



**ULAN COAL MINES LIMITED
2023 ULAN CREEK STABILITY
MONITORING REPORT**

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1.0 Introduction

Ulan Coal Mines Pty Limited (UCMPL) engaged Pacific Environmental Pty Ltd (PE) in November 2023 to complete the annual creek stability monitoring for Ulan Creek. The section of Ulan Creek visited in 2023, as directed by UCMPL, was to focus the survey effort downstream of LDP6 between sites UC08 and UC37 (**Figure 1**). Water flowing in the creek restricted observations of the channel bed at some locations. Observations were limited at several sites to one side of the bank. Cross sectional surveys were not completed in 2023 due to water in the creek.

Ulan Creek was photographed and assessed for changes in channel stability at established monitoring sites (**Section 3.1**) applying the methodology as outlined in **Section 2**. Other opportunistic instability sites identified during previous monitoring (**Section 3.2**) were revisited in 2023. Ulan Creek stability monitoring occurred on the 28 November 2023 with a UCMPL representative. LDP6 was not discharging water into Ulan Creek at the time of the inspection, however the creek was flowing at all sites visited in 2023. The annual creek stability monitoring of Ulan Creek is required by UCMPL to monitor a section of Ulan Creek, as described in the Ulan West Extraction Plan¹ and Surface Water Monitoring Program (SWMP).

1.1 Background

As required by Condition 38, Schedule 3 of Project Approval 08_0184 (PA 08_0184), UCMPL have developed and implemented a SWMP². A requirement of the SWMP, is monitoring the stability of selected ephemeral creeks and unnamed flowlines annually (**Figure 1**) and for a period of two years after longwall mining has occurred beneath.

Ulan Creek is not directly undermined³ by Ulan West longwall mining activities however the creek flows are augmented by Licensed Discharge Point 6 (LDP 6). In accordance with Environmental Protection Licence No. 394 (EPL 394), UCMPL can discharge up to 15ML of treated water per day from LDP6. The 2023 creek stability monitoring locations for Ulan Creek are displayed in **Figure 1**. In previous discussions with UCMPL, the creek stability assessment methodology would follow the *CSIRO Ephemeral Stream Assessment*⁴ guidelines for completing a rapid visual assessment at each monitoring site (**Section 2**) to assess the creek stability.

1.2 Purpose & Scope

As required by the SWMP, the creek stability monitoring involves an observational survey that includes:

- Documenting locations and dimensions of significant erosive or depositional features so that any subsequent changes can be evaluated quantitatively;
- Photographic monitoring points at representative locations to enable a comparison over time of channel stability; and
- Written descriptions of the stream at each of the photographic points focusing on evidence of erosion and exposed soils.

The assessment of channel stability is to include a review of the current monitoring results against historical monitoring results to identify any potential deterioration or improvement in stream stability. As required by the Ulan West Extraction Plan for LW1 to LW8, monitoring of Ulan Creek is required annually to distinguish between natural erosion and erosion from mine subsidence instability. The scope of the 2023 Ulan Creek stability monitoring program (**Figure 1 & Appendix B**) included Ulan Creek monitoring sites UC8 to UC37.

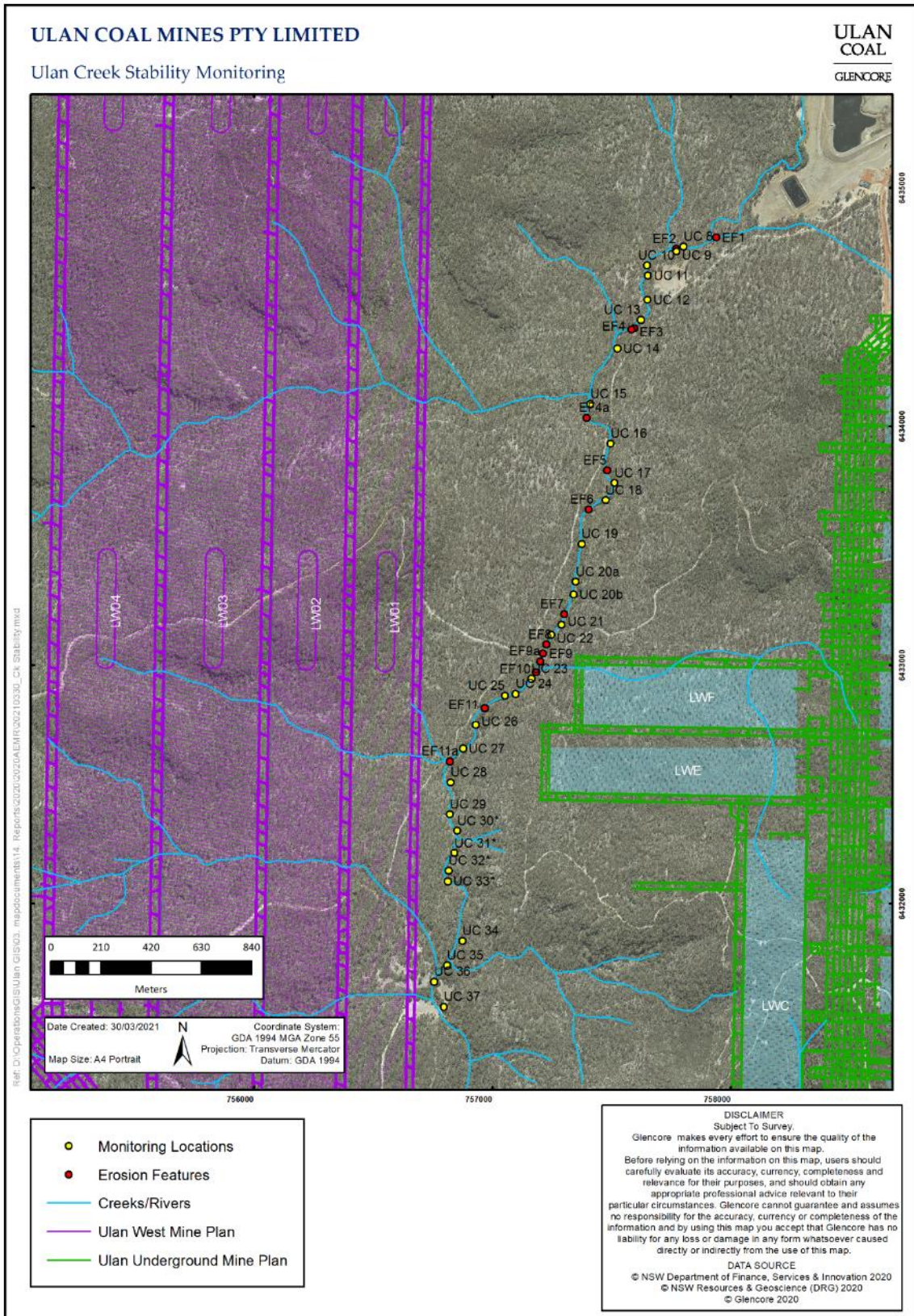
¹ Ulan West Extraction Plan for Longwalls 1 to 8 (approved by the DPE on 20 July 2022)

