MORPHUM
environmental

Memorandum

Date:	20/11/2025
To:	Vineway Ltd
From:	[redacted]
CC:	[redacted]
Project Number:	P05513
Reviewed by:	[redacted]
Released by:	[redacted]

Subject: Delmore Development Geomorphic Assessment

Vineway Ltd are applying for consent under a fast-track application for a proposed development within the Ōrewa River West catchment. Healthy Waters' feedback (25 June 2025 and 23 July 2025) identified the need for a geomorphic assessment to evaluate whether the proposed riparian setbacks are appropriate given existing stream conditions and expected future adjustment.

Morphum undertook field and desktop investigations to characterise stream condition and identify high-risk reaches, sharing preliminary findings to support layout refinement and coordinate technical inputs. Building on these investigations, this memo provides Morphum's final geomorphic assessment for the site, summarising the reach-based findings, recommended riparian offsets, and associated geomorphic considerations. The extent of the assessment is shown in Figure 1.

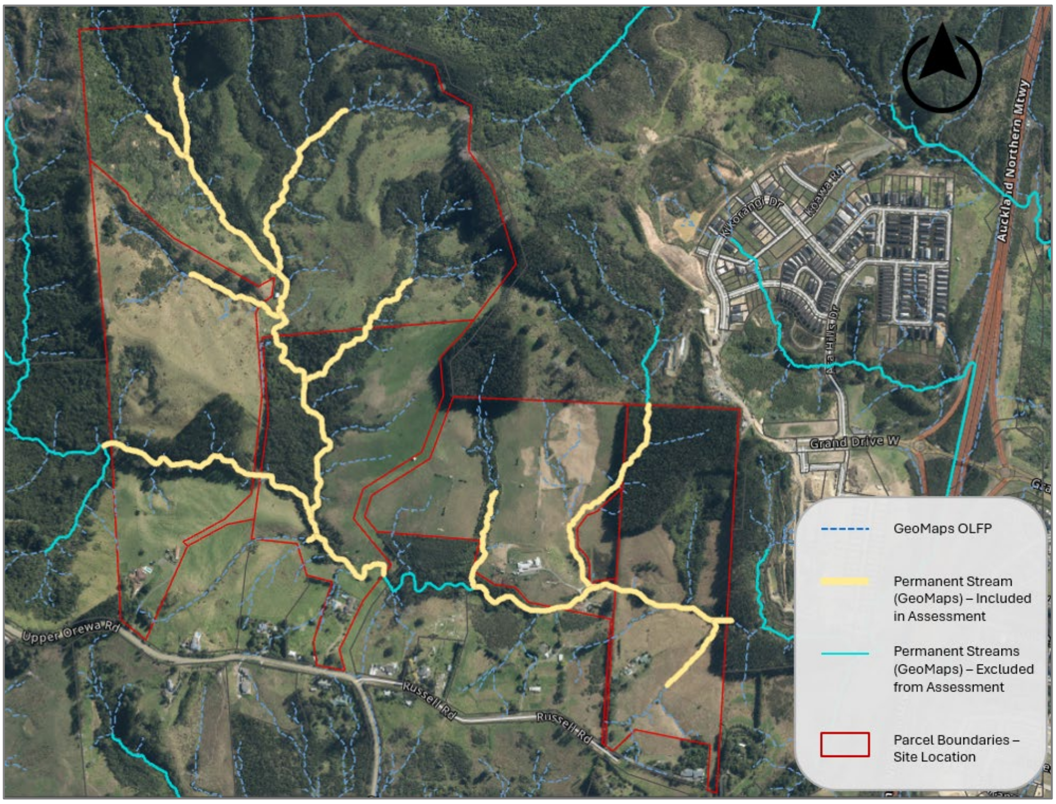

Figure 1. Extent of geomorphic assessment (shown by the permanent stream)

Catchment Overview and Scope of Assessment

The site lies within the southern tributary of the Ōrewa West Catchment, draining through a motorway culvert to the Grand Drive catchment and then to the coast. This assessment covers approximately 650 m of permanent stream and tributaries within the site, as shown in Figure 1.

The assessment focuses on:

- Evaluating incision and erosion risk, including knickpoints and toe erosion.
- Identifying areas with potential for channel migration or widening.
- Considering stream bank stability relative to the proposed riparian margins.

Method

This geomorphic assessment comprised three components.

1. A desktop review of available data to understand the sites setting and the proposed development, in addition to historical channel adjustment. The desktop review included:
    - Geotechnical report by Riley Consultants Ltd Subsurface Consulting (Boyd, 2025)
    - GNS geology data (GNS, 2025)
    - Ecological Impact Assessment of the site by Viridis (Viridis Consultants, 2025)
    - Auckland Region Digital Elevation Model (DEM) (LINZ, 2024)
    - Auckland Council Geomaps data including streams, overland flow paths and the stormwater network (Auckland Council, 2025)
    - Historic aerial imagery of the area from Retrolens and Google Earth.
2. A field investigation to understand the current character and behaviour of the stream and its potential for future erosion and migration. This included:
    - Collection of GPS-tagged photos and notes on geomorphic units, stability indicators, bank conditions, and other attributes required for subsequent RGEA scoring.
    - Recording of channel geometry, degree of confinement, substrate characteristics, and evidence of incision or adjustment.
3. Calculation and analysis of data using the Draft Auckland Council Stream Bank Erosion Assessment Guidance (Speed, 2017), including RGEA scoring, supported by field observations to inform the current and future erosion potential of the assessed reaches.

    The following variations to the guidance document were made:
    - The degree of incision calculation in the method uses low flow water depth above bank height, but this can yield a result of greater than 100%. The calculation has been changed to use low flow water depth over bankfull depth. The score associated with the degree of incision remains unchanged.
    - Scoring has been inverted for the field degree of constriction. The guidance document scores the reaches with high constriction a low erosion score, which is contrary to the erosive functions of constrictions.
    - The scoring for established riparian woody vegetative cover and bank accretion was also inverted, such that conditions associated with lower erosion susceptibility (higher woody cover or greater deposition) receive lower RGEA scores.

Desktop Review

Geological and Geomorphic Context

The site is mainly underlain by the East Coast Bays Formation (ECBF), comprising interbedded sandstone and mudstone, with localised Hukerenui Mudstone from the Northland Allochthon. The valleys and lower slopes contain colluvial and alluvial deposits, several metres thick in places, formed by historic shallow slips and slope wash. Geotechnical records and field observations show relic instability, hummocky terrain, and elevated groundwater in north-facing slopes and gully heads where fine-grained soils and seepage coincide. Groundwater levels between 1.5 m and 5.2 m below ground and the presence of reeds and saturated soils indicate active subsurface flow paths contributing to localised erosion and shallow failures. Overall, the site shows a moderate to high susceptibility to slope instability, incision, and gully development if surface or subsurface flows are altered.

The geotechnical report confirms that much of the site comprises sensitive slope materials, including colluvium, alluvium, and weathered mudstone. Factors of safety below 1.5 under long-term conditions were reported in several slope sections, supporting the need for stabilisation measures such as shear keys, palisade walls, MSE slopes, counterfort drains, and soil nails. These structures are generally located along steeper riparian margins where instability is already present or may develop. The proposed remedial works and slope stabilisation measures, adapted from the geotechnical report, are included in Appendix 2 - Stream Offset Adequacy Plans.

Historical Channel Adjustment and Vegetation Coverage

Historic aerial imagery from 1940, 1965, and 2024 was reviewed to assess channel adjustment. Figures 2 to 4 show the georeferenced images, sourced from Retrolens and Geomaps.

