GeoSolve Ref: 240038
6 June 2024

Hartley Road Partnership
1 Jennings Way,
Earnscleugh 9391
CC' Peter Dymock (Patersons)

Attention: Leon Van Boxtel

Geological Review and Natural Hazards Assessment State Highway 8 and Springvale Road, Intersection

1.0 Introduction

This report summarises the results of a preliminary geological review and natural hazards assessment completed for a proposed plan change to a property on the corner of State Highway 8 (SH8) and Springvale Road, Clyde. This report is intended to support the plan change application to Council.

Photo 1. Panoramic site photo looking northwest across the proposed area for plan change.

The assessment was completed for Hartley Road Partnership in accordance with GeoSolve Ltd.'s Short Form Agreement (Ref no. 240038) dated 19th of January 2024, which outlines the scope of work and conditions of engagement.

2.0 Proposed Development

It is proposed to re-zone the existing property from a rural to industrial land use on the Central Otago District Plan. Access to the development will be via Springvale Road.

Preliminary geological and natural hazards information is required from GeoSolve to support an application to Council for plan change. Confirmatory subsurface investigations have not been undertaken as part of this report but are recommended later as part of the resource consent or design phase. Sufficient engineering geological information exists at this stage of the process.

A conceptual plan outlining what a potential future development might look like on the property should it be re-zoned to industrial is presented on Figure 2 attached.

3.0 Preliminary Geological Review

The GNS Science 1:250,000 geological map area of the Wakatipu indicates that the property is underlain by glacial outwash gravels (Q4a and Q12a). These soils are in turn underlain by over-consolidated Bannockburn Formation lake sediment of the Manuherikia Group (mMm) at an unknown depth. Regionally extensive schist bedrock is exposed on the range northwest of Clyde Township and will underlie the site at considerable depths.

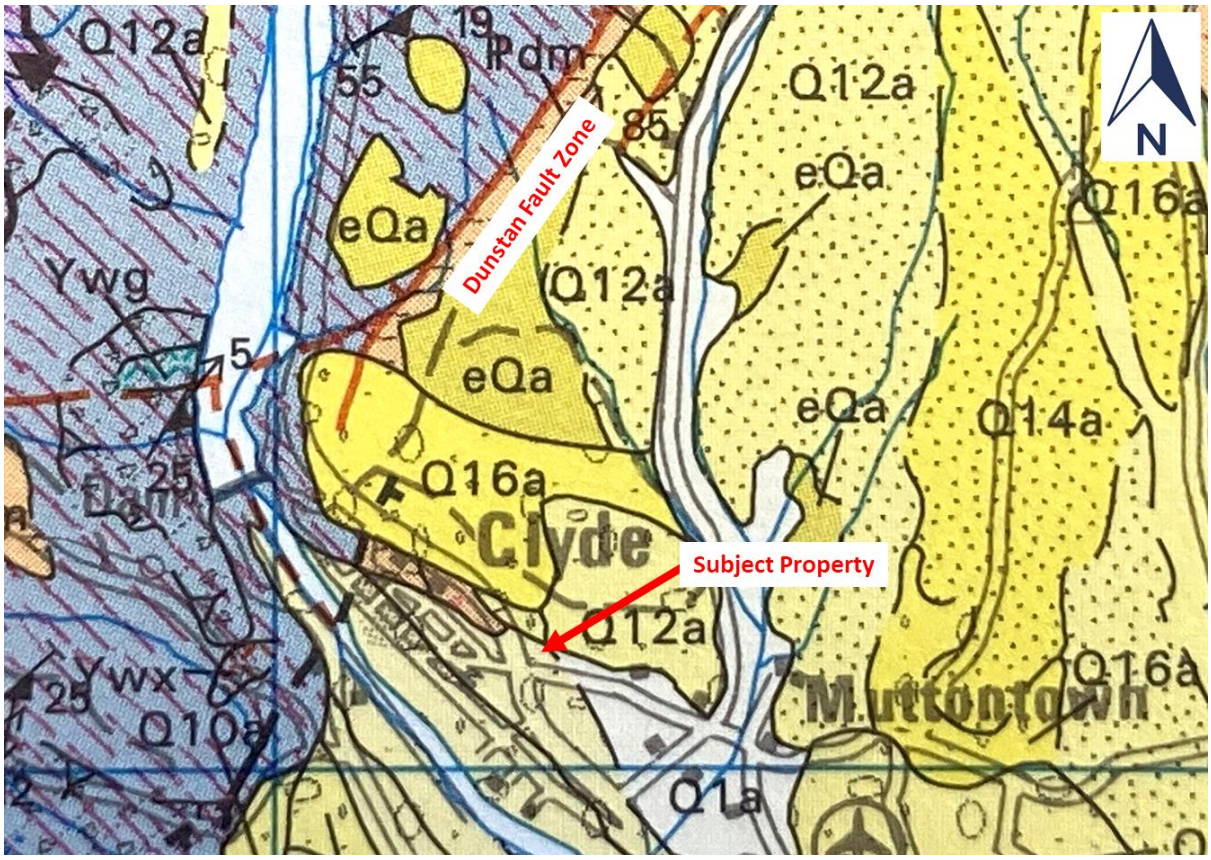


Figure 1. Image taken from the GNS Science 1:250,000 geological map of the property and surrounding area.