² SWMP (ULN SD PLN 0055) as required by Condition 38, Schedule 3 of PA08_0184

³ The overburden depth in this area is approximately 70m, Ulan Creek is protected by design being further than half depth from the goaf edge of LW1 (Ulan West Extraction Plan)

⁴ *Commonwealth Scientific and Research Organisation (CSIRO) (date unknown) - Ephemeral Stream Assessment*

Figure 1 Creek Stability Monitoring Locations, Erosion Features & Results



Source: Figure 1 provided by UCML

1.3 Soil Landscape

The soil types occurring within the Ulan Mine Complex are mapped on the Dubbo 1:250,000 Soil Landscapes Map Sheet (Murphy and Lawrie, 1998). Soil landscapes present within the Ulan Mine Complex (Umwelt, 2009) are presented in **Figure 2** and include:

- Bald Hill Soil Landscape;
- Lees Pinch Soil Landscape;
- Munghorn Plateau Soil Landscape;
- Turill Soil Landscape; and
- Ulan Soil Landscape.

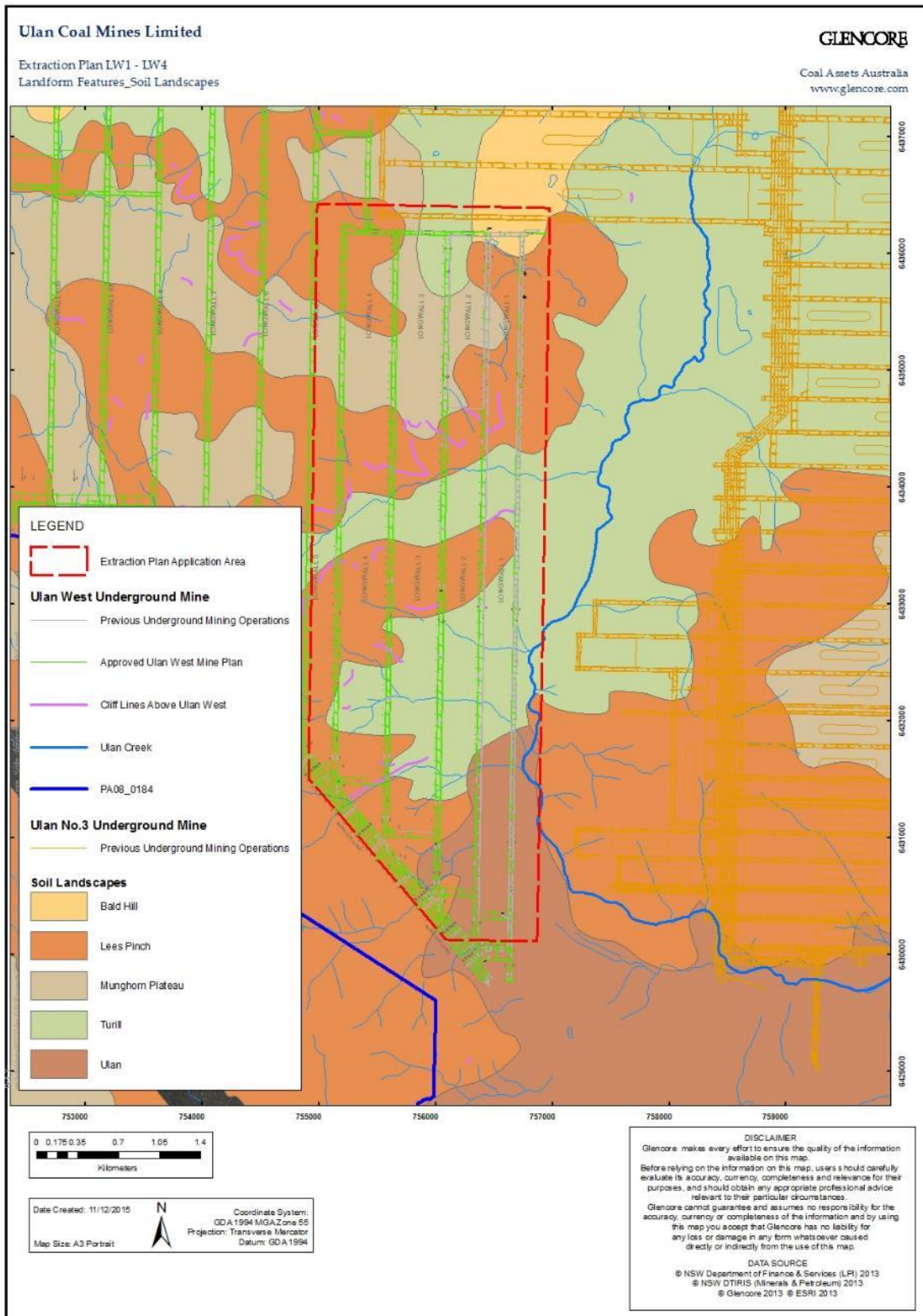
The soils within the Ulan Mine Complex vary in nature and thickness. The thicker, more fertile and alluvial deposits occur in the low-lying areas, predominantly associated with watercourses, whilst poorly developed and shallow soils occur on the higher areas where rocky outcrops occur. With the exception of the Bald Hill Soil Landscape⁵, the soil landscape units within the Ulan Mine Complex typically display limitations such as:

- Variable (i.e. poor to good) drainage capability;
- Poor to low fertility;
- Moderate to high erosivity; and
- Variable (i.e. slight to strongly) acidic topsoil.

The dominant soil landscape along the upper reach of Ulan Creek is Turill soil landscape with highly susceptible erosion characteristics. The mid to lower reaches of Ulan Creek are Ulan and Lees Pinch soil landscapes with moderate to high erosion characteristics (Umwelt, 2009).

⁵ Bald Hill Soil Landscape: Steep slope with rock outcrops; stoniness; mod to high fertility and water holding capacity.

Figure 2 Soil Landscapes



Source: UCML LW1-4 Extraction Plan

1.4 Rainfall Analysis

Rainfall data recorded by UCMP's meteorological station⁶ was reviewed for significant rainfall events between the 11 October 2022 and the 28 November 2023 (the monitoring period). Significant rainfall events may result in creek flooding and potential scouring to occur.

