

# METHOD FOR ACCOUNTING REDUCTION IN SEDIMENT RUN-OFF THROUGH GULLY REHABILITATION – VERSION 1.0

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Authors: Andrew Brooks<sup>1</sup>, Tim Pietsch<sup>1</sup>, Robin Thwaites<sup>1</sup>, John Spencer<sup>1</sup>, James Daley<sup>1</sup>, Nicholas Dorian<sup>1</sup>, Justin Stout<sup>1</sup>, James Schultz<sup>2</sup>, and Jenny Sinclair<sup>2</sup>

1 Griffith Centre for Coastal Management, Griffith University

2 GreenCollar Group, Sydney NSW

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## CONSULTATION PROCESS

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This method was developed in consultation with the Reef Credit Methodology Technical Working Group. Members of the working group include representatives from Industry, Qld Government, CSIRO, JCU, Griffith University, advocacy groups, NRM groups and subject matter experts. The method approach arose from discussion at two workshops, the first in September 2017 and the second in March 2018.

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# 1 PROJECT DESCRIPTION

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## 1.1 GOVERNING DOCUMENTS

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Reef Credit Standard

Reef Credit Guide

## 1.2 REFERENCES

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This methodology references the following policy documents and tools:

Reef 2050 Long Term Sustainability Plan

Reef 2050 Water Quality Improvement Plan 2017-2022

Paddock to Reef Integrated Monitoring, Modelling and Reporting Program 2018-22

Paddock to Reef Program Grazing Water Quality Risk Framework

Reef Trust Phase IV Gully and Streambank Toolbox

## 1.3 SUMMARY DESCRIPTION OF METHODOLOGY

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This methodology (here onwards called the 'Method') describes the approach to achieve and quantify reductions in Fine Sediment (FS) from rural landscapes through gully rehabilitation, within the catchments of the Great Barrier Reef World Heritage Area (GBRWHA).

The core Method components are as follows:

1. Determine Eligibility: Sets the criteria for eligibility of projects under the methodology and the Reef Credit Standard.
2. Establish Project Boundaries and Scope: Provides guidelines for defining the geographical and temporal boundaries of the project, scope of activities and pollutant pools to be accounted for in the project.
3. Quantify Baseline FS Yields: Provides guidelines for determining FS yields for the baseline period.
4. Quantify Project FS Yield: Provides guidelines for determining project FS yield for the reporting period.
5. Quantify FS Yield Reduction: Details how to determine the reduction in FS resulting from project activities at end of catchment for the reporting period.
6. Quantify Reef Credit Units: Outlines the steps to determine the number of reef credits based on calculated pollutant reductions.
7. Project Monitoring: Provides guidelines for the implementation of a monitoring plan and identifies monitored parameters to assess the gully rehabilitation management strategy.
8. Project Reporting and Credit Issuance: Outlines requirements for reporting project abatement to the Reef Credit Secretariat and the application process for the issuance of Reef Credits.

## 1.4 PROJECT ACTIVITIES

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The scope of this methodology includes the design and implementation of landscape rehabilitation measures to reduce the amount of sediment loss from gully erosion. Gully rehabilitation interventions may include:

- 1) Engineered rock-chute head control structures;
- 2) Engineered grade control structures;
- 3) Gully reshaping and capping with rock or mulch, or both;
- 4) Gully catchment drainage diversion structures (contour-banks and flow-spreaders);
- 5) Soil amelioration (i.e. with gypsum and other non-toxic chemical stabilisers);
- 6) Revegetation of treated gullies and gully catchments;
- 7) Livestock exclusion;
- 8) Grazing management;

This methodology is not limited to the above interventions and activities to rehabilitate gullies but the project must provide a ***Gully Rehabilitation and Management Plan*** that describes the proposed gully rehabilitation interventions, management and monitoring activities for the project duration.

## 1.5 DEFINITIONS

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**Additionality** – as defined in the Reef Credit Standard Schedule 1.

**Baseline period** – a period of time immediately prior to project commencement that is either a) at least twenty (20) years prior to project commencement for a linear sediment yield trajectory, and > fifty (50) years if claiming a non-linear trajectory; or b) the length of time since the gully commenced more recently than twenty (20) years, where it can be demonstrated that it is not a function of some recent change in land-use intensification, or land-use practice.

**Baseline sediment yield** – The sediment yield determined over the baseline period, assuming a linear relationship through time. Baseline sediment yield must be reported as tonnes of fine sediment per annum (over water-year – 1 July – 30 June as defined by BOM) (t/a).

**Crediting period** – as defined in the Reef Credit Standard Schedule 1.

**Crediting period length** – 25 years

**Fine sediment (FS)** – particles < 20 µm, i.e. the fine clay, clay, and silt particle size fraction of the soil material (NCST, 2009). This must be determined by sediment particle size analysis in a certified laboratory using a Mastersizer (or similar) with mechanical dispersion only or by the hydrometer method (Rayment & Lyons, 2010).

**Great Barrier Reef World Heritage Area (GBRWHA)** – the marine and estuarine waters of the Great Barrier Reef from the low tide limit as defined by the Australian Government Department of Environment

**Gully erosion** – A persistent erosional landscape feature > 0.3m deep (from the surrounding residual land surface) that has multiple modes of expansion, but always including headward retreat into an otherwise un-dissected landscape since land use intensification (from Brooks et al., 2018a). For defining characteristics of a gully refer to the Method for Accounting Reduction in Sediment run-off through Gully Rehabilitation Implementation Guidance Document v1.0.

**Gully Rehabilitation and Management Plan** – Documented proposal for implementing project activities for the duration of the project period

**NRM Regions** – The six Natural Resource Management Regions as defined by the that comprise the catchments that drain to the GBRWHA. In Cape York this is the eastern draining catchments only. See <https://data.qld.gov.au/dataset/natural-resource-management-regional-boundaries-queensland>.

**Project application** – As defined in the Reef Credit Standard.

**Project application date** – As defined in the Reef Credit Standard.

**Project commencement** – As defined in the Reef Credit Standard.

**Project end date** – 25 years after project commencement and must be defined at project application.

**Reef Credit** – Quantified mass of nutrient, pesticide or sediment reduction under the Reef Credit Standard.

**RCAZ** - Reef Credit Accounting Zone, hereby defined as the catchment area (including the active gully) at the most downstream point of the gully(ies) being monitored for Reef Credits. See Section 3.4.

