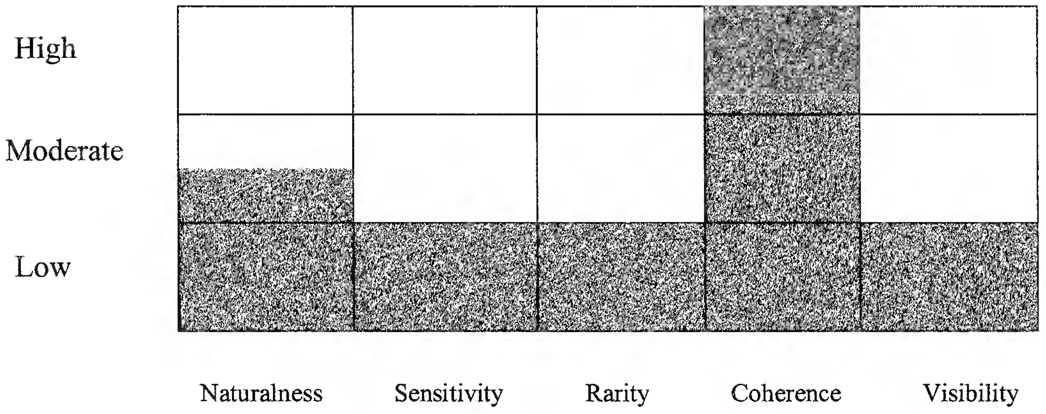

Fig 1. Summary of effects on the character and quality of the landscape

95. Although the site will incorporate built forms, it will also become more diverse especially with vegetation. The effect will be a change from a pastoral grassland landscape to a residential subdivision of houses, roads, and vegetation. The effect on the wider community will be a limited one and mainly due to the form and existence of buildings and new roads. Locating the closer density housing areas at lower elevation as proposed, will contribute to reducing the landscape and visual impacts.

Development Concept

Suitable vegetation

96. Suitable vegetation will be planted which will adapt well to the site conditions. The overall theme will consist of both native vegetation for riparian areas and exotic vegetation for streets and amenity.

97. The planting schemes will achieve the following landscape objectives:

- re-establishing native dryland vegetation and associated ecosystems that will enhance the natural environment.
- mitigating the visual effects of roading and residential development.

- improving the ‘living’ environment for future residents with strategic landscape planting for privacy, shelter and shade, and for visual amenity.
- enhancing slope stability and reducing erosion by planting in order to slow and filter the runoff into the ephemeral streams on the site.
- Control and maintenance of weed growth.

Exotic vegetation

Native vegetation

(see also images 10.1-10.4 in Graphic Supplement).

Recreation Reserves

98. In consultation with the Marlborough District Council Reserves team a recreational area will be set aside for land between the Taylor River and Taylor Pass Road. This area will not only serve the amenity of local residents but will be a destination for the wider community. Design of any reserve area will be done in concert between the developer and the MDC Reserves team.

99. The proposed extension to the Taylor Dam Reserve offers a significant area for developing a range of recreational opportunities. This expanded and enhanced reserve will be a feature of the lifestyle that the Maxwell Hills development will offer future residents (see images 11.0-14.0 and plan 15.0 in Graphic Supplement).

100. The new reserve area combined with the existing Taylor Dam reserve also offers a substantial area that could be developed to create a significant Regional Park.

Mitigation Measures

101. Building height: At present 10m is permitted in a rural zone. However, because of the density of this development as ‘rural-residential’ the standard residential height of 8.0m is more appropriate so that neighbouring properties do not have their views restricted, and that the buildings are not as prominent from outlying-g viewpoints.

102. The colour scheme for buildings (roofs and cladding) is reasonably liberal. However, bright roof colours (such as orange, red and bright blues) should be avoided. Integration of buildings with bright colours would be very hard to mitigate and could create adverse visual effects so as to have a negative effect on the landscape character of the location. It is recommended that muted, natural or earthy tones are used so as to avoid incongruous colours with the landscape.

Conclusion

103. In the Wairau / Awatere Landscape Assessment, it stated that the Wairau Valley was a “highly modified natural environment” and that, *“the Wairau Plain allows fewer opportunities for development to blend into the landscape, where as the valley areas were less sensitive given their enclosed environment and the ability for development to be well integrated into the gullies and vegetated areas”.*

104. The Maxwell Hills Plan Change area is a development which could quite easily assimilate into the valley landscape which is visually enclosed. This site has a high absorption capacity.

Appendices

Appendix 1 – Plant List

Suitable native trees with their botanical names are:

akiraho;	*Olearia paniculata.*
black beech;	*Nothofagus solandri.*
broadleaf;	*Griselinia littoralis.*
cabbage tree;	*Cordyline australis.*
five finger;	*Pseudopanax arboreas.*
Halls totara;	*Podocarpus hallii.*
kahikatea;	*Dacrycarpus dacrydioides*
kanuka;	*Kunzea ericoides.*
kohuhu;	*Pittosporum tenuifolium.*
kowhai;	*Sophora mycrophylla.*
lancewood;	*Pseudopanax crassifolius*
lemonwood;	*Pittosporum eugenioides*
mahoe;	*Melicytus ramiflorus.*
manuka;	*Leptospermum scoparium.*
matai;	*Prumnopitys taxifolia.*
ngaio;	*Myoporum laetum*
red beech;	*Nothofagus fusca.*
ribbonwood;	*Plagianthus regius*
titoki;	*Alectryon excelsus.*
totara;	*Podocarpus totara.*
wineberry;	*Aristotelia serrata.*

Suitable native shrubs and groundcover includes:

flax;	*Phormium tenax.*
matagouri;	*Discaria toumatou.*
mountain flax;	*Phormium cookianum.*
pink tree broom;	*Carmichaelia carmichaeliae*
porcupine shrub;	*Melicytus "Waipapa".*
prostrate kowhai;	*Sophora prostata.*
shrubby torararo;	*Muehlenbeckia astonii.*
silver tussock;	*Poa cita.*
tauhinu;	*Ozothamnus leptophyllus.*
toetoe;	*Cortaderia richardii.*
tree hebe;	*Hebe parviflora.*
wiggy wig;	*Muehlenbeckia complexa.*

