CHAPTER 10

CHAPTER 10

BEST PRACTICE IN ENVIRONMENTAL MANAGEMENT OF CONSTRUCTION ACTIVITIES

10.1 INTRODUCTION

Over the past decade, the community has become increasingly aware of the need to protect the environment against degradation attributed to human activities and the linkages between environmental conservation, ecologically sustainable development and economically sustainable development. Construction activities invariably lead to disturbances of the landscape, with the consequential impacts on the environment. Major forms of pollution include noise pollution, air pollution and water pollution. In relation to water pollution and water-induced pollution, erosion of exposed areas leading to significant transportation of sediment and silt into receiving waters is a primary concern amongst many environment protection authorities. Oil and other associated chemical spillages as well as litter generated from construction sites are common issues raised by the community when lodging complaints about environmental impacts of construction activities. The community now demands that proper environmental precautions are undertaken to mitigate these impacts and an environmental management plan is now an essential part of any construction activities.

Environment protection organisations have wide powers to enforce environmental standards on air and water quality. For example, the Environment Protection Authority of Victoria, Australia has legislative powers to impose environmental compliance criteria on construction activities although these have not been strictly enforced in the past. Over the past few years however, more stringent environmental standards on construction activities are being imposed by the relevant environment protection organisations in an effort to engender "best practice" in environmental management of construction sites. In the state of Victoria, breaches of the Environmental Protection Act through the relevant state environmental protection policies can lead to significant fines ($200 to $1 million) and even jail terms in extreme cases. Contractors are expected to embrace best practice philosophy in meeting the challenge of higher environmental standards. This paper examines what is meant by "best practice" and explores the basic principles leading to "best practice" in environmental management of construction activities in greenfield sites and built-up areas. Current environmental management methods are examined for their effectiveness with particular emphasis on mitigating the impact of construction activities on stormwater pollution.

10.2 THE CONSTRUCTION INDUSTRY

The construction industry is currently under-going significant cultural change in their engineering practice with the advent of Design and Construct (D&C) projects and rising expectations in their environmental management practices. Under a highly competitive tendering climate, the two objectives of a cost-competitive and innovative engineering solution and a sound environmental management plan for the construction activities are often in conflict. Contractors often fall into the trap of either formulating a sound environmental management plan and pricing their tender out of contention or "promising" environmental management and adopting a reactive approach to environmental management in response to surveillance by environment protection organisations and community groups. The latter is the very ingredient leading to an adversary outcome in environmental management.

Often the broader issues of post-construction environmental effects of the proposed project would have been canvassed and resolved during the feasibility and environmental impact statement stage of the project. At the construction phase, issues are directed at facilitating the construction of the project with appropriate environmental controls. This is often a period of wide-scale disturbance of the project site where the character of the landscape is very much transitional. The risk for high intensity pollution of the receiving waters is often at its highest during this period. Quite often it would be argued that the risk is temporary and that there is little justification for the contractor to adopt elaborate environmental controls of such a dynamic site.

10.3 BEST PRACTICE IN ENVIRONMENTAL MANAGEMENT

Reference to "Best Practice" is presently widely used when establishing standards and procedures for most activities and construction activities are no different. There is a high degree of confusion and misconception on what is meant by best practice. The term can often mean different things to different stakeholders, often reflecting the individual stakeholder's primary objectives. These differences have often been the fundamental cause of misunderstandings amongst stakeholders of their respective obligations, roles, objectives and expectations.

Construction activities are carried out under a wide variety of circumstances. The construction site is often highly dynamic, changing in its landform and character almost on a daily basis. Pollution control measures will need to keep pace with this degree of dynamism. Highway constructions for example are often unique for their generally long and "narrow" works area and the dynamism of the site. These issues, even in a green field site, present many challenges associated with the environmental management of construction activities. The difficulties are compounded when retrofitting and augmenting existing road systems in a built-up area where there is a requirement for the existing infrastructure to remain in service with high traffic volumes passing through the construction site. In formulating an environmental management plan, best practices must include consideration of project constraints that may lead to inherently higher levels of risk associated with environmental impacts. With this higher level of inherent environmental risk, performance feedback and rapid response to perceived inadequacies become major elements in a system approach to environmental management. These issues are fundamental to the framework of an environmental management plan. By necessity, the facilitation of "best practice" construction site environmental management must involve a degree of customisation of the environmental management plan specific to the site in question.

Standard procedures in construction site management and erosion control are well documented, eg. Goldman *et al* (1986), Israelsen *et al* (1980), Garvin *et al* (1979), Environment Protection Authority of Victoria (1991), Quilty et al (1978), Richards and Middleton (1978) etc. Best practices in environmental management of construction sites however cannot be strictly technically and technologically based. A management system approach needs to be undertaken to ensure that an appropriate balance between economical and ecological sustainability can be achieved.

Best practice in environmental management is the adaptation of "standard" measures to the particular features of the construction site in question in a system approach with associated feedback mechanisms, response and contingency plans, audit procedures, hazard and risk assessments etc.