**Reef Plan Water Quality Risk Framework for Grazing:** see – [https://www.reefplan.qld.gov.au/data/assets/pdf\\_file/0034/78865/grazing-water-quality-risk-framework-2017-22.pdf](https://www.reefplan.qld.gov.au/data/assets/pdf_file/0034/78865/grazing-water-quality-risk-framework-2017-22.pdf)

**Scalding** – Highly degraded land on alluvial, colluvial or residual soils in which the surface soil materials (topsoil or A horizons, maybe some B horizon) have been stripped leaving bare ground which often forms a hard, sealed surface.

**Soil Material Analysis** – Laboratory analysis for each main soil material layer identified including particle size analysis (< 2 µm (clay), 2 – 20 µm (silt), 20 – 50 µm (fine-medium sand), 0.05 – 2 mm (coarse sand)); major cations (Ca, Mg, Na, K; and Al) and cation exchange capacity (CEC); electrical conductivity (EC) and chlorides (Cl) for salinity; the R1/R2 dispersion ratio, and bulk density.

**Water-year** – 1 July – 30 June.

## 1.6 DOCUMENTATION REQUIRMENTS

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This section outlines the documentation required for project application and for issuance of Reef Credits.

### 1.6.1 PROJECT APPLICATION

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When applying for a project, the project documentation must include a **Project Summary**. The Project Summary report must include:

- a. Names of project proponents and key partners with interest in the land parcel or enterprise.
- b. Project location.
- c. Summary description of gullies at the site, including:
  - i. Gully area spatial files including active portion; partially active areas (e.g. scalded but not gullied) and gully catchment area;

- ii. Estimate of Baseline sediment yield and proportion of fine sediment (< 20 µm);
- iii. Estimate of abatement potential over the crediting period. This will initially involve an estimation of the treatment effectiveness, which based on current evidence should not be more than 80% after two years.

The project application must also include a **Project Eligibility Report** outlining how the project complies with the Reef Credit Standard and the methodology eligibility requirements, and a **Gully Rehabilitation and Management Plan**.

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## 1.6.2 PROJECT CREDITING

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When applying for issuance of Reef Credits, project documentation must include:

1. Project Summary
2. Project Eligibility Report
3. Project Spatial Report
4. Gully Rehabilitation and Management Plan
5. Project Abatement Report
6. Monitoring Report
7. Evidentiary Documents

In addition to the requirements outlined in this methodology, the project proponent must address how the project adheres to all Reef Credit rules when applying this methodology (e.g. documentary evidence of land ownership or rights to land management over the project area).

## 2 PROJECT ELIGIBILITY

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This section outlines the project eligibility criteria to be eligible to implement this methodology under the Reef Credit Standard. For each of the eligibility criteria, credible evidence in the form of analysis, documentation and/or third-party expert reports is required as part of the project application.

### 2.1 LOCATION

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Proposed project area must be located within the boundaries of one of the following Great Barrier Reef NRM Regions:

1. Cape York Peninsula (eastern seaboard draining catchments only)
2. Wet Tropics
3. Burdekin
4. Mackay-Whitsunday
5. Fitzroy
6. Burnett-Mary

### 2.2 PROJECT LAND CHARACTERISTICS

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The project area must include land that:

- 1) has demonstrated gully erosion contributing to the sediment load entering the GBR during the baseline period;

- 2) gullies have been in existence for, at the minimum, **baseline period length**;
- 3) is predicted to contribute sediment to the GBR through gully erosion without intervention; and
- 4) the project proponent has the legal right to manage through implementation of project activities.

## 2.3 PROJECT ACTIVITIES

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Project activities must:

- 1) Include landscape rehabilitation measures with the intent to reduce the amount of sediment loss from gully erosion; and
- 2) Demonstrate that the proposed rehabilitation treatments are consistent with those described in the latest version of the Gully Toolbox from the Reef Trust phase IV – (<https://www.environment.gov.au/system/files/pages/1542be6d-c5bb-4259-b20e-c4847abc373f/files/reef-trust-phaseiv-toolbox.pdf>), or otherwise provide a justification as to why the strategies in the Toolbox are not appropriate; and
- 3) Address mitigative actions and monitoring approach to prevent additional erosion. For example, infrastructure, such as linear features (roads, tracks, fences, firebreaks, and water points) must be located and constructed to minimise risk of new erosion; and
- 4) Be consistent with the local NRM Plan, or otherwise provide a justification as to why the NRM Plan should be over-ridden.
- 5) Be compliant with all Federal, State and Local Government regulations.
- 6) Include ongoing site maintenance and management of weeds and pest animals.
- 7) Be on the be on the 'positive list' outlined in the Reef Credit Standard or Method.

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### 2.3.1 EXCLUSIONS

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The following treatments are not eligible:

- 1) Reshaping of gullies in sodic and/or magnesian soil materials (be they dispersive and/or slaking) without the application on the reshaped surface of either:
  - a. a stable topsoil; or
  - b. organic mulch; or
  - c. rock capping.

Note: This applies regardless of whether the sodic soils are treated with gypsum, seeded and/or have fertiliser added.

- 2) Gully plug dams.
- 3) Treatments that will increase the risk of downstream pollution.
- 4) High intensity grazing (cattle stomping) on sodic and/or magnesian, dispersive/slaking alluvial soil materials.
- 5) Any activity on the negative list outlined in the Reef Credit Standard or Method;

## 2.4 LAND USE CHANGE

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If the project involves a change in land use, the project proponent must have obtained any necessary permits to demonstrate that the project will not have a significant negative impact on catchment water quality.

## 2.5 ADDITIONALITY

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For a project to qualify as additional it must initially fulfil three requirements:

1. The law must not require the proposed project activity/ies;
2. The project activity/ies must be on the 'positive list' outlined in the Reef Credit Standard or Method; and
3. The project activity/ies must not be on the negative list outlined in the Reef Credit Standard or Method.

Project proponents must then demonstrate additionality by applying the Reef Credit Additionality Tool or if not available or applicable, the *Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) project activities version 3.0*<sup>1</sup>. When applying the tool project proponents shall consider any activity eligible under this method as an "eligible AFOLU activity". Further project proponents should substitute "pollutant reductions" for "GHG emissions" and "Reef Credits" for "GHG Credits" and where appropriate "Reef Credit Standard" for "VCS".

## 2.6 LEAKAGE

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Leakage may be considered to occur if there is an increase in erosion due to a move to higher risk land management practices on areas outside the project RCAZ but under the management of the same land manager that is responsible for implementation of project activities.

Project proponents must complete steps under 2.6.1 at the time of project application to determine if there is a risk of project leakage and if so the appropriate procedure to account for it.