Kapiti Views Trust

Maxwell Hills Development

Plan Change Landscape Report

Landscape Assessment
Graphic Supplement

08 Feb 2011

Prepared By:
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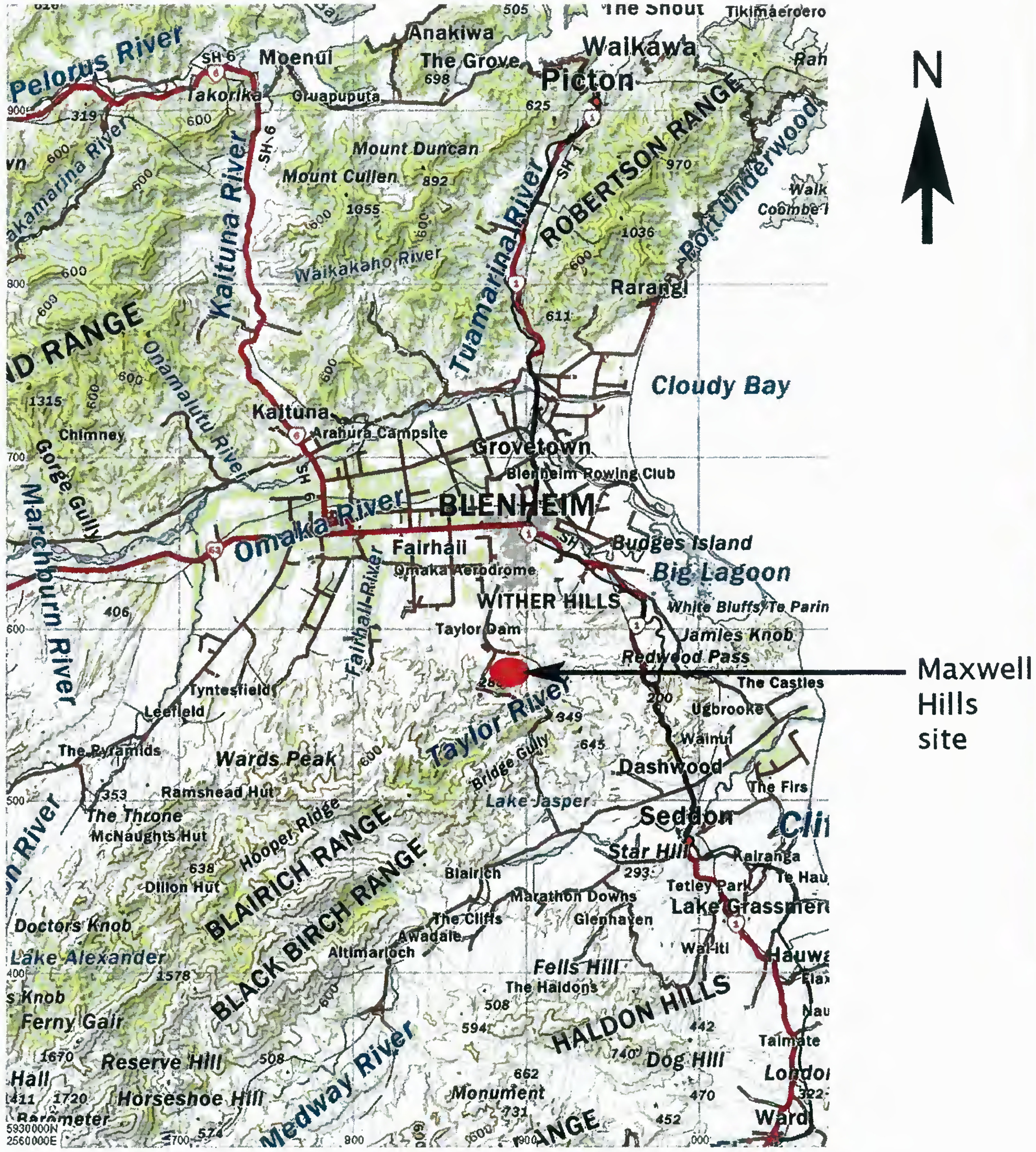
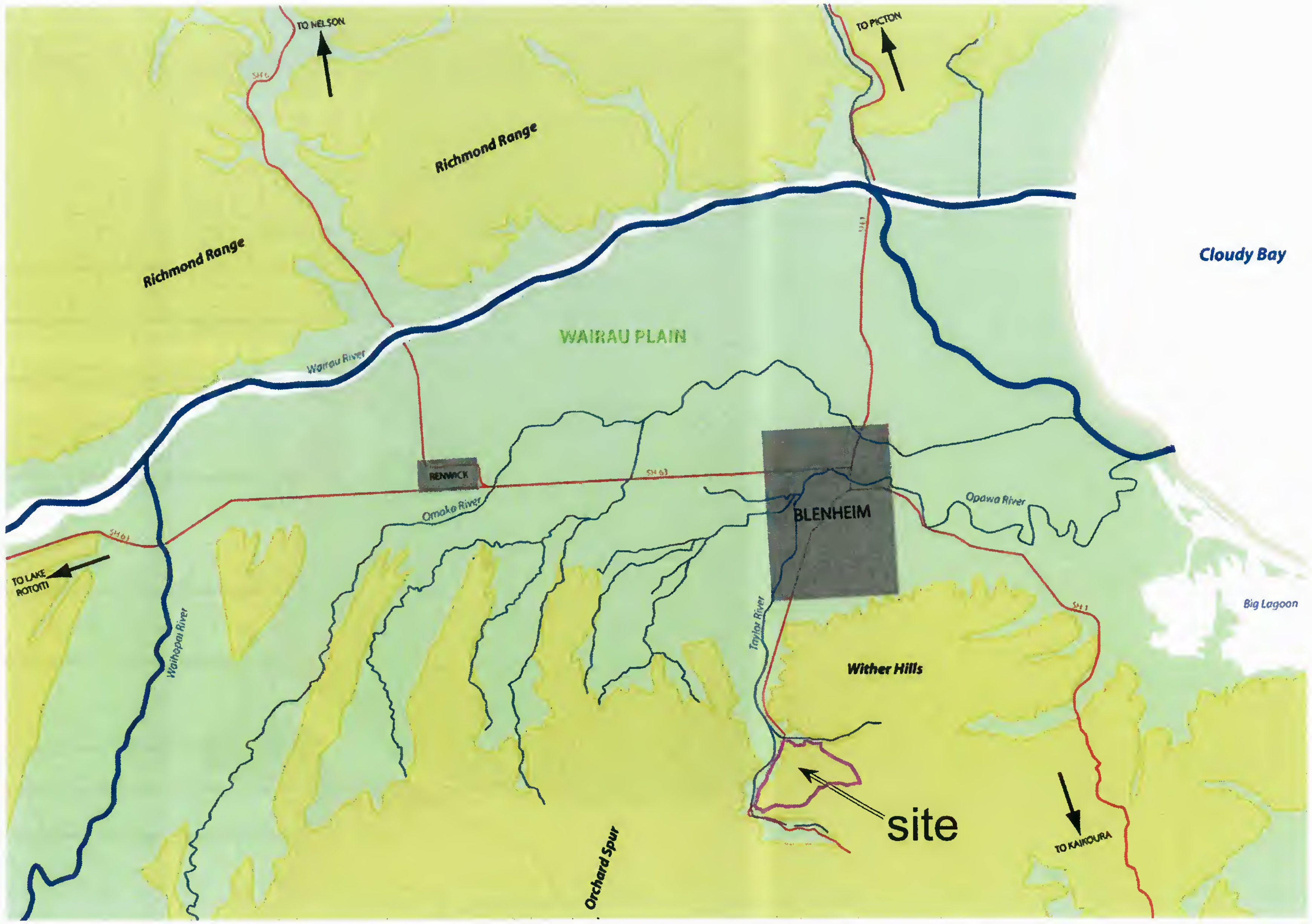
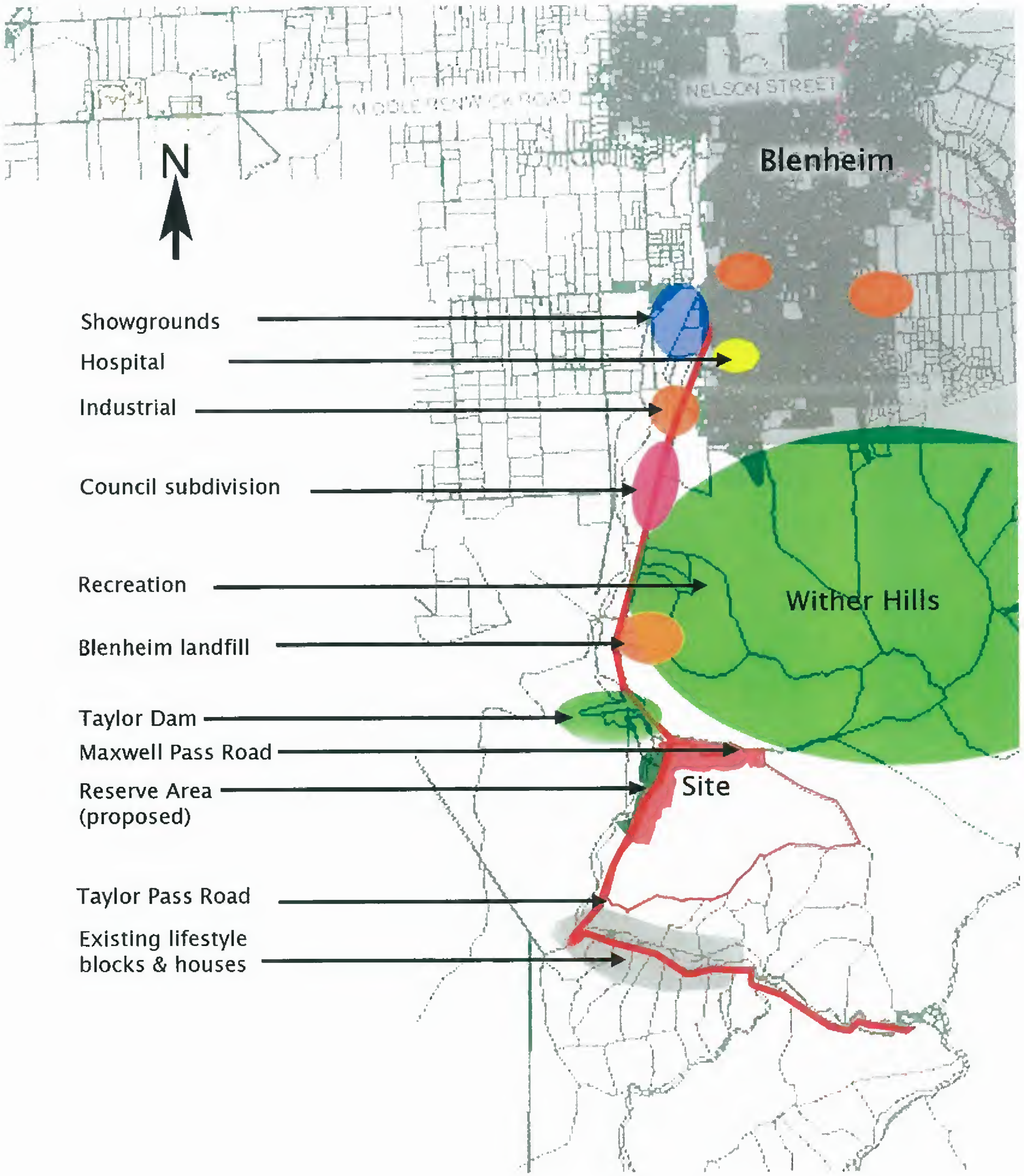
Christchurch 8141, NEW ZEALAND
P.O Box 13162
Ph. 03 3654599
www.chrisglasson.com



