Unit Two

CONTROLLING RUNOFF, EROSION, AND SEDIMENTATION ON CONSTRUCTION SITES

Introduction

This unit will present methods to control, minimize, or prevent runoff, soil erosion, and sedimentation on construction sites. The processes of runoff and soil erosion are so closely associated that methods to control either will usually result in the control of both runoff and soil erosion. Many runoff and erosion controls also control sedimentation, however, the opposite is almost never true: sediment controls rarely reduce runoff or erosion.

Wind can also be a major erosive force and it must be considered when developing and managing control measures. Silty, fine sandy, and organic soils tend to be the most susceptible to wind erosion. Soil may start moving, or eroding, when wind speed exceeds 13 miles per hour measured at one foot off the ground.

Best Management Practices for Construction Sites

To prevent soil erosion and subsequent sedimentation, BMPs need to be properly installed and maintained. BMPs are vegetative, structural, or managerial practices used to protect soil and water resources as well as adjacent properties. No single BMP can solve all the problems on a site, and not every site is going to use the same BMPs. The specific conditions of a site will dictate which BMPs are appropriate and used in an integrated system to protect water quality. It is recommended that a person who has been trained in SESC develop the SESC plan and select the appropriate BMPs for the site prior to beginning the project. Part 91 requires that the plan be reviewed and approved by someone with SESC training.

Detailed information for commonly used BMPs can be found in the Department of Management and Budget's *Soil Erosion and Sedimentation Control Guidebook*, Natural Resources Conservation Service's (NRCS) *Standards and Specifications*, the Michigan Department of Transportation's *Soil Erosion and Sedimentation Control Manual*, and the Michigan Department of Natural Resources and Environment's (MDNRE) *Guidebook of Best Management Practices for Michigan Watersheds.*

In the following descriptions, the appropriate use for each BMP is indicated with an abbreviation for runoff (**R**), erosion (**E**), or sedimentation (**S**) control, or for housekeeping or miscellaneous (**H**) controls. In the following paragraphs, BMPs that are used primarily for runoff and erosion control are considered first; sediment control and housekeeping BMPs follow. Each BMP described below also contains an "inspector's note", which indicates items that inspectors should monitor and document on inspection reports. At the very least, inspection reports should include descriptions of any failed BMPs or maintenance requirements, as well as documentation that required repairs or maintenance have been adequately completed.

When developing a runoff and SESC strategy, remember that runoff and soil erosion control is more effective and cost efficient than sediment control. Sediment control, although often a necessary component of an effective SESC strategy, should always be considered as a second line of defense to support runoff and erosion controls. Fine sediment particles – silts and clays – are difficult or impossible to capture by standard sediment control techniques. It is particularly important to emphasize runoff and erosion control on sites that contain fine textured soils.

Scheduling (R, E, S, H)

Before any construction begins or any earth change is undertaken, all aspects of the project should be incorporated into a schedule. Scheduling is a planning process that provides a basis for implementing all BMPs in a timely and logical fashion as construction progresses. It may be necessary to implement BMPs sequentially instead of all at one time (Figure 2-1).

Staging of construction is part of scheduling. Staging is sometimes called phasing. With staging, grading in a limited area is completed and stabilized before proceeding with additional grading or earth change activities (Figure 2-2). Staging allows you to take advantage of the existing vegetation on the site. Plan the stages or phases of development so that only areas which are actively under construction have bare soil. All other areas should have a good cover of vegetation or mulch.

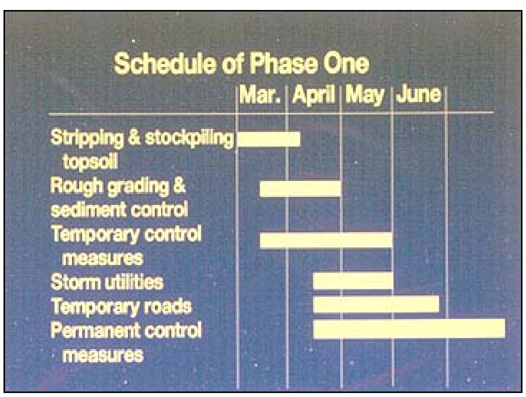

Figure 2-1

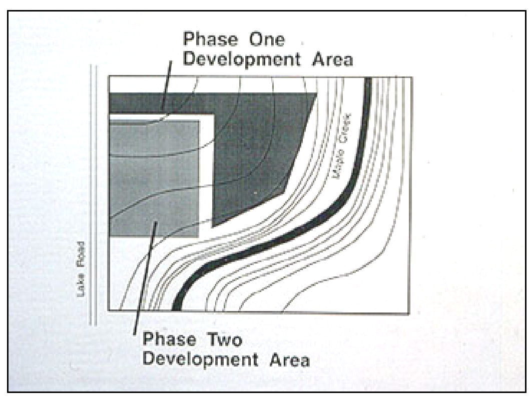

Figure 2-2

Source: John Warbach, Planning and Zoning Center, Inc.

Inspector's note: Do the activities on the ground correspond with the sequence described in the schedule? Is phasing proceeding only as each phase is stabilized or otherwise made secure?

Vegetation (R, E, S)

The most effective way to control runoff and erosion, and one of the most effective means of controlling sediment, is to keep the soil covered with vegetation, which:

- Shields soil from the impact of raindrops, the force of the wind, and the energy of runoff
- Creates structure in the soil with its roots and rhizomes, which both resists the erosive forces of runoff and increases soil permeability and infiltration
- Provides a continuing supply of organic matter, which improves fertility and infiltration
- Slows runoff to non-erosive velocities
- Filters sediment

As is the case with rainfall-induced erosion, the best way to protect against wind erosion is to keep the area covered with vegetation or with securely anchored mulch. Also, in areas subjected to strong winds, such as along the Great Lake shorelines, soil should never be placed in piles and left unvegetated or otherwise unprotected.

To the extent possible, preserve existing vegetated areas; this eliminates the effort and expense of reestablishing vegetation. Vegetation above a graded area will slow the runoff, reducing its potential to erode bare soils; vegetation below the graded area slows runoff and will filter some of the sediment before the runoff leaves the site (Figure 2-3).

Seed and mulch all areas that have no vegetative cover as soon as possible, but no more than five days after achieving final grade. If it is not feasible to permanently seed, establish a quick-growing temporary grass cover or install appropriate temporary BMPs. Mulch should always be placed on bare soil to protect it from rain or wind, whether or not it has been seeded.

Figure 2-3

Inspector's note: Ensure that seeded areas are germinating. Is irrigation necessary? Are mulch or mulch blankets providing adequate cover to protect the soil and seed and are they in place and adequately anchored? Look for damage to vegetation from erosion or sediment deposition or from mechanical damage from vehicles, foot traffic, or livestock. If the vegetation is separated from the construction area by barriers or silt fence, ensure that they are in good condition. In general, be sure that the vegetation is performing its intended function.