Figure 10.1 depicts what is believed to be the six essential principles towards "best practice" in environmental management of construction sites. These principles are:-

- Understanding of project constraints
- Appreciation of environmental objectives
- Pro-active implementation of pollution abatement measures
- Consistent utilisation of pollution control measures
- Monitoring and performance evaluation
- Rapid respond to inadequacies

A pre-requisite for sound environmental management practices in construction is a strong partnership amongst stakeholders, working together towards the common objective of minimising the impact of construction activities on the environment. In the first instance, there needs to be a genuine desire by all stakeholders to facilitate the development of the project without compromising their respective objectives. The partnership amongst the major stakeholders allows differing objectives of the stakeholders to be accommodated and reflected in the resulting environmental management plan formulated. In the absence of this approach, there is a higher tendency for an adversary outcome amongst the stakeholders, which can often lead to increased construction cost and loss of goodwill amongst participating organisations.

Figure 10.1 - Principal Elements of a Best Practice Environmental Management Plan

The above six principles form the common basis for this partnership amongst stakeholders in formulating the environmental plan. It is often effective for the environmental plan to be formulated by means of a workshop amongst the major stakeholders. In most cases, there are three principal stakeholders, ie. the client, the contractor and the environment protection agencies. The community is clearly a stakeholder but often the community interest is represented by the environment protection agencies and, in the case of public infrastructure, the client. The use of a partnering model in formulating the environmental management plans facilitates a cooperative approach to environmental management rather than a confrontative mode of operation based on policing and enforcement.

10.4 A SYSTEM APPROACH TO ENVIRONMENTAL MANAGEMENT

It is necessary for contractors to develop an environmental management system that establishes the basic protocols for implementing and administering the environmental management plan. The distinction is drawn between an environmental management plan and an environmental management system to reflect the latter being a more generic approach to environmental management.

Government departments for urban planning, stormwater management and environmental protection will be responsible for setting out the environmental objectives and all construction activities must conform to the associated environmental regulations and protection policies. The contractor is responsible for the formulation and execution of the Environmental Management Plan aimed at meeting the environmental objectives. It should be emphasised that these objectives have to be attainable and it is often necessary that they be set in consideration of the other interacting issues.

10.4.1 Understanding of Project Constraints

Constraints of the project have a direct influence in forming the most appropriate environmental management plan for the project. These constraints cover physical, ecological as well contractual issues including:-

- size of construction site and the available right-of-way set aside for construction activities;
- catchment area and climatic characteristics;
- project budget, milestones and completion date;
- maintenance and/or relocation of existing services and infrastructure;
- existing condition of the environment and the ability of the site to recover following the completion of the project;
- construction methods.

The above issues are by no means exhaustive but are important considerations when formulating realistic performance and compliance criteria. Particular emphasis is placed on achieving realistic and attainable environmental objectives in recognition of the constraints inherent in the site and the project. The setting of environmental objectives will always need to be in the context of the existing environmental quality of the site and the surrounding environment. There have been many occasions in the past where environmental criteria are unrealistically established which have ultimately lead to disillusionment amongst stakeholders and a breakdown in the partnership towards attaining higher environmental standards in construction activities. A workshop approach involving the major stakeholders is often a useful means of formulating the environmental objectives of a particular project (eg. Wong and Hart, 1995).

10.4.2 Appreciation of Environmental Objectives

The environmental objectives set up the target water quality standard for the receiving waters. It is important that all stakeholders have a clear appreciation of the environmental objectives, the basis for these objectives, the achievability of these objectives at the site in question, the means by which satisfying the environmental objectives can be demonstrated and the regulatory requirements. Key management staff should be familiar with the relevant legislation. The legislative requirements should be incorporated into the environmental management plan for the construction activity.

Typical water quality parameters used in setting environmental objectives are DO, turbidity, pH, conductivity and hydrocarbon. Of these parameters, DO, turbidity, pH and conductivity can be measured quantitatively on site without the need for laboratory analysis. The presence of hydrocarbon in the receiving waters in the form of oil and grease can be visually inspected.

Other water quality parameters such as TSS and nutrients (especially P) may be of particular importance. Often, turbidity can be use as a surrogate for TSS and nutrients (especially P) thus avoiding the need for frequent laboratory analysis. However, it is unlikely that the relationships between turbidity and TSS and nutrients are linear and thus water samples should be analysed for TSS and nutrients during occasional storm events to allow correlation with turbidity readings.

Air quality objectives would relate mainly to dust levels that are generated by construction activities within and in the vicinity of the construction site.

10.4.3 Pro-active Implementation of Pollution Abatement Measures

An environmental management plan is most effective if formulated at the planning and design stage of the project with it being an integral part of the overall staging of construction activities. In formulating the plan, environmental risk assessment of each of the construction activities are to be carried out and necessary pollution abatement measures identified. The environmental risk assessment should identify both the likely scenarios associated with each given activity and the appropriate course of action (and contingency plans) for each of these scenarios.

Fundamental to a pro-active approach to the implementation of pollution abatement measures is communication and awareness amongst site foremen and labourers. The level of communication and reinforcement of appropriate environmental practices for each activity depends on the level of environmental risk assigned to the particular activity. For high-risk activities, it may be appropriate to have specific briefing to personnel involved on the likely scenarios and appropriate measures prior to the commencement of the activity. Routine activities, on the other hand, may only require reminders of good environmental management practices at regular intervals.

