Our Ref: GE25.019.L1

Date: 8th April 2025

Charlie Resolved Pty Ltd
C/- Qualtest Laboratory Pty Ltd (Qualtest)
Via email: dennis@qualtestgeo.com

Attention: Mr. Dennis Alazigha

Dear Dennis,

RE: TECHNICAL MEMORANDUM – SOIL ERODIBILITY REVIEW: 'TRANCHE 1A" DEVELOPMENT, UNDULLAH

Introduction & Background

Gallagher Environmental (GE) was commissioned care of Qualtest Laboratory Pty Ltd to provide a 'soil erodibility review' of the proposed 'Tranche 1A' development located at Undullah.

As part of a broader geotechnical study undertaken by Qualtest, soil samples from ten (10) boreholes were provided to GE to undertaken a dispersive soil management plan (DSMP) for the development. Results from the DSMP assessment and additional field texture analysis was undertaken on the provided soil samples to determine the erodibility of site soils and to provide appropriate management practices for the construction phase of the development.

Soil Erosion Potential

'Soil erosion' can be defined as one or a combination of the following forms (Witheridge and Walker, 1996[1]):

- Wind Erosion – Soil movement, as a result of wind velocity and turbulence;
- Raindrop impact erosion - The impact of raindrops on bare soil surfaces or through a thin film of surface water, resulting in the detachment of soil particles;
- Sheet erosion - The uniform removal of soil in thin layers from sloping land;
- Rill erosion – The removal of soil by water from small, shallow yet well defined channels under concentrated overland flow;
- Gully erosion – An advanced stage of rill erosion where channels are larger and deeper than rills;
- Stream bank erosion - This form of erosion in an urban environment often results from changes in catchment hydrology; and
- Mass movement – When large areas of soil and rock slide or slip down steep slopes and the movement of deep subsoils on slopes of various gradients during high rainfall periods.

[1] Witheridge, G. and Walker, R (1996) *Soil Erosion & Sediment Control: Engineering Guidelines for Queensland Construction Sites*. The Institute of Engineers, Australia, Queensland Division. Brisbane.

Furthermore, Houghton and Charman (1986)[2] define 'soil erosion potential' as the susceptibility of a parcel of land to the prevailing agents of erosion and is dependent on site-specific factors such as climate, landform, soil erodibility, land use and land management factors.

Soil Dispersion Potential

The DSMP study revealed that the development area primarily contains 'Sodosols grading to Kurosols', with minor areas of 'Paralithic Leptic Tenosols' associated with very shallow bedrock. The DSMP test results included Emerson Class, Soil pH, Soil EC and Soil Sodicity, as summarised below:

Topsoil Materials

- Emerson Class testing undertaken on 8 topsoil samples revealed Class 7 characteristics indicating a very low soil dispersion risk.
- The obtained topsoil pH values of 5.5 – 6.2 (median of 5.7) are generally moderately acidic, and do not indicate a higher risk of soil sodicity or significant benefit from bio-available aluminum levels.
- The calculated EC_e (saturated) values for the sampled topsoil materials were 0.4 – 1.0 dS/m (median of 0.8 dS/m), indicating that the topsoil materials are non-saline.
- The ESP level of the topsoil (A horizon) sample was 2.4%, indicating non-sodic soils and a very low soil dispersion risk.

Overall, it is considered that the site topsoil exhibits a **very low risk** for soil dispersion.

Subsoil/Subsurface Materials

- Emerson Class testing undertaken on 10 subsoil/subsurface samples revealed Class 1 - 3 characteristics, revealing a variable soil dispersion risk ranging between moderate and very high.
- The obtained subsoil/subsurface pH values of 5.2 – 7.6 (median of 6.6) ranged from neutral to strongly acidic. These levels do not indicate a higher risk of soil sodicity, and exhibit a sporadic, mild benefit from bio-available aluminum levels.
- The calculated EC_e (saturated) values for the sampled subsoil/subsurface materials ranged between 0.4 – 2.5 dS/m (median of 1.8 dS/m), indicating that these materials are also non-saline.
- The ESP levels of three (3) subsoil/ subsurface samples ranged between 13.4% and 29.6% (median of 23.7%), indicating sodic to strongly sodic subsoils and a high to very high soil dispersion risk.

Overall, it is considered that the site topsoil exhibits a **high risk** for soil dispersion.

[2] Houghton, P.D. and Charman, P.E.V. (1986) *Glossary of Terms used in Soil Conservation*. Department of Conservation and Land Management, Sydney.

