Guidebook for Best Environmental Practices

water resource management at LTA sites

Land Transport Authority

OWNER'S PARTICULARS

Name: _____

Designation: _____

Company: _____

Contract No: _____

Contact No: _____

Published by the Land Transport Authority

Enquiries can be directed to LTA Safety Division

Land Transport Authority

ACKNOWLEDGEMENT

The Land Transport Authority (LTA) would like to thank the Public Utilities Board (PUB) for their invaluable contribution and support in producing this guidebook.

The LTA would also like to thank Dr. Chew (Assistant Professor, Department of Civil and Environmental Engineering, National University of Singapore) for his advice on the contents of the guidebook.

Special thanks also go out to all staff who have provided feedbacks and suggestions and to those who have helped in one way or another.

Lastly, we would like to thank our contractors for their continued support and efforts in maintaining environmentally friendly sites.

Land Transport Authority

ENVIRONMENTAL POLICY STATEMENT

LTA is committed to nurture its staff to care and protect our environment. We incorporate environmental protection in our strategic decisions and conduct our business in a manner that balances the environmental and economic needs of the communities in which we operate.

We will:

- Comply fully with all relevant environmental legislation and regulations and meet or exceed good environmental practices;
- Work with our partners i.e., transport operators, contractors, suppliers, interest groups and other government agencies in a concerted effort to operate in an environmentally responsible manner;
- Create a cleaner and greener environment by making continuous efforts to be energy-efficient and to practice Reduce, Reuse and Recycle; and
- Monitor, evaluate and continually improve our environmental management practices to ensure efficient use of the limited resources.

Chew Hock Yong
Chief Executive

Date: 1 September 2010

FOREWORD

Under the Active, Beautiful and Clean Waters (ABC Waters) programme, PUB, the national water agency, seeks to transform the network of 17 reservoirs, 32 major rivers and more than 7,000 km of drains into scenic water fronts and recreation options for all to enjoy.

However, sustaining clean and clear waterways/bodies also depends very much on the public and the business community to play their parts. For example, while the waterways are clear most of the time, they will turn murky when it rains due to silt from exposed earth surfaces. Silt discharged into waterways increases water treatment cost as well as the risk of flood as it reduces the conveyance capacity of the drain.

Construction site is one of the major sources of silt.

This guidebook on Water Resource Management at construction sites provides best management practices contractors can adopt to prevent their site from becoming sources of water pollution. It emphasizes the importance of proper earth control measures to prevent silt and also gives contractors tips on how water can be conserved through site reuse and recycling.

FOREWORD

I congratulate LTA for this effort in engaging its construction partners to do their part in protecting our precious water resources. I hope all LTA contractors will apply these practices consistently and also cascade them to all their staff, so that all of us can play a part, in sustaining our water resources making our water bodies and waterways active, beautiful and clean at all times.

Yap Kheng Guan

Senior Director
Public Utilities Board

CONTENTS

Chapter 1
Introduction

Control of water discharge from construction sites is critical especially in a water scarce city such as Singapore. Today, two-thirds of Singapore's land area is already used to collect rain for our water supply and Singapore's water demand is expected to double in the next 50 years.

Blue map of Singapore 2011
(Source: http://www.pub.gov.sg/water/Pages/LocalCatchment.aspx)

As LTA continue to deliver our Land Transport Master Plan (LTMP), there is increasing number of projects situated near waterways. To help in ensuring a sustainable supply of clean water for everyone, it is therefore vital for construction sites in LTA projects to adopt a holistic management of water resources that helps prevent water pollution and conserve water resources.

Chapter 1
Introduction

Enhancing water resource management is beneficial for any construction site.

The benefits of effective water resource management are significant:

- Improved environmental performance will result in an improved environmental profile – this will help to ensure that projects are run smoothly and delivered timely.
- Less money lost through wasted water resources – Reusing and recycling water on site reduce the demand of potable water from PUB mains hence contributing to less utility bills.
- Reduce damage to water bodies - Construction activities if not properly planned, not only cause serious harm to water bodies, plants and wildlife, they can also affect the quality of drinking water resources and making them visually unattractive.
- Avoidance of fines.
- Less time and money spent on cleaning up.

Chapter 1
Introduction

Effective water resource management can be established at construction sites by integrating the 4-steps approach:

Step 1 outlines the legislation and other regulatory requirements that relates to the control of water pollution on site. This will be covered in Chapter 2.

Step 2 reviews how construction activities can result in water pollution and identifies how best management practices can help to prevent them from occurring. See Chapter 3, 4, 5, 6 and 7.

Step 3 provides recommendations on how water can be re-used and recycled at construction sites to reduce demand on potable water. This will be covered in Chapter 8.

Step 4 highlights different ways of effective communication and emphasizes the importance of awareness to prevent ignorance and complacency of workers. See Chapter 9.

STEP 1

MEETING REGULATORY REQUIREMENTS

Land Transport Authority

Chapter 2
Regulatory Requirements

2.1 Overview

This chapter highlights the salient requirements of water pollution control at LTA construction sites and should be read in conjunction with the following regulatory requirements:

- The Sewerage and Drainage Act
- Environmental Protection and Management Act
- Sewerage and Drainage (Surface Water Drainage) Regulations
- Code of Practice on Pollution Control
- Code of Practice on Surface Water Drainage
- LTA Contractual Requirements

- Protection of Storm Water Drainage System
- Earth Control Measures
- Hydrocarbon and Chemicals

2.2 Protection of Storm Water Drainage Systems

1. Storm water drainage system not to be constructed or altered without Board's certificate or approval

No person shall construct, alter, discontinue or close up any storm water drainage system or drain without obtaining approval from the Public Utilities Board (PUB).

2. Drainage inlets such as drop-inlet chambers and scupper drains shall not be blocked by any material or debris

3. Prohibition on extraction of water

No person shall, without the approval of the Board, construct any works for taking or intercepting water from any place or sea, within the territorial limits of Singapore.

Chapter 2
Regulatory Requirements

2.2 Protection of Storm Water Drainage Systems

4. Drains and drainage reserves not to be interfered with

No person shall –

a) erect or place any structure or object in, above or across any drain;

b) cause any obstruction to the flow of any storm water drainage system; or

c) erect, construct or lay within any drainage reserve any fence, retaining wall, foundation, manhole, pipe, cable mains or any obstruction or structure (whether temporary or permanent), without the approval of the PUB.

2.3 Earth Control Measures

1. Minimal or no discharge

A construction / earthwork site should practise recycling of water. The recycled water could be used for non-potable purposes in order to minimise discharge into the storm water drainage systems.

2. Prohibition of discharge of silt, etc., into storm water drainage system

No person shall discharge or cause or permit the discharge into the storm water drainage system of Total Suspended Solids in concentration greater than 50mg/L of the discharge.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

Every person carrying out earthworks or construction works shall comply with the Code of Practice on Surface Water Drainage and in particular with the following requirements:

- earth control measures shall be provided and maintained in accordance with the Code of Practice;
- runoff within, upstream of and adjacent to the work site shall be effectively drained away without causing flooding within or in the vicinity of the work site;
- all earth slopes shall be set outside a drainage reserve;
- all earth slopes adjacent to any drain shall be closely turfed; and
- adequate measures shall be taken to prevent any earth sand, topsoil, concrete, debris or any other material to fall or be washed into the storm water drainage system from the stockpile thereof.

2.3 Earth Control Measures

3. Material from any stockpile shall not be allowed to fall or be washed into the drain.

Adequate preventive measures, including the provision of proper and stable barricades or screens where necessary shall be provided.

4. Permit to start earthworks

The site operator / contractor shall obtain a written permission (or a clearance certificate) from PUB before the commencement of any earthwork.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

5. Submission of ECM proposal before commencement of works

Before commencement of works, the site operator / owner shall engage a Qualified Erosion Control Professional (QECP) to plan and design a system of earth control measures (ECM) to meet the requirements of TSS in concentrations not greater than 50 mg/L of the discharge.

The ECM plan and design, endorsed by the QECP, shall also be submitted 4 weeks after the award of Contract to PUB. Prior to the submission to PUB, the Contractor shall submit the said plan to the Engineer (LTA) for review.

2.3 Earth Control Measures

6. Design criteria of ECM

The ECM shall be designed to cope with a minimum design rainfall intensity of a return period of 1 in 2 years storm.

7. ECM to be installed before commencement of work

The ECM shall be installed by the site operator / contractor according to the endorsed plans and the completed ECM at site shall be approved by the QECP before commencement of construction and earthworks.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

8. Erosion Control Measures

The erosion control measures shall minimise the extent and duration of any exposed / bare / erodible surfaces by:

a) Proper work sequencing – Adopting proper construction staging and work sequencing will help to ensure that no large bare / erodible surfaces are exposed for a long duration of time.

b) Covering up of all bare / erodible surfaces – All bare surfaces (including earth stockpiles) shall be by concrete-lining, concrete-paving, milled waste, erosion control blankets, close turfing or other suitable materials. Accesses within the site and at exit / entrance as well as the surfaces where site facilities (such as office, fabrication and storage yards) shall be paved. For those work areas, they shall be covered by canvas sheets, tarpaulin sheeting or other suitable materials during rains or before work ends every day.

2.3 Earth Control Measures

c) Progressive and timely revegetation and stabilisation – this is to ensure that all bare surfaces are restored immediately upon completion of work at every stage.

