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1. INTRODUCTION

(a) Sedimentation ion and Pollution Potential of National Work Agency's Activities.

Road construction and river training activities carried out by the National Work Agency in the performance of its responsibilities will necessarily cause or induce changes in land and aquatic resources and features that may result in soil erosion and transportation of sediments and in the sedimentation and pollution of sensitive aquatic resources.

Road construction activities result in changes to the volumes, characteristics and composition of stormwater runoff. These activities increase runoff volumes by increasing the amount of impervious surface area in the watershed. They change the characteristics by rerouting and concentrating flows (and occasionally redistributing them leading to sheet flow). They affect the composition of the runoff by changing the characteristics of the surfaces (often making them more erosion-prone), by rerouting runoff over more erodable surfaces, and by depositing, dumping or storing pollutants at locations in or near the path of runoff. They may also affect runoff composition indirectly by their association with other activities that often cause or promote erosion and pollution such as the operation of borrow pits and construction camps and yards.

The construction operations often result in sedimentation and contamination of sensitive water resources (into lakes, rivers, wetlands, coastal waters, and ground waters) by directly discharging sediments and pollutants into the resources or by permitting the sediment- and pollutants-laden runoff to reach the resources untreated. Hydrologic modification directly caused or induced by the construction operations may also adversely affects the biological and physical integrity of surface waters.

(b) Management Practices to Reduce Erosion Prevent Sedimentation and Pollution.

The effectiveness of a particular management measure at a particular site is subject to a variety of factors too complex to address in a single set of simple, mechanical prescriptions developed on a programmatic basis. Technical factors that may affect the suitability of management measures include, but are not limited to, land use, climate, size of drainage area, soil permeability, slopes, depth to water table, space requirements, type and condition of the water resource to be protected, depth to bedrock, and pollutants to be addressed.

The selection of the management measures or practices for a specific project should be based on project specific criteria developed from information gathered during the planning stages. The information requirements are discussed in Section II of this document. Measure selection should be based on its technical and economic viability and its capacity to minimize erosion and prevent sedimentation at a specific site potentially affected by the project. Section III of this document presents a list of practices that should be considered for implementation, as necessary to reduce erosion and prevent sedimentation caused by construction activities. The list is not all-inclusive and does not preclude designers or contractors from using other technically sound practices that would accomplish the same objectives.

The designers who select or design the erosion/sedimentation control measures should do so from a management systems approach as opposed to an approach that focuses on individual practices. That is, they should view the pollutant control achievable from any given management system as the sum of the parts, taking into account the range of effectiveness associated with each single practice, the costs of each practice, and the resulting overall cost and effectiveness. Some individual practices may not be very effective alone but, in combination with others, may provide a key function in highly effective systems.

By their nature, erosion and sedimentation control practices often bring with them side effects that must be accounted for. For example, practices that intercept pollutants leaving the construction area or pollution source may reduce runoff, but also may increase infiltration to ground water. For instance, infiltration basins trap runoff and allow for its percolation. These devices, although highly successful at controlling suspended solids, may not, because of their infiltration properties, be suitable for use in areas with high ground-water tables and nitrate or pesticide residue problems. Thus, the designer should select management practices giving attention to the total water quality impact of the practices.

The designer should be aware that the performance of sediment and pollutant reduction practices is to a large extent dependent on suitable designs, operational conditions, and proper maintenance. For example, filter strips may be effective for controlling particulate and soluble pollutants where sedimentation is not excessive, but may be overwhelmed by high sediment input. Thus, in many cases, filter strips are used as pretreatment or supplemental treatment for other practices within a management system, rather than as an entire solution to a sedimentation problem.

