Best Management Practices On Soil Erosion And Sediment Control In The Construction Industry

Part 2

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INCORPORATING BEST MANAGEMENT PRACTICES FOR EROSION AND SEDIMENT CONTROL

Specific BMPs should be incorporated for common construction activities that result in erosion of construction sites and the generation of sediment, which impact waterways and off-site properties.

Recommended erosion and sediment control measures for construction sites are summarised in *Table 2* in relation to BMP objectives, and this information is suitable for inclusion in the ESCP.

Site Planning Considerations

■ Scheduling

Defined as sequencing the construction project to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking. Proper sequencing of construction activities should be incorporated into the schedule of every construction project. However, use of other more costly yet less effective erosion and sedimentation controls may often be reduced through proper construction sequencing.

The approach would be to integrate into existing land contours as far as practicable, incorporate existing natural areas, avoid rainy periods, practise erosion and sediment control all year round, minimise the extent of soil exposed at any one time and also carry out trenching operations.

This procedure may increase other construction costs due to reduced economies of scale in performing site grading. The cost-effectiveness of scheduling techniques should be compared with other less effective erosion and sediment controls to achieve a cost-effective balance.

■ Preservation of Existing Vegetation

Carefully planned preservation of existing vegetation minimises the potential of removing or injuring existing trees, shrubs, and/or grass that serve as erosion controls.

Corridors of vegetation act as buffer zones to separate disturbed land from an adjacent watercourse, protected forest, or other sensitive areas. Leaving a clearly marked buffer zone around these unique areas will help to preserve them, as well as benefiting from their natural erosion prevention and trapping characteristics.

The inspection and maintenance requirements for protection of vegetation are low and there is little cost associated with preserving existing vegetation if properly planned during the project design. Aesthetic benefits may also enhance property values.

Vegetative Stabilisation

■ Seeding and Planting

Seeding of grass and planting of trees, shrubs and ground covers provide long-term stabilisation of soil. Grass may also be planted for temporary stabilisation. It is appropriate for site stabilisation - both during and after construction - in any graded or cleared areas where construction activities have ceased, open space, cut and fill areas, steep slopes, spoil stockpiles, vegetated swales, landscape corridors and stream banks.

Shrubs and trees must be adequately watered, fertilised, and pruned if needed. Grass may need to be watered and mowed too.

However, permanent and temporary vegetation may not be appropriate in dry periods without irrigation. Fertiliser requirements may have the potential to create stormwater pollution if improperly applied.

■ Mulching

Mulching is a temporary ground covering that protects the soil from rainfall impacts, increases infiltration, conserves moisture around trees, shrubs, and seedings, prevents compaction and cracking of soil, and aids the growth of seedings and plants by holding the seeds, fertilisers and topsoil in place until growth occurs.

Mulching can be used either to temporarily or permanently stabilise cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibres, decomposed granite and gravel. A variety of mats of organic or inorganic materials and chemical stabilisation may be used with mulches.

Mulch prevents erosion by protecting the soil surface and fostering growth of new seedings that do not stabilise by themselves.

Table 2: Erosion and sediment control measures and objectives

BMP CATEGORY	Standard Drawing Numbers	BMP OBJECTIVES						
		Practise Good Housekeeping	Contain Waste	Minimise Disturbed Area	Stabilise Disturbed Area	Project Slopes and Channels	Control Site Perimeter	Control Internal Erosion
Site Planning Considerations								
Scheduling		√	√	√	√	√	√	√
Preservation of Existing Vegetation				√	√	√	√	
Vegetative Stabilisation								
Seeding and Planting					√	√		
Mulching					√	√		
Physical Stabilisation								
Geotextiles and Mats					√	√		
Dust Control		√		√	√		√	
Temporary Waterway Crossing		√		√	√	√		
Construction Road Stabilisation		√		√	√	√		
Construction Access Stabilisation		√		√	√		√	
Diversion of Runoff								
Earth Bank			√			√	√	√
Diversion Channel						√	√	√
Slope Drain						√		
Flow Velocity Reduction								
Drainage Outlet Protection						√		
Check Dam						√		
Sediment Trapping / Filtering								
Sediment Fence							√	√
Sand Bag Barrier						√	√	√
Brush or Rock Filter						√	√	√
Drainage Inlet Protection							√	√
Sediment Traps								√
Sediment Basins								√

