists available to assist in planning and implementing conservation projects.

County Health Departments

Clark and Washoe Counties both have Health Districts that are responsible for certain environmental programs in those areas. In general, Clark and Washoe County Health Departments perform solid waste, individual septic system inspections and other public health programs. They also respond to hazardous waste spills and reports of leaking underground storage tanks. Clark and Washoe Counties also administer the Air Quality programs. NRS 439.370 through 439.580 enables these districts to be formed with the primary mandate to protect public health.

GLOSSARY

ABATEMENT: The method of reducing the degree or intensity of pollution, also the use of such a method.

ABSORPTION LOSS (Irrigation): The initial loss of water from a canal or reservoir by wetting of the soil when water first enters the structure.

ACCESS ROAD: A vehicular travelway constructed to provide entry to an area.

ACID SOIL: Soil with a pH value less than 7.0. The term is usually applied to the surface layer or to the root zone unless specified otherwise.

ACRE-FOOT: The volume of water that will cover 1 acre to a depth of 1 foot.

AEROBIC: Growing or occurring in the presence of molecular oxygen (see anaerobic).

AGRICULTURAL POLLUTION: Liquid and solid wastes from all types of farming, including runoff from pesticides, fertilizers, and feedlots; erosion and dust from plowing; animal manure and carcasses; and crop residues and debris.

AIR POLLUTION: The presence the contaminants in the air in concentrations that prevent the normal dispersive ability of the air and that interfere directly or indirectly with man's health, safety, comfort, or the full use and enjoyment of his property.

AIR QUALITY STANDARDS: The prescribed level of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified geographical area.

ALGAE (sing.,alga): Simple plants, many microscopic, containing chlorophyll; forming the base of the food chain in aquatic environments. Some species may create a nuisance when environmental conditions are suitable for prolific growth.

ALKALINE: Having the properties of an alkali; opposite of acidic.

ALKALINE SOIL: Soil with a pH value greater than 7.0, particularly above 7.3 throughout most of the root zone, although the term is commonly applied to only the surface layer or horizon of a soil.

ALLOTMENT: An area designated for the use of a prescribed number of cattle or sheep, or by common use of both under one plan of management.

ALLUVIAL LAND: Areas of unconsolidated alluvium, generally stratified and varying

widely in texture, recently deposited by streams, and subject to frequent flooding; a miscellaneous land type.

ANAEROBIC: Growing or occurring in the absence of molecular oxygen (see aerobic).

ANGLE OF REPOSE: Angle between the horizontal and the maximum slope that a soil assumes through natural processes.

ANIMAL UNIT (A.U.): A measurement of livestock numbers based on the equivalent of a mature cow (approximately 1,000 pounds live weight); roughly one cow, one horse, one mule, five sheep, five swine, or six goats.

ANIMAL UNIT MONTH (A.U.M.): A measure of forage or feed requirement to maintain one animal unit for a period of 30 days.

ANNUAL PLANT: A plant that completes its life cycle and dies in 1 year or less.

AQUATIC PLANTS: Plants growing in or near water with true roots, stems, and leaves other than algae.

AQUIFER: A geologic formation or structure that transmits water in sufficient quantity to supply the needs for development; usually saturated sands, gravel, fractures, or cavernous and vesicular rock.

ARID: Regions or climates that lack sufficient moisture for crop production without irrigation. The limits or precipitation vary considerably according to temperature conditions, with an annual limit for cool regions of 10 inches or less and for tropical regions up to 15 to 20 inches.

ARTESIAN WATER: Water confined under enough pressure to cause it to rise above the level first encountered in drilling. Flowing artesian wells are produced when the pressure is sufficient to force the water above the land surface.

ASPECT: The direction that a slope faces.

AUTOMATED SYSTEM: An irrigation system using timers or self-propulsion to reduce labor requirements in the application of irrigation water.

AUXILIARY SPILLWAY: A dam spillway built to carry runoff in excess of that carried by the principal spillway.

AVAILABLE FORAGE: Forage that is accessible for animal consumption.

BACKFILL: The material used to refill a ditch or other excavation, or the process of doing so.

BASE MAP: A map showing certain basic data to which other information may be added.

BASIN: 1. In hydrology, the area drained by a river. 2. In irrigation, a level plot of field, surrounded by dikes, which may be flood irrigated.

BASIN IRRIGATION: A method of irrigation in which a level or nearly level area, surrounded by an earth ridge or dike, is flooded with water.

BEDLOAD: The sediment that moves by sliding, rolling, or bounding on or very near the streambed.

BERM: A shelf or flat area that breaks the continuity of a slope.

BIENNIAL PLANT: A plant that requires 2 years to complete its life cycle.

BIOCHEMICAL OXYGEN DEMAND (BOD): A measure of the oxygen used in meeting the metabolic needs of aerobic micro-organisms in water rich in organic matter; also called biological oxygen demand.

BLOOM: A readily visible concentrated growth or aggregation of minute organisms, usually algae, in bodies of water.

BORDER DIKES: Earth ridges built to guide or hold irrigation water within prescribed limits in a field; a small levee.

BORDER DITCH: A ditch used as a border of an irrigated strip or plot; water is spread from one or both sides of the ditch along its entire length.

BORDER IRRIGATION: A surface method of irrigation by flooding between border dikes.

BRACKISH: Slightly salty; applied to water with a saline content that is intermediate between that of freshwater streams and sea water.

BROADCAST SEEDING: Scattering seed on the surface of the soil, in contrast to drill seeding, in which seeds are placed in rows in the soil.

BROAD-CRESTED WEIR: An overflow structure for measuring water, often rectangular in cross section, in which the water adheres to the surface of the crest rather than springing clear.

BROWSE: Twigs or shoots, with or without attached leaves, of shrubs, trees, or woody vines available as forage for domestic and wild browsing animals.

BROWSE LINE: The line on woody plants marking the height to which browsing animals have removed browse.

