1.6 IMPLEMENTATION GUIDELINES

Planning

Planning is necessary if effective solutions are to be provided for erosion and sediment control on construction sites. Plans can guide development and prevent waste. In planning, the permanent features of the development should conform to the natural characteristics of the site.

Soil survey information provides an understanding of the capabilities and general limitations of a site. The soil survey contains information on the feasibility of planned land uses, economic considerations, and the conservation requirements of the site. Detailed soil maps and related data are available in the local SWCD offices and will provide the following information:

1. Descriptions, erodibility, capabilities, and construction limitations
2. Soil properties and suitability of soil material for topsoil, gravel, and sand or for dams and levees
3. Construction site suitability for roads, buildings, septic systems, sanitary landfills, vegetation, reservoirs, dams, recreation areas, or wildlife development

Addresses, fax numbers, and phone numbers of the local SWCD offices can be found at http://www.agriculture.state.ia.us/swcdnm.asp.

An erosion and sediment control plan is necessary for all of the land to be developed. A great deal of information must be reviewed to develop an effective plan for the construction site. The erosion and sediment control plan needs to show the existing topography and how it will be changed. The plan needs to indicate what control measures will be used and how and when they will be installed, maintained, and coordinated with the phasing schedule.

Site Management

Efficient site management for effective erosion and sediment control may involve the following considerations:

- Keep silt on the construction site.
- Clear and grade only what is needed for immediate construction; avoid complete clearing and grading; stabilize disturbed areas as soon as possible; divert runoff from highly erodible soils and steep slopes.
- Mark protected areas so workers can see the area. Plastic snow fencing is a good material to use to protect and define the area.
- Ensure all workers understand the provisions of the erosion and sediment control plan.
- Have one person responsible for implementing the erosion and sediment control plan.
- Arrange for routine inspection of all erosion and sediment control measures. When the sediment traps are half-full, they should be cleaned and the sediment disposed of on-site and in an area where sediment will not fill the trap during the next precipitation event. Inspections should be made of all control measures following each precipitation event.

As an aid in planning, refer to the flow charts in Figures 1.6–1.8.

Drainage

Safe disposal of runoff water from a construction site is a major concern. For information about drainage ditch design, see the Natural Resources Conservation Service Engineering Field Handbook. A major item in ditch design is stability of the soil.

Vegetated Channels

The following information will be helpful in designing channels and waterways. Additional details may be found in Chapter 2 under Vegetation and Soil Stabilization Erosion Control Measures: Grass Channels.

When the channel can be protected from erosion, the allowable velocities can be increased, resulting in deeper and narrower channels. An inexpensive and permanent form of protection is vegetation, specifically grasses. Vegetation protects the channel material from the erosive action of the flow and binds the channel material together.

Vegetated waterways generally can be used to carry intermittent flows such as storm water runoff. However, they are not recommended for channels having sustained base flow, as most vegetation cannot survive continual submergence or continual saturation in the root zone. For example, vegetated waterways would not be used as the channel carrying the discharge from a pipe spillway in a detention basin because this flow is likely to be sustained. A compound channel with a small, lined channel in the center to carry base flows and a vegetated portion to carry storm flows may be used in these situations.

Vegetated waterways are somewhat more complex to design and require more care in their establishment than waterways without vegetation. They will carry high flows at high velocities and require a minimum of maintenance if properly constructed.

Typically, a tall grass presents a great deal of flow resistance to shallow flow. As the flow depth increases, the resistance may decrease. Often the grass will lay over in the direction of flow when the flow reaches sufficient depth. In this condition, the resistance is considerably reduced as compared to the shallow flow situation.

Grasses have been divided into five classes by their ability to retard flow (retardance). The classes are designated A, B, C, D, and E. If the grass will be mowed part of the time and left long part of the time, both the flow conditions and retardance classes must be considered. See Tables 1.6–1.8 for flow retardance classification.