The foregoing paragraphs provide only a brief overview of vegetation from the perspective of conducting routine inspections. Unit 3 provides a more thorough treatment of vegetative practices, including information on site analysis and preparation, seed specifications, follow-up maintenance, and treatments other than seeding. The emphasis of Unit 2 is runoff and erosion control.

Appendix 3A “Filter Strips” details the use of vegetation as a sediment control. Although the document is primarily for use in agriculture, forestry, and wildlife habitat protection, the principles and specifications are relevant and appropriate to isolate earth changes from sensitive areas.

Surface Roughening (R, E, S)

The rate of runoff can be reduced by surface roughening. It is an easy and economical method that simply creates an uneven or bumpy condition on the soil surface. Horizontal grooves tend to spread runoff over the slope, slowing it down and allowing more of it to infiltrate into the soil (Figure 2-4).

Scarification is one way to roughen the soil surface. It can be easily accomplished with a drag, cultivator, or by driving a dozer or other tracked vehicle perpendicular to the slope (Figure 2-5). Roughening also produces a soil surface more suitable for the growth of vegetation because it will hold the seed and retain moisture.

Figure 2-4

Figure 2-5

Inspector’s note: At the initial inspection, ensure that the grooves created by the roughening is perpendicular to the direction of flow and that the entire sloped surface has been treated. If a roughened surface is the final grade, seed and mulch or other non-erodible surface should be installed within five days. Ensure that rilling or gullying has not broken through the roughened surface; it may be necessary to supplement the roughening with other BMPs.

Rock, Stone, and Riprap

Several of the BMPs described in this training make use of rock or stone. Assemblages of rock or stone to create a functional structure are often referred to as “riprap”, particularly when associated with water. A few general comments about the use of riprap is in order.

It is important to remember that no matter what riprap is used for, proper rock size and thickness must be based on the application and the maximum expected water velocity or wave energy. In most situations, geotextile should be placed between the riprap and the soil. Occasionally, it is desirable to allow vegetation to grow through the riprap, in which case either nothing or biodegradable erosion control mat can be used in lieu of geotextile.

Rock that is too large may allow sediment transport between the rocks or may allow runoff to pass through at erosive velocities. If rock is too small, the energy of moving water may move the rock and destroy the structure. To keep the interstices of riprap structures free of sediment, bare soil upslope of riprap should be stabilized with sod or seed and mulch or the riprap otherwise protected by means of temporary sediment controls. To avoid slumping, riprap should not be used on slopes steeper than 2:1. If placing riprap requires the reconfiguration of banks, slopes, or channels, filter fabric and riprap should be placed immediately after grading. The geotextile and riprap should be "keyed-in" at the top and bottom of slope. If riprap is used as an energy dissipator at the discharge of a concentrated flow, it should be designed to reduce the anticipated flow to non-erosive velocities. The riprap should be installed before any concentrated discharge occurs.

Diversions and Channels (R, E, S)

Diversions are specialized channels and many of the same considerations apply for both design and inspections. Diversions always capture runoff, but depending on their location, diversions can provide erosion control, sediment control, or both. Diversions upslope of a construction site intercept runoff that would otherwise flow across an exposed slope and cause erosion (Figure 2-6). Diversions below a construction site intercept sediment laden runoff and route it to an area where the sediment can be contained.

A diversion is generally constructed as a channel with a ridge on the lower side. Often the excavated material from the channel is used to construct the ridge. The channel and ridge can be bare compacted soil or vegetated. When the anticipated runoff velocities exceed 1.5 to 2.0 feet per second, diversions should be vegetated. Reinforcing measures, such as erosion control blankets, turf reinforcement mats, or check dams may be necessary while establishing vegetation in the channel or on the ridge.

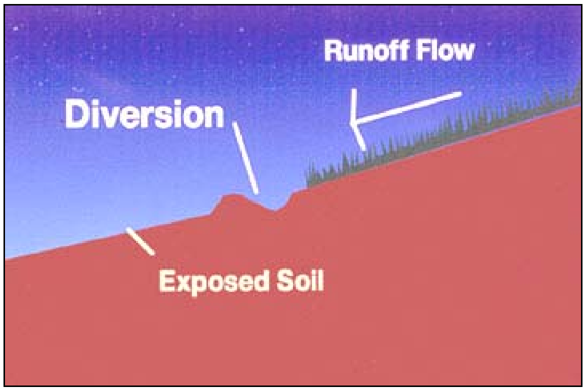

Figure 2-6
Source: John Warbach, Planning and Zoning Center, Inc.

All diversions should be constructed in accordance with NRCS specifications to ensure adequate flow capacity and to keep velocities within acceptable ranges. Specifications for permanent diversions are more rigorous than for temporary ones. The slope of the channel should be sufficient to generate an adequate runoff velocity to create good positive drainage. Care must be taken not to exceed velocities that will erode the diversion channel (Figure 2-7).

Care must be exercised when using diversions above steep slopes; a slide could occur (Figure 2-8). The major cause of sliding is the saturation of the soil by water concentrated behind and within the diversion structure. Soil saturation can be prevented by increasing the channel grade or lining the diversion channel with impervious materials such as concrete or asphalt.

Figure 2-7

Figure 2-8

Overland flow that is captured in a diversion and concentrated must be disposed of without causing erosion or depositing sediment where it is undesirable. This can be done by diverting the flow onto vegetation, into a basin or grade stabilization structure, or by minimizing flow velocities within the channel or at the discharge point with energy dissipaters (Figure 2-9).

The easiest way to dispose of diverted water is directly onto well-established vegetation. Vegetation has limits, however, and will erode if runoff velocities become too high or are subjected to continuous runoff for extended periods of time. Newly planted grass cannot withstand concentrated flows (Figure 2-10). It may be necessary to temporarily divert the runoff until the seeded areas become permanently stabilized.

Figure 2-9

Figure 2-10

Inspector's note: Examine the diversion or channel bottom for erosion, ponding, or sediment deposits. If mulch blankets, turf reinforcement mats, or check dams are installed, ensure that they are secure and functioning properly. Ensure that runoff is being captured by the diversion and not flowing around or overtopping it. The discharge from the diversion should not be creating erosion and any sediment carried by the discharge should be properly contained. For interceptor dikes, ensure that the diverted runoff is not creating erosion and be sure that the dikes have not been damaged by vehicle traffic.

Grade Stabilization Structures (R, E)

Grade stabilization structures are used to carry runoff from one level to another (Figure 2-11). All grade stabilization structures must be designed to carry the anticipated runoff from the site and constructed in such a manner to prevent "piping." Piping occurs when water erodes small channels under or along the side of the water conveyance structure (Figure 2-12). The potential for piping can be minimized by using flared metal inlets and compacting the soil around the inlet section.