BRUSH MANAGEMENT: Management and manipulation of stands of brush by mechanical, chemical or biological means or by prescribed burning.

BRUSH MATTING: 1. A matting of branches placed on badly eroded land to conserve moisture and reduce erosion while trees or other vegetative covers are being established. 2. A matting of mesh wire and brush used to retard streambank erosion.

BUFFER STRIPS: Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

CARRYING CAPACITY: 1. In recreation, the amount of use a recreation area can sustain without deterioration of its quality. 2. In wildlife, the maximum number of animals an area can support during a given period of the year. See grazing capacity.

CESSPOOL: A lined and covered excavation in the ground which receives the discharge of domestic sewage or other organic wastes from a drainage system, so designed as to retain the organic matter and solids by permitting the liquids to seep through the bottom and sides.

CHANNEL IMPROVEMENT: Improvement of the flow characteristics of a channel by clearing, excavation, realignment, lining, or other means in order to increase its capacity.

CHANNEL STABILIZATION: Erosion prevention and stabilization of velocity distribution in a channel using jetties, drops, revetments, vegetation and other measures.

CHECK: A structure, permanent or portable, designed to raise or control the water surface in a channel or ditch.

CHECK DAM: Small dam constructed in a gully or other small watercourse to decrease streamflow velocity, minimize channel scour and promote deposition of sediment.

CHUTE: A high-velocity, open channel for conveying water to a lower level without erosion.

CLEAN TILLAGE: Cultivation of a field so as to cover all plant residues and to prevent the growth of all vegetation except the particular crop desired.
CLEARCUTTING: A method of cutting that removes the entire timber stand on the area

cut.

CLEARING AND SNAGGING: The clearing of trees and brush, and the removal of sediment bars, logs, snags, boulders, debris and other obstructions from the flow area of channels in order to improve flow characteristics.

CLOSED DRAIN: Subsurface drain, tile, or perforated pipe that receives surface water through surface inlets.

COLIFORM: A group of bacteria used as an indicator of sanitary quality in water. The total coliform group is an indicator of sanity significance, because the organisms are normally present in large numbers in the intestinal tracts of humans and other warm-blooded animals.

COLLUVIUM: Soil material or rock fragments moved by creep, slide, or local wash and deposited at the bases of steep slopes.

COMMON USE (Range): Grazing use by more than one kind of animal, either at the same time or at different times within the same growing season.

COMPACTION: 1. In geology, the changing of loose sediment into hard, firm rock. 2. In soil engineering, the process by which the solid grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing the weight of solid material per cubic foot. 3. In solid waste disposal, reducing the bulk of solid waste by rolling and tamping.

COMPLETE PROTECTION: The withdrawal of all grazing animals from a given range.

COMPREHENSIVE PLAN: A report from a governmental planning agency that describes how its areas of jurisdiction should be developed, expressing both policies and a coordinated plan for public and private land use, a transportation system, and public services, and facilities. Also called comprehensive development plan, general plan, master plan.

COMPREHENSIVE PLANNING PROGRAM: A continuing process which includes research on the conditions and trends in physical, social, and economic development; preparation and adoption of a comprehensive plan; programming of capital improvements; and initiation of the regulatory and administrative measures for implementation and maintenance of the plan.

CONCENTRATION: The amount of suspended particles in a unit volume as specified for a given temperature and pressure.

CONCRETION: A local concentration of a chemical compounds, such as calcium carbonate or iron oxide, in the form of an aggregate or nodule of varying size, shape, hardness and color.

CONDUIT: Any channel intended for the conveyance of water, whether open or closed.

CONJUNCTIVE WATER USE: The joining together of two sources of irrigation water, such as ground water and surface water, to serve a particular piece of land.

CONSERVATION: The protection, improvement and use of natural resources according to principles that will assure their highest economic or social benefits.

CONSERVATION CROPPING SYSTEM: Crop production using a combination of cultural and management practices that will protect the soil from erosion and improve or maintain its physical condition.

CONSERVATION DISTRICT: A public organization created under state law as a special-purpose district to develop and carry out a program of soil, water and related resources conservation, use, and development within its boundaries; usually a subdivision of state government with a local governing body; often called a Soil Conservation District or a Soil and Water Conservation District.

CONSERVATION PLAN FOR FARM, RANCH OR NONAGRICULTURAL LAND UNIT: The properly recorded decisions of the cooperating landowner or operator on how he plans, within practical limits, to use his land within its capability and to maintain or improve the soil, water and other resources.

CONSERVATION PLAN MAP: An aerial photograph(s) covering a farm or ranch with planned land use, field boundaries, fences, etc., portrayed thereon.

CONSERVATION STANDARDS: Standards for various types of soils and land uses, including criteria, techniques and methods for the control of erosion and sediment resulting from land disturbing activities.

CONSERVATION TILLAGE: An tillage system which reduces loss of soil or water compared to unridged or clean tillage.

CONSUMPTIVE USE: The quantity of water used and transpired by vegetation plus that evaporated. See evapotranspiration.

CONTAMINATION: The act of polluting or making impure; used to indicate chemical, sediment, or bacteriological impurities.

CONTINUOUS GRAZING: Domestic livestock grazing a specific area throughout the

grazing season. Not necessarily synonymous with year-long grazing.

CONTOUR: 1. An imaginary line on the surface of the earth connecting points of the same elevation. 2. A line drawn on a map connecting points of the same elevation.

CONTOUR DITCH: Irrigation ditch laid out approximately on the contour.

CONTOUR FARMING: Conducting field operations such as plowing, planting, cultivating and harvesting on the contour.

CONTOUR FLOODING: Method of irrigating by flooding from contour ditches.

CONTOUR-FURROW IRRIGATION: Applying irrigation water in furrows that run across the slope with a forward grade in the furrows.

CONTOUR FURROWS: Furrows plowed approximately on the contour to prevent runoff and increase infiltration.

CONTOUR INTERVAL: The vertical distance between contour lines.

CONTROLLED BURNING: The use of fire for burning a predetermined area to accomplish some desired result.