If a construction site has very little bare / erodible surfaces, the operator / contractor will have less difficulty in containing and treating the silty discharges. For those areas within a construction site which have been paved / covered that will not cause silty discharge, it is possible to drain these areas directly into the storm water drainage system without treatment.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

9. Sediment Control Measures

The sediment control measures shall trap, contain and treat the silty discharges from within a construction / earthworks site (including rain, runoff, water from washbay, underground water at basement, etc) by providing:

a) Perimeter cut-off drain – Perimeter cut-off drains shall be concrete-lined (minimum C7 precast channel) and adequate to capture all runoff from the site to prevent overflow onto adjacent properties.

b) Perimeter silt fence – Silt fences shall be erected along the perimeter cut-off drain (between the construction site and perimeter cut-off drain). The silt fence is to be embedded firmly into the ground and made from an approved geotextile filter fabric or equivalents to capture the sediment from storm water runoff. The sediment built-up behind the silt fence must be cleared regularly.

2.3 Earth Control Measures

c) Intermediate silt trap – Intermediate silt traps of suitable size shall be installed at regular intervals along the perimeter lined cut-off drain. Within the intermediate silt traps, suitable geotextile filter fabric or equivalents shall be installed across the full depth and width and / or coagulation-assistance materials shall be placed. Silt traps relying primarily on hardcore, granite chips or sands for filtration, are not acceptable.

d) Sedimentation basin or storage pond / tank – Before silty discharge leaves the site, the silt and sediments shall be separated from the water. This can be achieved by either:

(i) In a sedimentation basin / pond (which will take days for settlement to take place and a large basin volume), or

(ii) Through a treatment system-cum-storage tank.

The basin / tank shall have a storage capacity to cope with the volume of water from a rain based on a minimum design return period of 1 in 2 years storm.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

e) Treatment system – If the design of a sedimentation basin cannot meet the TSS requirement, then other suitably-sized treatment system shall be installed to treat all silty discharge from construction and earthwork sites. The treated effluent could be recycled for non-potable use.

f) Turbidity curtains – For works in or adjacent to water bodies, such as canals, rivers, sea or in a reclamation work, turbidity curtain(s) shall be installed along all the exposed slopes / riverbanks. The silty discharge trapped within the turbidity curtain shall be allowed to be settled or treated, and the settled silt removed.

2.3 Earth Control Measures

g) Wheel wash – the water used to wash the wheels of the trucks / vehicles shall not be discharged into storm water drainage system at any time. The silty water within the wheel wash basin shall be connected to the sedimentation basin / treatment system.The silt collected at the bottom of the wheel wash shall be removed.

Chapter 2
Regulatory Requirements

2.3 Earth Control Measures

10. Review of ECM during contract duration

The site operator / contractor shall ensure that the ECM designed and installed shall be continuously reviewed by the QECP for every stage of the construction and earthworks. The ECM shall remain effective throughout the whole duration of works. The site operator / contractor shall add or amend the ECM at site according to the design of the QECP.

The contractor shall engage the QECP to conduct site inspection at least once a month to ensure that the ECM installed remains relevant and effective. The QECP shall provide an inspection report highlighting his observations, degree of compliance and recommended actions to be taken. The contractor shall improve or rectify the ECM accordingly.

2.3 Earth Control Measures

11. Maintenance of ECM during contract duration

The site operator / contractors shall operate and maintain the ECM regularly to ensure the ECM remains effective throughout the whole duration of works. Proper records detailing the maintenance works, supported by dated photographs, shall be kept by the contractor for verification.

12. Monitoring of discharge during contract duration

The contractor shall install a turbidity and TSS monitoring device for continuous monitoring of the TSS and turbidity of the discharge into the storm water drainage system. The contractor shall submit a report on the weekly TSS and turbidity levels to the Engineer (LTA) and to the PUB once every 2 weeks as required by the legislation.

13. Removal upon completion

The ECM shall not be removed before the completion of work. The site operator / owner shall inform PUB prior to removal of the ECM on completion of the project.

Chapter 2
Regulatory Requirements

2.4 Hydrocarbon and Chemicals

1. License for discharge of trade effluent, oil, chemical sewerage or other polluting matters

Any person who discharges or causes or permits to be discharged any trade effluent, oil, chemical, sewerage or other polluting matters into any drain or land, without a license from the Director-General (NEA), shall be guilty of an offence.

In the event of such occurrences, the Director-General shall be immediately informed.

2.4 Hydrocarbon and Chemicals

2. Specific requirements for chemical / oil store

A chemical / oil store shall be provided with facilities to contain any leak and spillage. Such an area shall not have any outlet / opening leading to a storm water drain or a sewer. All leaks and spillage shall be collected for proper disposal as toxic industrial wastes.

3. Specific requirements for chemical / oil bulk storage tanks

- Diesel drums and chemicals shall be stored under shelter within concrete bund walls or in storage containers with good ventilation. Drip trays shall be provided for all drums, plants and machinery and potentially pollutive substances used on site. Drip trays shall be regularly maintained to prevent rain from washing out the pollutive substances.
- All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge.

Chapter 2
Regulatory Requirements

2.4 Hydrocarbon and Chemicals

- For an elevated storage tank, the secondary containment facility shall be provided with measures to contain a shooting jet of chemical / oil escaping from a rupture in the tank.
- They shall stand within a bund constructed to contain a volume of 110% of the volume of the tank.
- There should be no breaches in the bund wall and the inner face of the bund wall shall be coated with a chemical resistant material.
- Rain water collecting in the bund shall be regularly removed to prevent build up. A chemical resistant valve, closed at all times, except when releasing rainwater into a storm water drain via an oil intercepting system, shall be installed at the outlet situated outside the bund.

2.4 Hydrocarbon and Chemicals

4. All activities involving repair, servicing, engine overhaul works etc. shall be carried out on a concreted area which shall be bunded or provided with scupper drains to channel all wastewater into the sewerage system. Oil removers / interceptors shall be provided to treat oil waste from workshop areas.

5. Spillage response

- Any spillages of diesel shall straight away be absorbed using sand or other absorbent materials, which shall be disposed of as contaminated waste. On no occasion should diesel be allowed to enter the site drainage system unless it is connected to an interceptor prior to the site.

This page is intended to be left blank.

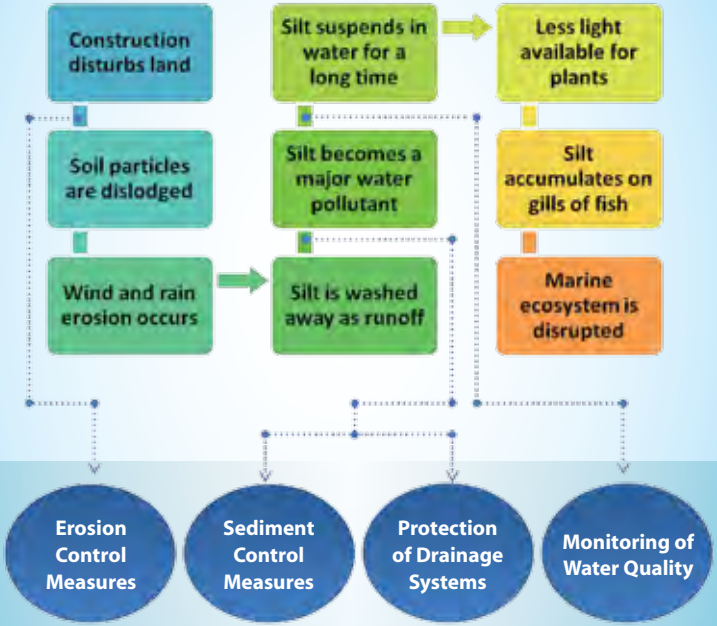
STEP 2

POLLUTION PREVENTION

Land Transport Authority

Chapter 3
Silt and Sediment

3.1 Overview



MITIGATION MEASURES

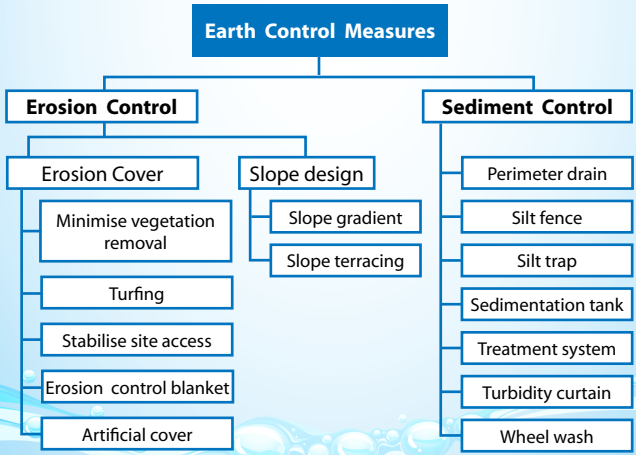
3.2 Earth Control Measures

An effective earth control measure (ECM) must comprise 2 aspects:

(a) Erosion Control – to minimise erosion from bare earth surface

(b) Sediment Control – to contain, store and treat silt sediments

Less erosion means less sediment in runoff water. Therefore, reducing the amount of sediment in runoff water means there will be fewer pollutants carried downstream from their sources.