Soil Erodibility (Soil K Factor)

In the context of formulating an Erosion & Sediment Control Plan (ESCP) for the development (by others), a Soil Erodibility Factor (K Factor) is required for use in the RUSLE Method. This in turn allows the ESCP designer to specify 'Type 1' (i.e. sediment basins) to 'Type 3' (e.g. sediment fences) ESC measures for each sub-catchment during the construction phase.

In order to estimate the Soil Erodibility (K) Factor, various soil properties were examined in accordance with 'Soils and Construction- Managing Urban Stormwater' (Landcom NSW, 2004), including soil texture/structure (field) analysis and soil dispersion potential.

Topsoil
The estimated K Factor of the site topsoil (representative) was estimated as **0.020.** On a spectrum ranging from very low to extreme, this value is considered to be 'low' erodibility.

Subsoil
The estimated K Factor of the site subsoil (representative) was estimated as **0.043.** On a spectrum ranging from very low to extreme, this value is considered to be 'high' erodibility.

K Factor worksheet summaries are provided below:

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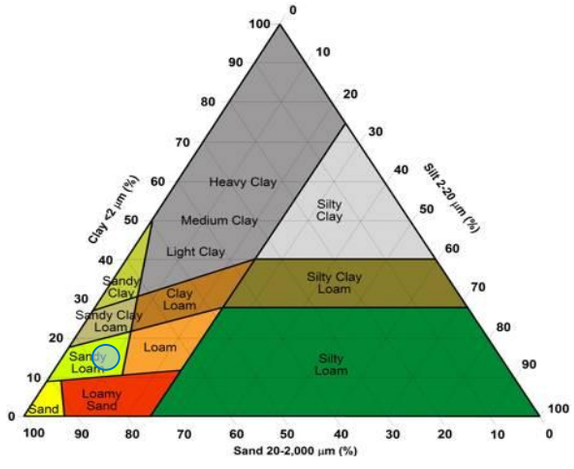
SAMPLE: Topsoil - Dominant

Estimation of Soil K Factor

(SOILOSS Program, Rosewell 1993)

Soil Texture	Sand (0.1 - 2.0mm)	65 %	*Sandy Loam*
- Fine Earth Fraction	Fine Sand (0.02 - 0.1mm)	10 %	*Mod. Structure*
- Field Texture Results	Silt (0.002 - 0.02mm)	10 %	*-Emerson Class 7*
	Clay (<0.002mm)	15 %	
	Gravel (>2mm)	<5 %	
Structure Grade	1- Very fine granular (<1mm)		
	2- Fine granular (1- 2mm)		✓
	3- Granular (2 - 10mm)		
	4- Blocky, platy or massive		
Permeability Grade	1- >130 mm/hr		
	2 - 60 to 130 mm/hr		
	3 - 20 to 60 mm/hr		
	4 - 5 to 20mm/hr		✓
	5 - 1 to 5mm/hr		
	6 - <1mm/hr		
Organic Matter	Topsoil (assumed)	2.0 %	✓
	Subsoil (assumed)	0.1 %	
	Laboratory Result	- %	
Soil Dispersion Factor	Dispersive	+20 %	
	Slightly Dispersive	+10 %	
	Non-Dispersive	0 %	✓
Calculated K Factor		.018	
Error Adjustment (+)		10%	
Estimated K Factor		**.020**	



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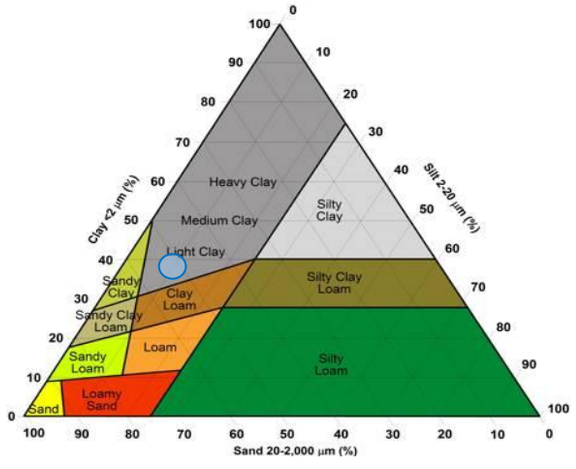
SAMPLE: Subsoil - Dominant

Estimation of Soil K Factor

(SOILOSS Program, Rosewell 1993)