Once the appropriate series of practices has been identified for use, it is essential that each practice be properly designed and implemented in order for the measures to be successful. This requires that design and installation be conducted by qualified and experienced personnel. Design of the management practices should be done in accordance with approved design guidelines and standards, including specific design criteria and specifications that, when followed, will ensure the proper design and installation of each practice. It is always desirable to have a qualified person present at certain stages during installation to ensure that the designs are being interpreted correctly and installed as specified

2. BEST MANAGEMENT PRACTICE FOR PROJECT PLANNING AND DEVELOPMENT

Effective erosion control and sedimentation prevention begin in the planning and location stages of a highway route. Each highway route alternative has a base erosion potential which varies from route to route. These alternative routes can also present a range of sedimentation problems and controls. Unless damage from erosion and sedimentation is considered in selecting a route location, project implementation may result in unreasonable economic and environmental costs that may have been avoided during the planning process.

It should be understood that the best management practices to be incorporated into planning and project development are the management practices that will lead to the selection of the ***Least Environmentally Damaging Practicable Alternative*** (LEDPA) that satisfies the purpose and need of the project. Although this document concentrates on best management practices for erosion control and sedimentation prevention, the selection of the LEDPA must be based on an evaluation of all the project's impacts to both the natural and the manmade environment, including its socio-economic impacts.

Once the least environmentally damaging practicable alternative is identified, the incorporation into the design of effective permanent runoff management and erosion control measures (and other appropriate mitigation measures) can further significantly reduce the long range economic and environmental costs of the project.

The measures discussed here are generally processes intended to help NWA planners and project development personnel fulfill their responsibilities in the implementation of a cost-effective, environmentally sensitive road improvement program.

(a) Processes to Be Implemented During Planning and Early Design Phase

1. Identify the need and purpose for the construction project.

Construction projects consume economic resources, which are limited, and at the same time have various degrees of environmental and socio-economic impacts. Projects that are not justified as necessary and worthwhile should not be considered for implementation.

2. Identify Erosion sensitive areas for the alternatives under consideration.

- Some soil types are known to be more erosive than others and their identification is a valuable aid in route selection.

- Areas with unstable or troublesome soils such as landslide areas and alluvial fans are potential problem areas when disturbed by highway construction.

* The natural drainage pattern, including subsurface flow, should be examined for the alternate routes considered. A dense pattern of steep gradient natural channels presents a much greater erosion potential than a flatter gradient and more disperse natural system.

* Knowledge of the geology of the area allows the engineer to detect problem areas and anticipate subsidence, landslides and erosion problems.

* A study of terrain features and past and present erosion patterns will allow evaluation of the comparative complexity of erosion and the control measures required for each route.

3. Identify sediment-sensitive areas for each alternative.

During the planning and location stages of project development, areas of potential damage from excessive sedimentation should be identified. These would include, among others, water supply sources, impoundments, irrigation systems, recreational waters, croplands, homes, wetlands, developed lands, and streams with particularly sensitive ecological systems. This information will assist in determining if the project can be located in the area without impairing significant resources. It will also help establish the criteria on which to base cost-effective erosion and sediment control measures.

4. Identify sensitive water-dependent resources that may be affected by project-induced changes in hydrology or water contamination.

Each alternative route has the potential of modifying the hydrology or discharging contaminants into water-dependent resources such as wetlands, fish and wildlife breeding grounds, aquifer recharge areas and potable water supply systems. These resources should be identified and the potential impacts assessed during the planning and location stages.

5. Identify sources of potential contamination.

Features such as landfills, active or abandoned mines, sites reflecting historical industrial usage, and underground storage tanks, if disturbed by highway construction operations could contaminate runoff discharged into sensitive water resources.

6. Identify project location alternatives that would address the need of the project while minimizing the project's adverse impacts on sensitive resources identified in previous stages.

These alternatives should:

* Avoid conversion, to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss.

* Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota.
* Protect, to the extent practicable, the natural integrity of waterbodies and natural drainage systems.

* Select the LEDPA considering all the project's environmental, social and economic impacts.

(b) *Measures/Processes To Be Implemented During Design Phase.*

1. Incorporate into the design appropriate nonstructural practices to prevent or minimize erosion (as well as practices or measures to mitigate other environmental impacts).

