PLANNING SCHEME POLICY NO.14

Erosion and sediment control

Contents

Appendices

1 Introduction

1.1 Purpose

The purpose of this Planning Scheme Policy is:

a) To provide a reference and technical support to the Code for Erosion and Sediment Control; and

b) To provide guidance on the preparation of:

- Erosion Risk Assessments,
- Erosion and Sediment Hazard Evaluation Reports,
- Erosion and Sediment Plans (including Concept, Minor and Major Plans).

c) To guide environmental performance standards on land development sites in order to achieve the environmental management objectives.

1.2 Applicability

This policy applies to all assessable development for which the Operational Works Code is applicable.

2 Environmental Management Objectives

The environmental management objectives of this policy are to protect the environmental values of our natural waterways, and the healthy functioning of aquatic marine and wetland ecosystems, natural processes, and habitat.

This will be achieved by ensuring that the influence of site topography, soils and climate is adequately considered when decisions are made, and by minimising the impact of development with respect to:

2.1 Hydrological Processes

Minimising changes to the natural hydrological characteristics of a catchment, including percentage imperviousness, stream power, frequency of runoff events, and base flows.

2.2 Natural Vegetation and Riparian Zones

Maximising ground surface and channel protection through the preservation of a natural vegetative cover, especially preservation of indigenous riparian, floodplain and foreshore vegetation. Clearing should not take place in these areas or in close proximity to wetlands unless it is in the overriding public interest.

2.3 Aquatic Habitat and Ecosystems

Protecting aquatic habitats and ecosystems, such as maintaining natural stream substrates, meander form, channel roughness and geometry.

2.4 Water Quality

Minimising the amount of pollution such as sediment and soil nutrients entrained in stormwater runoff, through appropriate erosion and sediment controls, and removing entrained pollutants by implementing best practice stormwater management.

3 Qualifications

Erosion and Sediment Risk Assessments, Hazard Evaluation Reports and Control Plans must be prepared by a registered professional such as a Registered Professional Engineer (Qld) who has appropriate experience and demonstrated skills in erosion and sediment control. This person must have completed an advanced specialised training course in erosion and sediment control, provided under the auspices of a reputable body such as the International Erosion Control Association.

Mass movement/slip potential assessments in an Erosion Hazard Evaluation Report must be prepared by a Registered Professional Engineer (Qld), skilled and experienced in geotechnical surveys.

4 Information Supporting Development Applications

The type and extent of information required in support of an application depends on the environmental risk and the stage of the approval process. See Figure 1.

4.1 Erosion Risk Assessment

All developments to which this Policy applies require an initial **Erosion Risk Assessment** to assess the level of further investigation required, and ultimately the kind of erosion and sediment control plan needed.

The assessment is made by calculating the predicted total soil loss from the site for the entire duration of the site disturbance. This involves using the Revised Universal Soil Loss equation (RUSLE), factoring in the area of disturbance and the time the area is to be disturbed.

The formula for calculating the predicted total soil loss is:

$$R = A \times B \times T$$

Where

R = predicted total soil loss in tonnes

A = calculated soil loss in tonnes/hectare/year (see Revised Universal Soil Loss Equation (RUSLE))

B = surface area of disturbance (hectares)

T = predicted duration of the disturbance (months disturbed/12)

The RUSLE application is freely available in a computer program called SOILOSS (Rosewell, 1993[1]). The local input data for the RUSLE equation can be found in the Maroochy Manual for Erosion and Sediment Control (MESC).

Development applications will need to be accompanied by calculations and supporting information.

Alternatively, applicants may use the Site Data Sheet to derive soil loss (see Appendix 5).

The assessment will categorise the development as either:

a) low risk site (150 tonnes or less of soil loss over the period of disturbance);

OR

b) high risk site (greater than 150 tonnes of soil loss over the period of disturbance).

The following supporting information, prepared in accordance with this policy, is required for:

1 *Rosewell, C.J. (1993). "SOILOSS-A program to assist in the selection of management practices to reduce erosion" NSW DNR web-site*

4.2 Material Change of Use or Reconfiguration of a Lot

All material change of use applications and reconfiguration of a lot (other than low risk sites) require an:

a) *Erosion and Sediment Hazard Evaluation Report* (see section 5 below); and

b) *Concept Erosion And Sediment Control Plan*

4.3 Operational Works and Building Works

All applications for Operational Works Approval and Building Works Approval (other than low risk sites) require:

a) an *Erosion and Sediment Hazard Evaluation Report*, and

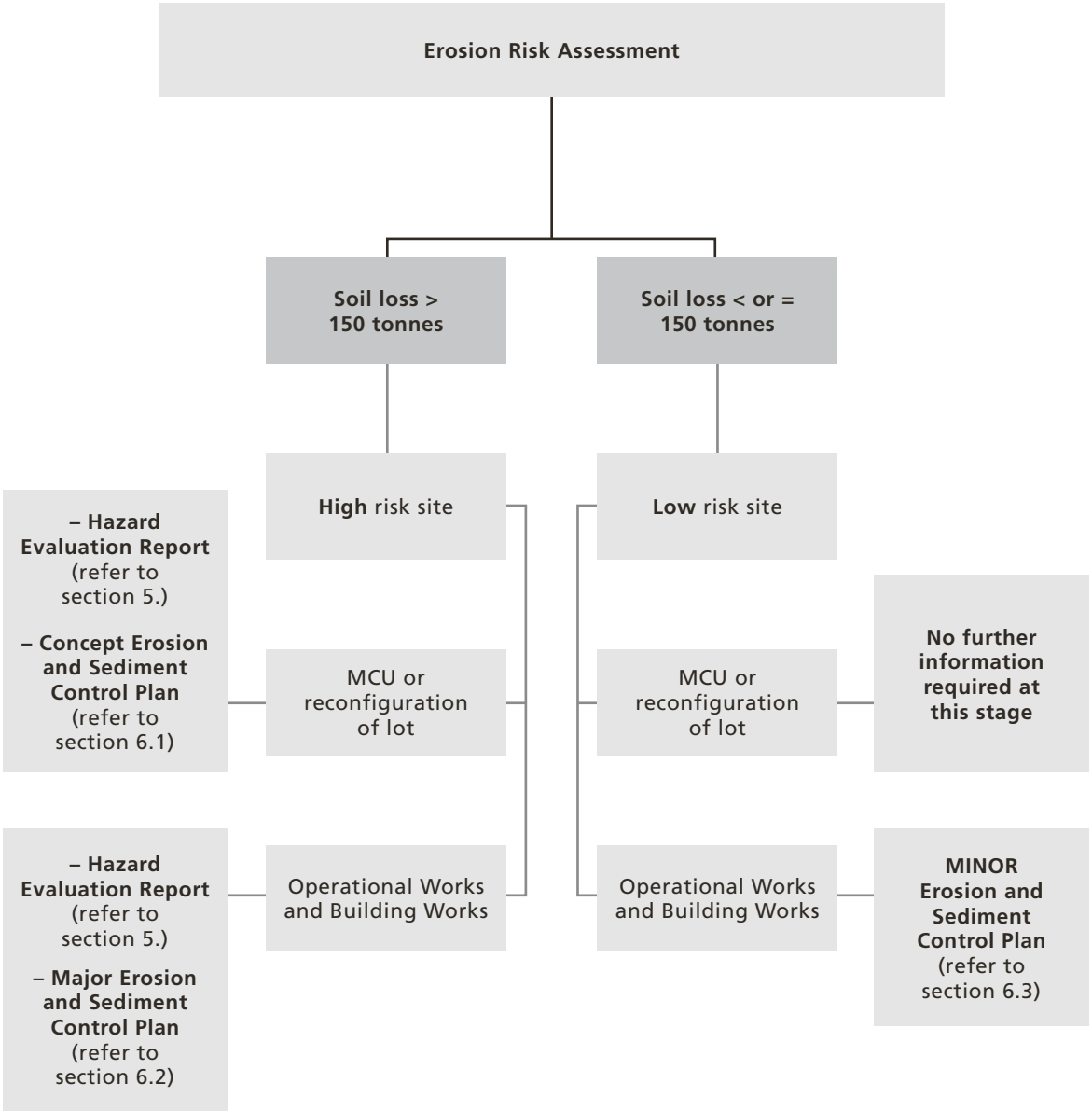
b) a ***Major*** *Erosion and Sediment Control Plan.*

All applications for Operational Works Approval and Building Works Approval which have been calculated as low risk sites require only a ***Minor*** *Erosion and Sediment Control Plan*.