Modelled creek velocities lower than 1.5m/s to 2.3m/s are typically non-scouring in vegetated channels (Umwelt 2009) within the Ulan Creek catchment area.

The total rainfall recorded for the monitoring period was 626mm, just 46mm below the annual average. The average annual rainfall for the Ulan area is approximately 672mm (Umwelt 2009). In comparison to 1,088.3mm of rainfall in the previous monitoring period, approximately 416mm above the annual average. There were only four daily rainfall events greater than 30mm in 24hr during the monitoring period (**Graph 1**), including:

- 20 October 2022 (54.1mm);
- 13 November 2022 (37.3mm);
- 14 December 2022 (38.9mm); and
- 22 January 2023 (36.8mm).

1.5 Ulan Creek Flow Analysis

As reported in the 2022 Annual Review⁷, discharge of blended product water from the Bobadeen Water Treatment Facility to Ulan Creek at Bobadeen (LDP6) occurred on 363 days with an average daily discharge volume of 7,470 KL/day.

A preliminary review of the rainfall data and flow monitoring data for SW03 was undertaken for the monitoring period, indicating at least one significant flow event corresponding with the 54.1mm of rainfall on the 20 October 2023 (**Graph 1**). A smaller flow event was recorded nearly three weeks later on the 13 November 2022 after 37.3mm of rainfall was recorded.

As with previous reports, analysis of flow data within Ulan Creek to determine potential damaging velocities at gauging station SW03 (above LDP6) was completed by EI Solutions (**Appendix E**).

The maximum flows for both SW03 and LDP6 were lower than during 2021-22, due to an overall dryer year in 2022-23.

SW03 was only flowing until mid November 2022, then is mostly dry till end of November 2023 (except for occasional minor flows that filled pools. Mostly, all other events did was to re-wet the catchment, i.e. little runoff (EI Solutions, 2024).

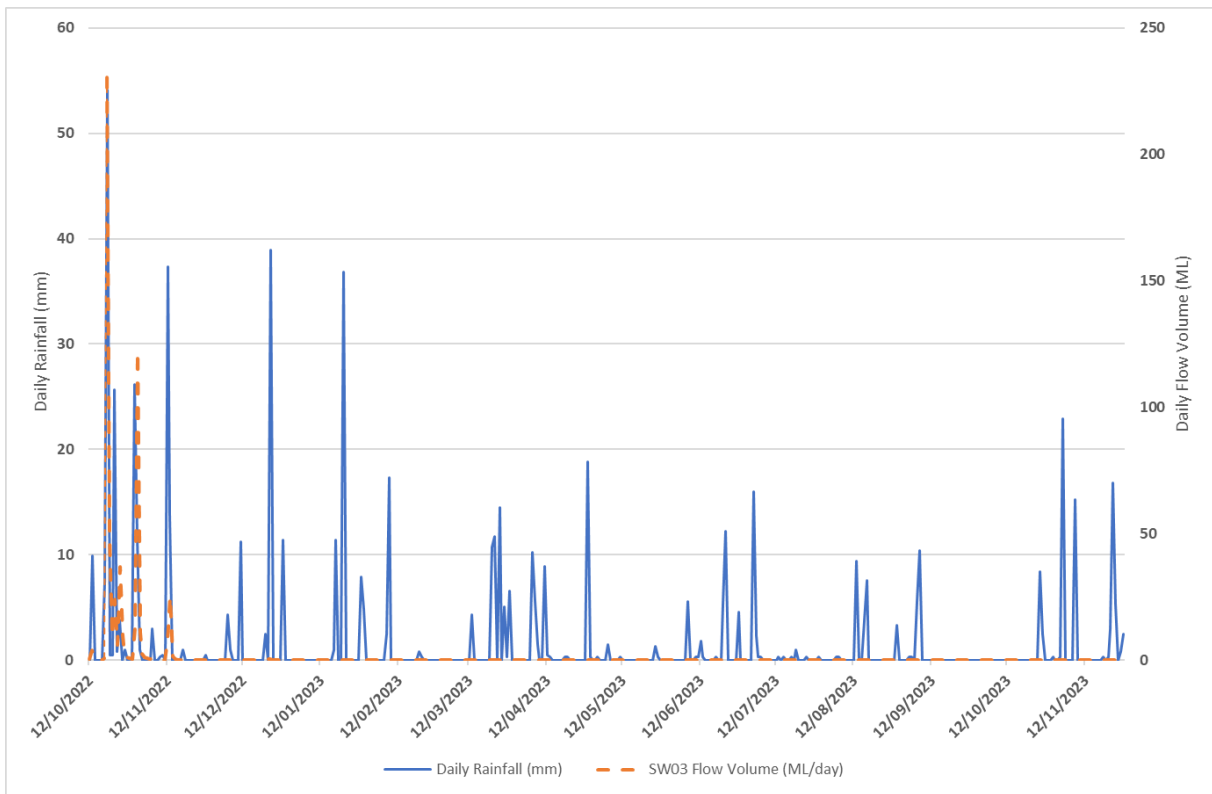
The largest event in the reporting period was on the 20th October 2022, with a peak discharge of 6,870 l/s caused by a storm (39mm total) with a maximum intensity (1 hour equivalent) of 84mm of rain (on a wettish catchment). The peak velocity for this event would have been approx. 1.8m/s with an approx. level rise of 0.5m (at SW03). This velocity would quickly dissipate as the channel widens and 'pools' immediately downstream of SW03, resulting in negligible (if any) channel change.

An event in November 2022 (second highest) with a total rainfall of 20mm only produced in a maximum intensity of 18mm of rain (1 hour equivalent), with a resultant peak discharge 3,570 l/s on a wettish catchment.

⁶ The 2021-2022 rainfall data was provided by UCMP

⁷ <https://www.glencore.com.au/rest/api/v1/documents/38926b6957bfa9a21418d553ab2ecfdd/Ulan+Coal+Annual+Review+2022.pdf> .

Graph 1 2022/23 Rainfall and Ulan Creek Flow Events



Notes: Data provided by UCMLP

2.0 Monitoring Methodology

2.1 Photographic Recording

The 2023 channel stability monitoring program included taking photographs at each of the monitoring locations. A photographic recording of the upstream and downstream condition of the channel was undertaken at each monitoring location to incorporate the condition of both the banks and channel bed. Qualitative comparisons are made against the photographic record from previous channel stability monitoring events.