Figure 2-11

Figure 2-12

Downdrains are one type of grade stabilization structure commonly used on construction sites. There are several types of downdrains:

- A pipe downdrain consists of a metal inlet and a rigid or collapsible drain tube made of metal or heavy-duty fabric (Figure 2-13).

- A chute or flume is a flat or round bottomed ditch usually lined with concrete or asphalt. Undercutting or flow around the side can be a problem unless a good bond is maintained between the diversion and the flume inlet (Figure 2-14).

Figure 2-13

Figure 2-14

No matter what grade stabilization structure is used, care must be taken to prevent scouring or erosion at the outlet. Scouring can be prevented by using one or more of the following: place large rocks on geotextile material downstream of the outlet, use flared end sections, or place large rocks or concrete blocks in the flume channel. If possible, run the structure beyond the bottom of the slope, or at least to an area of lesser grade; this will reduce discharge energy and make the job of energy dissipation easier.

Inspector's note: Ensure that the structure is capturing the runoff from the area it was intended to serve. Is water flowing down slope other than through the structure? Examine the inlet and outlet of the structure for piping and erosion. If erosion has occurred, ensure that the structure has not been undermined or otherwise damaged. If the structure is a rock lined chute, ensure that the rock is not migrating downslope and that the underlying geotextile is not damaged or shifted out of place.

Check Dams (R, E, S)

The primary purpose of check dams is to reduce water flow in ditches, diversions, or other areas of concentrated flows to non-erosive velocities. In some situations it is impossible to establish or maintain vegetation in areas of concentrated flow without installing check dams or other structural BMPs. Check dams can also function as sediment controls if runoff is slowed sufficiently to allow large-sized particles to settle out of the water and be deposited upstream of the check dam. The deposition of sediment can be increased by excavating sumps upstream of the check dams (Figure 2-15).

Figure 2-15

Check dams are generally constructed of rock. Silt fence or sandbags should never be used as check dams. When constructing check dams, place the rock in the ditch and up the sides to a level above that of the anticipated flow (be sure to consider the highest annual flow for the site). The middle of the dam should be nine inches lower than the outer edges (Figure 2-16). This allows water to flow over the depression in the center of the check dam, as opposed to around the sides where it could erode the banks.

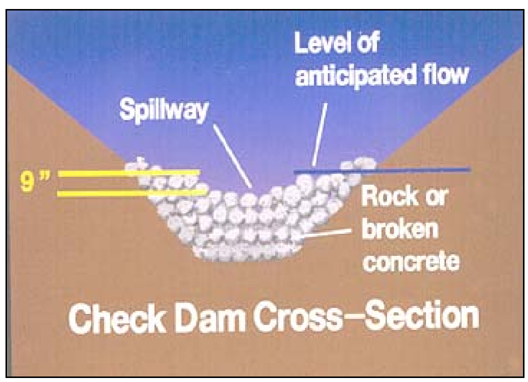

Figure 2-16
Source: John Warbach, Planning and Zoning Center, Inc.

Check dams are usually placed in a series (Figure 2-17). They should be located or spaced so that the toe of the upstream check dam is at the same elevation as the lowest point of the top of the downstream check dam (Figure 2-18). Therefore, the steeper the slope, the closer the check dams should be.

Figure 2-17

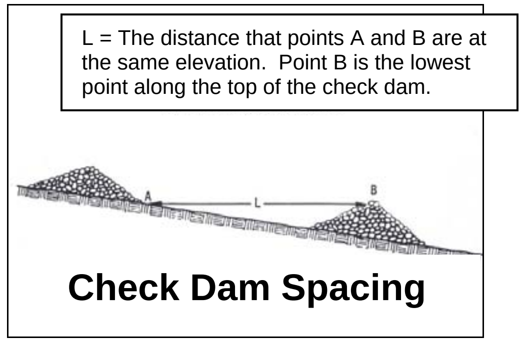

Figure 2-18

Riprap should be placed immediately below the check dam to help dissipate the energy of water flowing over the dam. Stone size should be increased with increased slope and velocity. The stone should be big enough to stay in place during anticipated high velocities. When larger sizes of stone are used, place smaller stones immediately upstream of the check dam to filter sediment.

The size of stone used, as well as base preparation, must adhere to strict engineering standards or failure of the structure can occur.

Temporary check dams made of a plastic grid are also available (Figure 5-19). Advantages of temporary check dams are that they are reusable and can be removed when vegetation is well established. Permanent rock check dams often create traffic hazards, interfere with mowing or other maintenance, may be aesthetically undesirable, and rock is difficult to handle. Instead of using permanent rock check dams, consider a vegetated channel lined with turf reinforcement mat with temporary check dams.

Figure 2-19

Inspector's note: Ensure that the check dam has not been damaged by vehicle traffic, vandalism, or excessive flows. Examine the channel bottom and ends of the check dams for erosion. Accumulated sediment on the upslope side of the check dam (or in the sump) should not exceed 40-50% of original volume. If temporary check dams are used, be sure they are properly secured to the substrate, are not damaged, and are not obstructed by debris. When the channel is well stabilized, schedule temporary check dams for removal.

Channel and Slope Stabilization (R, E)

Check dams alone are not always capable of reducing water velocities to levels that will prevent erosion; additional measures may be necessary to stabilize the channel bottom. Anticipated velocities, and to a lesser extent, aesthetics, will dictate which stabilization measures to use. For example, unvegetated bare channels can generally only sustain velocities up to 1.5 to 2 feet per second without eroding (Figure 2-20). Established grassed lined channels can accommodate velocities up to approximately 4 to 5 feet per second (Figure 2-21). Until grass is established, runoff may have to be diverted away from the exposed area to protect the seedlings and the channel itself from erosion. Under extreme conditions, channel velocities can reach 15 feet per second, and extreme measures will be needed for stabilization.

Figure 2-20

Figure 2-21

Another option is to line the channels with erosion control blankets or turf reinforcement mats (Figure 2-22). Blankets and mats are manufactured by several companies, each of which has specific applications. Primary differences between blankets and mats are in the materials that are used and how they are constructed (Figure 2-23). Some are designed for low velocity situations while others are capable of accommodating higher velocities.

Figure 2-22

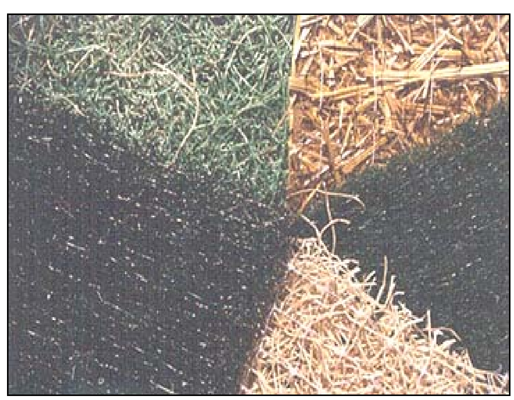

Figure 2-23

In the past, extremely high velocities in channels precluded the use of vegetation or blankets for stabilization and it was necessary to line the whole channel with riprap, rock gabions, or concrete (Figure 2-24). Although “hard” channel lining is still a viable option, turf reinforcement mats (TRMs) have been developed that are capable of withstanding channel velocities as high as 25 feet per second. TRMs are often more economical and less labor intensive than rock and concrete linings.