4.4 Prior Approvals

Where a requirement for an Erosion and Sediment Hazard Evaluation Report, or a Concept Erosion and Sediment Control Plan has been met as part of a prior approval for a site, and that Plan or Report is still relevant, the prior Assessment, Plan or Report can be presented in support of a current application.

Figure 1 Summary Site Assessment and Control Plan Requirements.



5 Erosion and Sediment Hazard Evaluation Reports – High Risk Sites

The Report must be prepared in accordance with the Maroochy Manual for Erosion and Sediment Control (2007).

The Report must be set out in the following format and address the specified issues:

5.1 Hydrologic Impact

Effects on receiving waterways, in terms of geomorphology, water quality and ecosystems as a consequence of the proposal including consideration of:

a) increased imperviousness; and

b) increased runoff during clearing, bulk earthworks and construction activities.

5.2 Physical Characteristics, Constraints and Opportunities

This includes erosion hazard, topography, hydrology, seasonal weather patterns and risks, and riparian and wetland protection issues.

It involves preparation of a contour plan to scale, and assessment of factors which could preclude the siting or effective implementation of any required erosion and sediment control measure, including:

a) site characteristics, e.g. topography (slope gradient and aspect), landform attributes (site morphology, slope morphology, landform elements), site condition (percentage ground cover, current condition, expected dry condition), lithology (rock outcrop, identification method, substrate material), hydrology (presence and depth of free water, permeability, profile drainage), erosion hazards, salinity, erosion, etc.;

b) soil profile and regolith characteristics, e.g. layer depth, colour, mottles, pH, layer boundary. Examine soil profiles to a depth of at least 1.5 metres or maximum depth of proposed disturbance and/or to bedrock;

c) soil water status, field texture, structure (grade, size, shape), ped coating, fabric, coarse fragments (type, amount, size), pans, segregations, consistence, lithology of parent material, etc.;

d) laboratory data, including:

- particle size analysis (<0.002 mm, 0.002 to 0.02mm, 0.02 to 0.2 mm, 0.2 to 2.0 mm and 2 to 75 mm) (AS 1289 C6.2),
- dispersion percentage (Ritchie, 1963) and Emerson Aggregate Test (AS 1289 C8.1). Note: with strongly subplastic soils (generally, those stabilised by iron and red in colour, e.g. Krasnozems) particle size analysis for determination of erodibility should be undertaken without the use of dispersing agents, such as Calgon;
- electrical conductivity, exchangeable cations, cation exchange capacity, and soil nutrient status; and
- other information at the discretion of the soil scientist to support designation of constraints and in consideration of any land use requirement, such as profile permeability class, soil wet strength, and mass movement hazard.

Where published soils data exists for a site (eg in the Maroochy Manual for Erosion and Sediment Control) this may be used to the extent of the dataset, which will usually only **partially** meet these requirements. At least one confirmatory full lab analysis test is required for every site, except for small sites where exempted in Table 1. This includes one borehole with a representative analysis of each major soil horizon and, where site geomorphology is variable, a competent borehole examination is required of each different landform element (eg drainage depression, foot slope, ridge) to assess whether further lab tests are necessary in each unique soil unit identified.

In areas not covered by the soils maps, or where confirmatory testing shows soils diverging from the map data, testing utilising a NATA laboratory is required, conforming with the methodology in the Maroochy Manual for Erosion and Sediment Control, at the intensity shown in Table 1.

Table 1 Soil sampling intensity for *Erosion Hazard Evaluation* for all sites outside Council soil maps.

Area of site disturbance	Number of Boreholes (Level 1 Assessment)	Number of Boreholes (Level 2 & 3 Assessments)
< 250 m²	No testing generally required	No testing generally required
< 1000 m²	2 holes	1 hole
Up to ½ ha	4 holes	2 holes
Up to 1 ha	4 holes	3 holes
1-2 ha	6 holes	4 holes
2-3 ha	8 holes	6 holes
3-4 ha	10 holes	8 holes
> 4 ha	5 holes / 2 ha	2 holes / ha

The methodology should, except as specified otherwise here, conform with the latest version of the document *Brisbane City Council Soil Sampling & Testing Guideline for Erosion Potential*.

In certain circumstances, more detailed levels of information might be required, such as in sensitive locations where a detailed land capability survey is required or where further site-specific information is required, e.g. suitability for onsite domestic waste water disposal. In these circumstances, where appropriate guidelines for collection of site data exist, they should be followed.

For Operational Works applications, soil nutrient analysis is also required to be included for revegetation purposes. This involves testing topsoils typically for pH, cation exchange capacity (CEC), exchangeable cations (calcium, magnesium, potassium, manganese, sodium and aluminium) as a percentage of CEC, calcium/magnesium ratio, phosphorus, nitrate nitrogen, conductivity (salt), trace elements, and organic carbon.

6 Erosion and Sediment Control Plans

This policy provides for three types of Erosion and Sediment Control Plans (E&SC Plans):

a) **Concept E&SC Plans**

b) **Minor E&SC Plans**

c) **Major E&SC Plans**

The type of E&SC Plan required is dependant on the type of application and the erosion risk associated with the site. Figure 1 above clearly sets out which type of E&SC Plan is required.

All E&SC Plans must:

a) be prepared by an appropriately qualified person (refer to section 3);

b) be submitted for approval prior to commencement of any site works;

c) provide a suite of measures which collectively constitute best practice environmental management and which are likely to enable the objectives of this Policy to be met;

d) where erosion and sediment control plans and calculations are required, be submitted to the standard and in the form shown in the appropriate Appendix herein;

e) be prepared in accordance with the Maroochy Manual for Erosion and Sediment Control (2007).

6.1 Concept E&SC Plans

Concept E&SC Plans are prepared as part of material change of use and lot reconfiguration applications for high erosion risk sites. Their purpose is to establish, for the benefit of Council and the proponent, that it is feasible to control receiving water impacts using cost-effective measures. Normally, conceptual plans do not contain engineering drawings of structures.

Such a plan must demonstrate the following:

a) The design, intensity, configuration and establishment of development, is compatible with the physical constraints of the site and receiving environment.

b) The natural hydrologic regime and catchment imperviousness is not altered to the extent that changes to waterway flow, or channel geometry are likely, or aquatic ecosystems and habitats are likely to be adversely affected.

c) The feasibility of effective erosion and sediment control measures being implemented is substantiated, including consideration of the impacts of the overall development until permanent stabilisation of the site, providing a drawing showing a conceptual treatment train, and giving preliminary calculations for the sizing of a sediment basin or basins.

It must include a contoured site plan showing natural features and location of the proposed control structures, including sediment basins, and an overview strategy for the site outlining the sequence of development, and temporary and permanent management mechanisms, until commissioning of permanent water sensitive design features.

Finally, it must take full account of the findings of the site Erosion and Sediment Hazard Evaluation Report. For example site geology or high groundwater levels may preclude the installation of a conventional sediment basin. This should be assessed and made clear, as it could have serious implications ultimately for project costs and therefore project feasibility.

6.2 Major Erosion and Sediment Control Plans – Higher Risk Sites

A major E&SC Plan must be prepared, submitted and approved before land disturbance activities occur on any non rural lands.