1.1 Site context - location map



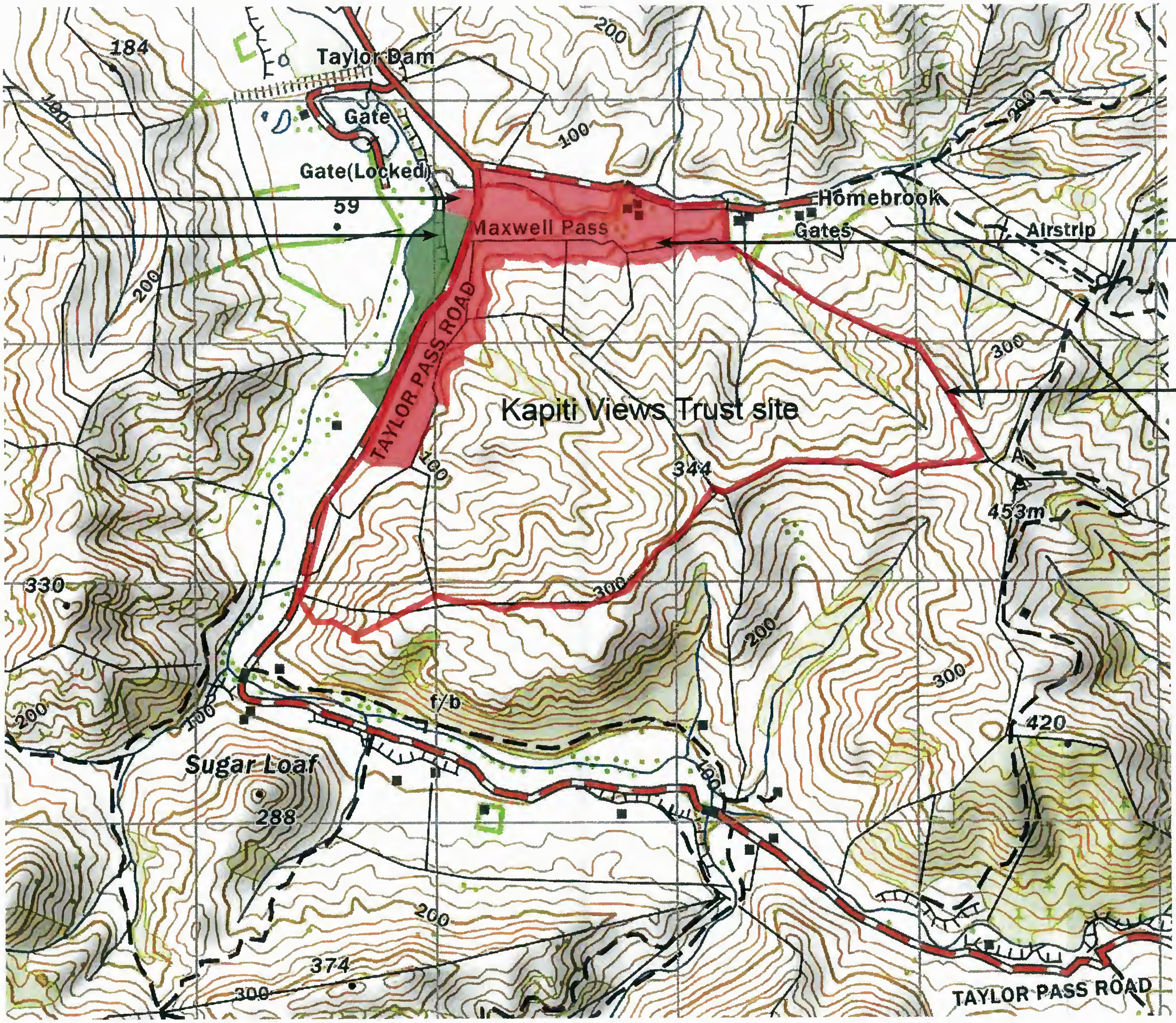
1.2 Site context - landscape of the Wairau Plain