2.2 CSIRO – Ephemeral Stream Assessments

The 2023 channel stability monitoring program applied the *CSIRO Ecosystem Function Analysis – Ephemeral Stream Assessment*⁸ to evaluate the stability status at each location. There are four main classes of indicators assessed to evaluate the degree of streambed condition:

- A. The type and condition of the vegetation present, if any;
- B. The shape and profile of the drainage line and type and condition of materials on the drainage line floor;
- C. The nature of the drainage line wall materials; and
- D. The nature of the stream bank bordering flats and/or slopes and regulation of lateral flow into drainage line.

The indicators produce a rating which ranks each location from very actively eroding through to very stable. The main issues causing the gully erosion can also be differentiated. This differentiates gully erosion caused by;

- i) High flow rates from upstream;
- ii) High lateral flow rates, and
- iii) Exposure of unstable side wall materials that slake and/or disperse. This classification can aid in defining the most appropriate form of remediation.

Within each indicator, there may be sub classifications that the scoring process uses to reach a score for that assessment point (**Appendix A**).

2.2.1 A. The Type & Condition of Vegetation Present Within the Drainage Line

Table 1 A.1 Vegetation on Drainage Line Floor

Rating	Description
1	Little or no vegetation growing on drainage line floor
2	Any vegetation present is annual or short-lived: partial burial of plants by recently deposited sediment evident
3	Dense perennial plant cover, similar to vegetation on the bank of the drainage line: characteristic wetland species composition: no observable plant burial by sediment

Table 2 A.2 Vegetation on Drainage Line Walls

Rating	Description
1	Little or no vegetation growing on drainage line walls
2	Any vegetation present is annual or short-lived: partial burial of plants by recently deposited sediment evident
3	Dense perennial plant cover, similar to vegetation on the bank of the drainage line: characteristic wetland species composition: no observable plant burial by sediment

⁸ Commonwealth Scientific and Research Organisation (CSIRO) (date unknown) - Ephemeral Stream Assessment

2.2.2 B. The Shape of the Drainage Line & Type of Material on Floor

Table 3 B.1 Shape and Aspect Ratio of Drainage Line Cross-Section

Rating	Description
1	Very actively eroding: caving, mass wasting and/or tunnelling present: depth > width (aspect ratio high)
2	Actively eroding: slight undercutting, near vertical walls, alluvial fans also eroding: depth = width
3	Potentially stabilising: side walls become rounded and crusted alluvial fan at foot of side walls: width > depth
4	Stabilising: wall angle less than 65o, small inactive alluvial fan at foot of side walls: width> depth
5	Stable: gently sloping walls, generally low, "S" shaped bed/bank continuum: width>> depth (aspect ratio very low)

Table 4 B.2 Longitudinal Morphology of Drainage Line

Rating	Description
1	Currently incising bed in pre-existing loose sediment; faceted lower wall/bed profile (benches), scour holes in bed. Morphology implies high flow rates and erosion
2	Flat, continuous, loose sediment with signs of recent/frequent movement
3	Flat with a cohesive fine textured "soil-like" bed
4	Non-cascading pools or ponds, with non-slaking, non-dispersive clay base, implying low energy flow.

Table 5 B.3 Particle Size of Materials on Drainage Line Floor- material available for Erosion

Rating	Description
1	Material on floor is similar or smaller in particle size and/or density than material in the walls (e.g. unconsolidated fine sand deposits)
2	Material on floor is slightly larger in particle size and/or denser (more consolidated) than material on walls (e.g. well sorted gravel)
3	Material on floor is much larger in particle size and/or denser than material on walls: surface armouring (e.g. cobbles, competent country rock)

2.2.3 C. Nature of Drainage Line Wall Material

Table 6 C.1 Nature of Drainage Line Wall Materials

Rating	Description
1	Dispersive material is exposed for greater than 1 metre of wall height
2	Materials that slake rapidly, or disperse are exposed on greater than 0.3 metres and less than 1 metre of vertical wall height (the sum of multiple layers if present)
3	Materials that slake and/or disperse are exposed on less than 0.3 metre of wall height
4	Materials that do not slake or disperse are exposed on wall surface

2.2.4 D. Nature of Bank Edge & Lateral Flow Regulation

Table 7 D.1 Shape of stream-bordering flats and/or slopes

Rating	Description
1	Very steep slope, >30° creating high velocity flows
2	Steep bank, 10-30°, permitting moderate to high velocity flows
3	Moderately sloped bank, 5-10°
4	Gently sloped bank/floodplain, laterally extensive, < 5°
5	Flat bank/floodplain, laterally extensive

Table 8 D.2 Nature of Lateral Flow Regulation into Drainage Line

Rating	Description
1	Side arm channel inflow: very high inflow rates
2	Bare bank, laterally extensive
3	Sparse grassland/woodland with bare soil bank lip: moderate flow rate, some highly focused inflow locations
4	Dense grassland: low inflow rate, mostly diffuse
5	Woodland with dense litter: very low, diffuse inflow rate

2.2.5 Activity Rating

Table 9 Activity Rating

Activity Rating	Activity Rating (%)	Classification	Discussion of Classification
30+	80+	Very Stable	Drainage line is very stable and likely to be in original form. It is able to withstand all flow velocities that have previously occurred in this area and only minimal monitoring is required, predominantly after high flow events, to ensure condition does not deteriorate.
25-29	70-80	Stable	Drainage line is stable. It is important to assess this zone in relation to the other classifications and define whether this zone is moving from potentially stabilising to a more stable form or if it is deteriorating from a very stable form. The nature of his relationship will identify the type of monitoring required.
20-24	60-69	Potentially Stabilising	Drainage line is potentially stabilising. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
15-19	50-59	Active	Drainage line is actively eroding and remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.
<15	<50	Very Active	Drainage line is very actively eroding and immediate remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

2.3 Cross Sectional Surveys

Cross sections of the channel bed and banks were not undertaken in 2023 due to Ulan Creek flowing at the time of the inspection.

2.4 Limitations

The following limitations encountered during the 2023 creek stability monitoring program need to be considered, including:

- Water flowing in the creek limited observations of the channel bed at some locations. Observations were restricted to generally one side of the bank.
- Cross sectional surveys applied an alternate methodology in 2021 and 2022. At several locations cross sections were not carried out due to water flowing in the creek. Variability of recording cross sections may be attributed to alignment issues when completing the cross section. No cross-sectional surveys were able to be completed in 2023 due to water flowing in the creek.
- Although all attempts were made to undertake each channel stability assessment and cross sections at the exact site coordinates in **Table 10** and **Table 11**, the exact site location was subject to varying accuracies of the GPS, fallen timber and flood debris. A permanent peg at each creek stability and cross section assessment site along Ulan Creek would assist to reduce this problem. Flood debris, flowing water at some locations hampered the assessment.