10.4.4 Consistent Utilisation of Pollution Control Measures

A necessary commitment to an effective environmental management of a construction site is the consistent utilisation of pollution control measures. This requires a heighten awareness of the role of pollution control measures and the promotion of the necessary cultural shift amongst all construction personnel towards better managing the impact of their activities on the environment.

Within a highly dynamic site where new work areas are constantly being established or where existing work areas are continually changing form, there is often the temptation to neglect the implementation of a consistent standard of pollution abatement measures. With a large project, the lack of widespread communication or appreciation of the need to apply such measures amongst the many personnel involved is often a common cause for inconsistencies in environmental management methods. Regular communication and reaffirmation of the contractor's commitment to good environmental management is a key strategy towards promoting consistency in the utilisation of appropriate pollution abatement measures throughout the site.

10.4.5 Monitoring and Performance Evaluation

Monitoring for short-term performance evaluation as well as for long-term recovery of the site following the conclusion of the construction activities is a vital component of an environmental management plan. The responsibility for monitoring is that of the contractor. Monitoring (both air and water quality) provides the mechanism for feedback on the effectiveness of measures implemented for continued improvement in pollution abatement measures.

As indicated in Section 10.4.2, key water quality parameters that can be readily monitored are turbidity, DO, pH and conductivity. These are physico-chemical parameters that can be used to quantitatively assess the outcomes of the environmental management plan. These parameters should be monitored at the upstream end of the site to establish the "control" and the downstream end of the site (to define the impacts). For most cases, the two sites representing the control and impact monitoring locations would be sufficient to demonstrate the overall effectiveness of environmental management measures within the site. Monitoring at intermediate locations within the construction site will be necessary if an evaluation of the effectiveness of individual management measures is sought.

Monitoring of the water ecosystem should continue well after the completion of the project to assess the rate at which the environment can recover following the project. This would provide much needed data for a better understanding of the resilient (or lack of) of the environment to the impacts of construction activities.

Monitoring also includes day-to-day surveillance of "hot-spots" within the site. This would often be simply visual inspection of pollution abatement measures (i) during storm events to determine their effectiveness, and (ii) post-storm events to assess their maintenance requirements. Again, the general awareness by site personnel of the environmental objectives and the role and significance of the pollution abatement measures installed would facilitate the surveillance program. It is vital that site personnel have a clear sense of ownership of the environmental management plan if it were to be sustained at a high level throughout the duration of the project.

10.4.6 Rapid Response to Inadequacies

The feedback mechanisms (monitoring and surveillance) set in place to evaluate the performance of pollution abatement measures installed on site are most effective if perceived inadequacies in these measures can be corrected rapidly and according to their relative level of significance. This mode of operation is in some way tied to the risk assessment carried out as part of the pro-active implementation of pollution abatement measures in that the risk assessment provides a basis for ranking the priorities at which corrective measures are to be undertaken.

The ability of the contractor to respond rapidly to inadequacies in pollution abatement measures is in some way a reflection of its commitment to maintaining a high standard of environmental management of the construction site.

10.5 STANDARD SITE MANAGEMENT MEASURES

Environmental measures are aimed at two fundamental effects of construction activities, ie. dust and runoff. Dust control is an important issue in construction site management, particularly within a built-up area. The nature of most large construction activities is such that large areas are necessarily left exposed. Non-structural measures such as work scheduling are often very effective compared to the more structural or works related measures such as placement of mulch, water spraying and other chemical additives. Various methods for dust control can be utilised in construction sites and their utilisation is often complementary. These control methods should be utilised in combination to achieve an integrated plan for dust control. The types of dust control measures include the following:

- Coverage of exposed areas by the following methods
  - Placement of mulch
  - Establishment of vegetation cover
  - Cover ground (geotextiles)
  - Temporary fences/wind breaks
- Water and chemical treatment by the following methods
  - Water spraying of exposed areas
  - Chemical additives
  - Truck washing
- Project management and planning
  - Traffic volume and speed limitations
  - Road maintenance and road vacuuming
  - Minimising exposed areas
  - Avoiding certain activities on windy days
- Earthworks and surfacing
  - Surfacing roads and exposed areas
  - Increasing surface roughness

Stormwater runoff in itself from the works area and from catchments external of the construction site does not pose an environmental problem. However, sediment and silt are often conveyed to the receiving waters by stormwater. Within a construction site, stormwater runoff is the fundamental cause of erosion and is also the transport mechanism of sediment and silt generated from the eroded sites to the receiving waters. Stormwater runoff management and associated erosion control measures are aimed at minimising further export of sediment and silt from work areas into the receiving waters. As is the case with dust control measures, a number of methods can be utilised in combination. These methods can be categorised as follows:

- Runoff and erosion reduction
  - Isolation of exposed site
  - Control of embankment slopes
  - Cutoff drains
- Runoff filtration
  - Establishment of vegetation buffer areas
  - Maintenance of existing buffer strips
  - Utilisation of silt traps and fences
  - Side entry pit baskets

- Scour protection
  - Geotextile cover on slopes and drainage channels
  - Utilisation of energy dissipators and scour protection
- Runoff retention and detention
  - Retardation of catchment runoff
  - Utilisation of sedimentation ponds
- Project management and planning
  - Construction traffic management
  - Road maintenance and road sweeping/vacuuming
  - Minimising exposed areas

10.5.1 Dust Control

10.5.1.1 Covering of Exposed Areas

Coverage of exposed sites by suitable dust suppression measures include the placement of mulch, the re-establishment of vegetation cover, temporary placement of geofabric and the installation of wind fences .