The focus of the E&SC Plan is soil and water management during the land disturbance phase of development. A separate Integrated Water Management Plan is typically required to address post-construction stage stormwater management. These plans need to be developed in a complementary and integrated manner.

Design Procedures

Procedures should provide a mechanism for feedback between those preparing major E&SC Plans and those preparing many other plans for the works. This might include:

a) works in or close to a watercourse;

b) layout of lots, roads, cycle and pedestrian access corridors;

c) provision of recreation facilities, public open space or natural heritage reservations;

d) drainage of stormwater;

e) provision of services; and

f) rehabilitation of the site.

In planning for an integrated development, these and other requirements will influence and modify planning for each other; soil and water management should not be an *ad hoc* add-on option. The major E&SC Plans should be prepared at the same time as engineering design for all construction works and include them as part of the final engineering plans. Once engineering plans are complete, integration can be very difficult to achieve. Cross referencing soil and water management planning with site rehabilitation is also important.

Detail design procedures and standard drawings for most aspects of Operational Works are set out more fully in the Maroochy Manual for Erosion and Sediment Control, and for service installation, refer to Soils & Construction Volume 2A (see section 10 References).

Data Input to Major E&SC Plans

Major E&SC Plans should be based on an assessment of the physical constraints and opportunities to develop at the particular site, including those for soil, landform type and gradient, and hydrology.

Accordingly, the soil and water management team should include members with relevant tertiary qualifications or proven skills recognized by the appropriate authorities.

Content of Major E&SC Plans

Major plans should:

a) provide a set of contour drawings showing the real property description, north point, roads, site layout, boundaries and features. Contours on, and surrounding, the site should be shown so that catchment boundaries can be considered;

b) be at a suitable scale for the size of the project (as a guide around 1:1000 at A3 for a 2 hectare development and 1:500 at A3 for a 3000m^2 development);

c) provide background information including site boundaries, contour maps, existing vegetation, location of site access and other impervious areas and existing and proposed drainage pathways with discharge points also shown; and

d) show the location of lots, public open space, stormwater drainage systems;

e) show the location of land designated or zoned for special uses;

f) provide a program of works containing details on the nature and specific location of works (revegetation, cut and fills, run-off diversions, stockpile management, access protection), timing of measures to be implemented and maintenance requirements (extent and frequency);

g) show the way that works will modify the landscape and surface and subsurface drainage patterns (adding new, or modifying existing constraints). In this regard, the E&SC Plan should result from a consideration of layout options, each of which harmonise with the overall planning strategy and with each assessed for economy, aesthetics and function;

h) include a number of E&SC Plan drawings (see Model Plan Appendix 2 and 3) for major developments (more than 5 lots) to show the staging of works, and scheduling of progressive and final rehabilitation as civil works progress;

i) identify the riparian buffers and areas of vegetation which are to be protected and fenced off to prevent vehicle access;

j) indicate the location and provide engineering details with supporting design calculations for all necessary sediment basins;

k) the location and diagrammatic representations of all other necessary erosion and sediment control measures;

l) identify the clean and disturbed catchments, and flow paths, showing:

- diversion of clean runoff;
- collection drains and banks, batter chutes and stream crossings;
- location of discharge outlet points; and
- water quality monitoring locations.

m) show calculated flow velocities, sizing and channel lining protection, and velocity/energy checks required for all stormwater diversion and collection drains, banks, chutes, and outlets to streams;

n) show streams (perennial and non-perennial) and detail of stabilisation measures for all temporary stream crossings;

o) locate topsoil stockpiles;

p) provide details of chemical flocculation proposed, including equipment, chemical, dosing rates and procedures, quantities to be stored and storage location, and method of decanting any sediment basin.

In addition to the above data, major E&SC Plans require the following information:

a) the location and basic details of any other facilities proposed to be included as part of the development or works, such as:

- constructed wetlands;
- gross pollutant traps;
- trash racks or trash collection/separator units; and
- water sensitive stormwater treatment measures, such as bioretention systems, vegetated swales and infiltration measures.

Detailed design criteria for these latter facilities should be sourced from other manuals/reports and are not an integral part of a construction phase E&SC Plan – except that it is essential to demonstrate that across the two plans, water quality is adequately and continuously protected through all phases of the development to commencement of the off-maintenance period.

Note that the above listed works should not be located in or very near to watercourses. This is to avoid compromising the values and functions of the watercourses and their current or future riparian zones.

Major plans should also:

a) provide a site based management plan (SBMP) or equivalent documentation setting out maintenance and monitoring measures including monitoring of sediment basin(s);

b) the SBMP[2] should include adaptive and contingency management measures for the site to ensure E&SC measures are effective at all times, particularly just prior to, during and after wet weather;

c) prepare an Inspection and Test Plan[3].

6.3 Minor Erosion and Sediment Control Plans – Lower Risk Sites

These plans should be prepared for sites including:

a) minor developments where approval is required from Council; and

b) minor civil infrastructure works, including:

- urban and rural road construction and reconstruction;
- stormwater pipelines, including culverts;
- sewerage pipelines;
- water pipelines;
- bulk earthworks, including retention basins and sports fields; and
- electricity, telephone and natural gas lines.

Notwithstanding the above, Council may vary this requirement and require submission of a major E&SC Plan where, in its view, a high risk of polluting receiving waters exists[4].

Content

Where a minor E&SC Plan is required, the following information should be presented in the plan:

a) a set of contour drawings showing the real property description, north point, roads, site layout, boundaries and features;

b) locations and sizing of erosion control measures, drainage and flow management works, and sediment capture devices;

c) where applicable, the diversion of runoff from upslope lands around the disturbed areas;

d) a narrative accompanying the plans to describe how erosion and sediment control measures were chosen and their maintenance requirements;

2 These issues might also be addressed through inclusion of a narrative chapter with checklists attached to the Erosion and Sediment Control Plan

3 Guidance on the preparation of such a plan is provided in the Maroochy Manual for Erosion and Sediment Control Chapter 3

4 Many smaller sites requiring E&SC Plans do not require sediment control basins or wetlands. Nevertheless, the need or otherwise should be investigated and conclusions should be clearly documented.

e) approximate grades, existing and proposed flow paths, with stormwater discharge points;

f) approximate location of trees and other existing vegetation, showing items for removal or retention (consistent with any other plans attached to the E&SC Plan); and

g) location of proposed roads and other impervious areas (e.g. parking areas and site facilities).

On the drawing or in a separate commentary, show how the various soil conservation measures will be carried out on site, including:

a) timing of works;

b) locations of lands where a protective ground cover will, as far as is practicable, be maintained;

c) access protection measures;

d) nature and extent of earthworks, including the amount of any cut and fill;

e) location of all soil and other material stockpiles including topsoil storage, protection and reuse methodology;

f) site rehabilitation proposals, including schedules;

g) frequency and nature of any maintenance program.

7 Other Issues Relating to E&SC Plans

7.1 Inclusion of E&SC Plans in Bill of Quantities

In order to clarify contractual responsibilities, and ensure that proper implementation of the Erosion and Sediment Control Plan is funded, Erosion and Sediment Control measures should be detailed in the Bill of Quantities or Schedule of Rates for the development project.

7.2 Changes to Plans

Major E&SC Plans should reflect the need for changes or modifications to their requirements as development progresses. Large developments may need to submit several stage plans to reflect changing site conditions. Changes to E&SC Plans which increase the risk erosion or sedimentation are not permitted.

Revised E&SC Plans may be required where:

a) changes occur in slope gradients and drainage paths during construction, with their exact form frequently unpredictable before works start;

b) works continue over an extended period, with revisions being required at the beginning of the second year of operations and further revisions at 2-yearly intervals after that. Any revised E&SC Plan should reflect reasonable new standards applying at that time; and

c) the desired outcome (e.g. protection of receiving waters) is clearly not being achieved. Structural measures are only part of the management strategy with other aspects being appropriate implementation, monitoring and corrective action.

