EROSION AND SEDIMENT CONTROL

The fundamentals for development in Tasmania

Derwent Estuary Program

TEER
Healthy waterways together

The Tamar Estuary and Esk Rivers (TEER) Program.

The Tamar Estuary and Esk Rivers (TEER) Program was established in 2008 and is a regional partnership between the agencies responsible for management of the kanamaluka / Tamar estuary and Esk rivers. The TEER Program provides a coordinated management approach and guides solutions and investment in activities that protect, maintain, and enhance the kanamaluka / Tamar estuary and Esk river systems from catchment to coast. The program focuses on improving our scientific understanding of issues impacting upon the health of waterways so that we can better identify and target priority areas requiring investment in on-ground works. The TEER Program fosters collaborative partnerships and works closely with a range of industry, community, government, research, and business partners to monitor and report on water health as well as coordinate activities to reduce pollutants entering our waterways. TEER Program partners include the Tasmanian Government, City of Launceston, West Tamar Council, George Town Council, Meander Valley Council, Northern Midlands Council, Hydro Tasmania, TasWater, TasPorts, Tasmanian Irrigation, the Environment Protection Authority, Petuna Aquaculture, Bell Bay Aluminium, GFG Alliance, UTAS, and NRM North.

The Derwent Estuary Program

The Derwent Estuary Program (DEP) is a regional partnership between local governments, the Tasmanian State Government, businesses, scientists and the community to restore and promote our estuary. We share science for the benefit of nature, the economy, and the community. The DEP was established in 1999 and has been nationally recognised for excellence in coordinating initiatives to reduce water pollution, conserve habitats and species, monitor river health and promote greater use and enjoyment of the foreshore. Our major sponsors include Brighton, Clarence, Derwent Valley, Glenorchy, Hobart, and Kingborough councils, the Tasmanian State Government, Nyrstar Hobart, Norske Skog Boyer, TasWater, TasPorts, Hydro Tasmania, the Institute for Marine and Antarctic Science, the Environment Protection Authority and NRM South.

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Find out more at www.teer.org.au or www.derwentestuary.org.au

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ACKNOWLEDGEMENT OF COUNTRY

We acknowledge the Tasmanian Aboriginal People as the traditional owners and ongoing custodians of Tasmania. We pay our respect to all Aboriginal and Torres Strait Islander peoples and to their Elders past and present.

Photo credit: Vince Brophy

CONTENTS

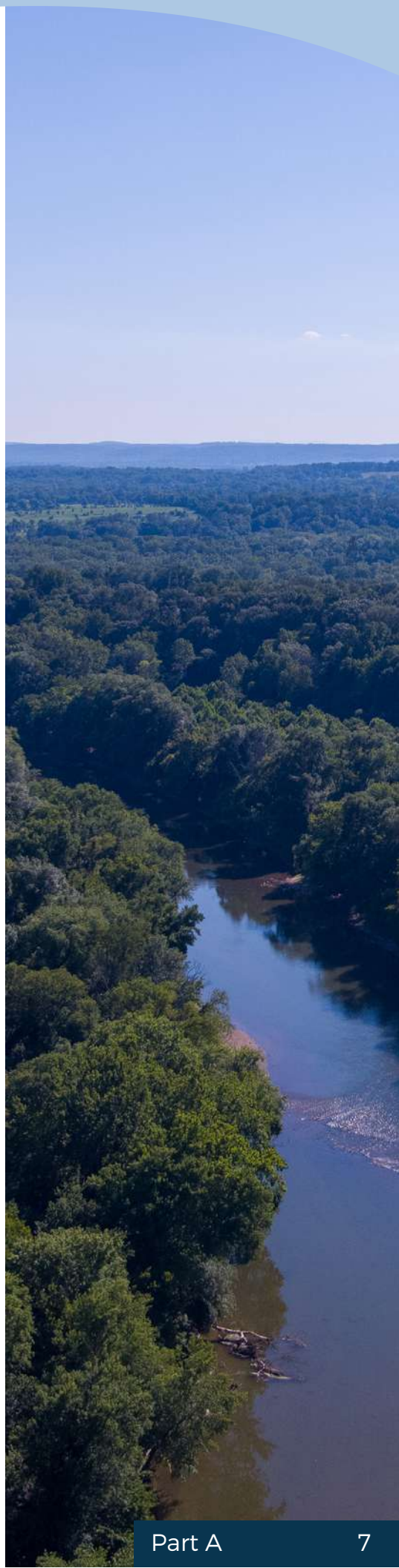
GLOSSARY AND ACRONYMS

Catchment area	The surface area of all land upslope of your work site that drains towards your site, including areas of ground disturbance (the 'effective catchment area'). The effective catchment area can be reduced by diverting clean water around the disturbed areas of your site (but not onto adjacent land).
Coagulant	A substance used to neutralize positive charges on clay particles, allowing them to 'floc' together and settle out under gravity.
Erosion and Sediment Control (E&SC)	Management techniques including temporary drainage, erosion, and sediment controls which aim to prevent or reduce the movement of sediment and pollutants from a development site. These include installing structures, using land management techniques, and timing works. 'Erosion and Sediment Control' is the newer and more specific name for 'Soil and Water Management'.
Erosion and Sediment Control Plan (ESCP)	The plan and description of drainage, erosion, and sediment controls for a development site, where they will be installed, and how they will be managed. This was previously referred to as a Soil and Water Management Plan (SWMP).
Flocculant	A substance that promotes adhesion (clumping) of particles into larger clusters, which then settle out under gravity.
International Erosion Control Association (IECA)	A non-profit, international member organisation that provides education, resource information, and business opportunities for professionals in the erosion and sediment control industry.
Level spreader	An erosion control device that converts high-velocity surface runoff into sheet-flow so that it infiltrates into the soil. It is used both on construction sites as a temporary control, and for permanent applications such as drainage for roads.

Revised Universal Soil Loss Equation (RUSLE)	Equation predicting long-term annual soil loss (see IECA Principles of Construction Site Erosion and Sediment Control, Version 1, 2012). The primary function of the equation is to assess erosion risk. The resulting risk level guides the minimum drainage, erosion, and sediment controls to be used.
Soil and Water Management	An older term synonymous with Erosion and Sediment Control.
Suitably qualified person	A suitably qualified person must have qualifications and experience relevant to the work being undertaken and be a current member of a relevant professional organisation.
Total suspended solids (TSS)	A measure of the amount of particulate matter (tiny pieces of things) floating in water. They are particles (solids larger than 2 microns) suspended in water that can be trapped by a filter, including particles of clay or silt, usually reported in units of mg/L.
Wash-out areas	A place on a development site where work including machinery cleaning, cement mixing, and concrete, brick, and tile cutting occurs, and waste water from that work and cleaning is collected and treated.

PART A

The ‘what’ and ‘why’ of erosion and sediment control.



WHO IS THIS DOCUMENT FOR?

Are you a builder, site supervisor, project manager, subcontractor, council planner, engineer, works crew member, landscaper, or civil contractor? Are you designing or working on a building or construction site? Are you disturbing or clearing ground? Then this information is for you.

This information applies to building and construction sites of any size (referred to here generally as 'development sites'). The controls described can be used whenever soil is disturbed for on-ground works. This includes housing developments, driveways, road projects, installing underground services, excavations (including channels), dams, and landfills. ***If your work disturbs the ground, you are at risk of causing sediment and pollutants to escape from your site into the stormwater system, and then local waterways. You must put controls in place to prevent this.***

People working in the development industry are responsible for erosion and sediment control throughout all stages of a development. To comply with legal responsibilities, you must have a practical understanding of erosion and sediment control techniques and when to use which ones. This information will assist you to manage the soil and water on your site, to operate legally, to avoid fines, and limit damage to your business reputation. Getting the drainage, erosion, and sediment controls right will reduce the impacts of development activities on our natural environment.

- **Drainage controls** ensure surface runoff upslope of your development site is appropriately diverted away from the area of works, reducing the amount of water needing to be treated.
- **Erosion controls** stop soil on your development site from moving in the first place.
- **Sediment controls** capture soil that has become mobile (eroded) and prevents it from leaving the development site.

To decide which drainage, erosion, and sediment controls are best for your site, check the "What is this?" section of each control for a summary. Remember, each site and stage of development is different – your drainage, erosion, and sediment controls need to be designed on a site-by-site basis, for different activities, and each stage.

WHAT IS EROSION AND SEDIMENT CONTROL AND WHY IS IT IMPORTANT?

Erosion is the movement of soil by wind and water. As a natural process it usually occurs at a very slow rate but is significantly increased by development activities that remove vegetation and expose soil to rain, runoff, and wind. When erosion occurs, soil particles suspended in water or air are transported downstream or downwind, eventually settling out as sediment, sometimes far away from the building or construction site, causing damage to infrastructure and the environment.

Soil is soil when it is in its proper place – it is called sediment when it is eroded away. If not properly managed, more soil is lost due to erosion in the construction-phase of a project than during the entire post-construction lifespan of the development. In fact, in the development of a single lot - without any controls in place - up to four truckloads of soil can be eroded in one heavy rain event.

If sediment moves off a development site and enters stormwater drains it can block the stormwater system. Pollutants including nutrients, oils, heavy metals, and hydrocarbons, stick to eroded sediment and are carried into local waterways, and eventually into the ocean. This makes flooding worse, smothers aquatic plants, reduces food for aquatic animals, and impacts the function and amenity of our rivers, estuaries, and oceans. The loss of topsoil makes it harder for vegetation to re-establish after works are complete. Sediment also increases council's maintenance costs, wasting the community's money.

Preventing soil loss is one of the most important actions you can do so we can all continue to enjoy boating, swimming, fishing, and having beautiful healthy waterways, both for now and for future generations. Make the actions in this document part of your everyday work practice, and help to protect the land, water, and air of Tasmania.

Employing effective erosion and sediment controls help to protect our aquatic environments, as well as recreational activities that rely on healthy waterways. Photo credit: Inland Fisheries Service.

WHAT ARE THE BENEFITS OF EROSION AND SEDIMENT CONTROL?

- Avoid compliance action against you, including fines and possible prosecution.
- Improve the wet weather working conditions on your site, improve safety, reduce down-time, and earlier building completion.
- Create a better public image for your business, stand out from the competition, and get fewer public complaints.
- Reduced stockpile losses and clean-up costs.
- Reduce the risk of flooding from sediment build-up in the stormwater system and reduce council's maintenance costs.
- Contribute to healthier waterways and a cleaner environment for everyone.

WHAT ARE MY LEGAL RESPONSIBILITIES?

- Under Tasmanian law* and each council's Stormwater Management Strategy, you must control sediment from leaving your site so that it does not cause an environmental nuisance, environmental harm, or property damage.
- You face fines and prosecution if you breach the law and allow pollutants, including sediment, to be released from your site. You may also be required to clean up and repair damage at your own cost.
- Workers need to notify their supervisors if they see sediment or other pollution leaving the site and prevent any further pollution.
- For more information on the legal requirements for managing erosion and sediment on your site, contact the local council.

*Including planning permits issued under the *Land Use Planning and Approvals Act 1993*, and requirements of the *Building Act 2016*, *Urban Drainage Act 2013*, *Environmental Management and Pollution Control Act 1994*, *State Policy for Water Quality Management 1997*, or future equivalents.

Remember, each site is different.

Controls need to be assessed on a site-by-site basis as well as for different activities.

WHEN DO THE CONTROLS NEED TO BE IN PLACE?

Some drainage, erosion, and sediment controls need to be installed on day one, before the start of any ground disturbance on the site. Examples include upslope diversion drains, which can significantly reduce the amount of water needing treatment (see page 26), retaining a strip of vegetation on the downslope edge of the site to act as a natural sediment filter (see page 38), and site access control to prevent sediment being tracked onto roads (see page 56). Controls, whether they are for drainage, erosion, or sediment control, must be maintained in good working order throughout the development period and evaluated for upgrading as necessary. They must be inspected before, during, and after rain events, and must remain in place and be maintained until all disturbed areas have been stabilised, restored, or sealed.

'Day-one' controls include:

Upslope diversion drains can significantly reduce the amount of water needing treatment (see page 26).

Retaining a strip of vegetation on the downslope edge of the site can act as a natural sediment filter (see page 38).

Site access control can prevent sediment being tracked onto roads (see page 56).

Everyone working on a development site is responsible for preventing erosion and pollution. Follow the practices in this booklet and you will minimise erosion from your site, meet your legal requirements, and help protect our waterways.

HOW CAN I PLAN FOR EFFECTIVE EROSION AND SEDIMENT CONTROL?

It is most cost effective to specify all controls at the planning stage. You must also be prepared to add, adapt, and adjust controls so that they remain effective throughout all stages of the development. Effective erosion and sediment control on development sites depends on these steps:

- [ ] Consider the characteristics of your site including soil type, size of catchment, slope, existing flow paths, and area to be disturbed. For large sites you may also need to consider the 'soil loss rate'; see International Erosion Control Association (IECA) Appendix B, 2018. See also Appendix 1 in this document.
- [ ] Develop an Erosion and Sediment Control Plan (ESCP) (see page 17) for drainage, erosion, and sediment controls at the planning stage for assessment and approval.
- [ ] Ensure the approved ESCP integrates all design aspects, including the engineering design for retaining walls and structures.
- [ ] Make sure everyone working on the site understands and maintains the ESCP. Keep a copy of the ESCP on-site and include the function of all controls in the site induction.
- [ ] Install the controls required before any ground disturbance on DAY ONE, and other controls as soon as possible.
- [ ] Minimise the area of soil disturbed and exposed to erosion at all times and preserve existing vegetation to protect soil.
- [ ] Divert 'clean' upslope runoff away from or through the work site (avoiding any disturbed areas), but **NOT** onto adjacent property.
- [ ] If soil does accidentally become mobile, capture and treat runoff before it leaves the site.
- [ ] Cover and rehabilitate disturbed areas quickly.
- [ ] Inspect and maintain your controls throughout the development period.

Don't forget about dust! Research shows that average dust emission rates of over 2.5 tonnes per hectare per month occur on sites which have no dust controls in place. For more information, see the *Control dust and litter* section under Erosion Controls in Part B (page 53).

SEDIMENT CONTROL CLASSIFICATION

WHAT IS THIS?

Sediment is made up of different sized particles from very fine clay particles (less than 0.045mm) to large sand particles (more than 0.14mm), which differ depending on the site soil type. Sediment controls are grouped into four categories based on their effectiveness at trapping sediment of different sizes. Standard practice is to use a combination of controls to capture different sized particles (Figure 1).

Below is a brief description of each sediment control type and what sediment these controls are targeting. The details on how to plan for, install, and maintain these controls can be found in Part B of this booklet.

TYPE 1: CONTROLS TO CAPTURE SMALL PARTICLES - CLAY, SILT, FINE SAND (LESS THAN 0.045MM)

E.g. Sediment basin

Type 1 controls capture the greatest range in sediment particle sizes by allowing water to pool and for gravity to pull sediment to the bottom. These controls include sediment basins (see page 74) and more sophisticated filtration systems used in dewatering operations (see page 78). A flocculant or coagulant can be added, which causes even very fine clay particles to settle out of the water column. A Type 1 control is expected to achieve less than 50mg/L of total suspended solids (TSS) in discharged water (that is, quite clear).

TYPE 2: CONTROLS TO CAPTURE MEDIUM PARTICLES - SILT AND SAND (BETWEEN 0.045 AND 0.14MM)

E.g. Rock filter dam, compost filter berm

These controls capture medium sized particles from sand down to coarse silts. These controls include rock filter dams which can be used in concentrated flow paths to trap sediment by both filtration through an aggregate and/or geotextile lining, and particle settlement within the pond formed by the dam (see page 72). However, discharge of TSS< 50mg/L is typically not achieved. Mulch berms or berms operate in a similar way to rock filter dams but are used for treating sheet-flow in small catchments (see page 70).

TYPE 3: LARGE PARTICLES – SAND

E.g. Sediment fence, vegetated buffer zone

These controls are commonly used for small sites or catchment areas for sheet flow and low flow conditions and capture only large particles. Sediment fences should NOT be used in drainage channels (see page 67).

SUPPLEMENTARY CONTROLS - LAST RESORT

E.g. Protection of stormwater pits, stabilised site access

Although limited in effectiveness, these controls contribute to best practice sediment control. Supplementary sediment controls are used to support and complement Type 1, 2, and 3 controls on-site, based on specific work activities.

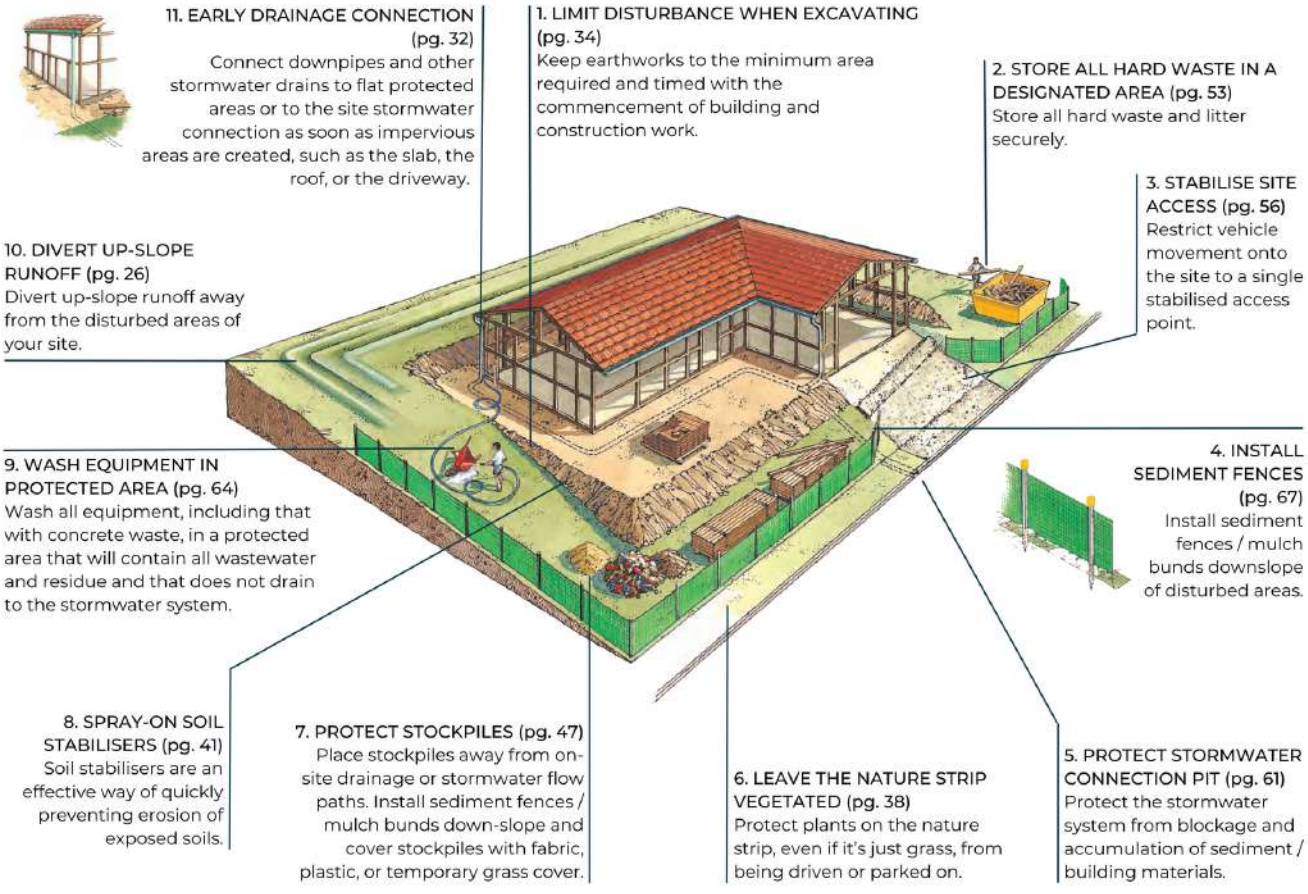


Figure 1: A summary of drainage, erosion, and sediment controls that can be combined on small development sites to achieve best practice. A3 sized version available as part of the *Erosion and sediment control - the basics,* on the TEER Program and Derwent Estuary Program websites. *Figure modified from Water by Design ESC Factsheet #1.*

WHICH CATEGORY OF CONTROLS SHOULD YOU USE?

