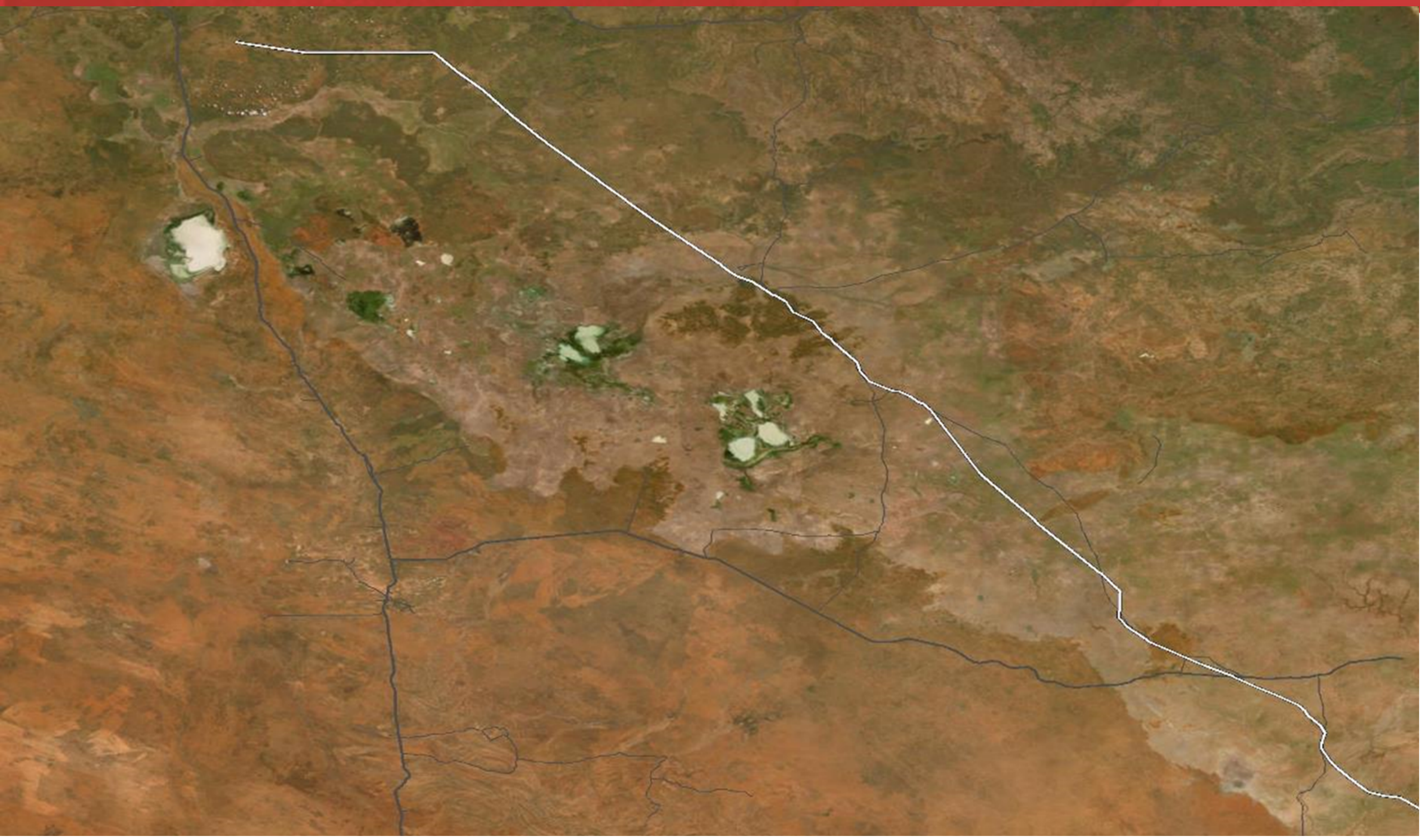
EROSION RISK ASSESSMENT

NEA Pipeline – Stage 1

APT Management Services Pty Ltd(APA)



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EcOz Pty Ltd.
ABN: 81 143 989 039
Level 1, 70 Cavenagh Street
DARWIN NT 0800
GPO Box 381, Darwin NT 0800

Telephone: +61 8 8981 1100
Facsimile: +61 8 8981 1102
Email: ecoz@ecoz.com.au
Internet: www.ecoz.com.au

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EXECUTIVE SUMMARY

EcOz Environmental Consultants (EcOz) was engaged by APT Management Services Pty Ltd (APA) to undertake an Erosion Risk Assessment (Erosion RA) for the proposed North to East Australia Pipeline (NEA Pipeline) – Stage 1 within the Northern Territory. The assessment focuses on the pipeline Construction Right of Way (CROW), which represents the largest area of disturbance and the primary erosion risk component of the Proposal.

The assessment provides a high-level, desktop-based evaluation of erosion hazards and risks associated with construction activities, in accordance with International Erosion Control Association (IECA) best practice guidance.

The proposed CROW extends approximately 662 km across predominantly pastoral land and traverses a range of land systems including alluvial floodplains, clay plains, and lateritic plains and rises. These environments are characterised by generally low relief, with average slopes typically less than 1%, and ephemeral drainage systems that are influenced by highly variable rainfall associated with a semi-arid climate.

Erosion risk was assessed using rainfall-based risk ratings and the Revised Universal Soil Loss Equation (RUSLE). Results indicate that:

- Rainfall-driven erosion risk is typically very low, increasing from low to moderate during wet season months (December to March), particularly in the northern sections of the corridor
- Calculated soil loss across all landform classes is consistently very low, with estimated values ranging from approximately 11 to 63 tonnes per hectare per year
- Spatial modelling indicates a maximum predicted annual soil loss of approximately 41 t/ha/yr, corresponding to a very low erosion hazard classification under IECA criteria

Despite the low inherent erosion hazard, the extensive linear disturbance associated with pipeline construction presents a material risk, particularly where works intersect drainage lines, clay-rich soils, and floodplain environments. Saturated conditions during the wet season may further increase susceptibility to soil disturbance and sediment mobilisation.

Wind erosion represents an additional consideration during the dry season, particularly where soils are exposed and surface cover is limited. However, due to the absence of sensitive receptors and the naturally erosive baseline environment, the overall wind erosion hazard is considered low.

To manage erosion risks effectively, the EE recommends a proactive and staged approach to erosion and sediment control, including:

- Development and implementation of a Primary ESCP and Progressive (site-specific) ESCPs aligned with construction staging
- Progressive stabilisation of disturbed areas to minimise exposure duration
- Scheduling of works to avoid peak rainfall periods where practicable
- Implementation of appropriate erosion, sediment and wind control measures scaled to risk level
- Enhanced controls at waterway crossings and high-risk land systems

With the application of these measures, erosion risks associated with the Proposal can be effectively managed, ensuring impacts to downstream environments are reduced to as low as reasonably practicable.

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ACRONYMS

ASS	acid sulfate soils
BOM	Bureau of Meteorology
CEMP	Construction Environment Management Plan
CPESC	Certified Practitioner in Erosion and Sediment Control
CROW	Construction Right of Way
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
IECA	International Erosion Control Association
NEA PIPELINE	North to East Australia Pipeline
NT	Northern Territory
RA	Risk Assessment
Qld	Queensland

1 INTRODUCTION

EcOz Environmental Consultants (EcOz) has been commissioned by APT Management Services Pty Ltd (APA) to assess the erosion hazards and risks for the proposed North to East Australia Pipeline (NEA Pipeline), herein known as 'the Proposal'. This Erosion Risk Assessment (hereafter referred to as Erosion RA) provides a high-level assessment of activities associated with the Construction Right of Way (CROW), which represents the primary disturbance footprint of the Proposal

This assessment has been based on site information available at the time of preparation. A Primary Erosion and Sediment Control Plan (ESCP), and subsequent Progressive (site specific) ESCPs, will be required prior to, and during construction.

This assessment has been developed in accordance with International Erosion Control Association (IECA) best practice erosion and sediment control guidelines.

1.1 Purpose

The purpose of this Erosion RA is to assess erosion-related environmental hazards and risks associated with the Proposal works and to provide high-level, risk-based recommendations for erosion management as the proposal progresses. This Erosion RA has been prepared by Certified Practitioners in Erosion and Sediment Control (CPESC).

It is intended as a preliminary, high-level assessment consistent with IECA best practice guidance for linear infrastructure projects, including Appendix P (Land-Based Pipeline Construction) of the Proposal and does not include detailed provisions or designs for specific erosion and sediment controls (ESCs). Development of this assessment has been constrained by desktop information available at the time of preparation, and it is subject to change as further site investigations are conducted and detailed site information becomes available. This assessment is not approved for construction.

A Primary ESCP and a series of Progressive (site-specific) ESCPs will be developed in accordance with IECA (2025) Appendix P (Land-based Pipeline Construction), to support the staged development and rehabilitation of the CROW. These will describe work-site specific erosion and sediment management requirements for construction works and activities in site areas considered likely to have high erosion risk, and/or with potential to impact on sensitive environments. These site specific ESCPs shall provide greater detail and be consistent with the management strategies described in this assessment.

1.2 Scope

This Erosion RA incorporates the following elements:

- Inclusion of an overarching erosion hazard and risk assessment
- Identification of the management strategy and controls to be implemented to effectively manage erosion, and subsequent mobilisation of sediment during the construction phase

2 PROPOSAL DESCRIPTION

The APA Proposal comprises a construction corridor that traverses many pastoral leases in a south-easterly direction from central NT to the Qld border west of Mt Isa. Land classes are predominantly either Clay Plains with heavy clay soils, or Lateritic Plains and Rises with sandy soils. The region has a semi-arid climate with hot, wet summers and warm, dry winters. For the purpose of this Erosion RA, it has been assumed that the following key components occur within the corridor:

- The CROW, which includes the construction (assembly) and undergrounding of approximately 662km long pipe consisting of:
    - Approximately 80km of smaller diameter pipe (herby known as Collection Header 1), to transport gas within the Beetaloo to Compressor station 1.
    - Approximately 582km of larger diameter pipe (up to 122 cm), (herby known as the Main Corridor (MC)), from Compressor station 1 to the NT/QLD border approximately 155km west of Mt Isa.
- Installation of associated above-ground infrastructure (main line valve (MLV) and delivery stations, anode beds to support cathodic protection, compressor stations, etc)
- Establishment of operational 4WD access track
- Supporting temporary infrastructure for construction, including:
    - Accommodation camps including workshop and laydown yard.
    - Pipe and material stockpiles
    - Access tracks (upgrade existing and new)
    - Groundwater bores for water extraction for construction and commissioning.

This Erosion RA has evaluated only the CROW, as this is by far the largest and most complex component. The other components can be addressed in future ESCP's. For the purposes of this Erosion RA, only works in the Northern Territory have been assessed.