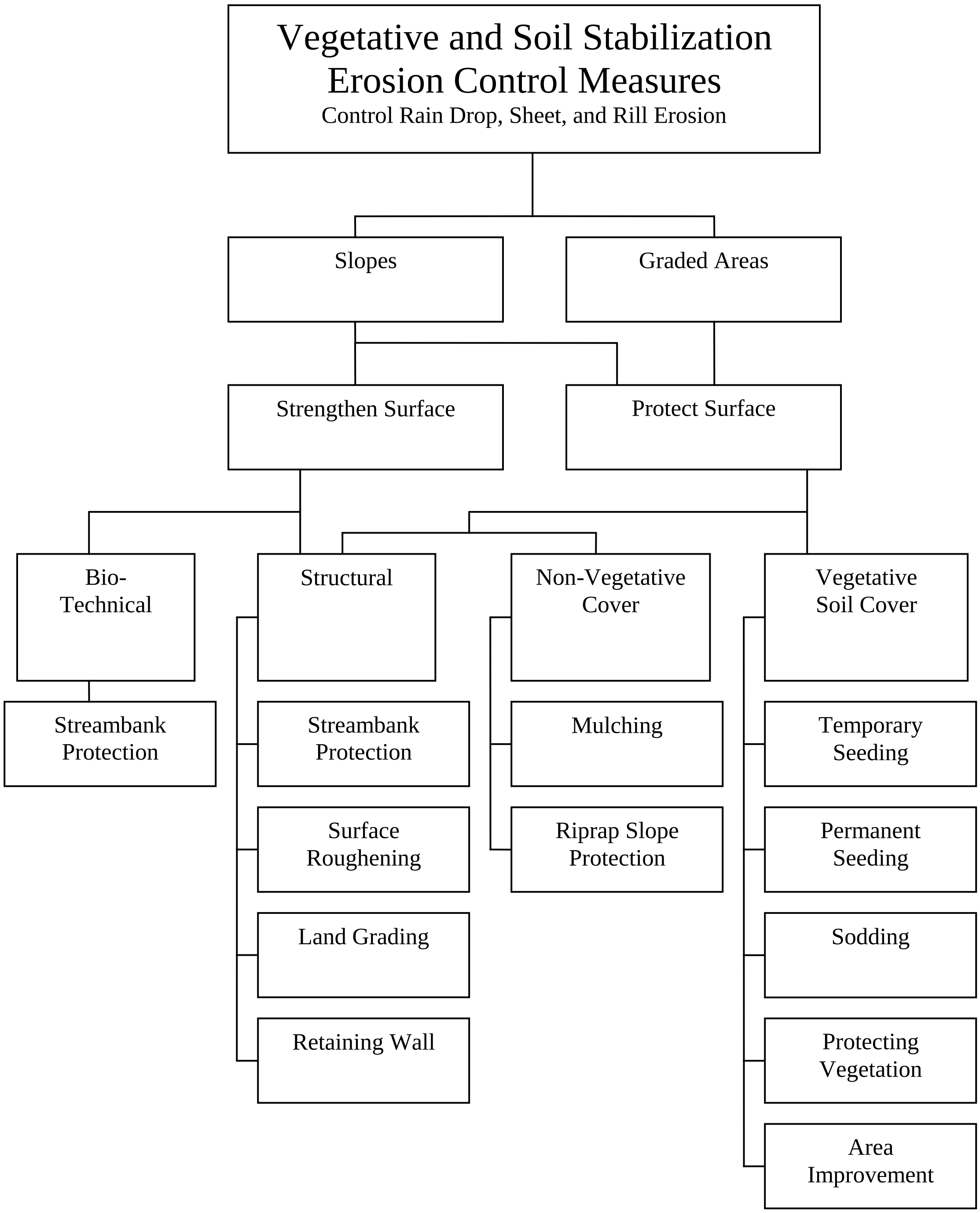

Figure 1.6. Vegetative and soil stabilization erosion control measures

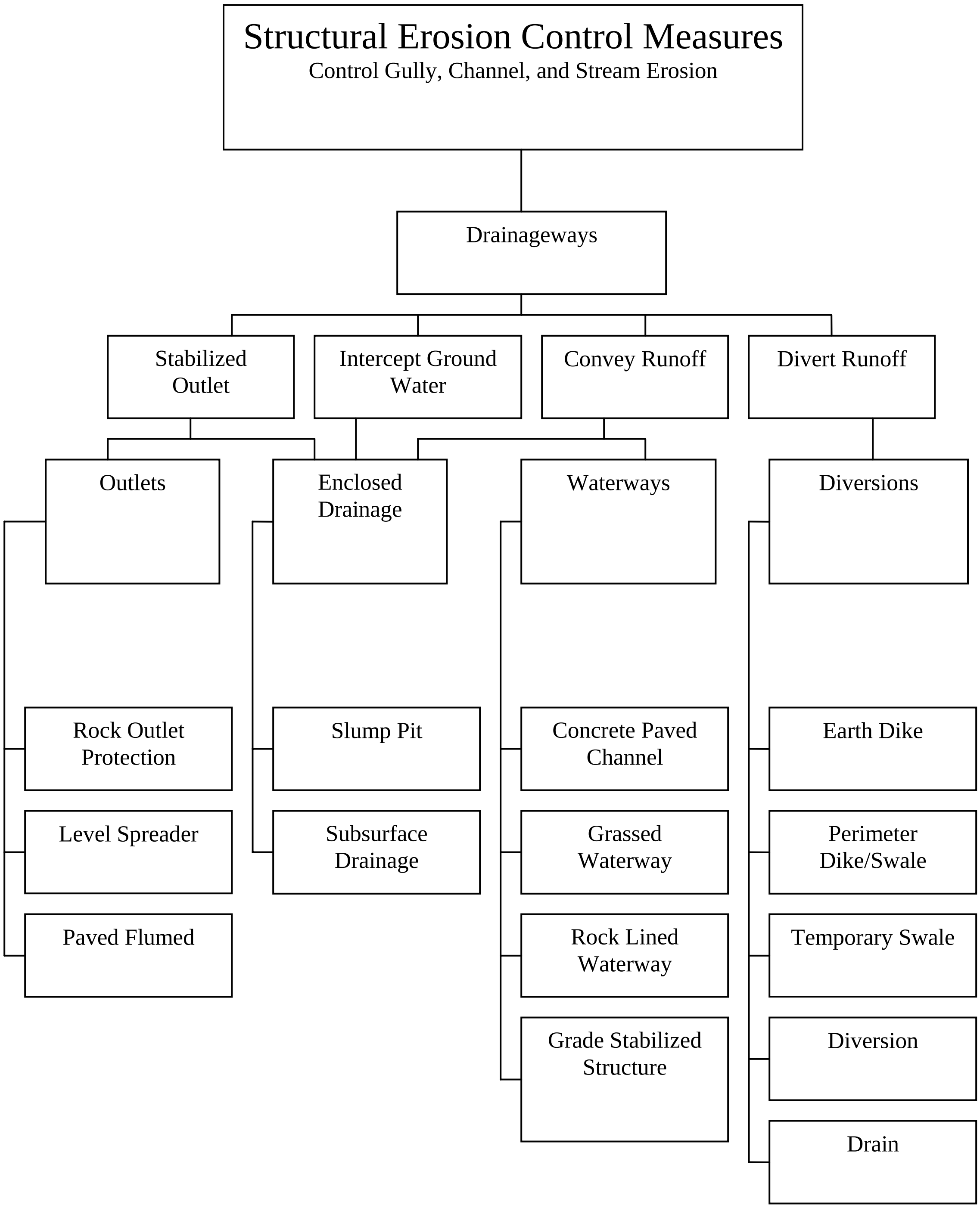