WHAT IS THIS?

When choosing the category of controls to use on your development site, you need to consider the catchment area (see Glossary)(Table 1), type of soil, gradient, existing flow paths, the area to be disturbed, and the soil loss rate. As a guide to best practice, IECA (IECA Appendix B, 2018) recommends a risk-based approach to selecting the appropriate category of controls based on the catchment area and maximum allowable soil loss rate. See Appendix 1 in this document for more information about how to calculate soil loss rate using the Revised Universal Soil Loss Equation (RULSE). It is normal to use a variety of control types on your site, with larger catchments requiring more stringent controls. The controls suggested below are the MINIMUM required. If in doubt, contact the council about which controls to use.

MINIMUM CONTROLS BASED ON CATCHMENT AREA (IECA APPENDIX B, 2018)

- **For catchment areas up to 250m^2** – the local council will determine the type of controls required based on the characteristics of the site. The default suggested by IECA is Type 3 and Supplementary Controls.
- **For catchment areas between 250m^2 and 1,000m^2** – Type 3 and Supplementary Controls are required for capturing large sediment particles; other controls may be necessary depending on characteristics of the site.
- **For catchment areas between 1,000m^2 and 2,500m^2** – Type 3, Supplementary Controls, and Type 2 controls are required for capturing medium and large sediment particles.
- **For catchment areas over 2,500m^2 –** Type 3, Supplementary Controls, Type 2, and Type 1 controls are required for capturing fine, medium, and large sediment particles. Specific analysis may be required by a suitably qualified specialist to design appropriate controls.

Area triggers used here are based on catchment area - the total ground area over which rainfall will run towards the development site, including areas of ground disturbance. The catchment area does not include any upslope 'clean' runoff which – by means of diversion drains – is made to bypass the disturbed area. A development site may include multiple catchments of different areas and different risks depending on topography, requiring site specific sediment controls.

Table 1: Minimum control types associated with different catchment areas, as recommended in IECA Appendix B, 2018.

Catchment area (m^2)	Type of controls recommended (minimum)
</= 250	Consult council; default is Type 3
250 > 1000	Type 3
1000 > 2500	Type 2 and 3
> 2500	Type 1, 2 and 3

EROSION AND SEDIMENT CONTROL PLANS

WHAT IS THIS?

Erosion and Sediment Control Plans (ESCPs) are specific site plans, drawings, diagrams, text, and sometimes reports based on site specific analysis. These plans guide management to prevent sediment and pollutant loss from your development site. An ESCP includes details of drainage, erosion, and sediment controls on a development site. An ESCP shows the type, location, and design of controls, as well as clearly identifying the people responsible for the installation, and a schedule of maintenance for the controls (Figure 2).

The need for an ESCP is determined by the council (as permit authority) and is dependent on the catchment area and size of the area being disturbed (Table 2, page 20), the duration of exposure, and other site conditions. Site conditions to consider include existing contamination, proximity to a watercourse or waterbody, environmental sensitivity, soil type and water table, average rainfall, slope of the ground, and excavation of a significant depth.

If you are creating ground disturbance of between 250 – 2,500m^2, provide an ESCP to your council at the planning or building permit stage. For development disturbing more than 2,500m^2, provide a comprehensive ESCP for each stage of development, with reports prepared by a suitably qualified person. Once approved by the council, all building and construction works need to be conducted in accordance with the ESCP. For development disturbing less than 250m^2, install erosion and sediment controls as necessary, depending on the characteristics of your site. If there is ANY risk of sediment and pollution leaving your site due to wind or rain, install and maintain controls for the duration of the disturbance. This will assist you in meeting your legal requirements, reducing flood risk, and protecting the environment.

Developing and implementing an effective ESCP on your site will help to protect Tasmania's waterways. Photo credit: Dahlia Westergreen.

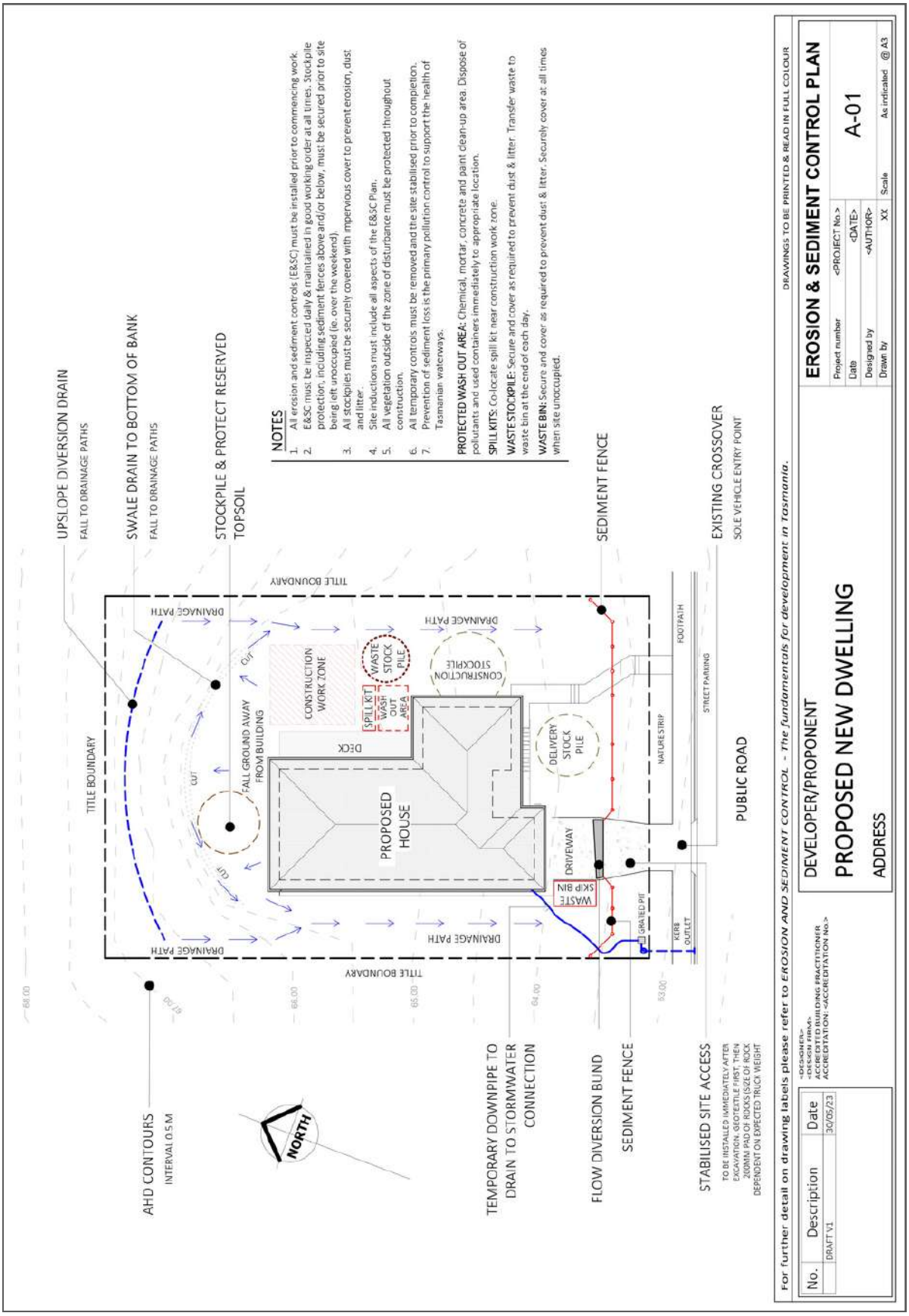


Figure 2: An example Erosion and Sediment Control Plan for a single lot development. The elements contained in this template (e.g. AHD contours, drainage lines, labelled controls) and the type of controls (e.g. diversion drains, protected stockpiles, sediment fences) also apply to larger subdivisions and construction sites. A3 sized version available for download from the TEER Program and Derwent Estuary Program websites.

WHAT DO I NEED TO DO?

Prepare an ESCP

Your ESCP should contain the following things:

- site plan, plan name, document version, date and author, and stage, if part of a series of staged ESCPs;
- north point, scale, all property boundaries, and contours (for staged ESCPs, the initial, intermediate, and final contours);
- general soil description, particularly noting dispersive soil if present (see page 36), and water table level if relevant;
- construction details (e.g. building footings, roadways, or subdivision layout), including location and volume of ground disturbance, and where material is to be stockpiled and managed;
- location of watercourses and existing surface drainage pathways including overland flow paths for flood events if relevant;
- existing stormwater infrastructure (public and private);
- stormwater connection (existing and proposed);
- location and details (dimensions, lining, and/or velocity control) of all proposed temporary **drainage controls** (including 'clean' upslope runoff diversion and internal drains directing 'clean' runoff to a level spreader (see page 26) or approved stormwater connection);
- location and details of all proposed **erosion controls**, including location of vegetation to be retained, with 'No-Go-Area's' clearly marked (see page 38);
- location of **sediment controls** (including the location and design of stabilised site access (see page 56);
- location of wash-out area and associated controls for potentially polluting activities and machinery cleaning (see page 64);
- a statement of who is responsible for establishing and maintaining all controls (including contact details);
- the installation sequence for different controls;
- the maintenance program for controls; and
- the revegetation and rehabilitation program.

The above is a suggested list of elements to include in a standard ESCP. Read and comply with the development planning permit conditions for your site. Seek advice relating to ESCPs and/or contact your council for details of any additional information you are required to submit. You may need to seek more tailored advice from a suitably qualified person, depending on the size and complexity of your site.

CONSIDERATIONS FOR LARGE DEVELOPMENT AND SUBDIVISION WORKS

Large development sites – classified as greater than 2,500m^2 disturbed area – typically pose a high erosion risk because of the greater area of disturbed ground, creation of runoff from large impervious surface areas (roofs and driveways), and long project timeframes. In addition, significant excavation work is often required to modify levels or install services. Because of these increased risks, staged ESCPs and Type 1 controls (e.g. a sediment basin, see page 74) may be required for large developments (Table 2). Staged ESCPs are typically prepared by a suitably qualified person and detail the drainage, erosion, and sediment controls within each stage of development, including the location, layout, and type of controls on **separate drawings for each stage**. As a minimum, this should include controls associated with 1) initial clearing based on existing levels, 2) bulk earthworks transitioning from existing to design levels, and 3) final levels, including final drainage and stabilisation of the site or lots.

For large developments and subdivision works, installing a Type 1 control to achieve water quality targets during the construction phase may be necessary. These controls may be designed to be integrated into the post-construction phase water treatment strategy as a water sensitive urban design (WSUD) element. A sediment basin must be designed and constructed by a suitably qualified person and included in the early planning and budgeting for the project.

Table 2: Requirements for an Erosion and Sediment Control Plan (ESCP) based on disturbed area sizes, as recommended in IECA Appendix B, 2018.

Disturbed area (m^2)	ESCP required?
</= 250	Consult council
250 > 1000	Yes
1000 > 2500	Yes
> 2500	Yes (staged)

WHERE CAN I GET MORE INFORMATION?

The information in this book provides the fundamentals of how to manage soil and water on your development site. If you require more information on what to include in your ESCP, contact the council or a suitably qualified specialist. If you require more comprehensive information about drainage, erosion, and sediment controls, or technical specifications, go to the IECA website (Australasia Chapter) at www.austieca.com.au, or engage a suitably qualified person, such as a Certified Professional in Erosion and Sediment Control (CPESC).

If you are using proprietary products, read the product installation manual and/or check with the manufacturer regarding appropriate application prior to use or installation.

PART B

The 'how' of designing and constructing **drainage**, **erosion**, and **sediment** controls.

DRAINAGE CONTROLS

DIVERSION DRAINS

WHAT IS THIS?

'Clean' runoff from rain will flow towards your development site from the upslope catchment. You can install surface drainage to divert upslope runoff away from the disturbed areas of your site to reduce the amount of water needing treatment. You must NOT divert runoff onto adjacent properties, only around or through the development site away from disturbed areas (also see 'Early Drainage Connection', page 32). Surface drainage controls must be removed before completion of the development. All clean diverted water must leave the site via the stormwater connection or be temporarily directed via a level spreader to vegetated No-Go-Areas (see page 38) away from/below the disturbed work area to soak into the ground.

WHAT DO I NEED TO DO?

Before starting site works:

'Clean' upslope runoff can be diverted with the use of a diversion drain to the site stormwater connection or a vegetated 'No-Go Area' via a level spreader outlet if appropriate. Identify areas within the site where runoff can be diverted around the disturbed or active work areas and ensure your ESCP (see page 17) includes the location of these controls. Any external runoff that cannot be diverted around the disturbed area is the responsibility of the developer to treat and its volume needs to be accounted for in the selection and sizing of sediment controls. Diversion drains must be adequately designed and constructed to convey water without overflowing, eroding, or failing due to excessive runoff velocity, or accumulating sediment. They should not accumulate sediment as they are only for clean runoff. Ensure the function and maintenance of diversion drains, catch drains, and soil berms are included in all site inductions.

Installing the controls:

Diversion drains: A diversion drain is a channel constructed on the upslope side of a site to divert clean upslope surface runoff from rain that would otherwise flow into the work site (Figure 3).

- Refer to diversion channel design guidance in the Diversion Channels factsheet (IECA Book 4 Design Factsheets, 2010) for design specifications, unless specified otherwise by the council.
- To protect the drain from scouring, line it with appropriately selected and installed geotextile, matting, or rock, or create rock check dams (see page 28).
- Ensure the drainage channel is at least 300mm deep (depending on your catchment size) with a freeboard of at least 150mm, and with a curved or flat base.
- Place the excavated soil from the channel on the down-slope side to increase the capacity of the diversion drain.

- If clean water from the diversion drain is not connected directly to the stormwater connection, flows must be diverted to a stable drainage area (via a level spreader) to ensure that the channel does not itself cause erosion where it discharges.
- The diversion drain must be kept clean and free of plantings and mulch to avoid obstructing water flow.

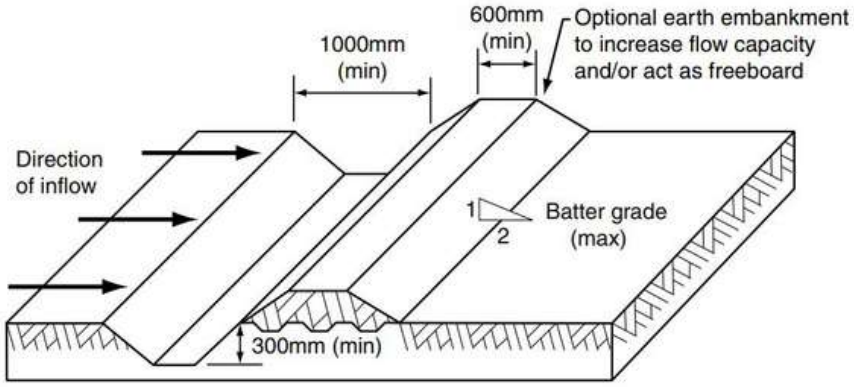


Figure 3: Typical profile of a diversion drain with downslope bank to increase flow capacity. *Figure from Catchments and Creeks Pty Ltd.*

Level spreader: A level spreader is a wide, level overflow sill built across a slope at the outlet of a diversion drain. It allows even spread of water flow, so velocities are reduced, and soil erosion is avoided. This should only be constructed to release water to a protected 'No-Go-Area' where:

- water flow will not become concentrated;
- soil is stabilised and the area is not within the path of construction activities;
- ground remains well-vegetated and can absorb water; and
- discharged water flow will be slow moving.

If the area is sloped or the runoff is at high flow velocities, a grass or geotextile fabric lined channel is required to return the diverted clean runoff to the site stormwater connection.

Maintaining upslope drainage controls:

Regularly check diversion drains, the connection to stormwater infrastructure, or level spreader outlet to a 'No-Go Area' for signs of damage, erosion, or sediment build-up, and maintain them accordingly. Inspections should be carried out specifically before and after rain events.

SCOUR PROTECTION

WHAT IS THIS?

Scouring is the erosion of soil by water, usually caused when fast-moving water removes sediment from around unprotected pipe and channel outfalls, or along unprotected open drainage channels. Rocks, matting, vegetation, or standing water can be used to prevent scouring by slowing down and breaking up concentrated flows, protecting and extending the life of existing controls and infrastructure. Consider what type of scour protection is appropriate for the gradients of your site and the expected runoff velocities, noting that fibre rolls, sandbags, and rock check dams are only appropriate for low velocities.