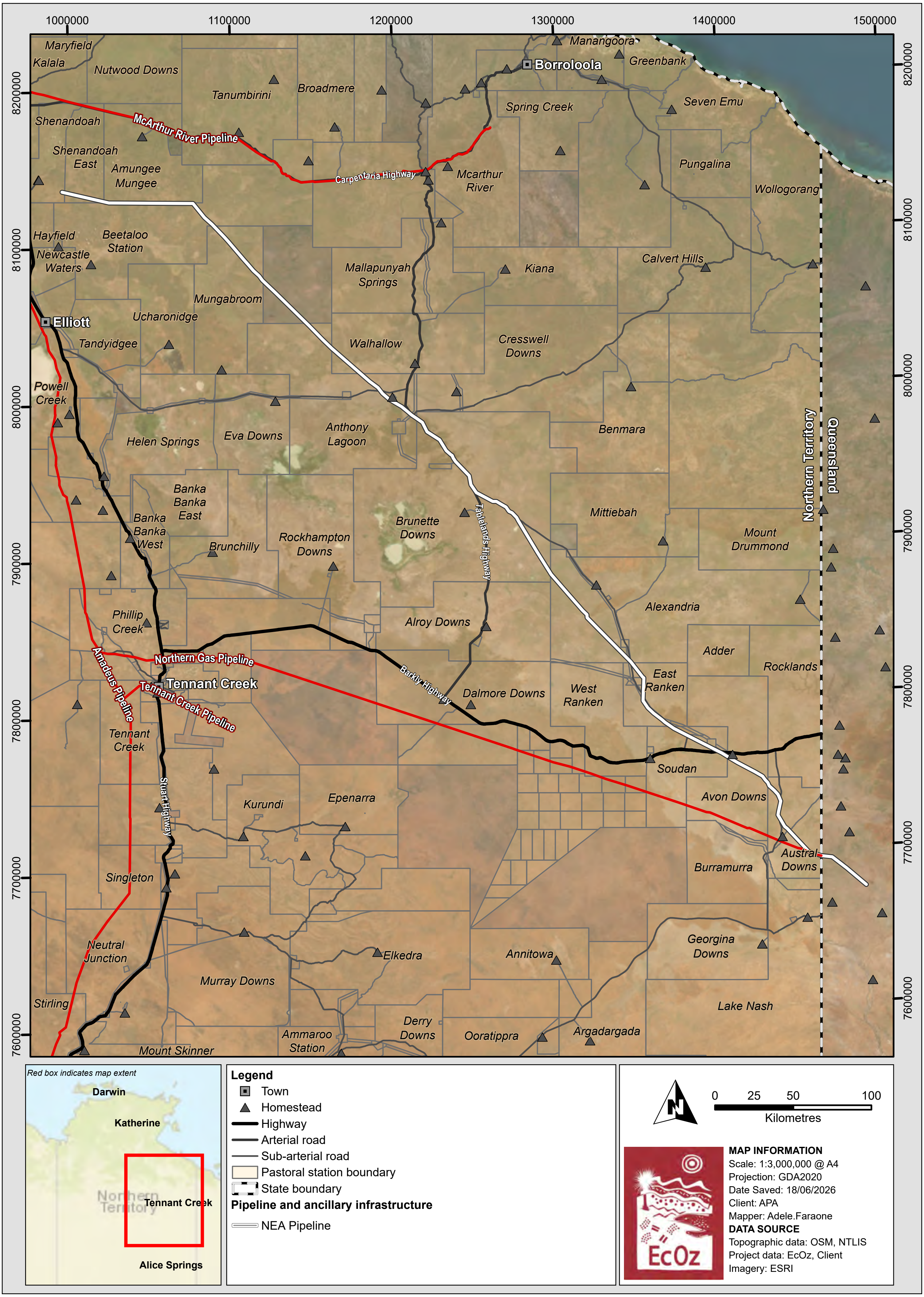

Figure 2-1. Map showing the location of the CROW

3 SITE CHARACTERISTICS

The site characteristics for the CROW are summarised below.

3.1 Site location

The proposal is a linear pipeline which commences at natural gas exploration and appraisal wells on Shanandoah pastoral lease, 600 km south-east of Darwin, and traverses numerous pastoral leases to the NT/QLD border approximately 155km west of Mt Isa.

3.2 Land use

Existing and previous land use within the proposal area broadly includes some disturbance and pastoral activities. Pastoral activities common in the area include cattle grazing, groundwater extraction, fire, pests and weed management.

This does not incorporate cultural heritage or First Nations assessment.

3.3 Climate

The region experiences a semi-arid climate, which is characterised by hot dry summers and warm dry winters, with a low average annual rainfall. Temperatures align with the seasonal patterns typical of northern and central Australia, with the highest daily maximums occurring in January. Higher rainfall volumes typically occur in the summer months associated with the northern monsoon. Annual rainfall in the region can be highly variable. In general, higher rainfall is expected in the northern part of the study area as seen in Figure 3-1 to Figure 3-4

The closest, long-term, BoM weather stations are listed below:

- Daly Waters (station ID 014626), ~100 km north of start of CROW
- Elliott (station ID 015131), ~100 km south of start of CROW
- Brunette Downs (station ID 015085), within 50 km, midway along CROW
- Camooweal (station ID 037010), ~100 km north of end of CROW

The mean average annual rainfall at Brunette Downs is 428.4 mm, with higher rainfall volumes typically occurring in the summer months associated with the northern monsoon. Annual rainfall can be highly variable from year to year – for example, 1897 experienced 85.1 mm of rain, while 1976 experienced 1200.4 mm of rain. The last complete year of rain records was 2022, which experienced 810.2 mm.

Temperatures follow the seasonal patterns typical of northern and central Australia, with the hottest daily maximums occurring in January. Annual evapo-transpiration is high – approximately 1,900 mm based on records from 1989-2005 (Long Paddock) – with the annual evaporation rate greatly exceeding annual rainfall. Surface water appears in streams and lakes seasonally during the wet season only.

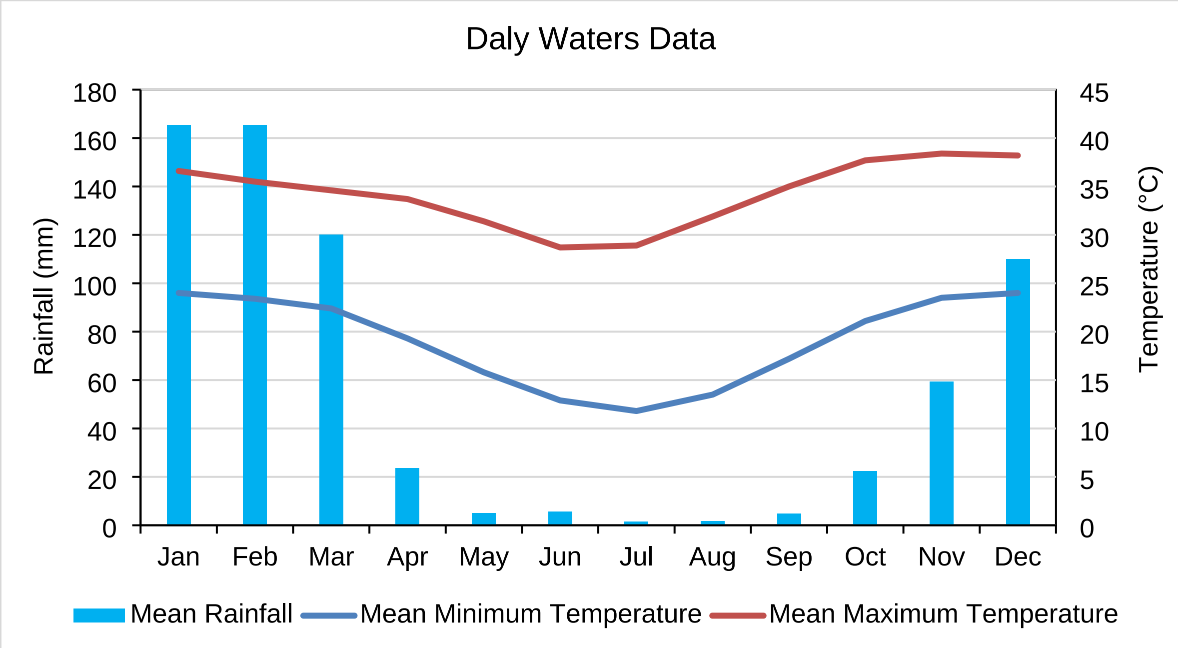

Figure 3-1. Daly Water climate data (BoM 2026)

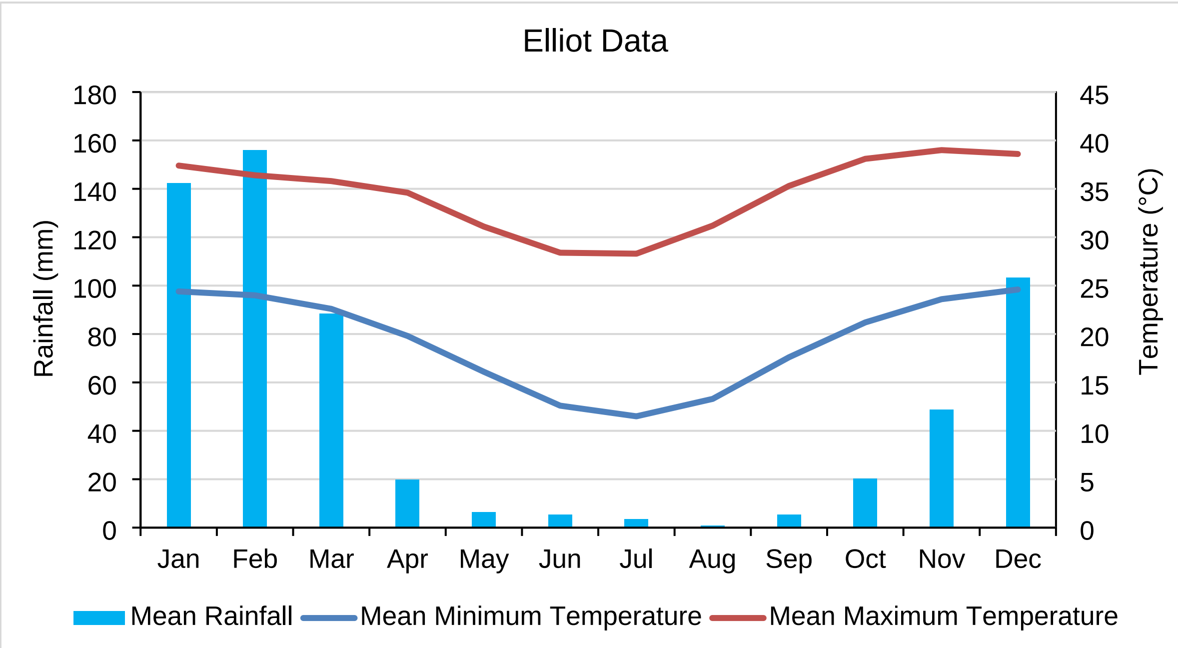

Figure 3-2. Elliott climate data (BoM, 2026)

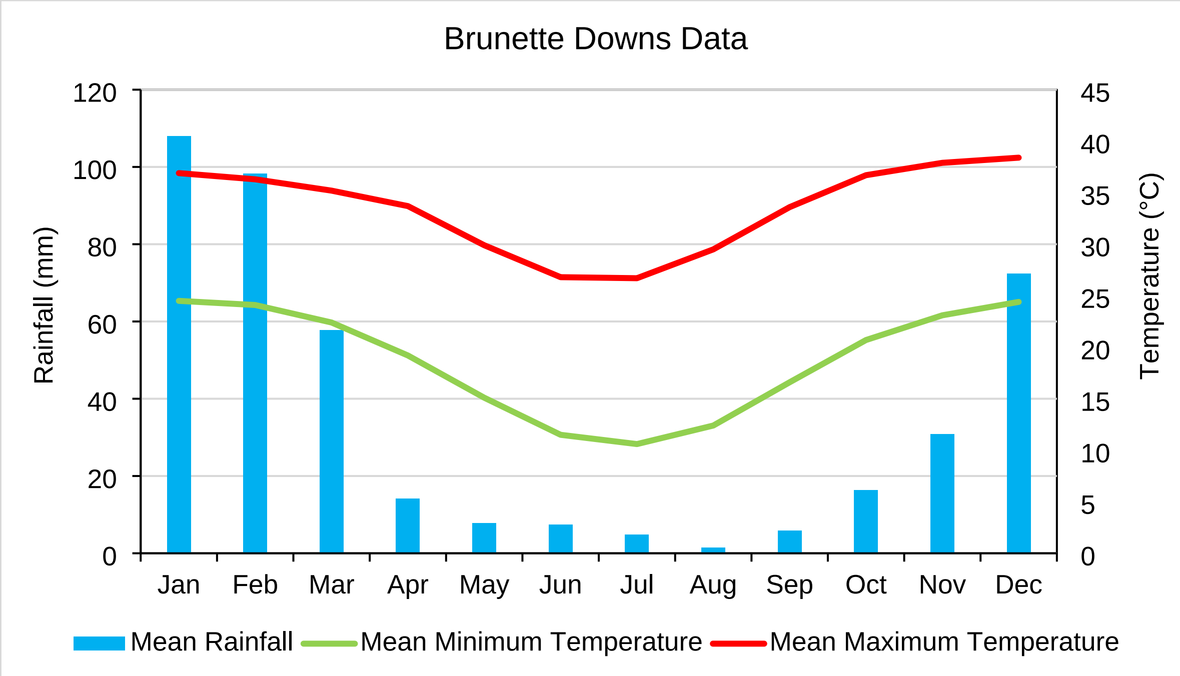

Figure 3-3. Brunette Downs climate data (BoM 2026)