The use of mulch cover on exposed areas are most appropriate on temporary areas such as stockpiles, embankments of the road and abutment of bridges being constructed. They are not suitable for road construction surfaces owing to the rapidly changing form of road surfaces. Straw and hay mulch are suitable for small exposed sites but often they will need to be used in association with the installation of wind breaks.

Figure 10.2 Spraying of paper machee on embankment

Paper machee can be an effective dust suppressant. A criticism of this type of dust suppressant is its tendency to be washed away during storm events and is thus not appropriate at locations where high runoff is to be conveyed (eg. at the toe of an embankment). This form of dust suppressant is probably most suitable for placement along the face of embankments and abutments (see Figure 10.2) where cutoff drains have been place on the top of the embankment to divert storm runoff away from the face of the embankment.

Vegetation cover is considered most appropriate for more permanent earth works or temporary works anticipated to be exposed for long periods.

10.5.1.2 Water and Chemical Treatment

Water treatment by spraying of exposed areas is costly but is considered most practical for road construction surfaces and haul roads. The application rate of water on exposed sites is an important consideration to ensure that highly turbid runoff can be appropriately managed. Water treatment is not appropriate on sealed roads due to safety consideration and the production of slurry.

Truck wheel washing is considered an essential measure in dust control. Sufficient allocation should be made of available sites for the installation of a wheel washing basin which are readily accessible for trucks from all work areas. Manual washing of wheels is a possible alternative and a solution to the problem of unavailable sites for wheel washing basin areas. It will be necessary for the manual washing area to be appropriately paved with a gravel base and runoff control and treated before it is allowed to be discharge into the receiving water. The possibility of utilising re-cycled water should be explored. Chemical surface stabilisers can also be used for dust control over exposed ares whilst construction is in progress but have a limited life expectancy. The use of geofabrics and revegetation should be considered for areas that require protection over extended periods.

10.5.1.3 Project Management and Planning

Fundamental to good practice is proper planning and management of the construction project in terms of the day-to-day activities and site management at the micro-level to minimise the cumulative impact of these activities on the environment. Routine site inspections are recommended and such measures as the proper location of stockpiles, work scheduling, and surveillance and maintenance of temporary works.

(i) Stockpile
Stockpile sites should be reasonably sheltered from wind effect and continually kept wet to minimise dust generation. This practice should be implemented with associated runoff and erosion control measures.

(ii) Permanent Earthworks
For permanent earthworks, work scheduling should be such that a minimum area is left exposed at any one time. For example, the nature of road construction involves the placement and compaction of earthworks at 200 mm layers. Each layer needs to be tested the following day before the next layer can be placed, ie. work on a section of road can generally occur on every alternate days. Optimum scheduling would be for each road building crew to be assigned two sections that they can alternate. An assignment of more than two sections would result in some sections left unattended for longer than necessary and if assigned only one section, the crew resources would not be efficiently utilised.

(iii) Construction Traffic Management
During construction, roads should be kept wet and other dust control measures implemented. Similarly, this applies to speed limits as a means of dust control notwithstanding other occupational health and safety consideration associated with speed limit in the works areas in general.

(iv) Street Cleaning
Vacuum sweeping of sealed roads is considered to be the most effective and unobtrusive means of dust control in sealed roads opened to public traffic. It is also recognised that there will be occasions when street washing will be necessary. When this is the case, specific management of runoff from the operation such as discharging into a vegetated buffer area, filtration using geofabric fences etc. will need to be implemented.

(v) Site Access
Continued maintenance of haul roads is considered a practical measure for dust control. Maintenance works would include placement of rock and gravel-on haul road and temporary waterway crossings. Other maintenance measures have been discussed in earlier sections, eg. grass and mulch cover, water spraying etc.

10.5.2 Runoff and Erosion Control

10.5.2.1 Runoff and Erosion Reduction

The most important measure in runoff and erosion control is the reduction in runoff and thence erosion generated from the construction site. Isolation of the construction site in general and exposed sites in particular is considered to be the most fundamental measure in this regard. Prevention of runoff of external sources reduces the flow rate (and therefore velocity) being conveyed across exposed sites. The photo on the left illustrates the problems associated with inadequate isolation of exposed areas from storm runoff generated outside the immediate works area. Site isolation is to be implemented by a combination of cut-off drains and earth embankments.