2.0 Landuse Map

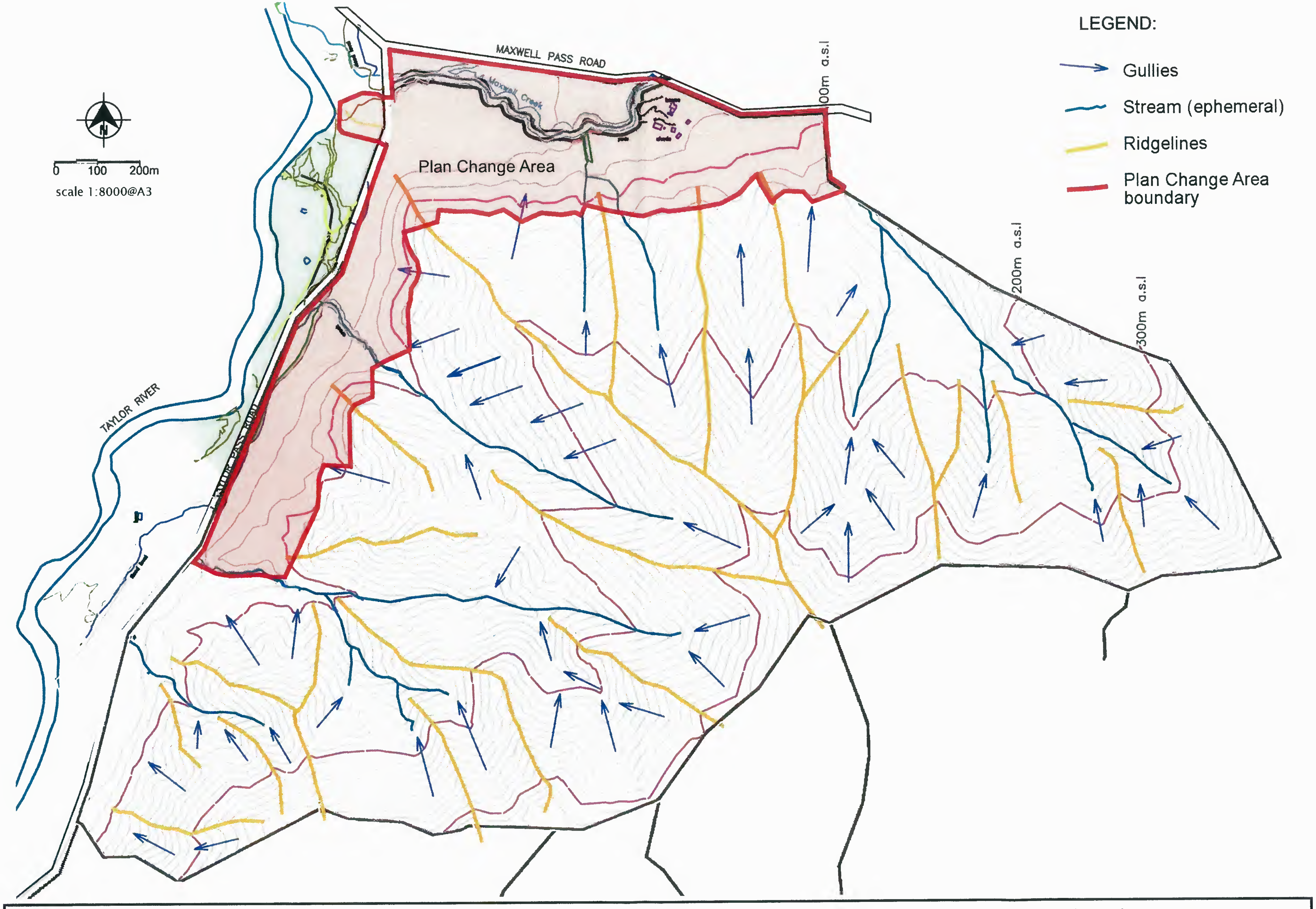
utilities area

proposed reserve area



Plan Change area

overall boundary of
Kapiti Views Trust site



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4.0 Topography and
Drainage Patterns