WHAT DO I NEED TO DO?

Before starting site works:

Protect temporary pipe outfalls: Temporary outfalls should be located in areas where there is a low potential for soil erosion (e.g. areas of naturally occurring rock). If this is not possible, create a hard rock scour protector below the outfall point (Figure 4). In instances where the temporary outfall feeds into a natural waterway, use natural rock and vegetation to prevent scouring. If the outfall will be the permanent stormwater connection, or will become public infrastructure, the location and design must be approved during the planning permit process, and/or be approved under a permit to construct public infrastructure.

Check dams: These are semi-pervious temporary dams typically created using loose or bagged rock, fibre rolls, or sandbags, that are placed in series along unlined, open drainage channels to 'check' (slow) the flow of water. Check dams are only suitable for small catchments (less than 4 hectares) and gently sloping channels with a grade of less than 10:1 (Horizontal:Vertical). For steeper slopes or larger catchments, use drainage controls lined with matting or rock (see Lined drainage channels section below). Drainage channels with check dams are for temporary use to protect a work site and must be removed at the completion of the development.

REMEMBER:

- DO NOT place check dams in channels that are already stabilised with vegetation.
- DO NOT construct check dams using sediment fences or straw bales; use secured fibre rolls, sandbags, or preferably, rocks.
- DO NOT construct check dams where dispersive soil is present (see page 36).

Lined drainage channels: Drainage channels which are steeper than 10:1 (H:V), below larger catchments, and with the potential for high flow velocities must be protected with natural or geotextile material, reinforced turf or rock. These drainage channels must be designed for the specified range in flow velocities and shear stress. Generally, rock is used for higher flow velocities and where good vegetation cover cannot be expected. When using matting, consider the longevity of the material in its application. For example, jute and coir mats have a lower allowable velocity limit compared to synthetic products, but synthetics can result in environmental pollution as they break down into microplastics. See the Drainage Control Factsheet series (IECA Book 4 Design Factsheets, 2010) for more detail.

Installing the controls:

Protect temporary pipe outfalls:

- Excavate the outlet pad footprint so that when the rock is placed in the excavated pit the top of the rocks will be level with the surrounding ground.
- Line the excavated pit with geotextile filter cloth, preferably using a single sheet or overlap by 300mm and ensure the filter cloth is protected from perforation or tearing during installation.
- Ensure that the rock used for scour protection is appropriately sized for the depth and flow rate as per Outlet Structures factsheet (IECA Book 4 Design Factsheets, 2010).
- Ensure there are at least two layers of rocks, and position larger rocks to ensure that the upper surface is not above the bottom of the pipe.

Note: If low water flow has been determined for the outfall (velocities not exceeding 1.5metres/second), 75mm rock may be used and stabilised with native grasses.

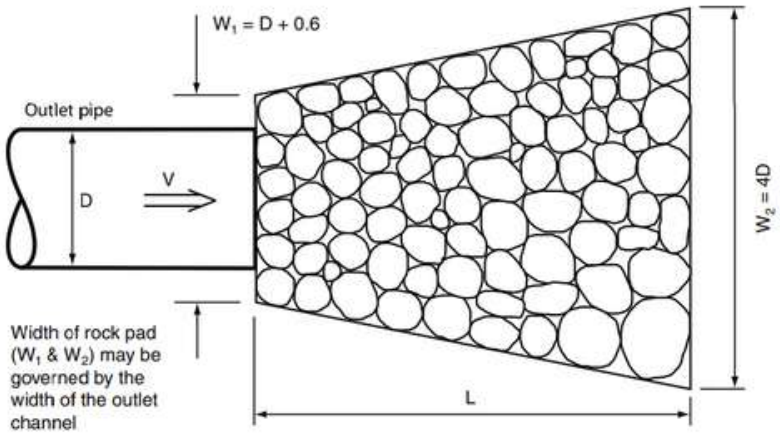


Figure 4: Plan view diagram indicating the dimensions and construction details of a recessed rock pad, which would act as protection against scour at a pipe outfall. *Figure from Catchments and Creeks Pty Ltd.*

Check dams: The number and frequency of check dams is based on the catchment size and slope of the drainage channel. General installation principles:

- Excavate a shallow (200mm) trench perpendicular to the drainage channel and prior to any channel curve.
- Place rocks or bags in the excavated trench and build up the dam wall. Check dams can be constructed with clean rocks or aggregate (washed sand/gravel) placed in geofabric sandbags for easy deconstruction.
- Ensure that the height of each dam 'spillway' is a minimum of 150mm below the outer wing points (Figure 5) with the spillway centred and built as wide and level as practical.
- Check dams rely on water overtopping the upstream dam onto standing water that pools and backs-up due to the height of the downstream dam. Space individual check dams so the downstream toe of the upstream dam is level with the spillway of the next downstream dam (Figure 5). Otherwise extend the downstream toe of each check dam to prevent scour and ensure regular maintenance checks are carried out.
- Ensure the outer edges of the check dam are continued up the slope to prevent flows scouring around the sides, which is the most common cause of check dam failure.

Note: If bagging rocks for building check dams, use geofabric bags or purpose-built netting rather than hessian bags, as hessian rots and breaks down, contributing to pollutant loads. Retrieve and dispose of bags or nets appropriately at the end of their use.

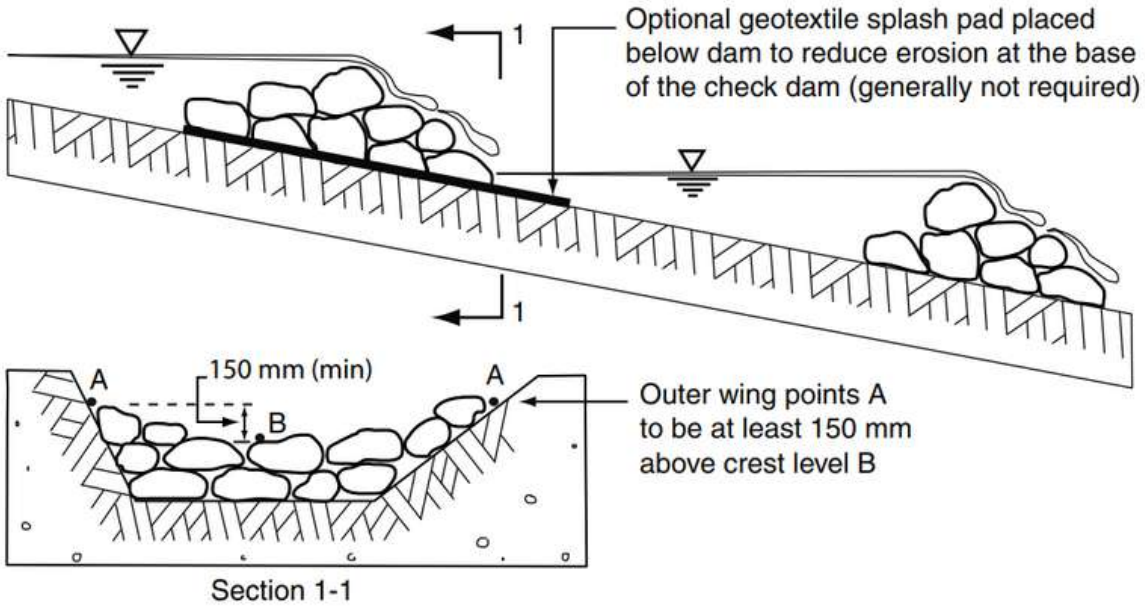


Figure 5: Cross-section and plan diagrams indicating the dimensions and construction details of a temporary check dam, shown in profile. *Figure from Catchments and Creeks Pty Ltd.*

Lined drainage channels - erosion mats: Drainage channels can be lined with synthetic or natural-fibre erosion mats - read the product installation manual and/or check with the manufacturer regarding appropriate application prior to installation. General installation principles:

- Remove surface irregularities to avoid puncturing.
- Anchor the upslope edge of each mat by backfilling within a 300mm deep by 150mm wide anchor trench (wire staples/pins can supplement).
- Overlap downslope mats with upslope mats by at least 300mm.
- Get good and consistent contact with the ground surface using 100mm wide by 150mm penetration length U-shaped, 8 to 11 gauge wire staples.
- For more information, see *Meshes, mats and blankets* section, page 44.

Lined drainage channels - rock: Rock lined drainage channels need to be installed according to approved plans, which must specify the location, extent, and rock size to be used for the expected flow velocity. General installation principles:

- Channel must be over-cut to a depth equal to the specified depth of rock placement so the finished rock surface will be level with the surrounding land.
- Base of the excavated channel must be lined with robust geotextile or equivalent.
- Armour rock must be placed so that it forms a dense, well-graded mass with minimum voids.

Maintaining the controls:

Inspect these scour protection controls prior to forecast rain, daily during extended periods of rain, and after significant runoff producing rain. For erosion mats, inspect for damage and if water is undermining the fabric, replace as necessary. For check dams and rock lined drainage channels, replace any displaced rock with rock of a significantly (minimum 110%) larger size than the displaced rock. Check dams require regular maintenance as accumulated sediment needs to be removed to prevent it becoming resuspended in the next rain event.

Drainage channels with check dams are for temporary use to protect a work site and must be removed at the completion of the development. Immediately after construction appropriately stabilise all disturbed areas.

EARLY DRAINAGE CONNECTION

WHAT IS THIS?

Connect roof downpipes and other drainage from sealed surfaces to the site stormwater connection as soon as the roof is on or other impervious surfaces are constructed, such as driveways, parking areas, or building slabs (Figure 6). If the permanent pipes and drainage cannot be installed yet, install temporary flexible downpipes. This control prevents 'clean' rainwater running through the disturbed or active work area, thereby reducing risk of pollution, the amount of water needing treatment, and saving time and money.

WHAT DO I NEED TO DO?

Before starting site works:

- Install a new permanent stormwater connection to the public stormwater system as approved by your plumbing permit prior to work, or identify the existing connection. Ensure it is functional and appropriately sized for the development. Only one stormwater connection is allowed per lot, unless otherwise approved under the *Urban Drainage Act 2013*.
- Ensure the stormwater connection location and design is included in your approved ESCP (see page 17).
- Ensure the function and maintenance of temporary drainage connections are included in all site inductions.

Installing the control:

- Ensure you have temporary flexible downpipes and other suitable materials on-site which are long enough to be connected to the site's stormwater connection.
- As soon as the roof goes on or impervious area is constructed – if the permanent pipes and drainage cannot be installed yet – connect temporary downpipes and other drainage such as flexible tubing to the site stormwater connection. Install the permanent private stormwater system as soon as possible.

Maintaining the control:

Check that the early drainage connections are in good order whenever rain is forecast, and after rain.

Figure 6: It is important to connect downpipes as soon as impervious surfaces are created. *Figure modified from the 'Do It Right On Site' brochure series, Southern Sydney Regional Organisation of Councils.*

EROSION CONTROLS

MINIMISE SOIL DISTURBANCE

WHAT IS THIS?

The less ground you disturb, the lower the risk of generating sediment, and the less controls and treatment you will need to do, saving you time and money. Timing ground disturbance with the commencement of building and construction work reduces the time that soil is exposed to the risk of erosion. Remember to check your site for dispersive soil (see page 36).

WHAT DO I NEED TO DO?

Design considerations:

- Limit earthworks by working with the natural contours of the site and avoiding construction on steep slopes. If building on a slope, choose a subfloor design and method that will minimise excavation.
- Limit the area of soil disturbance to the minimum required.
- Staging works - schedule earthworks in phases throughout the project to reduce erosion potential and rehabilitate or at least cover exposed areas quickly to reduce the amount of soil exposed at one time.
- Include specific drainage, erosion, and sediment controls for the excavation area in your approved ESCP (see page 17).
- Retain stripped topsoil in a protected stockpile for reuse as the top layer during landscaping and site rehabilitation.
- Areas of soil disturbance on slopes are more likely to erode and should be stabilised as soon as possible - roughen and terrace correctly to reduce erosion, and cover with erosion control blankets, mats, turf, mulch, or appropriate temporary soil stabilisers (see pages 41 & 44).

Before starting site works:

- You must NOT do any site disturbance before all permits, licences, and approvals have been obtained and you are ready to start work.
- Install drainage, erosion, and sediment controls early, as per your approved ESCP.
- Identify vegetation, including grass buffers, around the construction site to preserve throughout the development. Mark these as No-Go-Areas (see page 38) on all work plans, including the ESCP.
- As part of their site induction, ensure the operators of earthmoving equipment are aware of the excavation area limitations, where No-Go-Areas and stockpile areas are, and their maintenance requirements.

Once site works have commenced:

- Ensure all ESCP drainage, erosion, and sediment controls are maintained.
- Ensure vegetation buffers are protected.
- Carry out staged clearing/excavation and stabilisation.
- Stabilise and protect stockpiles with secured geofabric, plastic, or vegetation (see page 47), a diversion drain above (see page 26), and a sediment fence below (see page 67).
- Include an explanation of the function and maintenance schedule of controls in all site inductions.

Soil roughening

When using heavy machinery with continuous track propulsion (e.g. excavators) on exposed slopes:

- DO NOT smoothly grade slopes with compacted soils. This will increase runoff, is hard to revegetate, and is highly susceptible to soil erosion.
- DO NOT run tracked heavy machinery across the slope. Track marks will create furrows that water will flow down when it rains.
- DO run tracked heavy machinery up and down the slope to create grooves from the tracks that will catch seeds, fertiliser, and rain. The grooves will roughen the surface in a way that will slow runoff over the slope (Figure 7).

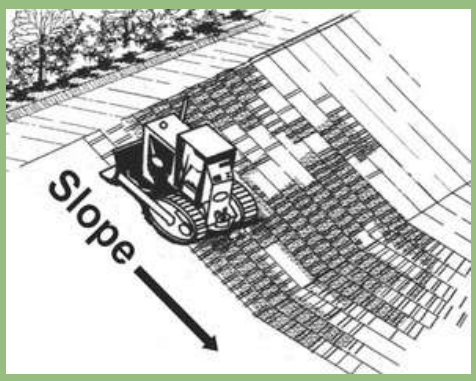


Figure 7: When using heavy machinery running on tracks (e.g. excavators), surface roughening should occur up and down the slope, not across. *Figure from Environment Canterbury Regional Council.*

Maintaining the controls:

If topsoil has been removed, replace it from where it was stockpiled - this will facilitate more rapid revegetation and stabilisation of the site (Figure 8).

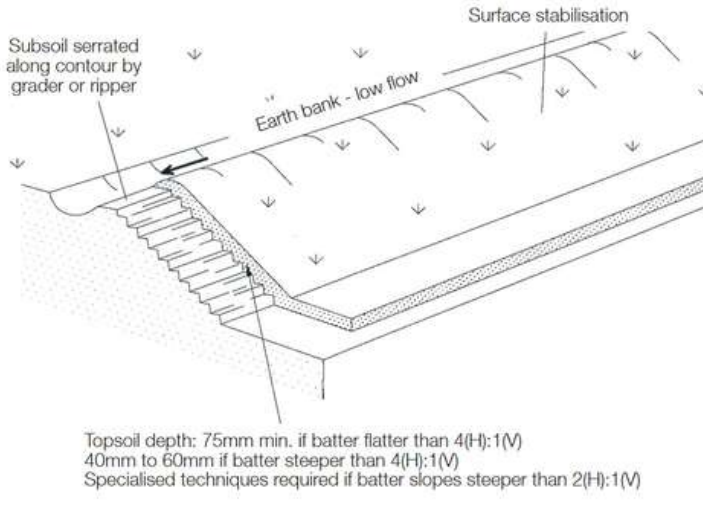


Figure 8: Before topsoil is replaced on slopes, the subsurface must be serrated along the contour by grading or ripping. Once replaced, topsoil should be stabilised using erosion control blankets and vegetation. *Figure from Landcom 2004 'Soils & Construction Volume 1 Managing Urban Stormwater (4th edition)'.*

SPECIAL CASE - DISPERSIVE SOIL

WHAT IS THIS?

Dispersive soil forms a dissolved slurry when it comes into contact with fresh water due to an imbalance in soil chemistry. This type of soil is also known as sodic soil because of a high sodium content: >6% exchangeable sodium. If this soil is disturbed during development and exposed to rain and runoff, soil dispersion and collapsing can result (Figure 9), which can lead to tunnel and gully erosion which is difficult and costly to repair. Building activities such as excavation, topsoil removal, and ponding of rainwater all increase the risk of initiating tunnel erosion. Dispersive soil has a patchy distribution but is particularly prevalent in southern Tasmania. Because this type of erosion is difficult to combat, it is important to know if your site contains dispersive soil, and to protect this soil from disturbance or exposure to water.

WHY IS MANAGING DISPERSIVE SOIL IMPORTANT?

Preventing exposure of dispersive soil is important to protect infrastructure and the surrounding environment. Exposing dispersive soil to runoff may result in the formation of rills which can quickly enlarge to form deep surface gullies or invisible underground tunnels. When underground tunnels collapse, they can result in surface slumping, which can undermine foundations, resulting in damage to buildings, roads and service infrastructure, septic systems, and increase environmental and public health risks.

The runoff from areas of disturbed dispersive soil will contain large amounts of clay and will appear cloudy and turbid. Because it is extremely fine, it is very difficult to remove this clay without the addition of chemical coagulants or flocculants (see page 77). If this runoff enters local waterways, it will reduce light levels and decrease water quality causing environmental harm.

WHAT DO I NEED TO DO?

Before starting site works:

The presence of dispersive (or sodic) soil must be identified at the planning permit stage via the Tasmanian government LISTmap layer 'Soil Vulnerability – Sodicity Hazard', and/ or by a qualified soil specialist. The approved plans must accurately show areas of dispersive soil on the site. Development should avoid areas of dispersive soil and minimise disturbance to topsoil and vegetation in these areas, including excavation and subsoil exposure.

Managing your site for dispersive soil:

- Avoid concentrating water flow over the areas of dispersive soil shown on the plans. Divert runoff into specifically designed sediment control systems where the soil is not dispersive, or where the ground has not been disturbed and sufficient vegetation is present. Remember dispersive soil can be very patchy in distribution.

- When diverting runoff where dispersive soil is present, **DO NOT** disturb the ground – **DO NOT** dig drains or create soakage pits. Create 'above-ground' diversion berms/banks on top of the ground with suitable material or topsoil to create banks upslope of areas of dispersive soil. This maintains grass in the diversion area and reduces infiltration directly to the subsoil.