Figure 2-24

Another product available from the erosion control industry that can provide good protection from high runoff velocities is cellular confinement systems (Figure 2-25). The cells can be filled with topsoil and seeded to improve their appearance or filled with gravel to enhance stream habitats (Figure 2-26).

Figure 2-25

Figure 2-26

Although much of this discussion has focused on channels, many of the products discussed are also very effective in protecting slopes. For example, erosion control blankets and cellular confinement systems are routinely used on steep, difficult to stabilize, slopes (Figure 2-27).

Figure 2-27

Contractors often believe that some of the erosion prevention products are unnecessary and expensive. However, if the contractor has to return to the site several times to re-grade and reseed, these products are very cost-effective. Additionally, it is often much cheaper to minimize erosion than to construct sedimentation basins to trap the sediment. If the resultant damage to the environment is included, the overall cost of stabilization becomes negligible.

Inspector's note: Examine the channel bottom and side slopes for erosion. If mats are in use, ensure that they have not slumped or shifted, remain well secured, and are in good contact with the substrate. Ensure cellular confinement or interlocking block systems, and any fill material used in them, are staying in place. Be sure that vegetation is establishing adequately. The outlet of the channel should not be causing erosion or discharging sediment.

Windbreaks (E, S)

Leave trees or other tall vegetation along the perimeter and intermittently across the site to serve as wind barriers (Figure 2-28). When trees or vegetation must be removed, snow fence can be used to form mini wind barriers. The snow fence must be placed perpendicular to the prevailing wind direction or perpendicular to the long dimension of the exposed soils at evenly spaced intervals across the site. Most barriers will protect the soil downwind for a distance of about 10 times the height of the barrier. Therefore, place rows of snow fence about every 40 to 50 feet (Figure 2-29). Although the primary purpose of fencing or other barriers is to reduce the erosive velocity of wind, they also create barriers to stop wind-born soil and keep wind-generated sediment on site.

Figure 2-28

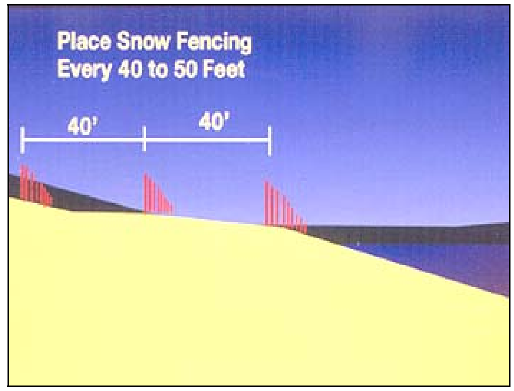

Figure 29

Source: John Warbach, Planning and Zoning Center, Inc.

Inspector's note: If established vegetative windbreaks are used, ensure that they are adequate to the task and do not need to be supplemented with structural controls. If vegetation is used as a surface covering, be sure it is in good condition. Snow fence should be upright, in undamaged condition, oriented appropriately to the wind, and properly spaced. Note the amount of accumulated sediments and recommend clean-out if necessary.

Watering (E)

Another temporary measure for controlling wind erosion is to keep the bare soil moist by watering. A readily accessible water source is required. Water should be applied to the site whenever moderate to high winds are anticipated. Haul roads may have to be watered continuously (Figure 2-30).

Figure 2-30

Chemical binders can be added to water before it is sprayed on to the soil surface. The chemicals penetrate into the soil and bond the individual soil particles, making them resistant to the forces of wind and water. One class of chemicals that are commonly used are polyacrilamides, or PAMs. A more complete discussion of PAMs is found in Appendix 2A. Be aware that the surface application of certain chemicals may be regulated or even prohibited, depending on location and proximity to waters of the state.

Inspector's note: Monitor soil moisture and dust potential and recommend application as appropriate. If watering has occurred, ensure that excess water has not created unintended runoff, erosion, or sedimentation problems. If PAMs or other binders have been applied, ensure that the binding qualities of the chemicals remain functional.

Silt Fence (S)

Silt (or filter) fence is one of the most commonly used BMPs; unfortunately, it is also commonly misused and neglected. Silt fence is intended to remove sediments entrained in runoff by slowing runoff, causing sediments to drop out of suspension, and by acting as a filter as water passes through it. Silt fence should only be used to filter sheet flow, never for concentrated or channelized flow. Silt fence must be placed along a horizontal contour, perpendicular to the direction of sheet flow. The fencing should be **trenched in to a depth of 6 inches and backfilled** with the stakes on the down gradient side of the fence (Figure 2-31). The fabric should be taut so it does not "wave" in the wind. If more than one course of fence must be joined end to end, the ends should be wrapped so there is no gap between courses. If possible, locate the silt fence away from the toe of the slope to enhance ponding and settling (Figure 2-32).

Figure 2-31

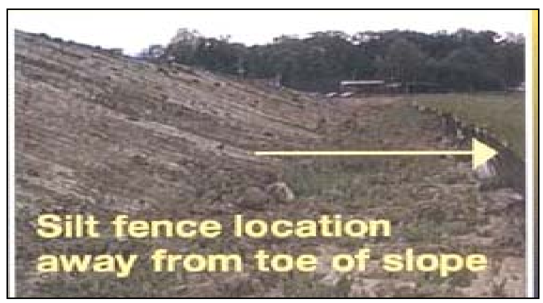

Figure 2-32

When sediment accumulates to 1/3 to 1/2 the height of the fence, the sediment must be removed. Filter fence that has been damaged by excessive sediment loading, vehicle traffic, or general wear and tear, must be repaired or replaced to restore its full function (Figure 2-33).

Figure 2-33

Straw bales are not an acceptable substitute for filter fence. Straw bales are impervious to runoff and act as dams, not as filters, particularly after they become wet. Runoff ponded behind the bales will eventually cause a breach, allowing an escape of both runoff and sediment.

Inspector's note: A large construction site may have several hundreds yards of filter fence; it is important when doing inspections to accurately record the location of any problems. Ensure that sediment accumulations are not excessive, that fabric and stakes are in good shape, and that the fence remains properly trenched in. If the filter fence is properly located along a contour, all runoff should be passing through the fabric as sheet flow. Runoff should not be concentrated by the fence nor should it be flowing around or between the ends of the fence. On long or steep slopes, determine if additional courses of fence are necessary to properly control sediment.