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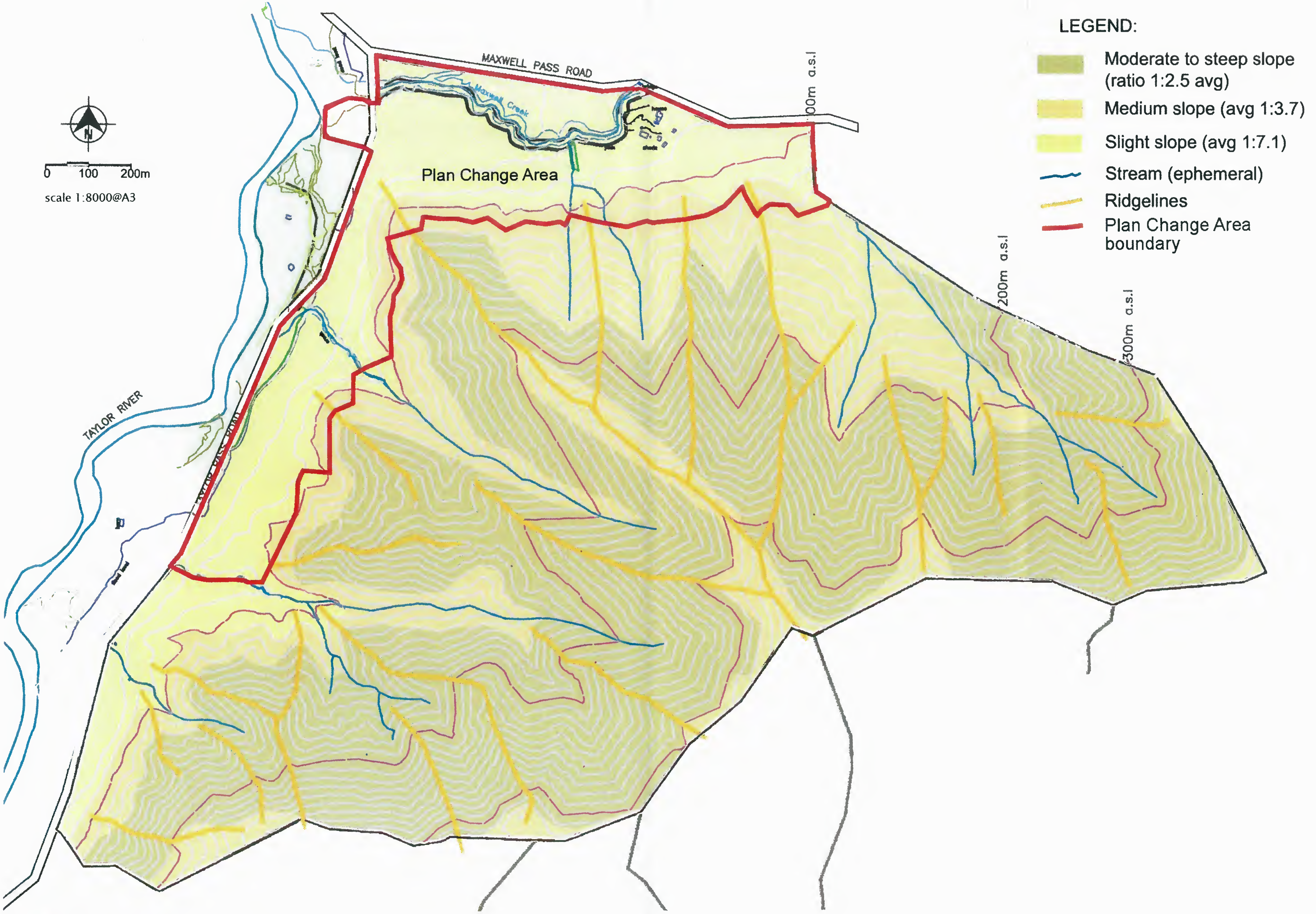

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Landscape Architects Ltd

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5.0 Slope Analysis

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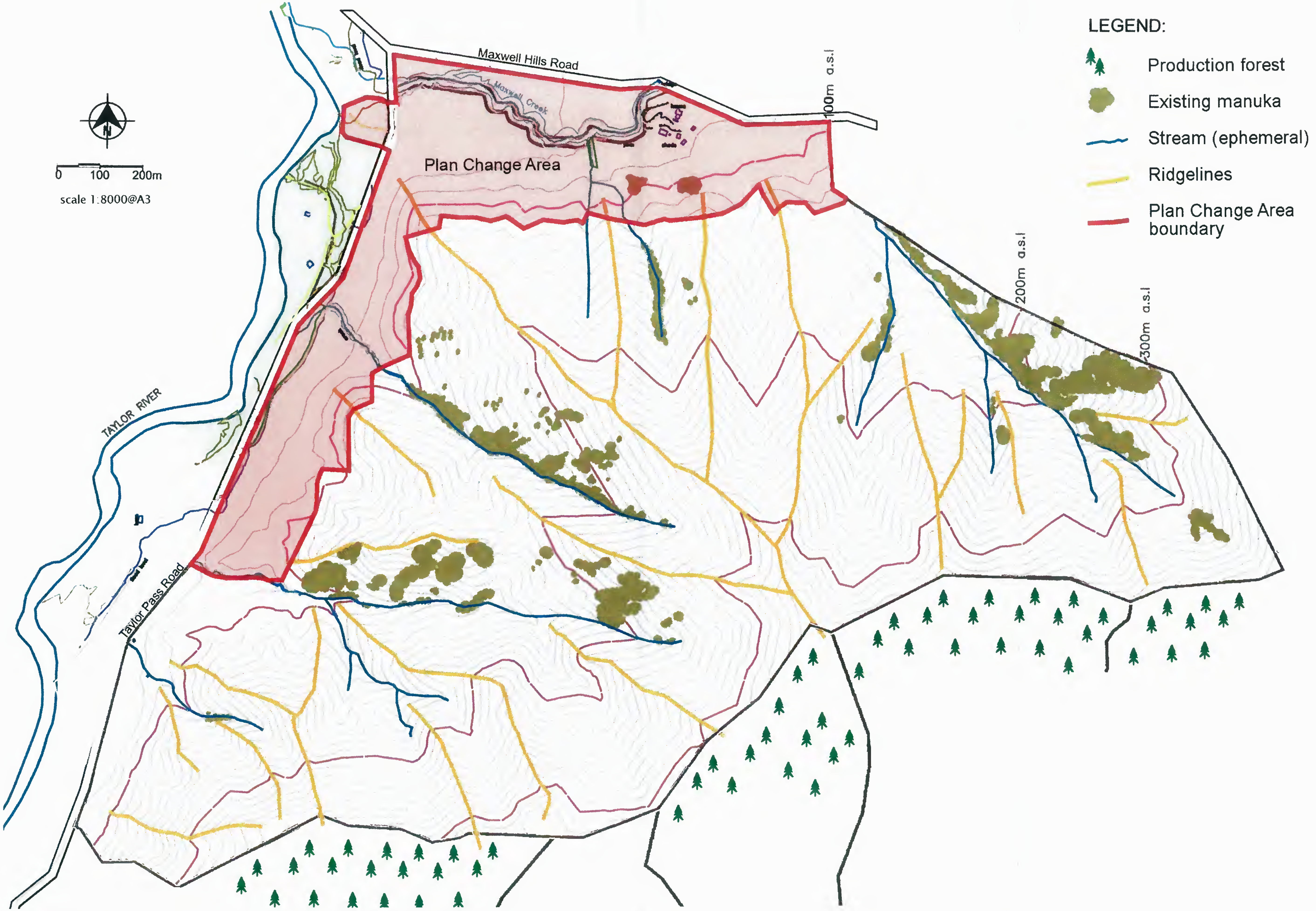