- Immediately infill any trenches or holes required for construction to prevent collection and ponding of water on subsoil surfaces.

- Always compact dispersive subsoil that has been disturbed or excavated. Dispersive soil requires above-average compaction. Consider using a 'whacker packer' for small areas or a 'sheep's foot roller' for large areas.

- If the soil pH is > 6.5, top dress the surface of potentially dispersive soil with gypsum, or if the soil pH is < 5, dress with lime. If soil pH is within the range of 5 to 6.5, use a mix of both gypsum and lime. If unsure, contact a soil specialist for advice.

- Cover dispersive soil with a minimum 100mm layer of nondispersive soil and bury subsoils prior to revegetation.

- If the approved plans showing the location of dispersive soil on-site are not consistent with site conditions, have them reviewed and revised by a suitably qualified person before proceeding with work.

Note: Covering dispersive soil directly with rock or another permeable material, which will allow water to continue to contact the problematic soil will NOT fix the problem. Dispersion and tunnel erosion is likely to continue. You can seek further information and advice on the issue of dispersive soil and tunnel erosion from the council, a geotechnical expert, soil scientist, or engineer.

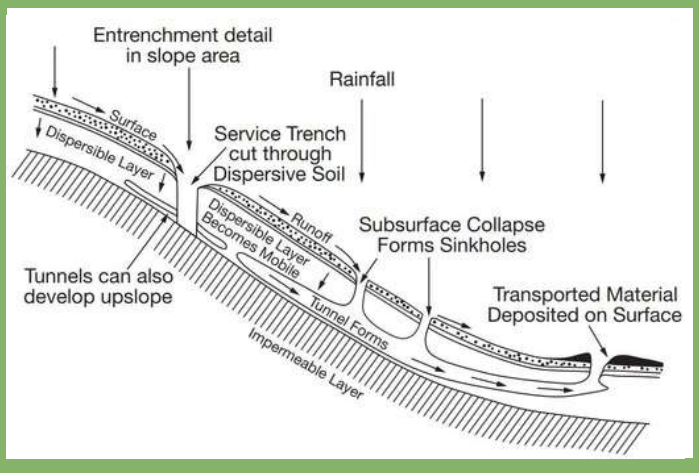


Figure 9: Cross-section illustration of how tunnel erosion can occur in dispersive soil when exposed to rain and runoff. *Figure modified from 'Field Erosion its Characteristics and Amelioration', Boucher (1990).*

PRESERVE VEGETATION AND MAKE NO-GO-AREAS

WHAT IS THIS?

Preserving grass, trees, and shrubs to protect soil from erosion by rain or wind is your cheapest and most effective form of erosion control. By keeping vegetation over half your development site, you will likely reduce the amount of erosion by half, halve the clean-up and maintenance work, and reduce the cost of keeping sediment controls operational during works. Preserving topsoil and existing vegetation along the lower boundaries of your development site can complement formal controls by acting as a natural sediment filter for upslope runoff.

WHAT DO I NEED TO DO?

Before starting site works:

Plan to keep as much of the original vegetation (grass, trees, shrubs) on the site by establishing 'No-Go-Areas' outside of the building and construction footprint and include this information on your approved ESCP (see page 17). The purpose of a No-Go-Area is to be a buffer and natural sponge for runoff from rain. It is particularly important to preserve vegetation in areas which are down-slope of the work site, where they can complement your formal on-site controls. Fence off the No-Go-Areas by placing coloured tape or other bright materials around the vegetated areas to be protected. Ensure function and maintenance of No-Go-Areas and other protected vegetation is included in all site inductions.

Keep groundcover plants bordering surface drainage areas and on steeper slopes. Native vegetation along streams and waterways must be retained and protected from sediment by installing additional sediment controls up-slope (e.g. fibre rolls and sediment fences, see page 67). Where vegetation in or adjacent to drainage channels has been approved for removal by the council, leave it in place for as long as possible to act as a natural erosion and sediment control, and stage earthworks to minimise the amount cleared at any time.

Once site works have commenced:

Maintain your No-Go-Areas and any public nature strips adjacent to your site. **DO NOT** allow vehicles to drive over or park on these areas. **DO NOT** allow materials to be stored or stockpiles to be made in these areas. Any native or non-weedy vegetation removed should be mulched and utilised on-site (see page 39).

Note: In the case of subdivisions, the responsibility to preserve vegetation rests with both the subdivider and their civil contractors and the individual lot developers.

MULCHING

WHAT IS THIS?

Mulching can be a cost-effective temporary way of protecting soil from water and dust erosion on a development site, as well as being part of landscaping or revegetation at the end. Mulching involves spreading dry, heavy plant material over disturbed ground to prevent erosion from rain or wind. If vegetation has to be cleared for the development, where appropriate, non-weed plants can be converted to mulch via chipping or shredding. Mulch can assist seedling growth by reducing moisture loss from the soil and suppressing weed growth.

WHAT DO I NEED TO DO?

Before starting site works:

- Include all areas to be mulched in your approved ESCP (see page 17).
- Keep as much existing vegetation cover on your site as possible and only remove vegetation to be mulched immediately prior to earthworks.
- If importing mulch, use only certified weed free mulch and check with a revegetation specialist to ensure use of mulch is suitable for the site and intended use.
- Process appropriate non-weedy vegetation removed during site preparation for mulch.
- Avoid putting mulch on steep slopes (unless secured) or in drainage lines or overland flow paths - displaced mulch can block your controls and become pollution.
- Install diversion drains or berms above batters to protect mulch from runoff.
- Include function and maintenance schedules for mulch in all site inductions.

Installing the control:

- Spread sufficient mulch to fully cover the surface of the soil, not less than 75mm thick.
- Avoid contamination with unwanted materials and weeds.
- Ensure the application surface is free of deep wheel tracks or ruts which may promote flow concentration down the slope and dislodge mulch (see page 34).
- DO NOT place mulch in drainage channels.
- DO NOT place mulch directly onto dispersive soil (see page 36).
- Ensure mulch use is consistent with bushfire hazard requirements for the site.

Maintaining the control:

Inspect mulched areas after rain and after strong winds. If mulch has been displaced, replace to maintain coverage, secure, and install additional drainage controls to prevent future displacement of mulch.

It is not a myth - mulch stockpiles can catch on fire if not appropriately managed.

Do not stockpile mulch higher than 2m to reduce fire risk.

SPRAY-ON SOIL STABILISERS (BINDERS AND HYDROMULCH)

WHAT IS THIS?

Soil stabilisers are cost-effective, surface spray-on liquid products which can be rapidly applied to disturbed flat or sloped areas to protect soil from erosion. The stabiliser creates a protective film on the surface of disturbed ground and has a dye in it so you can see where it has already been applied. How effective the soil stabiliser or binder is, and how long it works for depends on the product, but is usually 2-3 months if the ground is not disturbed.

Hydromulch is a special type of soil stabiliser containing a slurry mix of seed, fertiliser, mulch, and 'tackifier', which is designed to be sprayed onto disturbed ground. Seeds in the mix germinate and, as plant roots grow, they stabilise the area. Hydromulch is more effective when applied over an area where the topsoil has been retained or replaced after works. The hydromulch seed mix can be adjusted for the site, and can be used to establish grasses and native shrub species.

WHAT DO I NEED TO DO?

Before starting site works:

- Ensure areas to be stabilised and products to be used are shown on your approved ESCP (see page 17).
- Keep as much existing vegetation on your site as possible and only clear immediately prior to earthworks.
- Choose the appropriate soil stabiliser for the situation. For example, soil binders may be more appropriate for temporary soil protection, and hydromulch may be better for long term stabilisation.
- Ensure that the soil stabiliser does not pose an environmental risk and choose an appropriate weather window according to the forecast.
- Read the label/product information and if necessary, check with the manufacturer about when the soil binder can be planted over. If the water repellent properties have not fully broken down, it may result in poor revegetation outcomes.

- Choose products that can withstand expected traffic movements.
- Ensure no material is displaced from the site during the application and curing periods.
- Ensure diversion drains, catch drains, and/or berms have been installed to prevent upslope runoff getting underneath the soil stabiliser.
- Ensure the purpose and maintenance schedule for the soil stabilisers is included in the site inductions for that stage.

Installing the controls:

Soil binder: Read the product label or employ a suitably qualified person to determine the correct mixing ratio and application rates, surface preparation, and cleaning of equipment.

- The soil may need to be roughened. Allow sufficient drying time for applied product before forecast rain or dew.
- **DO NOT** apply to vegetation, areas of standing water, or to frozen soils.
- **DO NOT** apply in drainage channels or on slopes steeper than 3:1 (H:V).
- **DO** restrict vehicle and pedestrian access to the treated area to avoid damage.

Photo credit: Vital Environment

Soil binders are cost-effective and can be rapidly applied to disturbed areas to protect soil from erosion.

Always read the label carefully and do not apply to slopes steeper than 3:1 (H:V)

Hydromulch: Specialised equipment and experienced operators are required for hydromulching, including appropriate soil testing and preparation. Suitable subsoil and topsoil are fundamental to successful revegetation using hydromulch. Spreading topsoil from your protected stockpiles (see page 47) prior to hydromulch treatment will increase application success. The sprayed-on hydromulch 'slurry' will provide initial surface stability, and once the vegetation is growing, medium to long term soil stability will be achieved.

- Contract an experienced operator to apply hydromulch to your site.
- Ensure that the soil has been tested and site conditions considered to determine the right hydromulch product for your site.
- Prepare the correct soil moisture levels and surface conditions for the selected product.
- Install upslope drainage or berms to control runoff and scouring potential.
- With the specialised equipment and experienced operators, apply the product evenly with multiple passes.
- Restrict vehicle and pedestrian access to the area to avoid damage.
- Water as required to promote and maintain suitable germination and plant growth.

Maintaining the controls:

Soil Binder: Soil binders have a limited design life that can be affected by weather and traffic. Protect the application area from vehicle and pedestrian access to avoid damage. Re-application may be required – check the label for the suggested application frequency.

Hydromulch: Inspect the application area regularly to ensure sufficient moisture to maintain plant health. Water, weed, fertilise, and mow as required. After rain inspect the area to check for erosion or movement of mulch. If erosion is observed or runoff displaces more than 10% of the mulch media, fix your drainage controls to prevent further erosion or movement, and reapply hydromulch.

MESHES, MATS, AND BLANKETS

WHAT ARE THESE?

Erosion control meshes, mats, and blankets are used as a soil cover and a protective barrier to control erosion and/or allow vegetation to establish on steeper slopes and higher erosion risk areas, including stockpiles. Certain types of mesh, mats, and blankets can also be used in flow paths and drainage channels as scour protection. These controls can be thick or thin, made from biodegradable fibres or synthetic materials, and can be open mesh, full coverage, or a combination. When applied correctly they are one of the most effective ways to control erosion on disturbed land and can assist in weed suppression while allowing native vegetation to re-establish.

WHAT DO I NEED TO DO?

Before starting site works:

Identify where erosion risk is greatest on your site and where lesser controls may be ineffective. For example, consider areas of bare soil on slopes steeper than 3:1 (H:V), or steep drainage channels receiving high flow velocities. Consider likely delays in building and construction work or site rehabilitation. These situations may benefit from the soil being covered with meshes, mats, or blankets, which provide instant erosion protection and have a wide variety of lifespans and weave sizes to choose from. When deciding on a product, consult the supplier or manufacturer and read the product specifications to select the right product for the application, and make sure that you understand the correct installation procedure. The longer the service life of the product, the greater the protection provided against the erosive force of water.

Make note of areas where meshes, mats, or blankets will be used in your approved ESCP (see page 17) and ensure the purpose and maintenance schedule for the control is included in the site inductions for that phase. A brief description of erosion control mats and blankets is on the next page.

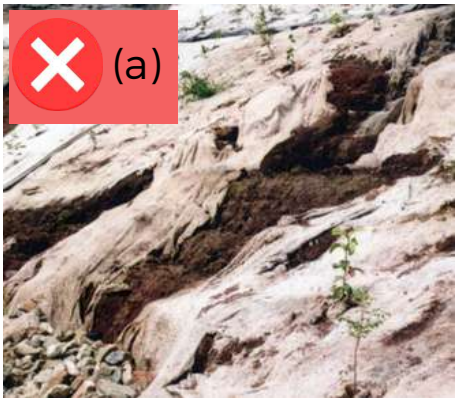
Erosion control mats (ECMs): ECMs are usually a biodegradable mat (e.g. jute or coir), with or without a synthetic reinforcing mesh. ECMs are generally applied to soils subject to concentrated flow such as drainage channels and suit a wide variety of flow conditions depending on the product. Organic and 100% biodegradable mats are suitable for short term applications where the volume and velocity of flow is low. Mats reinforced with non-UV stabilised synthetic mesh are suitable for longer term use but can be a danger to wildlife that can get entangled in the thin webbing. Permanent mats (e.g. turf reinforcement mats - TRMs) are thicker and more durable, and usually contain black UV stabilised mesh. When correctly installed, reinforced mats and permanent mats can tolerate high volumes and velocities of flow.

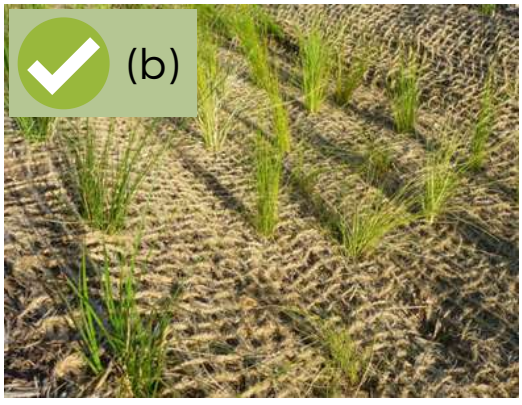
Erosion control blankets (ECBs): ECBs are generally used for establishing and reinforcing vegetation on slopes. They can be made of the same materials as ECMs, but their application is usually to control sheet-flow erosion, such as on batters with a slope steeper than 3:1 (H:V). Thin blankets allow seedlings to grow up through the blanket and have a similar effect to light mulching. Thicker blankets suppress weed growth, while allowing seeds sown by hydro-seeding on top to grow down through the blanket. The effect is similar to heavy mulching.

Installing the controls:

Install erosion control mats/blankets as soon as possible after soil disturbance to prevent rain and wind erosion (Figure 10). Installation varies depending on the type of product – consult the manufacturer or distributor for information. Key factors to remember when installing erosion control mats/blankets are listed below:

- Remove surface irregularities from the target area and prepare with seed if required.
- Always anchor the upper edge of the mat/blanket by burying within a 300mm deep and 150mm wide trench, backfill, compact, and staple at an interval specified by the manufacturer/distributor.
- Where more than one mat/blanket is used down the slope/channel, always overlap each by 300mm, with the bottom edge of the upslope mat/blanket placed over the downslope one. Remember to bury the upper edge of the downslope mat/blanket.





(a) Failed erosion control blanket due to poor surface preparation and water getting under the mat *(image from Landloch Pty Ltd.)*

(b) Well installed erosion control blanket with seedlings establishing *(image from Triton Environmental).*

- Always ensure that the erosion control mat/blanket makes good contact with the ground so that no water passes underneath.
- Erosion control mats/blankets which are synthetically reinforced with thin mesh webbing should be avoided near waterways and in bushland where they may entangle animals.
- Erosion control mats/blankets CANNOT be placed directly over dispersive soil (see page 36); minimum 100mm of non-dispersive soil must be correctly added over the dispersive soil prior to the placement of the mat/blanket.

Maintaining the controls:

Regular inspection, especially after rain events, is essential to check if the mat/blanket has been displaced by water or wind, if there are rips or tears in the material, or if water is running under the material. If so, restabilise with correct installation, anchor pins or wooden stakes. If significant erosion has occurred, repair the material and reassess/rearrange other drainage and erosion controls to reduce further impact. If erosion has caused rilling under the mat/blanket, re-grading may be necessary prior to reseeding (if required) and replacement of the mat/blanket. Continue inspections until vegetation is well established with adequate coverage to prevent erosion.

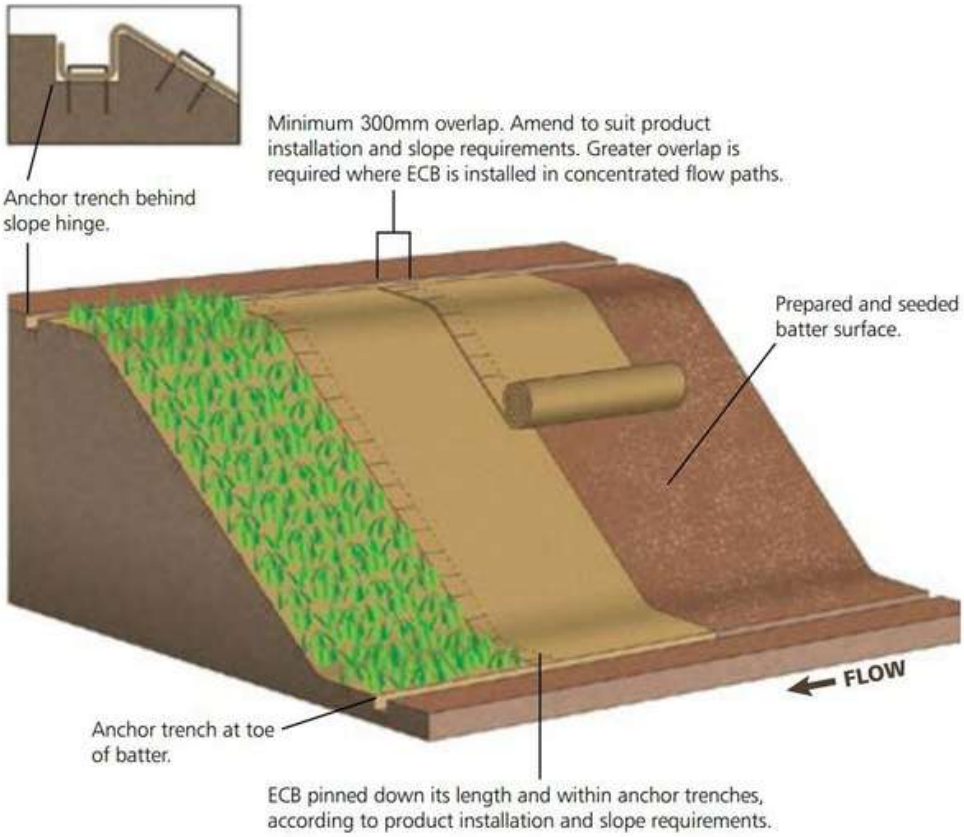


Figure 10: Correct erosion control blanket (ECB) installation showing the anchoring depth and overlap direction and width. *Figure from Roads and Maritime 'Guideline for Batter Surface Stabilisation using vegetation Fact Sheet 10'.*

PROTECT STOCKPILES AND SERVICE TRENCHES

WHAT IS THIS?