The following are some of the erosion and sedimentation control considerations that should be part of the design:

* Protecting areas that provide important water quality benefits and/or are particularly susceptible to erosion and sediment loss.

* Limiting increases of impervious areas, except where necessary.

* Limiting land disturbance activities such as clearing and grading to the minimum necessary. Avoiding disturbance of unstable soils or soils particularly susceptible to erosion. Where appropriate, protecting and retaining indigenous vegetation to decrease concentrated flows and to maintain hydrology.

* Incorporating appropriate permanent features to manage runoff without causing erosion.

* Minimizing the area of bare soil exposed at one time (phased grading).

* Making provisions for stream crossing areas (natural and manmade).

* Avoiding, as much as possible, alteration, modification, or destruction of natural drainage features and natural depressions (runoff storage areas) on-site.

* Designing the project so that natural buffers adjacent to coastal water bodies and their tributaries are preserved.

* Making provisions for stabilizing cut-and-fill slopes caused by construction activities.

* Including in the contract documents a project-specific erosion and sedimentation control plan (the plan will need to be amended after the construction Contractor is selected, to fit his construction practices and schedule). The plan should

emphasize the use of erosion controls to reduce the amount of suspended sediments along with the need for sediment controls.

2. The designer or the Design Project Manager, as applicable should develop an environmental protection plan incorporating all the measures or practices that are considered necessary to mitigate adverse environmental impacts. The main component of the environmental protection plan is an erosion and sedimentation control plan (ESC Plan) to control erosion and sediment and pollution problems on construction sites. The ESC Plan should generally contain the following:

* *Description of predominant soil types;*
* *Details of site grading, including existing and proposed contours;*
* *Design details and locations for structural controls;*
* *Provisions to preserve topsoil and limit disturbance;*
* *Details of temporary and permanent stabilization measures;*
* *Description of the sequence of construction;*
* *Provisions for monitoring implementation and performance of measures*

3. **Construction and Maintenance Best Management Practices**

(I) Erosion Control Practices

Erosion controls are used to reduce the amount of soil or sediment that is detached during construction and to prevent sediment from entering runoff. Erosion control is based on two main concepts:

* *Disturb the smallest area of land possible for the shortest period of time, and;*

* *Stabilize disturbed soils to prevent erosion from occurring.*

1. Schedule projects so that clearing and grading are done during the time of minimum erosion potential.

2. Stage construction. Avoid area wide clearance of construction sites. Plan and stage land disturbance activities so that only the area currently under construction is exposed. Stabilize the area as soon as the grading and construction in an area are complete. Install physical markers such as tape, signs, or barriers to indicate the limits of land disturbance and to indicate to equipment operators the proposed limits of clearing. Protect existing or newly planted vegetation that has been planted to stabilize disturbed areas by routing construction traffic around and by fencing, tree armoring, retaining walls, or tree wells.

3. Clear only areas essential for construction. Avoid disturbing areas that are not essential for completing construction activities. Avoid disturbing vegetation on steep slopes or other critical areas.

4. Locate potential non-point pollutant (NPP) sources (such as material stockpiles, borrow areas, borrow roads) away from steep slopes, water bodies and critical areas (such as highly erodible soils and areas that drain directly into sensitive water bodies).

5. Route construction traffic to avoid existing or newly planted vegetation. Where possible, construction traffic should travel over existing roads or over areas that must be disturbed for other construction activities.

6. Protect natural vegetation with fencing, tree armoring, retaining walls, or tree wells. Use tree armoring to protect tree trunks from being damaged by construction equipment. Use fences, located beyond the tree’s drip line to keep construction equipment away from trees. When cutting or filling must be done near a tree, use retaining walls or tree wells to minimize the cutting of tree’s roots or the quantity of fill placed over the tree’s roots.

7. Stockpile good quality topsoil (taking appropriate precautions) and reapply to revegetate site.

8. Cover and stabilize topsoil stockpiles to prevent erosion. Small stockpiles can be covered with a tarp; large stockpiles should be stabilized by erosion blankets, seeding, and/or mulching.

