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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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 <u>not</u> 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

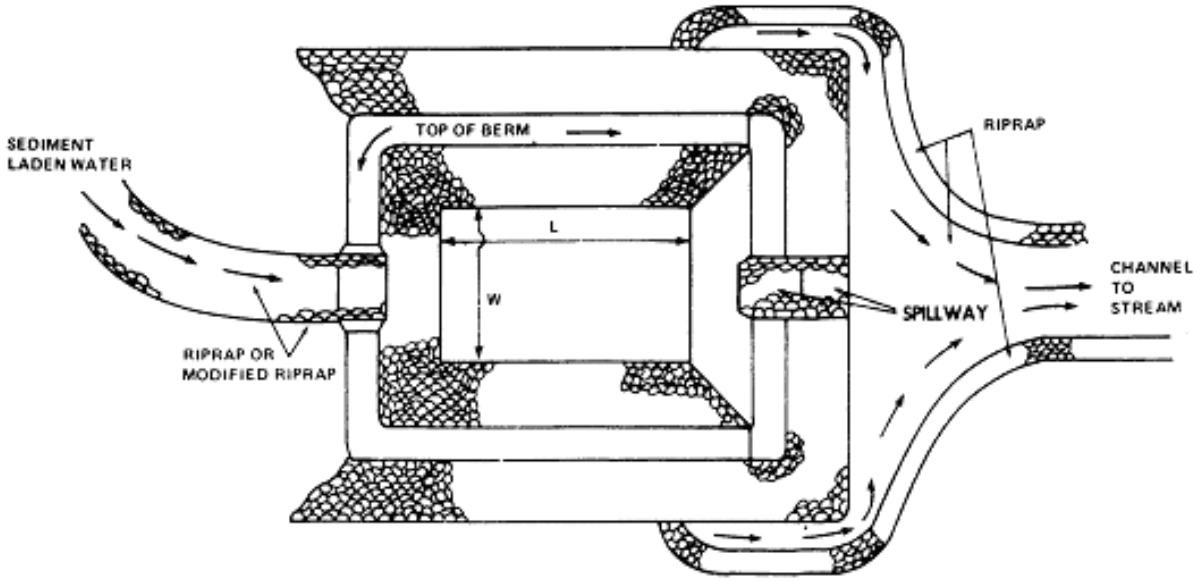


FIGURE A-2 (APP11.PCX)
TEMPORARY EROSION CONTROL STILLING BASIN

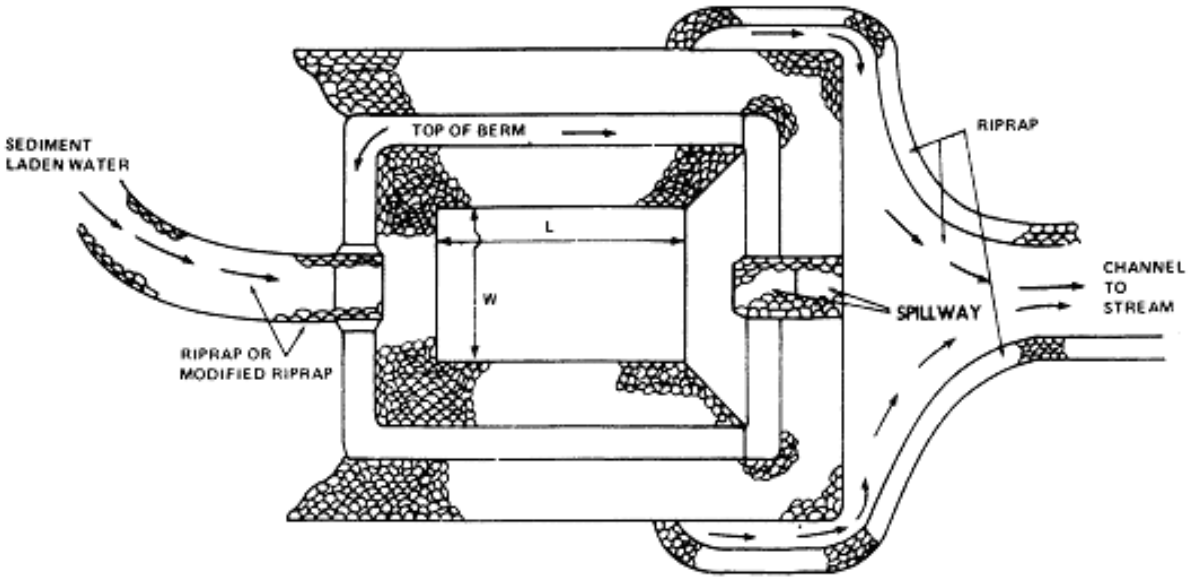
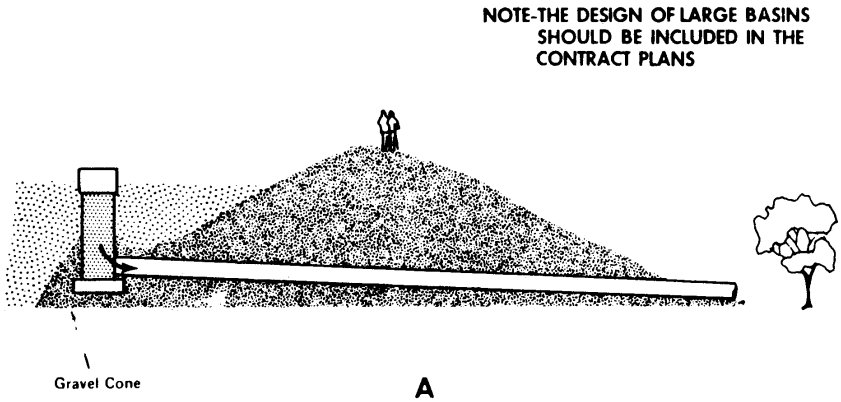
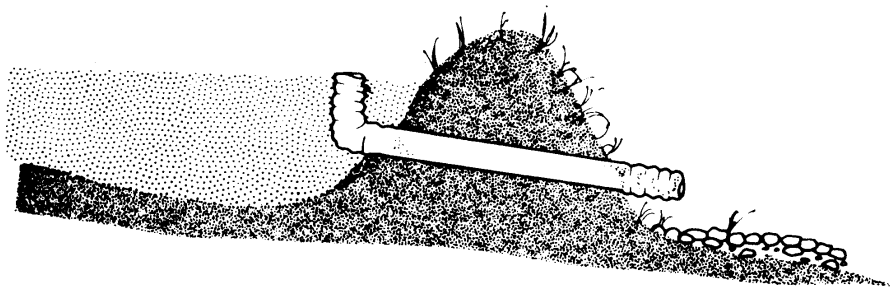


FIGURE A-3 (APP12.PCX)
SEDIMENT DAMS



A

LARGE-SEDIMENT POOL INSTALLATION

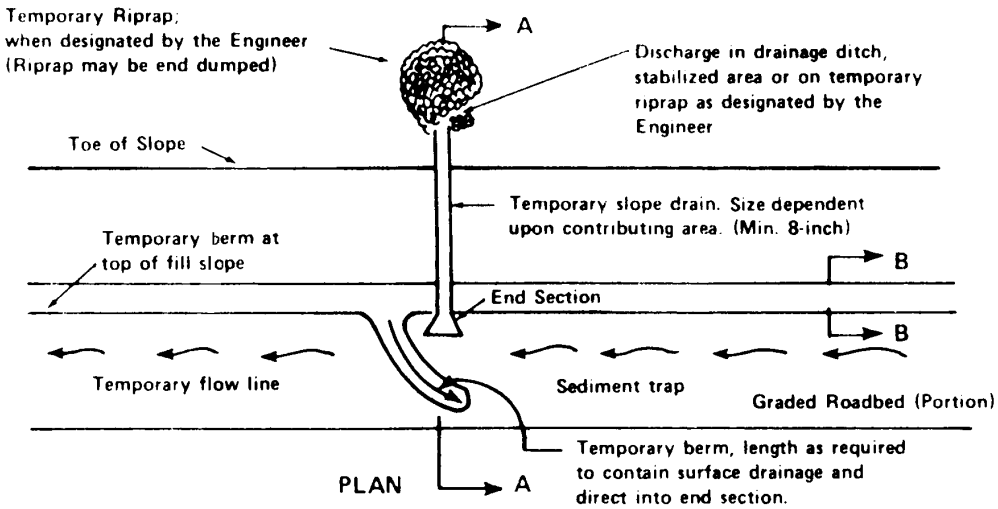


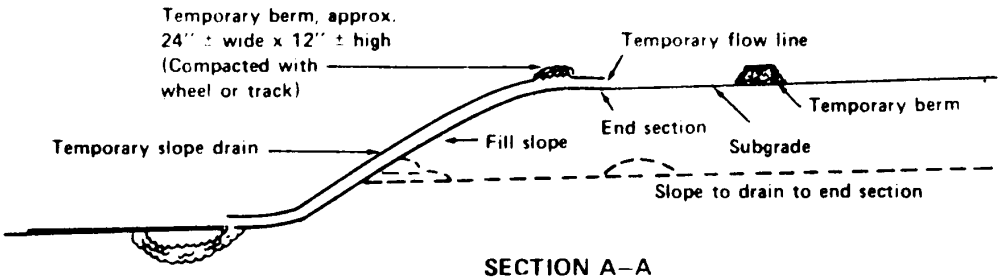
B

SMALL - TEMPORARY INSTALLATION

SEDIMENT DAMS

FIGURE A-4 (APP13.PCX)
TEMPORARY BERMS & SLOPE DRAIN





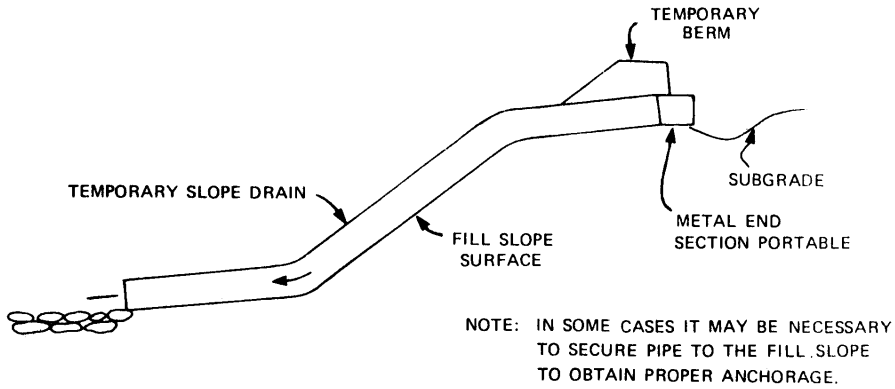
SECTION A–A

TEMPORARY SLOPE DRAIN, BERM AND RIPRAP
(FOR FILL SLOPES)

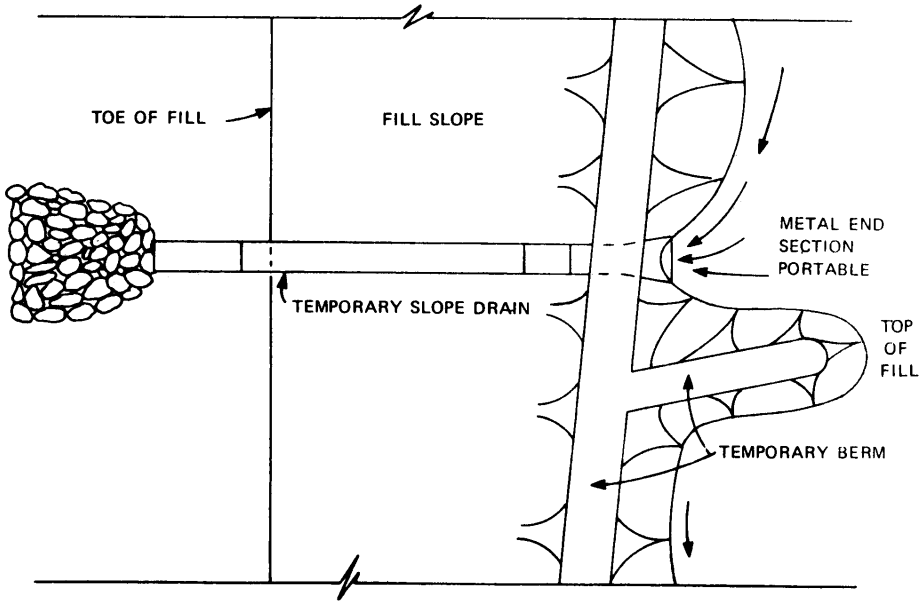
SECTION B–B

TEMPORARY BERMS & SLOPE DRAIN

FIGURE A-5 (APP14.PCX)
TEMPORARY SLOPE DRAIN (FLEXIBLE)



END VIEW

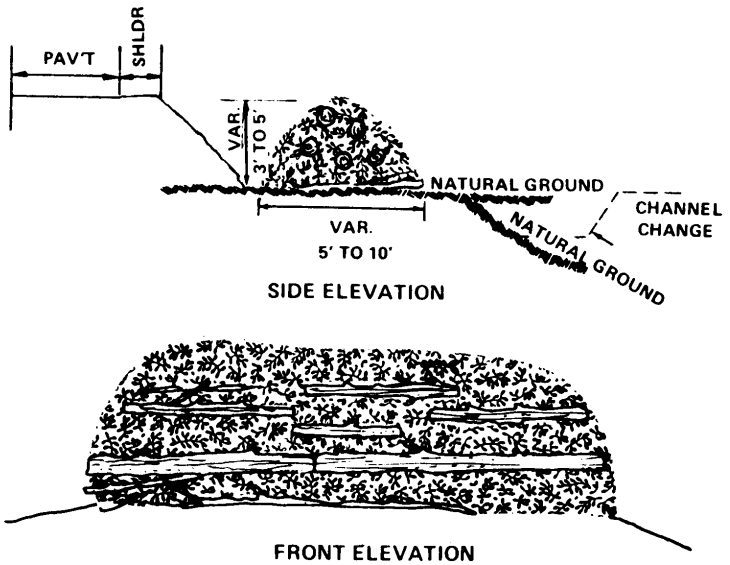


PLAN VIEW

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.



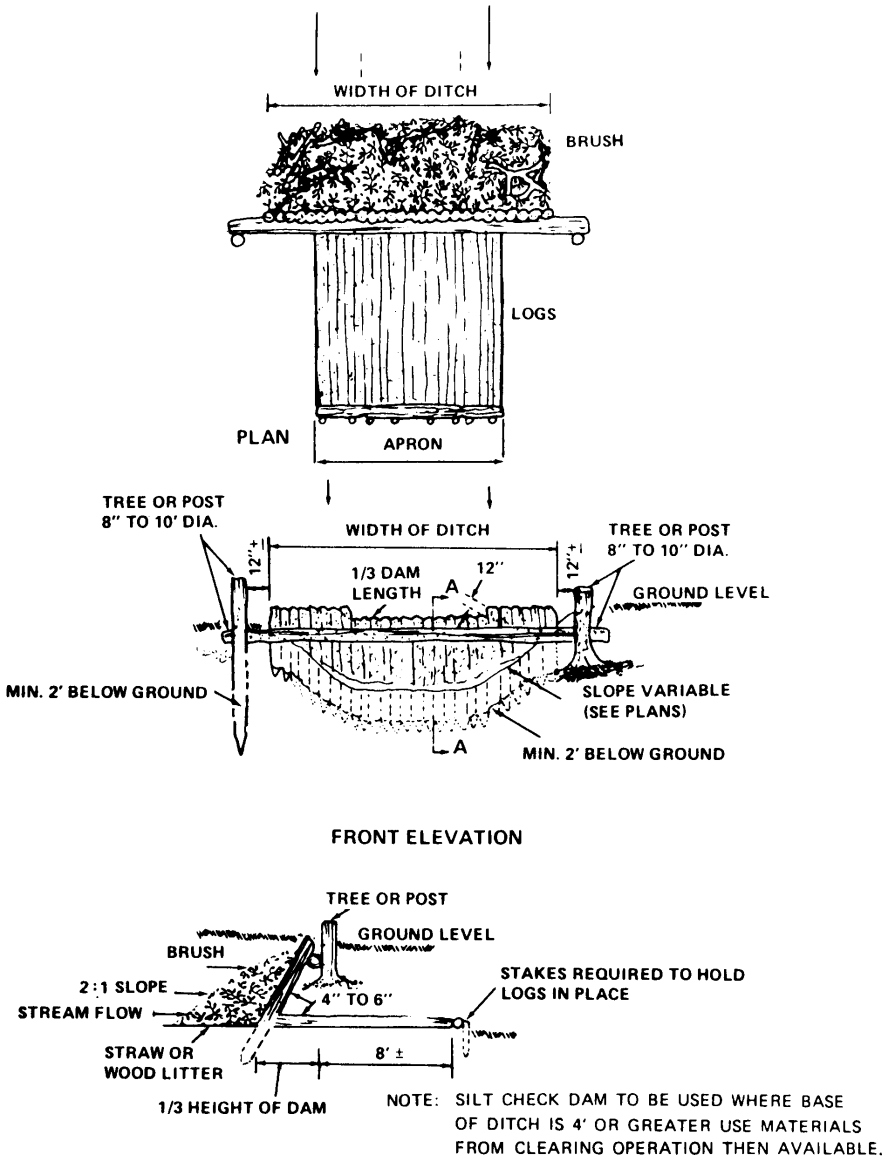
PLACE BRUSH, LOGS AND TREE LAPS APPROXIMATELY PARALLEL TO TOE OF FILL SLOPE WITH SOME OF THE HEAVIER MATERIALS BEING PLACED ON TOP TO PROPERLY SECURE THE BARRIER AS DETAILED ABOVE AT LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY THE ENGINEER.