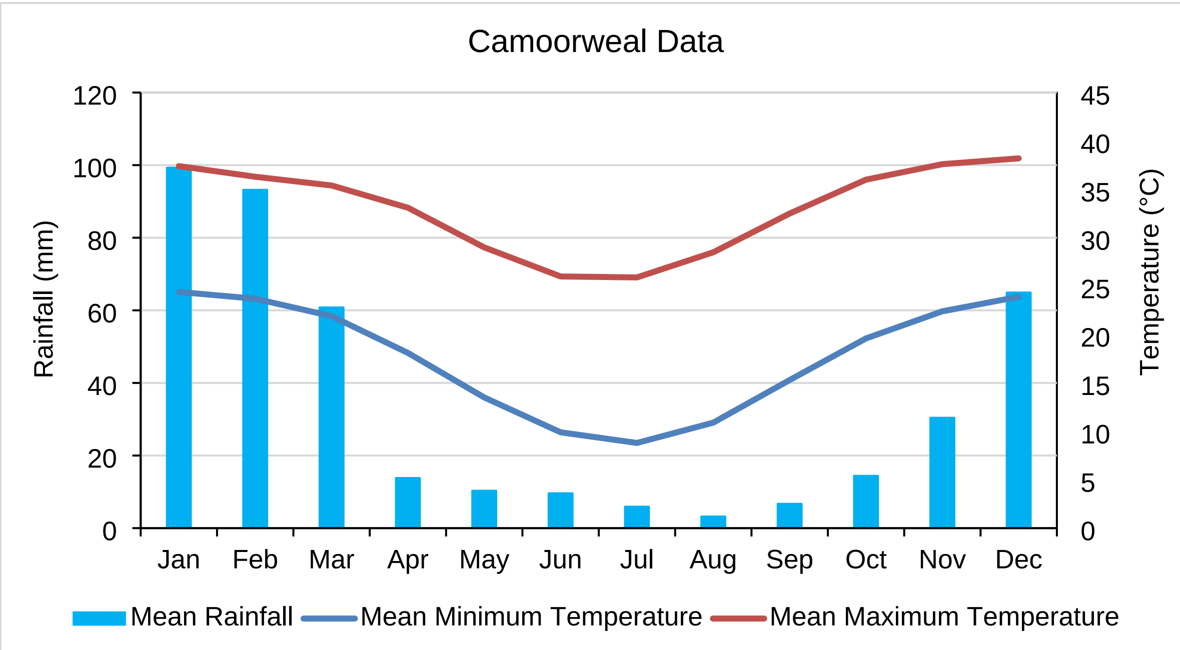

Figure 3-4. Camooweal climate data (BoM 2026)

3.4 Landform and Soils

Land and soils that occur along the CROW have been described with reference to available landform mapping (Christian and Stewart 1968). The 662 km long CROW intersects 4 landform classes as described Table 3-1

The CROW traverses various landforms from Beataloo Station to the NT/Qld border. In general, the northern half of the CROW predominantly traverses lateritic plains and rises. The southern half predominantly traverses clay plains. Table 3-1 describes the different landforms along the CROW.

Table 3-1. Landform and soils along the CROW

Class	Landform	Soil*
Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Red, brown, yellow silty and sandy earths, brown and grey clays
Clay plains	Level to gently undulating clay plains (black soil plains); cracking clay soils	Olive brown, brown and grey clays*
Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Loamy or gravelly red and yellow earths, siliceous and earthy sands, sandy brown and earths. *
Sandstone plains and rises	Skeletal soils and shallow gravelly loams and sands; yellow and red earths	Skeletal soils and shallow gravelly loams and sands; yellow and red earths*

**Soil and vegetation descriptions apply to northern NT only – these details are not available for southern NT land systems*

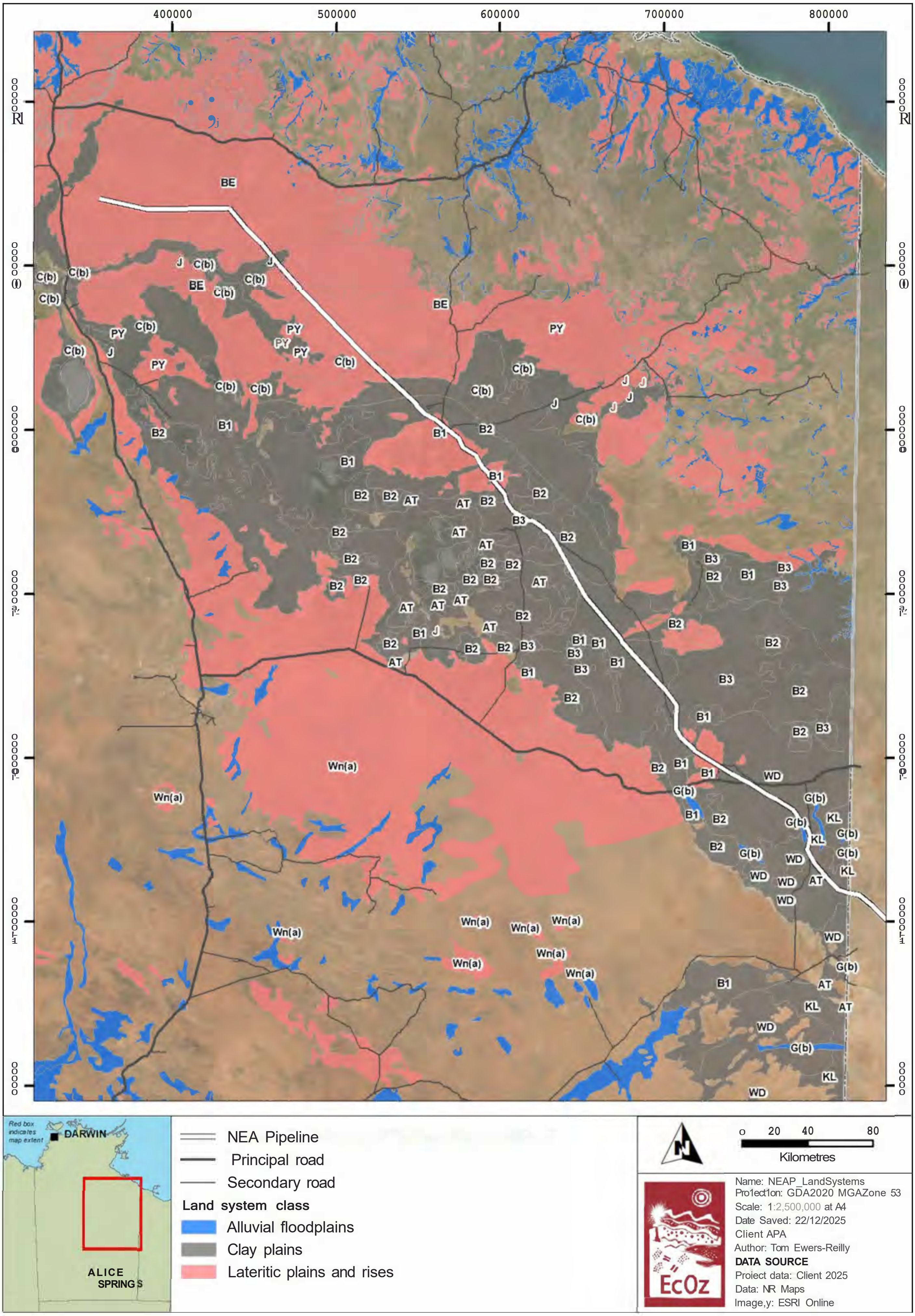

Figure 3-5. Map of land systems along the CROW

3.5 Topography and drainage

Topography

The corridor of the proposed CROW includes the Collection Header (CH) than runs west to east, and the Main Corridor (MC) that runs in a south-easterly direction. Preliminary analysis of the projected slopes along the 662 km corridor show that the average slope is approximately 0.4% for the CH and 0.1% for the MC. The maximum slope identified was approximately 2.4% for the CH and 0.9% for the MC. The elevation of the corridor generally increases as the CROW passes through areas of Lateritic Plains and Rises. Figure 3-6 shows the CROW corridor (white line) and its respective elevation and slope (graph).

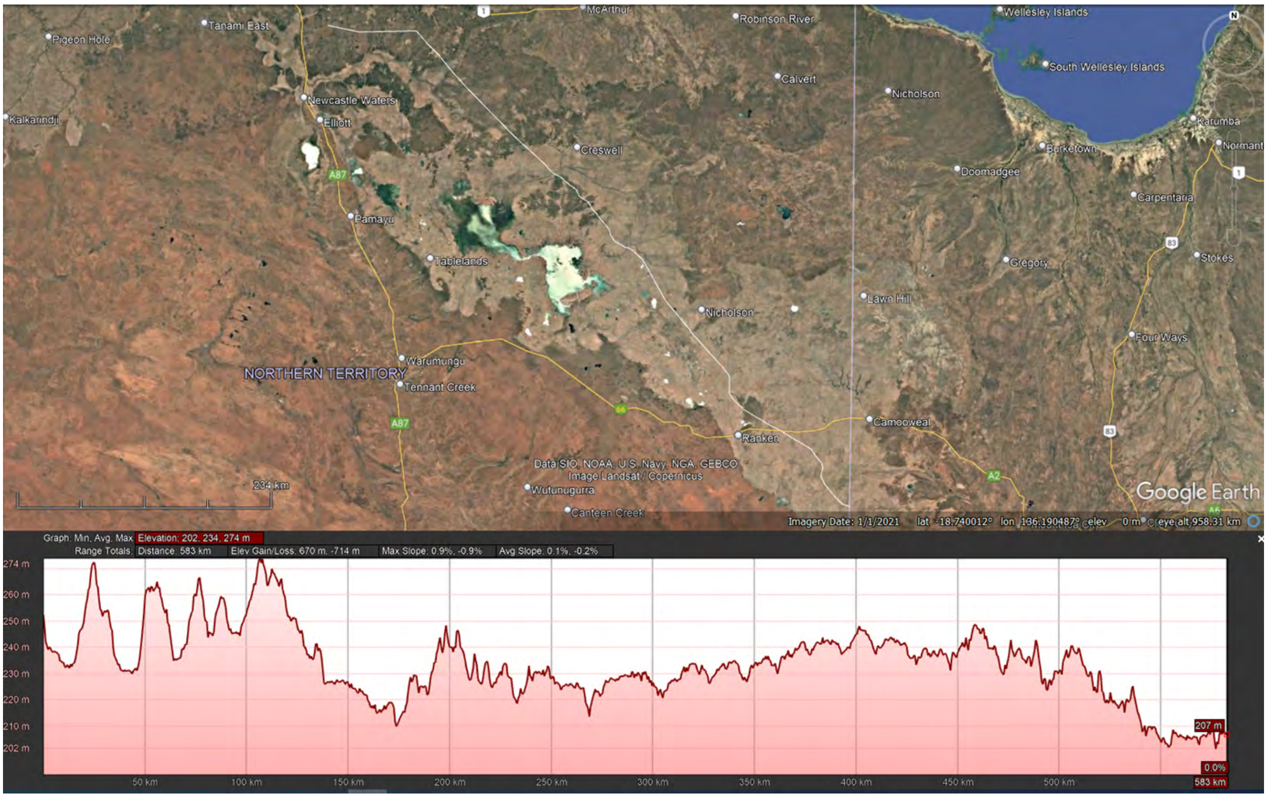

Figure 3-6. Slope of the proposed CROW (MC)

Figure 3-7. Slope of the proposed CROW (CH)

Surface water

The CROW stretches across several surface water drainage regions; most notably, the rivers that flow into Lake Sylvester and Tarrabool Lake to the south. Watercourses are exclusively ephemeral and episodic.