Figure 1.7. Structural erosion control measures

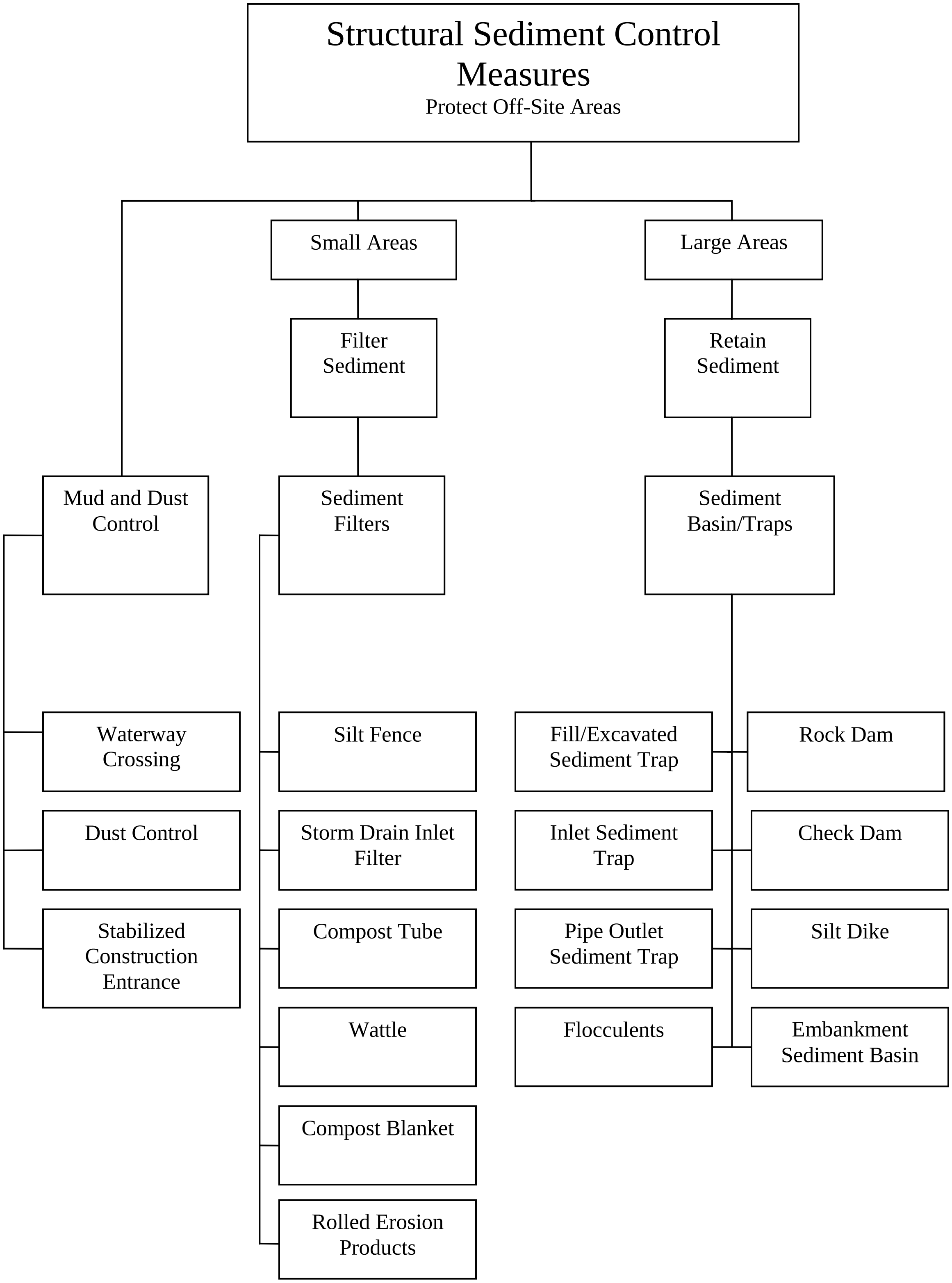

Figure 1.8. Structural sediment control measures

Table 1.6. Classification of vegetal cover in waterways based on degree of flow retardance by vegetation (Source: U.S. EPA 1976)