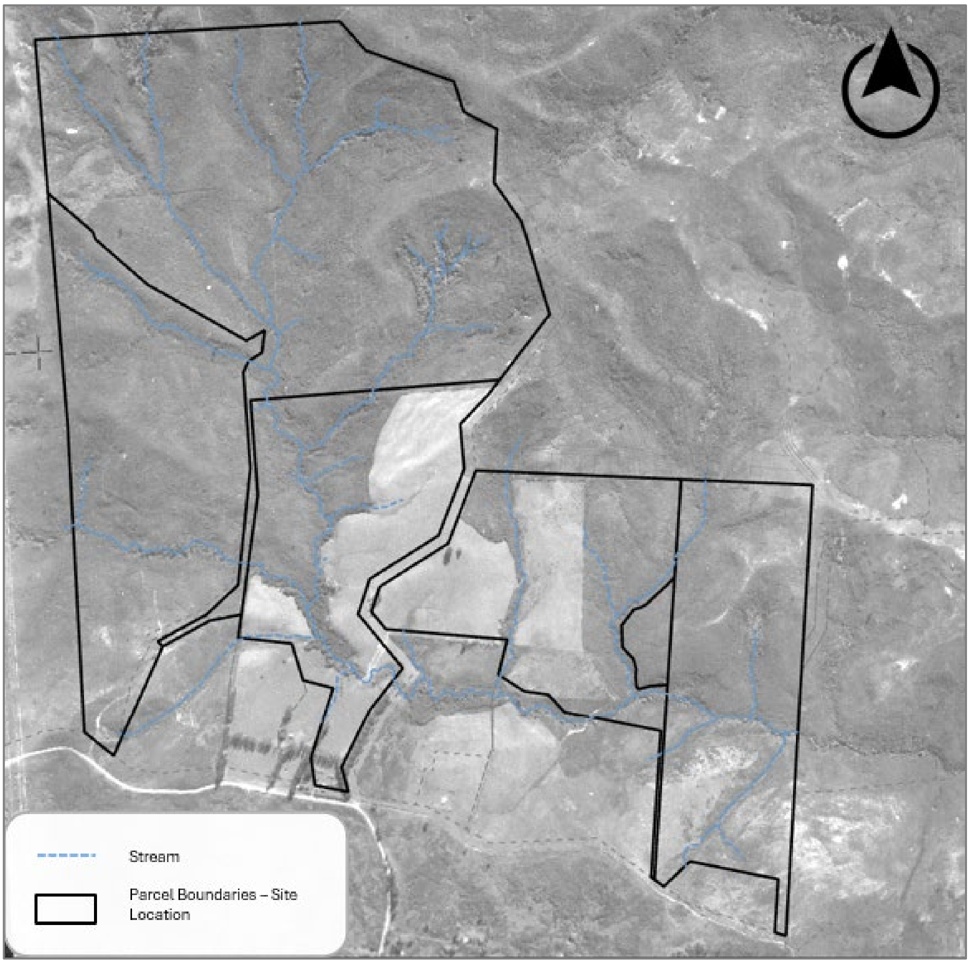

Figure 2. Aerial image. Retrolens (1940)

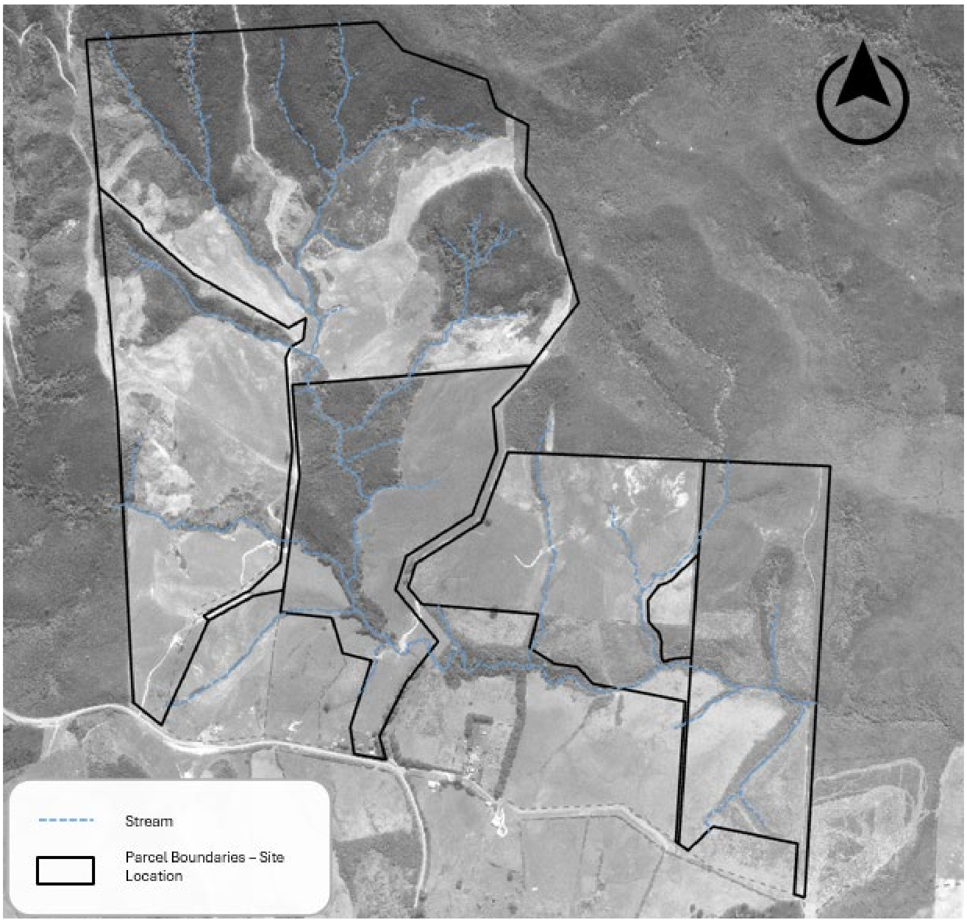

Figure 3. Aerial image. Retrolens (1965)

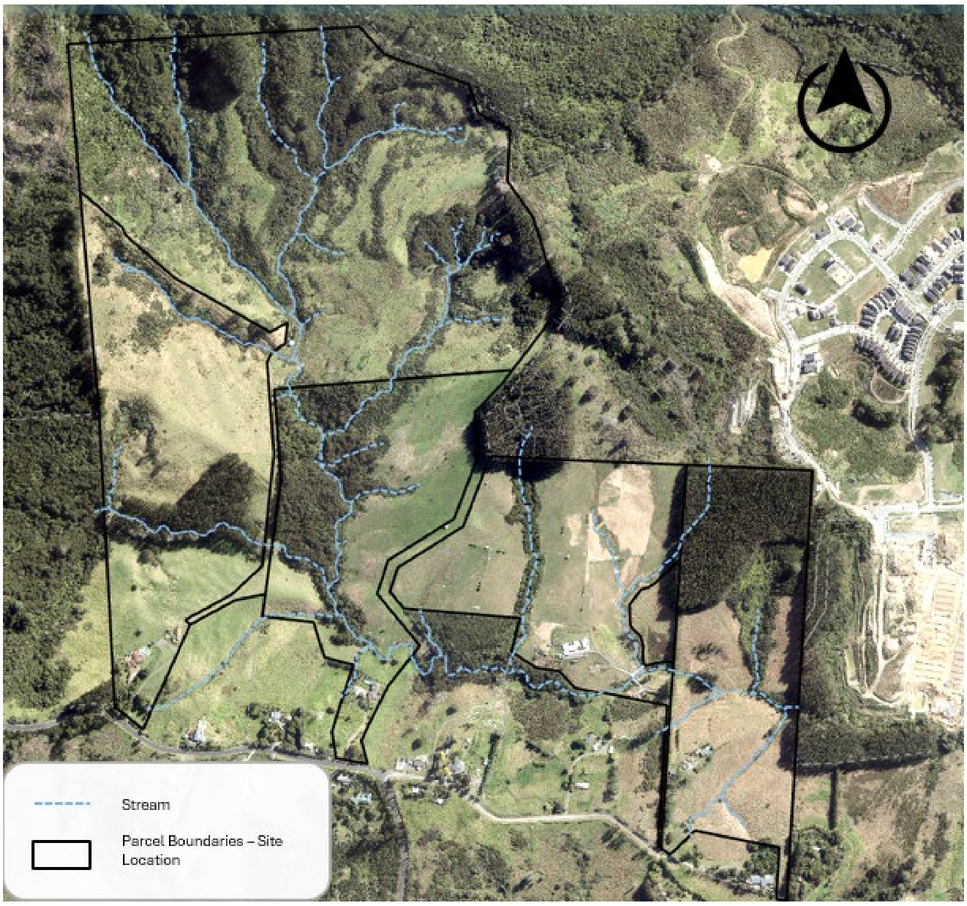

Figure 4. Aerial image. Geomaps (2024)

Across all three sets of imagery, the stream layer shown represents the current alignment and is included as a reference only. When compared with the historic photographs, no evidence was observed of past alignment shifts or other indicators of channel adjustment. The channel location appears to have remained generally unchanged over the periods assessed.

Based on this, the historic imagery review indicates no significant lateral migration or meander development within the assessed reaches.

Field Observations and Geomorphic Assessment

The site was visited on 30/09/2025 and 6/10/2025, with different stream reaches covered each day. Field observations were used to document stream geometry and erosion indicators. The results are presented below through the Rapid Geomorphic Erosion Assessment (RGEA) and the subsequent classification of reaches into geomorphic types.