Normally, however, changes are not required where the Plan has been properly prepared. Where required, only a suitably qualified person, as per section 3 and ideally the person who prepared the original E&SC Plan, should undertake such changes.

8 Development Standards and Requirements

8.1 Water Release Limits

On site erosion and sediment control measures and management practices must be adequate to achieve the stated release limits.

The release limits for stormwater from the development site, when measured at any point:

a) Entering a waterway; or

b) Entering a drain leading to a waterway; or

c) Leaving the site,

must comply with the following release limits:

- For releases caused by rainfall events which do not exceed the design storm event:
  - 50 milligrams litre (mg/L) of Total Suspended Solids (TSS) as a maximum concentration[5];
  - turbidity (NTU) value less than 10% above background[6];
  - pH value must be in the range 6.5 to 8.0 except where, and to the extent that, the natural receiving waters lie outside this range; and
- dissolved oxygen concentration must be greater than 80% saturation – for flowing waters.

For all releases:

a) Prevent litter/waste entering the site or adjacent stormwater system – minimise on-site production[7];

b) prevent hydrocarbons from entering the stormwater system – control storage, limit application and contain contaminants at source[8];

c) control of anions and cations as required under any relevant Acid Sulfate Soil Management Plan;

d) no other chemical, contaminant or impurity is discharged which is likely to alter the chemical, physical or biological condition of the receiving water[9].

Take all reasonable and practical measures to minimise changes to the natural waterway hydraulics and hydrology from:

a) stormwater run-off volumes entering receiving waters; and

b) uncontrolled release of stormwater (confine to defined discharge points).

Note: For a release caused by a rainfall event which exceeds the design capacity of a sediment basin, release limits will not apply to that release, providing that:

- *immediately prior to the rainfall event, the sediment basin had sufficient storage capacity available to capture all the runoff from the design storm event (see Sediment Basins, below); and*
- *all reasonable and practical measures are implemented before, during and after the rainfall event to minimise the discharge of sediment-laden water from the site.*

8.2 Surface Water Management

a) The natural channel geometry and meander form of perennial and non-perennial streams must not be altered, or riparian vegetation disturbed without approval.

b) Where, in exceptional circumstances, approval is obtained for channel or meander alteration or disturbance, works should only be carried out during the lower rainfall months and the involved area is to be promptly rehabilitated conforming to the natural channel form, substrates and riparian vegetation as far as possible.

c) The ground surface within all concentrated flow paths must be protected with turf, jute matting or similar effective protection consistent with the maximum design flow velocity for the surface (refer to Appendix 1).

d) Temporary creek and drainage line vehicle crossings, are to be designed to convey flow and remain stable in the 10-year average recurrence interval (ARI) event of critical duration.

e) Temporary hydraulic structures and their inlet and outlet works are to be constructed to convey water in the design peak flow and remain stable. The applicable design ARI for temporary hydraulic structures (not including basin embankments or spillways) when the consequences of failure are environmental degradation only, is the 10-year ARI event of critical duration.

The 100yr ARI event of critical duration remains the standard of protection applicable to dwellings and to ensure pedestrian and vehicle safety. Reference should be made to the Integrated Water Management Code and Queensland Urban Drainage Manual (QUDM) for applicable criteria including spillways and freeboards. It is the responsibility of the designer to correctly identify and clearly state the design ARI

5 *It is recommended that a site specific relationship is developed between turbidity and suspended solids on large and medium scale construction sites.*

6 *Background refers to receiving waters immediately upstream of site waters entry points.*

7 *Avoid wind blown litter, remove gross pollutants – use approved containment bins (with lids) to store litter and other waste on-site. Ensure regular clearance.*

8 *Store oil and fuel in accordance with Australian Standard AS1940 – no visible sheen on receiving waters.*

9 *See the prescribed contaminant list in the Environmental Protection Regulation 1999.*

selected for the design of all structures based on an analysis of the consequences of failure.

f) Discharges to waterways should mimic natural flows in terms of magnitude, seasonality, frequency and variability. Stream flows immediately downstream during and after construction should mimic the natural range for at least the 2 year ARI event, and desirably the 1 year ARI event, to minimise channel expansion.

g) Calculations are required to ensure that erosion thresholds (tractive forces) in stream channels are not exceeded so as to cause stream channel expansion or changes to stream substrate. This requires knowledge of depth of flow, slope, and the soils of the site, and natural substrates.

h) Concentrated flows of stormwater must be directed to appropriately designed and engineered release points which are capable of withstanding the flow velocities at least up to the 10-year ARI event of critical duration.

i) Where channels and pipes outlet to downstream receiving waters, they are to discharge to stabilised surfaces, and suitable water quality and quantity control structures installed so that discharges meet the performance criteria.

j) Any water quality and quantity control structures, such as oil/grease interceptors, sediment traps/basins, litter traps, constructed wetlands and detention basins, are to be constructed where feasible outside the riparian zone.

k) There must be properly constructed and stable check banks or drains maintained parallel to the contour-line across any area of bare soil which is not being actively worked, constructed at adequate intervals and gradients to ensure runoff flows at non-erosive velocities depending on the slope gradient, but in no case at intervals greater than 90 metres. The concentrated flow from the outlet of such banks or drains must be to drains or areas which are suitably protected against scouring and erosion.

l) Where works are to be conducted within waterways and stormwater drainage, the works must be timed to minimise the potential for exposure to flood events, having regard for the three-day weather Bureau of Meteorology forecast, as far as practicable.

8.3 Sediment Basins

a) Sediment basins must be designed to capture and store all the stormwater runoff from the design storm event (see Table 2).

b) Sediment basins must be designed to store sediment volumes in accordance with Table 2.

c) The calculated storage capacity must be determined in cubic metres.

d) Following the construction of sediment basins, the basin must be surveyed and volumetric capacity must be clearly displayed on a sign beside the basin, and the maximum sediment storage level, at which point sediment removal is required, must also be indicated by a peg.

e) Sediment basins must be maintained with sufficient capacity to capture and store all the runoff from the design storm event (see Table 2).

f) Sediment basins must be maintained in dry weather at a low water level (ie with sufficient capacity to capture the runoff from the design storm event) in readiness for capture, treatment and discharge of further runoff.

g) All stormwater captured in basins must be treated and lawfully disposed of preferably within one (1) day, but not more than five (5) days, of the cessation of any rainfall event.

h) A minimum stockpile of required flocculating agents, where appropriate, must be retained onsite to provide for at least three (3) complete treatments. It must be stored in a secure, bunded, undercover location.

i) Arrangements are to be in place for the continued operation and maintenance of sediment basins, until the total development site is permanently stabilised across 90% of the total surface area. A stable surface here means having a Revised Universal Soil Loss Equation (RUSLE) C-factor of 0.05 (equal to 70% grass coverage).

j) The decommissioning of the sediment basin is to be coordinated with the commissioning of permanent water sensitive design features to, as far as practical, reduce the possibility of sediment leaving the site, and hydrologic impacts.

k) The design of sediment basins including embankments, outlets and spillways, must be certified by a Registered Professional Engineer Queensland with appropriate professional experience.

l) Earthworks for erosion and sedimentation control basins shall be to the planned levels and dimensions shown on the submitted design plans.