Retardance	Cover	Stand	Condition and height
A	Reed canarygrass	Excellent	Tall (average 36 in.)
	Kentucky 31 in. tall fescue	Excellent	Tall (average 36 in.)
B	Reed canarygrass	Good	Mowed (average 12 to 15 in.)
	Kentucky 31 in. tall fescue	Good	Unmowed (average 18 in.)
	Red Fescue	Good	Unmowed (average 16 in.)
	Kentucky bluegrass	Good	Unmowed (average 16 in.)
	Redtop	Good	Average
C	Kentucky bluegrass	Good	Headed (6 to 12 in.)
	Red fescue	Good	Headed (6 to 12 in.)
	Redtop	Good	Headed (15 to 20 in.)
D	Red fescue	Good	Mowed (2 ½ in.)
	Kentucky bluegrass	Good	Mowed (2 to 5 in.)

Table 1.7. Grass establishment alternatives (Source: VSWCC 1980)

Establishment Technique	Conditions	Remarks
1. Seeding with straw mulching and tack coat	1. Slopes less than 10%–15% 2. Velocity less than 3 fps 3. Majority of drainage cannot be diverted away from channel during germination and establishment 4. Erosion-resistant soils	1. See permanent seeding requirements. When mulching, use 2 tons/acre small grain straw with an acceptable tacking agent.
2. Seeding with straw mulching and jute mesh or erosion netting	1. Slopes less than 10%–15% 2. Velocity less than 5 fps 3. Majority of drainage cannot be diverted away from channel during germination and establishment 4. Moderately erodible soil	2. In addition to the first technique, straw mulching should be secured with netting. If using jute mesh, use only 1 ton/acre small grain straw, evenly distributed. If using a light plastic or paper erosion netting, 1 1/2 to 2 tons/acre of straw is appropriate. Excelsior blankets, used alone, are also acceptable mulching for waterways.
3. Sodding	1. Slopes greater than 10%–15% 2. Velocity between 5 and 6 fps 3. Majority of drainage cannot be diverted away from channel during germination 4. Highly erodible soil	3. See Sodding section for soil installation requirements.

Table 1.8. Maximum flow velocities (Source: USDA, SCS 1979b)

Channel lining	**Maximum velocity (fps)**	
Natural channels not completely clear	Water transporting	
Lined with vegetation	*Water*	*Colloidal silt*
(1) Sand and sandy loam	1.50	2.5
(2) Silt loam	2.00	3.0
(3) Sandy clay loam	2.00	3.5
(4) Clay loam	3.00	4.0
(5) Clay, fine gravel, and graded loam to gravel	3.75	5.0
(6) Graded silt to cobbles	4.00	5.5
(7) Shale, hardpan, and coarse gravels	6.00	6.0

Intercepting and Diverting Runoff

The water-handling structures discussed here are used to divert collected flow away from critical areas, and discharge collected runoff in suitable disposal areas, and intercept surface water runoff before it can cause damage. Structures used to collect and convey runoff are generally referred to as diversion structures. Diversion structures serve to do the following:

- Prevent surface runoff from higher undisturbed or stabilized areas from coming in contact with exposed soil surfaces
- Direct on-site water away from critical areas such as steep slopes, highly erodible soil, and landslide-prone areas
- Prevent sediment-laden runoff from an exposed slope from leaving the restoration site without first passing through a sediment-detention structure

Typical diversion structures are dikes, swales, ditches, or a dike and ditch combination. Diversion structures are ridges of compacted soil placed above, below, or around a disturbed area. Diversion swales are excavated temporary drainageways used above and below disturbed areas. Diversions are permanent or temporary drainageways constructed by digging a shallow ditch along a hillside and building a soil dike along the downhill edge of the ditch with the excavated soil.