Watercourses

The proposed CROW crosses 15 major waterways; and access tracks cross 4 major waterways; most of which are located in the southern half of the study area (south of KP 173) (shown on Figure 3-8; described in Table 3-2). There are also numerous crossings of minor watercourses / streams / drainage depressions on the CROW and access tracks.

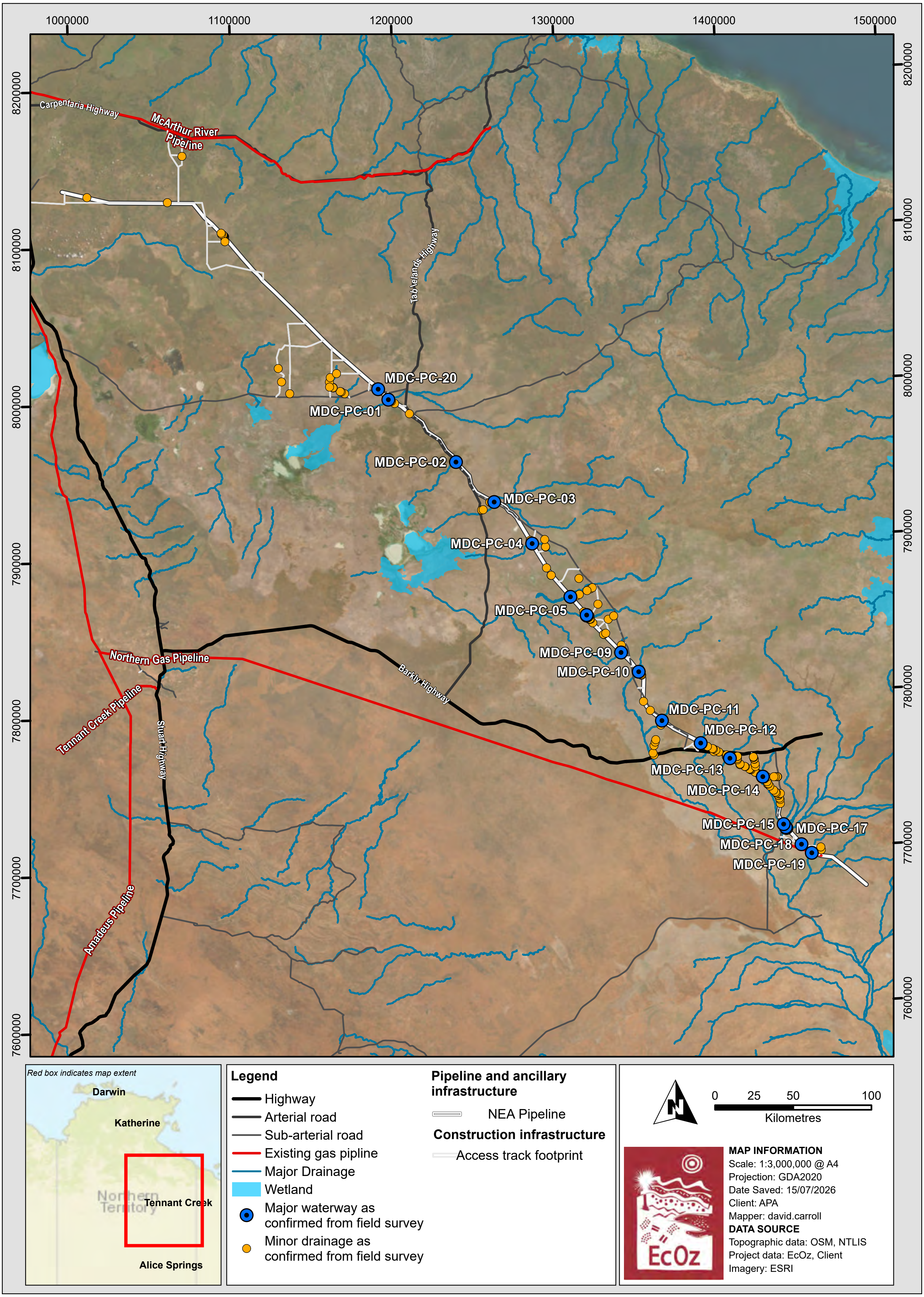

Figure 3-8. Map of waterway crossings along CROW

Table 3-2. Description of major waterways crossings[1] [2]along the CROW

Waterway ID	Name (if available)	Stream order	Location	Latitude	Longitude
MDC-PC-01	Creswell Creek	5	KP 173.5	-17.99610694	135.5097572
MDC-PC-02	Corella Creek	3	KP 232.2	-18.35429284	135.8980368
MDC-PC-03	Brunette Creek	5	KP 268.2	-18.58394146	136.1174812
MDC-PC-04	Boree Creek	2	KP 304.5	-18.82246409	136.3356538
MDC-PC-05	Playford Creek	5	KP 345.8	-19.12897478	136.5552762
MDC-PC-06	Buchanan Creek	3	KP 360.9	-19.23317351	136.6482699
MDC-PC-07	Buchanan Creek	3	KP 361.2	-19.23577774	136.6490188
MDC-PC-08	Buchanan Creek	3	KP 361.3	-19.23643548	136.6492156
MDC-PC-09	N/A (unnamed)	3	KP 392.7	-19.44811047	136.8461946
MDC-PC-10	Ranken River	3	KP 409.1	-19.55894461	136.9474353
MDC-PC-11	Lorne Creek	5	KP 445.8	-19.83950662	137.0810632
MDC-PC-12	Six Mile Creek	3	KP 472.4	-19.96839844	137.3036975
MDC-PC-13	James River	5	KP 493.4	-20.05578332	137.4714201
MDC-PC-14	Shakespeare Creek	4	KP 516.3	-20.16126074	137.6604673
MDC-PC-15	Happy Creek	5	KP 551.1	-20.43391447	137.7801239
MDC-PC-16	Georgina River	5	KP 553.5	-20.45233941	137.7920459
MDC-PC-17	Georgina River	5	KP 554.1	-20.45628196	137.7955848
MDC-PC-18	Gidyea Creek	5	KP 567.8	-20.54930652	137.8825763
MDC-PC-19	Blue Bush Creek	5	KP 576.3	-20.59902456	137.9423280
MDC-PC-20	Six Mile Creek	4	KP 163.7	-17.93579416	135.45111620
MDC-AC-01	Cobb Creek	2	Access	-17.94946048	135.2330099
MDC-AC-02	Lignum Creek	2	Access	-17.96180231	135.2583268
MDC-AC-03	Cobb Creek	1	Access	-17.84648881	135.2119326
MDC-AC-04	Boree Creek	2	Access	-18.84066083	136.4124497
MDC-AC-05	Buchanan Creek	3	Access	-19.24194973	136.6643387
MDC-AC-06	Shakespeare Creek	4	Access	-20.42286414	137.7611171
MDC-AC-07	Georgina River	5	Access	-20.50843066	137.7748854
MDC-AC-08	Blue Bush Creek	5	Access	-20.55830609	137.9562123
MDC-AC-09	N/A (unnamed)	5	Access	-20.55502821	137.8777954
MDC-AC-10	N/A (unnamed)	2	Access	-19.40577664	136.8482106

[1] *Note that the watercourse crossing locations were based on the proposed CROW at the time of the survey and are indicative. Any changes to the corridor that significantly alter the locations of watercourse crossings will require further assessment prior to construction*
[2] *Light grey shaded rows indicate waterway crossings that have been demoted from major drainage (as per desktop review) to minor drainage (based on field assessment).*

4 EROSION HAZARD AND RISK ASSESSMENT

Erosion risk refers to the evaluation of the “risk” of soil erosion when consideration is given to both the degree of erosion (consequence) and the likelihood of the erosion occurring. Best practice erosion and sediment control for pipeline construction depends on temporal variability in rainfall (e.g. wet vs dry season) and the spatial segmentation of disturbance areas, consistent with IECA Appendix P guidance, and therefore requires an assessment of erosion risk utilising information such as mean monthly rainfall data and mean monthly erosivity (i.e low, medium and high) (IECA, 2025).

Rainfall Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. This method was adopted due to its capability in being able to provide specific detail around estimated soil loss volumes and risk ratings for each of the Proposal’s components.

This Erosion RA focuses on the CROW, representing the primary disturbance footprint and key erosion risk area. The hazard and risk assessments are undertaken for all Land Classes along the CROW.

See Section 5 for Rainfall Erosion Hazard Mapping.

4.1 Assessing erosion risk, erosion hazard and soil loss

4.1.1 Erosion risk

Erosion risk ratings are calculated using average monthly rainfall data (via BoM) from the weather stations surrounding the Project. Rainfall depth is only used where monthly erosivity data is not available.

The erosion risk and hazard ratings are taken from *IECA* Table 4.4.1 and Table 4.4.2, respectively:

Table 4-1. Erosion risk rating system (IECA, 2008)

Rating	Average monthly erosivity (R-factor)	Average monthly rainfall depth (mm)
Very Low	0 to 60	0 to 30
Low	61 to 100	31 to 45
Moderate	101 to 285	46 to100
High	286 to 1500	101 to 225
Extreme	> 1501	> 226

4.1.2 Erosion hazard using RUSLE

Erosion hazard considers surface area, land slope, soil type and land use in addition to raindrop impact. Potential soil loss is determined from the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is commonly used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. The RUSLE is represented by the following equation:

A = R * K * L * S * P * C, where:

A: estimated soil loss (tonnes/ha/yr)

R: rainfall erosivity factor

K: soil erodibility factor

LS: slope length/gradient factor

P: erosion control practice factor

C: ground cover and management factor

The following paragraphs outline each of the components that contribute to the RUSLE equation.

Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is a product of two components: total energy (E) and maximum 30-minute intensity for each storm (Landcom 2004). The R-factor is an input component in measuring estimated soil loss using the RUSLE calculation. In cases where the R-factor is not made available by IECA or the Darwin Harbour Advisory Committee Research Group, the following annual R-factor equation can be used.

$$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$$

Where:

$$S = 2\ yr\ ARI, 6hr\ event\ (0.5\ EY\ design\ rainfall)$$

Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). Soil texture is the principal component affecting K, but soil structure, organic matter and profile permeability also contribute. Various K factors will have been adopted for the Proposal, based on the location of proposed infrastructure within different land types and soil conditions. K-factors can be identified from IECA 2008 *Table E5 – Typical K-factors based on Unified Soil Classification System*.

Slope (LS–factor)

The LS-factor describes the combined effect of slope length and slope gradient on soil loss.

Cover factor (C–factor)

The cover and management factor is a measure of the level of soil surface protection provided by various groundcovers. It can include a proportion of vegetation, rock, hardstand, paving, soil binders, matting and associated non-erodible material. The C-factor for the proposal will vary depending on stabilisation and management of surfaces exposed by construction and operation and is to be updated progressively within each Progressive ESCP. For the purposes of this Erosion RA, a combination of pre-construction and post-construction scenarios have been assessed.

Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas within the proposal without permanent stable groundcover is 1.3 (based on the default construction phase condition).

4.1.3 Estimated soil loss

Estimated soil loss from the site can be categorised into seven distinct categories, which outline the volume of soil lost per year in tonnes per hectare. The soil loss classes as identified by IECA Table 3.1 are as follows:

Table 4-2. Soil loss class (IECA, 2008)

Erosion hazard	Soil loss (tonnes/ha/year)	Soil Loss Class
Very Low	0 - 150	1
Low	151 - 225	2
Low to Moderate	226 - 350	3
Moderate	351 - 500	4
High	501 – 750	5
Very High	751 - 1500	6
Extremely High	>1501	7

The following section breaks down each of the abovementioned erosion risk and hazard factors, to identify an overall soil loss risk rating for the CROW, which is the component of the Proposal that creates the largest and most complex disturbance.