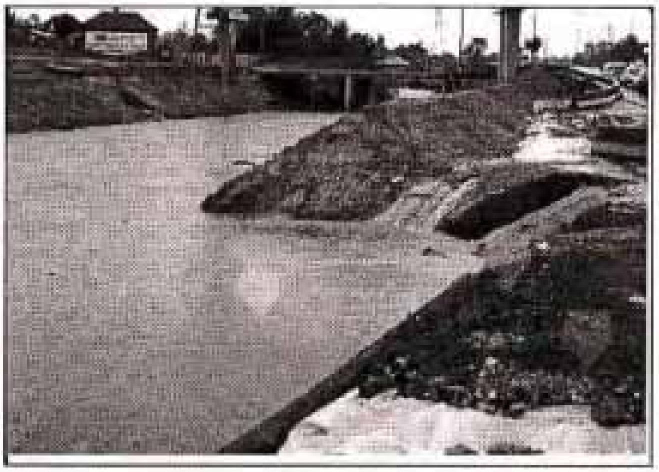

Figure 10.3 Inadequate isolation of source area

Control of embankment slopes to reduce runoff velocity is also very useful in preventing excessive erosion along the embankments. It is often effective to break up the embankment slope with a series of benches to reduce the runoff catchment area and the slope of the rills formed in conveying the runoff away from these embankments.

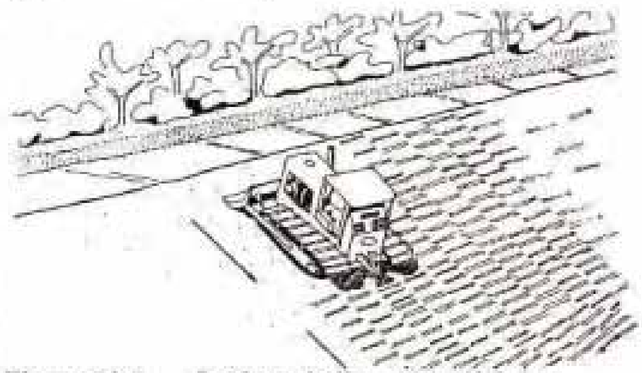

Figure 10.3 Preferred alignment of dozer track mark

The alignment of the tracks made by a dozer in constructing an embankment should be such that the groves created are perpendicular to the slope as shown in Figure 10.3 (Goldman *et al*, 1986). These track marks also serve to provide surface roughening of the embankment face and are particularly appropriate for temporary landforms).

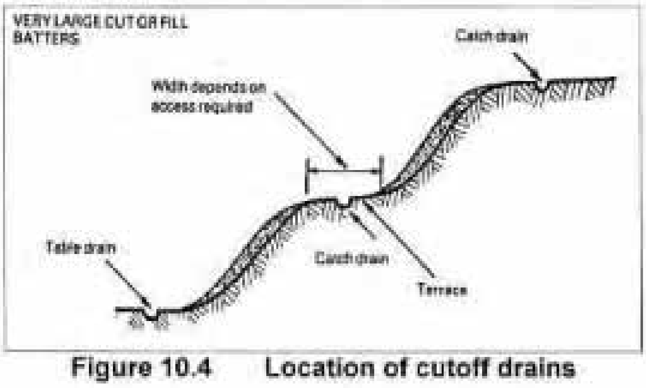

Figure 10.4 Location of cutoff drains

The installation of cut-off drains at the top of an embankment is vital in isolating the face of the embankment from potentially high runoff from catchment areas outside of the embankment. For large embankments, it may be necessary to also include intermediate cutoff drains as shown in Figure 10.4 (Ransom, 1987).

10.5.2.2 Runoff Filtration

Filtration of runoff generated from exposed areas is a measure applied in construction sites. This involves the used of such measures as silt traps and geofabric fences (see Figure 10.5 and Figure 10.6), as well as conveying runoff via a vegetated buffer area to receiving waters.

Installation of hay-bales across temporary drainage lines within the construction site is an often-used practice to trap sediment. In recent times, the use of hay bales have been either superseded or complemented with the use of geotextile as the filter material.

Figure 10.5 Use of Geofabric and hay bales

Runoff filtration using silt traps and fences are usually effective in trapping heavier sediment but cannot be expected to completely reduce the turbidity of the runoff generated from the construction site. It is best to distribute these sediment barriers and fences at even intervals to ensure that they are not overloaded during a storm event.