Chapter 3
Silt and Sediment

3.3 Erosion Control

Erosion Control should be the primary treatment for effective earth control on site. It focuses on minimizing bare earth surfaces and slopes.

Type of Erosion Control should be implemented in order of merit as illustrated:

Section	Type of Erosion Control
3.3.1	Minimise vegetation removal
3.3.2	Turfing
3.3.3	Stabilise site access
3.3.4	Erosion control blanket
3.3.5	Alternative covers
3.3.6	Considerations in slope design
3.3.7	Slope gradient

3.3.1 Minimise Vegetation Removal

Vegetation removal can be minimised by proper management of construction. This is done by scheduling construction works in phases.

Sequencing of Construction Activities

Do(s)

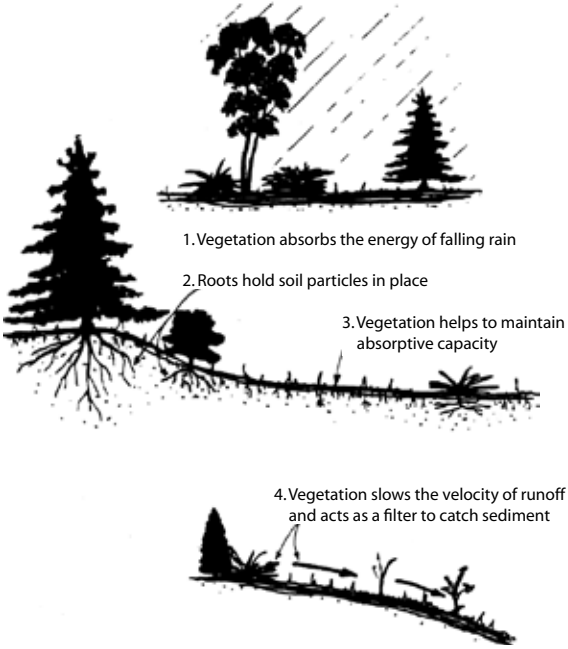
- ☑ Carry out construction activities at the designated area first. Then, move on to the next few parcel.
- ☑ Stabilise bare area before construction.
- ☑ Carry out construction activities only after installation of earth control measures.

Don't(s)

- ☒ Strip vegetation out of entire land at start of work.
- ☒ No proper scheduling of earthworks in stages.

Chapter 3
Silt and Sediment

Benefits of Vegetation



(Source: USEPA Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices)

C911: Construction works are carefully planned and sequenced to minimise removal of existing vegetation hence reducing soil disturbance activities. Exposed area is turfed back after use to prevent erosion of slope.

3.3.1 Minimise Vegetation Removal

Application

- Retain as much vegetation as possible, especially along the perimeter of the site and at sensitive areas such as slopes.

Maintenance

- Ensure equipments, construction materials, topsoil and fill dirt are kept outside the vegetated areas.
- Inspect for damaged vegetation. If damaged, replant vegetation immediately to maintain the integrity of the natural system.

Limitations

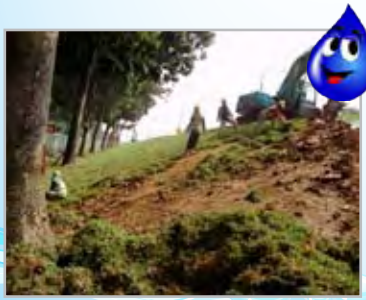
- Limited by the extent of existing vegetation in preconstruction conditions.
- Requires advance planning to preserve and maintain existing vegetation.

3.3.2 Turfing

Turfing is used to control runoff and erosion on disturbed areas by establishing perennial vegetative cover from seed. It reduces erosion and provides permanent stabilization.

The most common tropical grass used in Singapore is B*rachiaria Decumbens*.

C911: Grass is turfed on bare areas that have no work activities.



ER286: Workers turfing bare surfaces after completion of works.

3.3.2 Turfing

Application

- Prepare the soil on disturbed site to provide sufficient nutrients for seed germination and seedling growth.
- Sow seeds no deeper than 1cm using approximately 2 – 5kg of seeds per hectare.
- Protect the seeds using erosion control blanket to retain moisture, regulate soil temperatures and prevent erosion during seedling establishment.
- Water the grass during hot and dry days.

Maintenance

- Inspect seeded areas for failure and, if needed, reseed and repair them as soon as possible.

Limitations

- Turfing does not immediately stabilise soils, therefore use temporary erosion and sediment control measures to prevent silty surface runoff.

3.3.3 Stabilise Site Access

PAVING

Paving is a common way to stabilise disturbed areas for vehicular and site access. This can be done by layering the exposed surface with concrete or milled waste.

Unstabilised entrance creates more erosion and leads to heavily soiled vehicles.

C1590: Paving of vehicular access using concrete such that there is no soil surface exposed. It is very durable for use as vehicular access.

3.3.3 Stabilise Site Access

Milled waste is a recycled waste product that comprises graded aggregate and bitumen. It is more economical and environmentally friendly to use milled waste for paving compared to concrete.

Degradation of milled waste caused by excessive vehicular movements. If it is not maintained, access path becomes unstabilised.

ER286: Soil is compacted and layered with milled waste to provide stabilised construction routes.

3.3.3 Stabilise Site Access

USING STEEL PLATES

Layering of steel plates has to be done neatly and carefully to prevent gaps or overlaps which will in turn allow rainwater to seep through and reduce its effectiveness.

C917: Steel plates are aligned neatly to one another. Sufficient maintenance of steel plates is provided.

Steel plates should only be used for manageable areas such as site access. For large exposed surfaces, paving using concrete or milled waste should be considered instead.

3.3.3 Stabilise Site Access

Application

- Pave bare areas as soon as land is cleared and before construction activities begin. This is especially recommended for construction access, entrance to site, vehicular routes and areas designated for equipment parking.

Maintenance

- Silt and sediment accumulated at site access path should be cleared regularly by workers.

Concrete	• Inspect for possible wear and tear. Reapply once soil is exposed.
Milled waste	• Inspect for degradation. If degraded, reapply layer.
Steel plates	• Ensure plates are aligned tightly to one another. • Inspect for movement of plates. Plate should be properly aligned to ensure that there are no overlaps and gaps.

3.3.4 Erosion Control Blanket

Erosion control blanket (ECB) is used best complemented with turfing. This helps in slope stabilisation by:

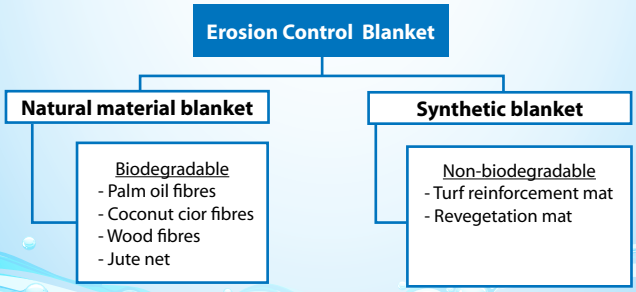
1) Having a more permeable surface to the oncoming sheet flow, thus facilitating infiltration

2) Cushioning rain and wind impact on the slope

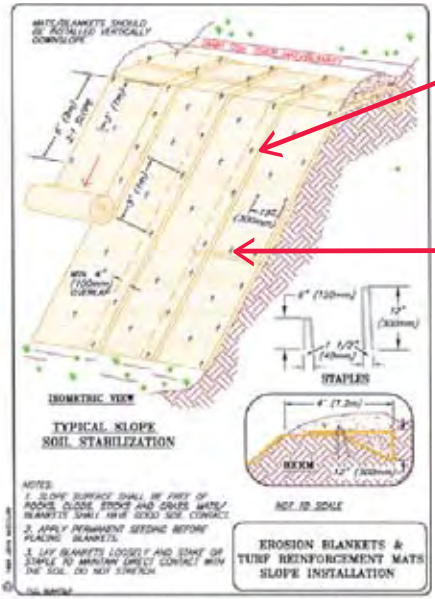
3) Retaining moisture in soil and enhancing plant growth

4) Reinforcing root system and reducing soil migration

There are many different types of ECB, some are made of natural material while others are synthetic material.



Proper techniques for installation of ECB



Overlap blankets top over bottom layer at least 150mm.

Ensure blanket is secured along entire slope with staples and pins.

(Source: http://www.urbancreeks.org/Homeowner_Resources.html)

3.3.4 Erosion Control Blanket

C918: ECB is anchored properly along slopes.

C911: ECB is used for steep slope protection.

3.3.4 Erosion Control Blanket

Application

- Anchor ECB properly to ensure that it will not be undermined by storm.
- Overlap top over bottom material to prevent zone of bare surfaces.
- Use sufficient number of staples to maintain good contact with soil and material.

Maintenance

- Inspect blanket regularly for cracks and tears. If torn, replace with new ones.
- Ensure that the contact between ground and blanket is maintained at all times.
- Use additional staples to anchor the material so that the ECB will not be dislodged by strong wind or heavy rain.

Limitations

- ECB is sensitive to light and will degrade overtime under sunlight. It should be kept in dark places prior to installation.
- The slope must be uniform and relatively smooth before installation to ensure complete contact with the soil.

3.3.5 Alternative Covers

Other alternative covers that can be used on site include canvas sheet and hardcore. They should only be considered when all other options for erosion control are not feasible.

Insufficient canvas used to cover stockpile making it susceptible to erosion by wind and rain.