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.

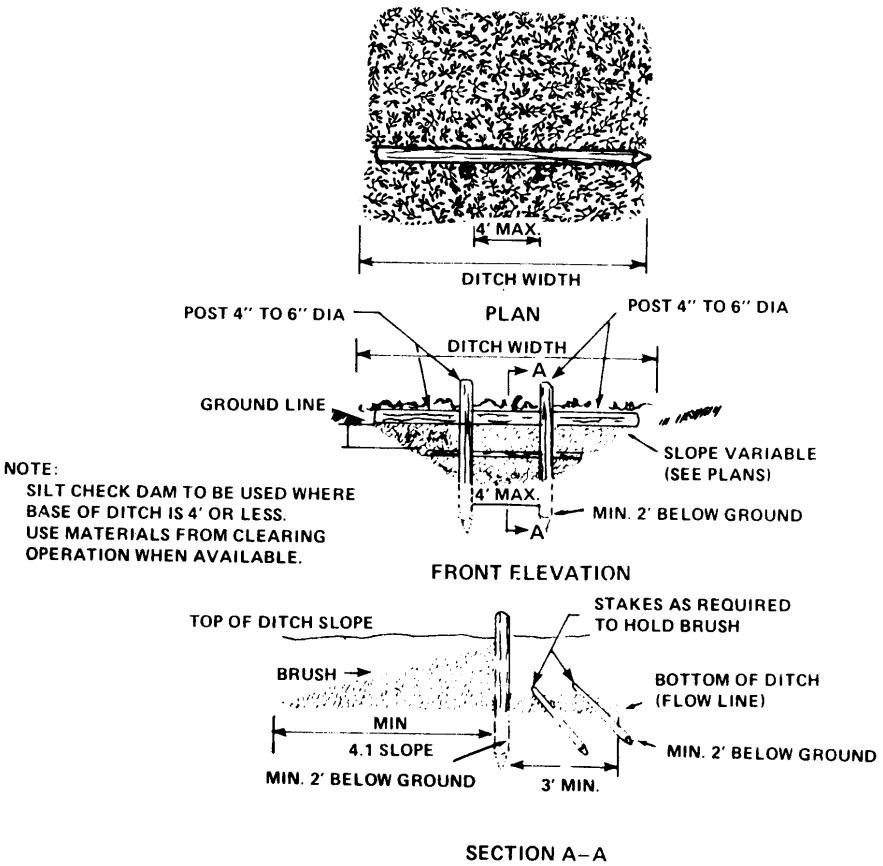
DETAIL OF BRUSH BARRIER

FIGURE A-6B (APP16.PCX)
DETAIL OF SILT CHECK DAM TYPE A



DETAIL OF SILT CHECK DAM TYPE A

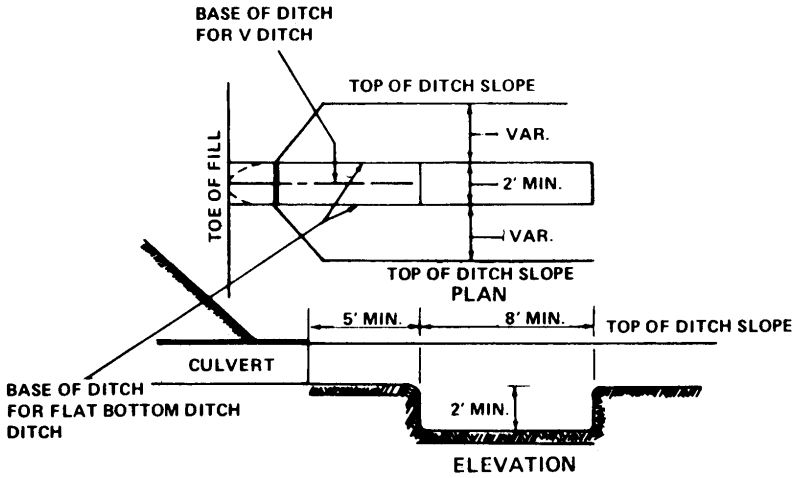
FIGURE A-6C (APP17.PCX)
DETAIL OF SILT CHECK DAM TYPE B



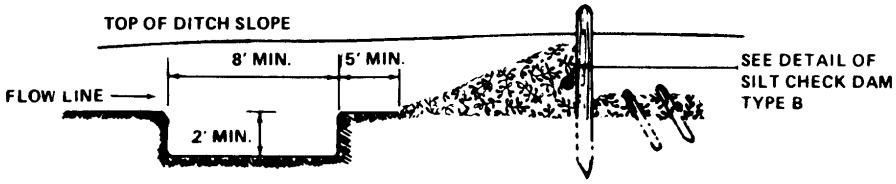
WHERE LOGS ARE NOT AVAILABLE, WOVEN WIRE FENCE MAY BE USED TO RETAIN WOODS LITTER FOR BRANCH FILTER. IF WOVEN WIRE FENCE IS USFD, THE WIRE SHALL BE ANCHORED SECURELY AND TO THE SATISFICATION OF THE ENGINEER PRIOR TO PLACING THE LITTER AND FOLIAGE FILTER MATERIALS.

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



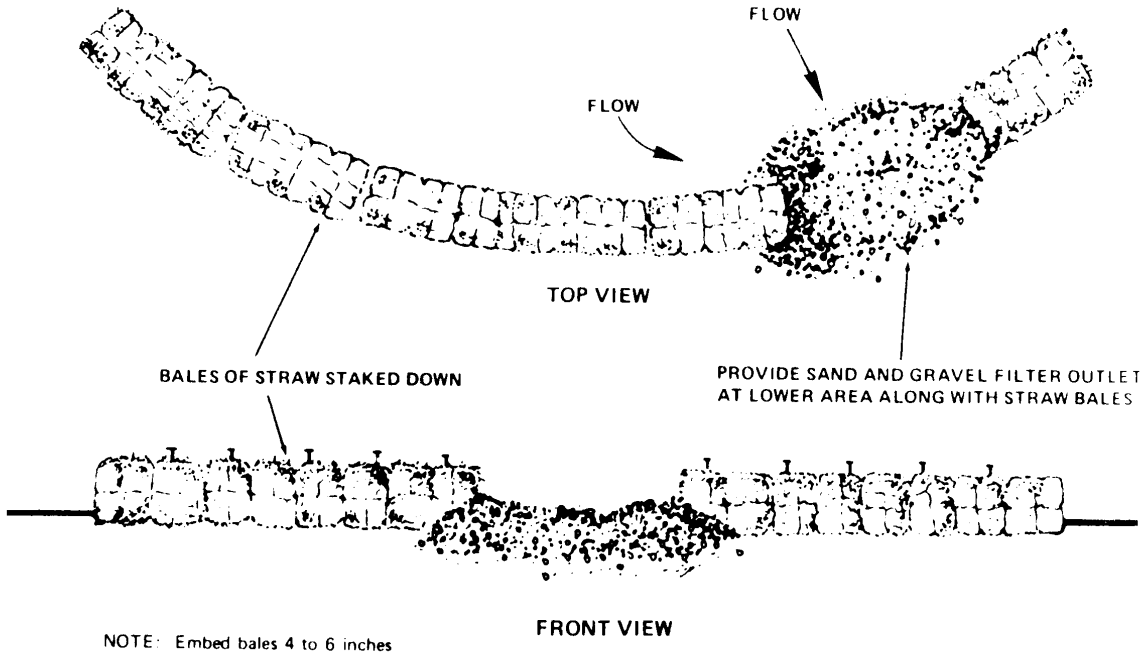
NOTE:

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'

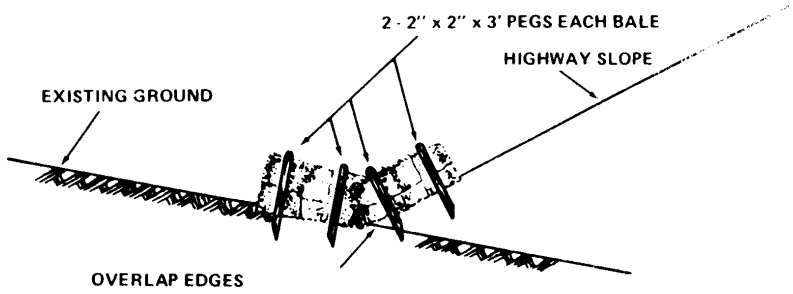
DETAIL SHOWING COMBINATION OF SILT CHECK DAM TYPE B AND SILT BASIN TYPE B

FIGURE A-7 (APP19.PCX)
HAY BALE DAMS USED ALONG TOE OF SLOPE



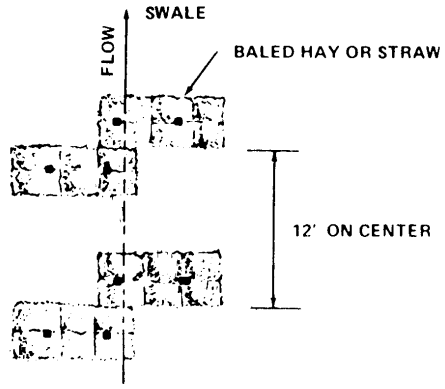
HAY BALE DAMS USED ALONG TOE OF SLOPE

FIGURE A-8 (APP20.PCX)
TYPE A--BALED HAY OR STRAW EROSION CHECKS



ELEVATION

NOTE: Embed bales 4 to 6 inches



PLAN

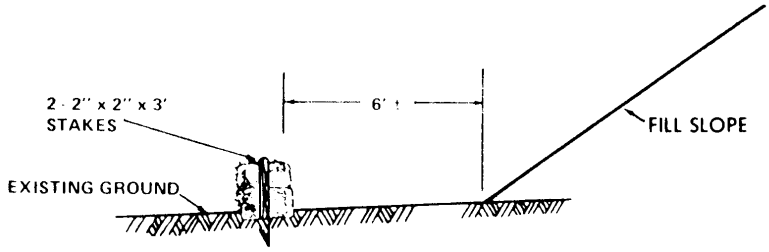
TO BE USED WHERE THE EXISTING GROUND SLOPES **TOWARDS** THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.

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"

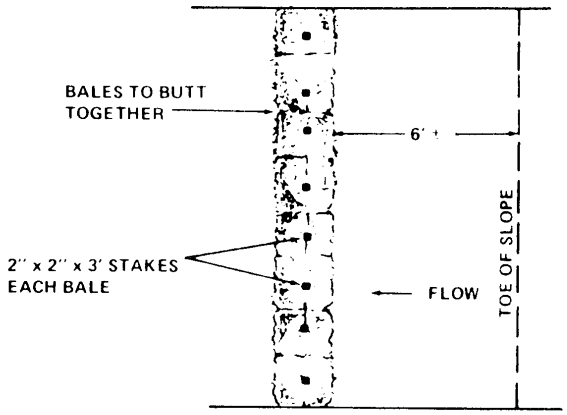
BALED HAY OR STRAW EROSION CHECKS

FIGURE A-9 (APP21.PCX)
TYPE B--BALED HAY OR STRAW EROSION CHECKS



ELEVATION

NOTE: Embed bales 4 to 6 inches



PLAN

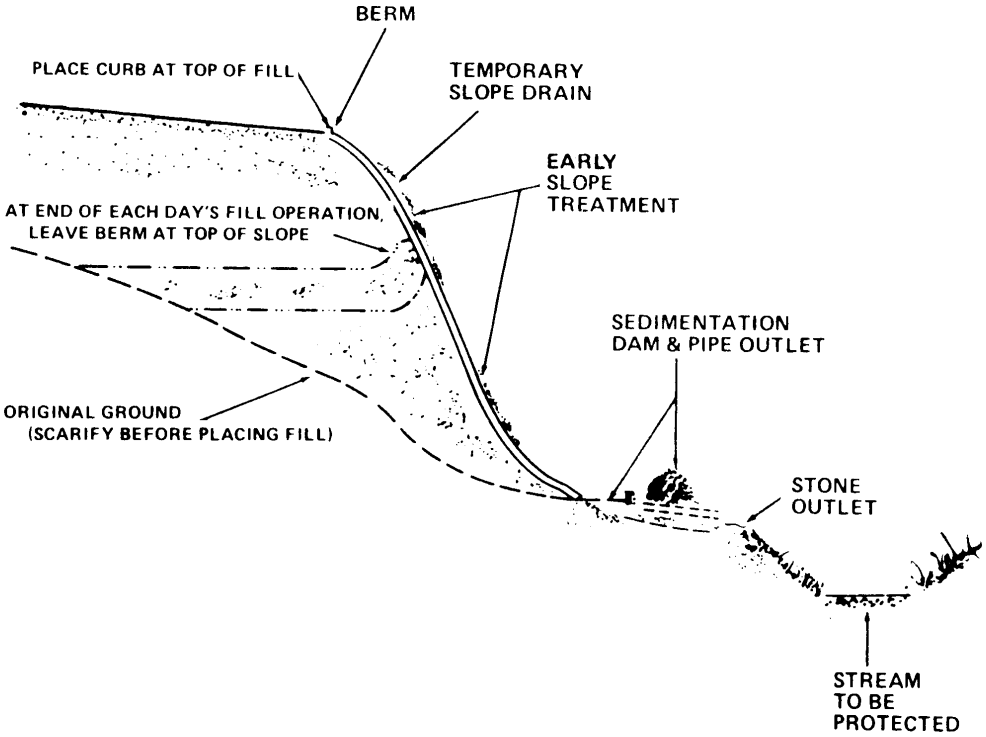
TO BE USED WHERE THE EXISTING GROUND SLOPES AWAY FROM THE HIGHWAY EMBANKMENT AS CALLED FOR ON PLANS.