Organic mulch materials such as straw, wood chips, bark and wood fibre are most effective where re-vegetation will be provided by reseeding. The choice of mulch should be based on the size of the area, site slopes, surface conditions (such as hardness and moisture), weed growth and availability of mulch materials.

However, the limitation is that organic mulches are not permanent erosion control measures. Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.

Physical Stabilisation

■ Geotextiles and Mats

Mattings are made of natural or synthetic material, which are used to temporarily or permanently stabilise soil. Mattings reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, mattings may be used alone or with mulch during the establishment of protective cover on critical slopes.

Mattings are typically suited for permanent site stabilisation, but may be used for temporary or permanent stabilisation of highly erosive soils. Mattings may be applied to disturbed soils and where existing vegetation has been removed.

Mattings, on the other hand, are more costly than other BMPs, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes). They may also delay seed germination, due to reduction in soil temperature.

■ Dust Control

Dust control measures are used to stabilise soil from wind erosion and reduce dust generated by construction activities. They are suitable to be applied in clearing and grading activities, construction vehicle traffic on unpaved roads, drilling and blasting activities, sediment tracking onto paved roads, soil and debris storage stockpiles, batch drop from front end loaders and areas with unstabilised soil. Final grading/site stabilisation usually is sufficient to control post-construction dust sources.

Installation costs for water/chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

The limitations include watering prevents dust only for a short period and they should be applied daily (or more often) to be effective, and over-watering may cause erosion.

■ Temporary Waterway Crossing

A temporary access waterway crossing is a temporary culvert, ford,

or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to be used by the general public.

The purpose of a temporary crossing is to provide a safe, erosion-free access point across a waterway for construction equipment. An engineer should establish minimum standards and specifications for the design, construction, maintenance and removal of the structure. Crossings may be necessary to prevent construction equipment from causing erosion of the waterway and tracking of pollutants into the waterway.

However, the temporary waterway crossings may be an expensive measure for a temporary improvement and require other BMPs to minimise soil disturbance during installation and removal.

■ Construction Road Stabilisation

Access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes should be stabilised immediately after grading, and frequently maintained to prevent erosion and control dust.

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilisation. Such areas also tend to collect and transport surface runoff. During wet weather, they often become muddy quagmires, which generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilisation not only reduces on-site erosion, but significantly speeds on-site work, avoids instances of immobilised equipment and delivery vehicles, and generally improves site efficiency and working conditions during adverse weather.

The roadway however, must be removed or paved when construction is complete. Certain chemical stabilisation methods may cause stormwater or soil pollution and should not be used.

■ Construction Access Stabilisation

A stabilised construction access is a stabilised pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site from or to a public right-of-way, street, alley, footpath or parking area. Stabilising the site entrance significantly reduces the amount of sediment (dust and mud) tracked off-site, especially if a wash rack is incorporated for removing caked-on sediment.

Applications include all points of construction entry and exit from the site and unpaved areas where sediment tracking occurs from the site onto paved roads. This access should be used in conjunction with street sweeping on the adjacent public right-of-way and it requires periodic top dressing with additional stones.

Diversion of Runoff

■ Earth Bank

A temporary earth bank is a temporary beam or ridge of compacted soil used to divert runoff or channel water to a desired location, thereby reducing the potential for erosion and off-site sedimentation. Earth banks may also be used to divert runoff from off-site and from undisturbed areas away from disturbed areas, and to divert sheet flows away from unprotected slopes.