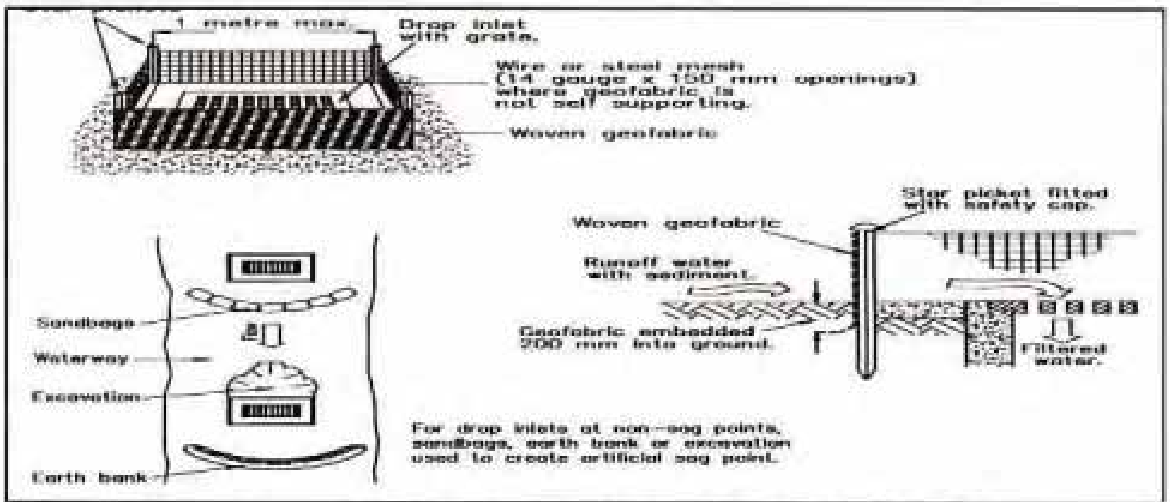

Figure 10.6 Location and installation of geofabric filters (ref. Inst. Engrs, Aust, 1996)

Maintaining existing vegetated areas and creating new vegetated areas along creeks would promote filtration of runoff from the project area discharging into the creek. The use of vegetated buffer strips is considered to be the most effective if runoff is allowed to evenly distribute over the area. A good example of how this can be effective is shown in Figure 10.7. A line of silt fence has been installed along the toe of the embankment and runoff discharging through (and over) the silt fence passes through a densely vegetated area before entering the creek. The even distribution of runoff over the buffer area can be promoted by increasing the number of

Figure 10.7 Buffer strip between exposed area and receiving waters

discharge points from the exposed site to the vegetated buffer strip. Retrofitting of existing drainage system and landform includes directing runoff from exposed sites to these vegetated buffer areas by means of temporary trenches and pipes.

10.5.2.3 Scour Protection

Scour protection along temporary steep slopes and drainage lines is a further measure which can be implemented to prevent excessive erosion in exposed areas. Scour protection includes vegetation, geofabric lining of the exposed area or the placement of rocks and gravels. In placing geofabric protection, particular attention must be paid to how the various sheets of fabric overlap each other and in the anchoring of the sheets. Geofabric sheets should be laid such that the overlap is in the downstream direction with the layer on top being the upstream fabric sheet.

Generally, runoff should not be allowed to overfall freely over steep banks. There are two means of preventing free overfall conditions. One involved diverting runoff along the face of the bank over a longer flow path and a flatter slope. A second method is the piping the runoff with a standard UPVC pipe to the toe of the bank with rocks used as energy dissipater at the outlet of the pipe as shown in Figure 10.8 (Institution of Engineers, Australia, 1996). If free overfall cannot be avoided, the bank should be protected by a combination of geofabric and rocks and gravel.

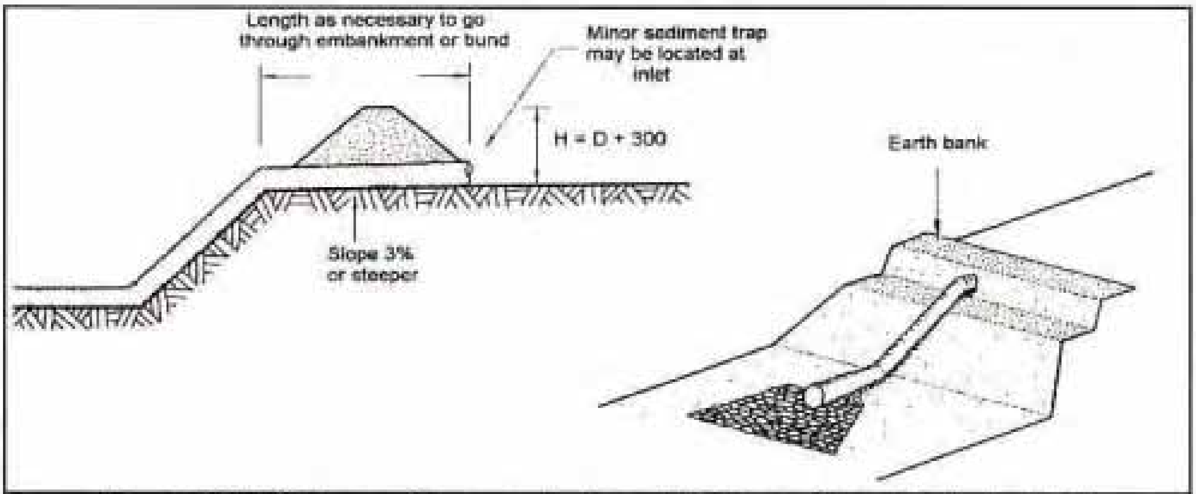

Figure 10.8 - Piping runoff over embankment (ref. Inst. of Eng., Australia, 1996)

10.5.2.4 Runoff Retention and Detention

The use of sedimentation basins in construction sites is now a standard practice and they generally consist of a designated stormwater detention area to trap any remaining sediment before runoff exit the construction site. They are generally located at the lowest possible point in the site and serves as a final "line of defence" against sediment export from construction site. The effectiveness of sedimentation basins is limited to removal of medium to coarse particles. Stormwater runoff from the site is diverted toward the basin where they are detained for a nominal period to allow suspended particles to settle. The combined effect of the outlet discharge characteristics and the storage volume of the basin control the detention period. A typical layout of a sedimentation basin is shown in the Figure 10.9.