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6.0 Existing Vegetation

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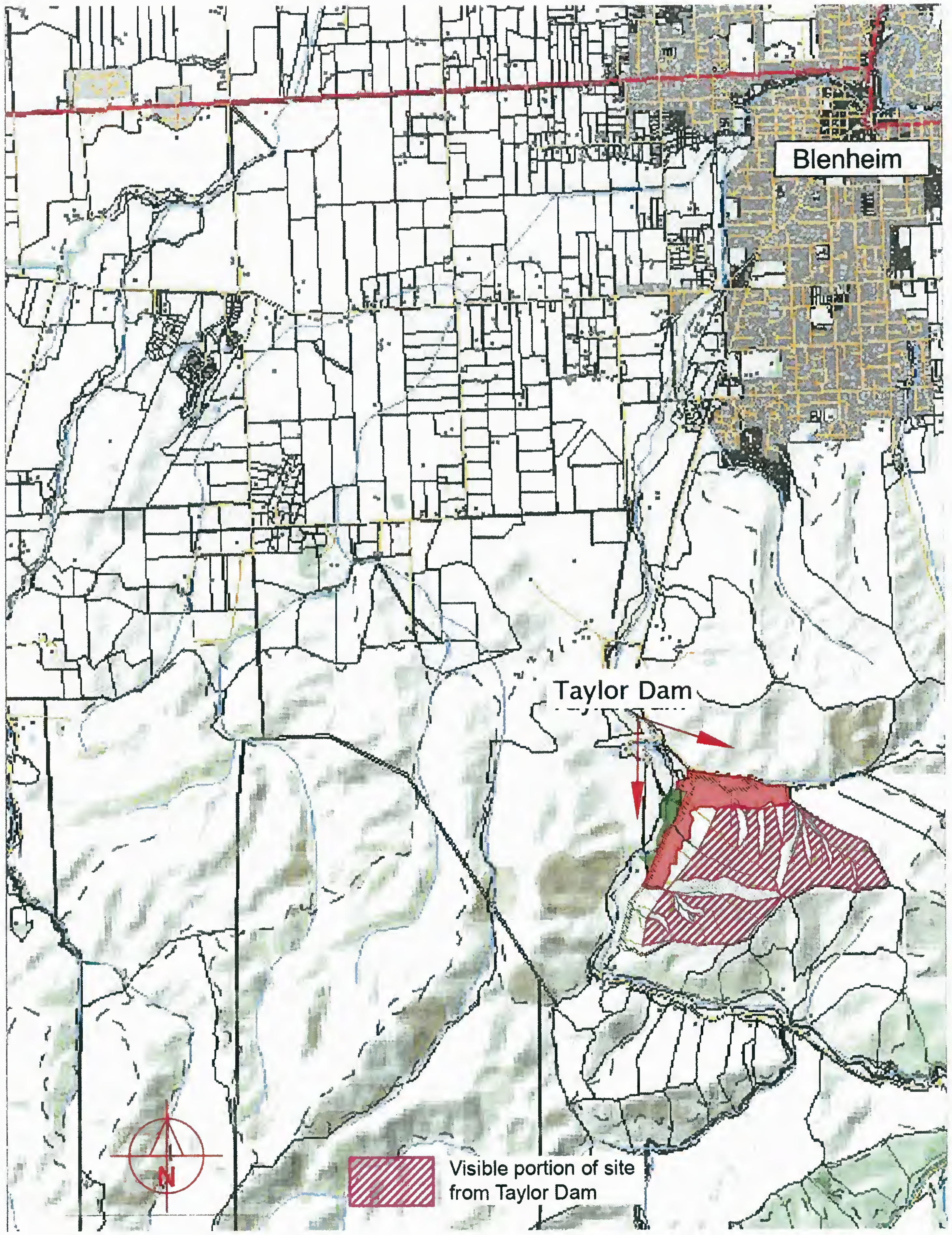
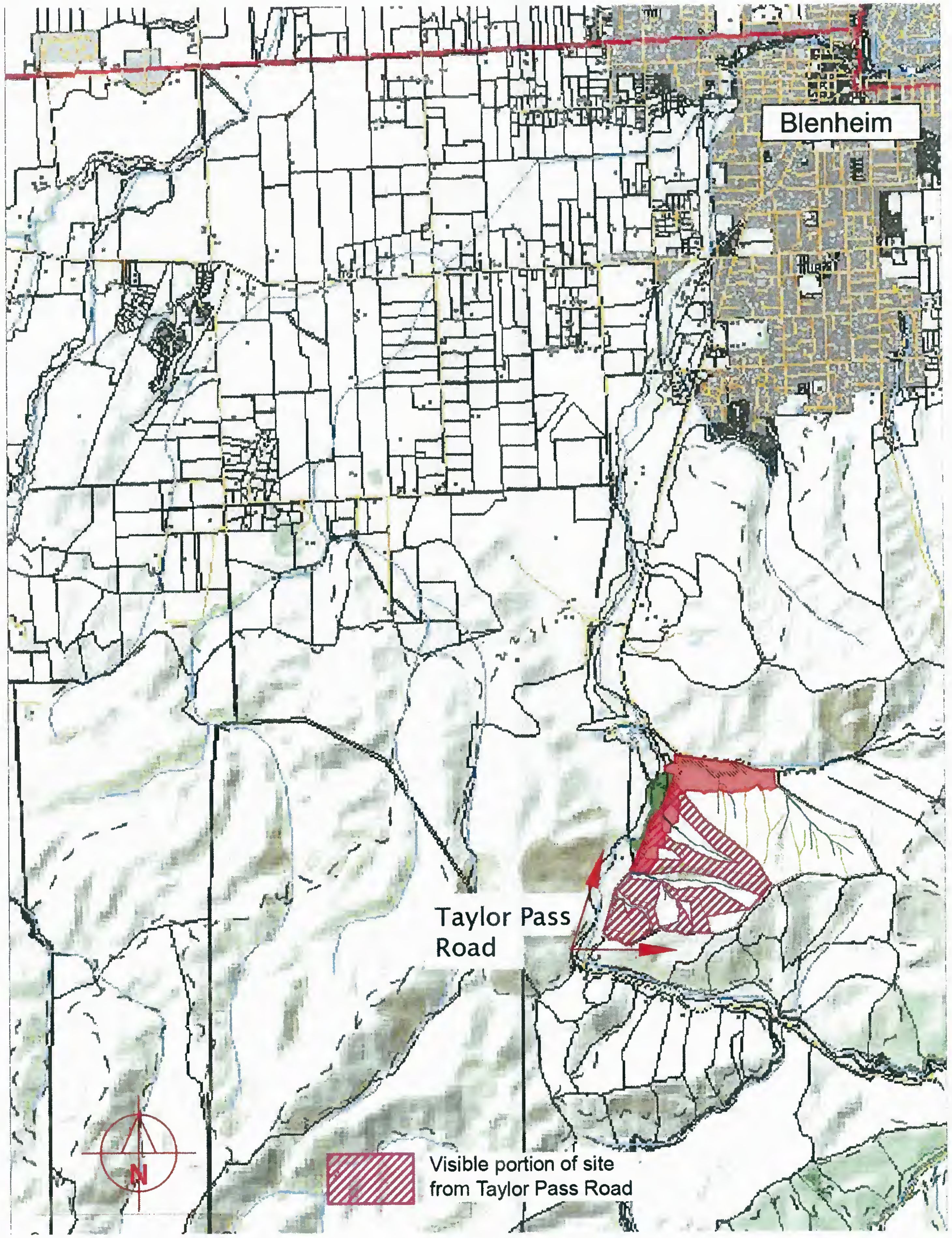