Dewatering (S)

Dewatering is the removal of groundwater, surface water, or storm water from a site to allow construction to be done "in the dry." The water that is removed from such an area must be discharged to a stabilized area at a non-erosive velocity. If the water is laden with sediment, measures must be taken to remove the sediment prior to its reaching a waterbody or storm sewer inlet. Sediment laden water may be pumped through geotextile filter bags, into sediment basins, or through filter berms constructed of small stone. If the suspended sediments are clays or fine silts, it may be necessary to introduce PAMs into the discharge water to facilitate filtration or settling.

Inspector's note: If the pump does not have a continuous live watch, ensure that it is running properly and oil and gas are at acceptable levels. Examine the suction inlet to ensure it is properly submerged and not sucking air or clogged. Be sure the discharge is not causing erosion or carrying sediments to waters of the state or adjacent properties. If dewatering to a filter bag, sediment basin, or other structural containment system, ensure that the discharge hose remains in place and that no sediments are leaving the containment system.

Access (and Exit) Roads (S)

Sediment is often carried out of construction sites in the tires of vehicles. (Figure 2-34). Sediment tracked on to roads can create a serious traffic hazard or may discharge to waters of the state, either directly or by way of storm sewers (Figure 2-35).

Figure 2-34

Figure 2-35

Tracking can be minimized by restricting vehicular traffic to designated areas. Vehicle routing should be determined and access roads installed prior to the commencement of earth change activities. At all designated exit areas, nonwoven geotextile fabric should be placed on the soil surface and covered with a bed of 4-8 inch diameter crushed rock or stone at least 50 feet in length (Figure 2-36). In addition to eliminating off-site sedimentation at construction exits, limiting access into and within a construction site is also essential when attempting to stabilize the area.

Construction exit roads provide an area that allows soil from vehicles and equipment to fall off tires prior to being tracked onto the primary road; thus, to be effective, egress from the site must be limited to the exit road. Exit roads need to be maintained periodically. This can be done by adding new layers of stone as the old layers become compacted. Ruts in the road, water pooling in the road, and an incomplete or absent stone layer are signs that the access road requires maintenance.

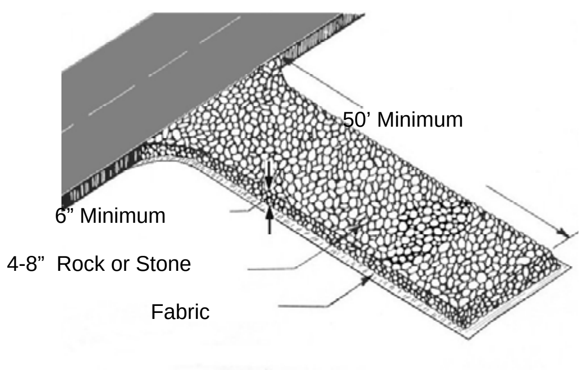

Figure 2-36

Periodic street sweeping in the vicinity of the exit roads may be necessary even with the use of rock exit roads. Sediment that collects on the shoulder of the roads or the curb systems from the sweeping activities must be removed. If a large amount of sediment must be removed, or if sweeping the sediments is likely to create excessive dust, use another means of removal or dampen the sediments prior to sweeping. If tracking of sediment cannot be controlled with rock access roads or sweeping, wheel wash systems may have to be installed. These systems are used to spray the sediment off the wheels and under carriage of vehicles before they exit the site.

Inspector's note: Check the road(s) for sediment and, if present, schedule sweeping or other means of removal and determine the cause of the BMP failure. Ensure that the road(s) does not contain ruts or sediment loading, that the geotextile is not ripped, shifted, or subsiding, and determine if additional rock should be applied. Look for evidence that vehicles are entering and leaving the site at unauthorized locations; if they are, have traffic barriers installed.

Sedimentation Basins (S)

Sedimentation basins are commonly used on construction sites to trap sand and large silt sized sediment carried by storm water runoff. Sedimentation basins can have a variety of designs and shapes (Figures 2-37 and 2-38). They are generally created by excavating a depression in the ground, by constructing a barrier or berm to impede water flow, or by a combination of both a depression and a barrier. A general overview of basin design is presented here; a more thorough treatment is found in Unit 9.

Figure 2-37

Figure 2-38

For effective sediment control, basins should be at least four times as long as wide with the inlet and outlet at opposite ends. If this is not possible due to site constraints, baffles or convolutions should be placed within the basin to increase the water travel distance (Figure 2-39).

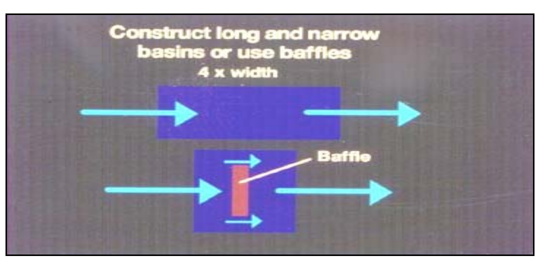

Figure 2-39
Source: John Warbach, Planning and Zoning Center, Inc.

The amount of sediment removed from the storm water runoff is dependent upon water velocity, how long the water remains in the basin, and the size and density of the sediment particles. The slower the water flows through the basin and the longer it remains in the basin, the greater quantity of sediment that will be deposited. The heavier the soil particle, the quicker it will settle out. Sand tends to settle out rapidly in basins, silt settles more slowly, and clay (and finest silt particles) may never settle out. In general, basins are not effective in removing clay and fine silt, but see the discussion on polyacrilimides (PAMs) in Appendix 2A. Precise engineering is required when constructing basins to accommodate large flows. The engineer must determine the appropriate volume of the basin, as well as how to discharge the water from the basin. Basin volume depends on such factors as anticipated storm events, the size of the drainage area, and the type of soils in the drainage area.

Water can be discharged from a sedimentation basin in a number of ways. The most common way is through a vertical riser pipe connected to a horizontal discharge tube. Collected storm water runoff will leave the basin only when water levels rise above the top of the riser pipe. The water near the surface in the basin generally contains less sediment than the water near the bottom of the basin. Therefore, it is preferable to drain the basin from the surface through a riser pipe rather than through a discharge pipe located at the bottom of basin (Figure 2-40).

Figure 2-40

After a storm has passed, it is often advantageous to lower the water in the basin below the top of the riser pipe to create storage volume to accommodate the next storm. This can easily be accomplished by using a perforated riser pipe instead of a pipe with solid walls (Figure 2-41). The holes will allow the water to slowly exit the basin, lowering the depth of the water to that of the bottom holes. To minimize the loss of sediment passing through the holes, the riser pipe should be wrapped with wire mesh and surrounded with pea stone (Figure 2-42).

Figure 2-41 Figure 2-42

In addition to the principal outlet, emergency spillways are often required to protect the basin when storm water runoff from storm events exceeds the design capacity of the basin (Figure 2-43). The amount of freeboard between the crest of the emergency spillway and the top of the dam should be indicated by the engineer.