CONTROL STRUCTURE: A regulating structure to maintain water at a desired elevation, usually installed in gravity flow systems.

CONVENTIONAL TILLAGE: The combined primary and secondary tillage operations normally performed in preparing a seedbed for a given crop grown in a given geographical area.

CONVEYANCE LOSS: Loss of water from delivery systems during conveyance, including operational losses and losses due to seepage, evaporation, and transpiration by plants growing in or near the channel.

CORE TRENCH: Excavation for a core wall in the construction of an earth embankment.

CORE WALL: Wall of masonry, sheet piling or compacted earth placed near the center of a dam or embankment to reduce seepage.

CORROSION: The wearing away of earth materials through the cutting, scraping scratching and scouring effects of solid material carried in the currents of water or air.

CORROSION: The solution of rocks and other materials by chemical action.

CORRUGATION IRRIGATION: A partial surface flooding method of irrigation, normally used with drilled crops, where water is applied in small graded channels or furrows so spaced that an adequate lateral spread is obtained by the time the desired amount of water has entered the soil.

COVER CROP: A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of regular crop production or between trees and vines in orchards and vineyards.

COW MONTH: The grazing needed to maintain a mature cow in good condition for 30 days.

CREST: 1. The top of a dam, dike, spillway or weir, frequently restricted to the overflow portion. 2. The summit of a wave or peak of a flood.

CRIB DAM: A barrier of timber forming bays or cells that are filled with stone or other heavy material.

CRITICAL AREA: A severely eroded sediment producing area that requires special management to establish and maintain vegetation in order to stabilize soil conditions.

CRITICAL REACH: The point in the receiving stream below a discharge point at which the lowest dissolved oxygen level is reached and recovery begins.

CROP RESIDUE: The portion of a plant or crop left in the field after harvest.

CROP RESIDUE MANAGEMENT: Use the of that portion of the plant or crop left in the field after harvest for protection or improvement of the soil.

CROP ROTATION: The growing of different crops in recurring succession on the same land.

CULTURAL EUTROPHICATION: Acceleration by man of the natural process of enrichment (aging) of bodies of water.

CUT: Portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

CUT-AND-FILL: Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

CUTOFF: 1. Wall, collar, or other structure, such as a trench, filled with relatively

impervious material intended to reduce seepage of water through porous strata. 2. In river hydraulics, the new and shorter channel formed either naturally or artificially when a stream cuts through the neck of a bend.

DAM: A barrier to confine or raise water for storage or diversion, to create a hydraulic head, to prevent gully erosion, or for retention of soil, rock, or other debris.

DAM, DIVERSION: A structure constructed to divert part or all of the water from a waterway or stream into a different watercourse, irrigation canal or ditch, or a waterspreading system. For sediment control purposes, a diversion dam may divert runoff from an unstable eroding watercourse into a stable nonerosive watercourse. Diversion dams may be constructed of compacted earth-fill, concrete, masonry or timber. Outlet works must provide positive control of the water to be diverted. By-pass works must be capable of passing all flows needed to satisfy downstream owners in cases where all water is not diverted. This may require a system of weirs, orifices or gates. An emergency spillway is required to pass maximum flows in excess of the capacity of the diversion and by-pass system unless such system is designed to handle such maximum flows.

DEBRIS BASIN: A dam constructed across a waterway or at other suitable locations to form a silt or sediment basin, thus preventing sediment damages to downstream areas. Basins can be excavated or formed by a combination of earthfill dam and excavation. An ungated pipe through the dam with a perforated riser within the basin and above the sediment storage level will permit the passage of runoff waters. An emergency spillway should be provided to pass flows exceeding the capacity of the basin without overtopping the dam. Other systems of controlling the flow of water through the dam may be used depending on individual sites, however the pipe and riser combination are most common. Debris basins may be temporary during a construction period or may be permanent, some of which may have dual purpose by storing both debris and water.

DEBRIS DAM: A barrier built across a stream channel to retain rock, sand, gravel, silt or other material.

DEBRIS GUARD: Screen or grate at the intake of a channel, drainage or pump structure for the purpose of stopping debris.

DECOMPOSITION: The breakdown of organic waste materials by bacteria; may be aerobic or anaerobic.

DEEP PERCOLATION: Water that percolates below the root zone and cannot be used by plants.

DEFERRED GRAZING: The discontinuance of livestock grazing for a specified period of

time during the growing season to promote plant reproduction, establishment of new plants or restoration of vigor by old plants. The postponing or resting of grazing land provides more cover for soil protection while providing a feed reserve for fall and winter grazing or emergency use.

DEFERRED-ROTATION GRAZING: A systematic rotation of deferred grazing.

DEGRADATION: To wear down by erosion, especially through stream action.

DEGREE OF USE: Utilization or consumption of plant growth in respect to weight--may be expressed in qualitative terms such as unused, slight, moderate, full, close, severe, over extreme, destructive, etc. or as percent of weight for either an individual plant or the vegetation as a whole.

DELIVERY BOX (Irrigation): Structure diverting water from a canal to a farm unit, often including measuring devices.

DENSITY: The number of plants or specific plant parts per unit area of ground surface.

DEPOSITION: The accumulation of material dropped because of a slackening movement of the transporting agent (water or wind).

DESALINIZATION: 1. Removal of salts from saline soils, usually by leaching. 2. The conversion of salt water to sweet water. Also spelled desalination.

DESILTING AREA: An area of grass, shrubs or other vegetation used for inducing deposition of silt and other debris from flowing water; located above a stock tank, pond, field or other area needing protection from sediment accumulation. See filter strip.

DESIRABLE PLANT SPECIES: Species of moderate to high palatability that are preferred by animals. Also, species that are beneficial with respect to soil and water conservation.

DETACHMENT: The removal of transportable fragments of soil material from a soil mass by an eroding agent, usually falling raindrops, running water or wind. Through detachment, soil particles or aggregates are made ready for transport - soil erosion.