ER217: Stones and sand bags at close intervals are used to ensure canvas sheets have firm contact with ground.

3.3.5 Alternative Covers

CANVAS SHEET

Application

- Anchor canvas sheet firmly into the ground by folding the edges of canvas sheet inward before stapling it down.
- Overlap material to prevent zone of bare surfaces and ensure that canvas cover entire targeted surface area.
- Use sufficient number of staples or pins to maintain good contact with soil and material.

Maintenance

- Inspect sheet regularly and after every rain event for tears. Change to a new sheet when torn.
- Ensure firm contact between ground and sheet.

3.3.5 Alternative Covers

CANVAS SHEET

Limitations

- Canvas sheet is not as effective as erosion control blanket, especially on slopes, as the gap between the blanket and soil may form a drainage channel.
- Canvas sheet can be easily blown away by wind or washed off by rain, if not properly installed.
- It should only be considered as a temporary measure as it is not durable.

3.3.5 Alternative Covers

HARDCORE

Application

- Layer bare earth with a compact and thick layer of hardcore.

Maintenance

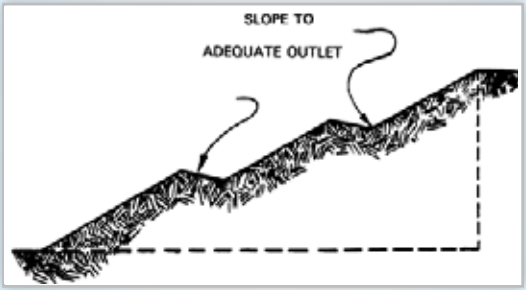
- Inspect for accumulated sediment.

Limitations

- Only effective for gentle rain.
- Difficult to maintain once coated with soil.
- Easily displaced by heavy vehicles.

3.3.6 Slope Gradient / Slope Terracing

Gradient terraces are earth embankment or ridge-and-channels constructed along the face of slope at regular intervals. They reduce erosion damage by capturing surface runoff and directing it to a stable outlet at a lower velocity.



C854: Gradient terraces used for long steep slopes.

3.3.6 Slope Gradient / Slope Terracing

Application

- For use on long steep slopes.

Maintenance

- Inspect terraces regularly and after major storms.
- Ensure outlets of terraces are not eroded by runoff through the scouring effect. If eroded, protect outlets with paved section, hardcore or gravels.

Limitations

- They cannot be constructed on slopes of sandy or rocky soils.
- They are effective only where suitable runoff outlets are available.

3.4 Sediment Control

Sediment control measures are secondary measures implemented to trap soil particles after they have been detached by wind or water.

They are usually passive systems that rely on filtering or settling the particles out of the water.

Depending on the nature of works, elements of a Sediment Control System may contain some of the following:

Section	Type of Sediment Control
3.4.1	Perimeter drain
3.4.2	Silt fence
3.4.3	Silt trap
3.4.4	Sedimentation basin or storage pond / tank
3.4.5	Treatment system
3.4.6	Turbidity curtains
3.4.7	Wheel wash

3.4.1 Perimeter Drain

Perimeter drains are designed to contain silty water runoff and to prevent it from flowing out of the site boundary.

Earth drains are strictly not allowed on site. They need to be concrete lined.

Perimeter drains that are not maintained will cause obstruction resulting in upstream flooding.

3.4.1 Perimeter Drain

C911: Perimeter drains provided should be at least C7 precast channel to prevent overflow.

C485: Perimeter drains are concrete lined and well maintained by workers.

Maintenance

- Inspect perimeter drains regularly and after every rain event.
- Clear sediment and debris to ensure free flow.
- Inspect for sufficient gradient to ensure continuous flow of water.

3.4.2 Silt Fence

Silt fence are installed along perimeter drains or around interior of the sites to prevent soil from getting into drains.

Silt fence is not embedded into the soil. The use of sandbags to hold down silt fence will result in gaps between fence and ground hence making it ineffective.

Silt fence should be maintained regularly to ensure that it is upright standing.

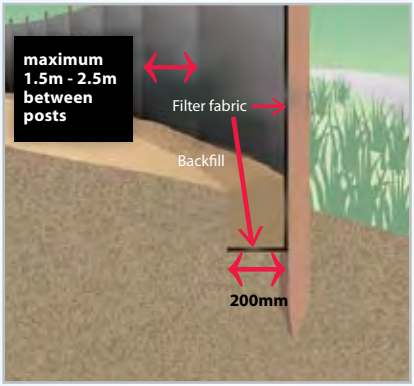
3.4.2 Silt fence

The integrity of the silt fence should not be tempered with. Cutting slits at the silt fence renders it ineffective.

Silt fence that is not embedded into the soil at all is not effective.

3.4.2 Silt Fence

Proper techniques for installation of silt fence



- Cut a trench and embed the silt fence at least 200mm into the ground for firm anchoring.
- Compact the trench with soil.
- Drive stakes adequately deep to provide the lateral resistance.
- If a continuous roll of fabric is not available, overlap the fabric from both directions only at stakes. Overlap at least 150 mm.

3.4.2 Silt Fence

C852A: Silt fence is firmly embedded into the soil.

C911: A multiple silt fence system allows more filtration of silty runoff and helps to dissipate velocity of flow.

3.4.2 Silt Fence

Maintenance

- Inspect weekly and after every rain event. If damaged, repair or replace silt fence.
- Remove sediment when it reaches 1/3 the height of fence.

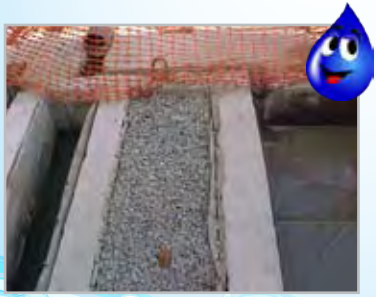
Limitations

- Silt fence disintegrates under prolonged exposure to ultraviolet light.
- It cannot be placed on slope or across any contour line.
- It cannot be installed in locations where ponded water may cause flooding.
- It cannot be installed in channels or places where flow is concentrated.

3.4.3 Silt Trap

An effective silt trap comprises both suitable stone aggregates and geotextile. When installed in perimeter drains, the stone aggregates reduce velocity of runoff while the geotextile helps to filter away soil particles.

The large stones in the silt trap and lack of geotextile layers compromises the effectiveness of the silt trap.



Good screening of silt by geotextile and stone aggregates.

3.4.3 Silt Trap

Application

- They should be installed at regular intervals along the perimeter lined cut-off drain.
- Suitably sized clean aggregates of diameter 25 – 50mm should be used.

Maintenance

- Inspect during and after a rain event to ensure proper drainage.
- Replace geotextile when heavily soiled or damaged.
- Remove sediment once it reaches ¼ of total volume.

Limitations

- Sharp aggregates should be avoided as they tend to damage geotextile.
- It should be adequately designed to prevent chokage of perimeter drains.

3.4.2 Sedimentation Basin or Storage Pond / Tank

Sedimentation basin or storage pond / tank is constructed to retain runoff for sediment to settle. As it can only facilitate the settling of heavy particles, effluent from sedimentation tank is channeled to the treatment plant before final discharge.

Debris and algae growth indicates lack of maintenance of sedimentation tank. Proper maintenance is required for sedimentation tank to function properly.

Sedimentation pond should be fully lined. Earth ponds contribute to more sediment in the water.

3.4.2 Sedimentation Basin or Storage Pond / Tank

Sedimentation tank is under designed for high flow of influent resulting in insufficient time for particles to settle.

Water inside sedimentation tank should be treated and discharged on dry weather to cater for sufficient containment during rainfall event.

3.4.2 Sedimentation Basin or Storage Pond / Tank

C911: Use of concrete-lined ponds as sedimentation basins. Additional feature of filter fabric curtain helps to contain high concentrated flow and filter sediments.

ER198: Regular maintenance of sedimentation tank for optimal results.

3.4.2 Sedimentation Basin or Storage Pond / Tank

Application

- Flocculants can be added to sedimentation basin / tank to increase the settling rate of suspended sediment .
- Baffles can be added to increase flow length hence improve efficiency.

Maintenance

- Remove sediment once it reaches ½ of total volume.

Limitations

- Water should not be retained more than 48 hours due to mosquito breeding potential.
- Limited effectiveness for sites with fine-grained soil such as silt and clay due to long settling time required.

3.4.5 Treatment System

There are various types of treatment systems to ensure that sediment laden water is treated to satisfy the legislative requirement of not more than 50 mg/L of TSS before its final discharge into storm water drainage.

1. Using Chemicals – To help in coagulation to form larger particles
2. Using Membranes – To filter out particles
3. Using Centrifugal force – To separate solid from water

Comparison of three methods

	Chemicals	Membranes	Centrifuge
Flow rate capacity	• Slow	• Very slow	• Fast
Total volume capacity	• Range from low to high • 10 m^3/h to 100 m^3/h	• Low • 20 m^3/h	• High • Up to 300 m^3/h
Life span	• 6 – 10 years	• 1.5 – 2 years	• 6 – 10 years
Suitable incoming TSS range	• 100 to 40,000 mg/L	• < 3000 mg/L	• ≥ 10,000 mg/L

Chapter 3
Silt and Sediment

C920: Example of chemical treatment system

C902: Example of membrane treatment system

C911: Example of centrifuge treatment system

3.4.5 Treatment System

The treatment system should be complemented with a CCTV and a continuous, real-time, "live" monitoring of TSS levels for every final discharge point. This system should also consist of an "alert" feature when allowable limits are exceeded.