9. Use wind erosion controls to limit the movement of dust from disturbed soil surfaces. Use wind barriers to block air currents and water sprinkling, repeated as needed, to moisten the soil surface. Monitor application of water to prevent excessive runoff and erosion.

10. Intercept runoff above disturbed slopes or newly seeded areas and convey it to a permanent channel or storm drain. Use earth dikes, perimeter dikes/swales or diversions and pipe slope drains. The intercepting structures should be stabilized within 14 days of installation.

    * An earth dike is a temporary berm or ridge of compacted soil that channels water to a desired location.

    * A perimeter dike/swale or diversion is a swale with supporting ridge on the lower side that is constructed from the soil excavated from the adjoining swale.

* A pipe slope drain, or pipe drop structure, is a temporary pipe placed from the top of a slope to the bottom of the slope to convey concentrated runoff down the slope without causing erosion.

11. On long or steep disturbed or manmade slopes, construct benches, terraces, or ditches at regular intervals to intercept runoff. The benches, terraces and ditches, complemented by pipe slope drains as needed, should direct the flow to a suitable outlet, such as a sediment basin or trap. The frequency of the benches, terraces or ditches will depend on the erosion potential of the soils, steepness and length of the slopes, and rock outcrops.

12. Use retaining walls to reduce the steepness of slopes and to reduce erosion potential.

13. Provide lining for urban runoff conveyance channels if the runoff during or after construction will cause erosion. Use grass or sod for lining, as much as possible, since this will reduce runoff velocities and provide water quality benefits through filtration and infiltration. Use riprap, concrete or gabions if the velocity in the channel would erode the grass or sod.

14. Use check dams across swales and channels to reduce the velocity of concentrated flow and thus reduce erosion. Check dams should be used when a swale or channel will be used for a short time and is not feasible or practical to line the channel or implement flow control BMPs.

15. Seed or otherwise stabilize bare soils within 15 calendar days after final grading. Denuded areas that are inactive and will be exposed to rain for 30 days or more should be temporarily stabilized by planting seeds and establishing vegetation or by other suitable means. Seed and fertilize to establish a permanent vegetative cover in disturbed areas. Avoid untimely or excessive application of fertilizer. Because this practice does not provide any protection during the time of vegetative establishment, plain seeding and fertilizing should be used only on favorable soils in very flat areas and not in sensitive areas.

16. Use mulch/mats for temporary protection of the soil surface or when permanent seeding is not feasible. Mulching involves applying plant residues or other suitable material on disturbed soil surfaces. Mulch/mats used include tacked straw, wood chips, and jute netting and are often covered by blankets or netting. The useful life of mulch is approximately 2 to 6 months and varies with the material used and with the amount of precipitation.

17. Use seeding and mulch/mats to establish a permanent vegetative ground cover on moderate to steep slopes, on erosive soils and on sensitive areas. On steep slopes or highly erodible soils, multiple mulching treatments should be used.

18. Use sodding for permanent stabilization of critical areas; where establishment of permanent vegetation by seeding and mulching would be difficult; and when there is high erosion potential during the period of vegetative establishment from seeding.

19. Use wildflower cover whenever possible. Because of their hardy, draught-resistant nature, wildflowers may be more beneficial as an erosion control measure than turf grass. Wildflowers do not need fertilizers, pesticides, or herbicides, and their watering requirements are minimal.

(3) SEDIMENT CONTROL PRACTICES.

Sediments control capture sediments that is transported in runoff. The main processes used to remove sediments from urban runoff are filtration and detention.

1. Sediment or Silt Basins

Sediment/silt basins are engineered impoundment structures that allow sediment to settle out of the urban runoff. They are installed prior to full-scale grading and remain in place until the disturbed portions of the drainage area are fully stabilized. They are generally located at the low point of sites, away from construction traffic where they can be most effective in trapping sediment-laden runoff.