Unprotected service trenches can concentrate runoff and cause rapid soil erosion. Unprotected temporary stockpiles (including sand, gravel, topsoil, mulch, and woodchips) are at risk of being washed or blown away. Protecting service trenches and stockpiles avoids the risk of soil erosion and significantly reduces the time, cost, and frequency of clean up, and maintaining other on-site controls.

WHAT DO I NEED TO DO?

Before starting site works:

Ensure the maintenance schedule for checking stockpile and service trench protection is included in site inductions.

Stockpiles:

- Identify a protected storage area for soil and building material away from on-site drainage or stormwater/overland flow paths, on flat or gently sloping land, and show this area on your approved ESCP (see page 17).
- Avoid stockpile loss and stormwater pollution by limiting the amount of material on-site and remove all excess material when work is complete.
- Provide easily identified (i.e. well signed from the road) stabilised vehicle access for drivers delivering material to the designated stockpile area.

Note: Do not stockpile any material off site on roadways, footpaths, over gutters, or drainage areas.

Service trenches:

- If your site has dispersive soil, specific protection measures will be needed (see page 36).
- Decide where the service trenches will need to go and document them on your approved ESCP.
- Trenches must be located away from areas where water is likely to flow or concentrate.
- Where possible, coordinate the various service connections in a single trench.
- Minimise the duration that trenches will be exposed - backfill as quickly as possible.

Installing the controls:

Stockpiles (Figure 11):

- Build stockpiles as low, flat-topped, elongated mounds, less than 1.5m high.
- Place a soil bank or berm on the upslope side of the stockpile to divert water flow away and install a sediment fence (see page 67) or berm (see page 70) 1–2m downslope of the stockpile. The ends of the sediment fence must 'return' upslope at either end to capture and allow ponding of localised runoff from the stockpile.
- Securely and completely cover your stockpiles with fabric or plastic, particularly prior to forecasted rain and/or high wind and when the site is unattended, such as on weekends.
- Vegetate topsoil stockpiles (e.g. with hydromulch, see page 41) if the soil will not be immediately reused.

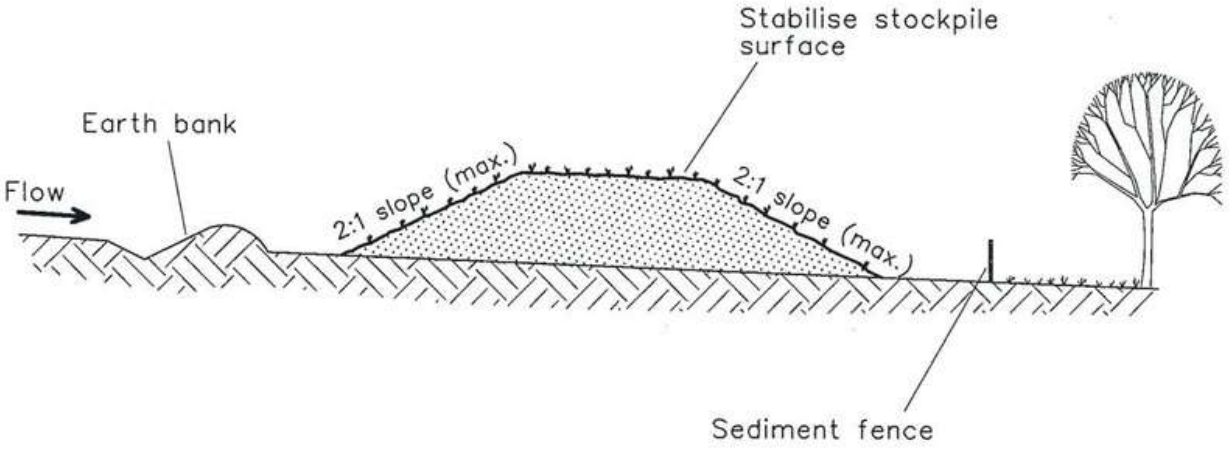


Figure 11: Diagram illustrating how to protect stockpiled material to avoid erosion. If practical, cover stockpiles with plastic sheeting or erosion control blanket and secure against wind. *Figure from Landcom 2004 'Soils and Construction Volume I Managing Urban Stormwater (4th Edition)'.*

Service trenches (Figure 12):

- Schedule trench work during dry weather.
- Store topsoil removed when excavating trenches SEPARATELY from subsoil.
- Place a subsoil bank or bund on the upslope side of the trench to divert water flow away from trenches, ensuring flows from this diversion are correctly controlled to avoid sediment in runoff.
- For long trenches (i.e. > 100m) complete works in manageable sections that can be completed and backfilled as you go. Backfill trench with subsoil and compact.
- Replace topsoil, level, and top up with more topsoil to account for soil settling, then revegetate.
- If a service trench must be installed on a steep slope, ensure back filled material is well compacted and the area is protected from scouring.
- Store/stockpile any excess soil correctly so that it does not create a wind or water erosion hazard (see stockpile section above).

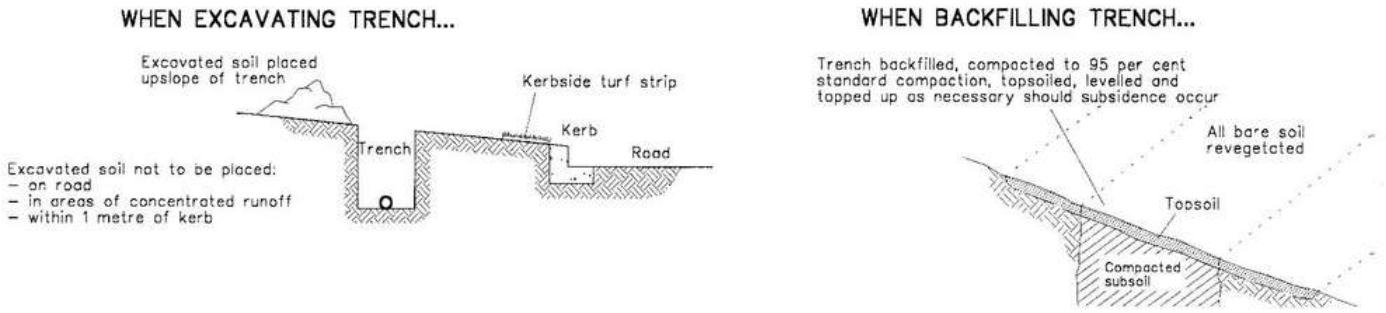


Figure 12: Cross-sectional views of how to construct and backfill a service trench to minimise erosion of materials. *Figure from the NSW Department of Communities and Justice.*

Maintaining the controls:

Stockpiles: Coverage of stockpiles must be regularly checked, especially before, during, and after rain or very windy conditions. Cover more securely if protection has shifted. The controls installed above and below stockpiles (e.g. soil banks, berms, and sediment fences) need to be monitored and maintained at the same frequency.

Service trenches: If constructed as above, water should not get into trenches. In the event that trenches fill with water from groundwater or other sources, pump water out and treat appropriately (e.g. spread evenly over a large vegetated area, or pump into a sediment basin (see page 74)). If trench water contains very turbid water, add the correct amount of approved coagulant or flocculant, and allow the suspended particles to settle before pumping the clean water out. If the water has been tested and meets specified conditions, it may be pumped to a stormwater connection (see *Dewatering* section page 78).

REVEGETATE

WHAT IS THIS?

All areas disturbed by development activities must be promptly and progressively stabilised through landscaping and revegetation to reduce the potential for erosion. To support vegetation to grow, topsoil must be stockpiled separately from subsoil, and returned as the top layer to areas stripped during works. Once a development stage is complete, topsoil stabilised and revegetation established, downslope erosion and sediment controls can be removed.

Progressively revegetating or landscaping areas as works are completed (as opposed to delaying until the end of the development) will:

- reduce the cost of rework to areas impacted by erosion;
- reduce time and cost of maintenance to sediment controls;
- avoid possible fines; and
- improve your reputation.

WHAT DO I NEED TO DO?

Site revegetation as erosion control:

As you finish works in one area of the site, revegetate it. Vegetation is an ideal and usually inexpensive method of stabilisation because it reduces soil erosion by:

- absorbing the impact of raindrops;
- reducing the volume and velocity of runoff;
- binding the soil with plant roots; and
- protecting the soil from wind erosion.

Note: Revegetation should not be expected to provide all the soil erosion protection required on your site. Other erosion controls will be required if the soil is not stable. Use erosion control meshes, mats, and blankets on steep slopes to provide temporary protection until the vegetation is fully established (see page 44). Best practice requires any exposed areas at finished levels, including stockpiles of erodible materials or inactive areas, to be stabilised WITHIN 30 DAYS (maximum) or less.

Include explanations of the function and maintenance schedule for revegetation in all site inductions.

Temporary revegetation: Once established, annual grass species (e.g. annual ryegrass – *Lolium rigidum*) are an effective temporary ground cover (for a maximum of one year) because they are fast growing and can quickly develop a root system. Use annual grass species as erosion control and prevention where:

- the area can be watered to establish and maintain grasses;
- the area can be protected from grazing by wildlife;
- exposed soil needs to be stabilised until permanent vegetation grows;
- temporary protection (between 6-8 months) is required until landscaping occurs; and/or
- the area will be re-disturbed as part of site works (e.g. topsoil stockpiles).

Note: Annual grasses DO NOT provide effective erosion control during their early growth phase (first few weeks) unless the soil is prepared with a mulch layer (see section Spray-on soil stabilisers, page 41). Annual grasses die within one season providing limited soil coverage after 6-8 months. Grass may need mowing (mow without catcher) at least once before it can provide adequate soil coverage.

Permanent revegetation: Use native species from the surrounding area which are adapted to the local climate and have the greatest potential to establish successfully. This will also save you water and create habitat for wildlife. Options include planting with native perennial (long-lasting) grasses, including tussock grass (*Poa spp*), wallaby grass (*Rhytidosperma spp*) or kangaroo grass (*Themeda triandra*), installing turf strips, planting larger native or other species from seed, tube stock or spreading from surrounding bushland. If local seed stock is to be used for propagation, collect in advance. Plant into moist topsoil, not sub-soil (Figure 13).

You may need to cultivate with ripping to 300mm if there is a compacted layer. Use mulch (75-100mm deep) to stop weeds and limit moisture loss, and tree guards to protect emerging plants from browsing wildlife. If dispersive subsoils are likely (see page 36), seek the advice of a suitably qualified person, such as a soil scientist with revegetation experience.

Note: If rainfall is low, revegetation may require irrigation for germination and to sustain plant growth. If the plants are slow growing, other erosion controls will need to be maintained until the vegetation is established and able to bind the soil sufficiently to prevent erosion.

Maintaining the controls:

The main reason for failure of revegetation is lack of maintenance, especially when plants are young and less resilient. Regularly monitor and maintain site revegetation, including watering, mowing, weeding, replacing any lost topsoil (from rain or wind), resowing grass, protecting from grazing, and replacing any dead plants.

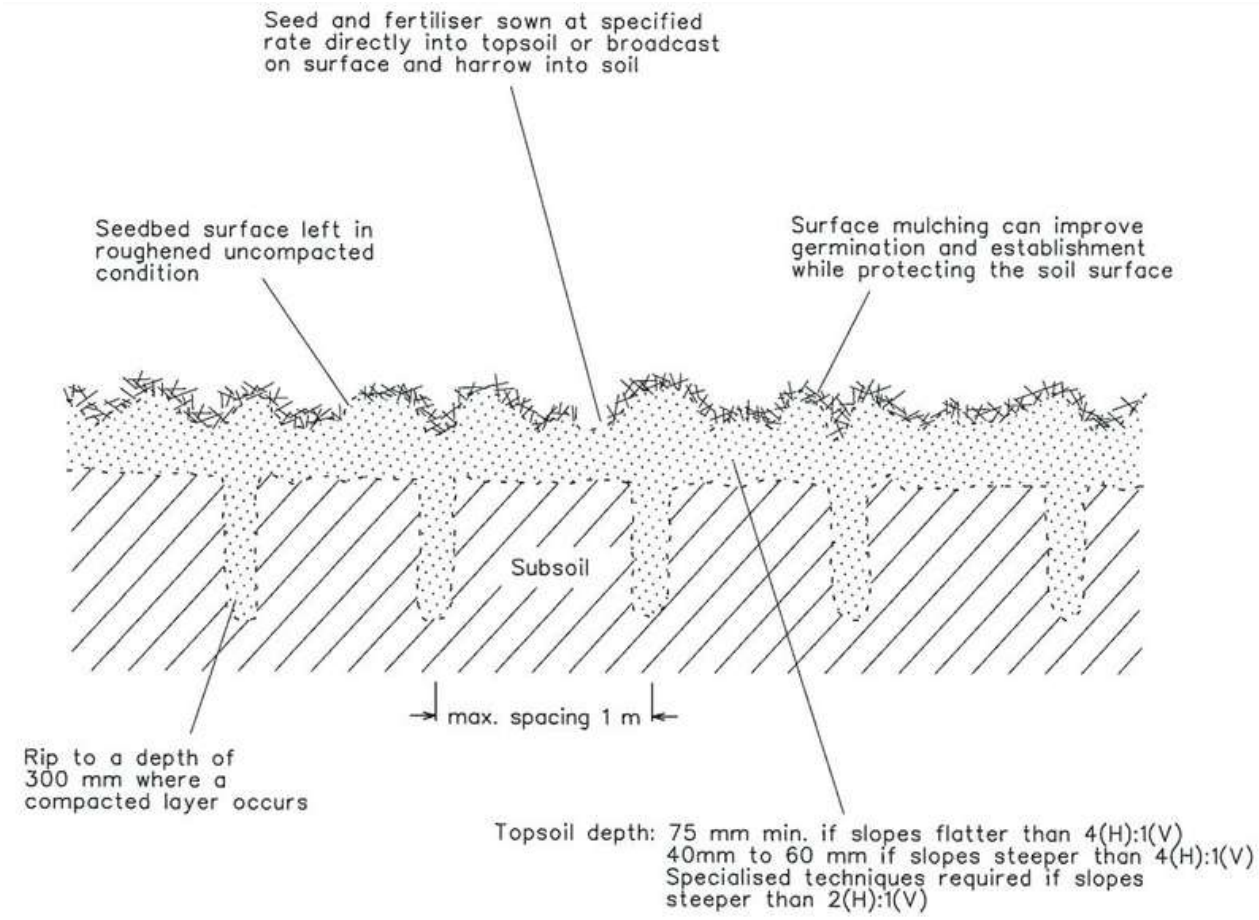


Figure 13: If revegetating with seed, surface roughening, ripping, fertilizing, mulching, and watering will assist in successful establishment of plant cover. *Figure from Landcom 2004 'Soils & Construction Volume 1 Managing Urban Stormwater (4th edition)'.*

CONTROL DUST AND LITTER

WHAT IS THIS?

Research has shown that 2.5 tonnes of dust per hectare per month can occur on sites with no dust controls. Dust and litter controls minimise the amount of dust and litter generated by wind erosion on your development site. Protect the soil from becoming airborne by setting up wind barriers or scheduling regular watering of exposed areas. Make sure all machinery have dust suppressors fitted.

Note: A sediment fence CANNOT be used as a wind barrier - they are made from different materials and are for different purposes.

WHAT DO I NEED TO DO?

Before starting site works:

Good site planning can virtually eliminate dust being a problem.

- Assess the dust potential of your site. Dust generating activities include major soil disturbances or heavy construction activity such as vegetation clearing, excavation, demolition, cutting concrete, or excessive vehicle traffic.
- Document all potential dust generating activities and the associated controls on your approved ESCP, considering the specific site, type of development, and potential weather conditions during the development period (see page 17).
- Include an explanation of dust control function and maintenance schedule in all site inductions.

Installing the controls:

- Stage works and limit soil disturbance to the minimum required for each stage (see page 34).
- Maintain as much vegetation as possible (see page 38). Existing trees and shrubs provide coverage to surface soils and act as wind breaks, slowing wind velocities.
- Install wind barriers if there is high risk of dust generation. Wind fences divert the wind up and over the site. Ensure the material used is semi-permeable open weave mesh (Figure 14), otherwise down-wind turbulence can make erosion worse.
- Dampen the site slightly with a light application of water during excavation or when dust is being raised. Be careful to only moisten the ground surface, DO NOT wet it to the point of creating mud and runoff.

- Apply mulch to recently disturbed areas (see page 39). Mulch is a cheap solution and can reduce wind erosion by 80%.
- Where plants and mulching cannot be used (i.e. on-site roads and entrances and some slopes) apply gravel and rocks.
- For large open areas for some soil types, deep ploughing (tillage) brings soil clods to the surface where they rest on top of the dust, preventing it from becoming airborne. Consult a suitably qualified soil specialist to decide whether this is appropriate for your site.
- Spray-on soil stabilisers are a versatile option and can be used on small to large sites and on flat ground or slopes (see page 41).
- Stabilised site access (see page 56) will help to reduce dust generated by vehicle movement on and off the site.
- Cover sand and soil stockpiles with anchored fabric, plastic, or vegetation (see page 47).
- Ensure that relevant equipment and machinery have dust suppressors fitted.

Maintaining the controls:

Dust controls involving the application of water require more monitoring than structural or vegetation controls, to ensure water being applied is not creating mud or runoff. If structural controls are used, they should be inspected for deterioration regularly to ensure that they are still achieving their intended purpose.