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### 2.6.1 DETERMINE IF THE PROJECT MAY BE AT RISK OF LEAKAGE

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Step 1. Determine if the land manager is responsible for the management of other agricultural land outside the project RCAZ(s) within the Great Barrier Reef Catchments.

If the answer is no, then the risk of project leakage is considered to be zero and the project proponent should proceed to Section 3. If answer is yes, then proceed to Step 2.

Step 2. The project proponent must determine the area of **land subject to leakage** under the control of the land manager that is not a part of the project RCAZs. This would include, for example, areas of land that would be under the same kind of agricultural enterprise as the areas within the RCAZs.

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<sup>1</sup> <https://verra.org/methodology/vt0001-tool-for-the-demonstration-and-assessment-of-additionality-in-vcs-agriculture-forestry-and-other-land-use-afolu-project-activities-v3-0/>

Project proponents should follow the same procedures for mapping land subject to leakage as described in Section 3. Project Mapping.

Step 3. Once the area of land has been identified the project proponent must determine the **credible risk** of the **land subject to leakage** shifting to a management scenario as a result of the project where a higher risk level of management practice is undertaken as defined in the **Reef Plan Water Quality Risk Framework** or equivalent framework in place at time of **project application date**.

**Credible risk** should be qualified as either likely or unlikely. If the risk is considered to be likely the proponent must prepare a leakage management plan detailing the steps that will be taken to ensure that project leakage does not occur. The area must be monitored for compliance with the leakage management plan and reported on at the end of each monitoring period.

Step 4. At the end of each monitoring period the project proponent must provide evidence that the steps outlined in the leakage management plan were implemented to mitigate the risk of leakage. If the leakage management plan was not implemented, then the project will not be eligible to receive reef credits until the proponent can demonstrate that the risk of leakage has been mitigated by complying with the existing plan or implementing a revised plan.

### 3 PROJECT MAPPING

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The project area boundaries must be delineated in accordance to the requirements of this section.

For the purposes of stratification of the project area into Reef Credit Accounting Zones (RCAZ), the project proponent must use remotely-sensed imagery.

#### 3.1 GEOSPATIAL CAPTURE

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A project proponent may use any of the following sources of data to delineate the boundaries and/or features within the project area:

- a) Aerial LiDAR
- b) Terrestrial LiDAR
- c) UAV (drone)-derived photogrammetry
- d) Air-photo photogrammetry
- e) Ortho-rectified aerial photographs
- f) Ortho-rectified satellite imagery
- g) Cadastral database

The application of each method must comply with the accepted current best-practice requirements at the time of reporting, commensurate with the technique's resolution and "limit of detection" and its application within the monitoring framework.

#### 3.2 FITNESS FOR PURPOSE

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Prior to using a dataset, project proponents should assess the appropriateness of the dataset for the intended use, or its fitness-for-purpose against criteria that include:

- a) Age
- b) Scale

- c) Resolution
- d) Accuracy
- e) Signal-to-noise ratio – or “limit of detection”
- f) Classification, aggregation, generalisation systems (e.g. smoothing)
- g) Integrity of dataset

### 3.3 ACCURACY

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For all projects under this method, the minimum requirement for spatial data is a horizontal accuracy of at least 0.5 m (95 % Confidence Interval (CI)) and for 3D data +/- 30 cm vertical accuracy (95 % CI). Historical airphoto analyses should aim to achieve +/- 1.0m accuracy.

For post-treatment spatial monitoring data the required horizontal accuracy is +/- 10 cm (95 % CI) and a vertical accuracy of +/- 10 cm (95 % CI).

### 3.4 REEF CREDIT ACCOUNTING ZONES

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For accounting purposes, it is convenient to place interventions within a Reef Credit Accounting Zone, with credits from each zone being claimed separately. As a guide, an RCAZ will ideally comprise and encompass a single gully and its catchment, including all the monitoring points either in or associated with it. Where interventions are undertaken in the gully catchment (e.g. fencing out livestock) then the catchment (or part thereof) will be included within the RCAZ. Where gullies are clustered together such that their catchments are adjoining, then the proponent may choose to treat the entire cluster as a single RCAZ, providing the output from the cumulative gully area can be monitored and has a baseline yield determined for the whole area.

The project area must be stratified into zones according to gully type as outlined in 3.4.1:

- a) Active gully to be treated;
- b) Gully catchment area;
- c) Control gully (if applicable)

Such that the treatment and control zone (+ catchment) have a single definable drainage outlet at which water quality and quantity monitoring can be undertaken.

In situations where the gully outlet is subject to backwater inundation from the connected stream or river (*sensu* Shellberg et al., 2013b), an explanation will need to be provided as to how this will be accounted for in any monitoring data that is influenced by the backwater flows.

The geographic boundaries of each project zone must be identified on a geospatial map consistent with the requirements of this section and submitted at the time of project application.

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#### 3.4.1 GULLY TYPOLOGY

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At sites where several gullies having similar attributes are being rehabilitated, a proponent may make the case that it is not necessary to monitor all gullies at the same level of intensity, and therefore that it may be possible to monitor representative gullies of a similar type. In this situation the project proponent will need to demonstrate the comparability of the gullies that are being grouped, and the representativeness of the monitored gullies, according to the approach outlined in Brooks et al., 2018. This will need to be detailed in the *Gully Rehabilitation and Management Plan*.

## 4 GULLY REHABILITATION & MANAGEMENT PLAN

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A Gully Rehabilitation and Management Plan outlining the project design, implementation & monitoring must be submitted with the project application.

### 4.1 GULLY REHABILITATION & MANAGEMENT PLAN CERTIFICATION

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A Gully Rehabilitation and Management Plan ('The Plan') must be developed in collaboration and signed off by a suitably qualified person with the following qualifications and/or experience:

- 1) Professional training in the field of geomorphology and/or soil conservation; and/or
- 2) Is certified by one of the following professional bodies:
  - a) EIANZ CEnvP Specialist Geomorphologist (pending Professional Geomorphologist certification developed by the Australian and New Zealand Geomorphology Group and EIANZ).
  - b) Certified Practicing Soil Scientist (CPSS, Australian Soil Science Society)
  - c) Certified Practicing Erosion and Sediment Control (CPESC, Australian Institute of Engineers).
- 3) Auditors will have access to similarly qualified professionals for review.