No matter which type of outlet structure is used, care must be given to insure that the receiving area can accommodate the discharge without scouring. Generally, energy dissipaters will have to be constructed at the basin outlet (Figure 2-44).

The foregoing discussion refers to basins with outlet structures designed to release water at a controlled rate through a structure; these are referred to as detention basins. Basins that do not have an outlet structure (other than an emergency overflow) and are designed to release water only through infiltration and evaporation are referred to as retention basins. Retention basins should only be considered in locations with very permeable soils and where the sediment inputs contain no fine soil particles. Permeable soils are necessary for adequate infiltration (occasionally referred to as “vertical drainage). If runoff entering the basin contains fine soil particles, the fine particles will seal the basin, reduce or eliminate permeability, and cause failure of the basin.

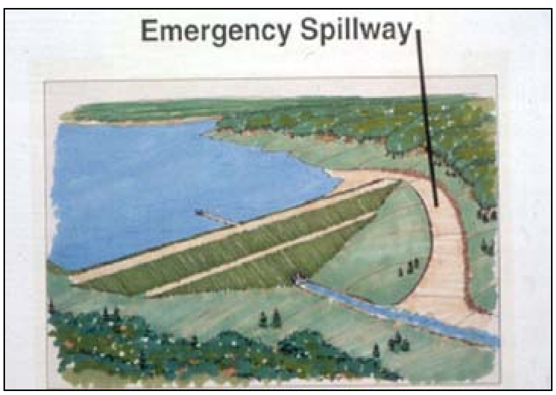

Figure 2-43


Figure 2-44

Periodic cleaning is essential if a basin is to remain functional. Sediment is generally removed with an excavator or front-end loader, so the basin must be accessible. All basins should be cleaned when 40 to 50 percent filled (Figure 2-45). Care must be taken to isolate the excavated portion of the basin from the basin outlet to reduce pollution downstream. This is usually done by diverting the incoming water or removing the sediment when the basin is dry.

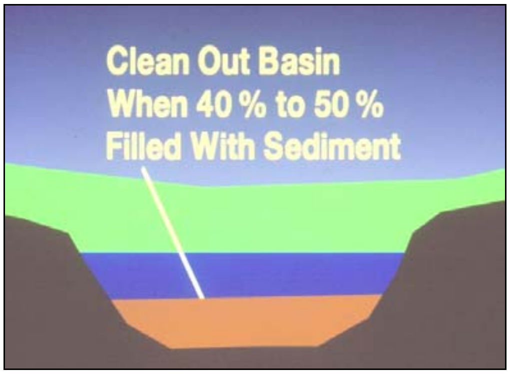

Figure 2-45

Inspector's note: Examine the basin outlet and ensure that water leaving the basin is not carrying sediments and that no erosion is occurring at the point of discharge. If sediments are leaving the basin, attempt to determine why: are fine materials not settling, does the basin need to be cleaned, is the outlet structure damaged or of improper design? Ensure that the outlet structure is not clogged or obstructed with debris. If a large storm event occurs, examine the emergency overflow for erosion or other damage and ensure that water is not leaving the basin other than through the outlet and overflow. Ensure that any earthwork done to create the basin is in a stable condition and is not contributing sediments into or outside the basin. If a retention basin, ensure that permeability is being maintained and that water is not ponding for excessive periods of time. If permeability has been sealed, attempt to determine the cause: is it fine particles or compaction from vehicle traffic? If permeability is lost, the basin may need to be converted to a detention basin with an outlet structure.

Runoff Storage

Runoff storage practices are BMPs that store storm water runoff to protect the receiving waters from high or frequent fluctuations in flow, and in some situations, allow time for treatment to occur. Runoff storage BMPs are normally not designed for sediment control, but are designed for use after a site has been stabilized.

Storm Water Basins (R)

Storm water basins are designed to withhold water and release it over a given period of time. The basin can be either a detention or retention basin as previously described. Although some sediments, nutrients, or pollutants may be removed from runoff while it is in a storm water basin, they are not designed to remove large amounts of sediment from construction sites. Storm water from construction activities should not be directed to these basins without pretreatment. In other words, control erosion and remove the sediment first.

If a sediment basin is being converted into a storm water basin, the sediment which has accumulated needs to be removed for the basin to function as a long-term storm water control.

Inspector's note: In addition to performing inspections as described above for sediment basins, ensure that the stormwater basin is draining adequately to its design level and that the inputs to the basin are not carrying large amounts of sediment.

Catch Basins (S, H)

Catch basins are inlets to storm sewers that contain a sump to capture coarse solids. They are installed primarily to prevent blockages in the sewer system. Although catch basins can capture some coarse sediments, they should never be used as a primary sediment control. Storm sewers often discharge directly to surface waters; other BMPs should be installed to prevent sediment from getting into the catch basins. Catch basins need to be cleaned periodically to remain functional.

Inspector's note: Check sump for accumulated trash and sediment; schedule a cleanout if necessary.

Oil and Grit Separators (S, H)

Oil and grit separators are usually multi-chambered devices that retain runoff to allow heavy material to settle to the bottom of the first chamber, and then skim floating material off the top in the second chamber. They are generally used for small drainage areas.

Catch basin and oil/grit separators should never be used as a BMP to control construction site runoff. However, roads and the storm sewer system are often installed as the first step in the development of the site. When construction is occurring in an area with a functioning storm sewer system, the inlets to catch basins and oil/grit separators must be adequately protected.

Inspector's note: Perform periodic inspections on the interior of the separator to ensure it is not becoming overloaded with oil or debris. Perform frequent, regular inspections at the discharge point of the separator (if accessible); look for sheens, staining, stressed or dead vegetation, or a lack of vegetation.

Storm Drain Inlet Protection (S)

Storm sewers often discharge directly to waters of the state with little or no prior treatment of the storm water. To prevent clogging of storm sewers and to protect our lakes, streams, and wetlands, all storm drain inlets must be protected from sediment inputs during construction.

Storm drain inlets can be protected in several ways. If it is not critical to drain water from the site, the inlet can be sealed with an impervious material until the site is stabilized. In most situations, water must be removed from the site so the drain must remain functional. Simple structural ways to protect inlets include:

- Silt sacks or other comparable products are structures made of filter fabric that are designed to be inserted below the grate of a storm sewer inlet. They allow water to pass through while containing sediment and usually have loops to facilitate removal and clean out.