7.1 Viewpoint and visible portion from Taylor Dam



7.2 Viewpoint and visible portion from Taylor Pass Road

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7.0 Visibility Maps

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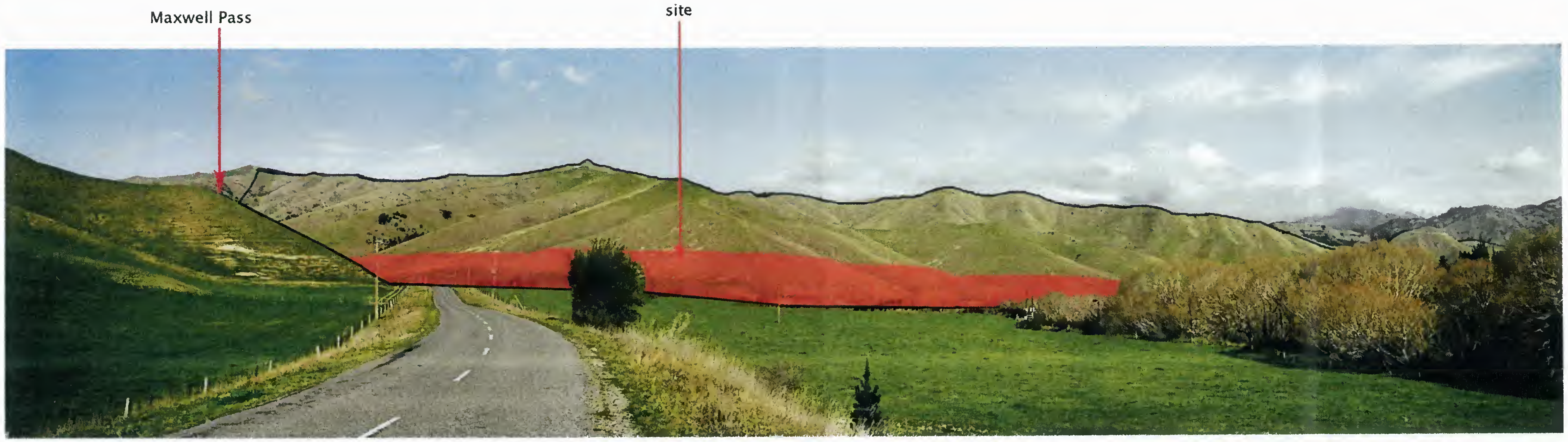
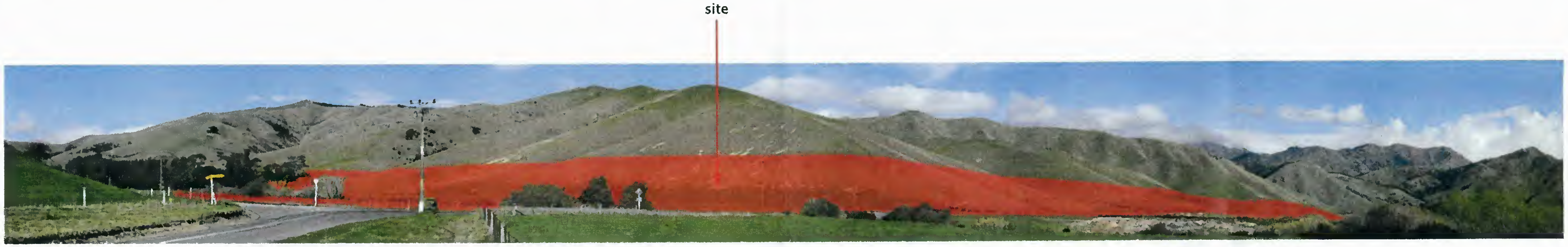