Figure 1.9. Intercepting and diverting runoff (Source: Iowa DOT)

Figure 1.10. Diversion structure (Source: Virginia Department of Conservation & Recreation)

Figure 1.11. Diversion dike and swale combination (Source: ISU/CCEE)

Handling and Disposing of Concentrated Flows

In handling concentrated water flows, the primary goals are to control the flow's distance, decrease the gradient, and obstruct the flow. Flow distance may be controlled by lengthening drainageways. However, care must be taken to ensure that the resulting flow will not erode or overflow the channel. Flow gradient can be controlled through the placement of check dams and other flow control structures across the channel. Grade control structures also serve to obstruct flow within the channel and, as a result, slow its movement. Placement of the water-handling structure nearly parallel to the ground contour is a means of controlling the gradient and maximizing the flow distance. Again, care must be taken to ensure that the channel can carry the design flow without overtopping in critical areas, such as along erodible slopes.

Materials such as rock riprap placed in the channel will dissipate the energy of the flow. This will also reduce the ability of the concentrated flow to cause erosion. Energy dissipators should be placed below grade control structures and outfalls, and when necessary, along the outside of channel bends. Further information on the design of energy dissipators can be found in the Federal Highway Administration's Hydraulic Engineering Circular No. 14 (1975). See www.ntis.gov or call (703) 487-4650 for the publication.

Structures used to control concentrated flow include downdrain structures (rock chutes, flumes, and pipe slope drains) and waterways. Paved chutes (flumes) are channels extending from the top to the bottom of the slope and lined with non-erodible material such as bituminous concrete, portland cement, or grouted riprap. Rock chutes (flumes) are constructed in the same manner as paved chutes, but utilize natural stones or riprap materials. Pipe slope drains may be rigid pipe or flexible tubing connected to the prefabricated inlet section. These are considered temporary measures and extend from the top to the bottom of a slope.

Waterways are stabilized channels designed to handle the anticipated flow rate safely. Channel linings vary according to flow rates. Grade control structures and energy dissipators are also used to stabilize the channel for high-velocity water flow. See Tables 1.9 and 1.10.

Each water control structure must have a stable outlet. The outlet may be a natural drainageway, vegetated area, or other stable watercourse. In all cases, the outlet must convey the water without incurring erosion. Disposal of small flows in upland areas can be performed by using a level spreader. The structure is a well-stabilized outlet constructed at zero percent grade (along the outlet lip) that converts concentrated flow into less erosive sheet flow. The flow is discharged onto a vegetated slope in an area where the water will not be reconcentrated immediately below the structure.

Impoundment structures may also be used to control runoff by trapping sediment from the site and reducing downstream channel erosion and flooding problems. Trapping sediment is their primary function. However, when increased runoff is expected, off-site erosion and flooding potential should also be given careful consideration in the design and construction of water detention or retention structures. Impoundment structures such as sediment basins detain runoff and release it at a controlled rate. Thus, the ability of the inflowing water to carry sediment is reduced.

Table 1.9. Waterway linings in order of increasing flow velocity and handling capacity

Type	Remarks	Maintenance
Grass	• Need to divert water to establish vegetation • Lime, fertilize, seed, and mulch • Methods of keeping seeds and seedings on steep slopes (using cloth, latex spray, chemical tacks, etc.) • Cut mulching at 90^{o} to line-of-flow with rolling cultipacker	• Fertilize • Mow at height of 4–6 in. at least two times per year to prevent thatching of grass (Do not mow unless waterway will support equipment. Waterlogged soils in spring should be avoided.) • Rotor mower preferable to sickle bar mower
Channel liner	• Used for channels with occasional water flow that cannot be diverted • Erosion checks of fiberglass: 50 ft apart on sandy soils, 100 ft apart on heavier soils, and at gradient changes • Erosion checks must be flush with surface • Paper netting at sites with little flow • Installation by experienced persons only	• Routine inspection and replacement if necessary
Low-flow channel	• Riprapped subgraded ditch for constant flow (spring, seepage, etc.) • Grass on waterway sides • Jute or Enkamat liner	• Replace missing or damaged stone areas to original protection levels
Riprap	• Uses filter cloth for soils with poor structure or seepage areas with settling to keep uniform gradient of stone • Used when either low-flow channel or entire channel is riprapped	• Remove bridges or obstructions created by foreign objects to avoid ponding • Check for loose stones from frost heave in spring
Mattress (Maccaferri)	• Use when riprap is being carried away by flow • Flexible for lining channel • Use filter cloth underneath mattresses • Gabions and weirs used for de-energizing • Recommended in place of riprap where removal of stones by public is potential problem • Plastic-treated mattress needed where water contains salt or caustic materials	• Requires least maintenance and has longest life of all linings • Soil will eventually cover mattress and waterway will revegetate
Concrete	• Monolithic reinforced • Energy dissipators needed • Not suitable for acid flow • Not recommended for critical areas • Expensive, last resort	• Check for water underneath channel • Check for voids under and around channel • Watch for undermining from seepage underneath waterway