8.4 Soils and Vegetation

a) All works that involve any disturbance to the surface of land are to be carried out in accordance with an approved Erosion and Sediment Control Plan (E&SC Plan).

b) No vegetation is to be removed or soil disturbed except where expressly indicated on the approved plan.

c) The stripping and filling operations must be undertaken in stages. The total exposed area at any time is to be kept to a minimum due to the inherent

Table 2 Sediment Basin Design Criteria

Soil Type	Soil characteristics	Treatment process	Basin design capacity Settling zone	Sediment storage zone
Type C (coarse)	Less than 33% finer than 0.02mm and less than 10% of the soil materials are dispersible	Rapid settling in wet or dry basins	Surface area of 4,100 m2/m3/sec in the 3-month ARI flow, minimum depth of 0.6m, and length:width ratio of >3:1	Capacity to store two months sediment loss as estimated by RUSLE. However, can be taken as 100% of the capacity of the settling zone on sites of low erosion hazard (as determined from Chapter 4 of MESC 2007)
Type F (fine)	all soils other than type C	Aided flocculation in wet basins. Capture, treat and release within 1 to 5 days of event.	Capacity to contain all runoff expected from the y percentile, x-day rainfall depth where, depending on the sensitivity of the receiving waters and/or the duration that the structure is in use: x is 2, 5, 10 or 20-days y is the 75th, 80th, 85th or 90th percentile. The default criterion, unless otherwise specified, is the 5 day 80th percentile rainfall depth for development where the works schedule achieves complete site surface protection within 6 months, and 5 day 85th percentile rainfall depth for other developments.	Capacity to store two months sediment loss as estimated by RUSLE. However, can be taken as 50 per cent of the capacity of the settling zone on sites of low erosion hazard (as determined from Chapter 4 of MESC 2007)

limitations of cost-effective structural control measures. The aim is to reduce the area of exposed land not being actively worked, and generating sediment, and hence to minimise nett sediment export from the site. In addition to the general staging as shown on the approved drawings, sub-staging is to be undertaken as necessary such that the total exposed areas do not exceed 2 hectares at any one time. The disturbed area may be increased to 5 hectares only where the proponent demonstrates that this has an over-riding public benefit.

d) For the purposes of compliance with the above condition, 'exposed areas' are defined as any area having less than 70% stabilised surface coverage. Stabilisation may be undertaken using grass seeding, seeded mulch, hydromulch or other methods which must be managed to ensure a stable long-term surface coverage, subject to the required 70% surface coverage being achieved. Hold points will not be required within the substaging or between stages unless the total exposed area exceeds 2 hectares. If this occurs then all soil disturbing activities are to cease until compliance with this condition is achieved.

e) The period between when land is cleared of vegetation and major civil/bulk earthworks commence must be minimised, but such period must not exceed four weeks unless temporary and effective stabilisation measures are immediately implemented after clearing. These requirements may be waived only where the proponent can make a case to demonstrate an alternative approach has an overriding public benefit.

f) There must be no site disturbance, including vegetation clearing, other than for initial survey work, the approved site office and store, and to enable compliance with this condition, until the following measures are implemented:

- Areas to be disturbed have been marked out;
- Vehicle barriers erected around areas to be protected;
- Vehicle stabilised site access point(s);
- Vehicle wash/rumble pad;
- Clean runoff diversion drain installed and stabilised; and
- Sedimentation basins (if applicable) have been installed, stabilised, surveyed, signed and pegged (as per Clause 7.3 (d) above).

g) Natural vegetation on site is to be preserved, except where removal is essential for initial site surveys and the carrying out of approved operational works.

h) Vegetation clearing must be limited, as far as reasonable and practicable, to two (2) metres from the edge of any essential construction activity as shown on the engineering plans, or as otherwise approved.

i) Effective access barriers must be maintained in position at all times to protect areas not to be disturbed by works, including in revegetation areas.

j) Sufficient stockpiles of mulch, geotextile and/or other similar required erosion and sediment control

Table 3 Soil Cover Requirements

Lands	Maximum C-factor	Remarks
Waterways and other areas subjected to concentrated flows post construction. Concentrated flow also requires consideration of flow velocities.	0.05	Coverage to be effective within 10 working days from completion of formation and before they are allowed to carry any concentrated flows. (Note: a *C*-factor of 0.05 can be achieved in various ways including with about 70% groundcover).
Stockpiles	0.10	Applies after 10 working days from completion of formation (Note: a *C*-factor of 0.10 is achieved with about 60% groundcover)
All lands, including waterways and stockpiles during construction	0.15	Coverage to be effective within 20 days of construction inactivity, even though works might continue later (Note: a *C*-factor of 0.15 can be achieved in various ways, including with about 50% groundcover).
All lands, including waterways	0.05	Coverage to be effective on release of the Survey Plan. Note: a *C*-factor of 0.05 can be achieved in various ways, including with about 70% groundcover and 100% synthetic cover.
All high erosion hazard lands during period December to March inclusive	0.1	Except where the 3 day Bureau of Meteorology forecast indicates a low probability for rainfall.

materials and stores must be maintained on site from commencement of earthworks and at all times thereafter to enable ongoing erosion control, as well as for site contingencies (e.g. imminent wet weather) until commencement of "off-maintenance".

k) Exposed soil areas such as embankments, and filled areas especially subject to erosive forces which are completed or are not being actively worked must be fenced off to plant and vehicular traffic, stabilised and protected by the application of seeded mulch, turf (not grass seeding alone), or other effective surface stabilisation measure to ensure that the area exposed, and time that areas are exposed, is minimised in accordance with Table 3.

l) All exposed soil areas are to be rehabilitated immediately on completion where feasible to ensure that the overall area of the site exposed, and time that areas are exposed, is minimised as far as practicable in accordance with Table 3.

m) Where it is impractical to schedule work on high or very high erosion hazard lands to periods when rainfall erosivity is low, such as during winter, the site must be managed such that disturbed lands are to have C-factors higher than 0.1 only when the 3-day forecast suggests that rain is unlikely. In any case, management regimes should be established that facilitate stabilisation within 24 hours should the forecast prove incorrect.

n) Soil stockpiles must be shaped to stable batters, effectively protected by sediment control fencing, not be located within flow paths, and those which are not being actively worked (in any 21 calendar day period) must be provided with effective temporary surface protection without delay, but in any case within 24 hours of cessation of the last activity.

o) Turf, or a turf strip 400mm wide, must be in place continuously adjacent to and parallel with all kerbs, and 70% grass coverage or 100% synthetic cover must be achieved elsewhere including on all exposed allotment areas prior to "on-maintenance" beginning.

9 Administration

9.1 Operations, Monitoring and Maintenance

a) All erosion and sediment control measures must be properly and effectively maintained and operated, and must be in good working order and fully effective condition at the completion of each day's work.

b) The maintenance of fully effective erosion and sediment control measures must continue until the site has been permanently stabilised and further disturbance of soil by erosion is prevented.

c) Scour of newly-formed cut and fill batters during and after embankment construction shall be minimised by diverting runoff from the formation away from the batter until vegetation is established.

d) Where more than 2,500 square metres of land are disturbed, a self-auditing program must be developed for the site prior to approved works commencing, and be produced at the pre-start plan. A site inspection using a Log Book or Inspection Test Plan (ITP) must be undertaken by the site supervisor:

- at least each week
- immediately before site closure
- immediately following rainfall events that cause runoff.

e) The ITP can take the form of a checklist, completed by simple tick and brief commentaries.

f) The self-audit must be undertaken systematically, recording:

- installation/removal of any erosion and sediment control management practices;
- the condition of each erosion and sediment control management practices employed, noting whether it is likely to continue in an effective condition until the next self-audit.

g) An effective water quality self-monitoring program, including at least one representative measurement of the total suspended solids quality of any flow or release from the site on each day runoff to receiving waters occurs, must be implemented continuously throughout the life of the works which are the subject of this approval.

h) A legible record is to be kept on-site of all self audits and water quality monitoring, and produced promptly to any authorised Council officer on request.

i) Where the findings of the required performance self-monitoring program indicate that any compliance limit is being or is likely to be exceeded, remedial action must be taken without delay to ensure ongoing compliance.

j) Access to the site is to be permitted at all times for any authorised Council officer for the purposes of administration of the approval or administration of any legislation for which Council is an administering authority.