Rapid Geomorphic Erosion Assessment

A total of 36 reaches were delineated across the study area, with boundaries defined where observable geomorphic characteristics changed. Each reach was assessed using the RGEA methodology (Speed, 2017) to identify the relative erosion susceptibility.

The RGEA results are shown in Figure 5, and RGEA calculation tables are provided in Appendix 4.

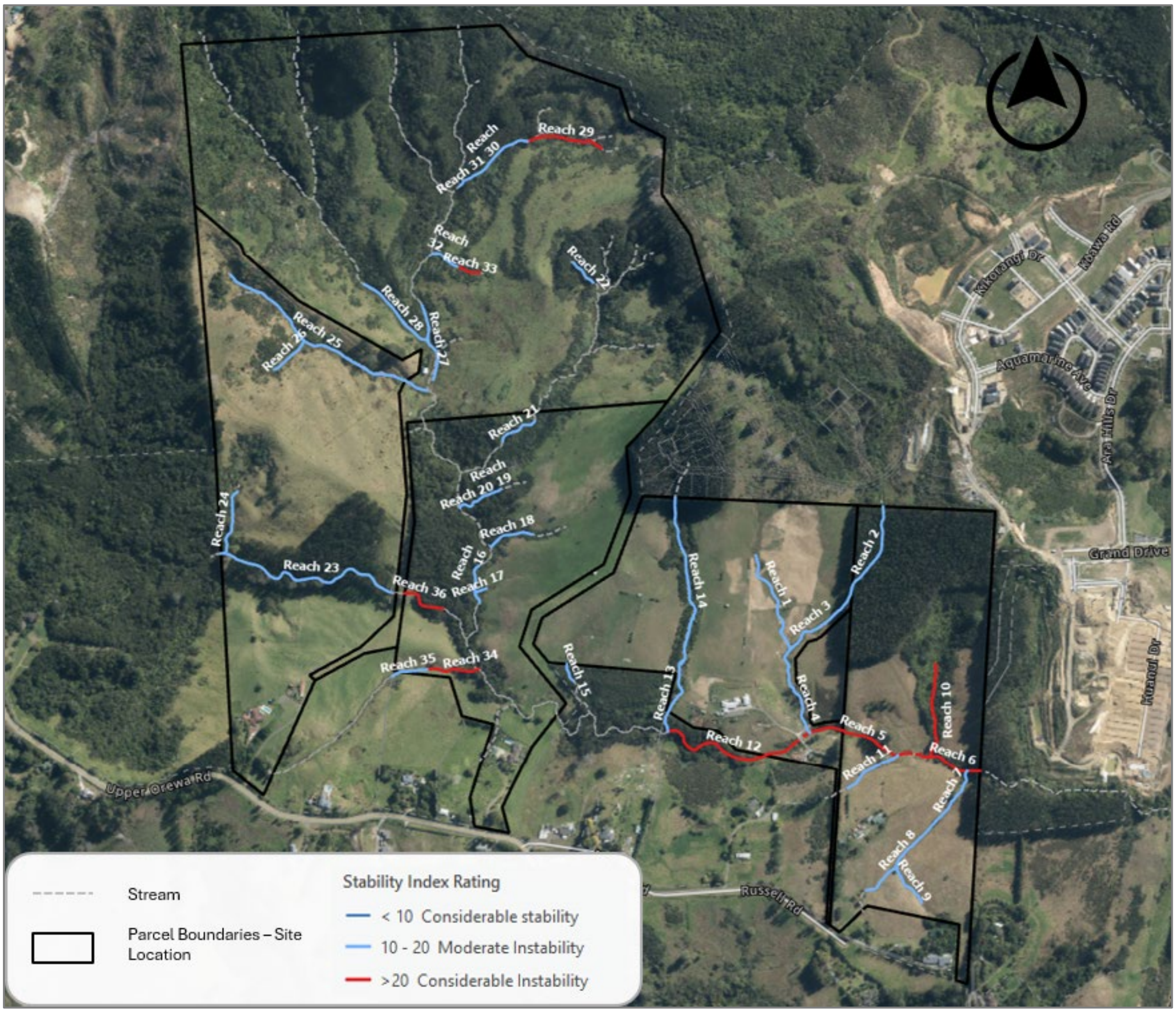

Figure 5. Stream categorized by RGEA category

Geomorphic Reach Types

Based on the field observations and the RGEA results, the assessed reaches were grouped into four geomorphic types reflecting similar characteristics and behaviour. This identified reaches with elevated susceptibility to erosion, and the expected progression of channel adjustment over time.

Type 1 – Wetlands (unincised)

- RGEA score: All reaches show moderate instability.
- Wide valley floor infilled with sediment and diffusive flow.
- No erosion.
- No risk or lateral adjustment.
- Potential for upstream knickpoint migration which could channelise the flow and convert the wetland to a defined stream channel.

Type 2 – Small and narrow channels (Early Incision)

- RGEA score: All reaches show moderate instability.
- Narrow, shallow channels (less than ~0.6 m deep) that have started to incise into the valley floor.
- Generally small tributaries with relatively steep gradients.
- Very low lateral adjustment potential, but incision is expected to continue.

Type 3 – Incising but not widening (Stage 3)

- RGEA score: Reaches show moderate instability, with some reaches showing considerable instability.
- Streams are downcutting, but there is currently little widening in the form of mass slumping.
- Occasional floodplain pockets on the valley floor that are engaged in higher flows.
- Lateral adjustment potential is low, but there will be overall widening to the channels from scouring of the stream banks which will be exacerbated on outside bends.
- Knickpoints are common, confirming ongoing bed incision

Type 4 – Incising and widening (Stage 4)

- RGEA score: Reaches show moderate instability and considerable instability.
- Streams are downcutting and widening by mass slumping.
- Where bedrock is exposed, stream widening progresses faster as bed incision slows.
- Knickpoints are common. Those flowing over clay will migrate upstream at a faster rate than those flowing over bedrock.
- Low lateral adjustment capacity, though overall widening will continue
- Risk of undermining the toe of the adjacent steep slopes that may lead to geotechnical instability.

Stream types are summarised in Table 1, mapped in Figure 6, and supported by site photographs in Appendix 2.

Table 1: Stream categorized by type

Type 1 – Wetlands (unincised)	Type 2 – Small and narrow channels (Early Incision)	Type 3 – Incising but not widening (Stage 3)	Type 4 – Incising and widening (Stage 4)
Reach 1	Reach 11	Reach 2	Reach 5
Reach 3	Reach 15	Reach 4	Reach 6
Reach 8	Reach 35	Reach 7	Reach 10
Reach 19	Reach 9	Reach 12	Reach 18
Reach 25		Reach 13	Reach 30
Reach 26		Reach 14	Reach 32
Reach 27		Reach 16	Reach 33
Reach 28		Reach 17	Reach 34
		Reach 20	Reach 36
		Reach 21	
		Reach 22	
		Reach 23	
		Reach 24	
		Reach 29	
		Reach 31	