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

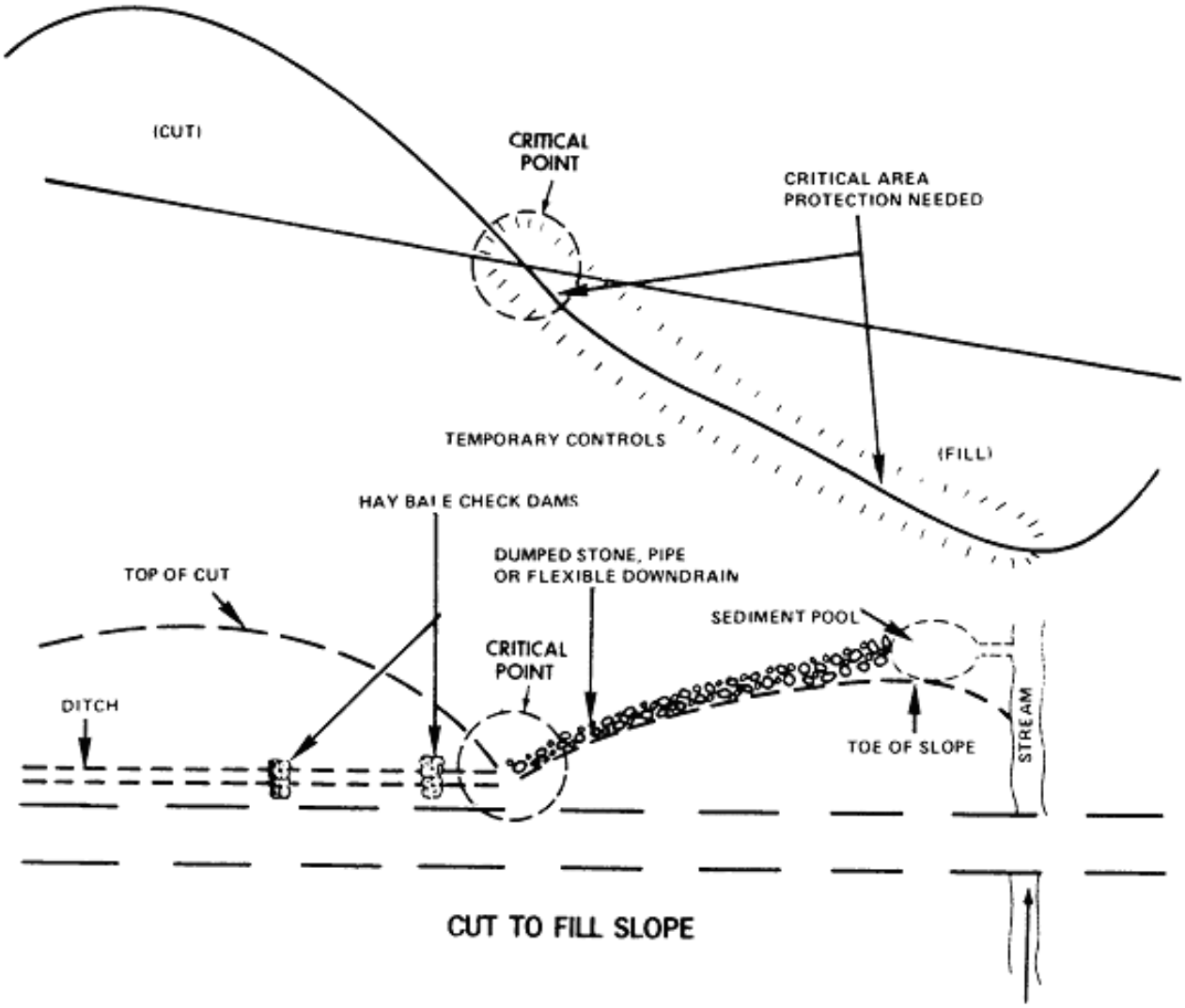
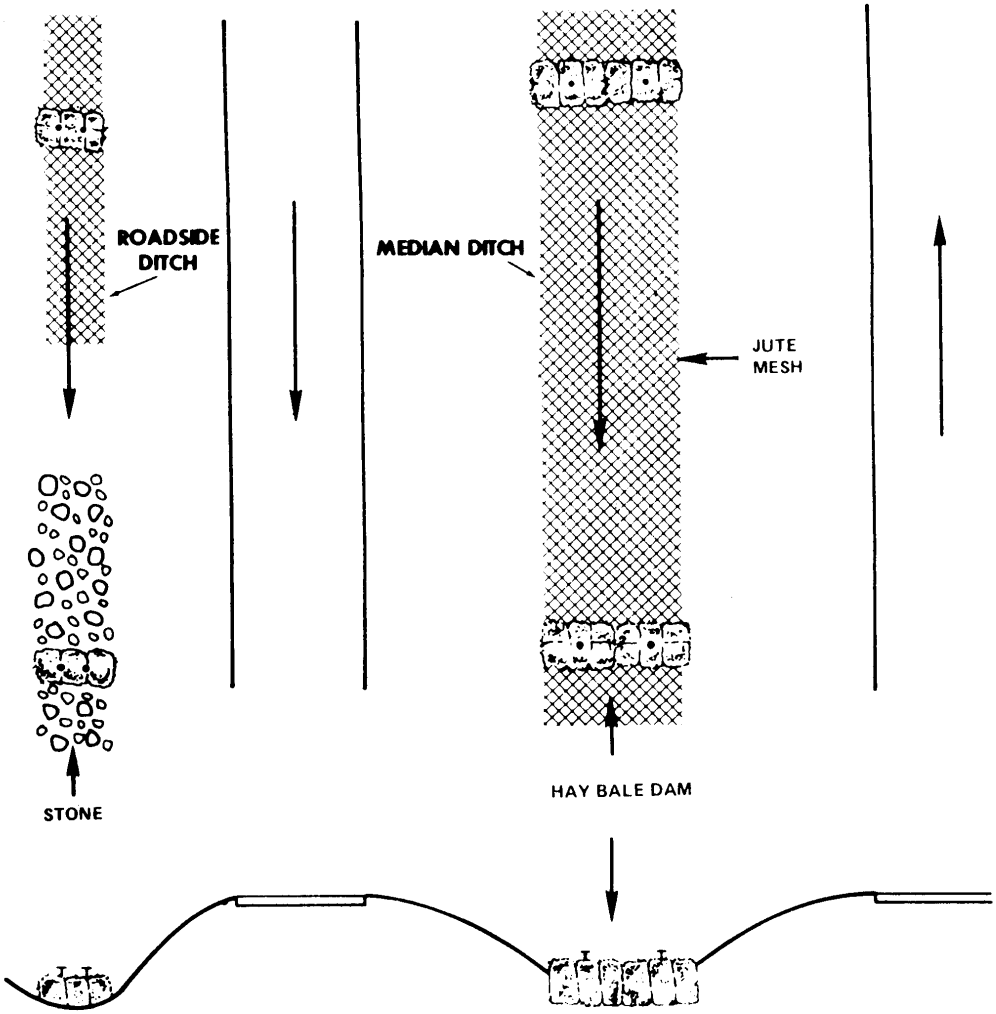


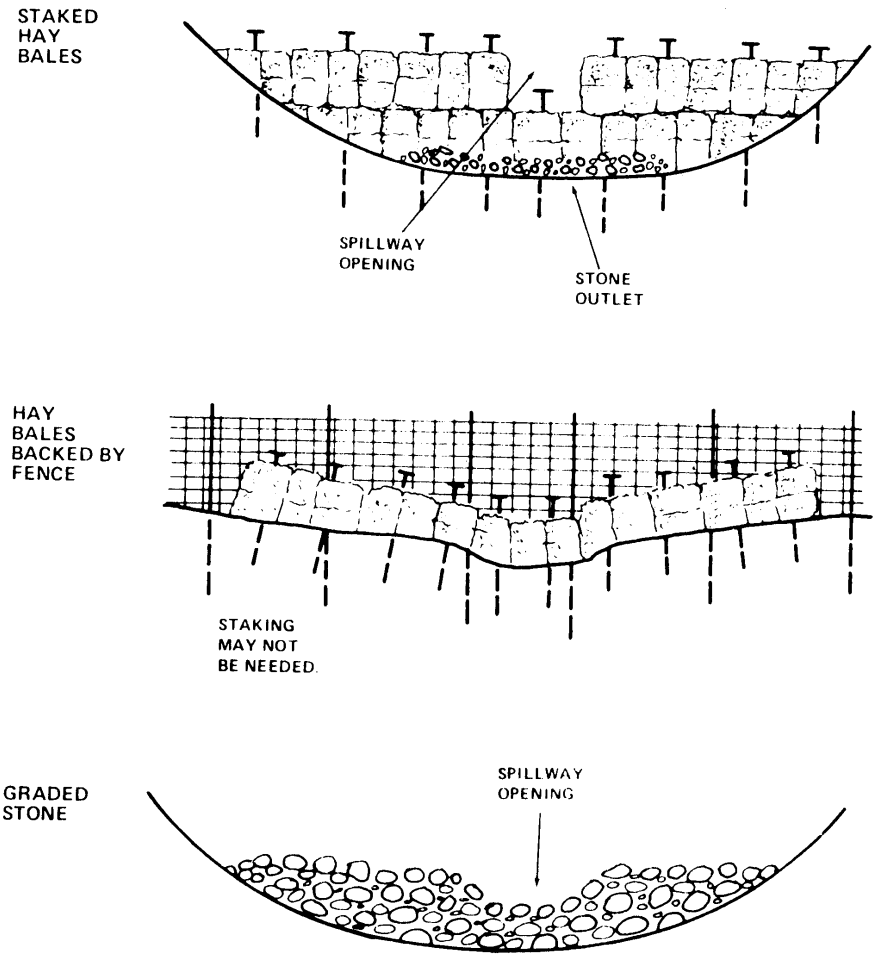
FIGURE A-12 (APP24.PCX)
HAY BALE DAMS USED IN DITCHES



HAY BALE DAMS
USED IN DITCHES

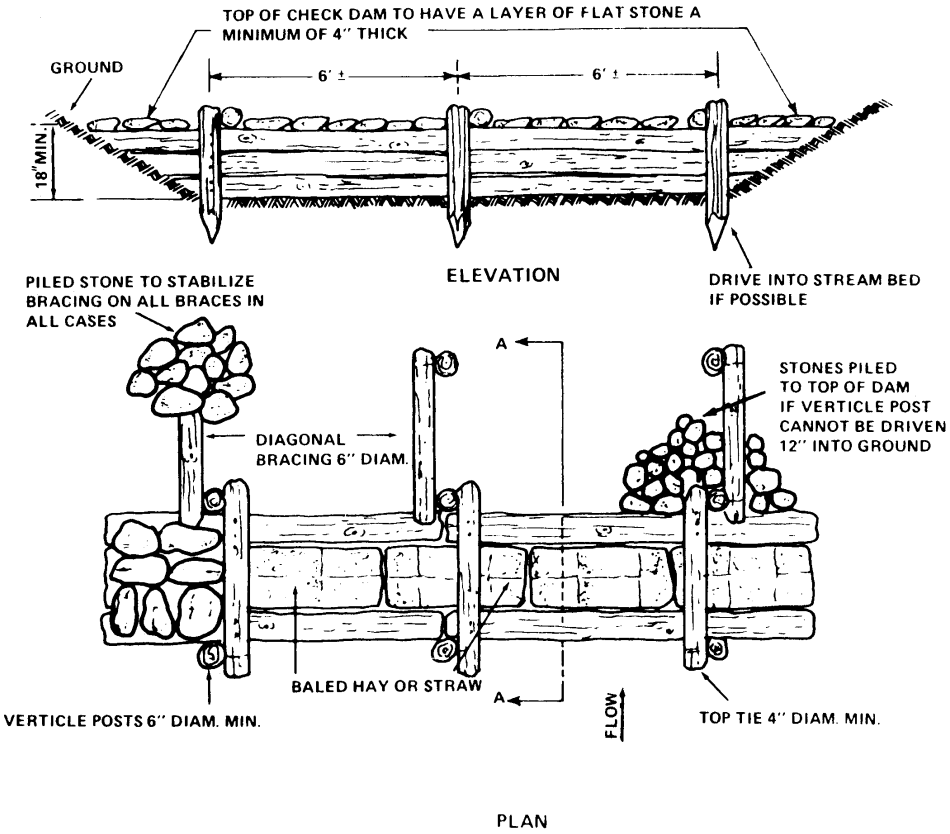
FIGURE A-13 (APP25.PCX)
TYPES OF TEMPORARY DAMS

NOTE: Dam should extend far enough up ditch side slopes to effectively pond the runoff and prevent erosion and washout.