DETENTION DAM: A dam constructed for the purpose of temporary storage of streamflow or surface runoff and for releasing stored water at controlled rates.

DETERIORATED RANGE: A range which has regressed or may still be regressing from its production potential; can be caused by many factors but is usually due to continued

overuse by livestock, wildlife, rodents or insects and certain types of erosion.

DIKE: An embankment to confine or control water, especially one built along the bank of a river to prevent overflow of lowlands; a levee.

DISCHARGE: Rate of flow; a volume of fluid passing a point per unit time, commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

DISCHARGE POINT: A location at which effluent is released into a receiving stream.

DISPOSAL FIELD: Area used for spreading liquid effluent for separation of wastes from water, degradation of impurities and improvement of drainage waters. Also called infiltration field.

DISSOLVED SOLIDS: The total amount of dissolved material, organic and inorganic, contained in water or wastes. Excessive dissolved solids make water unpalatable for drinking and unsuitable for industrial uses.

DISTRIBUTION SYSTEM: 1. System of ditches and their appurtenances which convey irrigation water from the main canal to farm units. 2. Any system that distributes water within a farm.

DIVERSION: A channel with a supporting ridge on the lower side constructed on a gradient across the slope to divert water from areas being damaged to sites where it can be used or disposed of safely.

DIVERSION DAM: A barrier built to divert part or all of the water from a stream into a different course.

DIVERSION TERRACE: Individually designed channels across a hillside used to protect bottomland from hillside runoff or, when placed above a terrace system, to protect against runoff from an unterraced area; may also divert water out of active gullies, protect farm buildings from runoff, reduce the number of waterways, and sometimes used in connection with stripcropping to shorten the length of slope so that the strips can effectively control erosion. See terrace.

DRAIN SYSTEM STRUCTURE: An auxiliary structure installed in a subsurface drainage system to control the flow of water and reduce erosion; this includes pipe drops, junction boxes, catch basins, sand traps and other special purpose structures; used to protect ends of drain lines, control grade and velocity, regulate flows, collect sediment and debris and prevent erosion in drainage channels; normally constructed of reinforced concrete, concrete block, stone, masonry or other suitable prefabricated materials.

DRILL SEEDING: Planting seed with a drill in relatively narrow rows, generally less than a foot apart. See broadcast seeding.

DROP STRUCTURE: A structure for dropping water to a lower level and dissipating its surplus energy; a drop may be vertical or inclined.

DUGOUT: A natural or artificial depression that impounds water and differs from a reservoir in that a dam is not relied upon to back up water.

EARTH DAM: Dam constructed of compacted soil materials.

ECOLOGY: The study of interrelationships of organisms to one another and to their environment.

ECOSYSTEM: A community, including all component organisms, together with the environment, forming an interacting system.

EFFLUENT: 1. Solid, liquid, or gas wastes which enter the environment as a by-product of man-oriented processes. 2. The discharge or outflow of water from ground or sub-surface storage.

EMERGENCY SEEDING OF BURNED AREAS: Stabilizing soils after wildfire burns by selecting and seeding adapted grasses and legumes. Such planting prevents soil erosion and reduces flood silt and sedimentation damage on or below burned areas.

EMERGENCY SPILLWAY: A spillway used to carry runoff exceeding a given design flood.

ENCLOSURE: An area fenced to confine animals.

ENVIRONMENT: The sum total of all the external conditions that may act upon an organism or community to influence its development or existence.

ENVIRONMENTAL IMPACT STATEMENT (EIS): A document prepared by a federal or state agency or a private firm detailing the environmental impact of a proposed law, construction project or other major action that may significantly affect the quality of the

environment; required by the National Environmental Policy Act and various state environmental laws.

EPHEMERAL STREAM: A stream or portion of a stream that flows only in direct response to precipitation, and receives little or no water from springs, snow or other sources; the channel is at all times above the water table.

EROSION: 1. The wearing away of land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. The following terms are used to describe different types of erosion.

ACCELERATED EROSION: Erosion much more rapid than geologic erosion, mainly caused by the activities of man or other animals or by a natural event, such as fire, that exposes a bare surface.

GEOLOGICAL (NATURAL) EROSION: The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, costal plains, etc.

GULLY EROSION: Removal of soil (sometimes to considerable depths) from narrow areas over a short period of time.

EUTROPHICATION: An aging process in lakes characterized by an abundant growth of aquatic plants and waters deficient in oxygen. The process is usually accelerated by surface runoff containing nitrogen and phosphorus.

EVAPOTRANSPIRATION: The combined loss of water due to evaporation from the soil surface and transpiration from plants.

EXCLOSURE: An area fenced to exclude animals.

FAUNA: The animal life of a region.

FERTILIZER: Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth.

FIELD CAPACITY: The amount of water retained in a soil or in solid wastes after it has been saturated and has drained freely. In soils, also called field moisture capacity (obsolete in technical work) and is usually expressed as a percentage of the ovendry weight of the soil. In waste management also called moisture holding capacity.

FILTER STRIP: Strip of permanent vegetation above farm ponds, diversion terraces and other structures to retard flow of runoff water, causing deposition of transported material, and thereby reducing sediment flow. See desilting area.

FIRE BREAK: A strip of bare land or fire retarding vegetation used to check creeping or running fires; can serve as a line from which to work and facilitate the movement of men and equipment during fire suppression activities.

FISH STREAM IMPROVEMENT: Improving channels of perennial streams for fish habitat by providing shade and deepening and altering stream flow characteristics. Land treatment measures are applied to watersheds to control erosion and reduce sedimentation in stream channels.

FIXATION: Soil processes in which certain chemical elements essential for plant growth are converted from soluble or exchangeable form to a less soluble or nonexchangeable form (i.e. phosphate fixation).

FLOOD IRRIGATION: The application of irrigation water where the entire soil surface is covered by a sheet of water; called "controlled flooding" when water is impounded or the flow is directed by border dikes, ridges or ditches.