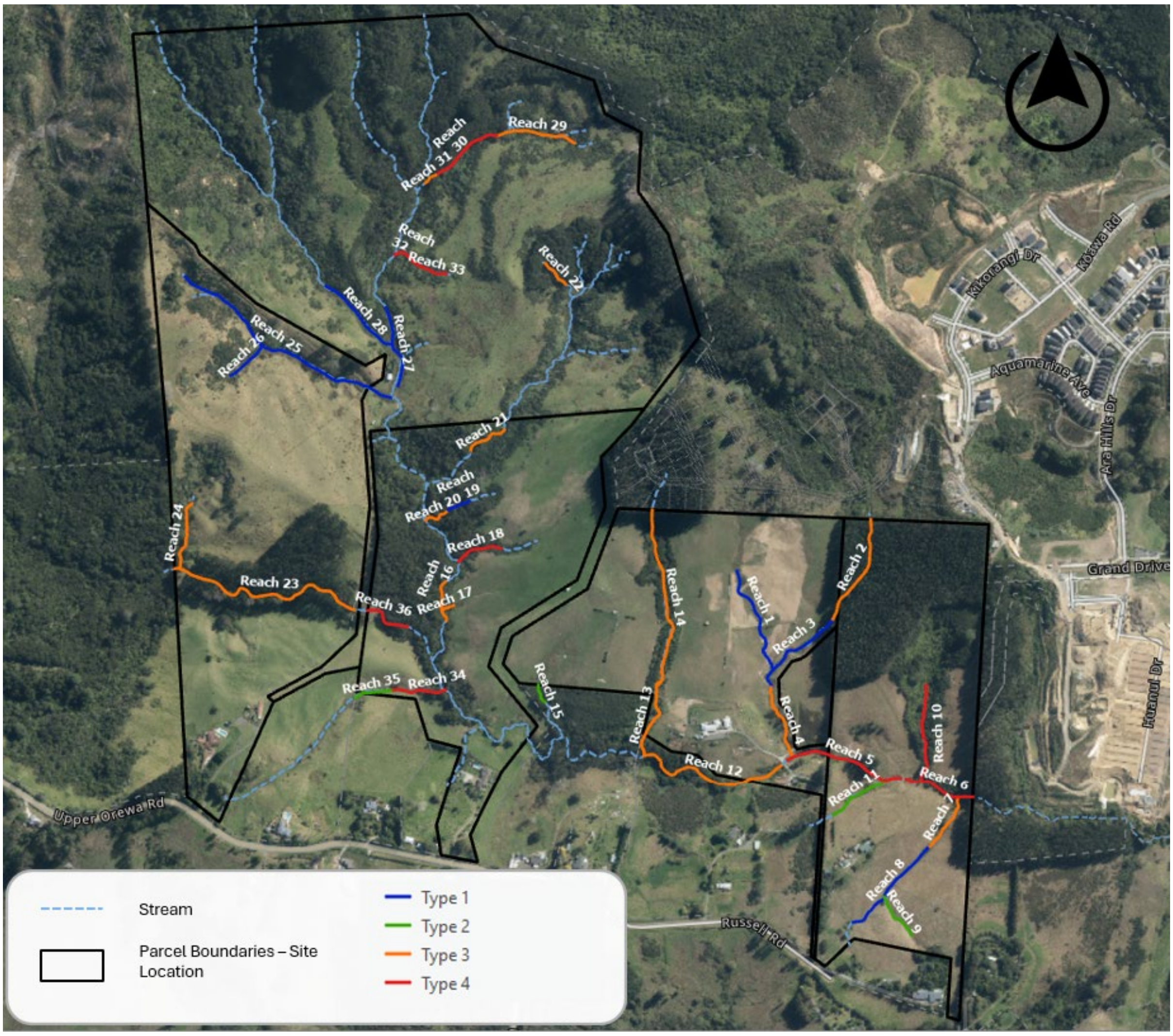

Figure 6. Stream categorized by type

Potential for Stream Adjustment

Based on the field observations and RGEA results, the following conditions were identified:

- The streams are showing evidence of incision. This will continue into the future, with the potential to cut down to bedrock (estimated to be approximately 2 m below ground surface). Therefore, an additional 1 to 2 m of downcutting may occur in many of the streams across the site. As the streams incise, the likelihood of bank instability will increase. Once stream incision reaches bedrock (which was exposed in some areas), erosion of the banks will become more pronounced, leading to increased risk of stream widening and mass slumping.
- The observed erosion is active and will continue to occur. Knickpoints are common (steps on the stream bed with increased velocity which erode back upstream, incising the streams). Development, with the increase in impervious surfaces and piped discharges to streams, changes the stream hydrograph leading to higher flood peaks and increase flow velocities. This will lead to an increase in erosion. Even with spreader bars, and other mitigation, the stream hydrograph is likely to be altered.
- The streams are confined within the gully side walls, so they are unlikely to move laterally and a 10m off set is generally considered to be sufficient. However, it is expected that the streams will widen, by an estimated 1 to 2 m. This may be asymmetrical, in that one bank will erode back while the other remains unchanged).
- Stream incision will undermine the toe of the upper banks which may induce slope instability.
- The wetlands diffuse the flow across the valley floor. If stream incision moves upstream and reaches the wetlands, these could become channelised. This will create an incised preferential flow path and wetland function will be lost. Monitoring these reaches for changes will help to catch and address issues before they result in a change in the character and behaviour of the wetland.

The riparian offsets are considered from a geomorphology perspective only, based on the anticipated stream adjustment processes identified in this assessment. It is assumed that no stream works that involve bed or bank lining will be undertaken as this will have additional impacts on stream geomorphology.

Appendix 1 summarises the geomorphic assessment for each stream reach and the associated considerations for offset adequacy. Reach locations are shown in the maps provided in Appendix 2.

Geomorphic Considerations for Stabilisation Measures

The outcomes of the preliminary geomorphic assessment indicate that incision-driven adjustment is the primary driver of geomorphic change across the site, with the location of the stream expected to remain relatively unchanged but may be subject to widening. As such, a riparian set back of 10 m is considered acceptable for most of the streams around the site. The exception is Reach 2, located within a recently felled forestry area, where we recommend a setback distance of 15 m. Due to the change in land use, the stream is actively downcutting and widening as it adjusts to the new flow and sediment regime.

Geotechnical structures are proposed across the site to support the proposed development. Due to the potential for future channel adjustment, these must consider the effect of channel incision and widening in the design and if this could undermine the toe of fill slopes and retaining walls. Our preliminary findings were shared with the geotechnical team to inform their stability analyses and refinement of the proposed stability works. As such, the updated geotechnical assessment incorporates allowances for expected channel incision and widening at several reaches and includes revised stabilisation measures such as steepened REB or MSE slopes, adjusted shear key dimensions, and updated palisade wall capacities. It should be noted that we have provided guidance on potential river adjustment to be incorporated into the stability analysis and design of the retaining structures, however, we have not reviewed the stability analyses or geotechnical design.

From a geomorphic perspective, Appendix 1 and Appendix 2 identify the reaches where geomorphic processes are most relevant, including active incision, knickpoint migration, and localised widening, and where the offset required specific consideration.

The detailed design, adequacy, and performance of these stabilisation measures remain within the geotechnical discipline and are not assessed in this memo. Morphum's role is limited to identifying geomorphic processes that may interact with these areas and ensuring that potential incision or widening is appropriately recognised in the development layout.

Stormwater Dispersal via T-Spreader Bars and Culverts

Stormwater should be managed to minimise changes to the hydrograph and where practicable, direct piped discharges to streams should be avoided. T-Spreader bars are proposed to discharge stormwater. From a stream geomorphology perspective, these are considered to be a better option than piped discharge direct to streams as they spread the flow across the bank, slowing the rate in which it enters the stream and minimising the creation of concentrated discharge point. However, if not correctly maintained, there is a risk that gullying and land instability can occur. On-going maintenance is therefore required to ensure that they are working efficiently and not resulting in scour to the bank or concentrated discharge due to the blockage of holes. Planting downslope of T-Spreader bars is suggested to slow flow and improve surface cohesion of the soils. This is a geomorphic assessment of T-Spreader bars in relation to the effect of the stream; it does not consider the geotechnical aspects of slope stability associated with the discharge of water onto the slope.

Culverts should be designed to minimise any changes to the flow regime, i.e., by constricting flow or changing the gradient of the stream through the culvert. Stormwater management plans and ongoing monitoring are recommended so that any areas of erosion can be identified early and addressed before they develop into larger issues. In particular, it is recommended to assess knickpoint migration to ensure it does not encroach into wetlands, as well as erosion around culverts and erosion caused by stormwater discharges.

Conclusion

This geomorphic assessment evaluated the condition and expected future behaviour of approximately 650 m of permanent and intermittent streams across the site. Field observations, RGEA scoring, and desktop analysis were used to identify reaches with elevated susceptibility to incision, knickpoint migration, and localised channel widening. These findings informed the assessment of the riparian offsets, to determine where they remain appropriate and where stream adjustment processes could interact with the proposed layout.

Key findings are summarised below:

- Incision is the dominant adjustment process, with most reaches expected to lower by an additional 1–2 m until bedrock is encountered.
- Knickpoints are common and actively migrating, reinforcing the likelihood of continued bed lowering.
- Lateral migration potential is low, as most reaches are confined within steep gully walls. However, localised widening of between 1-2 m is expected, particularly on outside bends and where banks are composed of alluvium or weathered mudstone.
- 10 m riparian setback is generally appropriate from a geomorphic perspective.
- Geotechnical retaining structures should be designed to take account of the potential for downcutting and future widening of the streams. We understand that this has been included within the geotechnical design.
- Wetland areas remain stable but may rapidly convert to channelised form if upstream incision propagates into them.
- Stormwater inputs will influence erosion, and concentrated discharges should be avoided to minimise hydrograph alteration and associated geomorphic impacts. From a geomorphic perspective, T-Spreader Bars will reduce changes to the hydrograph. On-going maintenance should be carried out to ensure they do not cause scouring or concentrated discharges.

- It is recommended that a stormwater management plan be put in place to monitor to for changes in the stream, particularly in relation to knickpoint migration to wetlands, erosion around culverts and erosion due to stormwater discharge.
- No bed or bank lining is assumed, as these works would alter natural adjustment processes and fall outside the geomorphic scope.