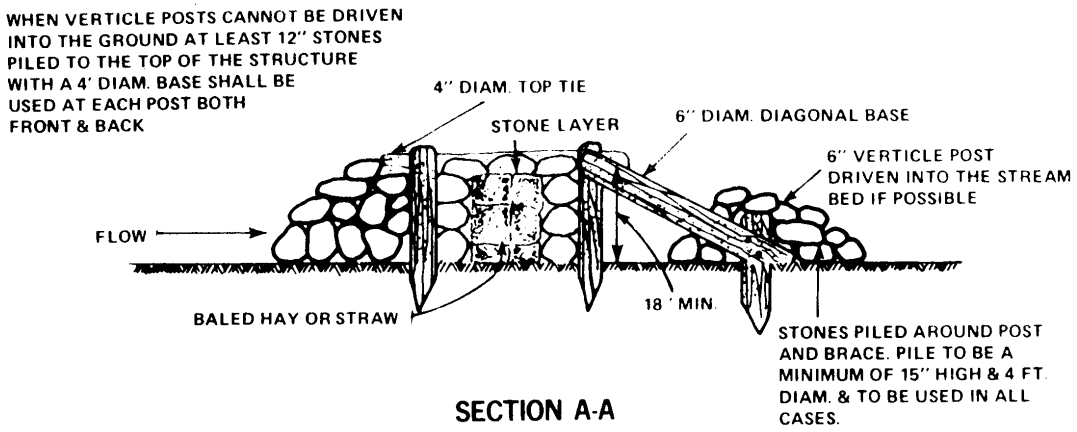
TYPES OF TEMPORARY DAMS

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

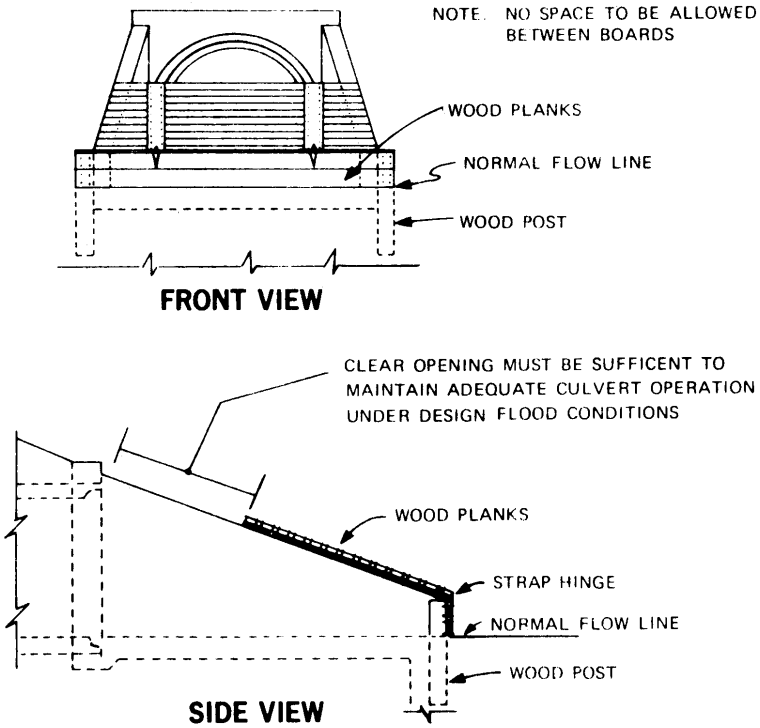


SECTION A-A

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

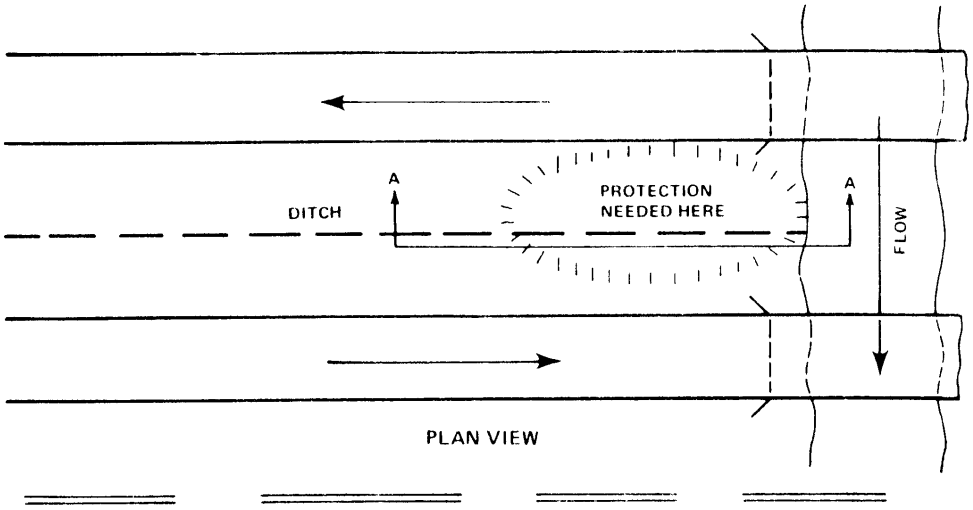
LOG AND HAY EROSION CHECK DAM

FIGURE A-15 (APP28.PCX)
CULVERT SEDIMENT TRAP

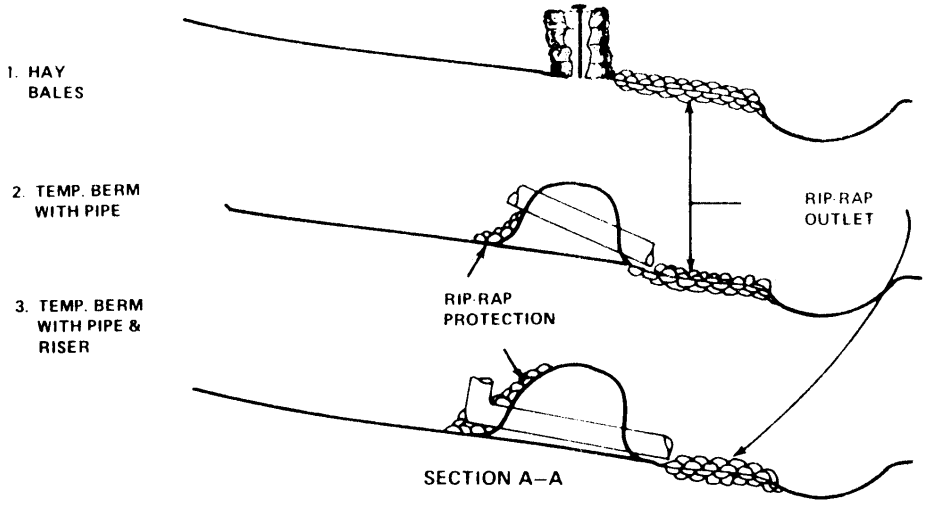


CULVERT SEDIMENT TRAP

FIGURE A-16 (APP29.PCX)
PROTECTION AT STREAM CROSSING MEDIAN & SIDE DITCHES

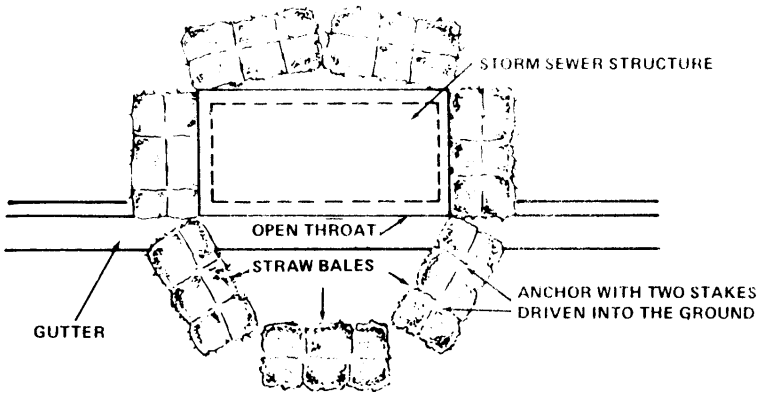


3 TYPES OF PROTECTION

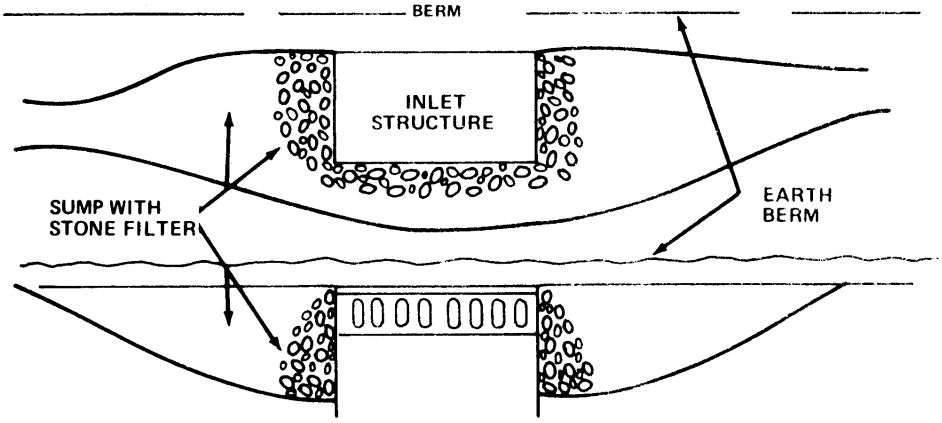


PROTECTION AT STREAM CROSSING
MEDIAN & SIDE DITCHES

FIGURE A-17 (APP30.PCX)
TEMPORARY SUMP - STONE FILTER INLET SEDIMENT TRAPS

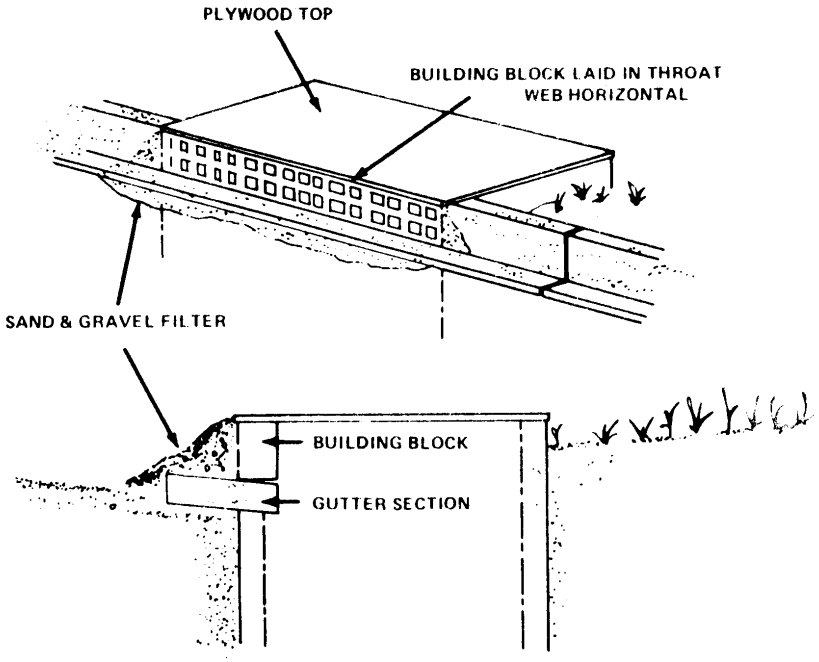


TEMPORARY BARRIER - HAY BALES



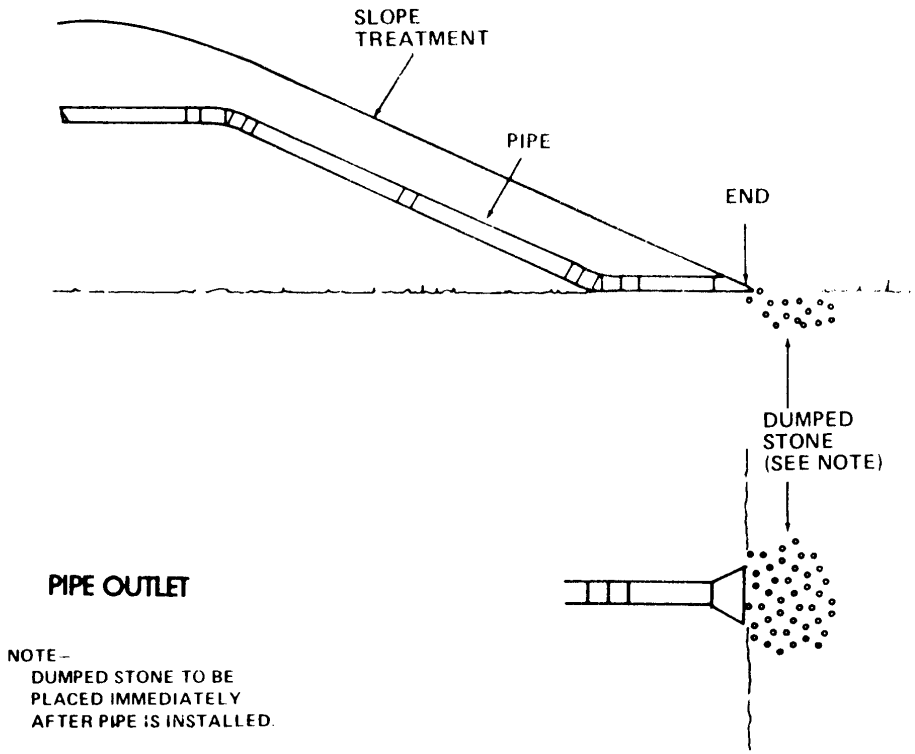
TEMPORARY SUMP - STONE FILTER
INLET SEDIMENT TRAPS

FIGURE A-18 (APP31.PCX)
SAND AND GRAVEL FILTER INLET SEDIMENT TRAP



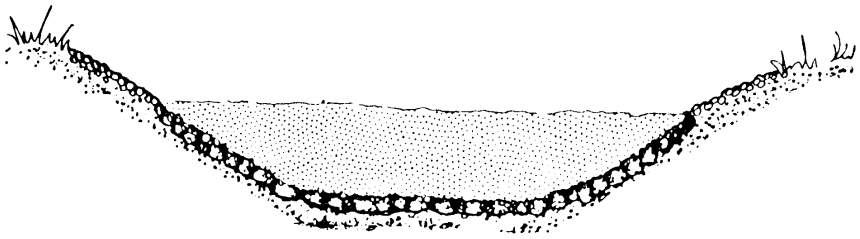
SAND AND GRAVEL FILTER
INLET SEDIMENT TRAP

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

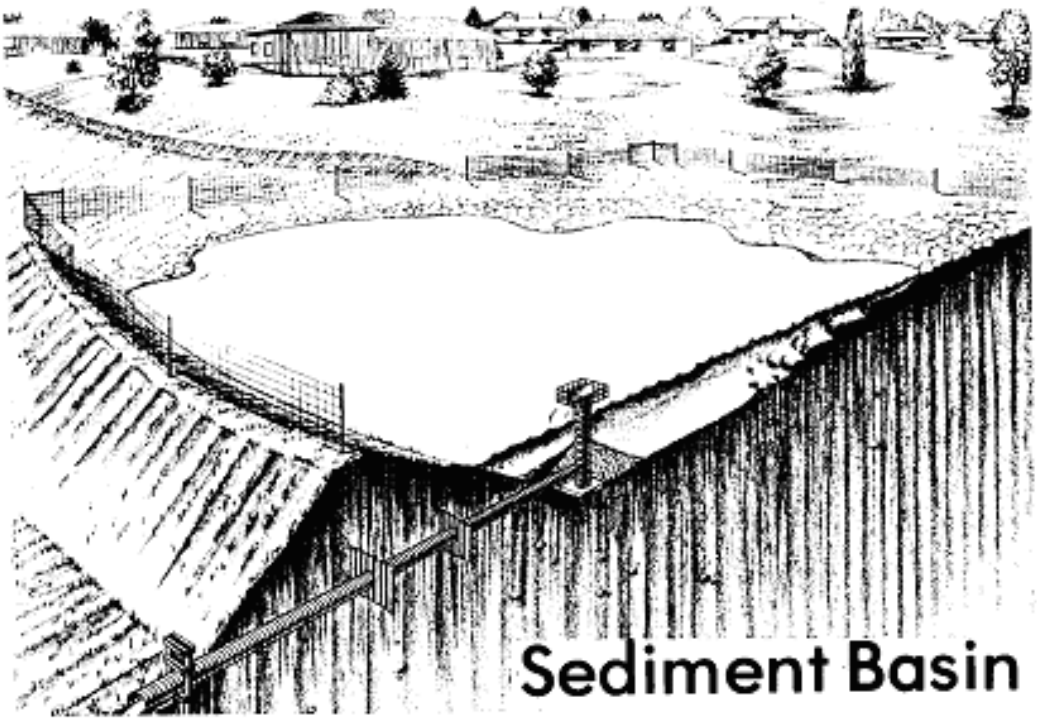


FIGURE A-22 (APPF2.PCX)
DROP STRUCTURE

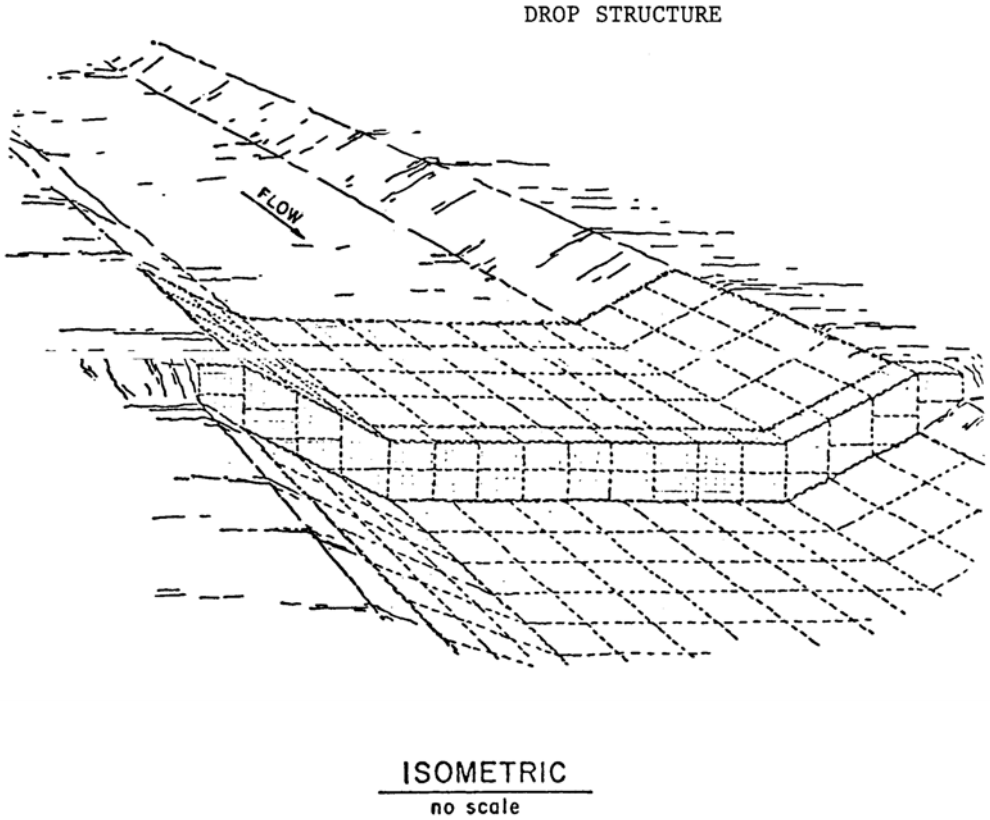
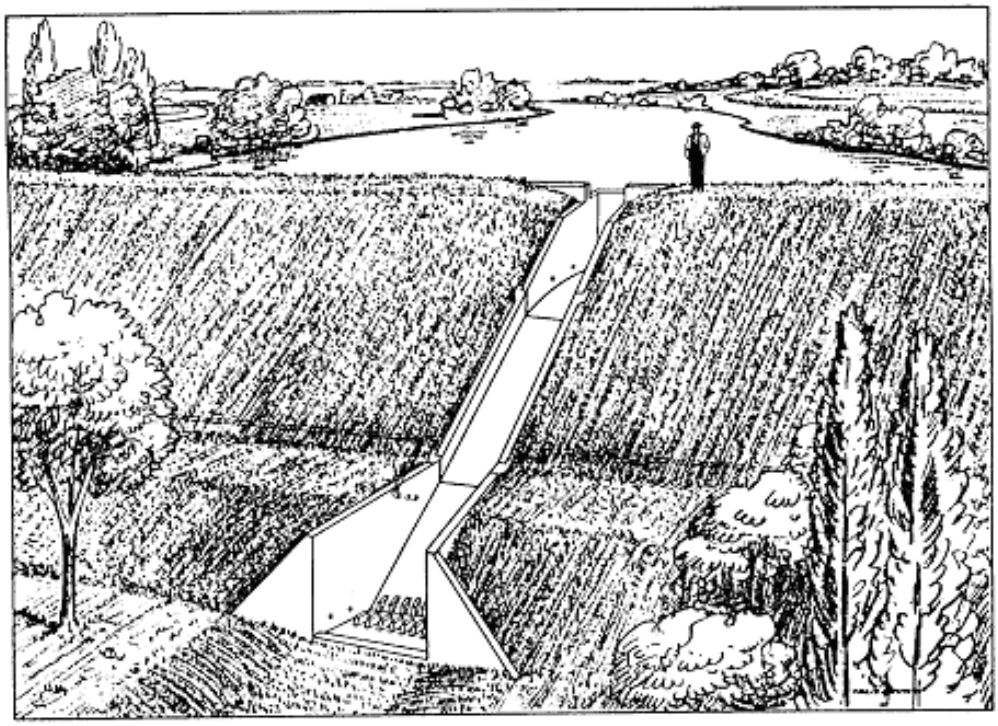
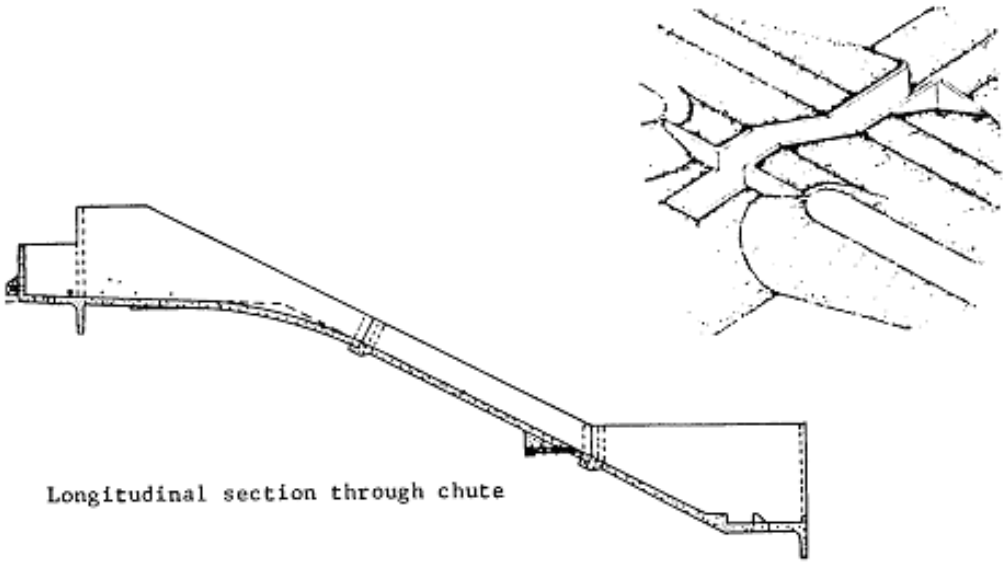