9.2 Bonds and Securement of Works

a) Where there is found to be a failure to adopt or maintain best practice environmental management including failure to carry out any part of an approved Erosion and Sediment Control Plan diligently, a part or all the bond monies held by Council under Planning Scheme Policy for Operational Works can be forfeited at Council's discretion, and used for carrying out any strategy for achieving compliance with the approval, for rectifying any environmental damage, or to recover environmental enforcement costs.

b) Where Council determines that there has been a failure to comply with the conditions of approval possibly justifying a draw down on the bond, it will give a warning in writing to this effect requiring compliance within a specified period of time, and specifying the intended draw-down amount.

c) In the event of a failure to fully comply with such a warning and direction, Council may proceed to draw down on the bond as forecast.

d) Where Council determines that a draw down of the bond is required, the applicant must restore the bond to its full amount within ten (10) working days of a notice in writing from Council to that effect.

e) Half of the bond, or of any portion thereof remaining, may be released, at Council's discretion on commencement of the On Maintenance period, subject to a satisfactory record of ongoing compliance, and after application in writing for a joint compliance inspection for this purpose.

f) The remaining amount of any bond will only be finally released by Council at the termination of the "On Maintenance" period.

9.3 Hold Points

a) No clearing or earthworks, other than to achieve compliance with this condition, may commence until the following erosion and sediment control measures are in place and approval to continue work is given in writing by a Council officer. Such written approval may be given on-site by the Council officer. These measures are:

- Areas to be disturbed marked out;
- Vehicle barriers around areas to be protected;
- Vehicle site access point(s);
- Vehicle wash/rumble pad;
- Clean runoff diversion drain installed and stabilised; and
- Any required sedimentation pond installed and stabilised.

b) Works must not continue after the sub grade approval until compliance with the Erosion and Sediment Control Plan has been verified by a Council officer and approval in writing given to proceed.

c) Works must not continue after the final trim/pre-seal inspection until compliance with the Erosion and Sediment Control Plan has been verified by a Council officer and approval in writing given to proceed. Such written approval may be given on-site by the Council officer.

9.4 Certification

The author or the supervising engineer must provide a completed statement of compliance in the approved form (available on the Sunshine Coast Regional Council website) certifying that all Erosion and Sediment Risk Assessments, Hazard Evaluation Reports and Control Plans have been prepared in accordance with the Maroochy Manual for Erosion and Sediment Control, except as otherwise required by the approval or this Policy.

9.5 Compliance Policy

a) There must be no exceedance of the relevant specified water quality release levels at any time up to the approved design storm event. Where there is reliance on this clause to justify any exceedance, it is incumbent on the holder of the approval or their agent to substantiate the appropriate rainfall data evidence.

b) The occurrence of an extreme event is not justification to fail to adopt best practice environmental management to reduce the hydrologic and sediment impacts of the development before, during and after such events.

c) "Best practice environmental management" is used here as defined in the Environmental Protection Act 1994. An example of a failure of such best practice is neglect to attend the site and manage control measures to prevent water pollution during a major rainfall event, including neglect to do so during wet weather after normal hours of work including weekends.

d) Should an operator find through their own monitoring that, in spite of adopting and maintaining genuine best practices, as advised by a qualified practitioner, that significant exceedance of the objectives is occurring, Council should be promptly advised by email or fax to the Waterways Unit Coordinator.

   This will enable both parties to cooperatively identify, on a "without legal jeopardy" basis, the technological shortfall (in achieving the planning environmental objectives) to enable feedback, to the engineering design and Council planning assessment and approval processes.

10 Reference Documents

The following documents may be referred to for detailed design information and specifications, where appropriate, to achieve compliance with the Erosion and Sediment Control Code and this Policy.

a) Queensland Urban Drainage Manual (QUDM)

b) Australian Rainfall and Runoff (AR&R)

c) Manual for Erosion and Sediment Control, Maroochy Shire Council, 2007 (MESC, 2007)

d) Managing Urban Stormwater – Soils & Construction Volume 2A Installation of Services (NSW Govt Jan 2008)

Appendix 1 Maximum Design Flow Velocities in Concentrated Flow Paths

Material Type	Thickness (m)	Aggregate size (mm)	Critical velocity (m/second)
Gabions and reno mattresses	0.50	120-250	6.4
	0.50	100-200	5.8
	0.30	100-150	5.0
	0.30	70-120	4.2
	0.25	70-100	3.6
	0.17	70-100	3.5

	Weight each (kg)	Turbulent flow	Normal flow
Loose rock (assume 100 percent soil cover)	1,000	4.8	6.6
	500	4.2	5.7
	100	3.3	4.5
	50	2.8	3.8
	10	2.3	3.0

	Form	
Revetment mattresses	Storm mattress	>6.0
	200 mm fp	6.0
	125 mm fp	4.0
	100 mm fp	2.0

Assume that all soils with 10 percent or more dispersible fines have high erodibilities. Of those with less, soils with K-factors below 0.2 have low erodibilities, those between 0.2 and 0.45 have moderate erodibilities, while those above 0.45 have high erodibilities.

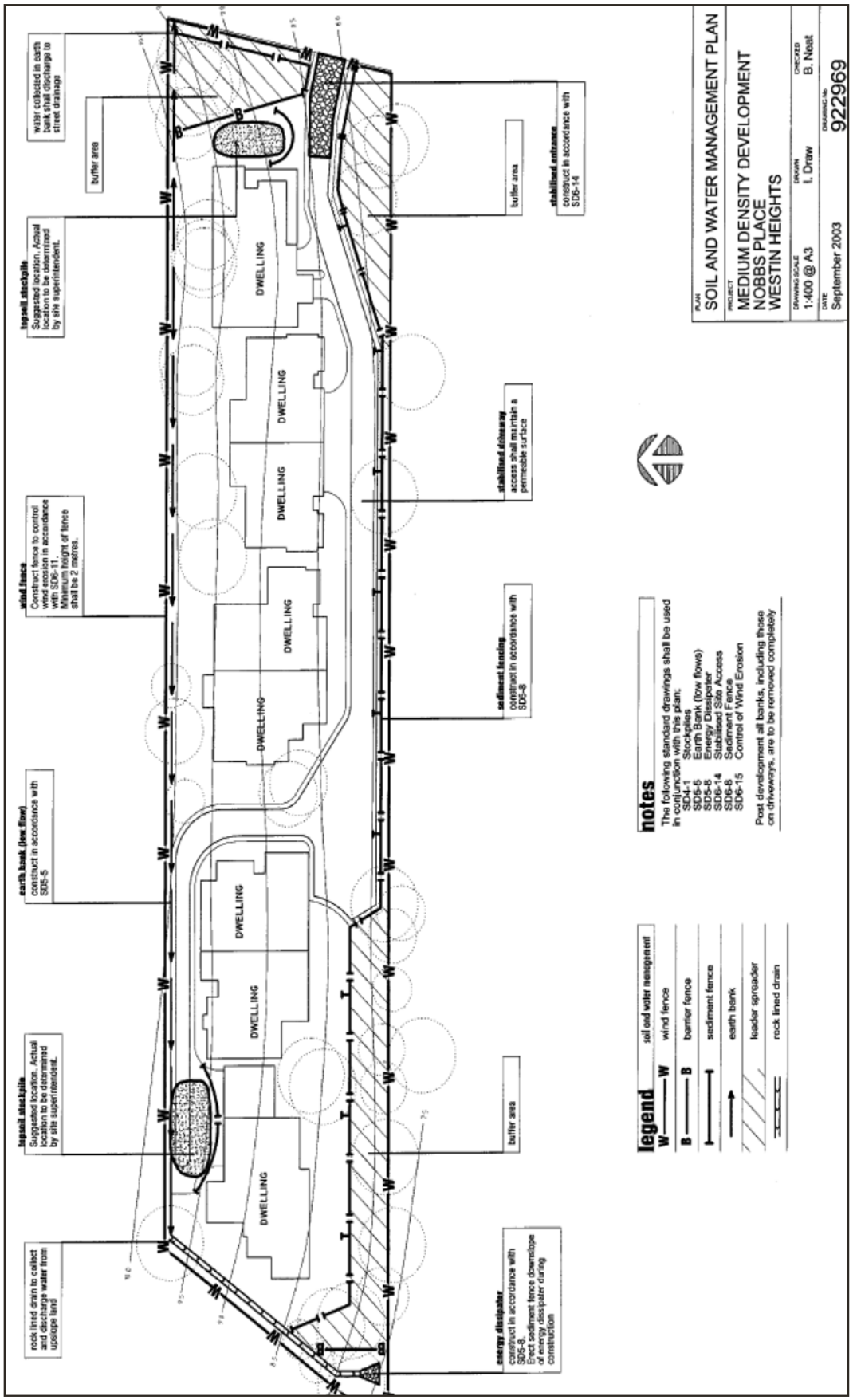
In addition, the figures here assume slope gradients of less than 10 percent and, where appropriate, good (>80 percent) ground cover. If good ground cover is not expected to be maintained properly (might die back seasonally or during short periods of drought) and is critical to the system, reduce all velocities by 1.0 metre per second. Alternately, seek the manufacurer's advice if these conditions are unlikely to be met.