Table 1.10. Maximum permissible design velocities for stable grass-lined channels (Source: USDA, SCS 1975)

Cover	Range of channel gradient, %	Permissible velocity, fps
1. Bermudagrass	0 to 5.0	6
Reed canarygrass		5
Tall fescue		
Kentucky bluegrass		
Grass legume mixture		4
Red fescue		2.5
Redtop		
Sericea lespedeza		
Annual lespedeza		
Small grain (rye, oats, barley, millet)		
Ryegrass		
2. Bermudagrass	5.0 to 10.00	5
Reed canarygrass		4
Kentucky 31 in. tall fescue		
Kentucky bluegrass		
Grass legume mixture		3
3. Bermudagrass	Over 10.0	4
Kentucky bluegrass		3
Reed canary grass		
Tall fescue		

Outlets

Each diversion must have a stable outlet constructed and stabilized prior to the operation of the diversion. The outlet may be a natural or constructed waterway, a stabilized open channel, a grade stabilization structure, a sediment trap or basin, a level spreader, or any of a variety of down-drain structures. In all cases, the diversion must discharge into the outlet in such a manner as not to cause erosion.

Stabilization

Once construction is completed, stabilization of the soil surface must be accomplished as soon as possible. Vegetative covers should be established as soon as possible. If anticipated velocities are greater than six fps, a non-vegetative material such as riprap lining should be considered.

Maintenance

Diversion structures should be inspected approximately every two weeks and after every substantial storm event. Repairs should be made whenever necessary. Sediment removal from the ditch line should be made when necessary to maintain the discharge capacity of the structure. A vegetative cover that has failed to establish or has otherwise failed should be promptly reseeded and mulched (see Table 1.10).

Table 1.11. Permissible velocities for earth-lined channels (Source: Soil & Water Conservation Engineering, Schwab et al., & American Society of Civil Engineers)

Soil types	Permissible velocity, fps
Fine sand (non-colloidal)	2.5
Sandy loam (non-colloidal)	2.5
Silt loam (non-colloidal)	3.0
Alluvial silts (non-colloidal)	3.5
Ordinary firm loam	3.5
Fine gravel	5.0
Stiff clay (very colloidal)	5.0
Graded, loam to cobbles (non-colloidal)	5.0
Alluvial silts (colloidal)	5.0
Cobbles and shingles	5.5
Graded, silt to cobbles (colloidal)	5.5
Coarse gravel (non-colloidal)	6.0
Shales and hard pans	6.0

Erosion Control Measures

In selecting a control measure, a number of items need to be reviewed and evaluated. More than one measure may work effectively, or a measure may be modified to fit a special situation. Each of the control measures will contain the following information: name of control measure, problem identification, design purpose, associated practices, design life, and estimated cost. From this information, the designer can select the control measure that is the most economical, practical, efficient, and adaptable to the site.

Erosion control measures are divided into three categories:

1. Vegetation and soil stabilization erosion control measures
2. Structural erosion control measures
3. Special condition erosion control measures

Individual measures are described in Chapters 2–4.