FIGURE A-23 (APPF3.PCX)
REINFORCED CONCRETE CHUTE SPILLWAY





Reinforced concrete chute spillway

FIGURE A-24 (APPF4.PCX)
CHUTE OR FLUME

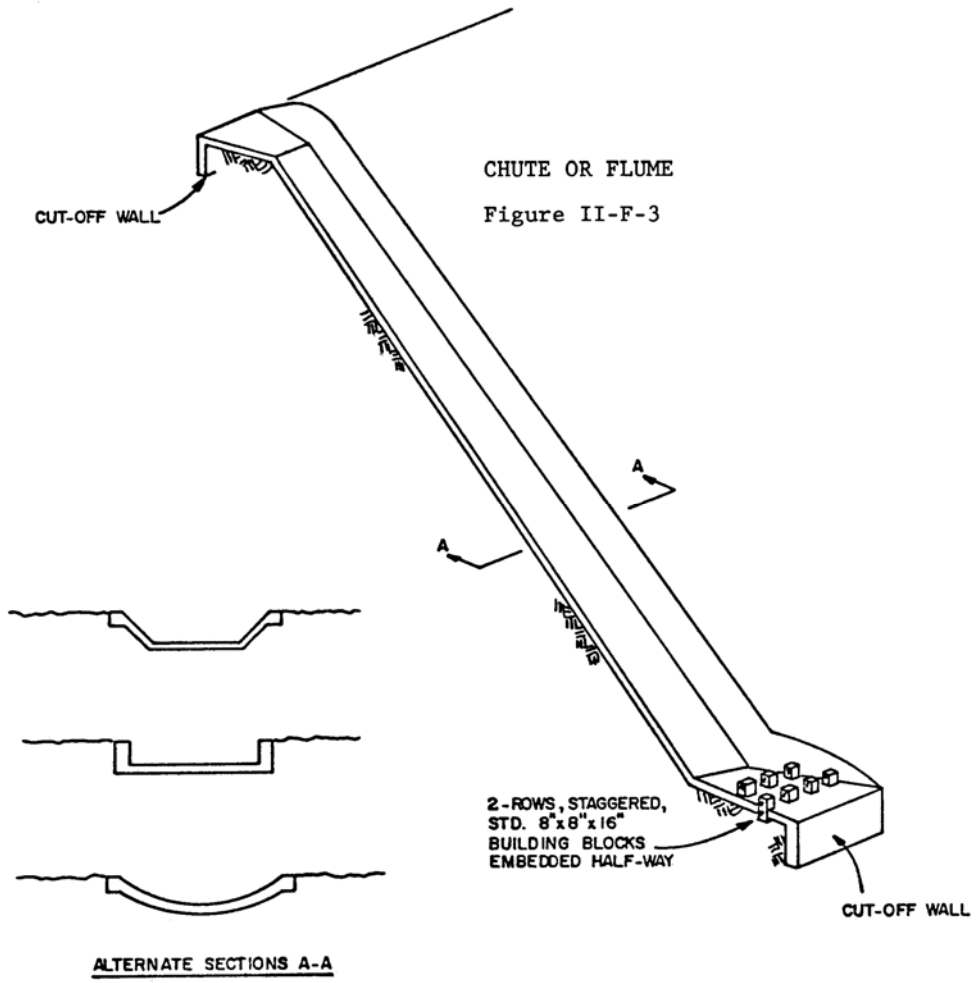


FIGURE A-25 (APPF5.PCX)
PIPE DROP

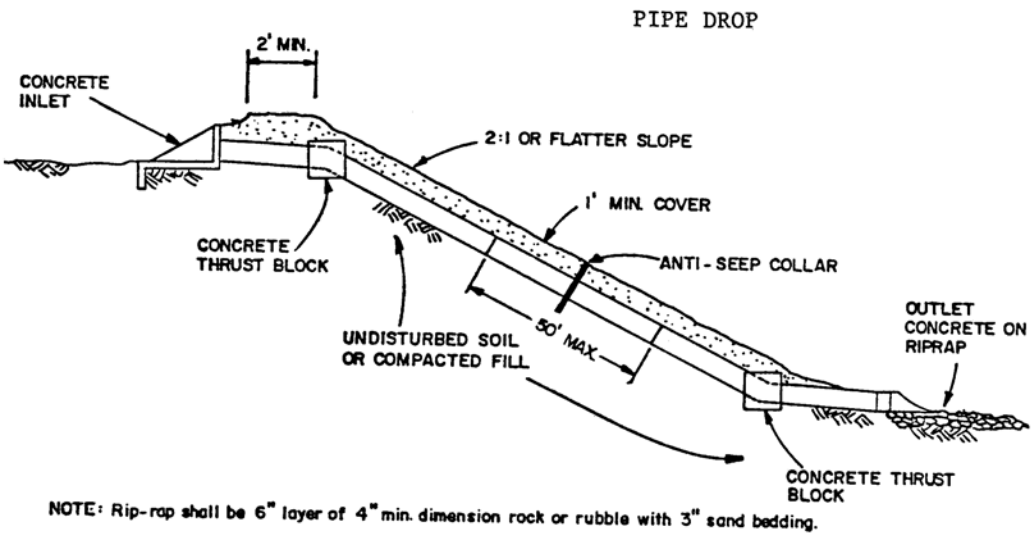
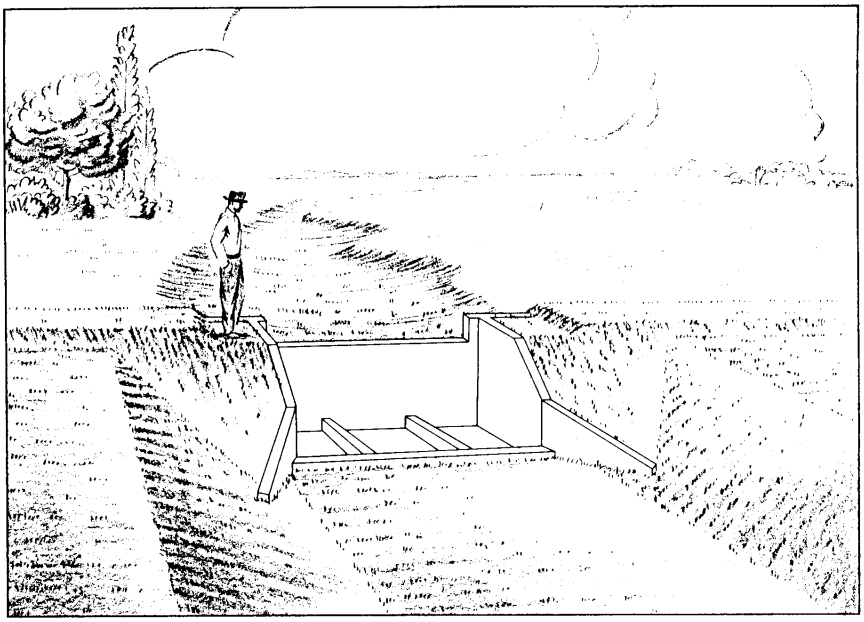
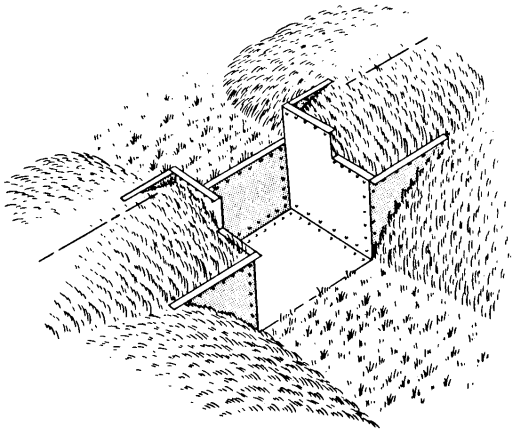


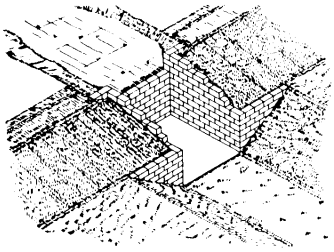
FIGURE A-26 (APPF6.PCX)
REINFORCED CONCRETE