4.2 Erosion hazard assessment

The below section summarises the erosion hazard assessment for the CROW. A representative segment of approximately 4 km length and 45 m width was assessed to reflect a typical sub-catchment scale consistent with pipeline construction sequencing and IECA Appendix P guidance on segment-based risk assessment. This is considered representative of the maximum continuous disturbance extent within a discrete sub-catchment prior to progressive stabilisation of completed section and/or before onset of the Wet season.

4.2.1 Erosion risk – rainfall erosivity and rainfall depth

Erosion risk ratings for the CROW were derived using average monthly rainfall depth data from BoM for the Daly Waters Station (ID 014618), Elliott Station (ID 015013), Brunette Downs (ID 015085) and Camooweal (ID 037010). Table P4 of IECA (2025) Appendix P stipulates comparing multiple factors to obtain a segment-specific erosion risk rating. As this Erosion RA discusses erosion risk at a larger scale, average monthly rainfall depth can better display the variation in risk both spatially and temporally.

Erosion risk ratings for weather station surrounding the CROW are provided in the below tables, as per Table 4.4.2 (IECA 2025).

Table 4-3. Daly Waters Station (ID 014618) erosion risk ratings for the CROW

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Erosivity (mm	165.4	165.4	120.1	23.6	5	5.6	1.5	1.7	4.9	22.5	59.4	110
Rating		High					Very Low				Moderate	High

Table 4-4. Elliott (ID 015013) erosion risk ratings for the CROW

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Erosivity (mm)	142.3	156	88.4	19.9	6.5	5.4	3.5	0.9	5.3	20.3	48.8	103.4
Rating	High		Moderate				Very Low				Moderate	High

Table 4-5. Brunette Downs (ID 015085) erosion risk ratings for the CROW

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Erosivity (mm)	108	98.3	57.8	14.2	7.8	7.4	4.8	1.5	5.9	16.4	30.9	72.4
	High	Moderate					Very Low				Low	Moderate

Table 4-6. Camooweal (ID 037010) erosion risk ratings for the CROW

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Erosivity (mm)	99.3	93.2	60.8	13.8	10.3	9.6	5.9	3.2	6.7	14.4	30.4	64.9
Rating		Moderate					Very Low				Low	Moderate

4.2.2 Erosion hazard

The inputs for the RUSLE equation for the CROW are shown below in Table 4-7. The outputs of the RUSLE equation (estimated soil loss) are shown in Table 4-8. Additionally shown are, soil loss class and minimum sediment control standard as per Table 3.1 and Table 4.5.5 (IECA (2025) respectively.

Table 4-7. CROW - RUSLE equation inputs

Factor	Description	Value	Comment
	Disturbed catchment area (ha)	18 ha	4000 m by 45 m (18 ha) is representative of the maximum continuous disturbance extent within a discrete sub-catchment prior to progressive stabilisation.
R	rainfall erosivity factor	2453 (Daly Waters) 2539 (Elliot) 1923 (Brunette Downs) 1732 (Camoorweal)	Erosivity calculated from 0.5EY for each location (BoM IFD tables), which is strongly correlated to the 2-year Average Recurrence Interval (ARI), 6-hour storm event (Landcom 2004).
K	soil erodibility factor	0.043 (Alluvial Floodplains) 0.025 (Clay Plains) 0.043 (Lateritic plains and rises) 0.053 (Sandstone plains and rises)	K value based on soil characterisation from NR Maps and referencing Table E4/E5 (IECA 2008). It is recommended that further geotechnical analysis of soils occur, prior to the development of any Progressive ESCP and construction works.
LS	slope length/gradient factor	0.19 (Alluvial Floodplains, Clay Plains) 0.36 (Lateritic plains and rises, Sandstone plains and rises)	Based on a maximum slope length of 80 m before sheet flow concentrates, and a slope of 1%. The average for the CROW is less. A length of 60 m and slope of 2% has been used for Lateritic plains and rises, and Sandstone plains and rises (worst case). Table E3 (IECA 2008).
P	erosion control practice factor	1.3	Construction phase condition - compacted & smooth. Table E11 (IECA 2008).
C	ground cover and management factor	1	No appreciable cover for disturbed areas (worst case). Table E9 (IECA 2008).
A	estimated soil loss (tonnes/ha/yr)	See Table 4-8	sediment controls required as per IECA table 4.5.1

Table 4-8. CROW - soil loss and hazard rating

Region / Landform class	Estimated soil loss (tonnes/ha/year)	Minimum sediment control standard	Soil loss class and erosion risk rating
Daly Waters			
Alluvial floodplains	26	Type 3	1 – Very Low
Clay plains	15	Type 3	1 – Very Low
Lateritic plains and rises	49	Type 3	1 – Very Low
Sandstone plains and rises	61	Type 3	1 – Very Low
Elliot			
Alluvial floodplains	27	Type 3	1 – Very Low
Clay plains	16	Type 3	1 – Very Low
Lateritic plains and rises	51	Type 3	1 – Very Low
Sandstone plains and rises	63	Type 3	1 – Very Low
Brunette Downs			
Alluvial floodplains	20	Type 3	1 – Very Low

Region / Landform class	Estimated soil loss (tonnes/ha/year)	Minimum sediment control standard	Soil loss class and erosion risk rating
Clay plains	12	Type 3	1 – Very Low
Lateritic plains and rises	39	Type 3	1 – Very Low
Sandstone plains and rises	48	Type 3	1 – Very Low
Camoorweal			
Alluvial floodplains	18	Type 3	1 – Very Low
Clay plains	11	Type 3	1 – Very Low
Lateritic plains and rises	35	Type 3	1 – Very Low
Sandstone plains and rises	43	Type 3	1 – Very Low

4.2.3 Rainfall Erosion hazard and risk summary

As the CROW traverses through a large portion of the Northern Territory, with varying climate conditions, the erosion risk rating for each area varies, as risk is dependent on rainfall characteristics. In general, erosion risk increases in severity and duration to the north of the project. e.g. Daly Waters for the months of December to March where the wet season has a stronger influence.

Overall, the erosion risk based on monthly rainfall depth is mostly categorised as very low, with a moderate to high risk in the northern portion of the CROW during the Wet season months. Erosion hazard based on RUSLE soil loss estimation is very low for all land classes in all areas.

It should be noted that much of the CROW traverses through Alluvial Plains and Clay Plains. These land classes and the associated drainage lines will likely be saturated at times over the Wet season, making the movement of heavy vehicles difficult. The clay and silt particles of these land classes are especially susceptible to mobilisation when disturbed.

5 EROSION HAZARD MAPPING

To provide regional spatial context and to corroborate the project-specific RUSLE analysis presented in Section 4, national scale RUSLE input data were mapped along the CROW corridor in ArcGIS Pro using the RUSLE.

Soil and landscape input grids were sourced from the Soil and Landscape Grid of Australia (SLGA), produced by CSIRO under the GlobalSoilMap specifications and managed within the Australian Soil Resource Information System (ASRIS) (Grundy et al., 2015; CSIRO data collection csiro:19354), providing nationally consistent soil attribute data estimates at 3 arc-second (~90 m) resolution.

These grids were clipped to the project extent, and values were extracted and extrapolated along the CROW so that each segment of the corridor carried a spatially correlated estimate of its erosivity, erodibility and slope contribution to soil loss and erosion risk.

The RUSLE factors were calculated and mapped for Erosivity (Figure 5-1), Erodibility (Figure 5-2), and Slope Length/Steepness (Figure 5-3). The Cover Factor and Erosion Control Practice Factor were held constant at 1 and 1.3 respectively, consistent with the assumptions used in the Section 4 calculation and representing a conservative bare soil construction phase condition.

The local factor grids were then combined via raster algebra to produce a spatial Estimated Annual Soil Loss surface for the CROW and surrounding region (Figure 5-4). The mapped soil loss values are consistent with the RUSLE results derived in Section 4, with a maximum of 41 t/ha/yr along the current CROW. This presents a Very Low erosion risk (Table 4.4.3 of IECA, 2025), and triggers only Type 3 sediment controls (Table 4.5.1 of IECA, 2025). See Map of Estimated Annual Soil Loss below in Figure 5-4.

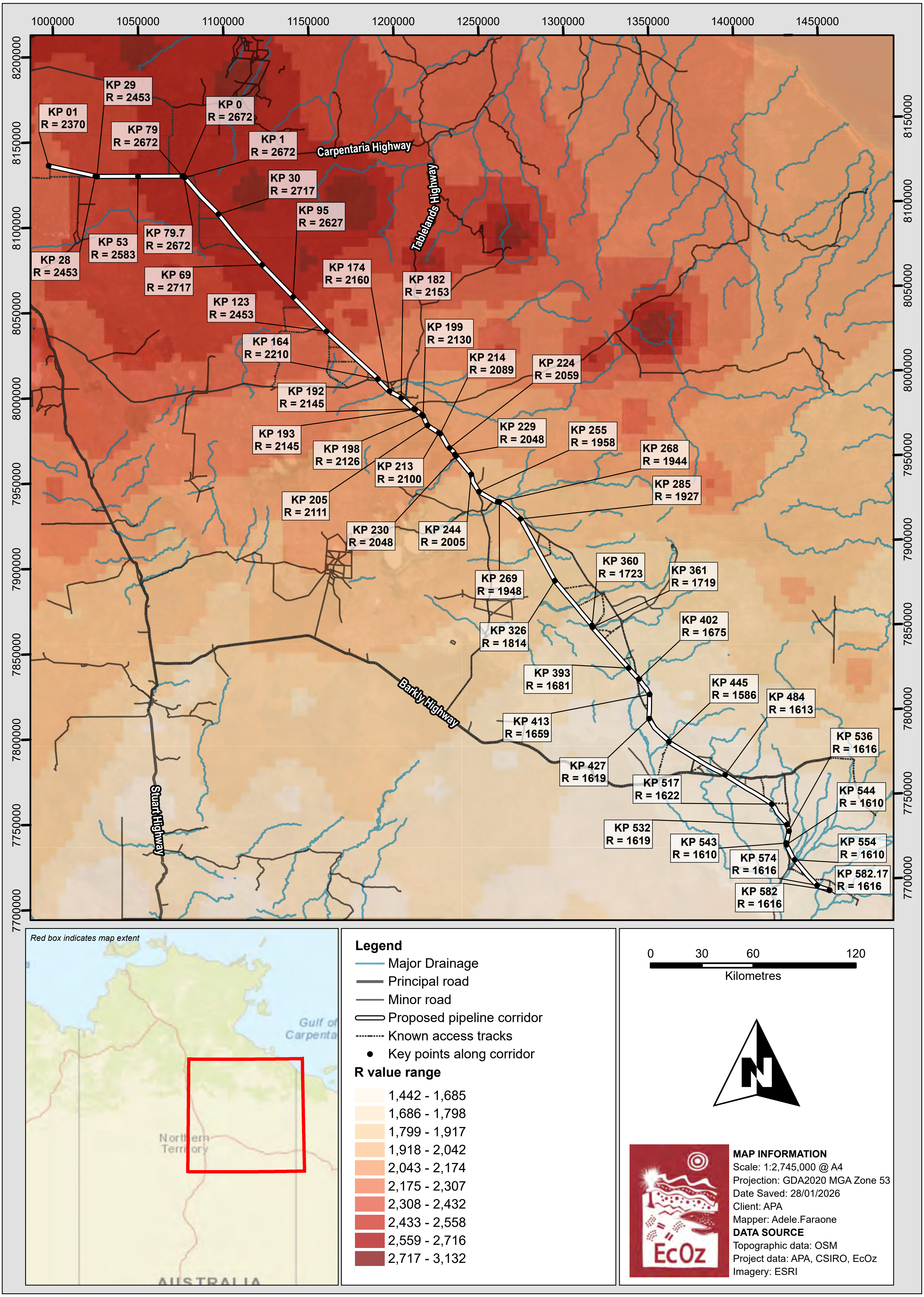

Figure 5 1. Map of Erosivity factor (R), which is a measure of the ability of rainfall to cause erosion