FLOODPLAIN: A nearly level alluvial plain that borders a stream channel and is subject to flooding unless protected artificially.

FLORA: The plant life of a region.

FORAGE: All browse and herbaceous food that is available to livestock or game animals; used for grazing or harvested for feeding.

FORAGE PRODUCTION: The weight of forage produced within a designated time period on a given area; may be expressed as either green, air-dry or oven-dry.

FROST ACTION: Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

FURROW IRRIGATION: A partial surface flooding method of irrigation normally used with clean-tilled crops where water is applied in furrows or rows of sufficient capacity to contain the designed irrigation stream.

GABION: A rectangular or cylindrical wire mesh cage filled with rock and used as a protecting apron, revetment, etc., against erosion.

GATE (Irrigation): Structure or device for controlling the flow rate into or from a canal, ditch or pipe.

GRADE: 1. The slope of a road, channel or natural ground. 2. The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction like paving or laying a conduit.

GRADE STABILIZATION STRUCTURE: A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further headcutting or lowering of the channel grade.

GRADIENT: Change of elevation, velocity, pressure or other characteristics per unit length; slope.

GRASSED WATERWAY: A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.

GRAZING CAPACITY: The maximum stocking rate possible without inducing damage to vegetation or related resources.

GRAZING SEASON: A period of grazing to obtain optimum use of the forage resource. On public lands, an established period for which grazing permits are issued.

GRAZING SYSTEM: The manipulation of livestock grazing to accomplish a desired result.

GREENBELT: A strip of land kept in its natural or relatively undeveloped state or in agricultural use and which serves to break up the continuous pattern of urban development; frequently planned around the periphery of urban settlements.

GROUND COVER: Grasses or other plants grown to keep soil from being blown or washed away.

GROUND WATER: All subsurface water comprising the zone of saturation.

GROWING SEASON: The period and/or number of days between the last freeze in the spring and the first frost in the fall.

GULLY: A furrow, channel or miniature valley, usually with steep sides, through which water commonly flows during and immediately after rains or snow melt.

GULLY CONTROL PLANTINGS: The planting of forage, legumes or woody plants in gullies to establish or re-establish a vegetative cover adequate to control runoff and erosion and incidentally produce useful products.

HEAD GATE: A water control structure; the gate at the entrance to a conduit.

HEADWATER: 1. The source of a stream. 2. The water upstream from a structure or point on a stream.

HEAVY METALS: Metals present in municipal and industrial wastes that pose long-term environmental hazards including boron, cadmium, cobalt, chromium, copper, mercury, nickel, lead and zinc.

HEAVY USE AREA PROTECTION: Protecting heavily used areas by establishing vegetative cover, surfacing with suitable materials (asphalt, concrete, gravel, cinders, bark) or installing needed structures.

HERBICIDE: A chemical substance uses for killing plants, especially weeds.

HOLDING TANK: A prefabricated structure of concrete, steel or like materials constructed to store liquid manure from animals or other wastes.

HYDROSEEDING: Hydraulic dissemination of seed in a water medium; mulch, lime, and fertilizer can be incorporated into the sprayed mixture.

IMPERVIOUS SOIL: A soil through which water, air or roots cannot penetrate.

IMPOUNDMENT: Generally, an artificial collection or storage of water, as a reservoir, pit, dugout or sump. See reservoir.

INTAKE RATE: The rate of entry of water into soil.

INTERMITTENT STREAM: A stream or portion of a stream that flows only in direct response to precipitation, and receives little or no water from springs and snow melt or other sources. It is dry for a large part of the year, ordinarily more than 3 months.

INTRODUCED SPECIES: A species not part of the original fauna or flora of a particular area.

IRRIGATION LATERAL: A branch of the main canal conveying water to farm ditches.

IRRIGATION SYSTEM, SURFACE AND SUBSURFACE: A planned system for the efficient distribution of irrigation water by surface means, such as furrows, borders, contour levees or contour ditches, or by subsurface means; systems must be carefully planned and installed to obtain optimum irrigation efficiency and to eliminate or minimize erosion.

IRRIGATION SYSTEM TAILWATER RECOVERY: A water runoff collection and storage system to provide a constant quantity of water back to the initial system or to another field. Water is applied to the rows at the same rate for the entire irrigation period. Advance time should equal irrigation recession time as nearly as possible. Recession time is usually one-fourth of the entire irrigation period.

IRRIGATION STRUCTURE: Any structure or device necessary for the proper conveyance, control, measurement or application of irrigation water.

IRRIGATION WATER MANAGEMENT: The use and management of irrigation water where the quantity of water used for each irrigation is determined by soil moisture-holding capacity and crop needs; water is applied efficiently and significant erosion and water loss does not occur. Irrigation water management is applicable to all methods of irrigation.

JETTY: A structure built of rocks or other material extending into a stream or into the sea to induce scouring or bank building, or for protection.

KEY MANAGEMENT SPECIES: Major forage species on which management should be based.

LAGOON: In sewage treatment, a reservoir or pond built to contain water and animal wastes until they can be decomposed either by aerobic or anaerobic processes.

LAND CAPABILITY: The suitability of land for use without permanent damage; involves consideration of the risks of erosion and difficulties in land use owing to physical land characteristics including climate.

LAND DISTURBING ACTIVITY: Any land change which may result in soil erosion from water or wind and the movement of sediments into water or onto land, including tilling, clearing, grading, excavating, etc.

LAND LEVELING: The process of shaping the land surface for better movement of water and machinery over the land; also called land forming, land shaping or land grading.

LAND SMOOTHING: Removing mounds, depressions and other surface irregularities by use of special equipment in order to improve drainage, provide more uniform cultivation and improve equipment operation and efficiency. It is not necessarily an erosion control practice in itself but a supporting practice for other erosion control practices.

LEACHING: The removal of soluble materials from the soil by percolating waters.