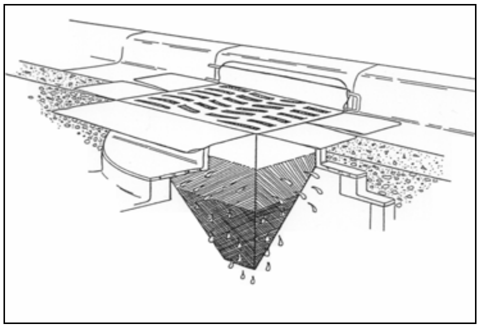

Figure 2-46

Figure 2-47

- Wrap the grate of the basin with geotextile materials (Figure 2-48). The geotextile fabric should be placed on top, not under the grate. This technique should never be used on flat or low-profile grates – they will quickly become clogged and cease to function. If the storm grate is flat, products are available that create a temporary raised structure to support filter fabric.

- Install silt fence around the perimeter of the drain inlet (Figure 2-49).

Figure 2-48

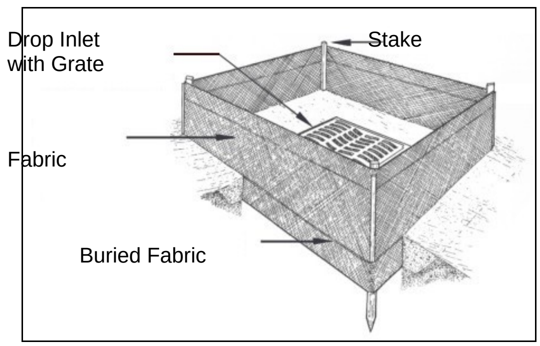

Figure 2-49
Source: Price and Company

- Place a filter made of coarse gravel or pea stone in front of or around the drain inlet. The gravel provides a certain amount of filtering action, and is highly resistant to erosion. Standard concrete building blocks or wire mesh are placed on the inside of the gravel filter to keep stones from being washed into the storm drain inlet (Figure 2-50). The configuration of the filter will depend upon the type of inlet being protected.

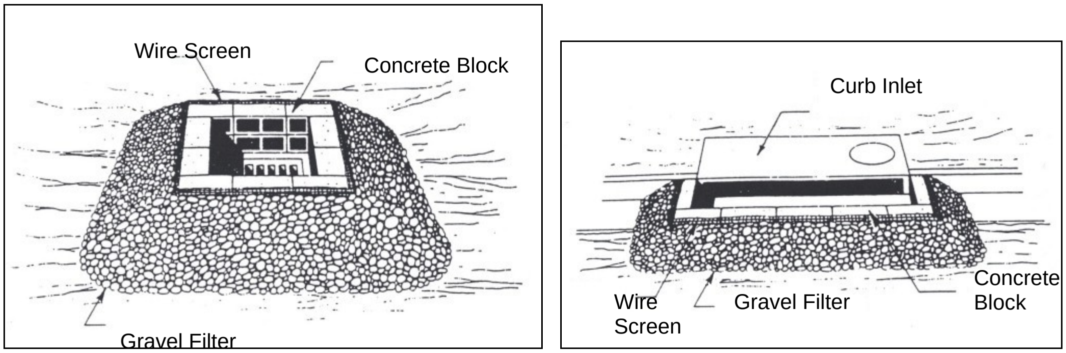

Figure 2-50

Inspector's note: Check for clogging of fabric or screens, overtopping, and structural integrity; in particular, ensure the structures are protected from, and not damaged by, vehicles. If sediment accumulations are sufficient to impede function, schedule sediment removal.

Equipment Maintenance and Storage Area (H)

To protect tree roots, and ultimately the health of the tree, vehicles or other equipment stored outdoors should not be left within the drip line of trees. The drip line is the outer most horizontal extent of the foliage of a tree. Vehicles and equipment storage should be at least 100 feet away from surface waters of the state. Runoff from the storage area must be directed to drain away from surface waters, storm sewers, or adjacent properties.

Vehicles and equipment should be washed in areas that do not drain to surface waters, storm sewers, or adjacent properties. Wash areas can be constructed of two to three inch stone at least six inches thick. Isolate wash areas with berms or diversions to prevent runoff from leaving the area. Additional stone may be needed during the construction phase to maintain the integrity of the wash area.

Inspector's note: Ensure that equipment and vehicles are not leaking oil or other fluids. Ideally, all maintenance will be done on impervious areas, or on pads designed to contain any pollutants that may spill. Impervious pads are particularly important on sandy and other course soils where spilled materials can easily leach into the groundwater. Also make sure that empty containers, scrap wood, metal, and all other wastes are disposed of in a well-managed rubbish container. Waste materials are **NOT** to be buried or burned on site.

Pesticides and Fertilizers

Pesticides, fertilizers, and other potentially hazardous materials should be kept in locked storage. Ideally, secondary containment will be provided for all such materials. The containment structure should be designed to hold 150 percent of the volume of the substances. For construction sites where potentially hazardous materials are used or stored, a spill response plan should be developed. A spill response plan should include the steps that will be taken to contain and clean up any spilled pesticides or fertilizers.

Small quantities of spilled liquid fertilizers can be cleaned up by applying kitty litter or sawdust, then sweeping it in newspaper, and disposing of it in the trash. Small quantities of powdered fertilizers should be swept up and disposed of in the trash. Never wash fertilizer spills down floor drains or driveways, which will likely either go to storm sewers (and consequently into water of the state) or could leach into the groundwater.

For large spills, or spills of hazardous materials, contact the Pollution Emergency Alert System, or PEAS line. The toll-free number (1-800-292-4706) is in service 24 hours a day for reporting spills.

Two important things to remember about pesticide and fertilizer management are:

- ✓ Never apply pesticides and fertilizers directly into or immediately adjacent to streams, rivers, lakes, or wetlands.

- ✓ Mix, apply, store and dispose of pesticides, fertilizers, and their containers in strict accordance with the manufacturer's instructions.

Subsurface Drains

Subsurface drains include tiles, pipes, or tubing installed below the ground to intercept, collect or convey drainage water. They are designed to remove excess water from the soil.

Inspector's note: Look for ponding in the area meant to be drained, which would indicate a system blockage. Also look for signs of erosion around outlets and check the outlet for blockages by roots or debris.

SUMMARY

We have completed our discussion of methods for controlling runoff, erosion, and sediment. Some of the more commonly used BMPs are discussed, but the discussion is not all-inclusive. SESC is an evolving technology, and one should remain aware that the introduction of new products and techniques can change the nature of “best management”.

To be effective, all BMPs must be regularly inspected and maintained. Damaged control structures must be immediately repaired or replaced. In addition to examining the condition and effectiveness of existing BMPs, a proper SESC inspection will examine the entire construction site to ensure that BMPs have been implemented in all areas that they are necessary. Sediment should be removed when it accumulates behind check dams, in diversions, or behind other sediment control structures.

The effectiveness of all BMPs is dependent on the magnitude of storm water runoff, size and weight of the particles being eroded, and routine maintenance of the structures. If the control measures are performing adequately, sediment will accumulate. If this sediment is not periodically removed, the structures will eventually become ineffective. Periodic maintenance of the control measures is necessary for effective sediment control.