### 4.2 GULLY REHABILITATION & MANAGEMENT PLAN PROJECT DESIGN

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The Plan must include the following project design documentation:

- 1) The gully rehabilitation project design/plan which is appropriate to the gully type. The Plan will identify which portions of the site require a design that requires an engineering design signed off by a RPEQ. If it is considered that a design does *not* require sign off by an Engineer, justification as to why not will need to be provided. Activities requiring an engineering design include:
  - a) Rock chutes
  - b) Fully or partially reshaped gullies with major cut-and-fill and rock armouring
  - c) Major rock grade control structures
- 2) A project area map with description and location of each gully and gully sub-unit to be rehabilitated. These will typically be synonymous with the RCAZ.
- 3) The contributing catchments for each gully/gully complex (as per Brooks et al., 2018a).
- 4) Site stock management plan(s).
- 5) A site access plan (roads, tracks etc and a strategy for minimising any impact during construction, and a plan for post-construction rehabilitation).
- 6) A maintenance plan (proactive and reactive). Proactive maintenance must include: fence maintenance, plans for weed and feral animal management within the gully exclusion area; fire management. Reactive management must include a strategy to deal with minor repairs to structures in a timely fashion.
- 7) A whole-of-property land management plan that includes:
  - a) identification of enterprise and project area map indicating agricultural management zones;
  - b) identification of all existing and new fence lines to ensure appropriate stock management into the future;
  - c) a summary report on the grazing management strategy that will be employed on the remainder of the property.

- 8) A Workplace Health and Safety Plan for the construction phase, and the ongoing monitoring phase.
- 9) Locations of any new or existing quarries that will be developed/accessed for the project. If these require permits, evidence of approval to be supplied.
- 10) Evidence for permit approval for working in designated streams and/or for any unavoidable tree clearing.
- 11) A cultural site clearance report.

#### 4.3 GULLY REHABILITATION & MANAGEMENT PLAN SOIL ANALYSIS

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The Plan must include a section outlining soil material analysis in accordance with the following criteria:

- 1) Gully soil material analysis comprising a minimum of three (3) soil material exposure profile descriptions and associated soil material analyses at the major soil material units within each gully. A minimum of three (3) samples must be collected and analysed for each soil material exposure profile, and more where there is more complex stratigraphy and/or vertical soil material differentiation. The boundaries of the major soil material units must be mapped so that the relative volume of the different soil units can be determined as far as possible, and their relative contribution to the historical and projected sediment yields assessed. Soil material analyses must include:
  - a) Particle size analysis (using Mastersizer method, or similar, with mechanical dispersion only; or hydrometer method – see Appendix 1: Soil Sampling and Laboratory Analysis)
  - b) Standard soil physicochemical analysis (major cations; CEC, pH, ESP, and bulk density etc.)
  - c) If topsoil is being used from the site and applied as a surface growth medium it must comply with the requirements for suitable topsoil material used in mine land rehabilitation (see Appendix 1: Soil Sampling and Laboratory Analysis).
- 2) Soil material amelioration treatments, including justification for the chemical application rates as a function of the soil material analyses outlined above in (1).

#### 4.4 GULLY REHABILITATION & MANAGEMENT PLAN MONITORING

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The Plan must include a project monitoring proposal. This must include a combination of some form of topographic monitoring, coupled with water quality and quantity monitoring that will enable sediment loads to be determined. The monitoring must include:

- 1) the location of all monitoring points;
- 2) tolerances;
- 3) topographic monitoring that includes surveys using one of the following techniques:
  - a) Repeat high-resolution aerial LiDAR survey (minimum 50 points/m<sup>2</sup>)
  - b) Repeat terrestrial LiDAR survey (minimum 500 points/m<sup>2</sup>) over at least 10 % of the treated gully area and/or the control site, encompassing representative sections of all residual, erosional, and depositional surfaces within the gully system (see Brooks et al 2018a for full description). Active zones to be delineated using the methods detailed in Brooks et al., 2018b.
  - c) Hand-held LiDAR surveys (e.g. Zeb-Revo) (minimum 500 points/m<sup>2</sup>) over at least 10 % of the treated gully area and/or the control site, encompassing representative sections of all residual, erosional, and depositional surfaces within the gully system (see Brooks et al., 2018a for full description).

- d) Other high intensity survey method that enables creation of a digital elevation model of equivalent precision and accuracy to that achievable using methods described in a-c above.
- 4) Water quality/quantity monitoring (minimum requirements are outlined below, and are based on the need for redundancy in the difficult conditions prevailing in many gullies):
- a) Tipping bucket rain gauge within a 500 m radius of any monitored gully (closer if possible).
  - b) At each gully outlet a monitoring station including:
    - i) Rising-stage samplers (three (3) minimum assuming relatively narrow gully outlet (< 2m); 2 sets of 3 for wider outlet channels); and
    - ii) Stage recorder (pressure-transducer type with a 5-minute minimum sampling interval); and
    - iii) A velocity meter (doppler type) or in the absence of a velocity meter – manually measured flow velocity data such that a flow rating curve can be derived (according to best practice methods) across the typical flow stage likely to be encountered in 80 % of the flows experienced within the gully; and
    - iv) A PASS sampler (time-weighted continuous sampler, after Doriean et al., 2019); and
    - v) A time-lapse camera; or
    - vi) Other instrument array that can be shown to provide data equivalent to, or better than, that obtainable with the instrumentation described in i-v above.
    - vii) Other instrument array(s) which will be subject to the discounts described below.
  - c) For gullies with a treated area > 1 ha an autosampler must be added to the array of equipment outlined above in (4)b).
- 5) Sediment yield will be determined using standard methods as outlined in Shellberg et al. (2013a).
- 6) Discounts will apply to the following:
- a) For sites that include sediment concentrations from a time-weighted sediment sampler only, a 20 % discount will be applied to the derived sediment yields.
  - b) Sediment yields determined using the TSS protocol will be discounted by 20 % (*sensu* Gray et al., 2000). The preferred method for determining FS concentration is the SSC protocol.
  - c) For sites with sub-optimal instrument arrays and or monitoring arrangements not described in a-b above, an appropriate discount can be determined in consultation with the secretariat. (Note a determination should be sought prior to commencement of the monitoring if non-standard monitoring is utilised).

## 5 PROJECT ACCOUNTING

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This section outlines the steps which must be followed to determine project FS reductions as a result of project activities.

### 5.1 RELEVANT SEDIMENT POOLS

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For this section, the relevant sediment fraction is the silt and clay fraction (< 20 µm: NCST, 2009) delivered to the GBRWHA (see definition of 'fine sediment').

### 5.2 BASELINE SCENARIO

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This section outlines the procedure to determine the sediment yield for the baseline period. Proponents must include a summary of the baseline scenario and provide an explanation of why the baseline scenario was chosen including an assessment of the barriers to implementation of the proposed project activities.