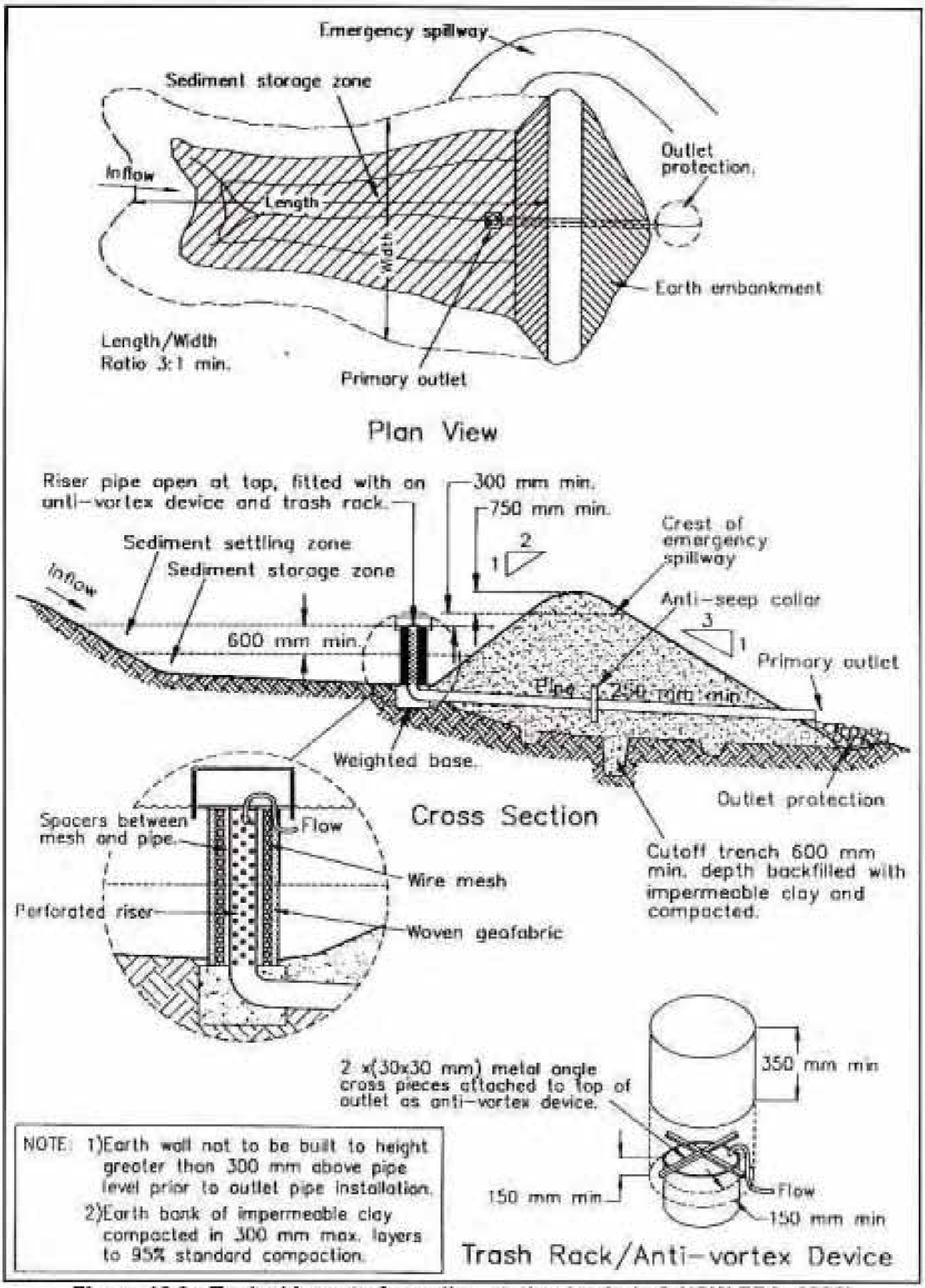

Figure 10.9 - Typical layout of a sedimentation basin (ref. NSW EPA, 1996)

Common problems experienced with their utilisation relate to inappropriate location, inadequate formation of diversion channels towards the sedimentation basin, inadequate maintenance of the basin (mainly related to the need for desilting), poor energy dissipation of inflow and poor selection of outlet devices. Short-circuiting of flows in the basin is also a principal cause of poor sediment capture efficiency. The use of silt baffle fences is common to prevent short-circuiting of flow paths in the basin.

In a recent technical note published by the Centre for Watershed Protection (1997), it was suggested that while the use of a perforated can potentially improve the capture efficiency of sediment compared to a standard culvert outflow structure in a sedimentation basin. The technical note reported on investigation conducted by Jarrett (1996) which showed that surrounding a perforated riser with a gravel jacket or a geofabric layer can significantly improve the capture efficiency of the sedimentation basin. A floating skimmer like that shown in Figure 10.10 was found to promote the highest trapping efficiency amongst the outlet types tested by Jarrett (1996). Various variations of the skimmer design have been used in Australian practice, particular one involving a horizontal perforated pipe at the end of the "floating arm" to allow higher discharge rates through the skimmer.