Soil Texture	Sand (0.1 - 2.0mm)	40 %	*Light Clay*
- Fine Earth Fraction	Fine Sand (0.02 - 0.1mm)	12 %	*Massive. Structure*
- Field Texture Results	Silt (0.002 - 0.02mm)	10 %	*-Emerson Class 1 & 2*
	Clay (<0.002mm)	38 %	
	Gravel (>2mm)	<5 %	
Structure Grade	1- Very fine granular (<1mm)		
	2- Fine granular (1- 2mm)		
	3- Granular (2 - 10mm)		
	4- Blocky, platy or massive		✓
Permeability Grade	1- >130 mm/hr		
	2 - 60 to 130 mm/hr		
	3 - 20 to 60 mm/hr		
	4 - 5 to 20mm/hr		
	5 - 1 to 5mm/hr		
	6 - <1mm/hr		✓
Organic Matter	Topsoil (assumed)	2.0 %	
	Subsoil (assumed)	0.1 %	✓
	Laboratory Result	- %	
Soil Dispersion Factor	Dispersive	+20 %	✓
	Slightly Dispersive	+10 %	
	Non-Dispersive	0 %	
Calculated K Factor		.041	
Error Adjustment (+)		5%	
Estimated K Factor		**.043**	



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Soil Erodibility Recommendations

The following management principles are recommended for the construction phase of the development:

- The site ESCP should be formulated using the estimated K Factors provided (RUSLE analysis). If a separate land clearing phase is proposed, the topsoil K Factor of **0.020** can be utilised. For standard construction phase earthworks, the subsoil K Factor of **0.043** shall be required.

- Given the dispersive nature of the site subsoils, it is recommended that a Flocculant Jar test in accordance with IECA Guidelines (2018) be undertaken to aid in High Efficiency Sediment (HES) Basin design and determine flocculent rates.

- Clean water diversion bunds/channels shall be required to divert a significant external catchment located south of the development. It is recommended that the bunds/channels are lined with secured geofabric and low-profile sandbags (<150mm) also placed at <40m intervals within the flow path to reduce flow velocity and scour/damage to the geofabric.

- Several existing gullies on-site (near northern and eastern boundaries) are proposed to be filled and re-profiled. During early clearing and earthworks, these gullies should have rock filter dams installed at <40m intervals to reduce flow velocity/scour, in addition to over-arching ESC requirements for their sub-catchments. A minimum of 225mm diameter rock should be used, including geofabric wrap and installed to IECA (2018) Guidelines.

- For sub-catchments designated as 'Type 2' or 'Type 3' by the ESCP designer, mulch bunds (using cleared vegetation) will be advantageous for the site – a practical measure for clearing phase disturbances, and also possible for site boundary ESC controls during the construction phase.

- For 'Type 3' control requirements, sediment fences (and coir logs) can be used. These controls are more effective on soils as clay content decreases and sand content increases. The 'Tranche 1A' subsoils commonly have a balanced sand to clay profile; these controls shall be somewhat effective with these soils.

- In accordance with the site DSMP, gypsum treatment is proposed for WSUD areas, stormwater flow paths and trench excavations to provide long-term asset protection – i.e. the gypsum treatment is not intended for temporary construction phase treatment of soils. Additional gypsum treatment of exposed soils during the construction is **not recommended**. Gypsum is slightly soluble and requires significant water interaction (rainfall or irrigation) to slowly release the gypsum into the soil for mitigation of soil dispersion. Depending on the initial gypsum treatment rate and rainfall, it is common that gypsum is not fully released int the soil chemical profile for several years. Therefore, for construction projects with limited soil exposure timeframes (e.g. <9 months of soil exposure and rapidly evolving earthworks), gypsum applications are considered to have a poor cost-benefit as an ESC measure.

- During the construction phase, all areas highlighted as a concern for potential scour (i.e. areas receiving concentrated stormwater flow, over and above standard rainfall impact) as earthworks progress can be stabilised with temporary soil binder (e.g. Vital Bon-Matt Stonewall at a min. rate of 1.5 L/m^2 , or equivalent product performance). In addition, these areas should be targeted by the Civil Contractor for rapid permanent stabilisation upon reaching final levels and in accordance with the Landscaping Plans. The above recommendations should also be documented in the site ESCP, with due reference to IECA stabilisation *timeframe* requirements that are devised by RUSLE analysis (ESCP designer), as per dot point 1 above.

We trust this is acceptable. Please feel free to contact me on 0438 724 929 or glen@genviro.com.au if you require further elaboration or wish to discuss anything further.

Yours faithfully,

Glen Gallagher BScApp(Env Sc)(Hons) MEIANZ CPESC
Principal Environmental Scientist | Gallagher Environmental

STANDARD LIMITATIONS