3.4.5 Treatment System

Features of the treatment system should include:

(1) "Live" monitoring of TSS on site

(2) Real-time,"live" monitoring of TSS for every discharge point made accessible on website

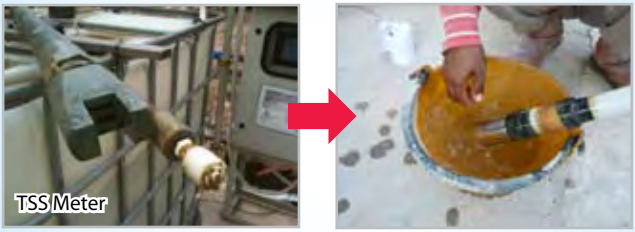
(3) Continuous, real-time, "live" monitoring of TSS at single discharge point made accessible on website

(4) "Alert" feature via SMS when TSS value exceeds allowable limits

3.4.5 Treatment System

Maintenance

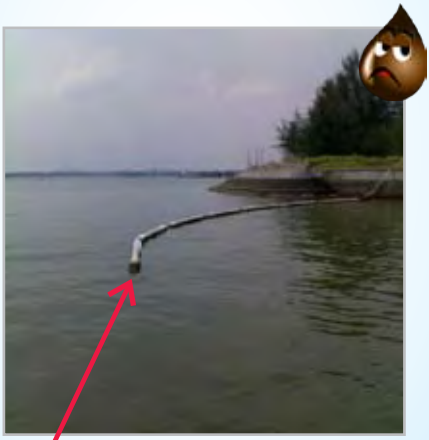
- The TSS meter should be cleaned at least once a week to get rid of accumulated sediment and ensure accurate reading of TSS of discharge.



- A detailed maintenance checklist of the water treatment plant should be requested from the supplier upon purchase / rental as the maintenance varies with model of treatment plant.

3.4.6 Turbidity curtains

Turbidity curtains allow suspended sediment to settle out in water by providing a controlled area of containment. This helps to reduce the impact of sediment laden water from spreading and damaging sensitive water bodies.



A turbidity curtain that has been dislodged by strong waves and wind makes it ineffective for use .

3.4.6 Turbidity Curtains

Guidelines for selection of turbidity curtains

1. Site Survey

Before selecting a curtain for a particular project, it is necessary to do a site survey of the following parameters.

Parameters	Remarks
1. Type of water body	• Calm lake / canal • Moving river / stream • Near shore ocean
2. Velocity of current	To determine tensile strength of material required
3. Water depth	To determine depth of curtain required
4. Wave height	To find out tidal range and determine depth of curtain accordingly
5. Bottom sediment types	To determine type of anchors to use

3.4.6 Turbidity Curtains

2. Specifications of Turbidity Curtains

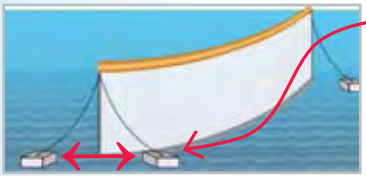
Turbidity curtains should be made of high strength polyester synthetic fiber (or equivalent). It should be easy to clean and resistant to marine growth, ultraviolet light and mildew. Depending on site conditions, the tensile strength of material should also be considered.

Type of site condition	Recommended tensile strength
• Calm lake / canal • Wave height: 0.5m or less • Velocity of current: 0.07m/s or less	100 kN/m
• Moving river/ stream • Wave height: 1.0m or less • Velocity of current: 0.2m/s or less	150 kN/m
• Near shore ocean • Wave height: 1.5m or less • Velocity of current: 0.5m/s or less	200 kN/m

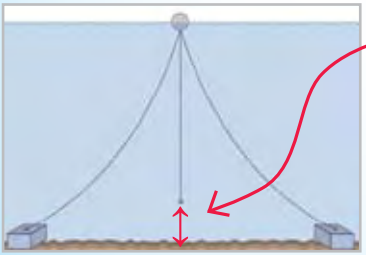
3.4.6 Turbidity curtains

Proper techniques for installation of turbidity curtains

Turbidity curtains should be oriented parallel to the directions of flow.



The curtains should be held in anchors placed at not more 30m apart on both sides.



The gap depends on calm-water condition, wave height, tidal and current velocity, etc.

(Source: http://siltcurtain.asia)

Chapter 3
Silt and Sediment

3.4.6 Turbidity curtains

C156: Turbidity curtain provides an area of containment and prevents sediment laden water from spreading into water bodies.

C485: For works near the Marina Barrage, turbidity curtain is installed as a last line of defence after discharged water is treated from the treatment plant.

3.4.6 Turbidity Curtains

Application

- To contain and control the dispersion of turbid water generated in dredging and works on the seas or rivers.

Maintenance

- Inspect regularly to ensure that the curtains maintain their integrity. If there is a tear, repair it immediately to prevent point of weakness.
- Inspect for visible plume of cloudy water passing beyond the curtain from the enclosed construction area. If any, modify or repair the turbidity curtain to correct inadequate performance.

Limitations

- Allow sediment to settle for 6 – 12 hours prior to removal of the curtain.
- Effective for water with velocity of current not exceeding 0.5m/s.
- Turbidity curtains are secondary measures and should only be used as a last line of defence together with other erosion and sediment controls.

3.4.7 Wheel Wash

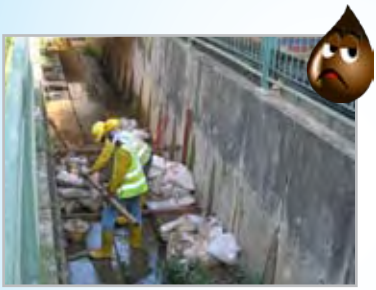
Wheel wash is installed at the egress of construction sites to clean soiled vehicles so that they do not litter or leave vehicular tracks on public roads which in turns contaminate surface water runoff.

ER 198: Vehicles are washed manually at the wheel wash before leaving the site. Water is then collected at the concrete-lined base for re-use.

C918: For sites with space/time constrains, the automatic wheel wash can be used as it requires less space for installation and can be used instantaneously.

3.5 Protection of Storm Water Drainage Systems

Storm water drainage systems are designed to carry uncontaminated rainwater directly to water bodies such as reservoirs.



Structures should not be erected or placed in, above or across any drains without the approval of PUB.

TSS of the discharge into the storm water drainage system shall not be greater than 50mg/L. This will affect the quality of water resources making them more costly to treat.

3.5 Protection of Storm Water Drainage Systems

For drop-inlet chambers and scupper drains situated near construction works, measures should be taken to protect them and prevent soil and debris from entering.

Some storm water drainage inlet protection measures include:

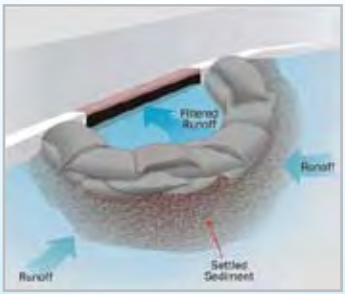
i. Erecting silt fence around an inlet slows runoff while catching silt and other debris at the drain inlet.

Silt fence removed partially for illustrative purposes only

(Source: http://www.pca.state.mn.us/)

3.5 Protection of Storm Water Drainage Systems

ii. Tightly packed sand bags can also be used to protect drain inlets and curb inlets by filtering storm water runoff before entering water bodies.



(Source: http://www.pca.state.mn.us/)

3.5 Protection of Storm Water Drainage Systems

Application

- Inlet protection should be constructed before the disturbance of surrounding area.

Maintenance

- Inspect all inlets protection frequently and after each rainfall.
- Ensure that there are no "gaps" allowing unfiltered storm water to enter the inlet.
- Remove accumulated sediment or debris from the sand bags/ silt fence to prevent choke point.

Limitations

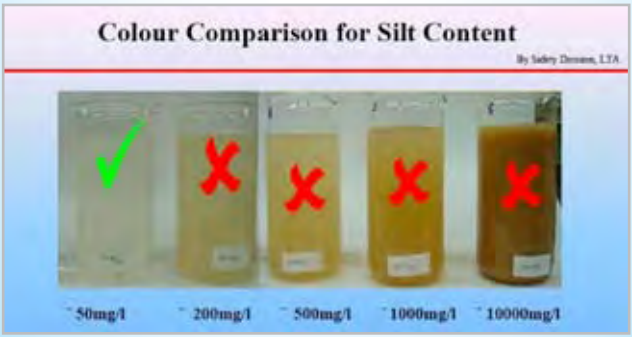
- Inlet protection is a secondary measure and it is only practical for areas receiving relatively clean runoff that is not heavily laden with sediment.
- Effectiveness of such measures are low and should only be used as a last line of defence together with other erosion controls and sediment controls.

3.6 Monitoring of Water Quality

Constant monitoring of water quality is necessary to identify and manage any risk of discharging water with more than 50mg/L of TSS into drainage systems. Monitoring measures include:

1. Using a colour comparison chart

Colour comparison chart can be pasted at treatment plants to give a quick estimate of whether treated water is within allowable limits.