- Not all of the indicators of *CSIRO Ecosystem Function Analysis – Ephemeral Stream Assessment* could be applied due to water either flowing or pooling at those locations. For example, previous erosion at many of the sites noted within the creek bed or walls of the creek during drier years or in drought conditions were covered by pooling or flowing water in 2021, 2022 and 2023. Often this is where the activity rating stability score was originally attributed to. In 2021 and 2022 a number of sites improved their activity rating stability scores as they appeared stable above the water line. In these instances, observations and assessment of the creek bed were limited to assumptions, previous observations or nearby observations.

3.0 Site Locations

3.1 Creek Stability Assessment Sites

Table 10 Ulan Creek Stability Assessment Sites

Creek Stability Assessment Site Ref#	Eastings	Northings
UC 8 ²	757800	6434755
UC 9	757770	6434734
UC 10	757647	6434676
UC 11	757651	6434633
UC 12	757649	6434531
UC 13	757621	6434447
UC 14	757522	6434327
UC 15	757408	6434095
UC 16	757495	6433929
UC 17	757510	6433763
UC 18	757473	6433691
UC 19	757372	6433508
UC 20a	757348	6433349
UC 20b	757339	6433297
UC 21	757289	6433168
UC 22	757246	6433127
UC 23	757162	6432943
UC 24	757096	6432880
UC 25	757052	6432871
UC 26	756929	6432750
UC 27	756876	6432651
UC 28	756824	6432508
UC 29	756821	6432374
UC 30 ¹	756851	6432305
UC 31 ¹	756840	6432211
UC 32 ¹	756816	6432138
UC 33 ¹	756812	6432094
UC 34	756873	6431844
UC 35	756809	6431741
UC 36	756754	6431673
UC 37	756795	6431567

Notes: Coordinate System GDA 1994 MGA Zone 55 ¹ not visited in 2020 due to creek flows and difficult access. ²Site relocated in 2017

3.2 Erosion Features

Table 11 Erosion Features

Erosion Features	Eastings	Northings
EF1 ¹	757937	6434793
EF2	757770	6434745
EF3	757593	6434412
EF4	757582	6434407
EF4a ²	757395	6434037
EF5	757479	6433816
EF6	757402	6433652
EF7	757301	6433213
EF8	757225	6433086
EF9	757212	6433048
EF9a ²	757201	6433016
EF10	757183	6432970
EF11	756966	6432820
EF11a ²	756820	6432597

Notes: Coordinate System GDA 1994 MGA Zone 55 ¹ not visited in 2019 & 2020 above LDP6 ² Erosion Feature (EF) added to monitoring in 2018

4.0 Results

4.1 Ulan Creek Stability Results

The Ulan Creek channel stability monitoring program indicates a range of stability trends at Sites UC08 to UC37 (**Graph 2 to 4**). Observed stability since 2015 at nearly all the sites fluctuates, with destabilisation predominately influenced by prolonged drought periods and significant rainfall events that can eventuate into destructive high flows in the creek, as recorded on the 17 February 2020 for example. The potential destabilising influence from LD6 is less obvious when compared to these natural high flow events, although the absence of established ground vegetation along the channel floor, possibly hindered by daily augmented creek flows from LDP6, is an aspect to consider.

Consecutive years of above average rainfall in 2020, 2021 and 2022 initiated and sustained an increasing groundcover along and above the banks of the creek. Germination of an abundance of eucalyptus species above the creek bank has also been observed. During this period creek flows upstream of LDP6 and inflows into Ulan Creek from lower order flow lines were noted during the annual inspection of Ulan Creek.

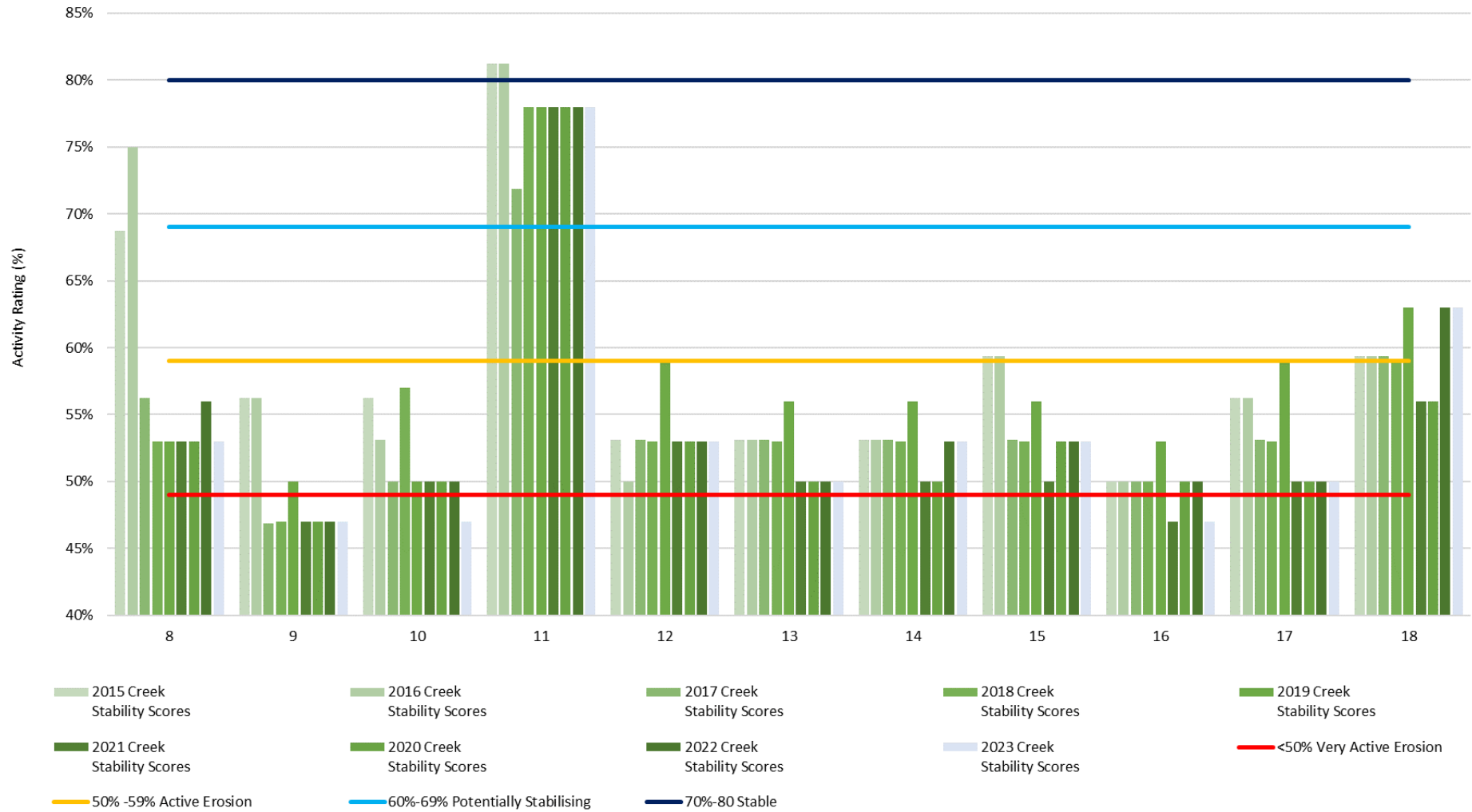
However, in 2023 the frequency and volume of rainfall has continued to decline. Observations in 2023 noted signs groundcover along the creek's riparian zone was decreasing and no inflows from lower order flow lines were observed. Decreasing groundcover was observed at UC8, UC10, UC16, UC19, UC32 to UC36, which slightly lowered the stability score at these sites. UC27 was the only site with a slight improved stability score due to increased groundcover establishment along sections of the creek bed. The remaining sites maintained their previous stability score from 2022.