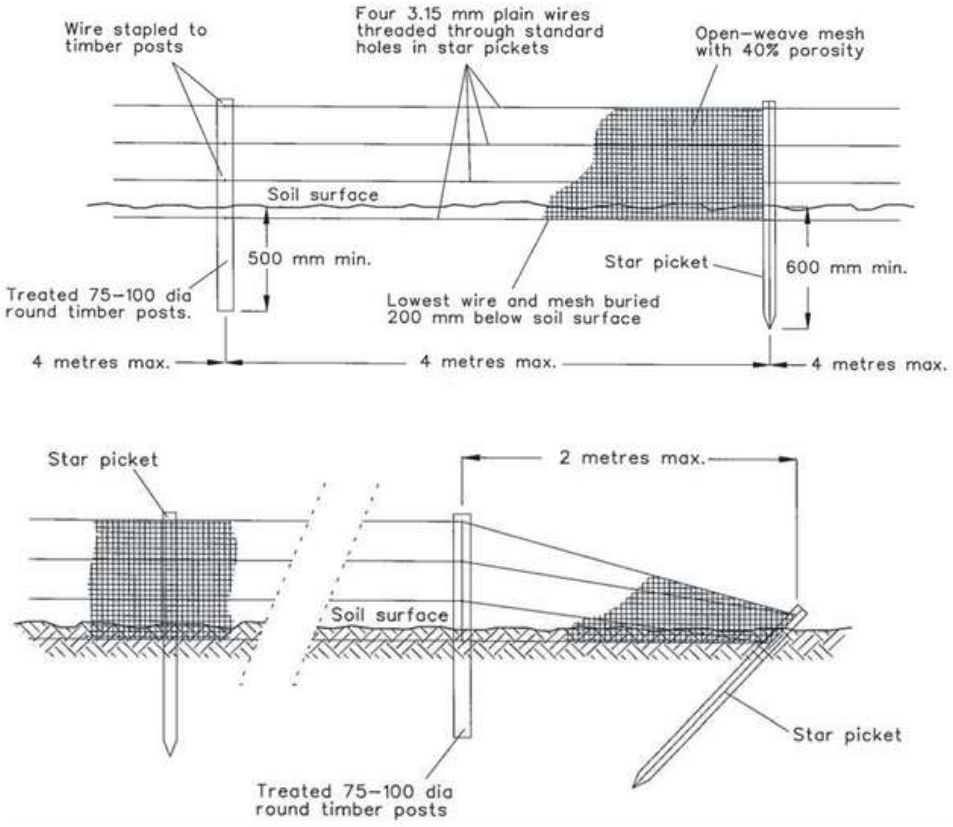


Figure 14: Construction details for the correct installation of a wind erosion barrier, including the depth and spacing of supports. *Figure from Landcom 2004 'Soils & Construction Volume 1 Managing Urban Stormwater (4th edition)'.*

SEDIMENT CONTROLS

Supplementary controls:

- Stabilise site access (pg. 56)
- Wheel wash or rumble grid (pg. 59)
- Protect stormwater pits (pg. 61)
- Protected slurry and clean-up areas (pg. 64)

Type 3 controls:

- Sediment fences (pg. 67)
- Mulch and compost filter berms (pg. 70)

Type 2 controls:

- Rock filter dams (pg. 72)

Type 1 controls:

- Sediment basins (pg. 74)
- Dewatering (pg. 78)

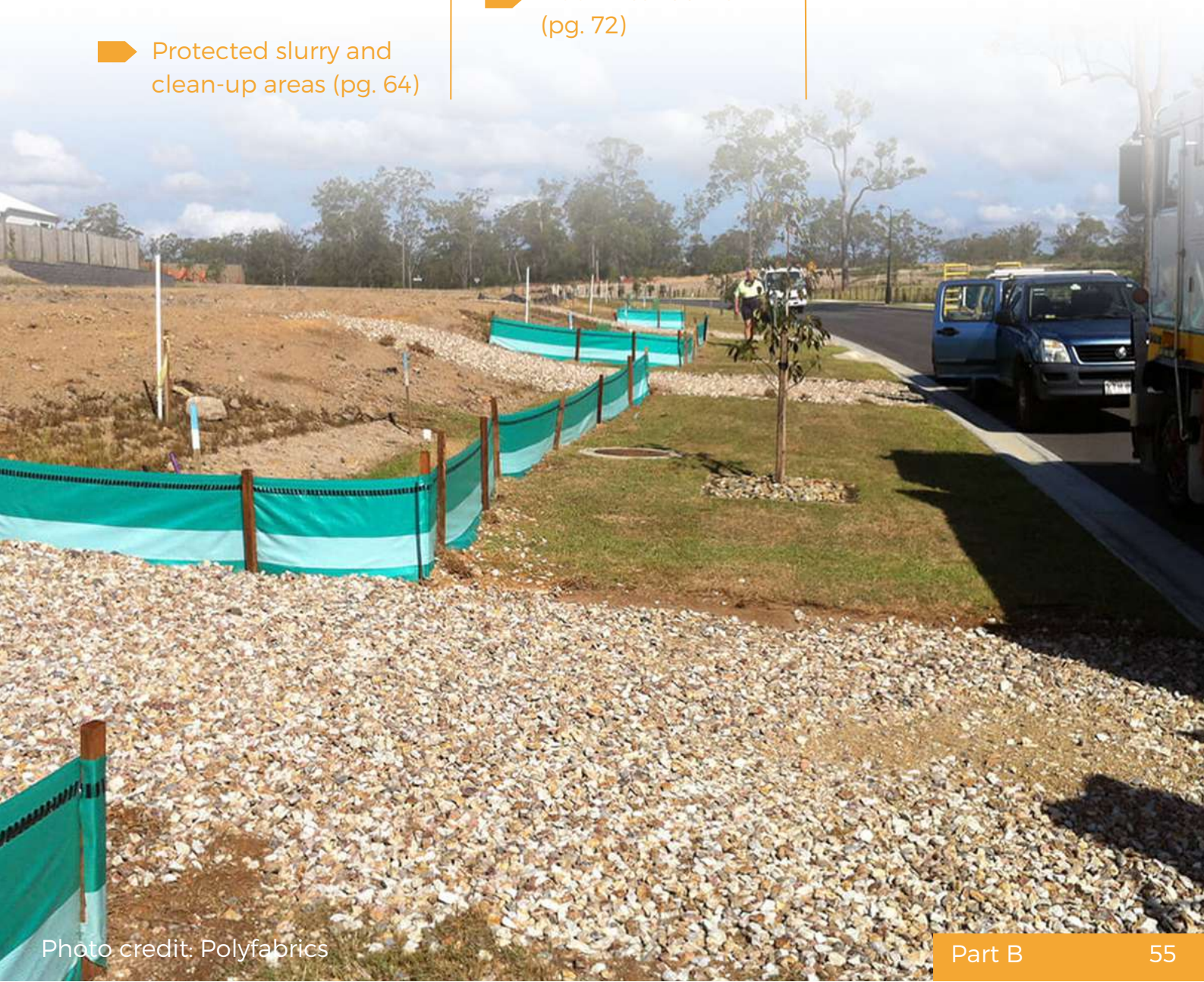


Photo credit: Polyfabrics

STABILISE SITE ACCESS

WHAT IS THIS?

Stabilised site access is a Supplementary Sediment Control and normally takes the form of a single entry/exit point to a site. It has a rock pad and reduces the tracking of soil and sediment off the site (Figure 15 & 16). The rock pad provides a clean, dry surface for vehicles to enter, unload, and exit during all weather conditions without impacting vegetation or carrying sediment onto roads. It should lead to, or be adjacent to, your formal stockpile areas (see page 47).

WHAT DO I NEED TO DO?

Before starting site works:

Identify the best location to place the stabilised site access, in an elevated position with little or no runoff flowing to it from up-slope, and away from any down-slope stormwater pits. All deliveries are to be made through this access. Document the location of the stabilised site access on your ESCP (see page 17), including rock size to be used, where runoff will be dispersed or treated, and associated controls. Include its function and maintenance in all site inductions.

Installing the controls:

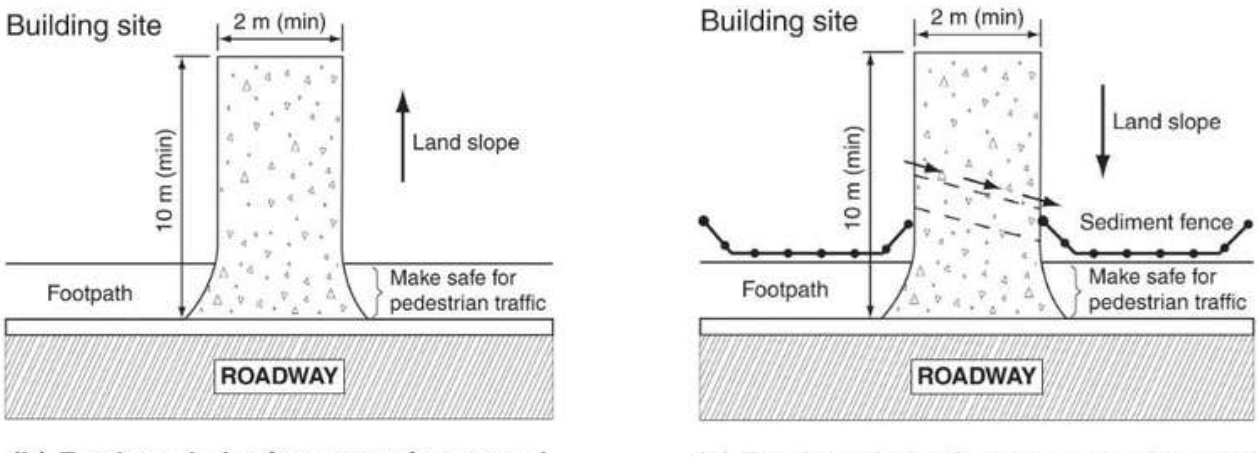
- A stabilised access is from a site boundary to a formal stockpile area or work area within the site. The minimum width and length of the access for small development sites is 2 x 10m; and for large development sites 3 x 15m.
- To prepare, strip at least 150mm of topsoil and level the stripped area, and stockpile topsoil appropriately (see page 47).
- Cover the exposed area with geotextile and cover this with a 200mm thick pad using rock, recycled concrete, or aggregate (not crushed sandstone)..
- For small sites with low truck usage, use rocks sized 50-75mm; for large sites use rock sized 100–150mm. Avoid rocks sized 75–100mm, as smaller rocks in this range can get stuck between dual tyres.
- If access slopes towards the public road, construct a trafficable water diversion hump within the lot boundary.
- Arrange to divert/drain runoff from this control to appropriate further sediment controls and ensure treated runoff can be drained to the site stormwater connection.
- If the construction process enables it, a permanent driveway can be laid and used as the access point, ensuring sediment controls as above.

Maintaining the controls:

As vehicles use the stabilised site access, they will gradually compact the gravel, recycled concrete, or rock. When it becomes too compacted the voids between the pieces disappear and the stabilised site access will no longer trap mud and dirt. Remove all materials and reinstate rocks once sediment has been appropriately removed. New geotextile will likely be required.

Monitor the surface of the stabilised site access and ensure that runoff is appropriately treated before being discharged to the site stormwater connection. Inspect the connecting public road for any accidental spread of sediment at the end of each day and clean up immediately. Sediment on the roadway outside your work site can be a traffic hazard and is a clear indicator your controls are not adequate and need immediate fixing. The council may charge you for the cost of extra street sweeping and you also risk prosecution.

Note: On large development sites where there is a greater risk of sediment being tracked off site, a 'rumble grid' or wheel wash can also be installed at the access point (see page 59).



(a) Rock pad sloping away from road

(b) Rock pad sloping towards the road

Figure 15: Rock pad construction for site access points on a small construction site (a) sloping away from the road and (b) sloping towards the road. *Figure from Catchments and Creeks Pty Ltd.*

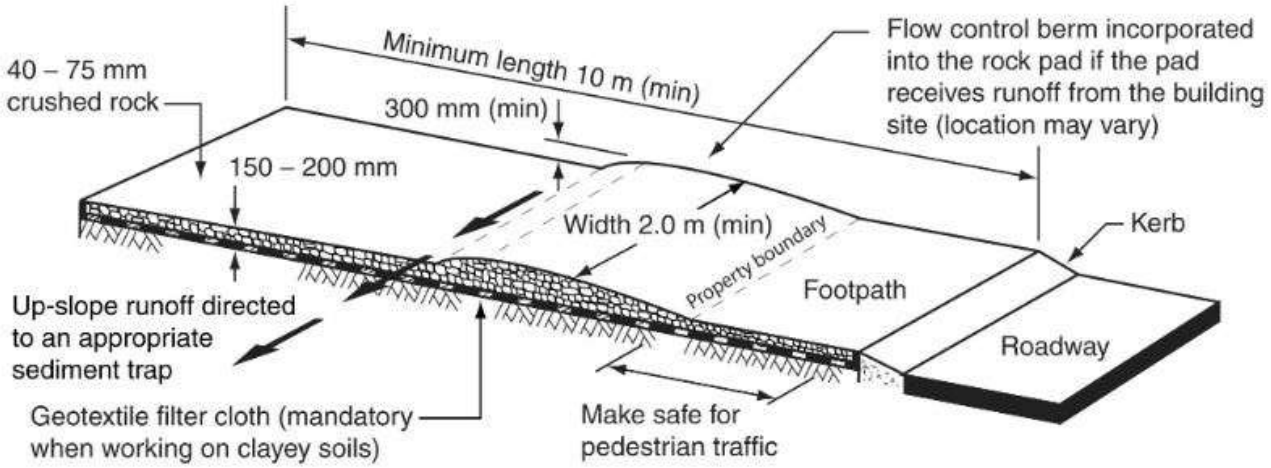


Figure 16: Dimensions and construction details for rock entry/exit pad for small building sites. For large construction sites the minimum length of stabilised site access structures is 15 metres, and a minimum width of 3 metres. *Figure from Catchments and Creeks Pty Ltd.*

WHEEL WASH OR RUMBLE GRID

WHAT IS THIS?

A wheel wash or rumble grid is a Supplementary Sediment Control that complements stabilised site access by further reducing the amount of sediment being tracked off the development site onto public roads (Figure 17). Both a wheel wash and a rumble grid should be considered for larger development sites where there is significant heavy vehicle movement on and off the site.

WHAT DO I NEED TO DO?

Before starting site works:

- Identify an appropriate location for a wheel wash on your site and include this in your approved ESCP (see page 17).
- Identify sediment controls required for the expected runoff from the wheel wash and note the type, size, and location of these on your ESCP.
- A rumble grid or 'dry' wheel wash may be appropriate where wastewater or runoff from a wheel wash cannot be managed on the site appropriately, or a water source is not readily available.
- Ensure the function and maintenance of the wheel wash is included in all site inductions.
- If biosecurity (e.g. weeds and plant disease) are an issue for your site refer to 'Tasmanian Washdown Guidelines for Weed and Disease Control' from the Department of Natural Resources and Environment Tasmania, Forestry Tasmania, and the Agricultural Contractors Association of Tasmania (or subsequent document).

Installing the controls:

- Construct a pad by evenly spreading a 200mm layer of coarse aggregate or recycled concrete greater than 50mm in size (crushed sandstone is not suitable) to a minimum depth of 300mm.
- Install a raised rumble grid/wash rack that is suitable for the known traffic and weight loads.
- Ensure water from the wheel wash does not enter the stormwater system without treatment. Provide a drainage channel to direct the runoff from the wash area to a suitably sized on-site sediment control (e.g. sediment basin (see page 74), sediment settling tank, or a flat vegetated area of adequate size). You may require a vacuum truck to service this.
- Ensure the drainage channel is correctly designed (including adequate gradient) and sized to carry the volume and velocity of wash water.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require all vehicles leaving the site with mud or dirt-caked tyres and undercarriages to use the wheel wash.

Maintaining the controls:

Inspect regularly and before forecast rain. Remove accumulated sediment from the rumble grid/wash rack and dispose of appropriately – this may be to fill on-site, or landfill. Ensure wheel wash is draining effectively to other controls and treated runoff is directed to the stormwater connection.

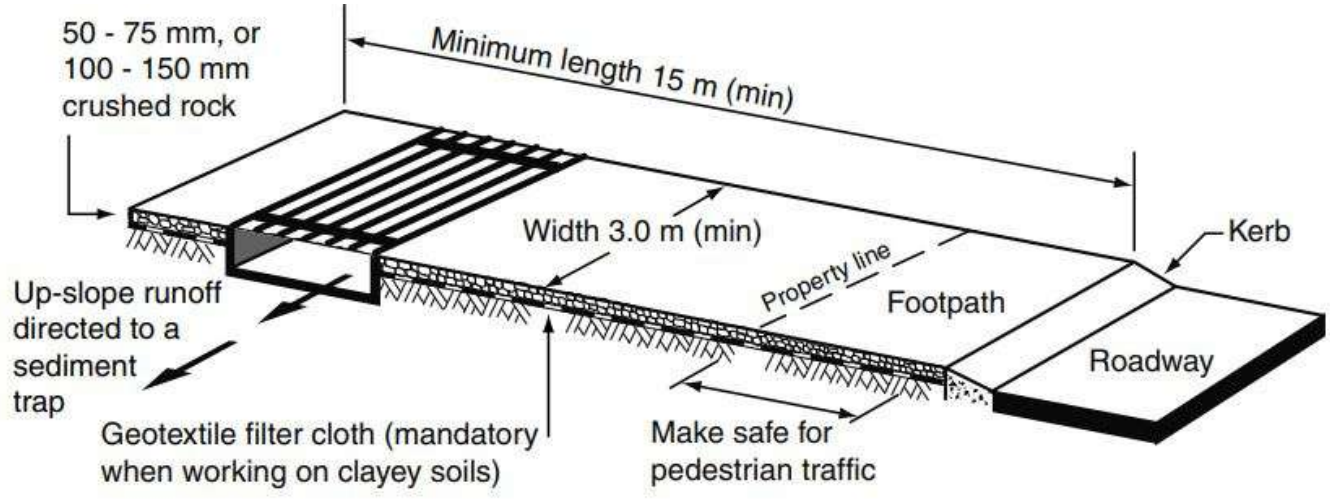


Figure 17: Typical layout of a rumble grid on a large construction site. *Figure from Catchments and Creeks Pty Ltd.*

PROTECT STORMWATER PITS

WHAT IS THIS?

As a last line of defence, stormwater pit protection (a Supplementary Sediment Control) protects the stormwater system from pollution, blockage, and accumulation of sediment and building debris. This control works by placing protection around or inside any stormwater pits on-site (private) and offsite (public). Such controls on public pits require consent from the council, state government, or the Crown (depending on who manages the road) and may require a traffic management plan. Stormwater pit protection is a last resort sediment control that should be used in conjunction with other drainage, erosion, and sediment controls and general site management.

WHAT DO I NEED TO DO?