Material [1]	Critical velocity (m/sec) [2]											
	Inundation <6 hours			Inundation <12 hours			Inundation <24 hours			Inundation <48 hours		
	Soil erodibility			Soil erodibility			Soil erodibility			Soil erodibility		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
High performance TRM's, vegetated	7.0	7.0	7.0	6.0	6.0	6.0	5.0	5.0	5.0	4.0	4.0	4.0
Medium performance TRM's, vegetated	5.0	5.0	5.0	4.3	4.3.	4.3	3.6	3.6	3.6	3.0	3.0	3.0
Light performance TRM's, vegetated	3.0	2.7	2.4	2.6	2.3	2.0	2.3	2.0	1.8	2.0	1.8	1.6
Mesh reinforced turf	3.0	2.7	2.4	2.6	2.3	2.0	2.3	2.0	1.8	2.0	1.8	1.6
Kikuyu	2.5	2.2	1.9	2.1	1.9	1.6	1.9	1.7	1.4	1.6	1.4	1.2
Jute or coir mesh (close weave, bitumen sprayed)	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Coconut/jute fibre mats	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Couch, carpet grass, Rhodes grass, etc.	2.0	1.8	1.4	1.7	1.5	1.2	1.5	1.4	1.1	1.3	1.2	0.9
Bare soil	0.7	0.5	0.3	0.6	0.4	0.3	0.5	0.4	0.2	0.4	0.3	0.2

[1] For further information, phone the office of Australasian Chapter of the International Erosion Control Association on 1800 354 322 or (+61 2) 4677 0901.

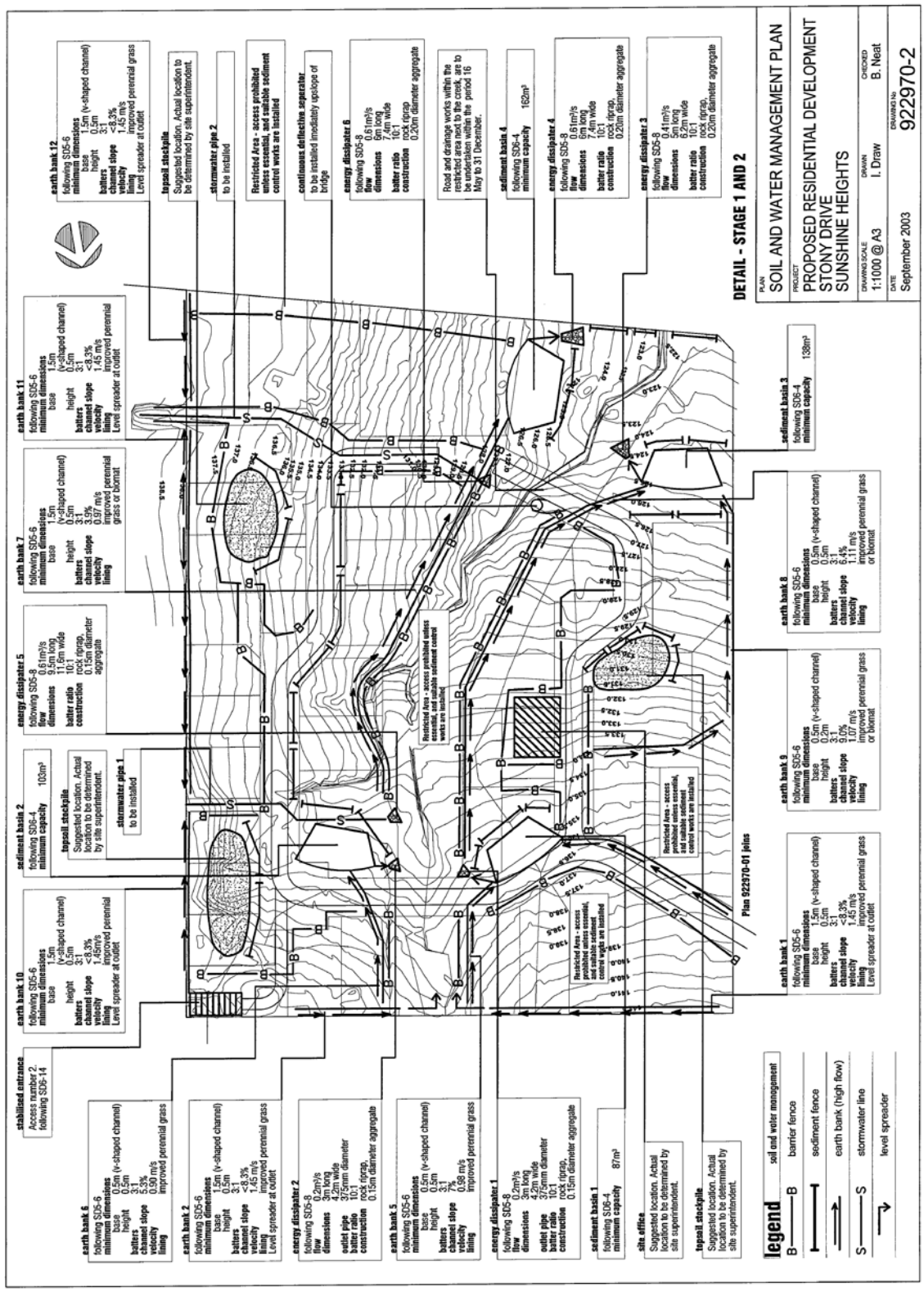
[2] The designer should also check shear stress as this becomes limiting as slope gradient increases.