Proponents may choose to either model the baseline scenario or use a control site.

If project proponents choose to model the baseline scenario they must follow steps 5.2.1-5.2.3.

If project proponents choose to determine the sediment reduction by relying on a comparison with a control site must follow the steps in 5.2.4.

---

#### 5.2.1 BASELINE FINE SEDIMENT YIELD ANALYSIS

---

Project proponents must complete a baseline sediment yield analysis for each gully being rehabilitated to determine.

$\Delta V_{b,i}$  = change in gully volume in RCAZ,  $i$ , during the baseline period,  $b$ , (This may be derived from regression equation for the gully volume time series);

- If a non-linear baseline is being claimed, a full report justifying the non-linear trend must be included in project application;
- Gully volume is to be determined using the approach outlined in Stout et al., 2019 in which a conservative 80 % surface reconstruction is used to determine gully volumes;
- Detailed field verification of the residual surface levels used to reconstruct the former 3D land surface prior to gulying must be provided and audited in the field.

$BD_i$  = sediment field bulk density of RCAZ,  $i$ , (using standard field sampling and laboratory methods);

$FS \%_i$  = proportion of gully source sediment in RCAZ,  $i$ , that is < 20 µm. (This requires particle size analysis as outlined in Section 4.3);

Baseline sediment yield analysis must include historical air-photo reconstruction of the gully expansion and may also include direct monitoring, or LiDAR change-detection, over more recent years.

A longer historical air-photo time series (50 years +), should be used for determining whether gullies are expanding in a non-linear fashion. Shorter term baselines derived from monitored data are acceptable if longer term rates cannot be determined from historical aerial photography, particularly for smaller gullies obscured by vegetation. If project proponents use a non-linear yield they must provide historical trajectory data over at least fifty (50) years.

Project proponents must demonstrate how the two-dimensional (2D) change data has been transformed into three-dimensional (3D) volumetric change data, including detailed survey data of the remnant surfaces that have been used to reconstruct the prior gully volume. Baseline sediment yield should be reported as tonnes of fine sediment per annum (over water-year)

---

### 5.2.2 CALCULATION OF BASELINE FINE SEDIMENT YIELD

---

Project proponents must apply the following equation to calculate baseline fine sediment yield for each gully/gully system for which credits are being claimed:

$$FSL_b = \sum \frac{\Delta V_{b,i} * BD_i * FS\%_i}{t_b}$$

EQUATION 1

where:

$FSL_b$  = fine sediment yield in baseline period,  $b$ , in tonnes year<sup>-1</sup>;

$\Delta V_{b,i}$  = change in gully volume in RCAZ,  $i$ , during the baseline period,  $b$ , as determined in section 5.2.1;

- If a non-linear baseline is being claimed, a full report justifying the non-linear trend must be submitted separately and approved by the secretariat before the commencement of the project.
- Gully volume is to be determined using the approach outlined in Stout et al., 2019 in which a conservative 80% surface reconstruction is used to determine gully volumes.
- Detailed field verification of the residual surface levels used to reconstruct the former 3D land surface prior to gullying must be provided and audited in the field.

$BD_i$  = sediment field bulk density of RCAZ,  $i$ , as determined in section 5.2.1;

$FS \%_i$  = proportion of gully source sediment in RCAZ,  $i$ , that is < 20 µm as determined in section 5.2.1

$t_b$  = baseline period in years.

---

### 5.2.3 DETERMINE MEAN ANNUAL RAINFALL DURING BASELINE PERIOD

---

To determine the Mean Annual rainfall for the site for the baseline period based on the relevant grid cell in the BOM 0.05 degree (~5km) grid data apply:

$$Rf_{avsb} = \frac{Rf_{TSb}}{t_b}$$

EQUATION 2

where:

$Rf_{avsb}$  = mean annual rainfall, in mm year<sup>-1</sup>, for site,  $S$ , during baseline period,  $b$ ;

$Rf_{TSb}$  = total rainfall, in mm, for site,  $S$ , for baseline period,  $b$ ;

$t_b$  = baseline period in years

**Note** for the purposes of calculating total rainfall, the Baseline Period begins on the 1<sup>st</sup> of July in the first year of the Baseline Period and ends on the 30<sup>th</sup> of June in the last year of the Baseline Period.

---

#### 5.2.4 CALCULATION OF BASELINE FINE SEDIMENT YIELD IF USING CONTROL SITE

---

Project proponents must choose a control site in accordance with section 3.4. Choice of the control site must be justified and approved at the project outset. The sediment yield must be measured at the control site in the same manner as that undertaken at the treatment site to determine the value for  $FSE_{Control,r}$  where  $FSE_{Control,r}$  = Fine sediment export, in tonnes, from the control site for the current project monitoring period,  $r$ ;

---

### 5.3 PROJECT MONITORING PERIOD CALCULATIONS

---

The methodology estimates fine sediment yield (in accordance with Shellberg et al. 2013a) based on empirical measurements of rainfall and water runoff, sediment production at gully head scarp modelled from retreat rates and change in gully area over time, and sediment transport loads using a combination of empirical data and modelling (i.e. empirical modelling). This section outlines the procedure to determine the sediment yield during the current project monitoring period.

---

#### 5.3.1 PROJECT SEDIMENT YIELD MEASUREMENT

---

Project proponents must measure the fine sediment yield (**FS**) from each RCAZ,  $i$ , in tonnes in accordance with standard procedures.

The proponent must use a multiple lines of evidence approach whereby a best estimate of the sediment yield over the monitoring period is arrived at by consideration in parallel of both topographic measurement and the water quality/quantity monitoring. The proponent must describe how the results from each independent approach are consistent with each other, or provide detailed description of, and analysis of the reasons for, any discrepancies.

Topographic surveys must be undertaken prior to and immediately after any ongoing maintenance undertaken during the monitoring period.

---

#### 5.3.2 CALCULATION OF FINE SEDIMENT YIELD FOR PROJECT MONITORING PERIOD

---

Determine the total Fine Sediment Export for the current project monitoring period using the following equation:

$$FSE_r = \sum FS_i * DF_1 * DF_2 \times DF_x$$

EQUATION 3

where:

$FSE_r$  = Total fine sediment export for the current project monitoring period,  $r$ ;

$FS_i$  = Measured fine sediment yield from RCAZ,  $i$ , in tonnes as determined in section 5.3.1

$DF_1$  = For sites that include sediment concentrations from a time-weighted sediment sampler only,  $DF = 0.8$  otherwise  $DF = 1$

$DF_2$  = For sites where sediment yields are determined using the TSS protocol  $DF = 0.8$  (*sensu* Gray et al., 2000) otherwise  $DF = 1$

$DF_x$  = For sites where sediment yields are determined using other sub-optimal instrumentation or monitoring arrangements (see 5.6.1 below), an appropriate discount factor will need to be negotiated with the secretariat. This discount factor will be more severe than those described above.