Reinforced concrete



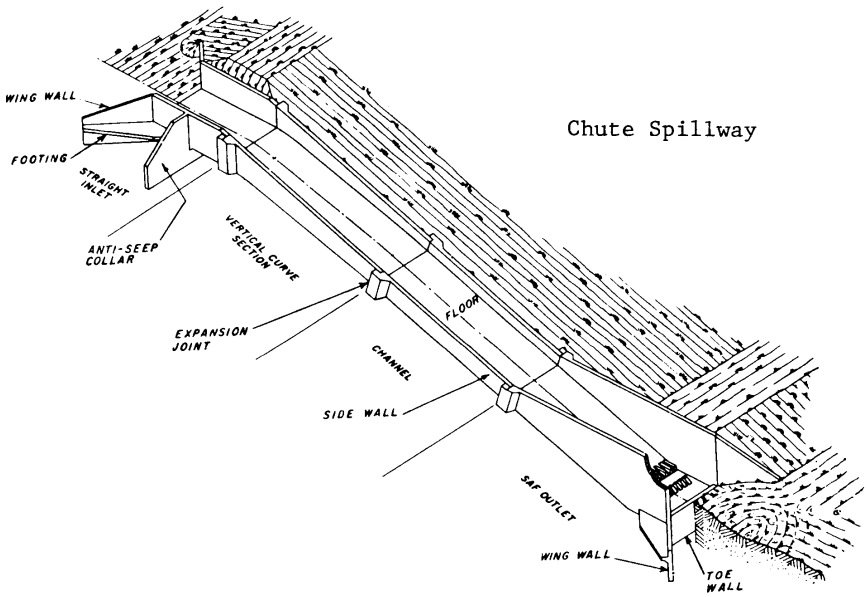
Prefabricated metal



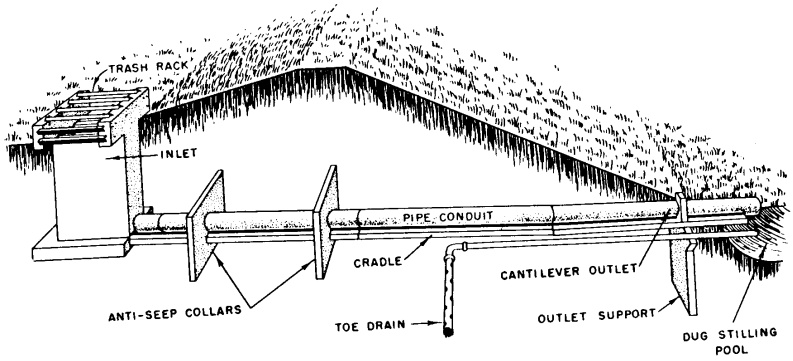
Concrete block

Straight drop spillways

FIGURE A-27 (APPF7.PCX)
DROP & CHUTE SPILLWAYS

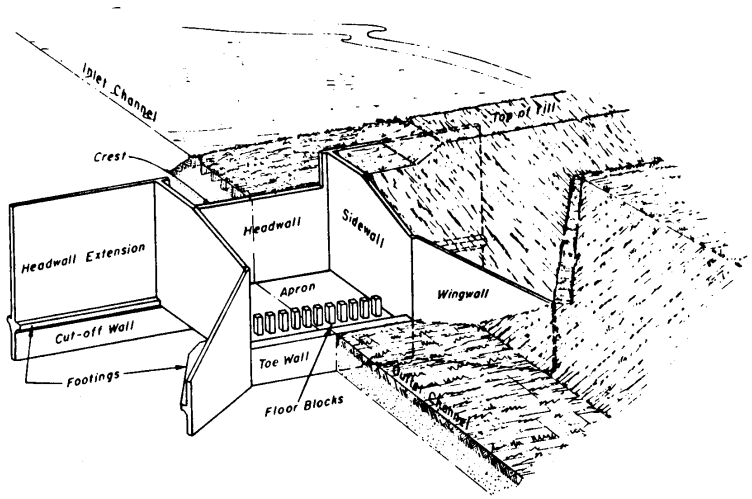


Chute Spillway

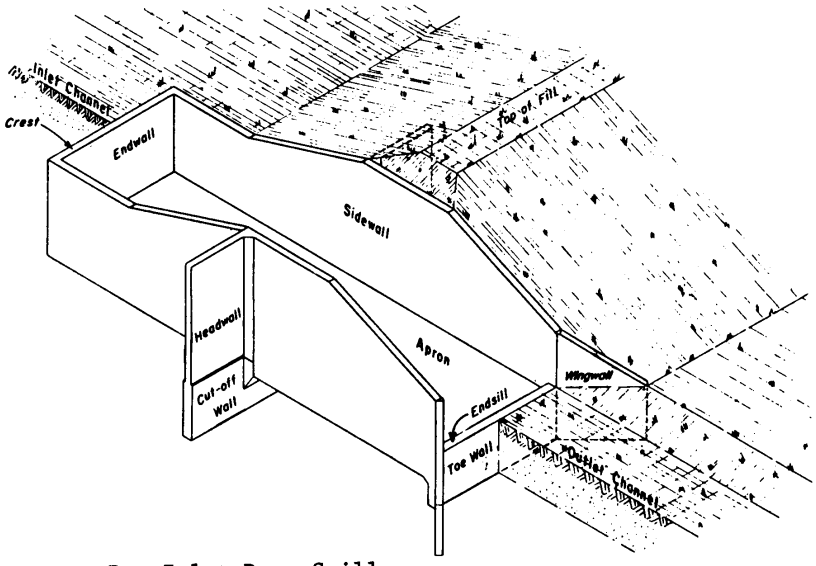


Drop Inlet Spillway

FIGURE A-28 (APPF8.PCX)
BOX & STRAIGHT SPILLWAYS



STRAIGHT DROP SPILLWAY



Box Inlet Drop Spillway

LOOSE ROCK CHECK DAM
FIGURE A-29

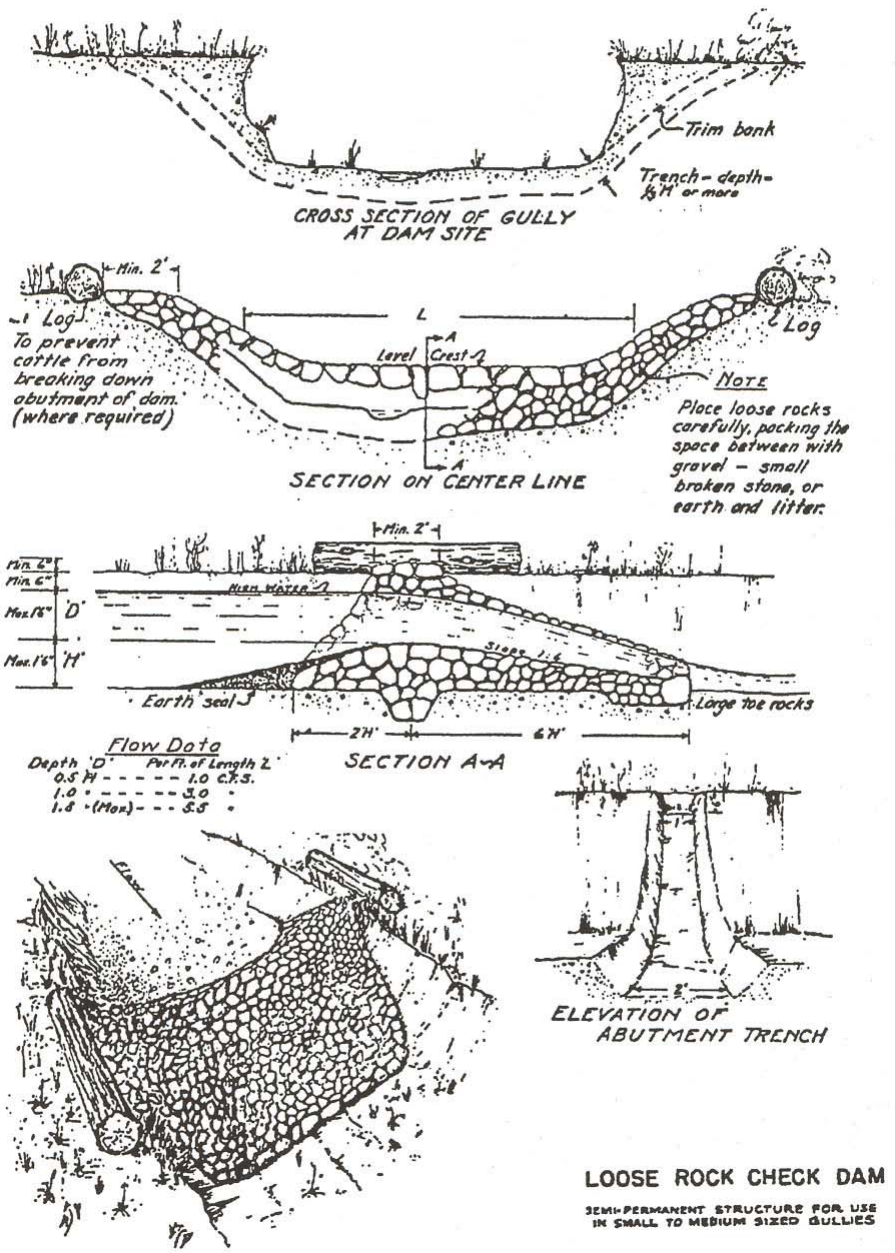


FIGURE A-30 (APPF10.PCX)
BRUSH CHECK

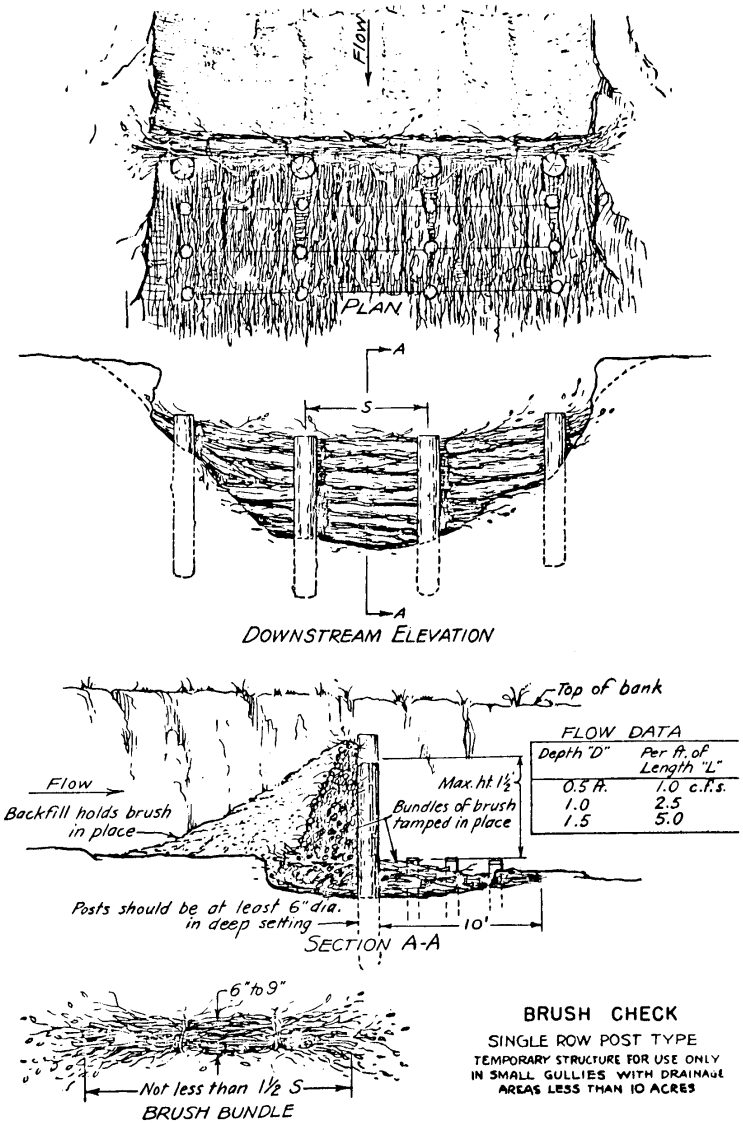
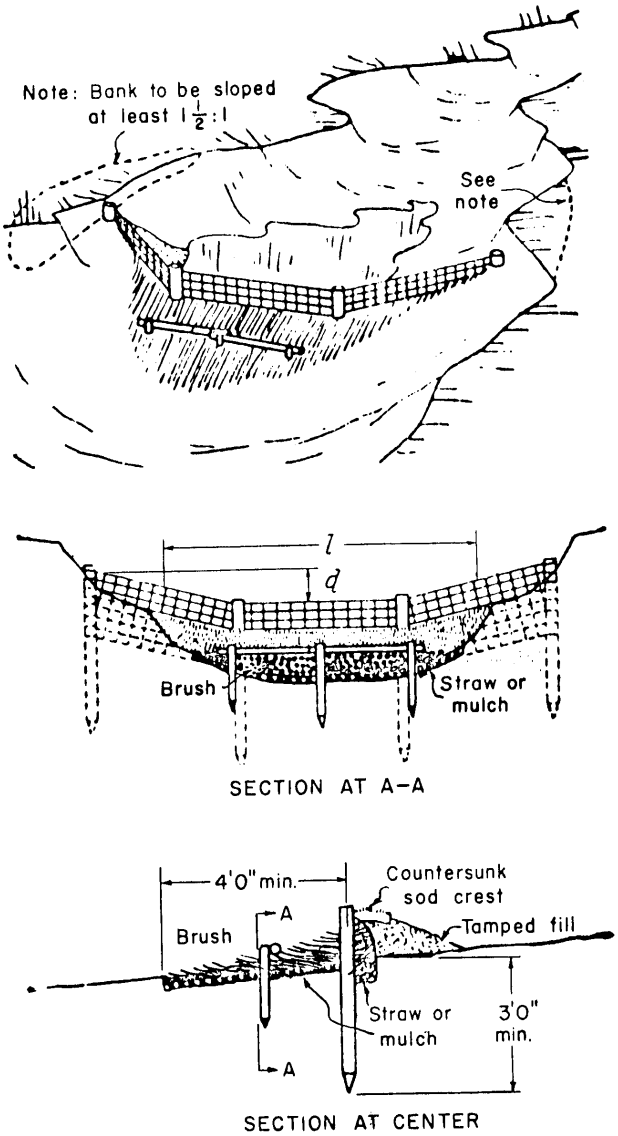


FIGURE A-31 (APPF11.PCX)
WOVEN WIRE DAM



WOVEN WIRE DAM

FIGURE A-32 (APPF12.PCX)
WIRE FENCE CHECK

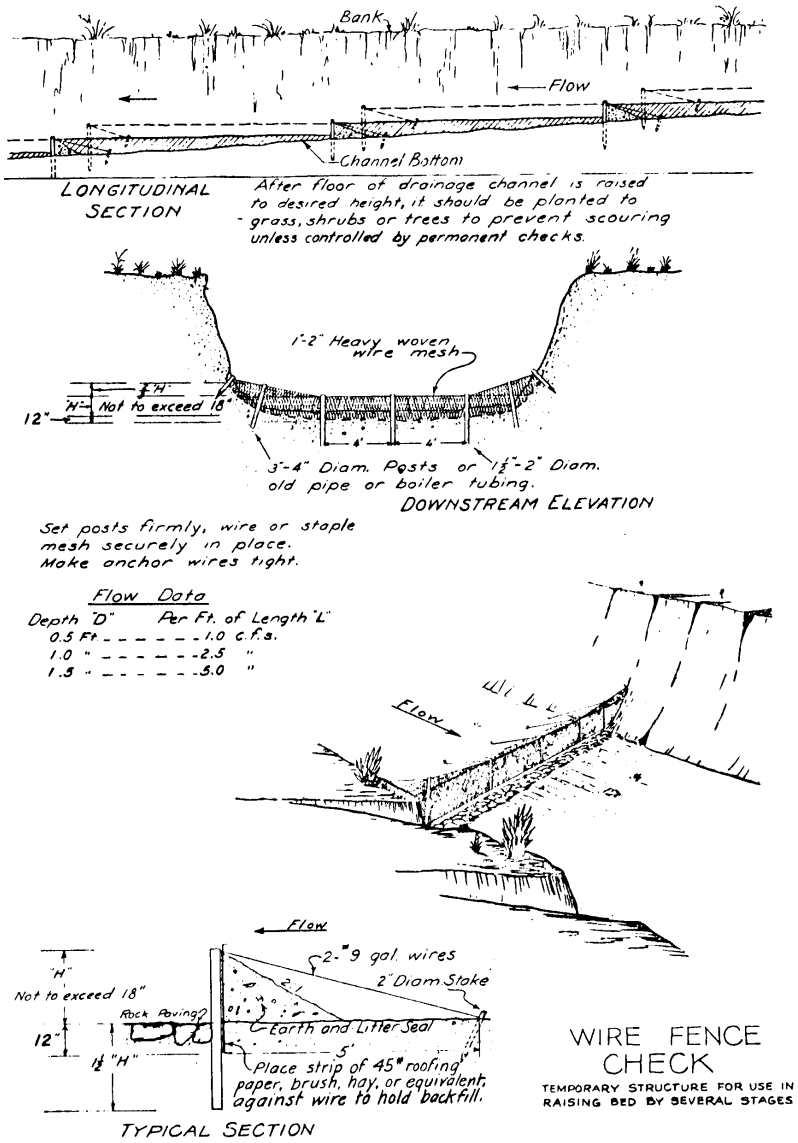


FIGURE A-33 (APPF13.PCX)
RUBBLE MASONRY CHECK

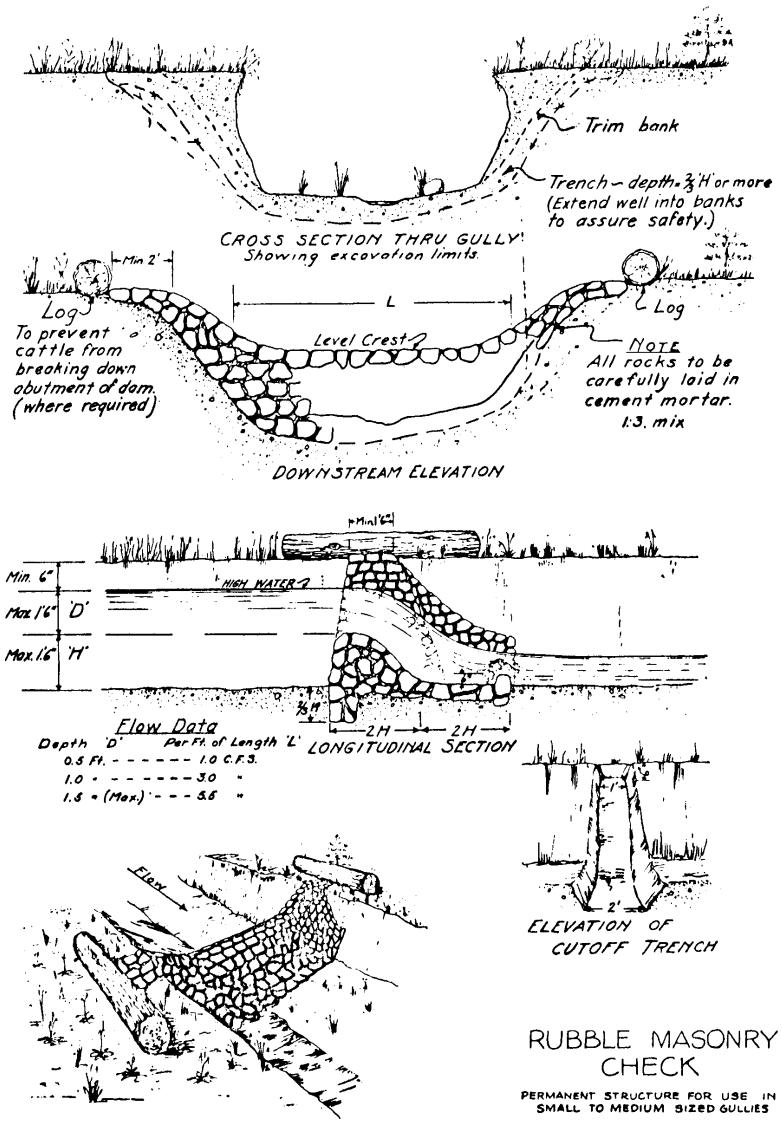
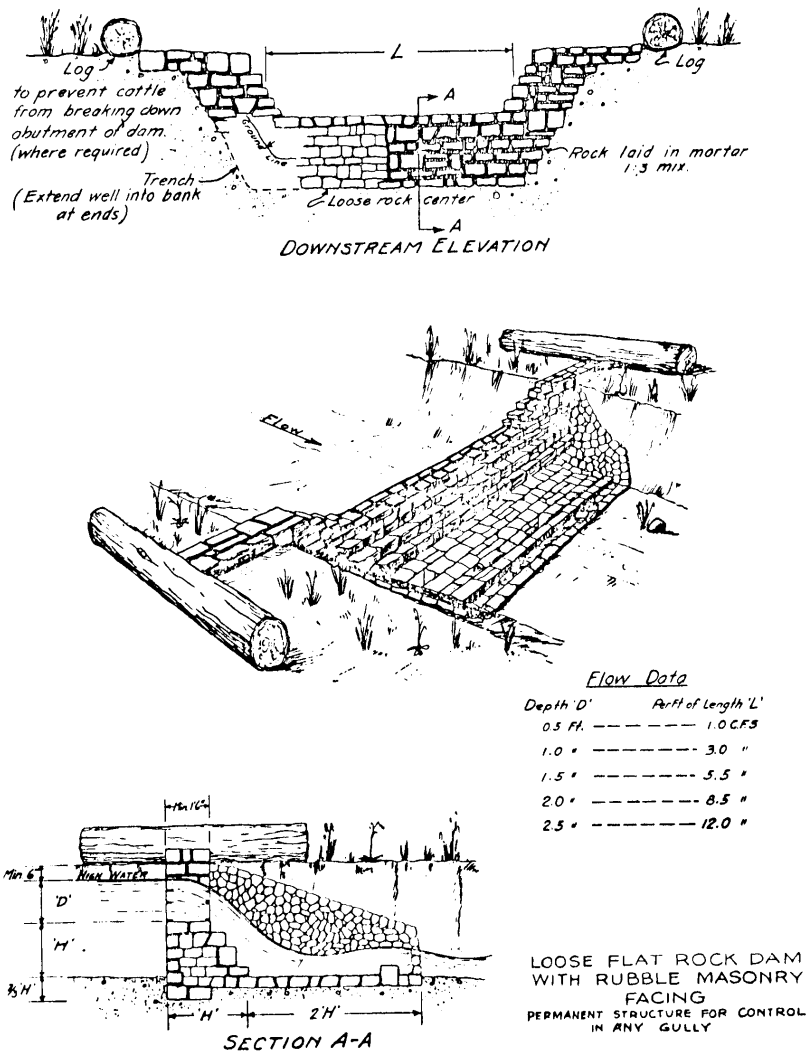


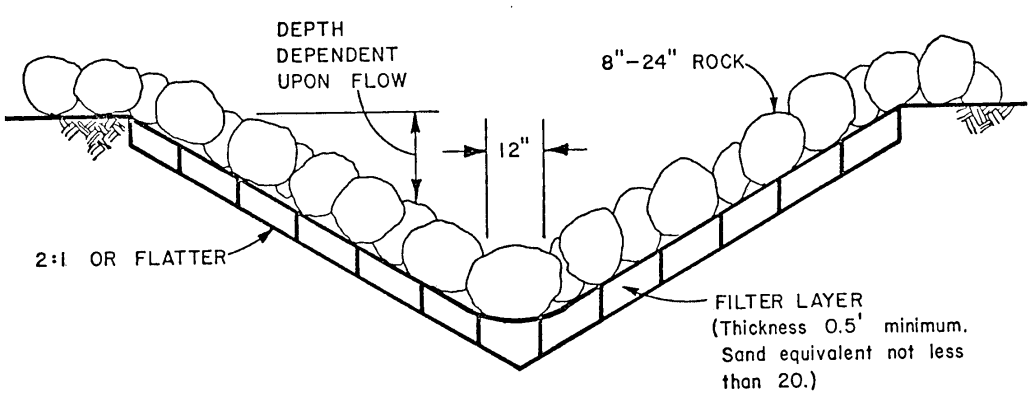
FIGURE A-34 (APPF14.PCX)
LOOSE FLAT ROCK DAM WITH RUBBLE MASONRY FACING



LOOSE FLAT ROCK DAM WITH RUBBLE MASONRY FACING
PERMANENT STRUCTURE FOR CONTROL IN ANY GULLY

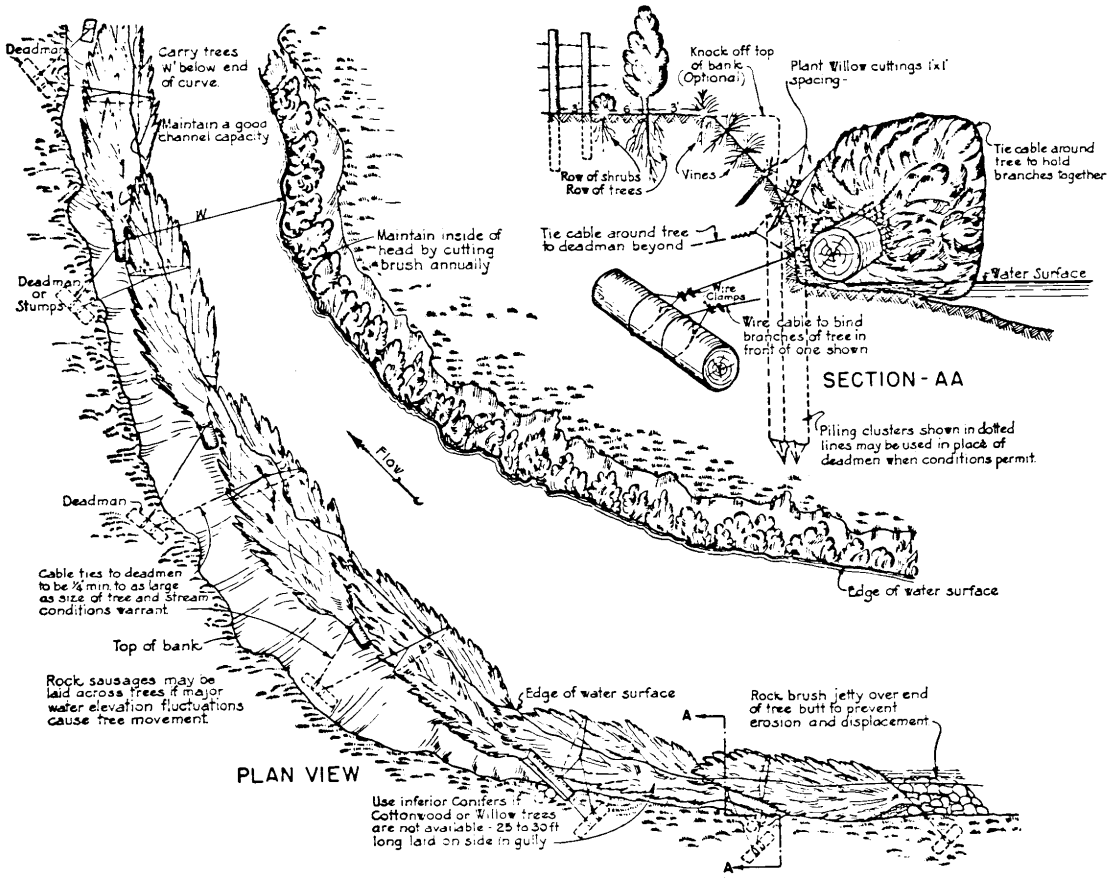
FIGURE A-35 (APPF15.PCX)
ROCK LINED CHANNEL