In summary, remember that:

- Water and wind are the major causes of erosion and sedimentation
- Erosion and sedimentation will occur on most construction sites unless measures are taken during the planning and early development stages to control runoff
- The most effective and least expensive method to control runoff, erosion and sedimentation is to keep the soil covered with vegetation. Bare soil on a site can be minimized by:
    - ✓ Staging construction
    - ✓ Preserving existing vegetation
    - ✓ Covering all disturbed areas with temporary seeding and mulch
    - ✓ Establishing permanent seeding as soon as possible
- Structural practices are used when vegetative practices are not sufficient or practical to do the job.
- Sediment control should not be used as a substitute for erosion control, but rather in conjunction with it.
- It is generally more effective to minimize erosion than it is to control sediment.

In this manual and the BMP Guidebook, some of the most common BMPs and SESC measures are described. However, there are many other possibilities available. Make note of the use of different BMPs and document any successes or failures. This information may be useful for future reference: if a BMP or SESC measure works -- use it.

UNIT TWO REVIEW

1. When developing a runoff and SESC strategy, remember that ________ and ____ _______control is more effective and cost efficient than __________ control.

2. Without proper planning, construction generally results in an _________ in runoff.

3. ___________ controls rarely reduce ________or _______.

4. Fine sediment particles, such as ____ and _____, are difficult or impossible to capture with standard _________ control techniques. It is particularly important to emphasize ______ and ________ control on sites with fine textured soils.

5. List five construction practices that minimize runoff and control erosion:

6. List five sediment control practices:

7. _______, sometimes called ________is part of scheduling. This is where grading and stabilization are finished in one area before proceeding to the next area.

8. The slope of a diversion channel must be adequate to provide good positive __________ but not so great as to create water velocities that will _____ the diversion channel.

9. Overland flow that is diverted must be disposed of without causing _______ or __________ ________ where it is undesirable.

10. Runoff may be disposed of onto ____ – __________ vegetation.

11. ______ ____________ structures are used to carry runoff from one level to another.

12. _______ occurs when water erodes small channels under or along the side of a water conveyance structure.

13. ______ ____ are often used in roadside ditches to reduce the velocity of water.

14. The center of the check dam should always be ____ ______ _____ than the outside edges to prevent scouring around the structure.

15. The size of the stone used in check dams should be __________ as slope and/or velocity increases.

16. When anticipated channel velocities are too great to establish grass, the channel can be lined with erosion control _________ or ____ _____________ mats.

17. Sediment basins should be at least ____ times as long as wide. If this is not possible, _______ or ____________ should be placed in the basin to increase the water's travel distance.

18. _____ tends to settle rapidly in a sediment basin, but ____ and ____ sized particles may never settle out.

19. Some methods used to control wind erosion include:
    placing ____ _____ perpendicular to the prevailing wind direction
    keeping the soil _____
    spraying ________ binders on the soil surface

20. To be effective, all BMPs must be periodically _________, _________, and/or replaced when necessary.

ANSWERS TO UNIT TWO REVIEW

1. When developing a runoff and SESC strategy, remember that **runoff** and **soil erosion** control is more effective and cost efficient than **sediment** control.

2. Without proper planning, construction generally results in an **increase** in runoff.

3. **Sediment** controls rarely reduce **runoff** or **erosion.**

4. Fine sediment particles, such as **silts** and **clays,** are difficult or impossible to capture with standard **sediment** control techniques. It is particularly important to emphasize **runoff** and **erosion** control on sites with fine textured soils.

5. List five construction practices that minimize runoff and control erosion:

6. List five sediment control practices:

7. **Staging,** sometimes called **phasing** is part of scheduling. This is where grading and stabilization are finished in one area before proceeding to the next area.

8. The slope of a diversion channel must be adequate to provide good positive **drainage** but not so great as to create water velocities that will **erode** the diversion channel.

9. Overland flow that is diverted must be disposed of without causing **erosion** or **depositing sediment** where it is undesirable.

10. Runoff may be disposed of onto **well – established** vegetation.

11. **Grade stabilization** structures are used to carry runoff from one level to another.

12. **Piping** occurs when water erodes small channels under or along the side of a water conveyance structure.

13. **Check dams** are often used in roadside ditches to reduce the velocity of water.

14. The center of the check dam should always be **9 inches lower** than the outside edges to prevent scouring around the structure.

15. The size of the stone used in check dams should be **increased** as slope and/or velocity increases.

16. When anticipated channel velocities are too great to establish grass, the channel can be lined with erosion control **blankets/mats** or **turf reinforcement** mats.

17. Sediment basins should be at least **four** times as long as wide. If this is not possible, **baffles** or **convolutions** should be placed in the basin to increase the water's travel distance.

18. **Sand** tends to settle rapidly in a sediment basin, but **clay** and **silt** sized particles may never settle out.

19. Some methods used to control wind erosion include:
    placing **snow fence** perpendicular to the prevailing wind direction
    keeping the soil **moist**
    spraying **chemical** binders on the soil surface

20. To be effective, all BMPs must be periodically **inspected, maintained,** and/or replaced when necessary.

Polyacrylamide (PAM)

PAM is effective in controlling erosion as well as off-site sedimentation. When placed on bare soil, PAMs bind fine soil particles (especially clays) together and also create larger aggregate particles. In addition to increasing resistance to erosion by binding the particles, aggregation increases infiltration, which reduces runoff and on-site erosion. PAMs can be applied in powder or liquid form on rough graded areas, spoil piles, or final graded areas in conjunction with other soil stabilization materials such as seed, mulch, or mulch blankets.

PAMs can also be used as a water treatment additive and placed directly in the water to remove suspended sediment. It can be sprayed or injected into the water or can be in the form of a solid block which is lowered into moving water such as the inlet to a sediment basin. PAMs are very effective in settling out the clay particles that normally will not settle out in a sedimentation basin.

PAMs come in various formulations with varying characteristics and thus are soil specific in regards to effectiveness. One must match the particular PAM with the type of soil on site and/or the sediment in the water. PAMs can be anionic (negative charged), cationic (positive charged), or neutrally charged. The positively charged PAMs are very toxic to aquatic organisms and should never be used in or near water; only the anionic form (negatively charged) of PAMs should be used.

If the PAM will be placed directly into the water as a water treatment additive, **approval must be obtained** from the DEQ – Water Bureau **prior** to its use. Please note that if PAMs are applied on a ditch or stream bank or in an area where it ultimately reaches the water, the person applying the PAM is liable for any aquatic damages.

Prior to applying Polyacrylamide products, review and follow the Technical Guidance for the Use of Polyacrylamide Products for Soil erosion and Sedimentation Control (SESC), https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/Storm-Water-SESC/polyacrylamide-products-technical-guidance.pdf, to ensure that the proper regulatory approvals are obtained prior to use.