Integration with Proposed Layout

The preliminary outcomes of this geomorphic assessment were shared with the geotechnical team during the refinement of their stability works, ensuring that allowances for future incision and potential widening were incorporated where relevant. The recommended offsets reflect the dominant geomorphic processes observed across the site and provide a consistent basis for managing expected stream adjustment under the proposed development scenario.

Overall, with the recommended riparian offsets adopted, and the geotechnical stabilisation works reflecting the geomorphic context, the proposed development layout incorporates the key stream adjustment processes identified in this assessment.

Limitations

This geomorphic assessment has been undertaken at a reach scale and therefore does not encapsulate the greater geomorphic processes occurring in the catchment. We have not investigated upstream or downstream of the subject reaches for any further threatening processes such as knickpoints, head cuts and sedimentation. No quantitative modelling has been undertaken and the conclusions from this assessment are based on observations only.

This assessment is based on the reaches as they are today and does not account for any further development of impervious areas in the catchment, beyond what is shown for the proposed development. Any changes to stream culverts up or downstream may change the hydrology of the streams and their geomorphic response. Similarly, additional piped discharge to the stream may affect hydrology. The existing instream vegetation is playing a key role in shaping the characteristics of the stream; the removal of vegetation will result in changes in flow characteristics which may impact on erosion. Vegetation is also assisting with stability of the stream banks and removal of vegetation may adversely impact on stream bank stability.

Disclaimer Statement

This memo has been prepared for Vineway Ltd, according to their instructions, for the particular purpose and objectives described in the memo. Morphum Environmental Ltd accepts no responsibility for the content of this memo if it is used by any other party or for any other purpose or objective. Any use of or reliance on the information contained in this memo for decisions made by third parties are the responsibility of these third parties. Morphum Environmental Ltd accepts no responsibility for damage incurred by third parties resulting from the use of or reliance on this memo, or if the memo is used by any party for other than the purpose and objectives described herein.

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Appendix 1 Geomorphic Assessment – Reach Conditions and Offset Review

The reach-specific geomorphic risks identified in this table were provided to the project team to support layout refinement and technical coordination.

The geotechnical inputs have since incorporated these geomorphic parameters (e.g., incision depth, widening potential, knickpoint migration) into the corresponding stability assessments.

The actions listed below reflect geomorphic considerations only. Geotechnical responses have been developed separately and are not reviewed in this memo.

Reach	Key Risk / Condition	Offset Adequacy	Relevant Geomorphic Notes
2 (forestry section)	Recently cleared, with multiple knickpoints, active erosion. Rapid widening and deepening are expected. The valley floor is wider in this location, and the channel location may adjust from where it currently is as it widens.	Acceptable Addressed through geotechnical design	Geomorphic assessment identified incision, knickpoints and potential channel widening across the broader valley floor. These inputs were provided to the geotechnical team and have been incorporated into the geotechnical stability modelling. Setback adequacy and stabilisation requirements are now addressed under the geotechnical design.
36 (critical)	Scouring below culvert; lots within 10 m, bank erosion risk.	Acceptable Addressed through geotechnical design	The potential for incision and toe erosion was identified as a key geomorphic driver in this reach. These inputs were provided to the geotechnical team and have since been incorporated into geotechnical stability modelling. Setback adequacy and stabilisation requirements are now addressed under the geotechnical design.
23	Meandering reach with floodplain pockets and several knickpoints. Stream erosion will likely be asymmetrical, concentrating on out bends.	Acceptable Addressed through geotechnical design	Geomorphic assessment identified asymmetrical erosion potential associated with knickpoints and meander geometry. These considerations were provided to the geotechnical team and have been incorporated into their stability modelling for this reach. Setback constraints for this reach are now managed through the geotechnical design.
24 (landslide complex)	Active landslides of the upper hillslopes with colluvium currently infilling the valley with loose sediment. This material will be easily mobilised, and the stream will incise back to the pre-landslide form.	Acceptable Addressed through geotechnical design	Geomorphic assessment identified active colluvial infill, potential for further incision toward the pre-landslide surface, and sensitivity of this reach to toe erosion. These considerations were provided to the geotechnical team and incorporated into their updated stability modelling, which includes an allowance for an incised channel. Setback management for this reach is now addressed through the geotechnical design.
10	Steep reach with proposed houses near the channel at downstream end. Channel is incising with potential slope stability risk if toe of slope is undermined from, toe erosion.	Acceptable Addressed through geotechnical design	Geomorphic assessment identified active incision and potential toe erosion along this steep reach. These considerations were provided to the geotechnical team and incorporated into their stability modelling. Setback adequacy and stabilisation requirements are now addressed under the geotechnical design.

Reach	Key Risk / Condition	Offset Adequacy	Relevant Geomorphic Notes
29	Fluvial incision, narrow channel over clay, small knickpoints.	Acceptable Addressed through geotechnical design	Geomorphic assessment identified incision risk, narrow channel geometry and sensitivity to downcutting. These considerations were provided to the geotechnical team and have been incorporated into their updated stability modelling for this reach. Setback requirements are now managed through the geotechnical design.
7	New road crossing, knickpoint at or near bridge, transition from non-incised to incised reach. Risk of upstream migration and culvert undermining.	Acceptable	Previous geomorphic comments relating to knickpoint migration and incision potential at the road crossing were provided to inform the design process. These considerations have since been incorporated into the updated geotechnical design.
5 – 6	Streams will continue to incise.	Acceptable.	Stormwater design/management plan
4	Incised reach to culvert with wetland above. Culvert appears to be maintaining the wetland. Risk of wetland becoming channelised if culvert removed.	Acceptable.	Geomorphic assessment identified that the upstream wetland is sustained by the existing culvert and is sensitive to changes that may create a preferential channel. These considerations were provided to the geotechnical team and incorporated into their updated stability modelling.
1	Shallow wetland area, low gradient.	Acceptable.	Maintain existing hydrology, avoid concentrated inflows. Stormwater design/management plan.
3 (wetland)	Stable at present. Potential risk of channelisation if flows increase or the downstream culvert is altered. The long-term stability of this reach is linked to what occurs in Reaches 2 and 4.	Acceptable	Prepare maintenance/monitoring plan.
12	Development is set back ~15 m from the stream. The potential adjustment is not expected to affect the lots or engineering structures.	Acceptable	Standard stormwater controls.
13 – 14	Retaining structures (palisade walls and batters) are located outside the 10 m riparian buffer, in an area with moderate instability.	Acceptable	Previous geomorphic advice relating to potential toe undercut and incision risk was provided to the geotechnical team. These considerations have since been incorporated into their updated stability modelling for this reach.

Reach	**Key Risk / Condition**	**Offset Adequacy**	**Relevant Geomorphic Notes**
15	Moderate instability with works sufficient distance from the stream.	Acceptable	—
34 – 35	Lower reach has incised up to the culvert with bedrock exposed in places. Upstream of the culvert, there is a shallow channel which transitions to wetland. Little development in this area so unlikely to have much change in hydrology (as part of this development).	Acceptable	Maintain wetland hydrology.
16	Incising. Lots are at sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
17	Incising. There is the potential for upstream incision to continue and extend into the lots, particularly if stormwater is allowed to discharge directly into this stream.	Acceptable	Check stormwater discharges into this stream and if there is any residual risk of increased overland flow post earthworks.
18	Incised down to bedrock. Earthworks will occur over an ephemeral flow path.	Acceptable.	Check drainage from road does not result in changes to the hydrograph. Check that proposed earthworks do not cause flooding/ponding or result in increased overland flow where the ephemeral channel is modified.
19	Wetland, diffused flow, incised reach downstream. Lots are at sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
20	Incising down, little mass slumping, knick point at confluence, wetland upstream. Lots are at sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
21	Active incision. Lots are at sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
22	Narrow and incising, intermittent stream, confined valley. Lots are at sufficient distance	Acceptable	Ensure stormwater discharge from road doesn’t create concentrated discharge points.