LINED WATERWAY OR OUTLET: A waterway or outlet with an erosion resistant lining of concrete, stone or other permanent material to eliminate erosion from the waterway. This practice is applicable to channels where the capacity requirements do not exceed 100 c.f.s. It is also applicable as a spillway outlet for earthfill dams.

MECHANICAL PRACTICES: Soil and water conservation practices that primarily change the surface of the land or that store, convey, regulate or dispose of runoff water without excessive erosion.

MINE DUMPS: Overburden and other waste materials from ore and coal mines, quarries or smelters, usually with little or no vegetative cover. A miscellaneous land type.

MINIMUM TILLAGE: The amount of tillage required to create the proper soil condition for seed germination and plant establishment.

MULCHING: Applying plant residues or other suitable materials not produced on the site to the soil surface for erosion control; also used to help establish plant cover and prevent surface crusting and compaction.

MULTIPLE LAND USE: Harmonious use of lands for more than one of the following purposes: grazing of livestock, wildlife production, recreation, wildlife habitat and timber production; not necessarily the combination of uses that will yield the highest economic return or greatest unit output.

NATIVE PASTURE: Land on which the climax plant community is forest, but which is used or managed primarily for the production of native species for forage.

NATURAL REVEGETATION: Natural re-establishment of plants - propagation of new plants over an area by natural processes.

NITRIFICATION: The biological oxidation of ammonium to nitrate and the further oxidation of nitrite to nitrate.

NONPOINT POLLUTION: Pollution whose sources cannot be pinpointed; best controlled by proper soil, water and land management practices.

NONRENEWABLE NATURAL RESOURCES: Natural resources that, once used, cannot be replaced.

NOTILL: The placing of seeds in a cut below the soil surface to create the proper soil coverage for seed germination with little or no disturbance on the surface.

NOXIOUS SPECIES: An undesirable plant species that is unwholesome to the range or animal. Not to be confused with species declared noxious by certain laws.

NUTRIENTS: Elements or compounds such as carbon, oxygen, nitrogen, phosphorous, etc., which are essential for the growth and development of plants and animals.

OPEN DRAIN: Natural watercourse or constructed open channel that conveys drainage water.

OPEN RANGE: An extensive grazing area on which the movement of livestock is unrestricted.

OUTLET: Point of water disposal from a stream, river, lake, tidewater, or artificial drain.

OVERBURDEN: The earth, rock and other materials that lie above a mineral deposit.

OVERSTOCKING: Placing a number of animals on a given area that will result in overuse at the end of the planned grazing period.

OVERSTOCKING (Forestry): Too many trees/acre for individual trees to be healthy or vigorous.

OVERUSE: Excessive use of the current year's growth, resulting in range deterioration or overgrazing, if continued.

OXIDATION POND: A man-made lake or pond in which organic wastes are reduced by bacterial action; often oxygen is bubbled through the pond to speed the process.

PARTICULATES: Solid or liquid particles in the air or in an emission including dust, smoke, fumes, mist, spray and fog.

PASTURE: An area devoted to the production of native or introduced forage and harvested by grazing.

PASTURE AND HAYLAND MANAGEMENT: The proper treatment and use of pasture and hayland; includes grazing and harvesting methods to maintain or improve the quality and quantity of plants for forage and to protect the soil.

PASTURE PLANTING: Establishing adapted herbaceous species on land to be treated and grazed as tame pasture.

PERCENT USE: Grazing use of current growth, usually expressed as a percent of weight removed.

PERCOLATION: The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

PERENNIAL PLANT: A plant that normally lives 3 or more years.

PEST: "Pest" means, but is not limited to any insect, fungus, rodent, nematode, snail, slug, weed and any form of plant or animal life or virus (except virus on or in living man or other animal) which is normally considered to be a pest or which the executive director may declare to be a pest (NRS 555.2665).

PESTICIDE: "Pesticide" means:
1. Any substance or mixture of substances, including any living organisms or any product derived therefrom or any fungicide, herbicide, insecticide, nematocide or rodenticide, intended to prevent, destroy, control, repel, attract or mitigate any insect, rodent, nematode, snail, slug, fungus, weed and any other form of plant or animal life or virus (except virus on or in living man or other animals) which is normally considered to be a pest or which the executive director may declare to be a pest.

2. Any substance or mixture of substances intended to be used as a plant regulator, defoliant or desiccant, and any other substances intended for such use as may be named by the executive director by regulation after calling a public hearing for that purpose (NRS 555.267).

pH: A numerical measure of acidity or hydrogen ion activity. Neutral is pH 7.0. pH values below 7.0 are acid; values above 7.0 are alkaline.

PHREATOPHYTE: A plant whose roots are in or very near the water table.

PLANNED GRAZING SYSTEM: A system of grazing in which two or more grazing units are alternately rested in a planned sequence over a period of years. The resting period may be throughout the year or during the growing season of the key species.

PLAYA: A shallow central basin of a plain where water gathers after a rain and is evaporated.

POINT SOURCE (Pollution): A stationary source of pollution, such as a smoke stack or discharge pipe. See nonpoint pollution.

POLLUTION: The condition caused by the presence in the environment of substances of such character and in such quantities that the quality of the environment is impaired or rendered offensive to life. See air pollution, water pollution.

POND, WASTEWATER STABILIZATION: A natural or artificial pond into which untreated or partially treated wastewater is discharged and in which natural purification and stabilization processes take place under the influence of sunlight, air, and biological activity. See lagoon.

PRIMARY WASTE TREATMENT: The first stage in wastewater treatment in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

PROPER GRAZING USE: Grazing ranges and pastures in a manner that will maintain adequate cover for soil protection and maintain or improve the quality and quantity of

desirable vegetation.

RANGE: All land producing native forage for animal consumption, and lands that are revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. Generally considered as land that is not cultivated.

RANGE CONDITION: The state and health of the range based on what that range is naturally capable of producing.

RANGE IMPROVEMENT: Any structure or excavation to facilitate management or range or livestock. Also an increase in the grazing capacity of range.