There is the likelihood at least one flow event of any significance (**Sections 1.4 & 1.5**) within the monitoring period has occurred, further exacerbating existing erosion observed along the creek from sites UC08 to UC37. Observations from the 2023 inspection along Ulan Creek noted continued mass wasting of the creek at UC20a, UC20b and UC23. Other observations noted fallen trees into the creek since 2022 at sites UC21, UC24, UC27 and UC31 and the removal of either geofabric from the creek bank wall at UC32 and jute mesh material (as flood debris) from UC29. Refer to **Appendix B** and **Appendix C** for further information.

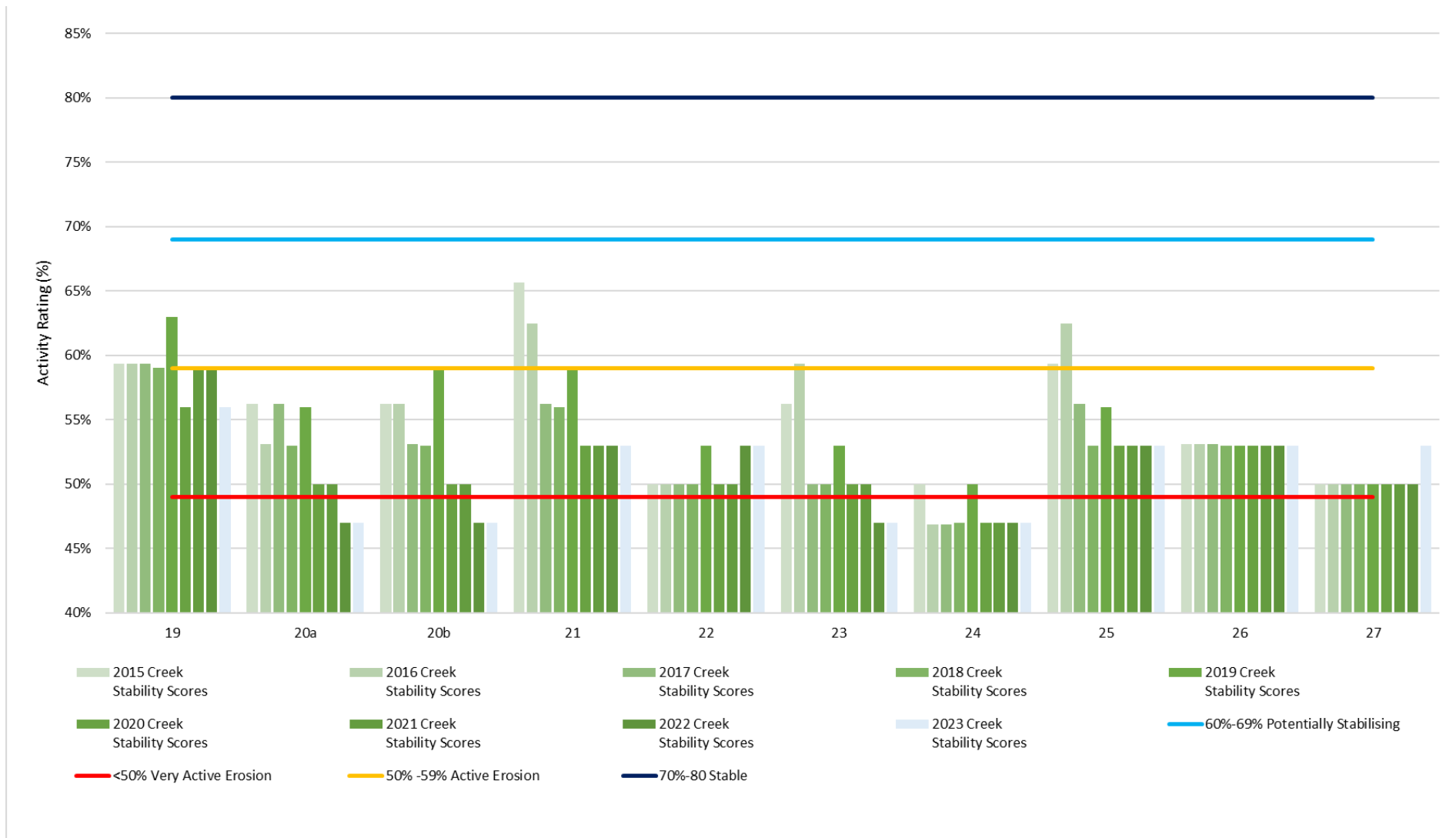
4.1.1 Photographic Comparisons

Appendix B contains the photographic comparisons from 2021, 2022 and 2023 at monitored sites along Ulan Creek. **Appendix D** contains the photographic comparisons of erosion features outside of the established monitoring sites.