ROCK LINED CHANNEL



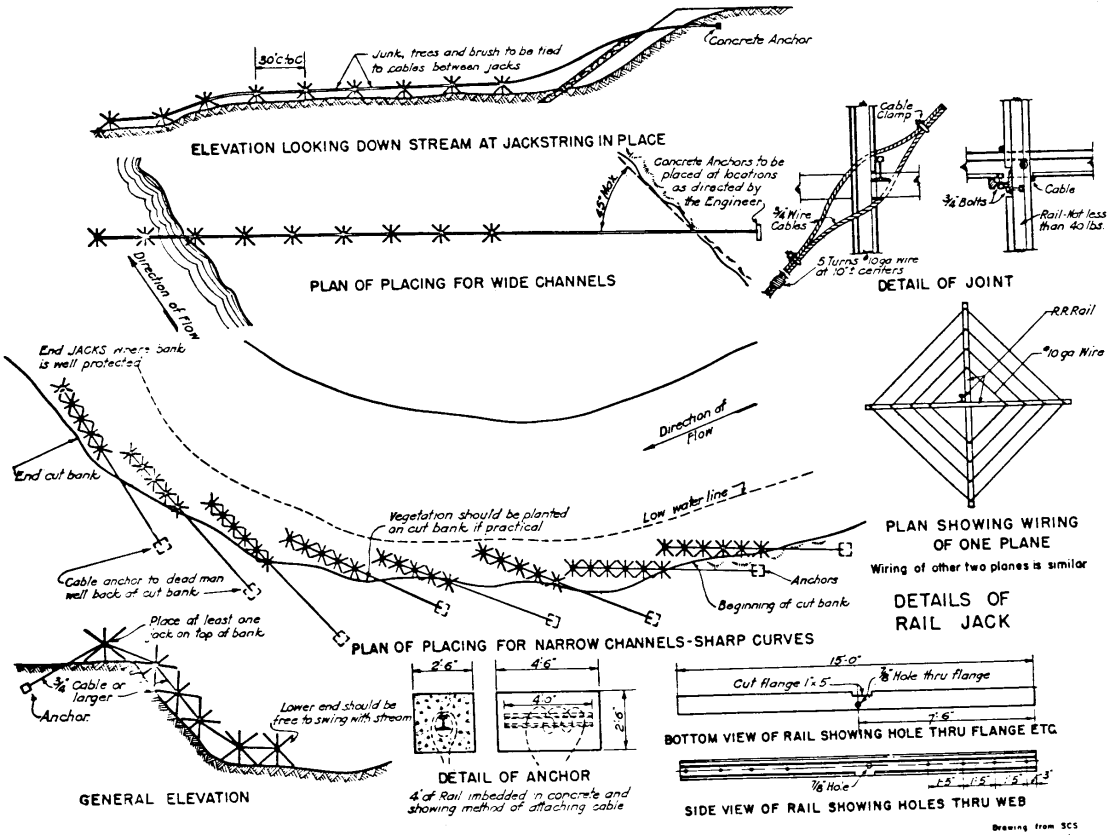
TYPICAL SECTION
no scale

FIGURE A-36 (APPF16.PCX)
ANCHORED CUT TREE REVETMENT



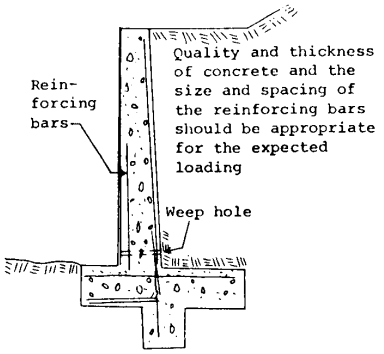
Anchored Cut Tree Revetment

FIGURE A-37 (APPF17.PCX)
RAIL JACK STRING DEFLECTORS

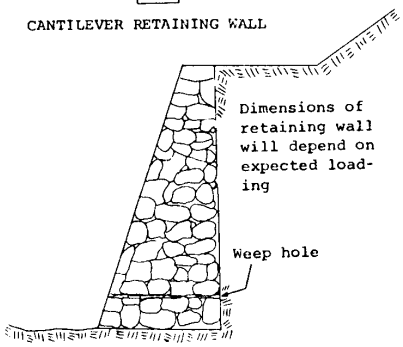


Rail Jack String Deflectors
(Bed Load Streams)

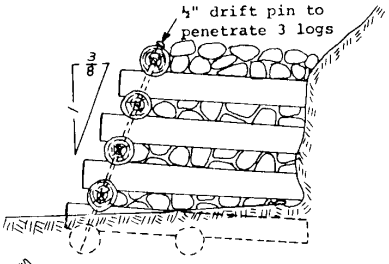
FIGURE A-38 (APPF18.PCX)
RETAINING WALLS



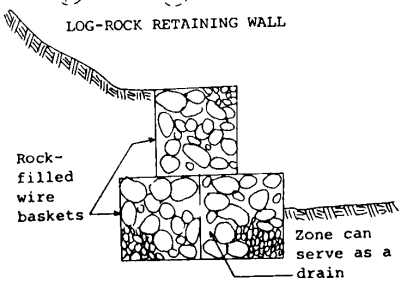
CANTILEVER RETAINING WALL



RUBBLE MASONRY RETAINING WALL



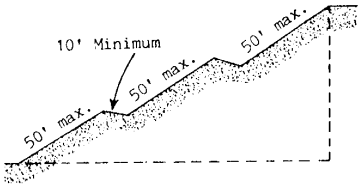
LOG-ROCK RETAINING WALL



GABION RETAINING WALL

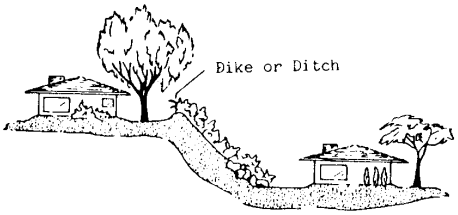
Terraces or Benches - Properly spaced terraces or benches will provide additional protection on long slopes and aid in the establishment of vegetation.

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.

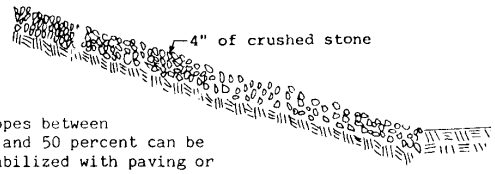


Diversions - Excess water from higher areas spilling over a slope or fill creates difficult erosion problems.

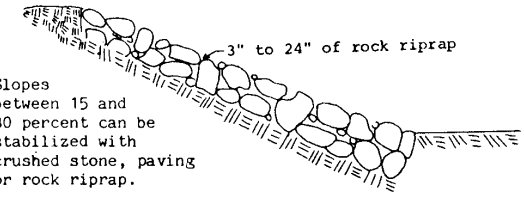
These problems can be avoided by placing a ditch or dike diversion at the top of the slope to intercept the runoff water and lead it to a safe place of disposal.



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.

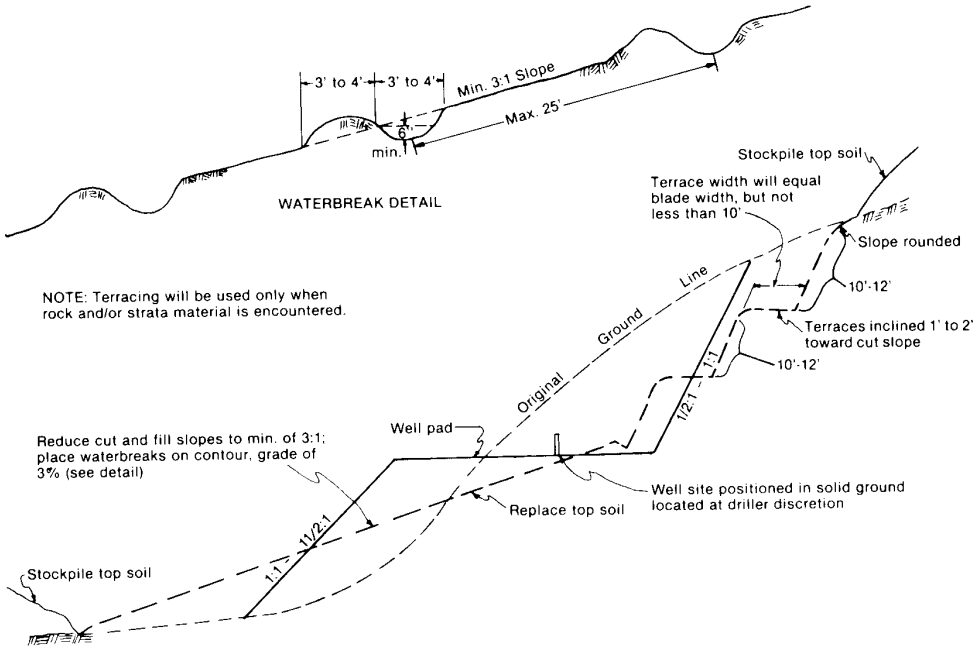


Slopes between 15 and 30 percent can be stabilized with crushed stone, paving or rock riprap.

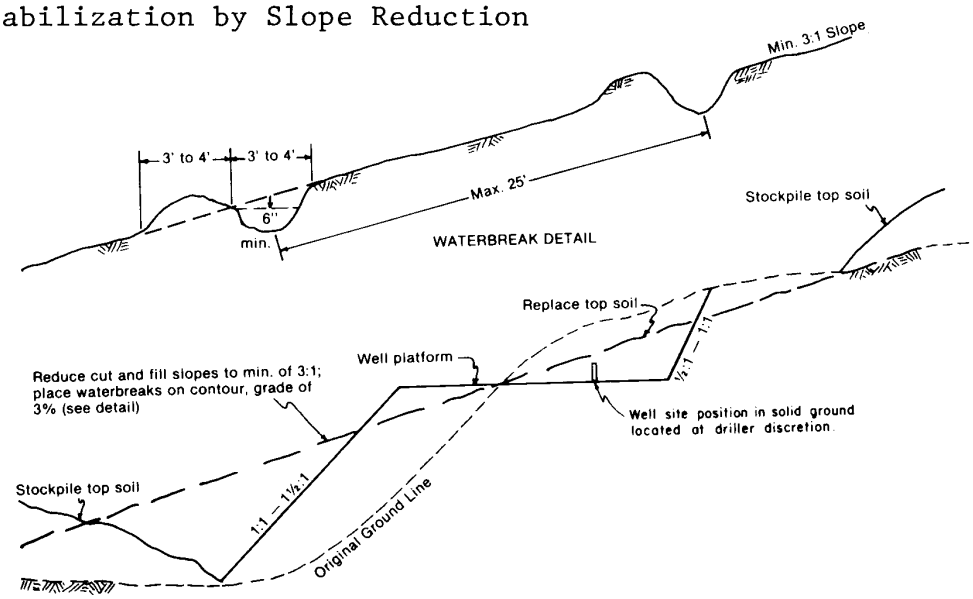
Retaining Walls

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.

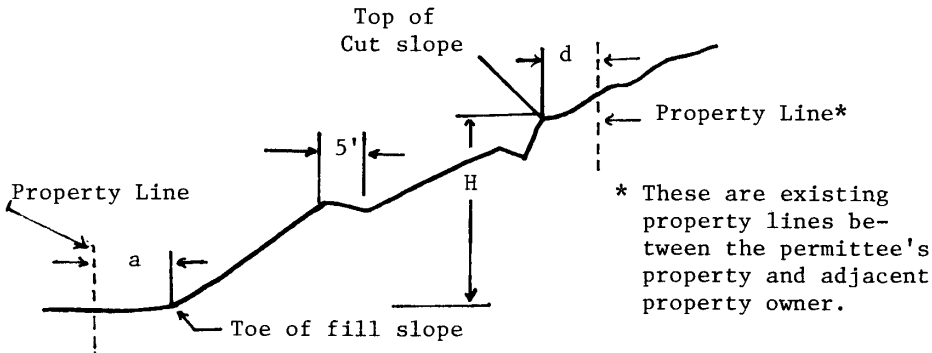
Slope stabilization may also be a serious problem on some sites and may require structural measures. Slopes must be stabilized, and sediment and erosion control measures installed before revegetation is initiated. Information contained in geologic, engineering, and soil survey reports can serve as guides 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)

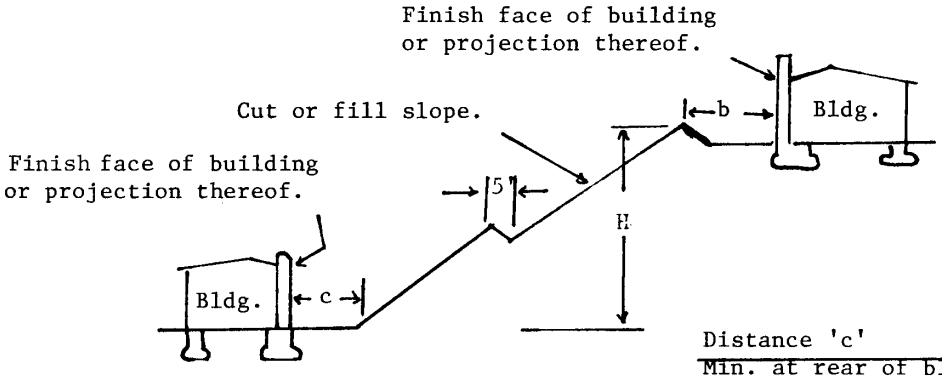
Slope Setback from Property Line

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, l 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.	1. Planting site is preferred as this is the equalization point 1. 20% crown cover
	2. Select shelter site	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	1. 20"X30"
	2. Trim tattered strings	
	3. Soak in water or vermiculite slurry	1. Thoroughly saturate. New burlap may take up to 24 hours.
4. Mix vermiculite with water	1. Use 5-gallon container or larger	1. Use clean water
	2. Mix to a consistency of cereal	1. Approx. 2 1/2 water to vermiculite
	3. Allow solution to age	1. 2 to 3 hours
	4. Retain premixed solution on hand	

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 pre-marked 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 fraffic. (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 polyproplyene 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 — Phone: (415) 744-1962
San Francisco, CA 94105-3901 — 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