3.6 Monitoring of Water Quality

2. Preparing labeled water samples

Labeled water samples can also be provided next to treatment plant to give workers a quick estimate of the TSS value of treated water.

3.6 Monitoring of Water Quality

3. Using a portable meter

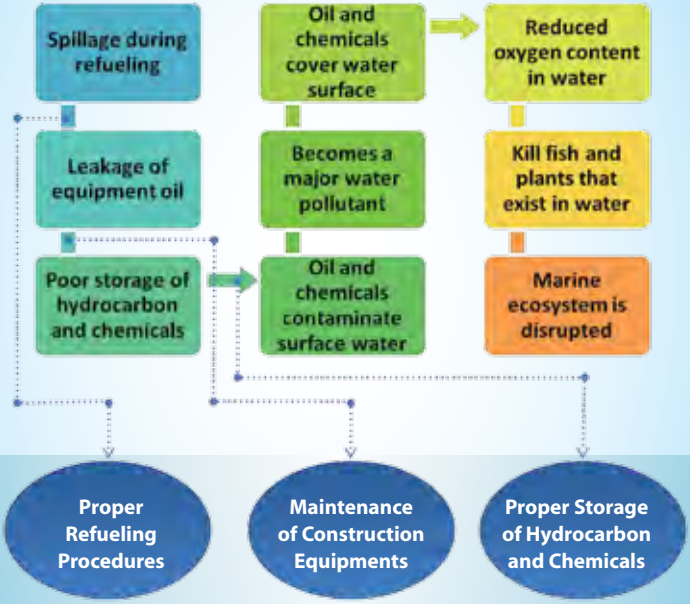
A portable meter gives better accuracy of the TSS value of treated water. The reading can be compared against the value provided by the sensor of the treatment plant to determine if it is working properly.

4. Conducting ad-hoc inspections

Conduct inspections during and after rain events. This is the best time to see if earth control measures in place are sufficient.

Chapter 4
Hydrocarbon and Chemicals

4.1 Overview



MITIGATION MEASURES

4.2 Proper Refueling Procedures

Most fuel spills occur during refueling. This is often due to poor control, overflow or if refueling operation is left unsupervised.

Measures to prevent such occurrences include:

i. Ensure that the vehicle / equipment is refueled in a poor designated area which has an impermeable base.

ii. Ensure that the vehicle / equipment being refueled is turned off and stationary.

iii. Always supervise fuel delivery operations to ensure that the correct procedure is used and any spillage is cleaned up.

iv. Never leave vehicle / equipment unattended during the refueling operation and always replace the fuel cap.

4.2 Proper Refueling Procedures

v. Delivery hoses and triggers must be located within the bund when not in use.

C902: Delivery hoses and triggers are kept within mobile bund.

vi. Ensure that facilities are checked on a regular basis so that any leaks or drips are fixed immediately to prevent loss and pollution.

vii. All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.

4.2 Proper Refueling Procedures

viii. Some accessories inside a spill kit may include:

Gloves

Goggles

Absorbent pads

Oil booms

4.3 Maintenance of Construction Equipments

When vehicles and equipments are not maintained regularly, oil leakage may occur and contaminate surface water during operation.

Rupture in crane leading to oil leakage.

Equipment lacking in maintenance may result in oil leakage.

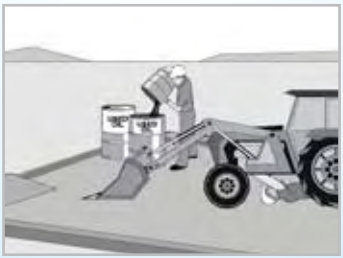
4.3 Maintenance of Construction Equipments

Here are some measures to prevent such occurrences:

i. Inspect onsite vehicles and equipments for signs of potential trouble, such as, oil or coolant leaks, structural cracks or excessive smoke produced during daily startup. Such machinery should be immediately serviced.

ii. Keep vehicles and equipments clean and do not allow excessive build-up of oil and grease.

iii. Repair vehicles and equipments offsite as much as possible. If maintenance must occur onsite, use designated areas, located away from drainage courses.



(Source: http://www.ci.concord.ca.us/pdf/living/recycle/brochures/vehicle-maintenance.pdf)

4.3 Maintenance of Construction Equipments

iv. Drip pans or absorbent pads should be used during vehicle and equipment maintenance work unless it is performed over an impermeable surface in a dedicated maintenance area.

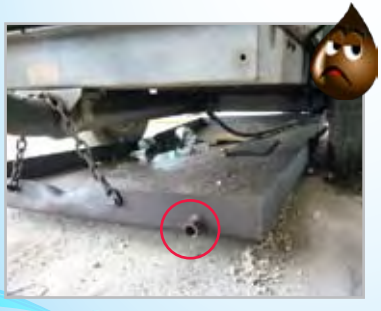
v. Place a stockpile of spill cleanup materials where it will be readily accessible during maintenance work.

vi. Records must be kept to provide information for planning maintenance and replacement activities so that they are not missed out.

4.4 Proper Storage of Hydrocarbon & Chemicals

Correct storage of chemical and hydrocarbon products are very important. Examples of improper storage include:

Drip trays are not provided for these chemical containers. Also, they must not be located next to water drainage systems.



The valve of the drip tray should remain closed at all times to prevent leakage during spillage.

Chapter 4
Hydrocarbon and Chemicals

4.4 Proper Storage of Hydrocarbon & Chemicals

Diesel drums should be stored in an upright manner to prevent spillage. Drip trays should also be provided to contain any possible spillage.

Drip tray provided is insufficient for the diesel drum. Water accumulated in the drip tray should be cleared to prevent overflow.

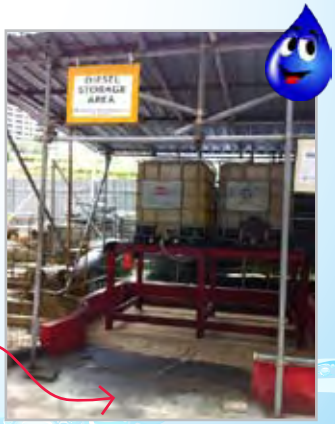
4.4 Proper Storage of Hydrocarbon & Chemicals

Here are some measures to take when storing and using fuel or oil on site.

i. Hydrocarbon and chemicals must be located away from the site drainage system and the edge of watercourses.

ii. All ancillary equipment (such as pumps) should be contained securely within the bund when not in use. Ensure that containers properly indicate their contents and capacities.

iii. Diesel drums should be kept within a bund / tray of sufficient volume to contain the contents of the largest drum in the case of accidental rupture, taking into account the presence of other drums within the bund / tray.



C902: Entrance for refueling / storage area is sloped inwards to prevent spillages from flowing out.

Chapter 4
Hydrocarbon and Chemicals

4.4 Proper Storage of Hydrocarbon & Chemicals

iv. Bulk diesel tanks should stand within a bund constructed to contain at least 110% of the volume of the tank.The inner face of the bund wall shall be coated with a chemical resistant material.

v. Use drip trays under all static plants such as pumps and generators and during refueling from mobile plant. Empty them into an appropriately contained area for disposal off-site.

4.4 Proper Storage of Hydrocarbon & Chemicals

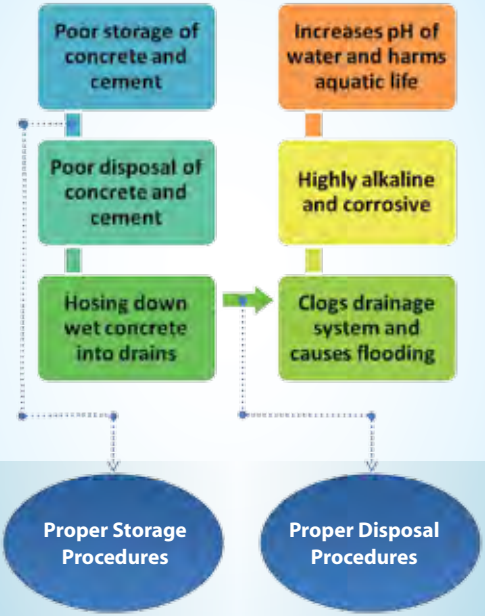
vi. Protect the storage area from rainfall by providing shelter.

vii. The storage area should be kept under lock and key to prevent hoses from being tempered with.

viii. The storage area should be located in an area away from vehicle movement to prevent collision.

Chapter 5
Concrete and Cement

5.1 Overview



MITIGATION MEASURES

5.2 Proper Storage Procedures

Concrete and cement should be stored as according to the Material Safety Data Sheet (MSDS). Failure to provide proper storage may cause pollution, damage to the material and loss of resources.

An example of storage of cement powder. (Doors are removed for illustrative purposes only)

(Source: http://www.pca.state.mn.us/)

Chapter 5
Concrete and Cement

5.3 Proper Disposal Procedures

Any excess cement and concrete should be disposed of properly. Concrete wash water is generated when washing out ready-mix trucks, drums and pumps. It also includes the water from rinsing off chutes, equipment, and concrete truck exteriors.

They should not be hosed down surface water drain as they are very aggressive materials, causing devastating impact on watercourses.

5.3 Proper Disposal Procedures

Here are some measures to take when disposing concrete / cement on site.

i. Washout of cement and concrete mixing plant or ready-mix lorries and equipment should be carried out in concrete washout areas.