Graph 2 Ulan Creek Stability Scores & Trends (2015-2023) Site 8 to Site 18



Graph 3 Ulan Creek Stability Scores & Trends (2015-2023) Site 19 to Site 27



Graph 4 Ulan Creek Stability Scores & Trends (2015-2023) Site 18 to Site 37

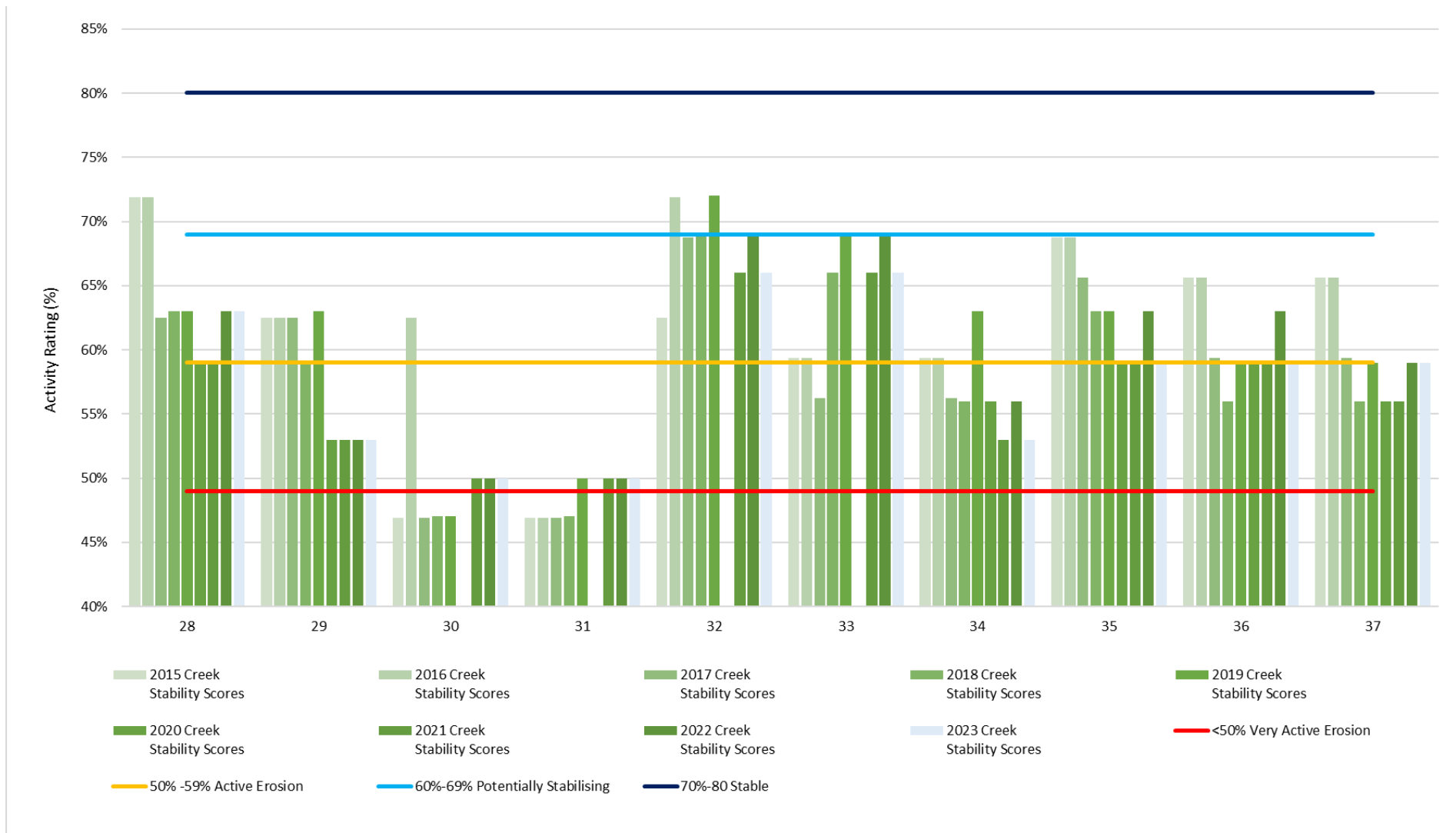


Table 12 CSIRO Ephemeral Stream Assessment Scores for Ulan Creek 2023

Indicator / Survey Point	UC 08	UC 09	UC 10	UC 11	UC 12	UC 13	UC 14	UC 15	UC 16	UC 17	UC 18	UC 19	UC 20A	UC 20B	UC 21	UC 22
Vegetation on D/L Floor (3)	1	1	1	1	1	1	2	2	1	1	2	1	1	1	1	1
Vegetation on DL Walls (3)	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
Shape of X-Section (5)	2	1	2	5	2	1	1	2	2	1	2	2	1	1	1	2
Longitudinal Morphology (4)	1	1	1	4	1	1	2	2	2	1	2	2	1	1	2	2
Types of Materials on Floor (3)	1	1	1	3	3	2	1	1	1	3	2	2	2	2	2	2
Nature of Materials (4)	3	1	1	3	1	1	1	2	1	1	3	3	1	1	2	2
Nature of Shape (5)	3	4	3	3	3	4	4	2	2	3	2	2	3	3	3	2
Lateral Flow Regulation (5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
% Activity Score	53	47	47	78	53	50	53	53	47	50	63	56	47	47	53	50
Indicator / Survey Point	UC 23	UC 24	UC 25	UC 26	UC 27	UC 28	UC 29	UC 30	UC 31	UC 32	UC 33	UC 34	UC 35	UC 36	UC 37	
Vegetation on D/L Floor (3)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Vegetation on DL Walls (3)	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	
Shape of X-Section (5)	1	1	2	2	2	2	1	2	2	3	3	2	2	2	3	
Longitudinal Morphology (4)	1	2	2	2	2	2	2	2	2	4	4	2	2	2	2	
Types of Materials on Floor (3)	2	2	2	2	2	2	2	3	3	3	3	2	1	1	2	
Nature of Materials (4)	1	1	1	1	1	3	3	1	1	3	3	3	3	3	3	
Nature of Shape (5)	3	2	3	3	2	3	2	1	1	1	1	1	3	3	3	
Lateral Flow Regulation (5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	
% Activity Score	47	47	53	53	53	63	53	50	50	66	66	53	59	59	59	

Classification: +80 Very Stable; 70-80 Stable; 60-69 Potentially Stabilising; 50-59 Active; <50 Very Active

4.2 Ulan Creek Erosion Features

During the 2023 creek stability assessments, several existing erosion features outside the established monitoring sites were revisited to provide a photographic record for future comparisons (**Appendix D**). A continuation of active to very active erosion was noted at nearly all these sites in 2023.