RANGE INVENTORY: An itemized list of resources of a management area such as range sites, range condition classes, range condition trends, range use, estimated proper stocking rates, physical developments and natural conditions such as water, barriers, etc.
RANGE MANAGEMENT: The art and science of planning and directing range use to obtain sustained maximum animal production, consistent with perpetuation of the natural resources. See multiple use.

RANGE RENOVATION: Improving rangeland by discing or other mechanical means.

RECHARGE: Process by which water is added to the zone of saturation.

RECLAMATION: The process of reconverting disturbed lands to their former uses or other productive uses.

RESERVOIR: Impounded body of water or controlled lake in which water is collected or stored.

RESIDUE: Material that remains after gases, liquids, or solids have been removed.

RESTORATION: The process of restoring site conditions as they were before the land disturbance.

RETURN FLOW: That portion of the water diverted from a stream that finds its way back to the stream channel either as surface or underground flow.

REVEGETATION: The re-establishment or improvement of vegetation through either natural or mechanical means.

REVETMENT: Facing of stone or other material, either permanent or temporary, placed along the edge of a stream to stabilize the bank and to protect it from the erosive action of the stream.

RIPARIAN AREA: Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody.

RIPRAP: Broken rock, cobbles or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the erosive action of water; also brush or pole mattresses, brush, stone or other similar materials used for soil erosion control.

RUNOFF: That portion of the precipitation on a drainage area that is discharged from the area in stream channels or through the ground water system.

SANITARY LANDFILL: A site on which solid wastes are disposed of in a manner that protects the environment; wastes are spread in thin layers, compacted to the smallest practical volume, and covered with soil.

SCOUR: To abrade and wear away; used to describe the wearing away of terrace or diversion channels or stream beds.

SECONDARY POLLUTANTS: Those pollutants that result from the chemical reactions involving primary pollutants or related atmospheric contaminants (i.e. oxidants from photochemical activity).

SECONDARY WASTE TREATMENT: The removal of up to 90 percent of the organic material from sewage by the metabolic action of bacteria. See waste treatment.

SEDIMENT: Mineral or organic solid material which is either in suspension, is being transported, or has been moved from its site of origin to another resting place by air, water, gravity, or ice.

SEDIMENT DISCHARGE: The quantity of sediment, measured in dry weight or by volume, transported through a stream cross-section in a given time. Sediment discharge consists of both suspended load and bedload.

SEPTIC TANK: An underground tank used for the deposition of domestic wastes. Bacteria in the wastes decompose the organic matter, and the sludge settles to the bottom. Effluent flows through drains into the ground. Sludge is pumped out at regular intervals.

SETTLING BASIN: An enlargement in the channel of a stream to permit the settling of debris carried in suspension.

SEWAGE: The total organic waste and wastewater generated by residential and

commercial establishments.

SEWAGE SLUDGE: Settled sewage solids combined with varying amounts of water and dissolved materials that is removed from sewage by screening, sedimentation, chemical precipitation, or bacterial digestion.

SHRINK-SWELL POTENTIAL: Susceptibility to volume change due to loss or gain in moisture content.

SLOPE: A slant or incline of the surface, usually measured in degrees or percent from the horizontal and characterized by direction (exposure).

SOD: Vegetation which grows so as to form a mat.

SOIL ABSORPTION SYSTEM: Any system that utilizes the soil for subsequent absorption of treated sewage, such as an absorption trench, seepage bed, or seepage pit.

SOIL IMPROVEMENT: The processes for, or the results of, making the soil more productive for growing plants by drainage, irrigation, addition of fertilizers and soil amendments, and other methods.

SOLID WASTE: Useless, unwanted, or discarded material with insufficient liquid content to be free flowing. See waste.

SOLID WASTE DISPOSAL: The ultimate disposition of refuse that cannot be salvaged or recycled.

SOLID WASTE MANAGEMENT: The purposeful, systematic control of the generation, storage, collection, transport, separation, processing recycling, recovery, and disposal of solid wastes.

SPECIES COMPOSITION: The relative proportions of various plant species in the total cover on a given area. It may be expressed in terms of cover, density, weight, etc.

SPOILBANK: A pile of soil, subsoil, rock, or other material excavated from a drainage ditch, pond, or other cut.

SPRING DEVELOPMENT: Improving springs and seeps by excavating, cleaning, capping, or providing collection and storage facilities for water. Spring developments are usually made to improve the distribution of livestock or recreation water supplies. Spring development may include collection systems, spring boxes and outlet pipes. Erosion control benefits may include better distribution of cattle grazing by improved water distribution facilities thereby reducing the possibility of overgrazing and erosion.

STABILIZED GRADE: The slope of a channel at which neither erosion nor deposition occurs.

STILLING BASIN: An open structure or excavation at the foot of an overfall, chute, drop or spillway to reduce the energy of the descending stream.

STREAMBANKS: The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.

STREAMBANK PROTECTION: Stabilizing and protecting banks of streams or excavated channels against scour and erosion by vegetation or structural means. Channel grade must be controlled before permanent streambank protection measures are installed unless the protection can be safely and economically constructed to a depth well below the anticipated depth of bottom scour. Streambank protection works can include many methods such as banksloping and vegetation, riprap, concrete paving, jetties, revetments or fencing. Each site must be considered individually and designed as an individual project.

STREAM CHANNEL STABILIZATION: Stabilizing the channel of a stream with suitable structures to control aggradation or degradation in a stream channel. Such structures may be concrete, masonry, timber or gabion check dams for major streams. Post, wire and brush may serve the purpose for smaller streams. Each site must be considered and designs made on an individual basis.

STREAM LOAD: Quantity of solid and dissolved material carried by a stream.

STREAMSIDE MANAGEMENT AREA (SMA): A designated area that consists of the stream itself and an adjacent area of varying width where management practices that might affect water quality, fish, or other aquatic resources are modified. The SMA is not an area of exclusion, but an area of closely managed activity. It is an area that acts as an effective filter and absorptive zone for sediments; maintains shade; protects aquatic and terrestrial riparian habitats; protects channels and streambanks; and promotes floodplain stability.