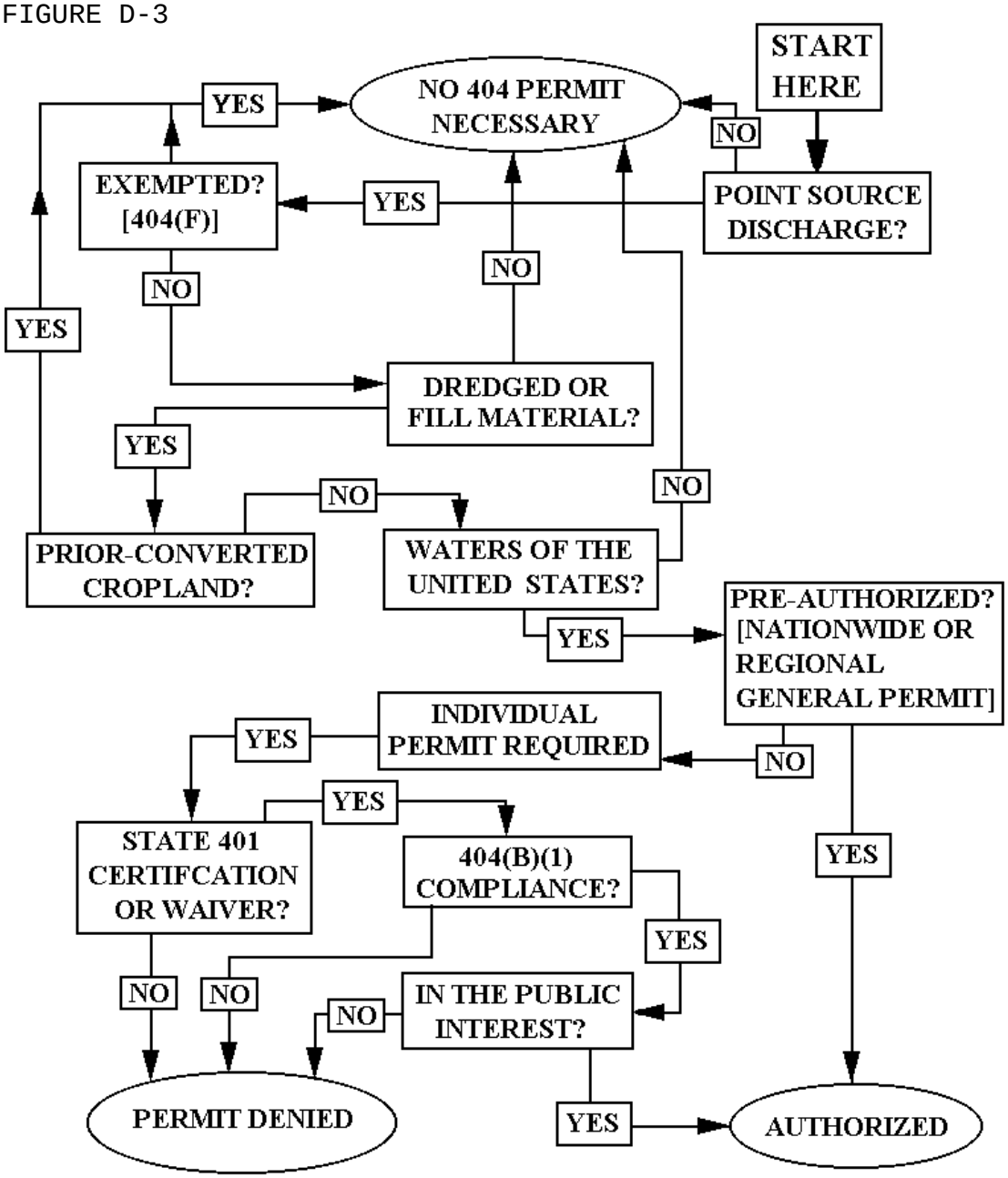
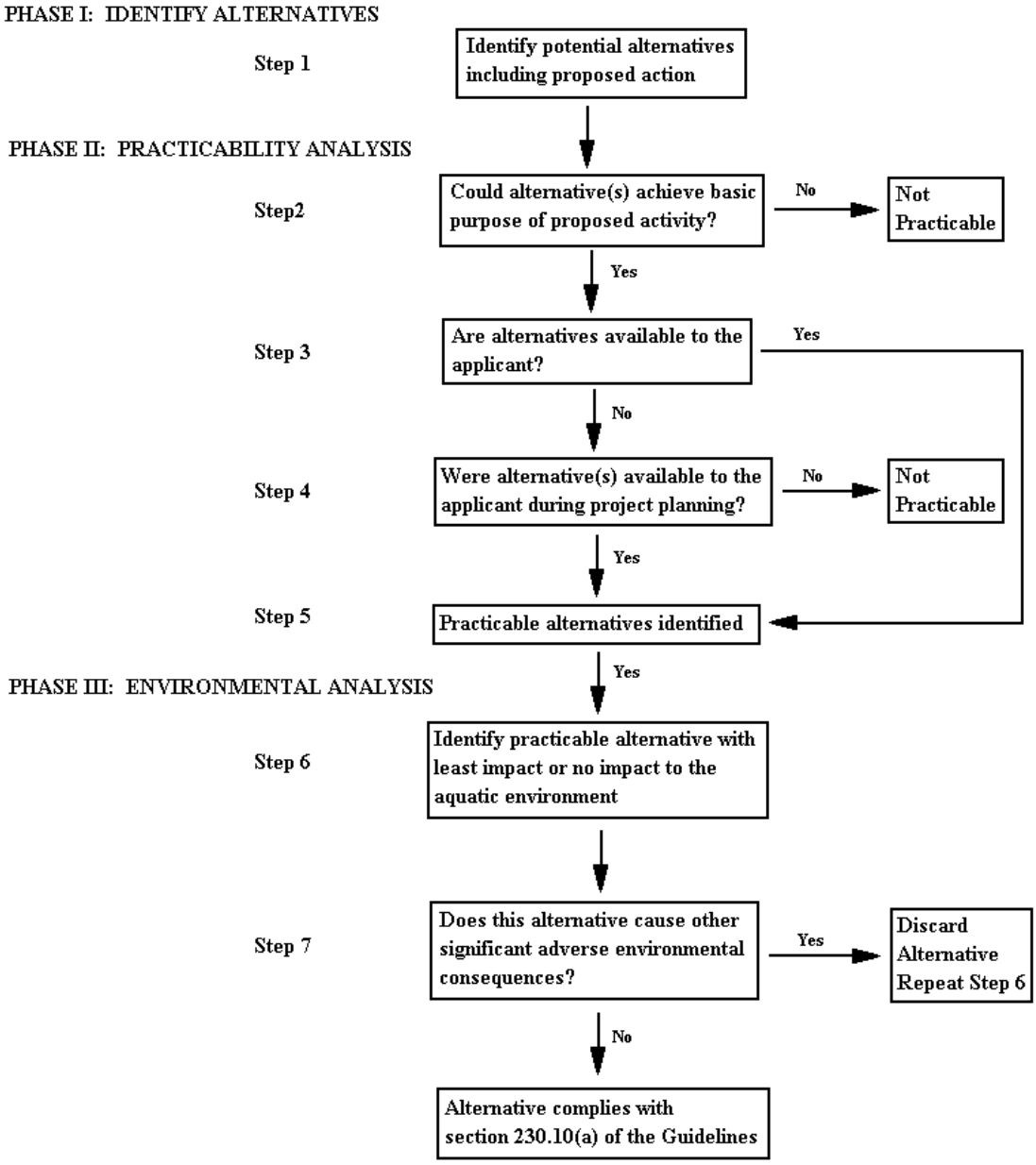

START HERE
NO 404 PERMIT NECESSARY
YES
NO
POINT SOURCE DISCHARGE?
EXEMPTED? [404(F)]
YES
NO
NO
YES
DREDGED OR FILL MATERIAL?
YES
NO
NO
PRIOR-CONVERTED CROPLAND?
WATERS OF THE UNITED STATES?
YES
PRE-AUTHORIZED? [NATIONWIDE OR REGIONAL GENERAL PERMIT]
INDIVIDUAL PERMIT REQUIRED
YES
NO
YES
STATE 401 CERTIFCATION 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

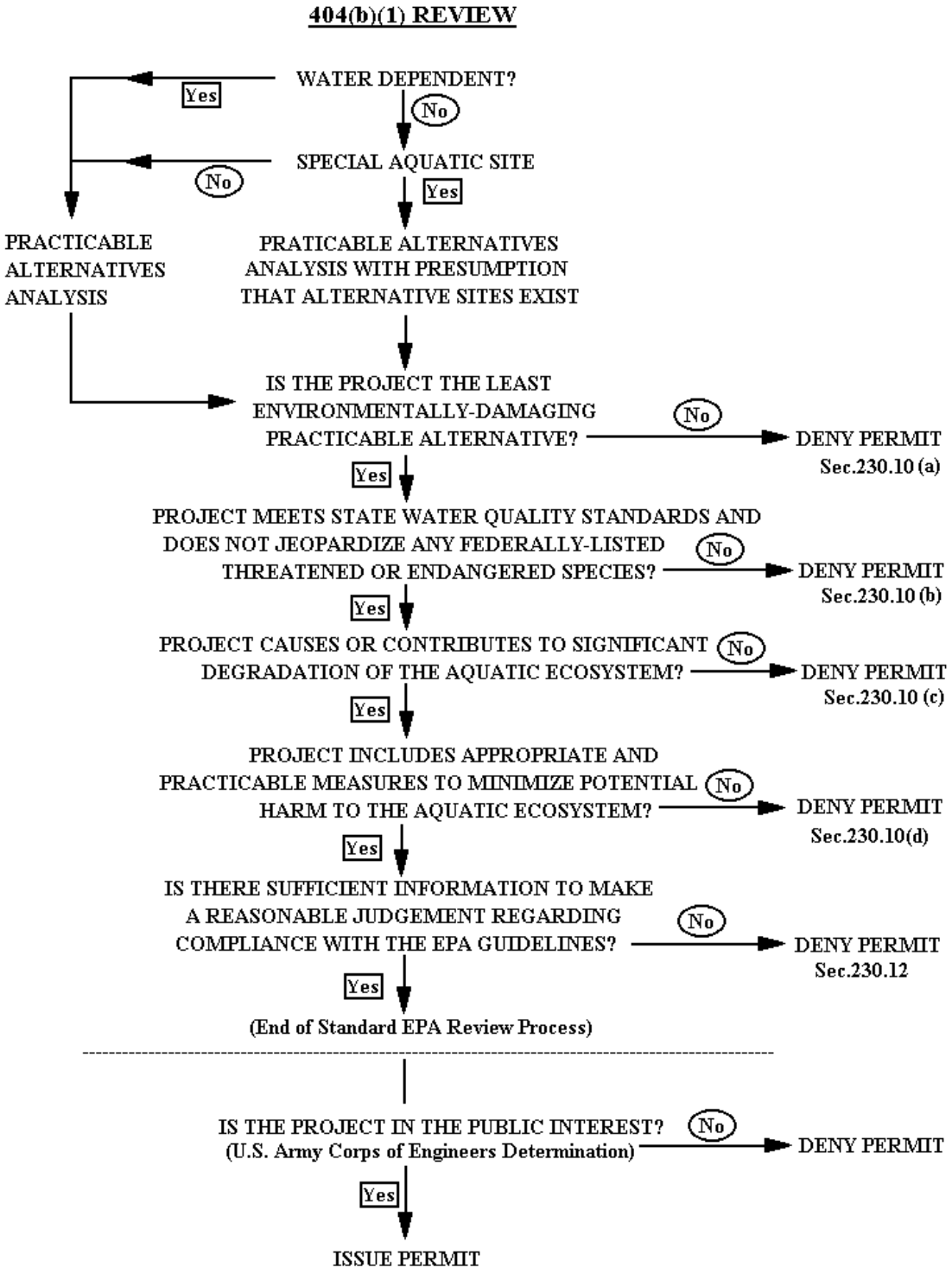

404(b)(1) REVIEW
WATER DEPENDENT?
Yes
No
SPECIAL AQUATIC SITE
No
Yes
PRACTICABLE ALTERNATIVES ANALYSIS
PRATICABLE ALTERNATIVES ANALYSIS WITH PRESUMPTION THAT ALTERNATIVE SITES EXIST
IS THE PROJECT THE LEAST ENVIRONMENTALLY-DAMAGING PRACTICABLE ALTERNATIVE?
No
DENY PERMIT Sec.230.10 (a)
Yes
PROJECT MEETS 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.

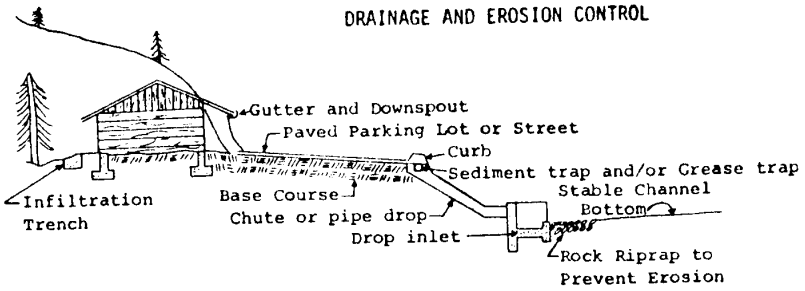
Well anchored straw or hay mulch will persist and aid in establishment of volunteer native plants as well as the seeded species. There have been instances where mulching with grass hay has resulted in the establishment of good plant cover without any seeding. A good mulching job may be the single most 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



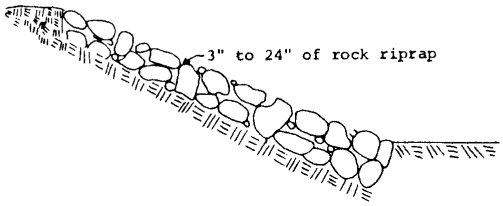
Provide for surface and subsurface drainage. This should include roof drainage and paved areas. The disposal of runoff should be made without causing erosion.

FIGURE E-2 (FIGC1A.PCX)
SLOPE STABILIZATION BY MECHANICAL MEANS-A*

SLOPE STABILIZATION BY MECHANICAL MEANS*

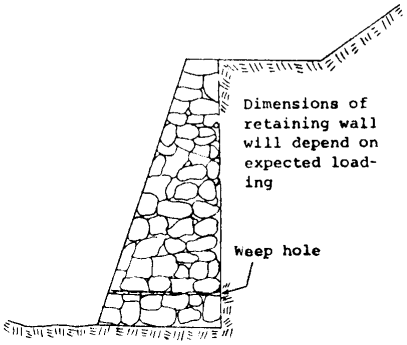
Slopes between 15 and 30 percent can be stabilized with crushed stone, paving or rock riprap.

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.

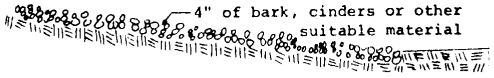
* Slopes less than 2:1 may also be stabilized with vegetation.



RUBBLE MASONRY RETAINING WALL

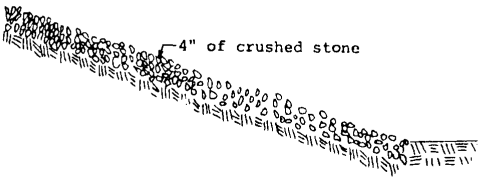
Slopes greater than 50 percent should be stabilized with the use of structural controls.

Slopes less than 15 percent (6.7:1)

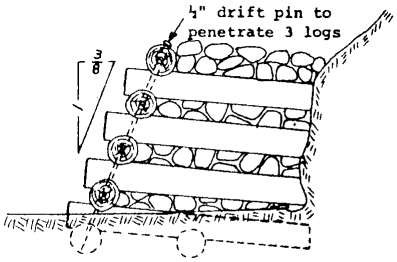


Slopes flatter than 15 percent can be stabilized with crushed stone, permanent mulch (bark, cinders, etc.), paving or rock riprap.

Slopes from 15 to 30 percent (6.7:1 to 3.3:1)

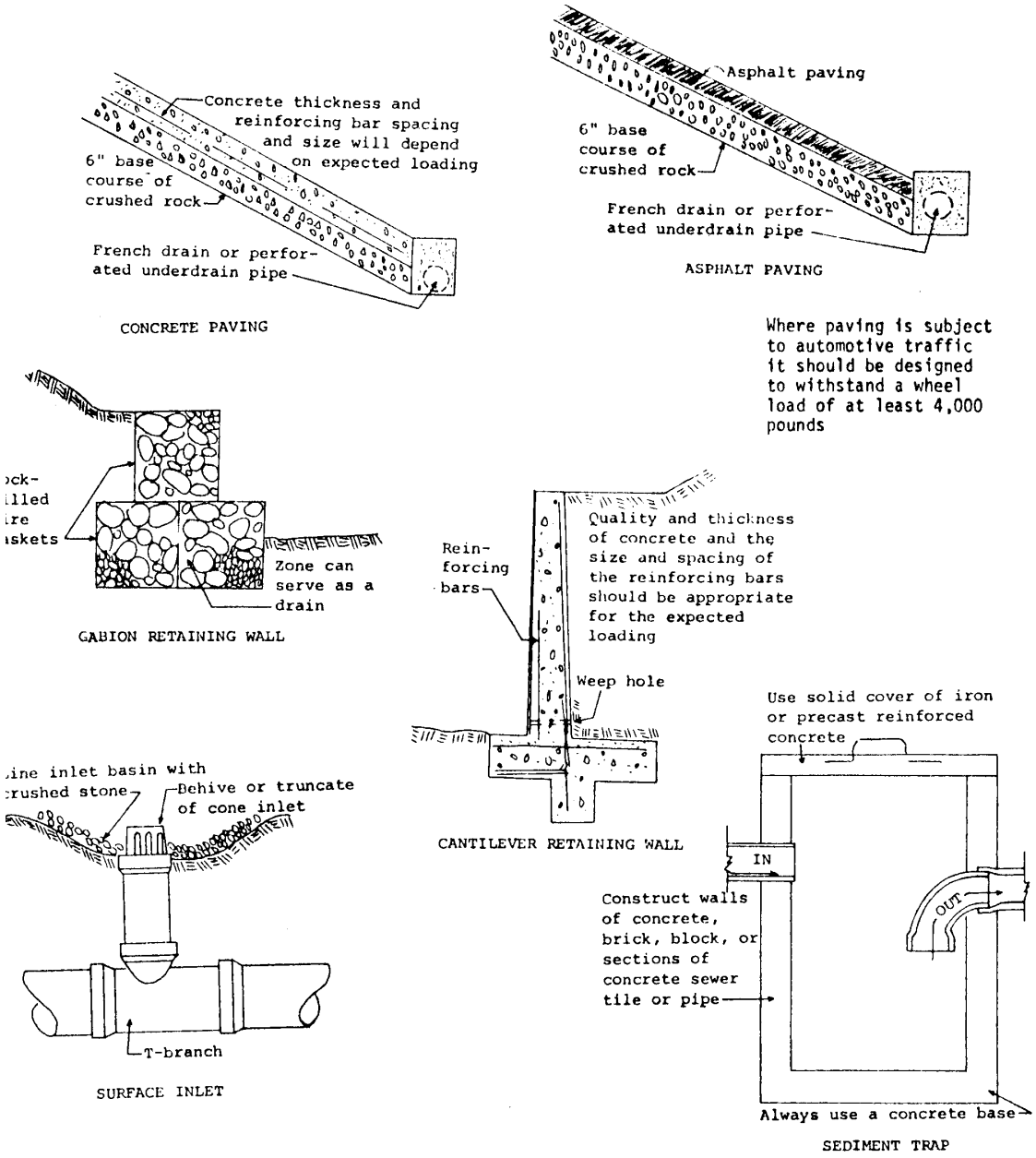


Slopes greater than 50 percent (Steeper than 2:1)



LOG-ROCK RETAINING WALL

FIGURE E-3 (FIGC1B.PCX)
SLOPE STABILIZATION BY MECHANICAL MEANS-B*



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_20_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:

<u>Shoreline Area</u>

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.