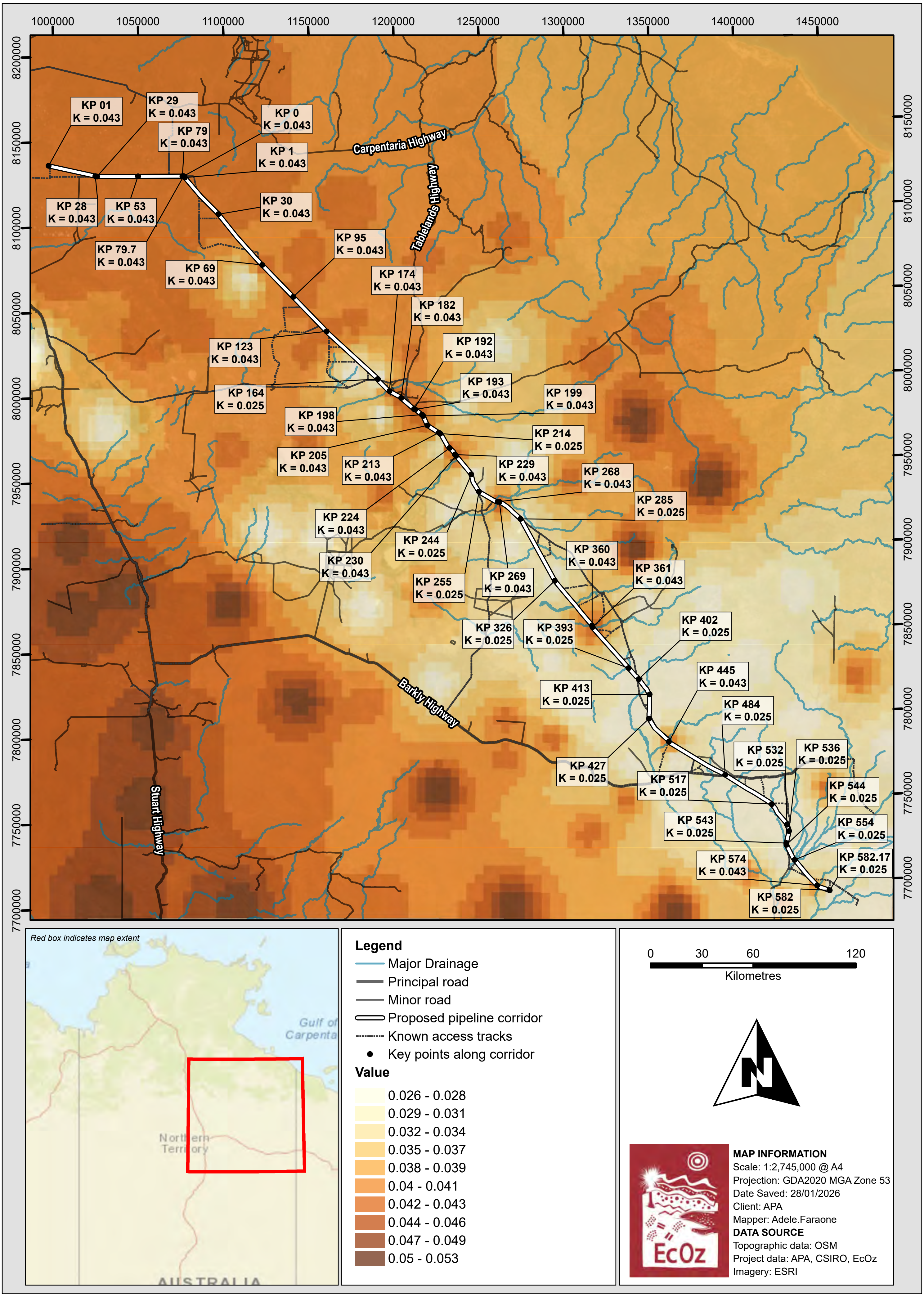

Figure 5 2. Map of Erodibility factor (K), which is a numerical representation of the ability of soils to resist the erosive energy of rain

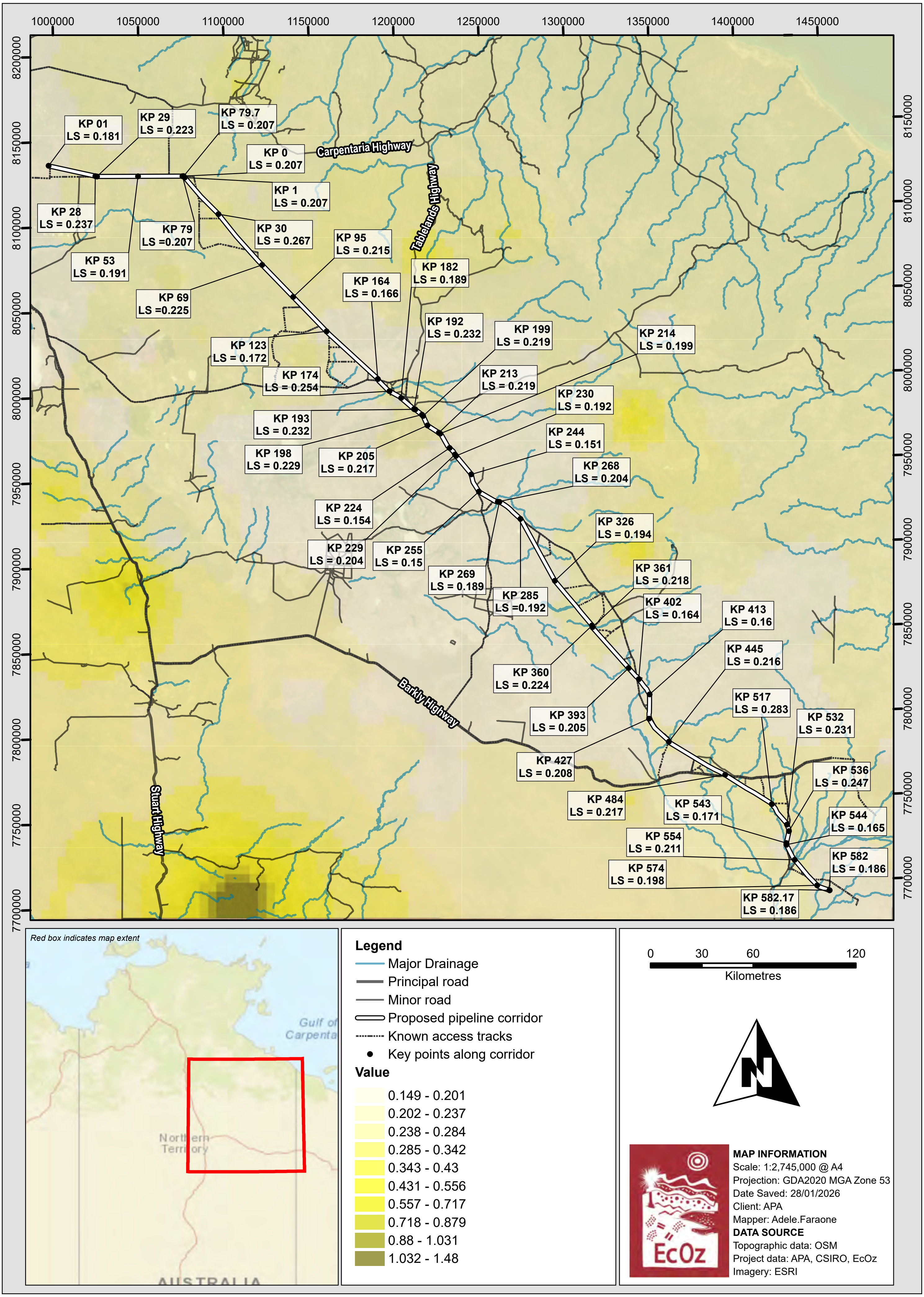

Figure 5 3. Map of Length/Slope Factor (LS), which describes the combined effect of slope length and slope gradient on soil loss.

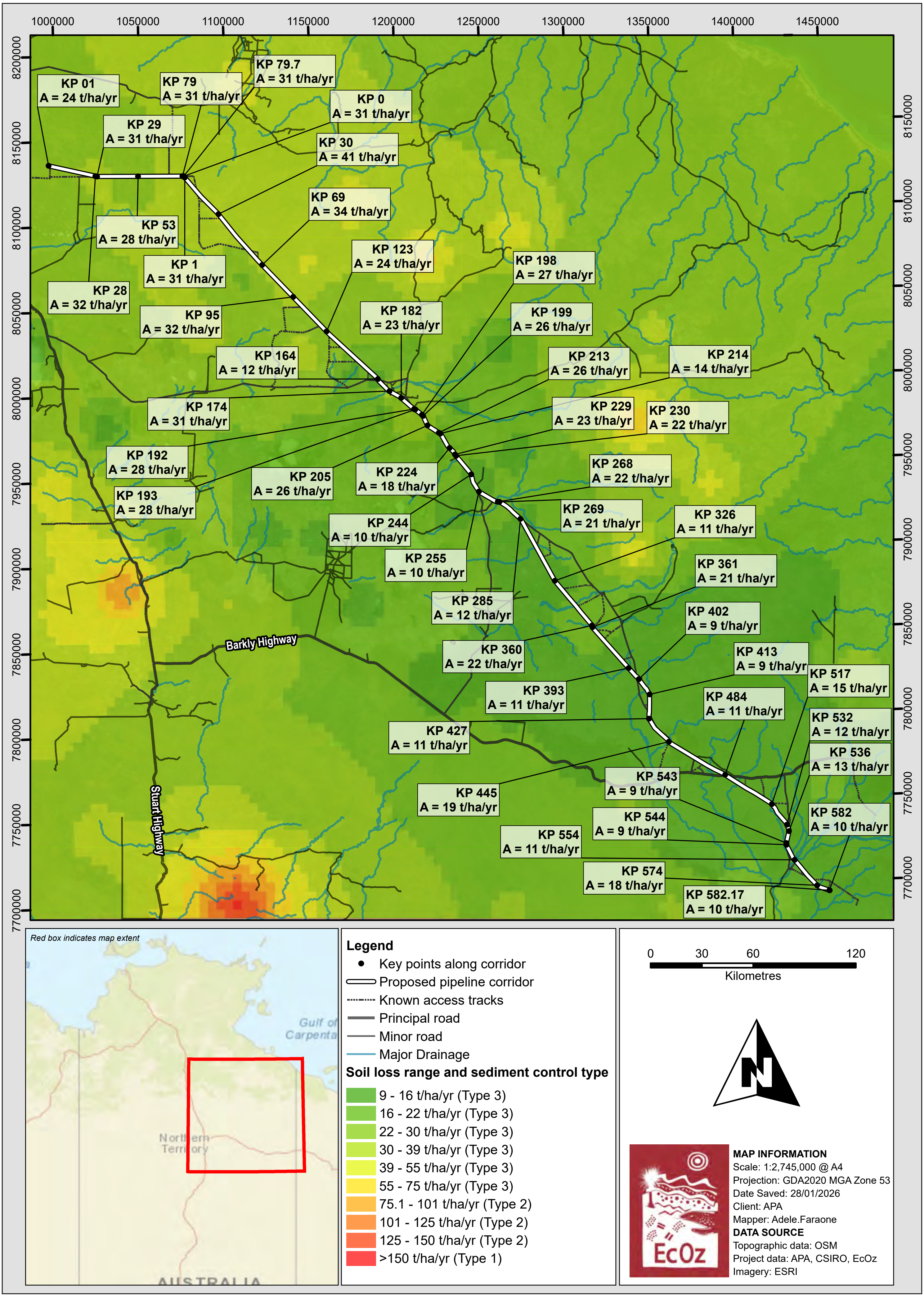

Figure 5 4. Map of Estimated Annual Soil Loss (A) in t/ha/yr due to rainfall

6 WIND EROSION

Wind erosion presents a potential risk during periods of dry weather where soils are exposed or disturbed. Consistent with IECA 2025 guidance, the risk of wind erosion is primarily influenced by soil texture, surface condition and prevailing wind characteristics. Soils with a higher sand content and low organic matter are more susceptible to particle detachment and entrainment under moderate to strong winds, particularly where surfaces are bare, dry or finely worked.