An earth bank does not in itself control erosion or remove sediment from runoff; it prevents erosion by directing runoff to an erosion control device such as a sediment trap or basin, or directing runoff away from an erosive area. Temporary earth banks should not adversely impact adjacent properties and must conform to any local floodplain management regulations.

Earth banks are typically used to divert concentrated runoff through disturbed areas into another BMP (e.g. a sediment trap or basin), to divert runoff away from disturbed or unstable slopes, to divert runoff from off-site and undisturbed areas around disturbed areas, and as containment for construction materials and wastes. The on-site banks should remain in place until the disturbed areas are permanently stabilised and must safely convey anticipated flood flows.

Banks should not be used for drainage areas greater than four hectares, or along slopes greater than 10%. For larger areas, more permanent drainage structures should be built.

■ Diversion Channel

Temporary diversion channels may be used to divert offsite runoff around the construction site, divert runoff from stabilised areas around disturbed areas, and direct runoff into sediment traps or basins. Diversion channels should be installed when the site is initially graded and remain in place until permanent BMPs are installed and/or slopes are stabilised.

Diversion channels are appropriate for diverting any upslope runoff around unstabilised or disturbed areas of the construction site in order to prevent slope failures, prevent damage to adjacent property, prevent erosion and sediments into waterways, increase the potential for infiltration and divert sediment-laden runoff into trapping devices. However, they must conform to local floodplain management requirements.

■ Slope Drain

A slope drain is a temporary pipe or lined channel to drain the top of a slope to a stable discharge point at the bottom of a slope without causing erosion. It is typically used in combination with an earth bank or diversion channel at the top of the slope.

A slope drain is effective because it prevents runoff from flowing directly down a slope by confining all of the runoff into a channel or enclosed pipe. However, the maximum drainage area per slope drain is two hectares. Larger areas would require a paved chute, rock lined channel, or additional pipes. Other limitations are that the clogged

slope drains will force water around the pipe and cause slope erosion, and failure of the slope drain can result in flooding and severe erosion.

Flow Velocity Reduction

- **Drainage Outlet Protection**

Drainage outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble which is placed at the outlet of a culvert, conduit or channel to prevent scour of the soil caused by high flow velocities, and to absorb flow energy to produce non-erosive velocities.

Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. Rock size should be increased for high velocity flows. The best results are obtained when sound, durable, angular rock is used.

However, large storms often wash away rock outlet protections and leave the area susceptible to erosion. Sediment captured by the rock outlet protection will be difficult to remove without removing the rock.

- **Check Dam**

A check dam is a small temporary dam constructed across a diversion channel or swale. Check dams reduce the velocity of concentrated stormwater flows, therefore reducing erosion of the diversion channel or swale and promoting sedimentation behind the dam. If properly anchored, brush or rock filter berms may be used for check dams.

Check dam is primarily used in small channels in steep terrain, where velocities exceed 0.6 m/s, in preventing erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales. Check dam is to be used only in small open channels, which drain an area of four hectares or less and not to be used in streams, or in lined or vegetated channels.

Sediment Trapping/Filtering

- **Sediment Fence**

A sediment fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of the fabric used, backed by a wire fence for support. Sediment fences trap sediment by intercepting and detaining small amounts of sediment from disturbed areas during construction operations in order to promote sedimentation behind the fence and decrease the velocity of low flows (up to 15 l/s) in swales and small diversion channels.

Sediment fences are generally effective in locations where the flow is concentrated, and are only applicable for sheet overland flows and not to be used in streams, channels, or any places where the flow is concentrated, and in locations where ponded water may cause flooding.

- **Sand Bag Barrier**

Stacking sand bags along a level contour creates a barrier, which detains sediment-laden water by ponding upstream of the barrier water, thereby promoting sedimentation. Sand bags provide a semi-permeable barrier in potentially wet areas and are more permanent than sediment fences. They also allow for easy on-site relocation to meet changing needs during construction.

Sand bag barriers are most costly, but typically more durable, having a longer useful life than other barriers and may be used in drainage areas up to two hectares.