---

### 5.3.3 DETERMINE MEAN ANNUAL RAINFALL FOR MONITORING PERIOD

---

Determine the mean annual rainfall for the site for the current project monitoring period based on on-site tipping bucket rain gauge data. Use:

$$Rf_{avSr} = \frac{Rf_{TSr}}{t_r}$$

EQUATION 4

where:

$Rf_{avSr}$  = mean annual rainfall, in mm year<sup>-1</sup>, for site,  $S$ , during the project monitoring period,  $r$ ;

$Rf_{TSr}$  = total rainfall, in mm, for site,  $S$ , for current project monitoring period,  $r$ ;

$t_r$  = monitoring period in years.

**Note**, as for Section 5.2.3, the Crediting Period should align with the Water Year (1<sup>st</sup> July – 30<sup>th</sup> June)

---

### 5.3.4 PROJECT RAINFALL ADJUSTMENT FACTOR

---

Determine the Rainfall Adjustment factor ( $A_{Rf}$ ). Use:

$$A_{Rf} = \frac{Rf_{avSr}}{Rf_{avSb}}$$

EQUATION 5

where:

$A_{Rf}$  = rainfall adjustment factor;

$Rf_{avSr}$  = mean annual rainfall, in mm year<sup>-1</sup>, for site,  $S$ , during the project monitoring period,  $r$ , as determined in Equation 4;

$Rf_{avSb}$  = mean annual rainfall, in mm year<sup>-1</sup>, for site,  $S$ , during baseline period,  $b$ , as determined in Equation 2.

---

## 5.4 CALCULATE CHANGE IN FINE SEDIMENT YIELD

---

If project proponents are using a modelled baseline in accordance with sections 5.2.1-5.2.3 they must apply the following equation to determine the change in fine sediment yield resulting from project activities, calculate the rainfall adjusted FS Abatement (*FSA*) for the monitoring period. If they are using a control site they should omit this step and follow the procedure under section 5.4.1:

$$\Delta FS_r = (FSL_b \times t_r \times A_{Rf}) - FSE_r$$

EQUATION 6

where:

$\Delta FS_r$  = the change in fine sediment yield, in tonnes, for the project monitoring period, *r*;

$FSL_b$  = baseline fine sediment load in tonnes year<sup>-1</sup> as determined by  $FSL_b = \sum \frac{\Delta V_{b,t} * BD_i * FS\%_i}{t_b}$

;

$t_r$  = monitoring period in years;

$A_{Rf}$  = rainfall adjustment factor as determined in Equation 5;

$FSE_r$  = Fine sediment export, in tonnes, for the current project monitoring period, *r*, as determined by Equation 3.

---

#### 5.4.1 CALCULATE CHANGE IN FINE SEDIMENT YIELD IF USING CONTROL SITE

---

Project proponents must calculate sediment reduction during the monitoring period as the difference between the measured yield of the treatment site, subtracted from the yield of the control site, adjusted for differences in gully catchment area:

$$\Delta FS_r = \left( FSE_{Control,r} \times \frac{A_T}{A_C} \right) - (FSE_{Treatment,r})$$

EQUATION 7

where:

$\Delta FS_r$  = the change in fine sediment yield, in tonnes, for the project monitoring period, *r*;

$FSE_{Control,r}$  = as determined in section 5.2.4

$A_T$  = total catchment area of the Treatment gully above sampling point;

$A_C$  = total catchment area of the Control gully above sampling point;

$FSE_{Treatment,r}$  = Fine sediment export, in tonnes, from the treatment site for the current project monitoring period, *r*;

---

#### 5.5 CHANGE IN FINE SEDIMENT ENTERING THE GREAT BARRIER REEF

---

The reduction achieved during the monitoring period in fine sediment exports transported to the end of catchment, must be calculated by applying the following equation:

$$FSA_r = \Delta FS_r * SDR$$

EQUATION 8

where:

$FSA_r$  = fine sediment abatement, in tonnes, exported to the Great Barrier Reef for monitoring period,  $r$ .

$\Delta FS_r$  = the change in fine sediment yield, in tonnes, or the project monitoring period,  $r$ , calculated in accordance with Equation 6 or Equation 7;

$SDR$  = Sediment Delivery Ratio from Qld Government P2R modelling team (fees may apply).

In order to be eligible for Reef Credits,  $FSA_r$  must be greater than zero.

## 5.6 CALCULATION OF MONITORING PERIOD REEF CREDITS

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To determine the quantity of Reef Credits generated by project activities during the Crediting Period, apply the following equation:

$$RC_r = (FSA_r \times C_f) + RC_{CP-1}$$

EQUATION 9

where:

$RC_r$  = Reef Credits generated in monitoring period,  $r$ ;

$FSA_r$  = fine sediment abatement, in tonnes, exported to the Great Barrier Reef for monitoring period,  $r$ .

$C_f$  = the correction factor to convert a fine sediment reduction to an equivalent dissolved inorganic nitrogen (DIN) Reef Credit as stated in the Reef Credit Standard.

$RC_{r-1}$  = negative balance of Reef Credits brought forward from previous monitoring period (if applicable).

If  $RC_r$  is zero or less than zero, then no credits are issued for the monitoring period.

### 5.6.1 WATER QUALITY MONITORING REQUIREMENTS FOR CALCULATION OF REEF CREDITS

---

For Reef Credits to be claimed in any one monitoring period at least three (3) separate flow events must be sampled for each water-year, including a minimum of three (3) samples per event at a range of discharges in accordance with the requirements of Section 4.4 of this methodology.

Sediment yields across a water-year will need to be determined either through the construction of a one-dimensional (1D) flow model (HEC-RAS V 5.0.6 or equivalent), calibrated with the monitored fine sediment concentration data, or through the construction of a calibrated 'at-a-station' discharge rating curve (see Shellberg et al., 2013a).

If claiming credits in the **first year** post-treatment, at least five (5) separate events must be sampled with a minimum of three (3) samples per event across a range of discharges. In the event that

insufficient events occur, or insufficient samples are successfully collected in a single water-year, the data from one year can be accrued to the next year/monitoring period.

## 5.7 UNCERTAINTY

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The method takes uncertainty in estimates of sediment loads that arise from quantity of monitoring data collected into consideration and discounts accordingly. Discounts for specific water quality and quantity monitoring scenarios are described in section 4.4 with calculations described in section 5.3.2.