5.0 Discussions & Recommendations

Ulan Creek is outside the immediate zone of subsidence from the first longwall panel (i.e. LW1) of the Ulan West underground mine (**Figure 1**), approximately 80m from the goaf edge of LW1⁹. Longwall mining of LW1 was completed by Ulan West on the 01 May 2015. As with previous monitoring of Ulan Creek since 2015, there were no perceptible signs of subsidence related impacts from the Ulan West underground mine in 2023.

The Ulan Creek channel stability monitoring program indicates a range of stability trends at Sites UC08 to UC37 (**Graph 2 to 4**). Observed stability since 2015 at nearly all the sites fluctuates, with destabilisation predominately influenced by prolonged drought periods and significant rainfall events that can eventuate into destructive high flows in the creek, as recorded on the 17 February 2020 for example. The potential destabilising influence from LD6 is less obvious when compared to these natural high flow events, although the absence of established ground vegetation along the channel floor, possibly hindered by daily augmented creek flows from LDP6, is an aspect to consider.

Consecutive years of above average rainfall in 2020, 2021 and 2022 initiated and sustained an increasing groundcover along and above the banks of the creek. Germination of an abundance of eucalyptus species above the creek bank has also been observed. During this period creek flows upstream of LDP6 and inflows into Ulan Creek from lower order flow lines were noted during the annual inspection of Ulan Creek.

However, in 2023 the frequency and volume of rainfall has continued to decline. Observations in 2023 noted signs groundcover along the creek's riparian zone was decreasing and no inflows from lower order flow lines were observed. Decreasing groundcover was observed at UC8, UC10, UC16, UC19, UC32 to UC36, which slightly lowered the stability score at these sites. UC27 was the only site with a slight improved stability score due to increased groundcover establishment along sections of the creek bed. The remaining sites maintained their previous stability score from 2022.

There is the likelihood at least one flow event of any significance (**Sections 1.4 & 1.5**) within the monitoring period has occurred, further exacerbating existing erosion observed along the creek from sites UC08 to UC37. Observations from the 2023 inspection along Ulan Creek noted continued mass wasting of the creek at UC20a, UC20b and UC23. Other observations noted fallen trees into the creek since 2022 at sites UC21, UC24, UC27 and UC31 and the removal of either geofabric from the creek bank wall at UC32 and jutesh material (as flood debris) from UC29. Refer to **Appendix B** and **Appendix C** for further information.

The 2023 channel stability monitoring observed similar morphological processes, as identified from previous monitoring, with numerous sites displaying a range of varying forms of erosion and instabilities, although the rate of erosion appears to have slowed at a number of sites when compared to 2020.

The 2023 channel stability did not observe additional sand deposits above the creek bank as noted in 2020. As observed in 2020 there were several locations of new flood debris and sand deposits transported above the banks of Ulan Creek during one or more high flow events that occurred during the 2020 monitoring period.

PE understand that UCMP are developing remediation plans to address and stabilise some of the more significant erosion sites and features encountered along Ulan Creek between LDP6 and UC37 that are potentially susceptible to further instabilities. Monitoring during or soon after a significant rainfall event is recommended to identify those creek flow events which are potentially triggering disturbances along the creek. UCMP may consider establishing additional survey pegs at each creek stability monitoring site and cross section sites prior to the 2024 creek stability monitoring program. Additional cross sections would also be recommended at selected erosion feature sites.

⁹ Ulan West Extraction Plan LW1-8

6.0 References

- *Umwelt (2009) Ulan Coal - Continued Operations Environment Assessment.*
- *Barnson Pty Ltd (March 2015) UCML Creek Stability Assessments, 2014.*
- *Pacific Environmental Pty Ltd (February 2016), 2015 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (February 2017), 2016 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (February 2018), 2017 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (March 2019), 2018 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (March 2020), 2019 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (March 2021), 2020 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (March 2022), 2021 Creek Stability Monitoring Report*
- *Pacific Environmental Pty Ltd (March 2023), 2022 Creek Stability Monitoring Report*
- *CSIRO (March 2009) Australian Soil and Land Survey Field Handbook*
- *Ulan West Extraction Plan for LW1 to LW4 (November 2015, UCML)*
- *Ulan West Extraction Plan for LW1 to LW8 (March 2022, UCMPL)*

APPENDIX A
ASSESSMENT PROFORMA

APPENDIX B
ULAN CREEK PHOTOGRAPHS

APPENDIX C
CHANNEL WIDENING /MATERIAL LOSS

Ulan Creek Stability Site UC20b – History of Erosion & Channel Widening at UC20b

2014 (Upstream)

2017 (Upstream)



LHB in 2014



Loss of material evident from LHB in 2017

Upstream 2018 & 2019



Continuation of material loss from LHB in 2018 and slumping of the creek bank.



Continuation of material loss from LHB in 2019 and slumping of the creek bank.

Ulan Creek Stability Site UC20b

2019



2020



2022



2023



2022



2023



APPENDIX D

EROSION FEATURES

APPENDIX E

ULAN CREEK FLOW ANALYSIS

Friday, 12th January 2024

ATTENTION:

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Ulan Creek – 2023 Flow Analysis

Dear Stephen,

As requested, I have looked at rainfall events in 2022-23 (Oct'22 to Nov'23) for Ulan creek (SW03 - upstream of Bobadeen discharge) that resulted in a rise in water level. Note, quoted rainfall intensities were recorded at Moolarben Dam. It has previously been noted, that due to the 'wild' rainfall spatial variation in this area, that it is recommended that a raingauge be installed in this catchment (at Bobadeen Dam).

The maximum flows for both SW03 and LDP6 were lower than during 2021-22, due to an overall dryer year in 2022-23.

SW03 was only flowing until mid November 2022, then is mostly dry till end of November 2023 (except for occasional minor flows that filled pools. Mostly, all other events did was to re-wet the catchment, i.e. little runoff.

The largest event in the reporting period was on the 20th October 2022, with a peak discharge of 6,870 l/s caused by a storm (39mm total) with a maximum intensity (1 hour equivalent) of 84mm of rain (on a wettish catchment). The peak velocity for this event would have been approx. 1.8m/s with an approx. level rise of 0.5m (at SW03). This velocity would quickly dissipate as the channel widens and 'pools' immediately downstream of SW03, resulting in negligible (if any) channel change.

An event in November 2022 (second highest) with a total rainfall of 20mm only produced in a maximum intensity of 18mm of rain (1 hour equivalent), with a resultant peak discharge 3,570 l/s on a wettish catchment.

The remained of the period was very dry, resulting in a drying catchment that 'absorbed' any rainfall events.

Kind regards,



Matt Austin
Director | EI Solutions