STRIP MINING: A process in which rock and top soil strata overlying ore or fuel deposits are scraped away by mechanical shovels. Also known as surface mining.

STUBBLE MULCHING: Leaving the stubble of crops or crop residue essentially in place on the land as a surface cover during fallow and the growing of a succeeding crop. Tilling, planting and cultivating operations are performed in such a way as to keep protective amounts of vegetation on the soil surface. Soil erosion losses are reduced by providing a cover along with improved physical condition and water infiltration.

SUBIRRIGATION: Applying irrigation water below the ground surface either by raising the water table within or near the root zone, or by using a buried perforated or porous pipe system that discharges directly into the root zone.

SUBSURFACE DRAIN: A conduit, such as tile, pipe, or tubing, installed beneath the ground surface to collect and convey drainage water. Drains are used for lowering or controlling ground water or surface runoff in areas having a high water table.

SURFACE WATER: All water whose surface is exposed to the atmosphere.

SUSPENDED LOAD: Solids or sediments suspended in a fluid by the upward components of turbulent currents or by colloidal suspension.

SUSPENDED SOLID: Any solid substance present in water in an undissolved state, usually contributing directly to turbidity.

TAILINGS: 1. In agriculture, forage material that falls behind the harvesting combine. 2. In mining, second grade or waste material derived when raw material is screened or processed.

TAILWATER: 1. In hydraulics, water in a river or channel, immediately downstream from a structure. 2. In irrigation, water that reached the lower end of a field.

TERTIARY WASTE TREATMENT: Wastewater treatment beyond the secondary or biological stage that includes removal of nutrients such as phosphorus and nitrogen, and a high percentage of suspended solids; also known as advanced waste treatment.

THERMAL POLLUTION: A term describing the act of changing the natural temperatures of bodies of water by discharging warmer water into them.

THINNING: Cutting within tree stands to provide adequate growing space and accelerate diameter growth but also, by suitable selection, to improve the average form of the remaining trees.

TOPOGRAPHY: The relative positions and elevations of the natural or manmade features of an area that describe the configuration of its surface.

TURBIDITY: 1. The cloudy condition caused by suspended solids in a liquid. 2. A measurement of the suspended solids in a liquid.

UNIVERSAL SOIL LOSS EQUATION: An equation used to design water erosion control systems: A = RKLSPC wherein A is average annual soil loss in tons per acre per year; R is the rainfall factor; K is the soil erodibility factor; L is the length of slope; S is the percent slope; P is the conservation practice factor; and C is the cropping and management factor.

UNPALATABLE SPECIES: Species that are not readily eaten by animals.

URBAN RUNOFF: Storm water from city streets and gutters that usually contains litter and organic and bacterial wastes.

URBAN WASTE: A general term used to categorize the entire waste stream from the urban area.

WASTES: Material that has no original value or no value for the ordinary or main purpose of manufacture or use; damaged or defective articles of manufacture; superfluous or rejected matter or refuse.

WASTE PROCESSING: Operations such as shredding, compaction, composting and incineration, in which the physical or chemical properties of wastes are changed.

WASTE TREATMENT: Any of the physical or chemical processes whereby the qualities of given waste are made more compatible or acceptable to man and his environment.

WATER DISPOSAL SYSTEM: The complete system for removing excess water from land with minimum erosion. For sloping land, it may include a terrace system, terrace

outlet channels, dams and grassed waterways. For level land, it may include only surface drains or both surface and subsurface drains.

WATER IMPOUNDMENT: A body of water created or stored by impoundment structures such as dams, dikes, and levees.

WATER POLLUTION: The addition of harmful or objectionable material to water in concentrations or sufficient quantities to adversely affect its usefulness or quality.

WATER RESOURCES: The supply of surface and ground water in a given area.

WATER RIGHTS: Legal rights to the use of water. They consist of riparian rights and those acquired by appropriation and prescription. Riparian rights are those rights to use and control water by virtue of ownership of the bank or banks. Appropriate rights for the exclusive use of water are those acquired by an individual, based strictly on priority appropriation and application of the water to beneficial use and without limitation of the place of use to riparian land. Prescribed rights are those to which legal title is acquired by long possession and use without protest of other parties.

WATERSHED: A natural hydrologic drainage area.

WATER TABLE: The upper surface of ground water or that level below which the soil is saturated with water; locus of points in soil water at which the hydraulic pressure is equal to atmospheric pressure.

WATERWAY: A natural course or constructed channel for the flow of water.

WEED: An undesired, uncultivated plant.

WETLANDS: Areas that are inundated or saturated by surface or ground water at a frequency and duration 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 similar areas. (This definition is consistent with the Federal definition 40 CFR 230.3; December 24, 1989. As amendments are made to the wetland definition, they will be considered applicable to this guidance.)

WIND EROSION: The detachment and transportation of soil by wind.

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State of Nevada
Division of Environmental Protection
Bureau of Water Quality Planning

Nonpoint Source Pollution Management — Best Management Practices

The NPS Pollution Management Program is responsible for developing and updating the state Best Management Practices Handbook.

An individual or agency can utilize Best Management Practices (BMP) to control a water quality problem. The BMP concept is based on the premise that individuals and agencies should take the most practical and feasible approach to prevent the release of pollutants into the surface and ground waters of the State.

Best Management Practices - Effective BMPs must be based on consideration of all existing site-specific conditions and must be cost effective. Factors that need to be considered include the occurrence and movement of surface and ground water, geology, soil type, climate, topography and habitat. Scheduling and timing are important, as are adequate design and application. BMPs should be designed and developed on a site-specific basis by qualified professionals.

Read / Print BMP Handbook

Branch Supervisor: Kathy Sertic — Phone: (775) 687-9455

Branch Home Pages

- Standards
- Monitoring
- NonPoint Source Pollutiion

Statutory Authority: NRS 445A.010 through 445A.730

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