Before starting site works:

- Identify any stormwater pits and drains on and below the site and show these on your approved ESCP (see page 17) with appropriate protection controls and maintenance requirements.
- Plan the layout of the site so that any wash-down areas, wash-out areas, and tile or brick cutting areas are not near stormwater pits (see page 64).
- Install these sediment controls before site work commences and include explanation of their function and maintenance in all site inductions.

Installing the controls:

Stormwater pit protection includes sediment fences, filter socks and stormwater pit traps. Those that collect sediment above the stormwater pit are easier to clean but have low storage capacity compared to controls that are installed inside stormwater pits. Place cones around controls in the gutters or on roads to prevent vehicles damaging them.

Sediment fence for stormwater pit protection: This is a sediment fence staked around the stormwater pit to trap coarse sediment. Fabric must be partially buried so that water and sediment does not flow underneath. The more space between the fence and the pit, the more chance of sediment settling and the greater the capacity of the trap (Figure 18). Only suitable for where pickets can be driven into the ground (see Sediment Fences, page 67). Ensure you have your Dial Before You Dig check for underground infrastructure before driving in pickets.

Figure 18: Construction details of a sediment fence for stormwater pit protection. *Figure from Landcom 2004 'Soils & Construction Volume 1 Managing Urban Stormwater (4th edition)'.*

Filter sock: This is a permeable synthetic sock, usually filled with sand, and placed in the pathway of runoff before it enters the pit. Sediment settles out with ponding up-slope of the sock (Figure 19). These can be used in many situations when secured carefully to avoid being dislodged, and require regular maintenance.

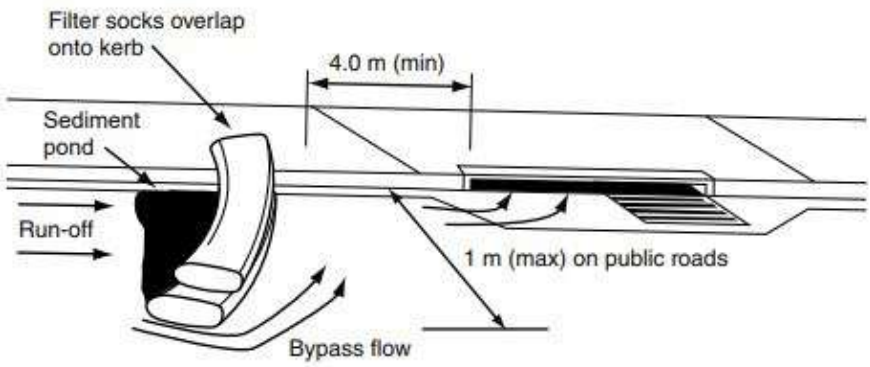


Figure 19: Correct placement of a filter sock to protect the stormwater system from sediment pollution. *Figure from Catchments and Creeks Pty Ltd.*

Stormwater pit traps: This is a basket, tray, bag, or screen placed just below the entrance of the stormwater pit. It captures coarse sediment, aggregates, and building debris before it enters the stormwater system. Fine mesh or fabric filters can be used to capture sediment. This control needs high frequency maintenance and may require traffic management. You must have consent from the relevant road authority to install this control. Not all pits are appropriate for this type of control.

Stormwater pit traps are designed to capture pollution before it runs into stormwater drains. This control is your last line of defence and must be vigilantly maintained.

Photo credit: oceanprotect.com.au

Maintaining the controls:

Inspect and clean stormwater pit protection arrangements prior to forecast rain and after rain events. This will significantly reduce maintenance time and costs. The built-up material can be re-used on-site (if not contaminated) or disposed of to landfill. Failure to maintain these controls will impact the stormwater system, increase flooding risk, and may lead to prosecution.

PROTECTED SLURRY AND CLEAN-UP AREAS

WHAT IS THIS?

Protected areas for all slurry generating and clean-up activities including concrete, brick and tile cutting, cement and mortar mixing, drilling, and cleaning of equipment, must be designed to contain wastewater. This is a Supplementary Sediment Control.

Concrete wastewater is highly toxic and can raise the pH of waterways to very alkaline which kills aquatic life when washed into waterways through the stormwater system. Disposal in the stormwater system and/or dilution is NOT an option; it would take 1 million litres of water to dilute 1 litre of alkaline wastewater back to being non-toxic.

Pollution from slurry generating and clean-up activities not only seriously impacts waterway health, but it can also form deposits in the stormwater system, reducing its capacity and increasing the risk of flooding. Additional control measures must be put in place when these activities are required to occur outside of the designated protected area (e.g. cutting of a footpath).

Section 18 of the *Urban Drainage Act 2013* states that '*a person must not discharge, or cause or permit to be discharged, anything other than stormwater into a public stormwater system*'. Dilution is not a legal option, and you can be prosecuted for allowing pollution such as untreated wastewater to enter the stormwater system. There are also harsh fines for this kind of pollution under the Environmental Management and Pollution Control Act 1994.

WHAT DO I NEED TO DO?

Before starting site works:

- Identify an appropriate location for protected slurry generating activities and clean-up area on the site, ideally away from stormwater pits and drains.
  - This area must contain all wastewater and residues in protected wastewater systems. Alternatively, wastewater can be pumped into on-site holding tanks and managed appropriately or removed with a vacuum truck. You may require a trade waste permit from TasWater.
  - The designated area may be best located close to your formal stockpile area (see page 47).
- Identify additional controls to ensure stormwater pits are always protected in case of accidental pollution (e.g. filter socks, see page 61).
- Include the location of this area with associated sediment controls in your ESCP (see page 17).

Installing the controls:

- The designated slurry generating activities and clean-up area must have a diversion channel up-slope to divert clean water around the area (see page 26), and wastewater collection controls/devices below to completely contain water from this work. If cutting concrete, tiles etc. in an area near a stormwater pit, use multiple temporary collection devices such as filter socks, berms, or skirts suitably installed to ensure untreated wastewater DOES NOT enter the pit untreated (see page 61) (Figure 20).
- Install filtration systems on your brick cutting machine with built-in slurry containment systems.
- Carry out works in a way that minimises the amount of slurry generated, thereby reducing the amount of clean up and disposal required.
- When equipment is washed down, use the designated clean-up area or a designated container such as a 'Slurry Tub' (pictured on page 66). Clean equipment by wiping down rather than hosing off.

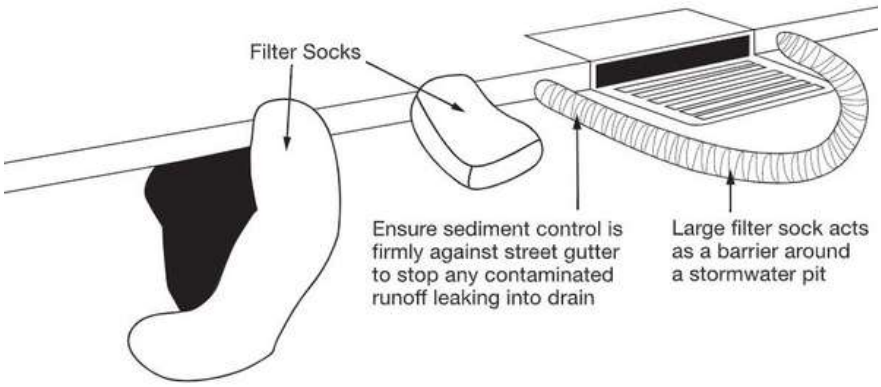


Figure 20: Installing a series of filtration systems is best practice for ensuring pollution from slurry generating or wash-up activities does not enter the stormwater system. *Figure from the NSW Department of Conservation 2004 'Environmental Best Management Practice Guideline for Concrete Contractors'.*

Vacuum systems with high-efficiency particulate absorbing (HEPA) filters can be used to suck up concrete slurry waste into larger holding tanks. The concrete slurry waste can then be reused or disposed of.

Photo credit: www.onlineconcrete.com.au

Maintaining the controls:

- Manage concrete, brick or tile cutting slurry in the designated area. DO NOT hose down – dilution is not an option. If there is no designated disposal area, place slurry into a portable settling tank or drum half full of water. Solids will settle to the bottom of the drum for later disposal and the water can be reused when concreting. Do not dispose of untreated wastewater in the stormwater system, it will be too alkaline.
- If you have an undercover storage area on-site, waste concrete slurry can be disposed of by tipping small amounts into plastic or geotextile-lined containers or ditches (Figure 21). This will enable the water to evaporate, and the solids can then be disposed of to landfill or reused as clean fill in construction or as road base.
- If you have no on-site means of treating alkaline wastewater, you may need to use a vacuum truck or other approved waste handler.
- All sediment controls require regular cleaning to maintain effectiveness and over time may need to be replaced. Remove any build-up of slurry or sediment from the designated protected area and regularly check for leaks or breaks.

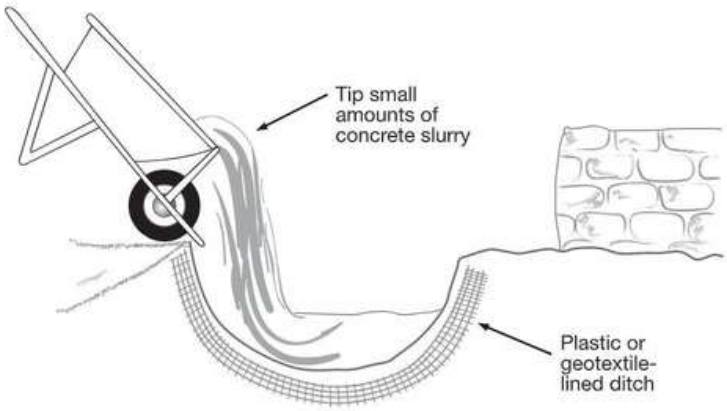


Figure 21: Small amounts of waste concrete slurry can be stored undercover in plastic or geotextile-lined containers or ditches for later management. *Figure from the NSW Department of Conservation 2004 'Environmental Best Management Practice Guideline for Concrete Contractors'.*

Avoid cleaning equipment on improvised wash-out areas such as lawns, driveways, or pavements. Slurry can leach into the ground and alter soil chemistry or find its way into the stormwater system and our waterways. Collect slurry generated from washing down machinery and tools in a container. After settling, the water should be reused on-site and the hardened waste can be disposed of. Not even filtered water can be disposed of to the stormwater system - it is likely to be too alkaline.

Photo credit: slurrytub.com

SEDIMENT FENCES

WHAT IS THIS?

A sediment fence is a vertical barrier made from purpose-made woven or composite fabric, NOT shade cloth, held in place with pickets and a backfilled trench (Figure 22). A sediment fence works by ponding runoff upslope of the fence and allowing coarse sediment particles to drop out with gravity.

A sediment fence (Type 3 Sediment Control, catching only big particles) is installed across slopes (i.e. along the contour) and at other locations such as below stockpiles, to capture sediment from sheet-flow erosion. It is crucial to use the correct materials and installation procedure, otherwise it won't work. Sediment fences should NOT be used in drainage channels.

WHAT DO I NEED TO DO?

Before starting site works:

- Determine the number and size of sediment fences required on your site and document the locations on your ESCP (see page 17).
- Design sediment fences across the contour so that the drainage area (or catchment) up-slope of the sediment fence suits the size and arrangement of the fences. A single row of sediment fences at the bottom of a large site is unlikely to be sufficient to capture sediment from runoff – several rows of sediment fences may be required.
- Ensure you have enough sediment fence supplies to construct fences as shown on your ESCP. It is better to have it and not need it than the other way around. Keep spare rolls of fabric and posts/stakes on-site for "running repairs".
- Include the function and maintenance of sediment fences in all site inductions.

Note: A sediment fence is NOT designed to function as a filter; clay and silt particles will not be captured by a sediment fence. Sediment fences are your last line of defence and will NOT adequately treat water when used as the only control. Prevent erosion in the first place by installing the erosion controls as described in the Erosion Control section.

Installing the controls:

- Install sediment fences before the start of site works.
- Survey and mark out the location of sediment fences, ensuring they are parallel to the contours of the site with the ends angled up-slope.
- Dig a 200mm deep trench, 150mm above the proposed sediment fence line. Offsetting the trench from the sediment fence line ensures maximum stability for the fence pickets, which will be place in undisturbed soil.
- Place the bottom edge of the fabric in the base of the trench.
- Backfill the trench and compact to secure anchorage of the fabric.
- Drive pickets into ground on downslope side of the trench, 2m apart to support the sediment fence fabric. Tension and fasten fabric to pickets using UV stabilised zip ties or wire ties. For best results, attach a wire support along the top edge of the sediment fence, tension, and attach to pickets. This will reduce sagging and overtopping of the fence during larger runoff events.
- Join sections of fabric at a support post with a 2m overlap.
- Curve the ends of the sediment fence upslope (like a smile) to avoid scouring at the outer edges.

Note: DO NOT place sediment fences across concentrated flow paths, creeks or major drainage lines. Rock check dams, lined drainage channels, or rock filter dams are the appropriate controls for concentrated flow paths.

Well installed sediment fences (a) work effectively to pond runoff, allowing sediment to settle out via gravity, while poorly installed sediment fences (b) - where the fabric has not been correctly buried - do little to prevent sediment moving off-site. *Images from TOPO Pty. Ltd.*

Maintaining the controls:

Check your sediment fences regularly, especially prior to forecast rain and after every rain event to clean and repair. The arrangement of sediment fences can be altered if the site's drainage patterns change. If the ponding area behind the sediment fence has filled up more than 1/3 of the depth of the fence with sediment, it must be cleaned. The built-up material can be re-stockpiled and used on-site (if not contaminated) or disposed of to landfill. Check that all the pickets and the bottom of the fence are secure and there are no tears in the fabric – repair or replace as necessary. If there is evidence of significant amounts of sediment passing through the sediment fence, you must install further controls to prevent this occurring in the next rain event.

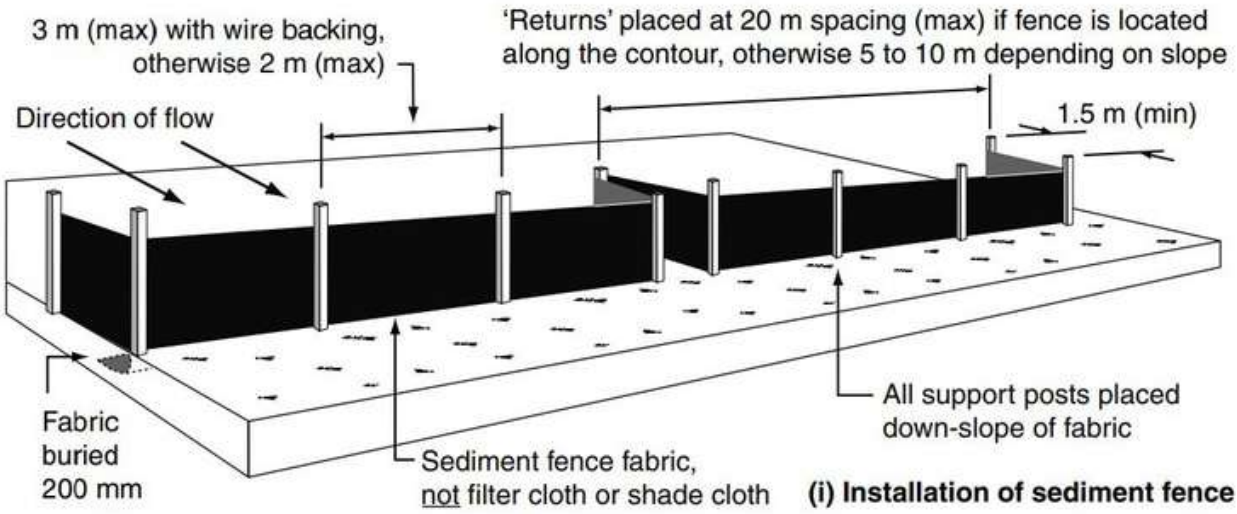


Figure 22: Nominal dimensions and constructions details for sediment fence installation. *Figure from Catchments and Creeks Pty Ltd.*

MULCH AND COMPOST FILTER BERMS

WHAT ARE THESE?

Mulch/compost filter berms function on the same principle as a sediment fence by forming a barrier against which sheet-flow/runoff ponds, and coarse sediment particles settle out under gravity. An advantage over sediment fences is that compost berms can provide some filtration of water, and are therefore classed as a Type 2 Control, catching big and medium sized sediment particles. Berms can be designed to be left in place after completion of works, as part of the site landscaping, lowering the cost of materials and creating less waste. It is best to use mulch produced from on-site green waste and to process the vegetation into interlocking fibres, rather than chipping (e.g. with tub grinding rather than chipping).

WHAT DO I NEED TO DO?

Before starting site works:

- Determine if you have sufficient on-site vegetation approved for clearing which can be mulched for use in mulch berms.
- Determine the number and size of mulch and compost filter berms based on the catchment area and document the locations and sizes on your ESCP.
- Note that these berms should be used in small catchments where a 10m length of berm services a maximum area of 250m^2.
- Include the function and maintenance of these berms in all site inductions.

Photo credit: Anthony D' Angelo for USEPA, 2012.

Installing the controls:

Mulch and compost filter berms need to be installed prior to the start of site works. They can be shifted, added to, or removed, depending on changes to the site's drainage patterns as works progress.

- Install mulch and compost filter berms across the contour to maximise the surface area available for ponding and turn up at the ends.
- For **mulch**, only use on-site vegetation free of weed seed, and mulch by using a horizontal or tub grinder rather than a chipper.
- For **compost**, ensure material is well-decomposed and 100% organic material.
- Ensure a moderate moisture content of mulch or compost in the range of 30 – 50%.
- Ensure berms are appropriately sized and spaced for the catchment; see the Mulch Filter Berms and Compost Filter Berms factsheets (IECA Book 4 Design Factsheets, 2010) for more information.
- Ensure all vehicle and foot traffic is kept off mulch and compost filter berms.

Note: DO NOT place mulch and compost filter berms across concentrated flow paths, creeks, or major drainage lines. Rock check dams, lined drainage channels, or rock filter dams are the appropriate controls for concentrated flow paths.

Maintaining the controls:

Check the berms at least weekly, as well as before forecast rain and after rain events. Repair or replace any damaged sections to the original configuration. Maintain moderate moisture content of mulch and compost filter berms to stop them from blowing away. Remove sediment from the ponding area if it has accumulated to a depth greater than 100mm or 1/3 of the height of the berm. Collected sediment can be reused on-site or disposed of to landfill.