An outwash terrace riser strikes northwest oblique to the northeast site boundary. The terrace riser marks the change from the upper Q12a outwash surface compared to the

lower degraded Q4a outwash surface. Site inspection confirmed the presence of four small alluvial fans which have formed along the base of the terrace riser. The fan alluvium is likely to grade between silt, sand, and gravel. An engineered fill batter boarders the western edge of the property beneath the state highway.

No spring flows or groundwater seepages were observed within the property and are unlikely in this terrain. An ORC registered borehole (G42/0117) drilled on the opposite side of Springvale Road around 190 m south of the property encountered the regional groundwater table at 26 m below ground level (bgl).

LiDAR contour data for the property and wider area is presented on Figure 2 attached.

4.0 Natural Hazards Assessment

Geological field mapping and relevant features discussed in the following subsections are shown on Figure 2 attached.

Alluvial Fan and Flooding:

Four relatively small alluvial fans terminate within the boundaries of the property. The fans have formed via localised runoff from the upper outwash surface and overlie the lower degraded terrace. Subdued ephemeral gullies dissect the face of the terrace riser above the fans. No evidence of recent sedimentation was observed, and the fans are currently inactive, although this doesn't suggest renewed activity in the future isn't possible. However, given the limited upslope catchment area it's likely the fans have formed due to extreme rainfall (i.e. >500-year return period), alternatively they could be geologically very old having formed immediately post glaciation.

Either way the defunct water race shown on Figure 2 cuts through the head of the fans and forms an effective cut-off trench to capture and divert upslope run-off away from future development. The water race trench ranges around 0.8-1 m deep and is now no longer used. Localised surface run-off from the ephemeral gullies and terrace slope during heavy rainfall is expected to be the primary issue rather than sedimentation.

An existing stormwater channel, shown below in Photo 2, runs alongside the state highway and discharges near the northwestern corner of the property along the edge of the fill batter. The channel collects upslope runoff from an even larger ephemeral gully further northwest along the outwash terrace. Stormwater runoff is currently dispersed via an elongated dispersion swale roughly 2000 m^2 in area between the toe of the batter and the western site boundary. We understand that Patersons have considered stormwater runoff and dispersion from the channel outlet as part of their scheme plan development.

Photo 2. Looking southeast along the stormwater channel towards the development area beyond.

The location of the stormwater channel and dispersion swale alongside the highway are also shown on Figure 2.

Slope Stability:

Given the gentle gradients within the property there are no slope instability issues for the development. The inclination of the terrace riser is also less than the upper repose angle of 36˚ for a cohesionless outwash gravel. Earthworks cuts will be required to form sub-horizontal construction platforms on gently sloping ground.

Rock-Roll:

Albeit relatively isolated, there is some potential for localised rock-roll into the development area originating from the upslope terrace riser. Several outwash boulders of variable size and embedment have become exposed by erosion and in some instances could be re-mobilised via seismic shaking or gradual weathering. The two example boulders shown below in Photos 3 & 4 have the most potential to be dislodged from the slope. However, this issue is straightforward to remediate using an excavator or hand tools to pluck the boulders from the slope well in advance of future development. Boulders which are partially embedded within the slope, preventing rock-roll, should be left untouched to avoid undue slope disturbance.


Photos 3 & 4. Example boulders with the most potential to become dislodged from the terrace slope. Geological hammer for scale.

No evidence of historic rock-roll is present on the ground surface within the development area along the base of the terrace.

Seismic Stability/Risk from Active Faults:

Active fault traces were not observed onsite although the Dunstan Fault Zone is mapped as a series of active fault structures within 3 km northwest of the property (refer Figure 1 above). However, due to the estimated >5,000 to ≤ 10,000 years average return periods for earthquakes on this fault zone, the seismic risk posed by this structure is considered relatively low. Furthermore, the property is situated outside the active fault entity area associated with the Dunstan Fault Zone, an inferred area of land potentially subject to ground surface rupture during fault movements.