Wind data from Mt Isa was used as an indicator for wind erosion, as the other NT weather stations do not collect wind data. The predominant winds in Mt Isa for the wet and dry season are displayed below in Figure 6-1 and Figure 6-2 respectively. Wet season has milder north-easterly to south-easterly winds. The Dry season has mostly easterly to southerly winds, with south-easterly winds displaying a higher proportion in the 20 to 30 km/hr range. Wind-driven movement of soil particles generally occurs only once threshold wind velocities are exceeded, typically corresponding to near-surface wind speeds of approximately 25–30 km/h for dry, unconsolidated soils, depending on particle size, surface condition and soil moisture (Stout & Zobeck, 1996). Therefore, wind erosion risk is expected to be higher in the dry season.

As per Table 1.4 (IECA 2025), the primary control measure for wind erosion is erosion control, rather than sediment control. Standard practices of covering soils with gravel, soil binder, erosion control blankets etc are not feasible on a project so large. Instead, the focus should be on surface roughening and protection techniques.

From IECA 2025, the US Soil Conservation Service presented the following:

- Covering the soil surface with a 30% cover of non-erodible material will reduce soil loss by approximately 80%.
- Roughening the soil by forming 150 mm high ridges perpendicular to the prevailing winds will reduce soil loss by approximately 80%
- A protected zone of approximately 2.4 to 3.0 metres width is achieved for each 300 mm in vertical height of a wind barrier.

Recommended wind erosion control measures include:

- Surface roughening (scarifying)
- Adopting speed limitations for site vehicles
- Stabilisation of stockpiles (Erosion Control Blankets, vegetation cover or polymer/soil binder)
- Reducing height of stockpiles
- Watering unsealed roads and open soil areas (and/or use of soil binders)
- Minimising total soil exposure at any given time as far as practicable

Wherever water is used to suppress dust, it is important to ensure that its application does not cause drainage or erosion problems.

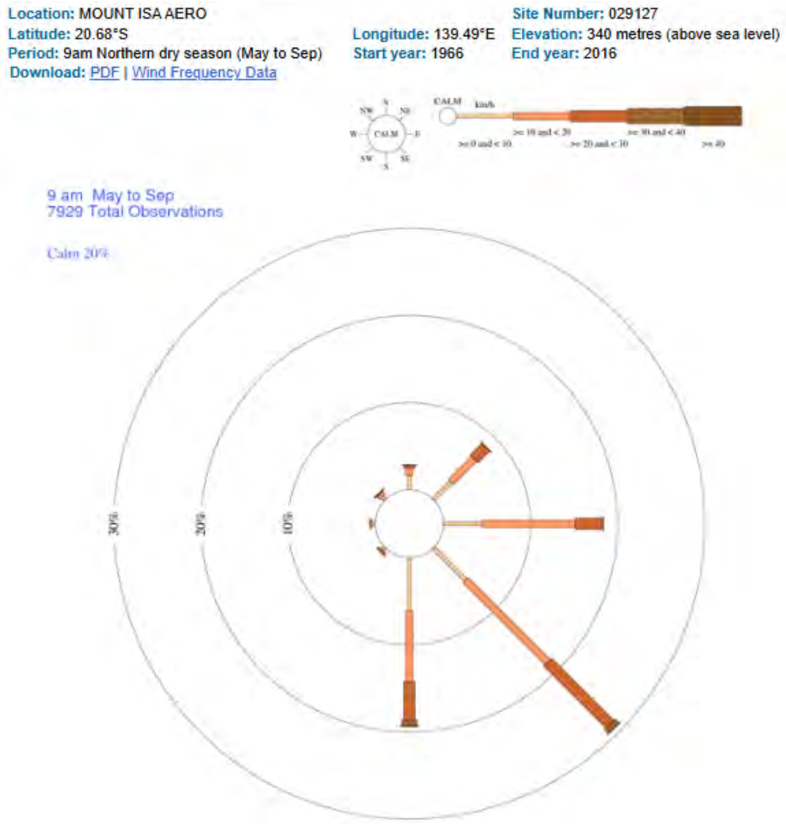

Figure 6-1 Dry season wind rose from Mount Isa (9am)

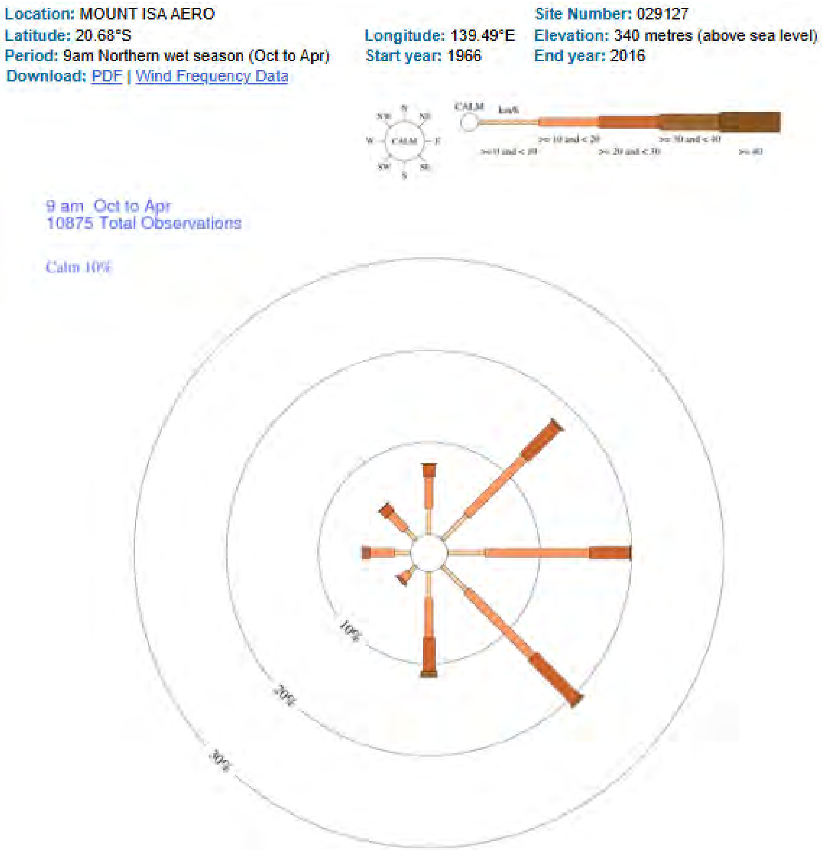

Figure 6-2 Wet season wind rose from Mount Isa (9am)

6 SUMMARY AND RECOMMENDATIONS

This Erosion RA concludes that although overall soil loss risk ratings across the Proposal are low, the scale and linear extent of disturbance within the CROW represents a material erosion risk if not effectively managed. Without appropriate controls, widespread disturbance has the potential to result in cumulative off-site impacts despite low inherent soil loss ratings.

Accordingly, erosion and sediment control must be proactively addressed by APA across all phases of the Proposal, including planning, design, construction, and rehabilitation, to ensure risks to the receiving environment are reduced to as low as reasonably practicable.

Erosion risk varies significantly between wet and dry season conditions. During the wet season (December–March), elevated rainfall intensity and soil saturation increase the likelihood of erosion and sediment mobilisation, particularly within clay-rich and alluvial land systems. During the dry season, erosion risk is lower; however, exposure duration and wind erosion become more relevant considerations. Management measures and ESCP requirements should therefore be seasonally responsive.

The following recommendations are provided to assist in managing the erosion risk throughout the Proposal:

- A clear, well-defined construction schedule and staging strategy should be developed, with particular consideration given to works proposed during higher-risk rainfall months (December to March).
- Primary and Progressive ESCPs shall be developed in accordance with IECA (2025) Appendix P and aligned with construction sequencing and seasonal risk variability.
- APA should consider, when developing the construction methodology for the CROW, that Progressive (site-specific) ESCPs will be required as per IECA (2025) Appendix P. Controls should be scaled to the assessed level of erosion risk, with targeted measures implemented where risk is elevated.
- All ESCPs are to be developed by a suitably qualified ESC specialist and/or reviewed by a CPESC.
- Construction methodologies should prioritise continuous progression along the alignment, with progressive reinstatement and stabilisation of completed sections to minimise disturbance duration
- Disturbance exposure shall be minimised as far as practicable, with erosion and sediment controls implemented in accordance with risk level and construction timing.
- Stabilisation and rehabilitation targets should be incorporated as key performance indicators and/or contractual hold points within construction contracts to drive timely implementation.
- Separation of clean and dirty water to be achieved via diversion of up-slope, run-on water around or through construction areas in a non-erosive manner.
- Site-specific Progressive ESCPs should be developed based on each stage of development and using soil data collected from the corridor. ESCPs shall include an adaptive management approach.
- Enhanced erosion and sediment control measures shall be implemented during higher-risk wet season periods (December–March), particularly within alluvial and clay-dominated land systems and at watercourse crossings. APA is also committed to stabilising the CROW prior to commencement of the Wet season.

Soil loss calculations may underestimate localised erosion risk at watercourse crossings, where concentrated flow conditions and soil disturbance increase vulnerability. The following additional measures should be considered for water crossings:

- Adoption of enhanced erosion controls during higher-risk periods (December–March), particularly within land systems exhibiting higher soil erodibility factors.
- Minimisation of disturbance where the CROW intersects watercourses, buffers, and riparian zones.
- Where works encroach into buffers or riparian areas, site-specific ESCPs must be developed to mitigate potential impacts.
- Rapid re-establishment of vegetative cover across disturbed sections of the CROW is essential to limit ongoing erosion, sediment transport, and secondary environmental impacts

Despite elevated wind erosion potential, the absence of sensitive receptors and the naturally erosive baseline conditions reduce the overall wind erosion hazard to low.

Examples of appropriate drainage, erosion and sediment controls are provided in Appendix A.

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APPENDIX A EROSION AND SEDIMENT CONTROL PRINCIPLES

Erosion and sediment control measures required during construction and operation are derived based on site-specific erosion hazard and risk, and in accordance with IECA (2025) Appendix P – Land-based Pipeline Construction. Conceptual descriptions of erosion and sediment control principles are provided in the sections below, based on the current level of design detail of the Proposal. As per the APGA Environmental Code of Practice, detailed drainage, erosion and sediment controls will be developed in accordance with IECA Appendix P, including segmentation of the CROW into discrete catchments and work fronts, with detailed design, placement and sizing of ESC within future Progressive (site specific) ESCPs.

Primary and Progressive ESCPs

The purpose of an ESCP is to define erosion and sediment control measures for discrete construction segments and sub-catchments along the CROW. ESCPs are dynamic ('live') documents which should be revised based on the evolution of the site.

The Primary ESCP shall be developed in accordance with IECA Appendix P and provide a framework for managing erosion and sediment risks across the full pipeline alignment, including segmentation of the CROW into manageable lengths based on topography, drainage, and construction sequencing.