Reach	**Key Risk / Condition**	**Offset Adequacy**	**Relevant Geomorphic Notes**
	from the stream that any adjustment will not impact them.		
25 -28 **Wetlands**	Potential for channelisation if and loss of wetland if stormwater regime changes	Acceptable.	Maintain low-energy wetland system. Ensure 10 m from edge of wetland
30	Incised to bedrock, widening in places but well vegetated. Lots are at sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
31	Moderate instability. Lots with sufficient distance from the stream that any adjustment will not impact them.	Acceptable	—
32	Active incision, continued head-cut migration	Acceptable from a geomorphic perspective, noting proximity of structures requires geotechnical confirmation.	Geomorphic risks relating to incision depth, headcut progression, and the proximity of retaining structures were provided to the geotechnical team. These considerations have been incorporated into their updated stability modelling and remedial design for this reach.
33	Active incision, continued head-cut migration	Acceptable	—

Appendix 2 Geomorphic Assessment – Stream Offset Adequacy Plans

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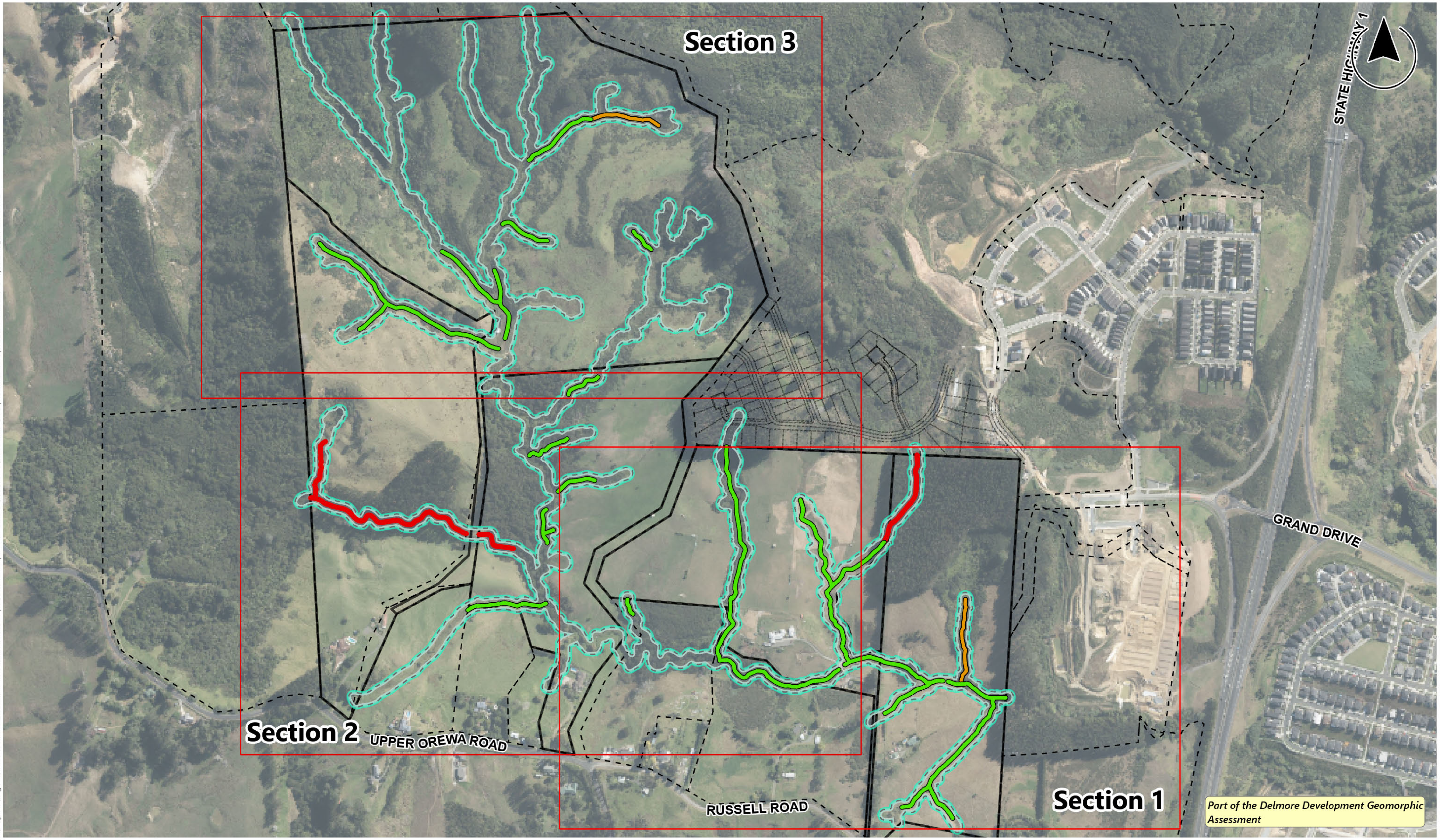
RGEA REVIEW RESULT - SITE OVERVIEW



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Stream Offset Adequacy

- Reaches Where Offset Requires Additional Consideration
- Reaches Where Localised Allowances May Be Needed
- Reaches Where Offset Is Acceptable
- 10m Stream Restriction Setback
- Adjacent Property Boundaries
- Delmore Parcels

Client VINEWAY LTD

Project DELMORE DEVELOPMENT GEOMORPHIC ASSESSMENT

0 250 500 m

Project no.	P05513
Date	20 Nov 2025
Drawn	PZ, ES
Approved	AR

RGEA REVIEW RESULT - SECTION 1

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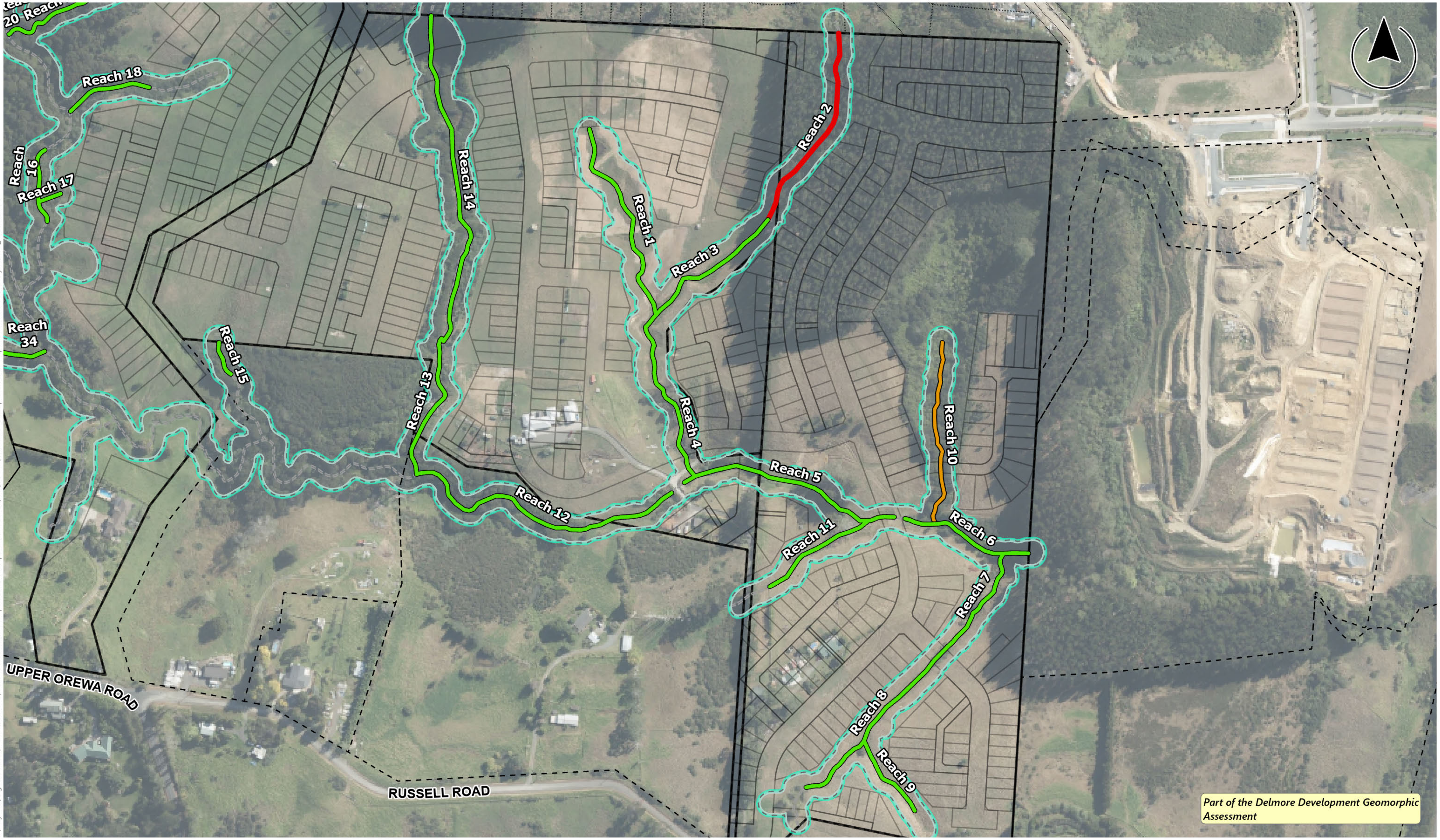