Appendix 2 Example Erosion and Sediment Control Plan for a Medium Density Development

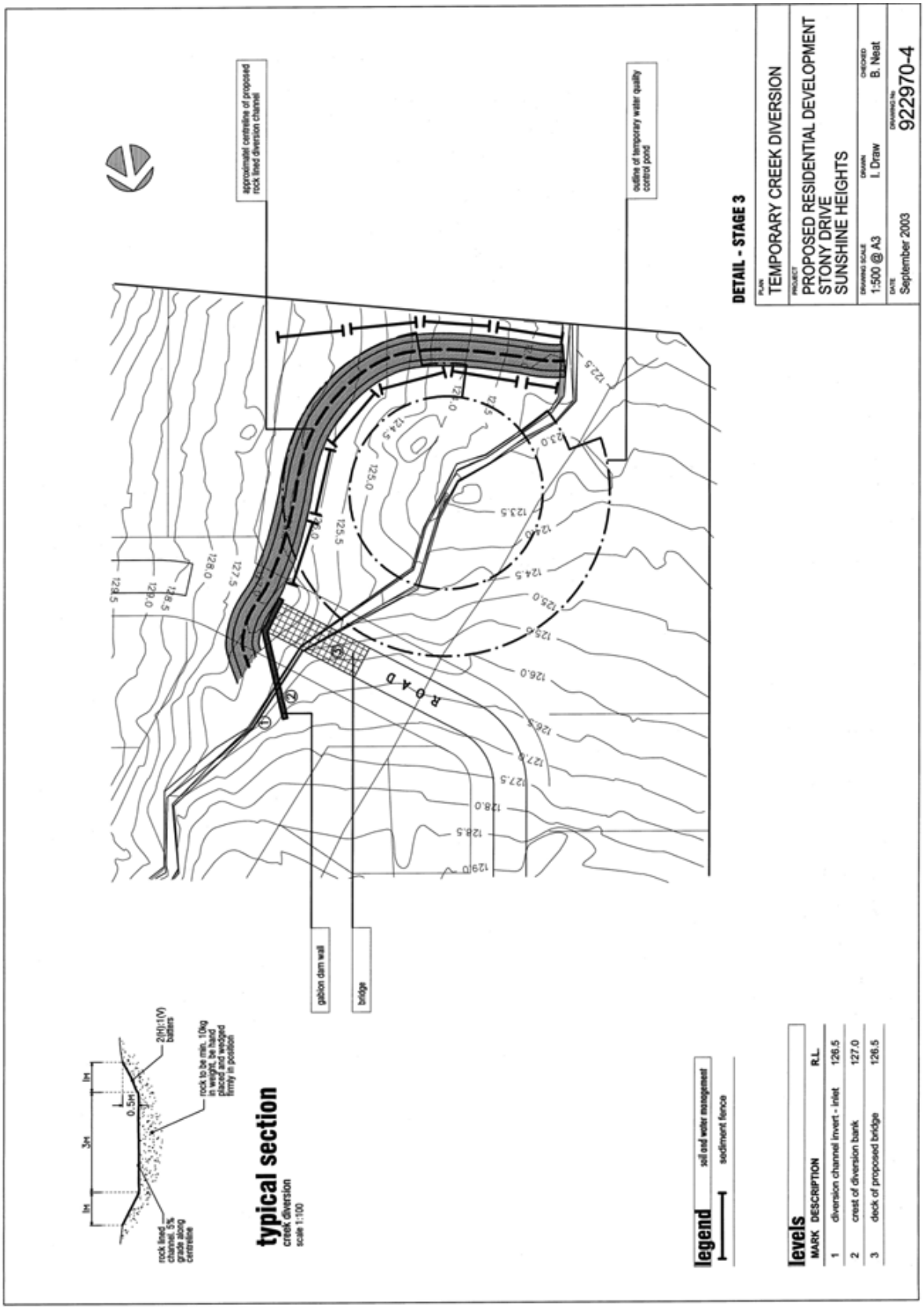


Appendix 3 Example Erosion and Sediment Control Plan for a Subdivision Development.

Note for a development of this scale several diagrams are generally required to reflect the changing conditions on site as the works proceed.



Appendix 4 Example Erosion and Sediment Control Plan for a Temporary Creek Diversion



Appendix 5 Site Data Sheet

All applications involving a total land area in excess of one hectare are to present technical information in the Site Data Sheet Format below

Note: These initial "Standard Calculation" spreadsheets relate only to erosion hazard lands of 4000 square metres to 1 hectare requiring a sediment basin, where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on lands greater than one hectare or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name:							
Site location:							
Precinct:							
Description of site:							
Site area	**Site**						**Remarks**
Total catchment area (ha)							
Disturbed catchment area (ha)							
Impervious area before development (ha)							
Impervious area after development (ha)							
Stream flows for the natural range for the 2 year ARI event							
Stream flows during and after disturbance for the same range, 2 year ARI event							
Stream flows immediately downstream during and after construction to mimic the natural range to avoid channel expansion							
Soil analysis (refer AS1289)							
Soil landscape							
Soil Texture Group							
Dispersion Index							
Particle size distribution							
Electrical conductivity & pH value							
Soil Hydrologic Group							
Sub Soil K Value							
Sediment type (C, D, or F)							
Acid sulfate potential							
Rainfall data							
Design rainfall depth (days)							
Design rainfall depth (percentile)							
x-day, y-percentile rainfall event							
Rainfall intensity: 2-year, 6-hour storm							See IFD chart for the site
Rainfall erosivity (R-factor)							Automatic calculation from above data
Comments:							

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$Q_y = 0.00278 \times C_{10} \times F_Y \times I_{y,tc} \times A$

where: Qy is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years

C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F

F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)

A is the catchment area in hectares (ha)

$I_{y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	

Peak flow calculations, 2

ARI yrs	Frequency factor (F_y)	Peak flows						Comment
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	
$1_{yr,tc}$								
$5_{yr,tc}$								
$10_{yr,tc}$								
$20_{yr,tc}$								
$50_{yr,tc}$								
$100_{yr,tc}$								

3. Volume of Sediment Basins: *Type C* Soils

Basin volume = settling zone volume + sediment storage volume

Settling Zone Volume

The settling zone volume for *Type C* soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

$Q_{tc,\,0.25} = 0.5 \times [0.00278 \times C_{10} \times F_y \times I_{1yr,\,tc} \times A\,]$ (m^3/sec)

where:

$Q_{tc,0.25}$ = flow rate (m^3/sec) for the 0.25 ARI storm event

C_{10} = runoff coefficient (dimensionless for ARI of 10 years)

F_y = frequency factor for 1 year ARI storm

$I_{1\,yr,tc}$ = average rainfall intensity (mm/hr) for the 1-year ARI storm

A = area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{tc,\,0.25}$ m^2

Particle settling velocities under ideal conditions (Section 6.3.5(e))	
Particle Size	**Area Factor**
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 100 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	$Q_{tc,\,0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
		4100								
		4100								
		4100								
		4100								

4. Stormwater storage volume of Sediment Basins for *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-}\%ile,\ x\text{-}day} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events

A = total catchment area (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	

Peak flow calculations, 2								
ARI (yrs)	Frequency factor (F_y)	Peak flows						Comment
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	
1 yr,tc								
5 yr,tc								
10 yr,tc								
20 yr,tc								
50 yr,tc								
100 yr,tc								

3. Volume of Sediment Basins: *Type C* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type C* soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

$Q_{tc,0.25} = 0.5 \times [0.00278 \times C_{10} \times F_y \times I_{1yr,\,tc} \times A\,]$ (m^3/sec)

where:

$Q_{tc,0.25}$ = flow rate (m^3/sec) for the 0.25 ARI storm event

C_{10} = runoff coefficient (dimensionless for ARI of 10 years)

F_y = frequency factor for 1 year ARI storm

$I_{1\,yr,tc}$ = average rainfall intensity (mm/hr) for the 1-year ARI storm

A = area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{tc,\,0.25}$ m^2

Particle settling velocities under ideal conditions (Section 6.3.5(e))	
Particle Size	**Area Factor**
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 100 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(v)).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

☐ 100% of settling zone capacity,

☐ 2 months soil loss calculated by RUSLE

Total Basin Volume										
Site	$Q_{tc, 0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
		4100								
		4100								
		4100								
		4100								

4. Volume of Sediment Basins *Type F* Soils

Basin volume	=	settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

V	=	10 x Cv x A x Rx-day, y-%ile (m3)
where:		
10	=	a unit conversion factor
Cv	=	the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period
Rx-day, y-%ile	=	is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).
A	=	total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

☐ 50% of settling zone capacity,
☐ 2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)