Concrete washout areas are designed to promote evaporation where feasible. They can be in the form of prefabricated washout containers or self-installed concrete washouts.

The prefabricated washout container used should be able to resist damage and protect against spills and leaks.

5.3 Proper Disposal Procedures

Concrete washouts should be built in a designated impermeable contained area.

(Source: http://www.eco-3.com/manuals/DOE/BMP-154-Concrete_Washout.pdf)

Maintenance

- Inspect concrete washouts daily for signs of weakening or damage. The facility should be cleaned when it is ½ full.
- Remove hardened concrete whole or break it up first. The concrete can be reused on-site or hauled away for disposal.

5.3 Proper Disposal Procedures

Other measures to take when disposing concrete / cement include:

ii. Ensure that all spillages of wet or dry materials are cleaned up.

iii. Washout water must not be allowed to flow into any drain or watercourse.

Chapter 6
Effective Maintenance

Effectiveness of pollution prevention measures depend on consistent and continual monitoring and maintenance of best management practices (BMPs).

A recommended maintenance sequence during construction is as follows:

1. Develop an inspection schedule

	Daily	Monthly
ECO	✓	
Team of workers	✓	
QECP		✓

It is recommended to schedule inspections before and after anticipated rain events. Conducting inspections during rain events also allows one to see if the BMPs are keeping sediment on site and to address minor problems before they turn into major ones.

2. Plan your inspection

Review the site map and plan how the inspection should be conducted especially for large construction sites. Consider the direction stormwater will flow and begin the inspection at the low point on the construction site, observing all discharge points before inspecting the rest of the site.

3. Inspect discharge points, off-site areas, down streams, drainage systems for signs of impact

Silty water flowing from site into public drain

Silty water overflowing onto public road

If there are signs of silty discharge, investigate and inform QECP.

4. Inspect earth control measures implemented on site

Compare and ensure that earth control measures in the ECM plan are consistent with construction site conditions. Describe in your report the potential violations and their location. Look for areas where BMPs are needed, but are missing and are not included in the ECM plan. To prevent missing out on any erosion or sediment controls, a checklist should be prepared and tailored according to site conditions.

Refer to Appendix 1 for suggested checklist

5. Feedback adequacy of BMPs to management and QECP

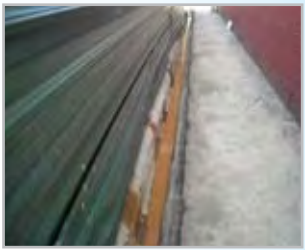
A change in design, construction, operation, or maintenance has a significant impact on the effectiveness of BMPs. When inspections indicate that the ECM plan is not effective, or when the site implementation is not consistent with the ECM plan, the ECO should feedback to his management and QECP.

The ECM plan is a dynamic document and should be reviewed as the site conditions change. It should also reflect and document all project modifications.

Chapter 7
Emergency Response

Oil spills or overflow of silty discharge should be prevented but when they do occur, they must be dealt with quickly and correctly to ensure the safety of workers, public and the environment.

Oil leak from equipment



Silty runoff overflows into public drain

Untreated water enters watercourse or drain causing surface water pollution

Slippery surfaces causing slip and fall

Contamination of water

Chapter 7
Emergency Response

The procedure of an emergency response should be as follows:

STOP - CONTAIN - NOTIFY

STOP work immediately and prevent further silty discharge/ spillage.

Eliminate any sources of ignition.

CONTAIN the spillage using bunds, sand, etc. immediately.

Check that spill has not reached any nearby watercourses. Bund drains to stop substance from entering the drainage system

NOTIFY the Environmental Control Officer (ECO) immediately giving the following information:

- **Water** – whether material has entered watercourse
- **What** – material involved
- **Where** – location
- **Why** – the reason for the pollution incident
- **How much** – the quantity of material involved

Chapter 7
Emergency Response

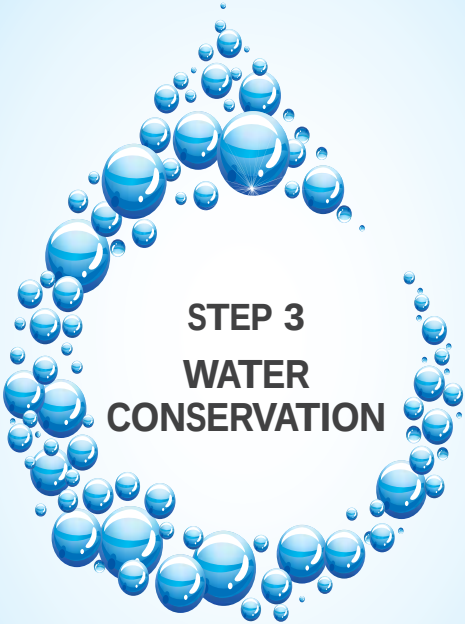
A minor oil spill from a crane is cleaned up using absorbent pads.

Saw dust is used to absorb oil spill and then disposed of as contamined waste.

Chapter 7
Emergency Response

Mitigation measures to take in the event of overflow:

	Water Pollutants	
Mitigation Measures	**Silt**	**Hydrocarbon/ Chemicals**
Sand	X	✓
Saw dust	X	✓
Absorbent pads	X	✓
Geotextile fence	✓	X
Drip trays	X	✓
Oil booms	X	✓



STEP 3

WATER CONSERVATION

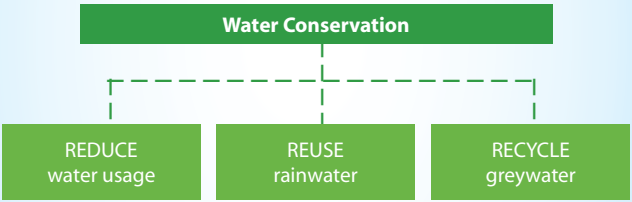
Land Transport Authority

Chapter 8
Water Conservation

8.1 Overview

In addition to pollution prevention, water conservation is also a key in water resource management to ensure a sustainable water supply in Singapore.

Water conservation for non-potable use in construction sites can be achieved by practicing the 3Rs – Reduce, Reuse and Recycle.



8.2 Reducing water usage

Metering water usage is the first step to water conservation.

How to Start a Metering Plan:

1. Install water meters on water intensive processes.
2. Evaluate the biggest water-using activities and consider installing sub-meters on them to track water use on an ongoing basis.
3. Continue to plot total water use as new water bills become available.
4. Evaluate trends and investigate or resolve any unexpected deviations in water use. For example, water leaks.
5. Track water use reductions and publicise your success.

Chapter 8
Water Conservation

8.2 Reducing water usage

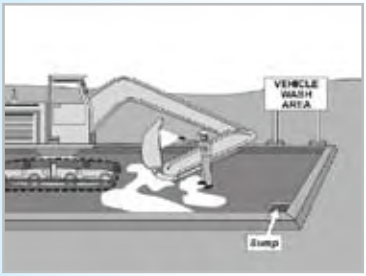
Ensure that all pipes, water fittings and faucets are checked regularly for water leaks.

(Source: http://coolexcooling.com/2009/05/03/conservewater-save-money-saveyour-generation/)

- Repair leaks and dripping taps promptly to prevent water wastage.
- Incorrectly made pipelines or insufficient support could lead to water leaks. Excess numbers of pipelines used could also result in water leaks because the base may not be able to handle the pipe's weight.

8.2 Reducing water usage

When cleaning vehicles, equipments or boots, use as little water as possible.



(Source: http://www.ci.concord.ca.us/pdf/living/recycle/brochures/vehicle-cleaning.pdf)

- Consider using high-pressure sprayers as they use less water than a hose.
- Use automatic shutoff valve to minimize water usage.

Chapter 8
Water Conservation

8.2 Reducing water usage

When installing water fittings and products such as taps and flushing cisterns in site offices, select products that are labeled with at least 1 or more ticks.

1. The more ticks shaded, the more efficient the product is.
2. There is an extra rating for Products Under Mandatory WELS, that is 0 (Zero Tick).
3. The label displays the product's Water Consumption and the following product information.
4. Registration Number is displayed on the Mandatory WELS Label, while Serial number is displayed on the Voluntary WELS Label.

(Source: http://www.pub.gov.sg/wels/rating/Pages/default.aspx)

Land Transport Authority

8.2 Reducing water usage

Other water- saving measures for existing site offices:

Install thimble in taps and showerheads to regulate flow rate.

(Source: http://www.pub.gov.sg/conserve/Households/Pages/WaterEfficientHomesProgram.aspx)

Chapter 8
Water Conservation

8.2 Reducing water usage

Other water- saving measures for existing site offices:

Install cistern water saving bag to reduce the amount of water used in each flush.

(Source: http://www.pub.gov.sg/conserve/Households/Pages/WaterEfficientHomesProgram.aspx)

8.3 Reusing rainwater

Rainwater collection systems can be used to harvest rainwater within the construction sites for non-potable uses, such as cleaning construction equipment and metal decking.

Used rainwater should then be treated to allowable limits before its final discharge into drainage systems or water bodies.

Maintenance

- Rainwater collection systems should be regularly maintained and cleaned to avoid standing water and prevent mosquito breeding.

Chapter 8
Water Conservation

8.4 Recycling greywater

C920: Treated wastewater is stored in a storage tank and recycled to wash boots.

C920: Treated wastewater is stored in wash bay and reused several times for wheel wash before pumping back into the treatment plant.