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Stream Offset Adequacy

- Reaches Where Offset Requires Additional Consideration
- Reaches Where Localised Allowances May Be Needed
- Reaches Where Offset Is Acceptable
- Stream
- Proposed Lots
- Adjacent Property Boundaries
- 10m Stream Restriction Setback
- Delmore Parcels

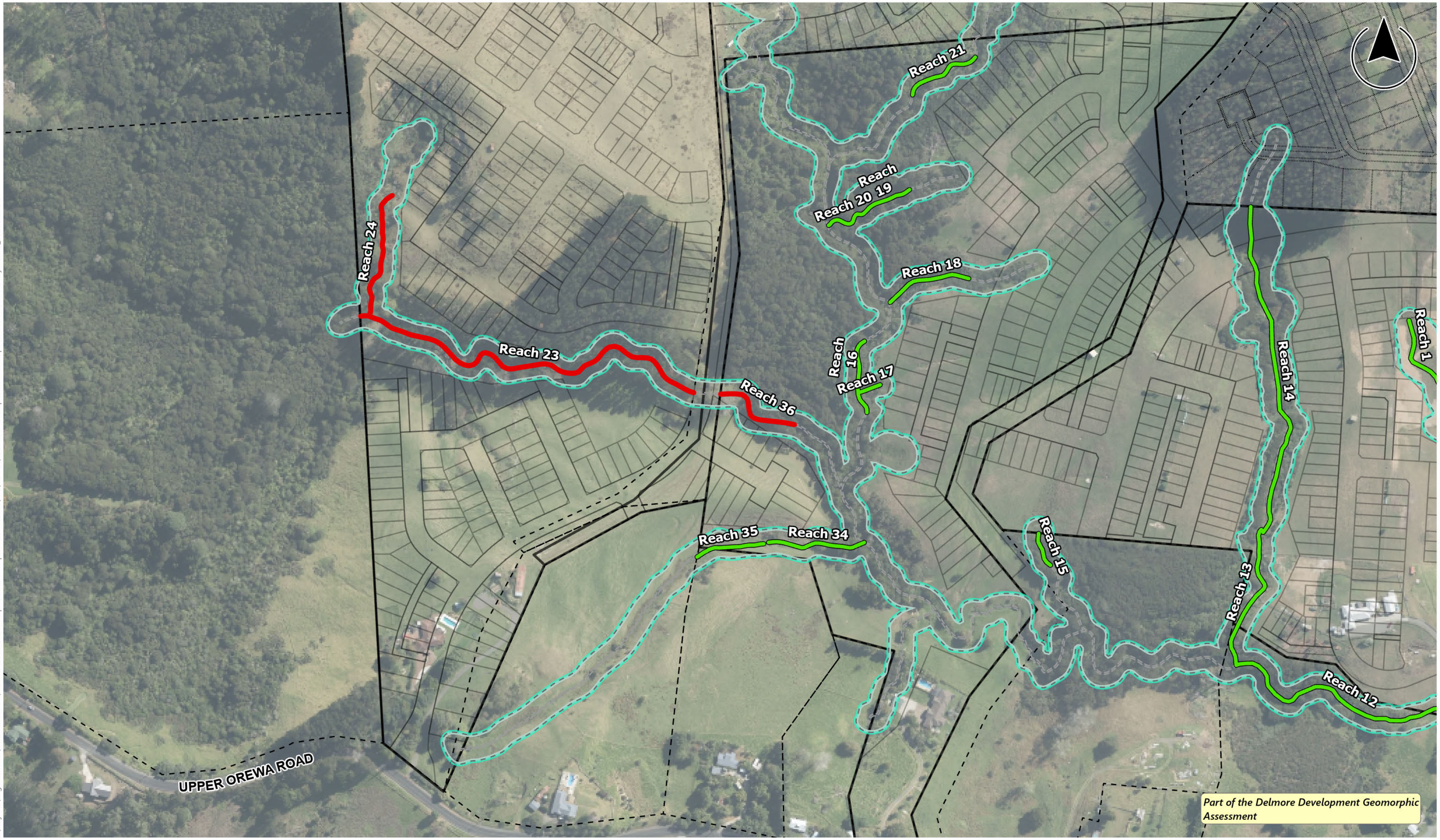
Client VINEWAY LTD

Project **DELMORE DEVELOPMENT GEOMORPHIC ASSESSMENT**

0 100 200 m

Project no.	P05513
Date	20 Nov 2025
Drawn	PZ, ES
Approved	AR

RGEA REVIEW RESULT - SECTION 2



Stream Offset Adequacy

- Reaches Where Offset Requires Additional Consideration
- Reaches Where Localised Allowances May Be Needed
- Reaches Where Offset Is Acceptable
- Stream

- Proposed Lots
- Adjacent Property Boundaries
- 10m Stream Restriction Setback
- Delmore Parcels

Client VINEWAY LTD

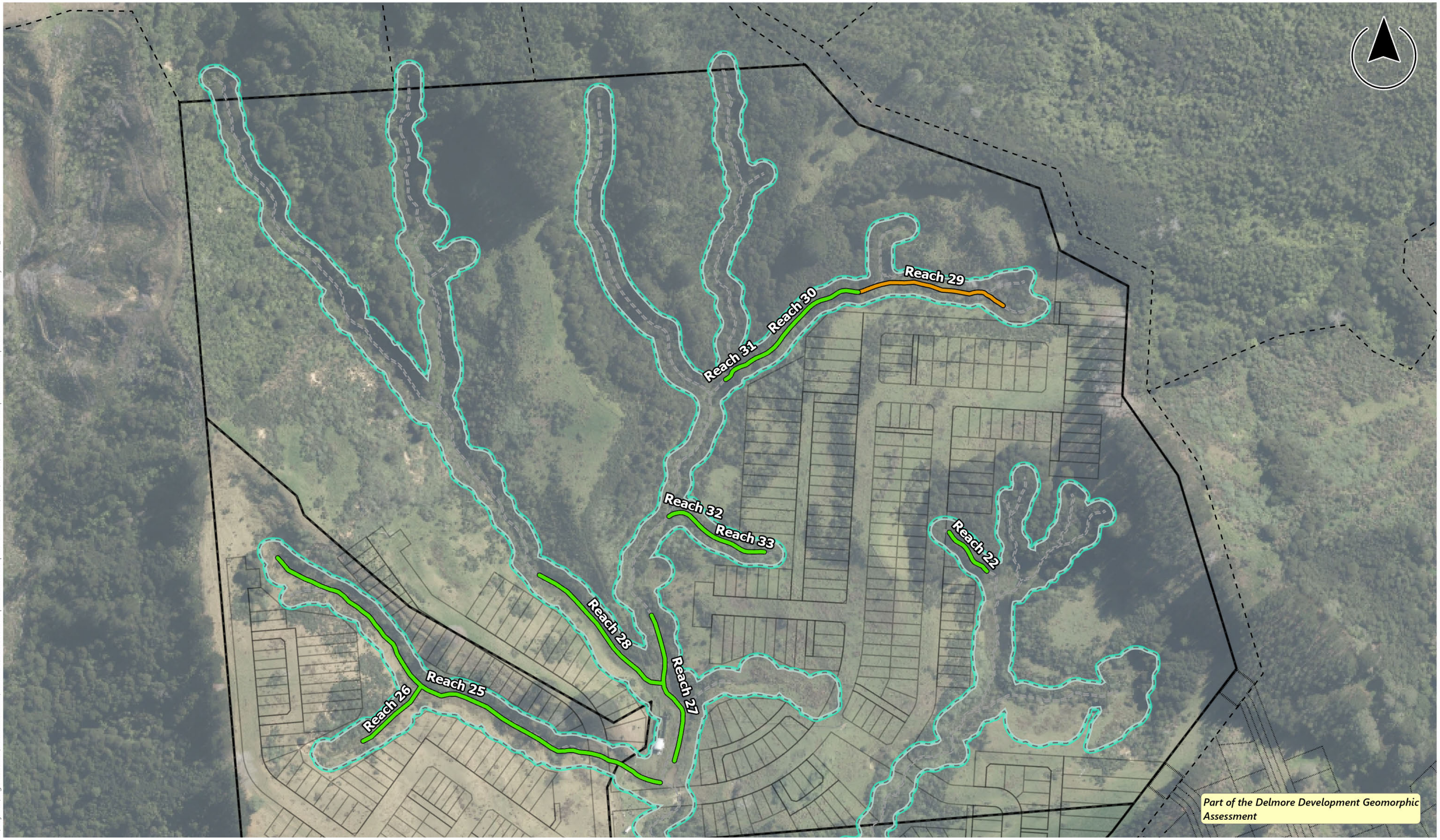
Project **DELMORE DEVELOPMENT GEOMORPHIC ASSESSMENT**

0 100 200 m

Project no.	P05513
Date	20 Nov 2025
Drawn	PZ, ES
Approved	AR

RGEA REVIEW RESULT - SECTION 3

MORPHUM
environmental



Z:\Projects\Organisations\McKenzie & Co\P05513 Delmore Development Geomorphic Assessment\GIS\ArcPro\Delmore Development Geomorphic Assessment V3 Layout: A3_RGEA Review

Stream Offset Adequacy

- Reaches Where Offset Requires Additional Consideration
- Reaches Where Localised Allowances May Be Needed
- Reaches Where Offset Is Acceptable
- Stream
- Proposed Lots
- Adjacent Property Boundaries
- 10m Stream Restriction Setback
- Delmore Parcels

Client VINEWAY LTD

Project DELMORE DEVELOPMENT GEOMORPHIC ASSESSMENT

0 100 200 m

Project no.	P05513
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Appendix 3 Site Photographs

Type 1 reaches

Figure 1. Reach 1.