A Primary ESCP should first be developed by APA for each proposal component and at a minimum include:

- Identify any further soil issues (sodic, dispersive, existing erosion etc) and update any further receiving environment information
- Provide an outline of the initial construction staging and construction methods
- Update of the erosion hazard and risk assessment (RUSLE), detailing specific catchments and/or areas of disturbance
- Identify the minimum sediment control measures required (Type, 1, 2 or 3)
- Provide concept plans showing catchments, overland flow direction, drainage, area of works, placement of controls and clean water vs dirty water diversion
- Preliminary sizing of controls i.e. culverts, sediment ponds (if required)
- Highlight areas where additional focus may be required to mitigate erosion issues

Progressive ESCPs shall be developed for each construction segment and sub-catchment, consistent with IECA Appendix P guidance for pipeline construction activities. Progressive ESCP's should include the following:

- Segment-specific details (e.g. defined CROW lengths, water crossings, camps, and laydown areas) including size, construction schedule, brief methodology of what's being constructed
- Segmentation of the CROW into discrete construction lengths and sub-catchments, with controls tailored to each segment based on erosion risk and construction timing (IECA Appendix P).
- Written and drawn explanation of specific erosion, sediment and drainage control measures as per the IECA guidelines. Measures should be written in a way that contractors implementing the controls can understand what needs to occur
- Staged drawings (if required)
- Design information for controls and major structures (i.e. drainage lines, sediment basins etc)
- Clear details of roles and responsibilities of all involved implementing the ESCP (including plan development, changes, inspections, maintenance and auditing)

- Provide clear details for rehabilitation of disturbed areas

Site preparation

Site preparation is a key component of an ESCP, and this involves both protection and clearing of vegetative material.

Vegetation clearing

Vegetation clearing (where required) is to be undertaken in accordance with applicable approvals and will require a Progressive ESCP to cover these works. Clearing methodology to be included in the ESCP should cover the following:

- Clearing activities to be implemented consistent with the *NTG Land Clearing Guidelines* (DENR 2019)
- Vegetation clearing shall be limited to the minimum extent required within the CROW to facilitate safe construction and access, consistent with pipeline construction practice
- Areas of protected vegetation and significant areas of vegetation which are to be retained, must be clearly identified prior to the commencement of clearing
- Approved areas for native vegetation clearing to be clearly identified.
- Previously cleared areas shall be utilised where possible for laydown and turn around points.
- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.
- Cleared vegetation is to be retained and reused in site rehabilitation wherever possible.

Buffers

Riparian buffer strips shall be implemented in accordance with NTG Land Clearing Guidelines and incorporated into segment-specific ESCPs for construction activities within or adjacent to watercourses and around impacted drainage features (relates largely to works within the CROW where watercourses are prominent) to protect riparian habitats and vegetation. Buffer distances are as per the *NT Land Clearing Guidelines* (NTG 2019).

Table of Riparian buffer widths (NTG 2019)

<table>
<tr><th>Riparian class</th><th>Stream order</th><th>Watercourse Class</th><th>Min buffer width (m)</th><th>Measured from</th></tr>
<tr><td>Drainage depression</td><td>NA</td><td rowspan="3">Minor</td><td>25</td><td>The outer edge of the drainage depression, which is the extent of the associated poorly drained soils and associated vegetation.</td></tr>
<tr><td>Intermittent streams</td><td>1st</td><td>25</td><td>The outer edge of the riparian vegetation or levee (whichever is greater). If braided channels are present, the edge of the outer-most stream channel.</td></tr>
<tr><td>Intermittent streams</td><td>2nd</td><td>50</td><td>As above</td></tr>
<tr><td>Creeks</td><td>3rd & 4th</td><td rowspan="2">Major</td><td>100</td><td>As above</td></tr>
<tr><td>Rivers</td><td>5th or higher</td><td>250</td><td>As above</td></tr>
</table>

The adoption of the buffer distances, as listed in the above table will have the following benefits:

- Reduce velocity of runoff entering drainage depressions and watercourses via sheet flow
- Promoting capture of sediment

- Reduce erosion within riparian areas (wind and water)
- Provide network of linked habitats and wildlife corridors
- Provision of shade and amenity

Drainage control

Drainage strategies shall account for the linear nature of the disturbance, including flow interception, cross-drainage, and progressive reinstatement to prevent concentration of flows along the CROW.

Drainage controls shall be designed to manage both clean and dirty water within each CROW segment, consistent with IECA Appendix P principles for pipeline construction. They will include ensure the diversion of 'clean' stormwater runoff around and through the proposal area; and the diversion of 'dirty' site stormwater runoff to enable treatment of sediment prior to release offsite, as defined below:

Clean water:

Water that both enters site from an external source and has not been further contaminated by sediment within site; or water that has originated from the site and is of such quality that it does not need to be treated in order to achieve the required water quality standard (IECA 2025). Site clean water constitutes surface runoff from areas of non-erodible cover, including vegetation, hardstand, soil binder, mats or blankets (e.g. geotextile fabric).

Dirty water:

Water not defined as clean, thereby requiring treatment with appropriate controls prior to release from site (IECA 2025).

Temporary drainage controls installed as part of construction will enable management of stormwater within work areas. Drainage controls will perform the following functions:

- Enable diversion of 'clean' up-slope run-on water either around or through the site at non-scouring velocities.
- Enable collection of 'dirty' runoff generated within construction areas and the delivery of this water to an appropriate sediment control measure.
- Minimise the risk of soil erosion caused by site-generated flows within the proposal area, through the use of 'intermediate' flow treatment and release points.
- Control of the flow velocity, volume and location of water passing through the proposal area at drainage line and waterway crossings.

Potential controls may include:

- Diversion channel – for diversion of large, concentrated flows.
- Flow diversion bank – flow diversion along CROW; cross drainage on unsealed roads.
- Check dams (e.g. rock) – velocity control device within concentrated flow channels. Also used as sediment control.

Erosion control

Prevention of erosion is the primary approach for the prevention of adverse impacts associated with sedimentation. Construction activities shall minimise the duration of soil exposure to erosive forces (wind and water), through progressive reinstatement and stabilisation of completed sections of the CROW. Measures to be used include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces.

Erosion control implementation shall be risk-based and responsive to seasonal conditions, with enhanced measures applied during wet season periods and in high-risk land systems (e.g. alluvial floodplains and clay soils) in accordance with IECA Appendix P.

Potential controls may include:

- Undertaking construction activities in dry months when erosion risk is lower.
- Promptly stabilising exposed areas once construction phase has been completed (permanent landscaping).
- Protection of soil surface (temporary and permanent) including placement of hardstand surfaces, use of soil binder, vegetation establishment (including mulch), and protection with mats and blankets (e.g. jute, geotextile fabric) where practical.
- Consideration of the use of ameliorants to stabilise catchment surfaces and reduce erosion (e.g. spreading Gypsum (calcium sulfate) across disturbed areas).
- Application of dust suppression by wetting of exposed surfaces (i.e. use of water trucks), application of soil binder, and/or application of soil cover.

Sediment control

Effective erosion and sediment control for pipeline construction is achieved through a combination of construction scheduling, and appropriately scaled control measures consistent with IECA Appendix P. This will be achieved by undertaking main earthworks activities during dry months, rather than focussing on implementation of extensive sediment control measures.

Typical sediment control practices within pipeline construction, as per IECA (2025) Appendix P Table P8 include:

- Treatment of 'dirty' water runoff generated within the CROW
- Sediment control at vehicle exit points from the pipeline CROW.
- Integration of sediment control attributes into the drainage/erosion control practices installed at drainage line and waterway crossings.

These practices will be achieved by the use of Type 2 and 3 control standards described below, and by adopting sediment control options S1 to S7 of Appendix P.

Sediment control standards are based on catchment area and soil loss calculations, and include Types 1, 2 and 3 as described below.

Type 1 Sediment control standard

A Type 1 sediment control is typically the minimum requirement for the following scenarios:

- Disturbance area > 2,500 m^2 and soil loss > 150 t/ha/yr
- Disturbance area > 10,000 m^2 and soil loss > 75 t/ha/yr

A Type 1 sediment control standard is provided by purpose-built sediment basins, designed to collect and settle sediment-laden water.

Application to the Proposal

It is unlikely that Type 1 sediment controls will be required, as the estimated annual soil loss is well below the 75 t/ha/yr trigger value and is unfeasible.

Type 2 Sediment control standard

A Type 2 sediment control is the minimum requirement for the following scenarios:

- Disturbance area < 2,500 m^2 and soil loss > 75 t/ha/yr
- Disturbance area < 10,000 m^2 and soil loss of < 150 t/ha/yr.

A Type 2 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.14 mm.
- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 2 controls include:

- Rock Filter Dam (RFD) - RFDs are structures formed by the incorporation of geotextile (e.g. A34 bidum®) and a coarse rock filter (40-75 mm nominal diameter).
- Filter Bag/Tube - Filter tubes are geotextile bags through which site runoff is directed to enable filtering and treatment of sediment.
- Coir logs - Coir logs are biodegradable tubes filled with densely packed coconut fibre wrapped in coir netting. They can be used as flow diversion berms or to provide sediment control by providing temporary ponding and filtering of site runoff.
- Mulch berms - Berms of coarse mulch located along the contour. Often incorporate a rock filter dam discharge point.

Application to the Proposal

Type 2 controls will be applied, if required, across most the Proposal components, pending the construction staging and timing approach. Key areas within each component where Type 2 controls may be applied include:

- Mulch berms located along the boundaries of cleared areas, particularly where vegetative material is available (i.e CROW and cleared areas for camp, laydown areas)
- Coir logs or sand bags weirs where drainage lines intercept the CROW
- Filter bags/tubes or stabilised bund at dewatering outlet
- Sand bags placed around open trenches
- RFD's at discharge/outlet points

Type 3 Sediment control standard

- A Type 3 sediment control is the minimum requirement where the area of disturbance is > 250 m^2, and calculated soil loss is < 75 t/ha/yr.

A Type 3 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.42 mm.
- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 3 controls include:

- Rock berms - clean rock may be placed as a perimeter berm to filter sheet flow runoff from site (typical size 75-150 mm).
- Rock check Dams (RCD's) - RCDs are structures built across a drain or channel to slow water flow, reduce erosion, and trap sediment, (75-150 mm nominal diameter).
- Sediment fence - sediment fence may be used in locations where placement of rock berms is not practical (due to access, materials and equipment constraints).

Application to the Proposal

Type 3 controls will be applied, if required, across most the Proposal components, pending the construction staging and timing approach. They can be applied in conjunction with Type 2 controls.

Both rock berms and sediment fences can be applied as boundary controls to filter sheet flow across a disturbed site. RCD's can be applied to drainage lines or channels where flow is concentrated.

Supplementary sediment control

Supplementary sediment controls are not considered effective to meet the Type 3 classification in isolation but form an important component of the erosion and sediment control system when implemented as supplementary controls. Supplementary controls that may be implemented during the construction program include:

- Soil binder
- Construction exits

In addition to adopting measures as per IECA Standard Drawings, variations to these may be implemented where it can be demonstrated that they are equally as effective and meet the intent of IECA standards.

Site stabilisation

Following completion of each construction segment, long-term protection of the site from erosion will be provided by reinstatement of vegetation of disturbed areas, as per the applicable Rehabilitation Plans when developed.

In the context of erosion and sediment control, the following practices will assist in achieving site stabilisation and long-term protection for downstream environments:

- Site preparation and reinstatement works are commenced as soon as practicable after completion of each stage of earthworks.
- Disturbed surfaces shall be stabilised through surface roughening (e.g. light ripping or scarifying with grader/dozer) where practicable to reduce runoff velocity and promote water infiltration and seed germination.
- Topsoil is managed to ensure preservation of its long-term value (i.e. limits to stockpiling duration, and stockpiling height limits).
- Stabilisation measures shall reflect construction methodology and may include surface roughening, topsoil management, and natural regeneration rather than reliance on mulch placement where not practicable

EcOz Environmental Consultants

EcOz Pty Ltd.
ABN 81 143 989 039

Level 1, 70 Cavenagh St,
GPO Box 381,
Darwin NT 0801

T: +61 8 8981 1100
E: ecoz@ecoz.com.au

www.ecoz.com.au