- **Brush or Rock Filter**

A rock filter berm is made of rock, with diameter between 20 to 75 mm, placed along a level contour where sheet flow may be detained and ponded to promote sedimentation. A brush barrier is composed of brush (usually obtained during the site clearing) wrapped in filter cloth and anchored to the toe of the slope. If properly anchored, brush or rock filters may be used as a check dam for sediment trapping and velocity reduction.

Rock filter berms should only be applied to drainage areas not exceeding two hectares, but if there is insufficient storage space, runoff will pond at upstream of the filter, possibly causing flooding in the area.

- **Drainage Inlet Protection**

Drainage inlet protection consists of a sediment filter or an impounding area around or upstream of a stormwater drain, drop inlet, or kerb inlet which prevents excessive sediment from entering stormwater drainage systems prior to permanent stabilisation.

All on-site stormwater inlets receiving sediment-laden runoff should be protected, either by covering the inlet or promoting sedimentation upstream of the inlet. Off-site inlets should be protected in areas where construction activity tracks sediment onto paved areas or where inlets receive runoff from disturbed areas.

Drainage inlet protection is recommended only for drainage areas smaller than 0.4 hectares, unless a sediment trap first intercepts the runoff. However, ponding will occur at a protected inlet, with possible short-term flooding.

- **Sediment Traps**

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation and/or construction of an earth embankment. Its purpose is to collect and store sediment from sites cleared and/or graded during construction. It is intended for use on small catchment areas with no unusual drainage features, where construction will be completed in a reasonably short period of time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months, and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Intended for use in any disturbed area less than two hectares, and the sediment traps only remove coarse sediment (medium silt size and larger).

- **Sediment Basins**

A sediment basin is a structure formed by excavation and/or construction of an embankment across a waterway or other suitable locations to collect and store sediment from sites cleared and/or graded during construction for extended periods of time before re-establishment of permanent vegetation and/or construction of permanent drainage structures. It is intended to trap sediment before it leaves the construction site. The basin

is a temporary measure (with a design life of 12 to 18 months) and is to be maintained until the site area is permanently protected against erosion, or a permanent detention basin or water quality control structure is constructed.

Sediment basins are suitable for nearly all types of construction projects. Wherever possible, sediment basins should be constructed before clearing and grading work begins. They are applied at the outlet of all disturbed catchment areas greater than two hectares or at the outlet of smaller disturbed catchment areas, as necessary.

However, sites with very fine sediment (fine silt and clay) may require longer detention times for effective sediment removal. Basins in excess of certain depth and storage volume criteria must also meet State and/or Federal dam safety criteria.

CONCLUSION

Soil erosion and sedimentation arising out of construction activities has posed a persistent threat to the environment, and cases of prolonged and uncontrolled erosion would lead to untoward incidences such as landslides and mudslides. It has also led to the cumulative effects of siltation and sedimentation as well as the shallowing of riverbeds and water courseways, thus prompting flash and regular floods in low-lying areas.

Fully aware of the impact of soil erosion, the Government has initiated a number of measures to minimise and control soil erosion resulting from road construction and land development projects. The mandatory requirements of the EIA, EMP and ESCP have now been formally documented as guidelines for construction activities. These guidelines also specify the proposal of specific mitigation measures imposed for the control of soil erosion and sedimentation during the pre-construction, construction and post-construction phases. The introduction of a more comprehensive *Urban Stormwater Management Manual for Malaysia* by DID has also outlined the BMPs on erosion and sediment control to better manage and mitigate the erosion and sedimentation issues. Therefore, with proper enforcement and implementation of these requirements, the dangers and impacts posed by soil erosion and sedimentation could be effectively prevented or minimised.

Last but not least, mutual responsibilities and commitment by both the approving authorities and the respective project proponents should also be emphasised in order to ensure the soil erosion and sedimentation issues arising from the construction activities could be effectively controlled and minimised for the benefits and interests of all parties concerned and the general public at large.

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