Figure 2. Reach 3

Figure 3. Reach 28

Figure 4. Reach 8

Type 2 reaches

Figure 5. Reach 35

Figure 6. Reach 35

Figure 7. Reach 11

Figure 8. Reach 9

Type 3 reaches

Figure 9. Reach 12

Figure 10. Reach 2

Figure 11. Reach 23

Figure 12. Reach 24

Type 4 reaches

Figure 13. Reach 6

Figure 15. Reach 34

Figure 14. Reach 5

Figure 16. Reach 36

Appendix 4 RGEA Assessment

RGEA Assessment

Reach	Primary Bed Material	Bed/Bank Protection	Degree of Incision	Degree of Constriction	TLB Erosion Process	TRB Erosion Process	TLB Instability/Mass Wasting	TRB Instability/Mass Wasting	Riparian Woody-Vegetation Cover (Left Bank)	Riparian Woody-Vegetation Cover (Right Bank)	Bank Accretion (Left Bank)	Bank Accretion (Right Bank)	Stage of Channel Evolution	Score	Stability Offset Rating
Reach 1	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 2	Silt Clay	No	26–50%	76–100%	Fluvial	Fluvial	0-10%	11-25%	0-10%	11-25%	11-25%	11-25%	Stage 3	**18**	**Moderate Instability**
Reach 3	Silt Clay	No	76–100%	26–50%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 4	Silt Clay	No	51–75%	26–50%	None	None	0-10%	0-10%	11-25%	0-10%	0-10%	0-10%	Stage 3	**17.5**	**Moderate Instability**
Reach 5	Silt Clay	No	26–50%	26–50%	Fluvial	Fluvial	26-50%	26-50%	11-25%	11-25%	11-25%	11-25%	Stage 4	**23**	**Considerable Instability**
Reach 6	Silt Clay	No	26–50%	26–50%	Fluvial	Fluvial	26-50%	26-50%	76-100%	11-25%	11-25%	11-25%	Stage 4	**21.5**	**Considerable Instability**
Reach 7	Silt Clay	No	26–50%	26–50%	Fluvial	Fluvial	11-25%	11-25%	76-100%	76-100%	11-25%	11-25%	Stage 3	**17**	**Moderate Instability**
Reach 8	Silt Clay	No	26–50%	26–50%	None	None	0-10%	0-10%	11-25%	11-25%	0-10%	0-10%	Stage 3	**18**	**Moderate Instability**
Reach 9	Silt Clay	No	11–25%	51–75%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 3	**19**	**Moderate Instability**
Reach 10	Silt Clay	No	0–10%	26–50%	Mass Wasting	Mass Wasting	51-75%	51-75%	76-100%	76-100%	26-50%	26-50%	Stage 4	**24**	**Considerable Instability**
Reach 11	Silt Clay	No	11–25%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 3	**18**	**Moderate Instability**
Reach 12	Silt Clay	No	26–50%	26–50%	Fluvial	Fluvial	11-25%	11-25%	11-25%	11-25%	0-10%	0-10%	Stage 3	**21**	**Considerable Instability**
Reach 13	Silt Clay	No	0–10%	76–100%	Fluvial	Fluvial	11-25%	11-25%	76-100%	76-100%	11-25%	11-25%	Stage 3	**17**	**Moderate Instability**
Reach 14	Silt Clay	No	76–100%	26–50%	None	None	0-10%	0-10%	51-75%	51-75%	0-10%	0-10%	Stage 3	**14**	**Moderate Instability**
Reach 15	Silt Clay	No	11–25%	51–75%	Fluvial	Fluvial	0-10%	0-10%	76-100%	76-100%	0-10%	0-10%	Stage 3	**17**	**Moderate Instability**
Reach 16	Bedrock	No	11–25%	11–25%	Fluvial	Fluvial	0-10%	0-10%	76-100%	76-100%	0-10%	0-10%	Stage 3	**15**	**Moderate Instability**
Reach 17	Silt Clay	No	0–10%	76–100%	Fluvial	Fluvial	11-25%	11-25%	76-100%	76-100%	0-10%	0-10%	Stage 3	**18**	**Moderate Instability**
Reach 18	Bedrock	No	11–25%	51–75%	Fluvial	Fluvial	11-25%	11-25%	0-10%	0-10%	11-25%	11-25%	Stage 4	**19**	**Moderate Instability**
Reach 19	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	76-100%	76-100%	0-10%	0-10%	Stage 1	**11**	**Moderate Instability**
Reach 20	Silt Clay	No	11–25%	76–100%	Fluvial	Fluvial	0-10%	0-10%	51-75%	51-75%	0-10%	0-10%	Stage 3	**17**	**Moderate Instability**
Reach 21	Silt Clay	No	26–50%	51–75%	Fluvial	Fluvial	0-10%	0-10%	76-100%	76-100%	0-10%	0-10%	Stage 3	**16**	**Moderate Instability**
Reach 22	Silt Clay	No	0–10%	76–100%	Fluvial	Fluvial	0-10%	0-10%	51-75%	51-75%	0-10%	0-10%	Stage 3	**18**	**Moderate Instability**
Reach 23	Silt Clay	No	26–50%	51–75%	Fluvial	Fluvial	11-25%	11-25%	76-100%	76-100%	0-10%	0-10%	Stage 3	**17**	**Moderate Instability**
Reach 24	Silt Clay	No	11–25%	76–100%	Fluvial	Fluvial	11-25%	0-10%	11-25%	26-50%	11-25%	0-10%	Stage 3	**18.5**	**Moderate Instability**
Reach 25	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 26	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 27	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 28	Silt Clay	No	26–50%	76–100%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**15**	**Moderate Instability**
Reach 29	Silt Clay	No	11–25%	11–25%	Fluvial	Fluvial	11-25%	11-25%	11-25%	11-25%	11-25%	11-25%	Stage 3	**22**	**Considerable Instability**
Reach 30	Bedrock	No	11–25%	26–50%	Fluvial	Fluvial	11-25%	11-25%	76-100%	76-100%	11-25%	11-25%	Stage 4	**16**	**Moderate Instability**
Reach 31	Silt Clay	No	26–50%	51–75%	None	None	11-25%	11-25%	11-25%	11-25%	0-10%	0-10%	Stage 3	**18**	**Moderate Instability**
Reach 32	Bedrock	No	0–10%	76–100%	Fluvial	Fluvial	11-25%	11-25%	11-25%	11-25%	26-50%	0-10%	Stage 4	**18**	**Moderate Instability**
Reach 33	Silt Clay	No	11–25%	26–50%	Fluvial	Fluvial	26-50%	26-50%	11-25%	11-25%	11-25%	11-25%	Stage 4	**24**	**Considerable Instability**
Reach 34	Silt Clay	No	26–50%	11–25%	Fluvial	Fluvial	26-50%	26-50%	0-10%	0-10%	0-10%	0-10%	Stage 4	**26**	**Considerable Instability**
Reach 35	Silt Clay	No	11–25%	51–75%	None	None	0-10%	0-10%	0-10%	0-10%	0-10%	0-10%	Stage 1	**17**	**Moderate Instability**
Reach 36	Silt Clay	No	11–25%	26–50%	Fluvial	Fluvial	26-50%	26-50%	76-100%	76-100%	11-25%	11-25%	Stage 4	**21**	**Considerable Instability**

Stability score key:

<10: Considerable Stability 10-20: Moderate Instability >20: Considerable Instability