8.4 Recycling greywater

ER198: Treated wastewater is used for water spray during hacking to minimise air pollution.

ER198: Treated wastewater is used for waterponding test to determine the watertightness of structures after completion of work.

Chapter 8
Water Conservation

8.4 Recycling greywater

C902: Treated water storage tanks are located at height to save energy through gravity flow. The pump will only need to be switched on when the water level gets too low.

This water can also be recycled to flush toilet systems as there is sufficient water pressure at height.

STEP 4

COMMUNICATION & AWARENESS

Land Transport Authority

Chapter 9
Effective Communication

Effective communication is essential to bind the project cycle together. Measures to reduce water pollution adopted at the early stages of planning and design must be followed through systematically and communicated to contractors responsible for the later stages of construction, completion and demobilization. A breakdown in communication is frequently the root cause of pollution events.

Before commencement of works	During construction	Before completion of project
Contractor engages QECP and ECO	**QECP** advises contractor on adequacy of ECM through regular inspections	**ECO and team of workers** to ensure ECM implemented are still effective
QECP prepares and submits ECM plan to PUB for approval	**ECO and team of workers** monitor and maintain ECM	**QECP** to approve removal of ECM
ECO implements ECM plan		

Communication with Management

To ensure issues on water resources management at site are continually reviewed and communicated among the Contractor, QECP, ECO and workers, environmental meetings should be held at least once a month for discussion. Topics to be discussed during the environmental meetings include:

i. Inspection Findings

Findings and close-up actions taken during site inspection should be reported and discussed. Other good management practices adopted should also be reviewed and highlighted.

ii. Investigation of Public Complaint / Feedback

Upon receiving a complaint / feedback with regards to water pollution on site from the public, the Contractor is expected to investigate and rectify the problem immediately.

Chapter 9
Effective Communication

Communication with Site Workers & Subcontractors

Site workers and subcontractors are sometimes not familiar with pollution preventive and water conservation measures. Ways to increase awareness and communicate effectively on site include:

i. Tool Box Talk and Training Program

Training them in the basics of erosion control, pollution prevention and water conservation is one of the most effective best management practices to institute on site.

Refresher training should also be conducted regularly for workers.

Choose a single topic to be covered, or program a series of talks throughout the construction duration.

Refer to Appendix 2 for suggested toolbox topics

Other forms of communication to workers include:

ii. Banners

3370B: Putting up banner on site reaffirms management's commitment in driving pollution prevention.

C920: Banner also serve as a reminder to workers on the importance of discharging clean water into water bodies.

Chapter 9
Effective Communication

iii. Bulletin boards and posters

C921: A dedicated Earth Control bulletin board explaining site's various BMPs.

C905: Poster on ECM to educate workers on best management practices.

iv. Signage reminding workers to conserve water

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Erosion Controls	Y/N	Remarks
SLOPE PROTECTION		
Are there any signs of damage to planted vegetation? If yes, replant.		
Are there any signs of damage for lean concrete / milled waste / hard core areas? If yes, replace.		
Are steel plates / lean concrete / milled waste / hard core covered with soil? If yes, maintain.		
Is proper covering material selected for slope protection? If no, inform QECP.		
Is material installed properly at the top of slope? If no, put in trench or extend onto flat area.		
Is there adequate number of staples to adhere material to slope? If no, add more staples.		
Is there adequate overlapping of material for slope protection? If no, rectify.		
Is material used for slope protection in a state of deterioration? If yes, replace.		
Is topsoil properly protected against erosion? If no, cover bare surfaces.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Sediment Controls	Y/N	Remarks
PERIMETER DRAIN		
Any signs of damage of perimeter drain? If yes, repair.		
Any signs of inadequacy for perimeter drain (i.e. flooding)? If yes, inform QECP.		
Any obstructing debris or sediment blocking perimeter drain? If yes, clear.		
Is bottom of drain concrete lined? If no, line the drain with concrete.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Sediment Controls	Y/N	Remarks
SILT FENCE		
Is the support of silt fence steady? If no, rectify.		
Is silt fence fabric torn? If yes, replace.		
Is silt fence properly toe-in? If no, rectify.		
Is silt fence accumulated with > 1/3 (total height) sediment? If yes, clear.		
Is stagnant water observed around, above or below the fabric? If yes, fabric could be choked.		
SILT TRAP		
Is silt trap fabric torn? If yes, replace.		
Are aggregates used in the silt trap too large and too sharp? If yes, replace.		
Is silt trap accumulated with sediment >50% height? If yes, clear.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Sediment Controls	Y/N	Remarks
SEDIMENTATION BASIN OR STORAGE POND/ TANK		
Has sediment in sedimentation basin reached ½ of total volume? If yes, remove sediment.		
Is the sedimentation pond concrete lined? If no, inform QECP.		
Is sedimentation basin / tank inlet choked? If yes, clear.		
Is sedimentation basin / tank outlet choked? If yes, clear.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Sediment Controls	Y/N	Remarks
TREATMENT PLANT		
Is capacity of treatment plant up to expectation (i.e. discharge >50mg/ L of TSS)? If no, maintain treatment plant and inform QECP.		
Is there continuous live monitoring of TSS? If no, install system for continuous live monitoring.		
TURBIDITY CURTAIN		
Is there visible plume of silty water passing beyond the turbidity curtain? If yes, check condition of turbidity curtain and inform QECP.		
Is there tear in the turbidity curtain? If yes, repair.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Hydrocarbon and Chemicals	Y/N	Remarks
Is the bund in good condition with no cracks or evidence of leakage, particularly at corner points? If no, repair.		
Is the bund free from excessive rainwater and debris build-up? If no, clear.		
Are there any leaks from the hoses, joints or valves? If yes, replace.		
Is the storage area locked off when not in use? If no, install locking system.		
Is the hydrocarbon / chemical facility appropriately labelled as to its content and capacity? If no, inform supervisor.		
Are spill response material and emergency instructions located nearby and readily accessible by the operator? If no, inform supervisor.		
Is secondary containment provided for generators / compressors and portable chemical / hydrocarbon containers? If no, inform supervisor.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Land Transport Authority

Appendix 1
Inspection Checklist

CHECKLIST – WHAT TO INSPECT?

Concrete and Cement	Y/N	Remarks
Are concrete lorries washing out in the designated area? If no, inform supervisor.		
Is the designated area away from drains and watercourses? If no, inform supervisor.		
Is the washout being suitably contained? If no, inform supervisor.		
Is the storage area locked off when not in use? If no, install locking system.		
Is the washout area ¾ filled? If yes, pump out to tanker.		

Note: This is a general guideline. Please consult QECP for detailed checklist.

Appendix 2
Tool Box Topics

TOOL BOX TALK – WHAT TO ADDRESS?

Site Operation
What are the main water pollutants to construction sites?
What do you report if you find water pollution and to whom?

Silt and Sediment
What construction activities cause silty water?
How can you treat water contaminated with silt?
Who is responsible for the operation of treatment plant?
How often should erosion and sediment controls be checked?

Appendix 2
Tool Box Topics

TOOL BOX TALK – WHAT TO ADDRESS?

Hydrocarbon and Chemicals
Who is responsible for the maintenance of fuel facilities?
What are the arrangements for refueling operations?
How often should fuel facilities be checked?
In the event of spillage, what should you do?
What is the capacity of a bund?
Who is the storeman and where should hydrocarbon and chemicals be stored?
What are the arrangements for disposal and where?
How can you eliminate or reduce the quantity of contaminated oil / chemicals?

Appendix 2
Tool Box Topics

TOOL BOX TALK – WHAT TO ADDRESS?

Concrete and Cement
Where is the concrete washout facility?
How often should concrete washout facility be checked?
What does poor storage and disposal of concrete lead to?
What are the hazards associated with concrete and cement?

Emergency Response
What are the arrangements for emergency response on site?
Where is spill response material kept on site? How is it use?
Who should be contacted in the event of a major spill?
What should you do if you cannot contain the spill?

References

Legislations

1. Sewerage and Drainage Act
2. Sewerage and Drainage (Surface Water) Regulations
3. Environmental Protection and Management Act
4. Code of Practice on Surface Water Drainage
5. Code of Practice on Pollution Control

LTA Contractual Documents

1. General Specification Appendix A (for Rail projects)
2. Particular Specification Appendix B (for Road projects)

Books

1. Ciria 2001. Control of Water Pollution from Construction Sites: Guidance for Consultants and Contractors
2. Ciria 2002. Control of Water Pollution from Construction Sites: Guide for Good Practice
3. Jerald S. Fifield 2004. Designing for Effective Sediment and Erosion Control on Construction Sites

References

Websites

1. http://cfpub.epa.gov/npdes/stormwater/menuofbmps
2. http://www.ci.concord.ca.us/
3. http://coolexcooling.com/2009/05/03/conserve-water-savemoney-save-your-generation
4. http://www.eco-3.com/manuals/DOE/BMP-154-Concrete_Washout.pdf
5. http://www.pca.state.mn.us/
6. http://www.pub.gov.sg
7. http://siltcurtain.asia
8. http://www.urbancreeks.org/Homeowner_Resources.html
9. http://www.wbdg.org/design/conserve_water.php
10. http://www1.eere.energy.gov/femp/program/waterefficiency_bmp1.html

Notes