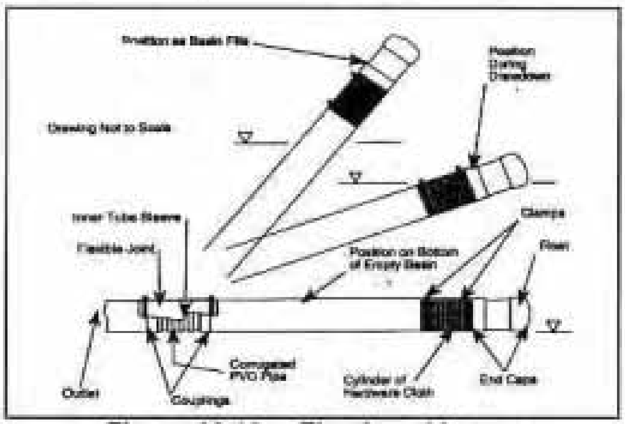

Figure 10.10 Floating skimmer

The operation of the skimmer is such that prior to a storm event, the skimmer pipe rests on the floor of the sediment basin. During the early stages of the storm, the inlet holes of the skimmer restrict the discharge, causing the sediment basin to inundate and the skimmer to rise. Sediment laden inflow thus flows into a permanent pool system but with water being continually skimmed from the surface. This promotes a significantly higher rate of sediment capture. The skimmer allows the basin to dry out completely in between storms and thus assist in the maintenance of sediment basins.

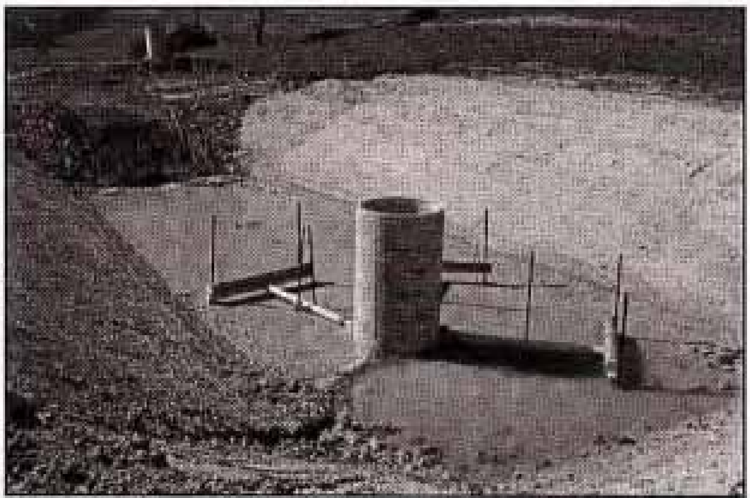

Figure 10.10 Floating skimmer system used in a sedimentation basin. The skimming system consists of three PVC T-pipes mounted on floats.

Figure 10.10 shows a modification to the skimmer system proposed by Jarrett (1996) commonly used in Australia. The skimming unit consists of a two PVC pipes attached as a T-section. Holes are drilled along the long axis of the pipe at the end of the T-section. This pipe is attached to a third pipe which is sealed and acts as a float for the T-section. Metal star-pickets are used to vertically guide the floating skimmer.

10.5.2.5 Project Management and Planning

As is the case in dust control, fundamental to good practice is proper planning and management of the construction project in terms of the day-to-day activities and site management at the micro-level to minimise the impact of these activities on the environment. These would include such measures as management of construction vehicles in exposed areas during and following wet weather, maintenance of temporary roads, work scheduling, and surveillance and maintenance of temporary works. Most of these measures have been discussed earlier.

The proper control of construction traffic is significant, particularly those of sub-contractors, to designated haul roads. Limiting vehicle access and speed during and following wet weather is also seen as a positive management option in reducing erosion from exposed sites. Maintenance of haul roads and continual re-grading of these roads to ensure that water flows off these roads rather than forming puddles are also important maintenance measures for erosion control.

Measures such as sediment weirs and rock check dams can be used for runoff retention along gullies and minor drainage lines but have a limited ability to trap sediment. These measures may be used in addition to sediment retention basins.

Infiltration trenches can be used during the construction phase of a project but are generally used as a permanent structure for the retention and filtration of runoff. They are often considered as a complimentary measure of sediment retention basins.

10.6 SUMMARY

Over the past decade, the community has become increasingly aware of the need to protect the environment from the onset of construction activities through to the day to day use of the facility in order to achieve ecologically sustainable development. Construction activities invariably lead to disturbance of the landscape with dust control and runoff and erosion control leading to significant reduction of sediment and silt being transported into receiving waters. The wider community now demands that proper environmental precautions be taken to mitigate these impacts and an environmental site work plan is now an essential part of construction activities.

For successful environmental outcomes to be achieved a clear and concise site work plan must be formulated before the commencement of construction activities so that all involved in the project understand the environmental constraints at the site in question. In formulating an environmental management plan, best practices must include consideration of site problems that may lead to inherently higher levels of risk associated with environmental impacts. Appropriate structural pollution control measures must be selected carefully and performance feedback and rapid response to perceived inadequacies become major elements in a system approach to environmental management.

CHAPTER 11

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