## 6 FS MONITORING AND RECORD-KEEPING REQUIREMENTS

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This section sets out monitoring and record-keeping requirements for a sediment reduction through gully remediation project that is a registered Reef Credit project.

A Monitoring Report must be submitted as a requirement for each reporting period. The project proponent must monitor the RCAZs of the project for compliance with the Gully Rehabilitation and Management Plan and document land management activities and any unplanned disturbances to project area.

The Monitoring Report must also include all spatial data, a change detection analysis and a detailed report on the documentary evidence of water quality monitoring during the reporting period including, but not limited to:

- a detailed description of the monitoring setup;
- all laboratory results;
- photographs of equipment setup;
- all field monitoring data and analysis, showing the time of sampling on the flow hydrographs;
- any DEM of difference data for the monitoring period, including the ground control data and the spatial tolerances;
- time-lapse camera imagery of the monitoring site.

Records must be kept in relation to each of the requirements for remotely-sensed imagery set out in Section 3, including but not limited to:

- i. The defined gully being treated;
- ii. Historical airphoto rectification points;
- iii. Shapefile polygons of the gully areas defined for each historical time slice;
- iv. The location of monitoring points;
- v. The location of soil sampling points and associated soil mapping indicating the representative nature of the soil materials sampled under the Method;
- vi. The field evidence used for the 3D reconstruction of the prior gully form (from which historical sediment yields have been calculated), i.e. the identification of the remnant surfaces used in the field for reconstructing the 3D land surface prior to gullying.

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## 8 APPENDICES

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### 8.1 APPENDIX 1: SOIL SAMPLING AND LABORATORY ANALYSIS

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#### 8.1.1 FIELD ASSESSMENT

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##### 8.1.1.1 DEVELOP A SIMPLE SAMPLING PLAN

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A simple sampling plan should aim to sample all the distinct soil material layers that have been identified. It should also include a check on the spatial variation of these layers if the gully site being investigated is large or complex, or both.

The most appropriate observation and sampling plan depends on:

- the type of gully (or gully system);
- the size of gully (or gully system);
- the perceived spatial complexity and number of the soil material layers;
- the time available for field assessment.

The number of samples to be taken for laboratory analysis will depend upon:

- the spatial complexity and number of soil materials layers;
- the scale of rehabilitation works being considered;
- the budget available.

##### 8.1.1.2 SELECT SOIL MATERIAL OBSERVATION POINTS (OPs)

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The number of observations of the soil materials to be recorded will depend on the size of the Gully or Gully (Sub-)System being investigated. See '*Sampling Intensity*' below.

- Observation Points should be selected where:
  - a full sequence of layers can be appreciated and accessed, especially in the active erosion zones;
  - there is evidence of most active erosion of heads and walls;
  - there is the greatest depth of exposure through the soil materials.

##### 8.1.1.3 SAMPLING INTENSITY

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**At least three (3) OPs** will be required to characterise the soil materials in any gully or gully system if it is less than one hectare in size. It is recommended that at least three (3) OPs usually be used to sample the soil material layers for any gully site investigation for rehabilitation management.

**At least three (3) OPs** for observing, recording and sampling for laboratory analysis will be required, depending on the size of the gully or gully system being investigated. Further soil material OPs will be required to describe the layer variation and to map the soil material pattern over the whole gully area.

*For small, isolated, gullies, up to 0.75 ha, two OPs* for observing, recording and sampling soil material layers for laboratory analysis may be sufficient. Further soil material OPs (as 'Check Sites') may be required to describe the layer variation and to map the soil material pattern.

A rule of thumb should be **no less than three (3) OPs per hectare** for recording soil materials, with **four (4) OPs per hectare** for more complex sites. All these specified OPs are 'Sample Sites' and should be

used for sampling for laboratory analysis. Further soil material OPs (as Check Sites) may be required to describe the layer variation and to map the soil material pattern.

Multiple soil material systems and Stratified systems may need further OPs. Choose further Sample Sites and Check Sites if soil material complexity demands it.

#### 8.1.1.4 SITE DESCRIPTIONS

Soil site descriptions should be undertaken with the provided field data recording protocols which are in accordance with the *Australian Soil Survey and Land Survey Field Handbook 3rd edition* (NCST, 2009), where relevant. Soil material site descriptions include a soil material exposure profile description and site observations of erosion features and processes at each location.

Soil material profile descriptions include (where applicable) the following details (see Table: Soil Sampling Methods for sampling procedures):

- Layer depth and thickness, and designation;
- Dominant colour;
- Presence and colour of mottles;
- Fabric (texture/structure);
- Segregations (nodules or soft precipitations, e.g. calcium carbonate);
- Gravel/rock inclusions (isolated or as beds/lines);
- Field tests (pH, CaCO<sub>3</sub>, aggregate stability).

#### 8.1.1.5 SOIL MATERIAL SAMPLING

- Gully exposures should be cut back by 0.2 m wherever possible by spade or pick.
- Samples should be taken from every main layer identified, starting at the top where sample material should be taken from the surface to 0.1m below the surface. It is preferable to sample the top layers (up to 0.1 m) by soil auger about 1 m back from the gully edge.
- **At least three (3) samples** down the exposure profile will be required to characterise the soil materials at any specific site, even if there are fewer than three layers.
- Bulk density samples also need to be taken from each sample site (see table below).

#### 8.1.1.6 SOIL MATERIAL SAMPLING METHODS

TABLE 1. THIS TABLE OUTLINES THE SOIL MATERIAL SAMPLING METHODS

Activity	Details
<b>Soil Material OP locations</b>	Sampling locations are recorded with a handheld Global Positioning System (GPS) unit with an accuracy of generally +/-4 m.
<b>Soil Material observation</b>	Appropriate gully exposure cut back by 0.20 m where possible by spade or pick to access fresh, unexposed material. Soil hand-auger can be used to gain fresh material from the top 1.0 m, 1 m back from the gully wall.
<b>Abandonment</b>	Any soil hand-auger holes on the land surface must be backfilled to the existing natural ground level using soil material retrieved during soil coring and surrounding material.
<b>Soil logging</b>	Soil material characteristics are described on provided field data sheets. These aid the description of the land surface condition in the vicinity, and the characteristics of each soil material layer in the gully exposure at each OP.
<b>Field tests</b>	Field tests are also conducted on each layer at each OP. Field pH, using a Raupach test kit, or horticultural/gardening pH test kit.