Sediment basins are typically used for drainage areas between 5 and 100 acres. Because highway projects are lineal in character and seldom affect single areas of this magnitude, sediment basins are not normally a practicable option for highway construction or maintenance projects.

2. Sediment traps

Sediment traps are small impoundments that allow sediment to settle out of runoff water. They are typically installed in a drainage way or other point of discharge from a disturbed area. Temporary diversions can be used to direct runoff to the sediment trap. Sediment traps should not be used for drainage areas greater than 5 acres. When properly built, they should have a useful life of approximately 18 to 24 months.

3. Filter fabric fence

Filter fabric fences filter sediment out of runoff as the sediment-laden runoff flows through the fabric. Filter fabric fences should be used only where there is sheet flow (no concentrated flow). The maximum drainage area contributing runoff to the fence should be 0.5 acres or less per 100 feet of fence. Filter fabric fence normally has a useful life of 6 to 12 months when properly used and maintained.

4. Straw Bale Barrier

A straw bale barrier is a row of anchored straw bales that detain and filters urban or construction area runoff. Straw bales are less effective than filter fabric in filtering runoff. However straw bales can perform as temporary check dams in channels where there is sheet flow and relatively low volumes of runoff. The maximum drainage area for this barrier should be o.25 acres or less per 100 feet of barrier. The useful life of straw bales is approximately 3 months.

5. Inlet protection.

Inlet protection consists of a barrier placed around a storm drain drop inlet to trap sediments before they enter the storm sewer system. The barrier could be made out of filter fabric, straw bales, gravel or sandbags.

6. Water quality inlets

Water quality inlets are underground retention systems designed to remove sediments from runoff. Several designs have been developed; the simplest one is a typical drop inlet with the bottom 2 to 4 feet lower than the outlet pipe to provide storage space for the collection of sediments. These sediments need to be removed periodically to preserve the effectiveness of the measure.

7. Construction entrance

A construction entrance is a pad of gravel over filter cloth located where traffic leaves the construction site. As vehicles drive over the gravel, mud and sediments are collected from the vehicles' wheels and offsite transport of sediment is reduced. Construction entrances must incorporate provisions for drainage.

8. Vegetated filter strips.

Vegetated filter strips are low-gradient vegetated areas that filter overland sheet flow. Runoff must be evenly distributed across the filter strip. Canalized flow decreases the effectiveness of the filter strips. Level spreading devices can be used to help distribute the flow evenly across the strip. Filter strips lose effectiveness as slopes increase to over 15 percent.

Vegetated filter strips should have relatively flat slopes and adequate length and should be planted with erosion-resistant plant species. The main factors that influence the removal efficiency of the strip are the vegetation type, soil infiltration rate, and flow depth and velocity.

9. Grassed swales.

Grassed swales are typically shallow, vegetated, man-made ditches designed so that the bottom elevation is above the water table to allow runoff to infiltrate into the groundwater. The vegetation prevents erosion, filters sediment, and removes a limited amount of nutrients.

The swale should be mowed at least twice each year to stimulate vegetative growth, control weeds, and maintain the capacity of the system.

10. Constructed wetlands.

Engineered systems designed to simulate natural wetlands to exploit the water purification functional value for human use and benefits. Constructed wetlands consist of former upland environments that have been modified to create poorly drained soils and wetlands flora and fauna for the primary purpose of contaminant or pollutant removal from wastewaters or runoff. Constructed wetlands are essentially wastewater treatment systems and are designed and operated as such though many systems do support other functional values.