The Alpine Fault, located approximately 140 km to the northwest, runs along the western foothills of the Southern Alps, and is likely to present a more significant seismic risk in the short term. There is a high probability that a major earthquake of Magnitude 8 or more will occur along the Alpine Fault within the next 50 years and such a rupture is likely to result in moderate ground shaking in the vicinity of Clyde-Alexandra. The Alpine Fault is considered to provide the governing seismic risk for the site from a geotechnical and planning perspective.

Seismic Liquefaction:

The ORC natural hazards database indicates the site is situated within mapped liquefaction category Domain A with low to no liquefaction potential. This has been categorised on the basis that the site is inferred to be predominantly underlain by rock or firm sediments i.e., Bannockburn Formation. Owing to the depth to regional groundwater (approximately 26 m bgl), GeoSolve considerers the risk of seismic liquefaction at this site to be low. No further assessment is necessary with respect to this hazard.

5.0 Foundation Bearing Capacity and Subsoil Category

Glacial outwash deposits comprising sand and gravel are likely to predominate beneath future building foundations, although loess and variable fan alluvium are also likely. Outwash gravel typically meets the minimum requirements for NZS 3604:2011 "good ground" conditions, however a range of bearing capacities can be expected on this site and will need to be confirmed via subsurface investigation. For sloping lots (i.e. Lots 1 and 17-21) requirements with regards to foundation footings and the adjacent sloping ground surface will need to be considered.

The site is likely to comprise "Class C" (shallow soil site) or "Class D" (deep soil site) in accordance with NZS 1170.5:2004 seismic provisions. The allocation of Class C or D subsoil category at this site is based on ORC registered boreholes located on the wider Clyde Terrace and the inferred depth to Manuherikia Group (very weak rock). If assurance of subsoil class is required for detailed design a deep borehole investigation would be required to confirm the depth to Manuherikia Group rock beneath the development area.

6.0 Recommendations and Considerations

Site-specific subsurface geotechnical investigations are recommended during resource consent and design stages for future building foundations. Test pitting and Scala penetrometer testing is required to confirm soil parameters and bearing capacity for foundation and earthworks design. Site investigations will also need to assess temporary and permanent batter slopes into sloping ground and any associated retaining parameters.

Future construction will need to consider the effects of surface water run-off and ponding from the upslope terrace riser, ephemeral gullies, and highway stormwater channel. The defunct water race shown on Figure 2 will form an effective cut-off trench to capture and divert upslope run-off away from future development. It is recommended that the defunct water race is assessed to ensure it can take the required overland flow volumes and that it should be upgraded then maintained to serve this purpose. The water race also needs to be checked to confirm any potential for leakage or run-off into the development during flow. Standard floor level elevations and additional cut-off drains can also be utilised to mitigate any residual run-off issue. Additional cut-off drains will need to be incorporated into the stormwater design for the wider development. It's important that design provisions for the highway stormwater channel be considered now as part of the scheme plan. A stormwater runoff assessment is recommended to be undertaken at the resource consent stage to address all the stormwater issues discussed above. Viable options to manage and mitigate site runoff issues are available.

Problematic boulders on the terrace riser above the development should be plucked/ removed from the slope in advance of future development. However, boulders with partial embedment should be left untouched to prevent undue slope disturbance. Removal of problematic boulders should be confirmed by a geotechnical practitioner at a later stage once the plan change application has been granted. We assume the removal of problematic boulders can be readily facilitated given their location within the town belt (refer Figure 2).

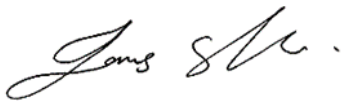
We don't foresee any site-specific constraints with respect to the prevailing geotechnical conditions or natural hazards which would prevent industrial development of the property; noting the recommendations provided above. A risk of seismic activity is present in the region from the Alpine Fault and appropriate allowance should be made for seismic loading during detailed design of any future building, foundations, retaining walls and earthworks.

Based on the current assessment, the development is technically feasible from a geotechnical perspective; noting that site-specific ground investigations and stormwater assessment, reporting and design will be required during the resource consent and design phases.

7.0 Applicability

This report has been prepared for the benefit of our client, Hartley Road Partnership, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Please do not hesitate to contact the undersigned if we can provide any further assistance with this project.