Activity	Details
	<p>Soil material aggregate stability test for slaking and dispersion. Status recorded a) at immersion and b) after 10 mins: 0-nil; 1-some; 2-obvious; 3-total.</p> <p>1 M HCl drops on nodules to test for calcium carbonate (CaCO<sub>3</sub>).</p> <p>Rate of reaction</p> <p>No audible or visible effervescence: non-calcareous</p> <p>Audible and slightly visible effervescence: moderately calcareous</p> <p>Moderate to strong visible effervescence: highly calcareous</p>
<b>Soil material sampling</b>	<p>Soil material samples, approximately 500 g in weight, should be obtained directly from the exposure or the auger from each evident layer between clear boundaries. If only two layers or one layer can be discerned then at least three samples must be taken down the profile: at 0.20 m from the surface, 0.20 m from the bottom, and one from the approximate middle.</p> <p>Topsoil / top layer samples should be gained from at least three different locations within the vicinity of the OP and bulked together (composite sample).</p> <p>Discrete soil material samples must be collected and placed into resealable plastic bags and appropriately labelled for dispatch to the laboratory.</p>
<b>Labelling</b>	<p>Sample bags should be labelled with the site name or code and site OP number; the layer ID; the sampling depth; the date of collection; and the unique ID for the sample. This data should also be recorded on a separate label and inserted in the sample bag with the soil material sample.</p> <p>For instance, a sample collected at OP 'DEL S01' at a depth of 0.10 m below the surface in layer 'DEL_01' is labelled as follows: DEL S01; DEL_01; 0.10 m; dd/mm/yy, 09886 (unique ID number)</p>
<b>Dispatch</b>	<p>Samples should be stored out of direct sunlight and transported for analysis. Topsoils requiring nitrogen and organic carbon analysis should be kept cool and dispatched to the laboratory as soon as possible.</p>
<b>Bulk density sampling</b>	<p>Samples for bulk density (BD) should be taken using a BD ring or square tin, open both ends, of known volume. The ring or tin should be pushed/eased into a fresh exposure (at least 0.2 m from the exposed face) and sunk into place by digging around the ring/tin so that the coherent, undisturbed soil material fills the ring/tin and extends beyond it for at least 5 mm. The back end of the ring/tin should then be dug out with the soil material still extending well beyond the margins of the tin.</p> <p>Once extracted, the excess soil material should be carefully shaved off both ends until flush, flat with the ring/tin edges. The enclosed soil material can then be fully emptied into a zip-lock sandwich bag, with any soil material adhering still to the inside of the ring/tin also included in the bag. The bag can then be suitably labelled as above and despatched for lab analysis.</p>

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### 8.1.2 LABORATORY ANALYSIS

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All soil materials samples should be analysed in an ASPAC/NATA accredited laboratory.

Any soil material management recommendations and amelioration rates are derived from this data.

Laboratory certificates for all sample sites analysed should be provided in the reporting as an appendix.

For consistency purposes it is recommended that the laboratory use the methods described in Rayment and Lyons (2010) which are a common standard Australia-wide. The Rayment and Lyons analytical code is provided after each analyte presented below.

- C = carbon
- Ca/Mg = Calcium: Magnesium ratio
- EAT = Emerson's Aggregate Test

- EC = electrical conductivity
- ESP = exchangeable sodium percentage
- N = nitrogen
- OM = organic matter
- PSD = particle size distribution
- P = phosphorus
- **Topsoil / top layer**  
(sample depth 0.0 – 0.2 m and bulked/composite from at least three locations in the vicinity)
  - pH (1:5 water) [4A1]
  - EC (1:5 water) [3A1]
  - Cl (1:5 water) [5A2b]
  - Exchangeable cations (Ca, Mg, Na, K,) (aqueous NH<sub>4</sub>Cl [15A1] or if soil pH > 7.3[alcoholic NH<sub>4</sub>Cl 15C1])
  - Exchangeable Al (15G1)
  - Total C (6B3) and OM (6G1)
  - PSD: < 2 μm (clay), 2 – 20 μm (silt), 20 – 50 μm (fine-medium sand), 0.05 – 2 mm (coarse sand) [Mastersizer or Hydrometer method for fines];
  - Colwell P (for alkaline soils) [9B2]
  - Total N [7A1, 7A5]
  - Total CEC [15J1]
  - ESP [15N1]
  - Ca/Mg [15M1]
  - Bulk density [oven-dry (105°) wt. / BD ring volume]
  - Mechanical dispersion:
    - EAT [Emerson, 1967; Australian Standard, 1980]
    - Dispersion ratio (R<sub>1</sub>, R<sub>2</sub>) [Baker & Eldershaw, 1993]
- **Subsoil / lower layers**  
(at nominated depths within the layers)
  - pH (1:5 water) [4A1]
  - EC (1:5 water) [3A1]
  - Cl (1:5 water) [5A2b]
  - Exchangeable cations (Ca, Mg, Na, K,) (NH<sub>4</sub>Cl [15C1] or ammonium acetate [15D3] depending on pH and EC of sample)
  - Exchangeable Al (15G1)
  - PSD: < 2 μm (clay), 2 – 20 μm (silt), 20 – 50 μm (fine-medium sand), 0.05 – 2 mm (coarse sand)) [Mastersizer or Hydrometer method for fines];
  - Total CEC [15J1]
  - ESP [15N1]
  - Ca/Mg [15M1]
  - Bulk density [oven-dry (105°) wt. / BD ring volume]
  - Mechanical dispersion:
    - EAT [Emerson, 1967; Australian Standard, 1980]
    - Dispersion ratio (R<sub>1</sub>, R<sub>2</sub>) [Baker & Eldershaw, 1993]

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### 8.1.3 TOPSOIL

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Determination of suitable soil to conserve for later use in gully rehabilitation can be conducted in accordance with modification of that proposed by Elliot and Veness (1981) with respect to mined land materials. The approach involves the assessment of soil materials based on their physical and chemical parameters. The key parameters are presented in Table 2. Topsoil / top dressing suitability criteria.

TABLE 2. TOPSOIL / TOP DRESSING SUITABILITY CRITERIA

Criterion	Desirable state or range
<b>Structure Grade</b>	Some structure evident (i.e. aggregates, peds)
<b>Coherence</b>	Coherent when wet and dry
<b>Mottling</b>	Absent
<b>Texture</b>	Finer than sandy loam
<b>Gravel and Sand Content</b>	< 50%
<b>pH</b>	5 to 8
<b>Salinity (EC)</b>	< 1.5 dS/m
<b>Sodic Limit (ESP)</b>	6 %

#### 8.1.4 REFERENCES

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