C. Chemical Control Management Measures on Construction Sites.

Many potential pollutants other than sediment are associated with construction activities. These pollutants include: *pesticides (insecticides, fungicides, herbicides, and rodenticides); fertilizers used for vegetative stabilization; petrochemicals (oils, gasoline, and diesel fuel and asphalt degreasers); construction chemicals such as concrete products, sealers, and paints; wash water associated with these products; paper; wood; garbage; and sanitary wastes.*

Toxic substances tend to bind to fine soil particles. Many of the NPS pollutants, other than suspended sediment, generated at a construction site are carried offsite in solution or attached to clay particles in runoff. Some metals (e.g., manganese, iron, and nickel) attach to sediment and usually can be retained onsite. Other metals (e.g., copper, cobalt, and chromium) attach to fine clay particles and have greater potential to be carried offsite. Insoluble pollutants (e.g., oils, petrochemicals, and asphalt) form a surface film on runoff water and can be easily washed away.

By implementing best management practices to control sediment mobilization, and to manage and control toxic substances and hazardous materials, it is possible to limit the loadings of these pollutants that reach water resources.

To prevent chemical and pollutant contamination of streams and other sensitive water resources, the NWA will incorporate into its maintenance and construction contracts all appropriate provisions requiring the implementation of best management measures and practices for pollution prevention during construction and maintenance of roads and bridges.

The following practices, where applicable, will be translated into contractual requirements:

1. ***Develop and implement a spill prevention and control plan.*** Contractors and other commercial entities associated with construction project that store, handle, or transport fuel, oil, or hazardous materials should have a spill prevention and response plan, especially if large quantities of oil or other polluting liquid materials are used.

2. The spill prevention and control plan should take into consideration the following factors that influence the pollution potential of construction chemicals:

   - *The nature of the construction activity;*
   - *The physical characteristics of the construction site; and*
   - *The characteristics of the receiving waters.*

3. Spill procedure information should be posted, and persons trained in spill handling should be onsite or on call at all times. Materials for cleaning up spills should be kept onsite and easily available. Spills should be cleaned up immediately and the contaminated material properly disposed of. Spill control plan components should include:

   - *Stopping the source of the spill;*
   - *Containing any liquid;*
   - *Covering the spill with absorbent material such as*
   - *Disposing of the used absorbent properly.*

2. Establish fuel and vehicle maintenance staging areas located away from surface waters and all drainages leading to surface waters, and design these areas to control runoff.

3. Maintain and wash equipment and machinery in confined areas specifically designed to control runoff.

4. Do not discharge thinners or solvents into sanitary or storm sewer systems, or surface water systems, when cleaning machinery. Use alternative methods, such as high-pressure, high-temperature water washing or steam cleaning for cleaning larger equipment parts. Equipment-washing detergents can be used and wash water discharged into sanitary sewers if solids are removed from the solution first. Small parts should be cleaned with degreasing solvents that can then be reused or recycled. Do not discharge or otherwise dispose of any solvents into sewers, or into surface waters.

5. Never dump washout from concrete trucks directly into surface waters or into a drainage leading to surface waters. Washout should be disposed of into:

   * *A designated area that will later be backfilled;*
   * *An area where the concrete wash can harden, can be broken up, and can then be placed in a dumpster; or*
   * *A location not subject to surface water runoff and more than 50 feet away from receiving water.*

6. Store, cover, and isolate construction materials, refuse, garbage, sewage, debris, oil and other petroleum products, industrial chemicals, and topsoil to prevent runoff of pollutants and contamination of ground water.

7. Provide adequate disposal facilities for solid wastes, including excess asphalt, produced during construction.

8. Provide sanitary facilities for construction workers.

9. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters. Properly timed application, and work fertilizers and liming materials into the soil to depths of 4 to 6 inches.

10. Dispose of all the vegetation removed during Construction or maintenance operations (trees, branches, stumps, roots, buried logs, shrubs, brush, and other vegetation) in an approved disposal site. Do not leave grass cuttings where they can be carried by runoff or by the wind into nearby streams and increase nutrient levels in these waters.

11. Implement appropriate structural practices to remove contaminants from runoff before they reach sensitive water resources (vegetated filter strips, grassed swales, constructed wetlands). Treat contaminants and contaminated sediments on site, as approved by NEPA, or dispose of them in an approved disposal facility.