Photo credit: www.sheetflow.com

ROCK FILTER DAMS

WHAT IS THIS?

Rock filter dams are a robust Type 2 Sediment Control that can be used in flow paths. They function by ponding water upslope of the dam wall, which is made from rocks wrapped in geotextile (Figure 23). Coarse particles are trapped and settled in the pond, with some filtration of coarse particles by the geotextile cloth. Rock filter dams can be used where higher runoff velocity is expected than where sheet flow controls are used, however, they need particular maintenance attention.

WHAT DO I NEED TO DO?

Before starting site works:

- Determine the size of the catchment to be directed to the rock filter dam and ensure the rock filter dam is designed in accordance with the Rock Filter Dams factsheet (IECA Book 4 Design Factsheets, 2010). Table 3 indicates standard dam sizing for catchment areas up to 0.5 hectares (5,000m^2).
- A rock filter dam should have a length that is at least three times its width. If this cannot be achieved (i.e. you have a square pond), the ponding area should be increased by 20%.
- Include the function and maintenance of rock filter dams in all site inductions.

Installing the controls:

- Install the rock filter dam as per your approved design and ESCP (see page 17).
- Construct the spillway to convey potential rain events in excess of the design event.
- Use armour rock that is well graded, hard, angular, and erosion resistant with a mean size of at least 225mm diameter.
- Use heavy-duty geotextile fabric minimum 'bidim' A34 or equivalent to line the bottom, filter layer, and crest of the spillway.
- Install a marker post with a maximum level indicating when sediment removal is required.
- Remove any organic matter and debris from the area (DO NOT mix into armour rock).
- Where soils are dispersive (see page 36), ensure these are stabilised prior to the installation of the rock filter dam.

Table 3: Standard rock filter dam sizing for catchment areas up to 0.5 hectares.

Maximum catchment area (m^2)	1000	2500	5000*
Minimum ponding surface area (m^2)	2	5	10
Minimum ponding depth (m)	0.5	0.5	0.5

*For catchments over 2,500m^2 construction of a sediment basin is preferred.

Maintaining the controls:

- Inspect the rock filter dam prior to forecast rain and after any rain events.
- Check the structure and downstream channel banks for damage and make repairs as necessary.
- Use the installed marker post to determine when sediment removal is required; remove sediment and restore original storage volume when collected sediment exceeds 10% of the storage volume.
- Dispose of sediment correctly – DO NOT create an erosion or pollution hazard.
- Remove the rock filter dam at the end of the project and dispose of geotextile appropriately.
- Once cleaned of sediment the rocks may be re-used on-site or stored for rock filter dams for your next project.

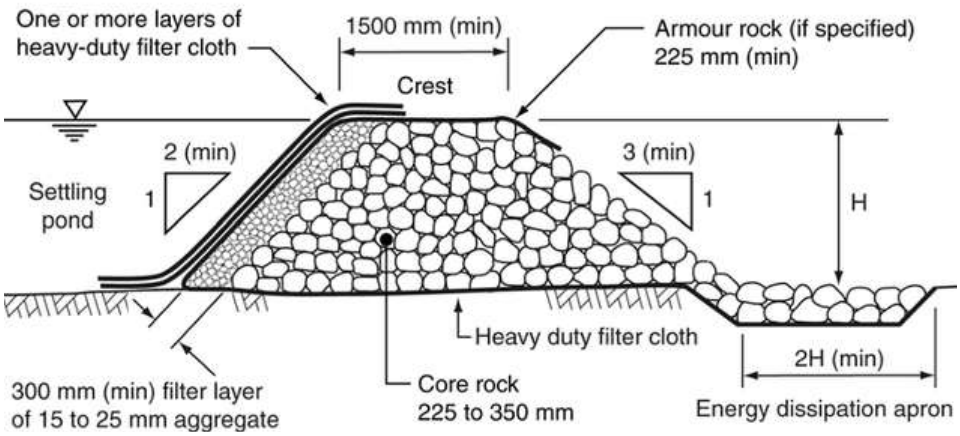


Figure 23: Example of a rock filter dam lined with geotextile fabric. Several overlapping geotextile layers may be used, thus allowing each layer to be removed individually once the fabric becomes clogged with sediment and loses its filtering capacity. *Figure from Catchments and Creeks Pty Ltd.*

SEDIMENT BASINS

WHAT IS THIS?

Sediment basins are primarily used for large development sites. They are temporary dams or ponds which capture sediment-laden water from large disturbed areas. A sediment basin is a Type 1 Sediment Control, effective for capturing fine, medium, and large particles. Sediment basins are one of the most useful and cost-effective means of treating runoff. If designed to be part of the final development, they can be an effective water sensitive urban design (WSUD) feature, ensuring better post-construction water quality outcomes, and adding amenity and value to the site.

A sediment basin is formed by excavating a dam or constructing an embankment with an appropriately designed outlet structure and overflow spillway – it MUST have an emergency spillway. A sediment basin is the only sediment control measure which will effectively treat highly turbid runoff, which has fine clay particles not captured by other controls. Where clay particles are suspended in runoff, using a coagulant or flocculant will be necessary to settle the clay particles out.

The requirement for a sediment basin will be determined at the planning permit stage if the expected ground disturbance area is greater than 2,500m² or for reasons determined by the council, such as specific water quality objectives associated with a receiving waterbody. A sediment basin must be designed by a suitably qualified person such as a Certified Professional in Erosion and Sediment Control (CPESC). Sediment basins over one megalitre may require a Dam Works Permit under the *Water Management Act 1999* (see: www.nre.tas.gov.au/water/dams/dam-works-permit-guidelines).

For smaller development sites where a large sediment basin is not required, an 'undersized' sediment basin can work well to achieve required water quality with the use of a coagulant or flocculant. These basins work the same way as larger basins, including a protected spillway. Construction should aim to maximise the storage volume as much as practical. Performance limitations will largely be due to capacity.

The preferred options for sediment basin construction are high efficiency sediment (HES) basins with automated dosing, namely Type A or Type B basins (Figure 24). Type D batch basins may be used where Type A/B HES basins are not considered reasonable or practicable. Due to their proven performance in achieving water quality discharge parameters, smaller footprint and ease of operation, Type B HES basins are quickly becoming the norm in Australia and are considered best practice in many parts of the country, where duration of soil disturbance does not exceed 12 months. The design procedure for Type A, B and D basins is specified in IECA Appendix B, 2018.

WHAT DO I NEED TO DO?

Before starting site works:

Have your sediment basin designed by a suitably qualified person and include the design specifications and associated reports in your ESCP (see page 17). More information on sediment basins can be found in the Sediment Basins factsheet (IECA Book 4 Design Factsheets, 2010) and in IECA Appendix B, 2018. The following factors will be taken into account by the designer:

- catchment size, gradient, and dominant soils;
- presence of dispersive soil;
- located so that if failure occurs, damage or a nuisance to property, people, or the environment will be minimised;
- located off-line and up-stream of the stormwater system and natural and constructed waterways and water bodies;
- location of existing flood event overland flow paths;
- access for machinery to remove sediment;
- chemical dosing requirements and equipment for adding flocculant or coagulant. See *Jar testing*, page 77;
- placement of a marker post within the basin to indicate depth; and
- the post-construction function of the sediment basin (i.e. the design will be different depending on whether the basin will be in-filled or converted to a wetland).

A sediment basin must be used in conjunction with other drainage, erosion and sediment controls upstream of the basin. The basin must remain functional until any potential erosion has been stabilised – usually just prior to completion. The ESCP, design plans and report must include detailed instructions about how the basin will be constructed, maintained, and decommissioned. Include the function and maintenance of sediment basins in all site inductions.

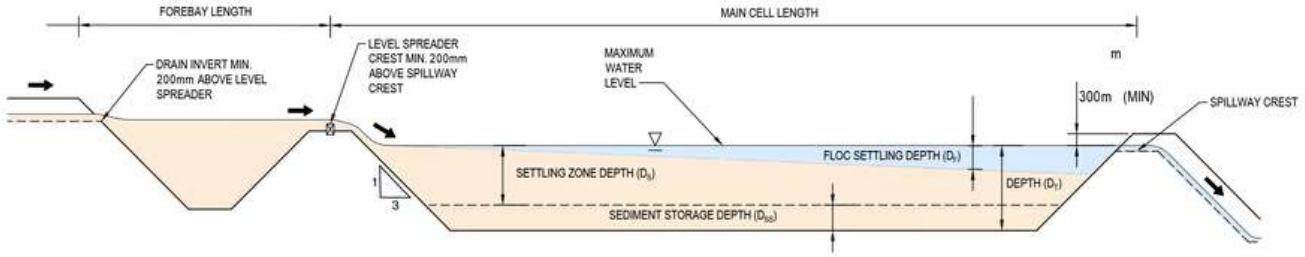
Note: When water is being released/pumped from the sediment basin to the receiving environment or a stormwater connection, 80% of the average annual runoff volume should be treated to less than 50mg/L Total Suspended Solids (TSS), and pH in the range 6.5 – 8.5. Automated coagulant or flocculant dosing systems are available, using either rainfall or flow activated inputs to determine required dosing volumes.

Maintaining a sediment basin:

Sediment basins require regular inspection prior to forecast rain and after rain events by a suitably qualified person. Litter and debris must be removed whenever observed in the sediment basin, and if the water within the basin is cloudy, the coagulant/flocculant dose rate should be checked.

Sediment basins must maintain a minimum sediment settling zone of 0.6m depth and should be treated and dewatered within five days after a rain event. Sediment basins must be cleaned when half full of sediment, by means of a vacuum truck or excavator bucket (depending on the depth of sediment and water). Sediment can be spread out/stockpiled to dry out above the basin above associated sediment controls, with water seeping back into the basin. The dried sediment can be left in place and vegetated/stabilised, reused on-site, or disposed of to landfill.

(a)



(b)

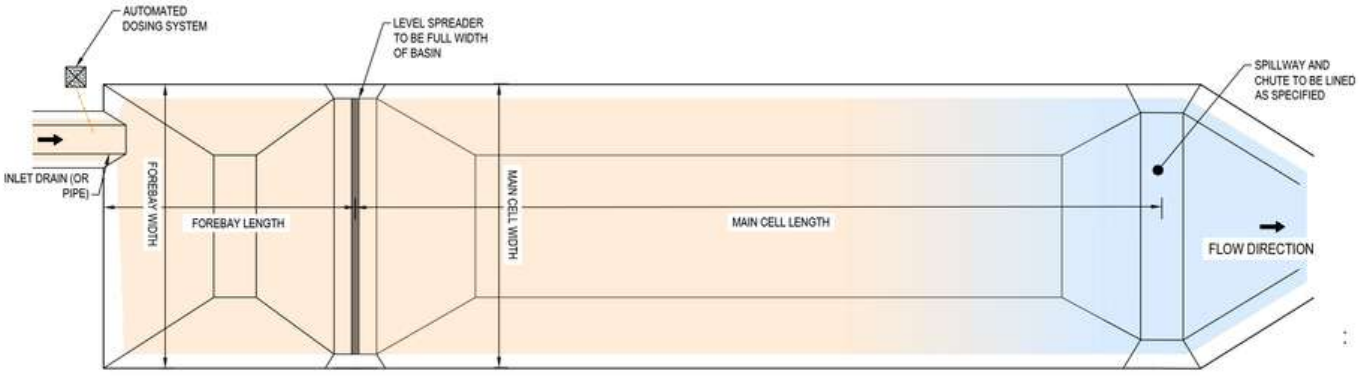


Figure 24: Technical diagrams indicating the dimensions and construction details of a Type B sediment basin in (a) cross-section and (b) plan views. Not to scale.

JAR TESTING

'Jar testing' is used to work out the chemical dosing with coagulant or flocculant which is needed to achieve acceptable water quality in sediment basins. It is recommended that this testing is done before designing the basin as the most suitable chemical (flocculant and/or coagulant) is likely to vary with different soil types. You need to keep checking whether these products are working well over time as what the basin is capturing will change during different phases of the project. More information, including a template Floc Performance Report can be found in IECA Appendix B, 2018.

Due to its effectiveness (which means lower dosing) and reduced effect on pH, the preferred coagulant for use in high efficiency sediment (HES) basins is aluminium chlorohydrate (ACH). In some cases a flocculant such as chitosan may work better. Unless justified for specific site use, aluminium sulphate (Alum) and polyaluminium chloride (PAC) should be avoided due to their potential to significantly alter pH. Gypsum may be used as an alternative coagulant in manually treated Type D batch basins, however the reduced effectiveness of gypsum compared to ACH requires significantly longer settling times (resulting in delays to dewatering). In addition, treatment with gypsum will require a considerable dose rate and labour effort to apply and effectively mix throughout the basin.

DEWATERING

WHAT IS THIS?

Dewatering is the process of pumping water out of a hole, excavation, or sediment basin. It may be required on a development site where sediment-laden water has collected in a low-lying area, or within trenches or sediment basins. If this water is being pumped for release into the stormwater system - as opposed to being trucked to a disposal facility - the water must be suitably treated to meet water quality criteria (i.e. turbidity and pH). Water quality criteria will depend on the types of contaminants and water quality objectives for the receiving environment. The time and cost of treating water can be minimised by keeping clean and dirty water separate through the use of drainage and erosion controls.

WHAT DO I NEED TO DO?

Before starting site works:

- You are responsible by law not to discharge pollutants (including sediment) into the stormwater system or receiving environment where it has the potential to damage infrastructure, cause an environmental nuisance or environmental harm.
- Check your planning approval and other permits for the required treatment standard for dewatering. Alternatively, seek advice from council or the EPA.
- Dewatering is ideally done by a qualified and experienced person through an approved service provider – ensure this is scheduled and budgeted for.
- Before you allow any captured stormwater to leave the site into the environment or stormwater system, make sure the pH is between 6.5 and 8.5, and total suspended solids (TSS) is less than 50mg/L. These recommended limits are from 'De-watering Activities – General', IECA Book 4 Design Factsheets, 2010. Be aware that there may be locally adopted treatment standards – read your planning permit to determine if this is the case. Discharged water absolutely must not result in a turbid plume being visible or a significant pH change in receiving waters.
- Ensure the sediment disposal arrangements have been considered in the control design so that the area requiring cleaning can be reached by a pump to the trailer tank/vacuum truck.

Image source www.cleanitup.com

Installing the controls:

- Test the site water to determine treatment options.
- Treat the water to reach the required standards.
- Retest the water and re-treat as needed.
- If water can be completely treated on-site to an acceptable standard, it can be released via the stormwater connection. If water cannot be adequately treated it must be disposed of via vacuum or pump truck to an appropriate disposal facility.

If runoff has coarse sediment only, filter bags may be appropriate - position to maximise filtration of outflow runoff prior to reaching the stormwater connection. Consider release via level spreader onto large, grassed area, if available. On large development sites, runoff with fine particles (clay) can be treated by dewatering to a Type 1 sediment basin. Addition of a coagulant or flocculant at this stage will assist further in treatment (see page 76).

Remember, the best way to prevent sediment leaving site is to minimise its generation in the first place.

RAPID ON-SITE TURBIDITY TESTING

Using a turbidity tube can be a quick and cost-effective way of measuring if water collected on your construction site is safe to release into the stormwater system, or requires further treatment. The relationship between the readings from a turbidity tube (measured in Nephelometric Turbidity Units, or NTU) and total suspended solids (TSS) varies widely depending on the type of sediments present on a site. For example, the more fine particles in sediment, the higher the expected NTU for a given TSS. However, in the absence of site-specific relationships, take all reasonable and practicable measures to achieve a NTU reading not exceeding 60. More information can be found in IECA De-watering Activities – General (IECA Book 4 Design Factsheets, 2010).

APPENDIX 1: SEDIMENT CONTROL STANDARD BASED ON CATCHMENT AREA AND SOIL LOSS RATE

Table 4: Sediment control standard based on catchment area and maximum allowable soil loss rate, as calculated using the Revised Universal Soil Loss Equation (RUSLE). Based on Table B1 in IECA Appendix B, 2018.

Catchment Area (m^2) [1]	Soil loss (t/ha/yr) [2]			Soil loss (t/ha/month) [3]		
	Type 1[5]	Type 2	Type 3	Type 1[5]	Type 2	Type 3
250	N/A	N/A	[4]	N/A	N/A	[4]
1000	N/A	N/A	All cases	N/A	N/A	All cases
2500	N/A	>75	75	N/A	>6.25	6.25
>2500	>150	150	75	>12.5	12.5	6.25
>10,000	>75	N/A	75	>6.25	N/A	6.25

[1] Area is defined by the catchment area draining to a given site discharge. Sub-dividing a given drainage catchment shall not reduce its 'effective area' if runoff from these sub-areas ultimately discharges from the site at the same general location. The 'area' does not include any 'clean' water catchment that bypasses the sediment trap. The catchment area shall be designed by the 'worst case' scenario, i.e. the largest effective area that exists at any instance during the soil disturbance.

[2] Soil loss defines the maximum allowable soil loss rate (based on RUSLE analysis) from a given catchment area. A slope length of 80m should be adopted within the RUSLE analysis unless permanent drainage to landscape features reduce this length

[3] RUSLE analysis on a monthly basis shall only apply in circumstances where the timing of the soil disturbance is/shall be regulated by enforceable development approval conditions. When conducting monthly RUSLE calculations, use the worst-case monthly R-Factor during the nominated period of disturbance.

[4] Refer to the relevant regulatory authority for assessment procedures. The default standard is a Type 3 sediment trap.

[5] Exceptions to the use of sediment basins shall apply in circumstances where it can be demonstrated that the construction and/or operation of a sediment basin in not practical, such as in many forms of linear construction where the available work space or Right of Way does not provide sufficient land area. In this instance, the focus must be erosion control using techniques to achieve an equivalent outcome. The 'intent' shall always be to take all reasonable and practicable measures to prevent or minimise potential environmental harm.

RUSLE Soil Loss Analysis

The Revised Universal Soil Loss Equation (RUSLE) is used to predict long-term average soil loss rates and has the following form:

$$A = R \times K \times LS \times C \times P$$

Where:

A = annual soil loss due to erosion (t/ha/yr);
R = rainfall erosivity factor;
K = soil erodibility factor;
LS = combined slope length and gradient factor;
C = cover factor, and;
P = land management/practice factor.

For more information, refer to Witheridge 2012, *Principles of Construction Site Erosion and Sediment Control*. Catchments and Creeks Pty Ltd., Brisbane, Queensland.

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