Report prepared by:	Reviewed for GeoSolve Ltd by:
	
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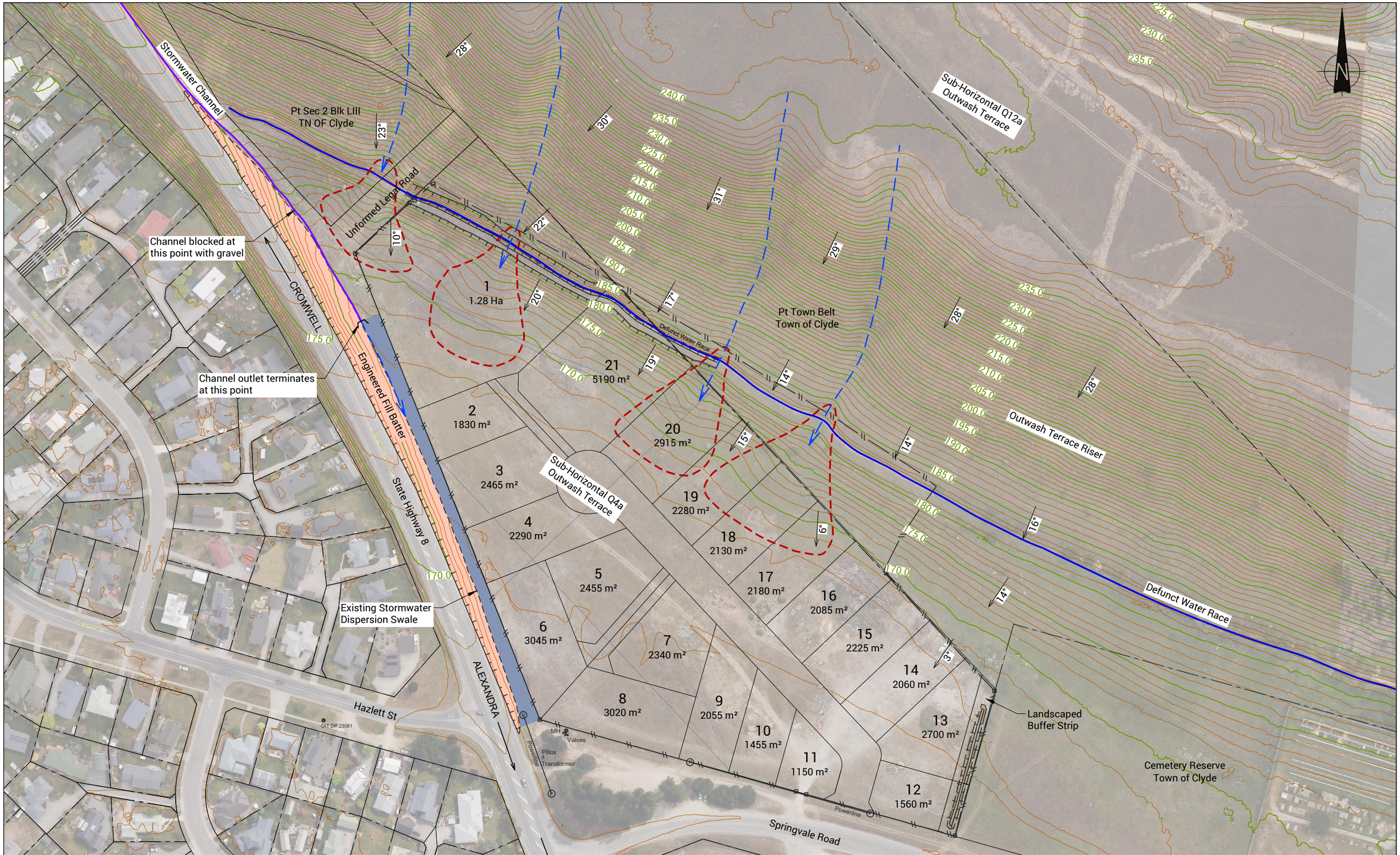
James Stewart Engineering Geologist	Fraser Wilson Senior Engineering Geologist

Attachments:

- Subdivision Scheme and Field Mapping Plan (Figure 2).



Notes:
1. These drawings have been prepared for the benefit of Hartley Road Partnership with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Legend:

- Alluvial Fans
- Ephemeral Flow Paths
- Defunct Water Race
- Engineered Fill Batter
- Existing Stormwater Dispersion Swale
- Stormwater Channel
- 19° Slope Direction and Angle

SCALE 1:2000

0 20 40 60 80 100 (m)

GEOSOLVE

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DRAWN	WCG	Jun.24
DRAFTING CHECKED	JAS	Feb.24
APPROVED	FAW	Feb.24
CADFILE: 240038.dwg		
SCALES (AT A3 SIZE): 1:2000		
PROJECT No: 240038	FIG No: Figure 2	REV. 0

Hartley Road Partnership

Corner of SH8 and Springvale Road, Clyde

Geotechnical Assessment

Site Plan