8.1 View of site looking eastwards from the road south of the Taylor Dam



8.2 View of site from near Maxwell Pass Road and Taylor Pass Road intersection

8.3 View of site from the Taylor Dam

9.1 Kanuka on south facing slopes

9.2 Regenerating slopes

9.3 *Muehlenbeckia complexa*

9.4 Kowhai

9.5 Kowhai

9.6 Taylor Dam – wetland

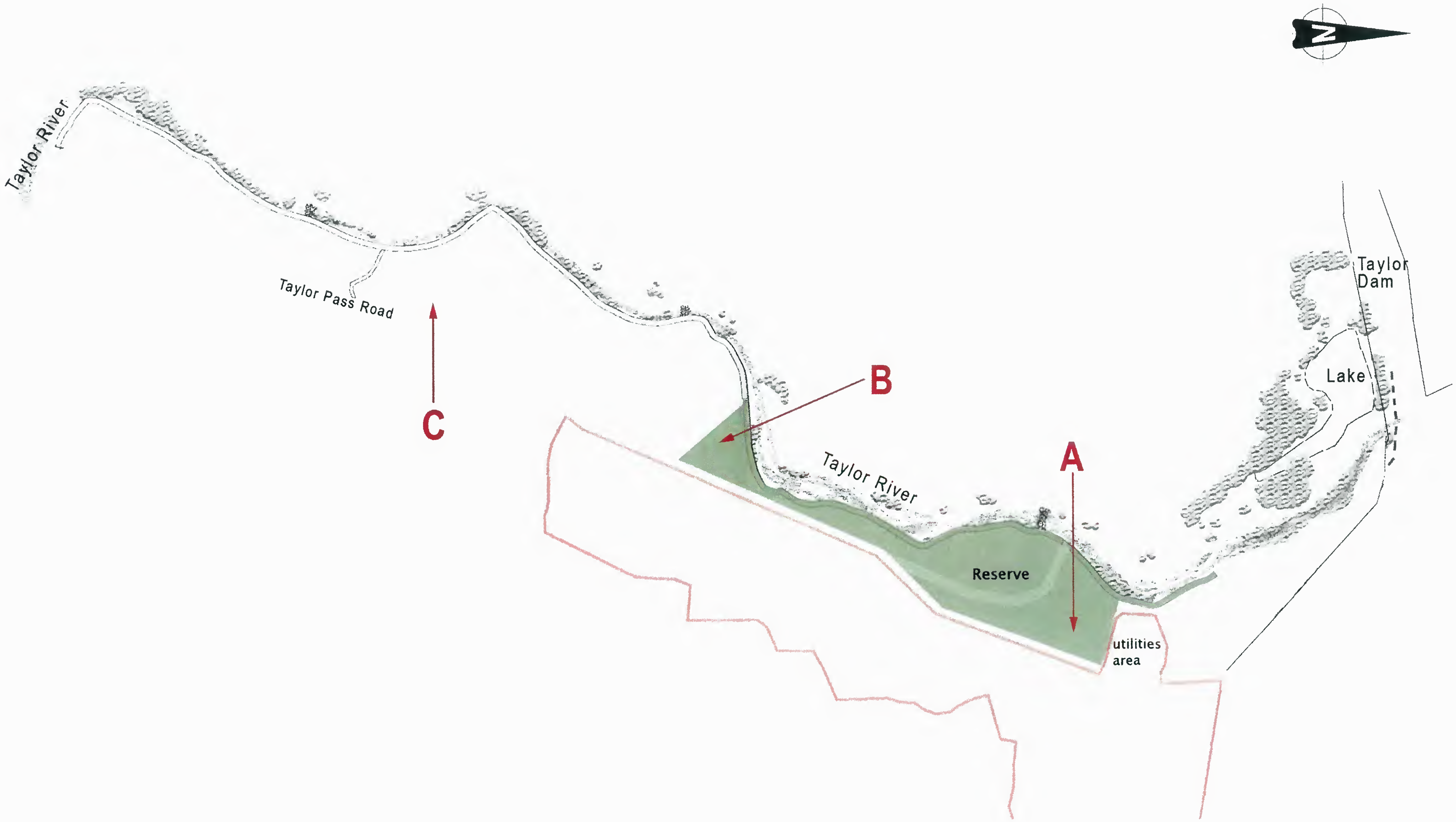
10.1

10.2

10.3

10.4

10.0 Examples of successful planting, Blenheim Landfill


Taylor River
Taylor Pass Road
C
B
Taylor River
A
Reserve
utilities area
Taylor Dam
Lake
N

12.1 View of the reserve at viewpoint 'A' looking southwards

12.2 View of the reserve, Maxwell Pass Road and subdivision site from viewpoint 'A', looking eastward

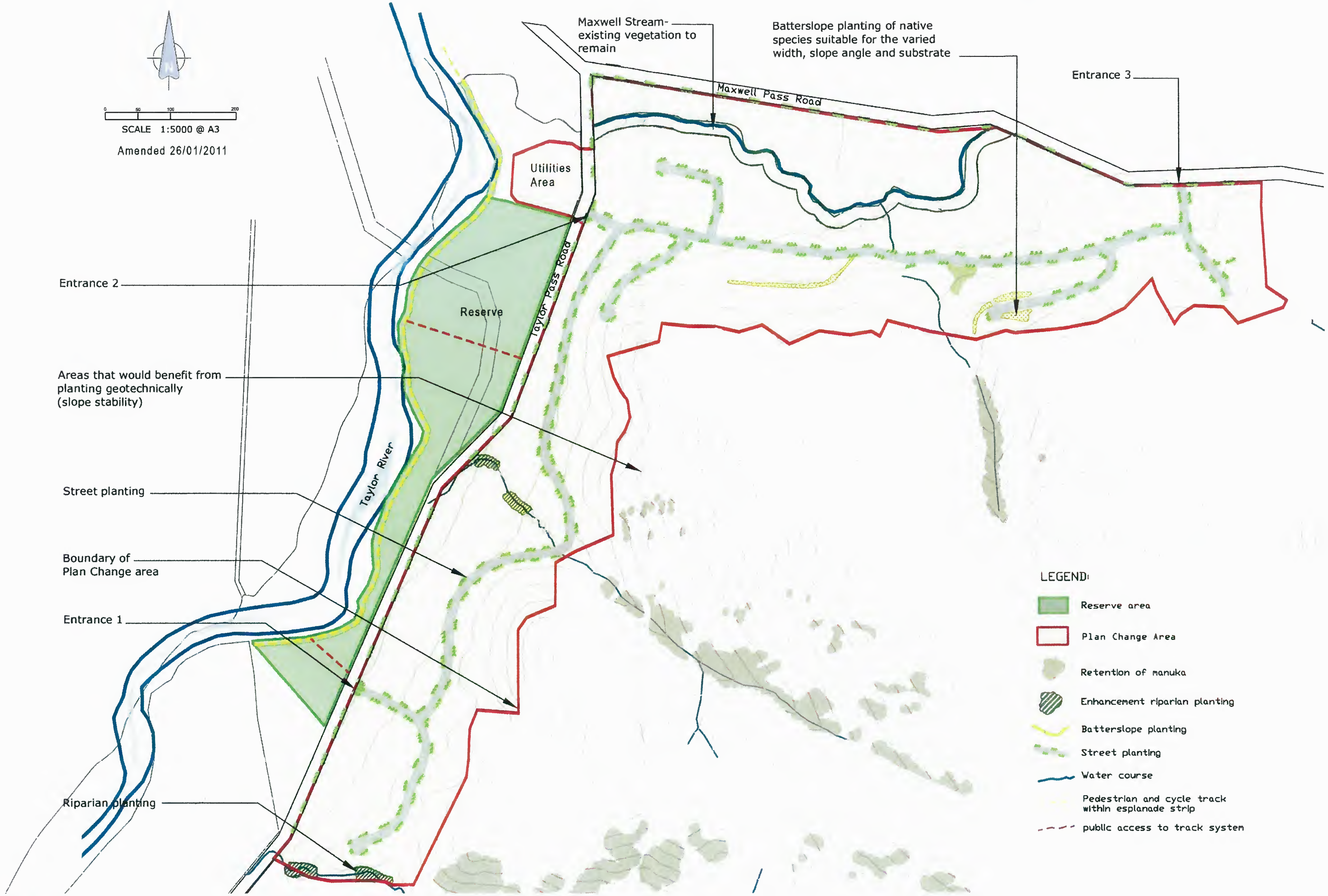
13.1 View of proposed reserve area (in foreground) looking southward

13.2 View of land between the Taylor Pass Road and the river looking southward

14.1 View of the subdivision site near entrance 1, opposite viewpoint 'B' (see page 11)

14.2 View of the subdivision site adjacent Taylor Pass Road near entrance 1, opposite viewpoint 'B' (see page 11)

14.3 View at point 'C' (see page 11)



Maxwell Stream- existing vegetation to remain

Batterslope planting of native species suitable for the varied width, slope angle and substrate

Entrance 3

Entrance 2

Areas that would benefit from planting geotechnically (slope stability)

Street planting

Boundary of Plan Change area

Entrance 1

Riparian planting

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15.0 Landscape Concept Plan

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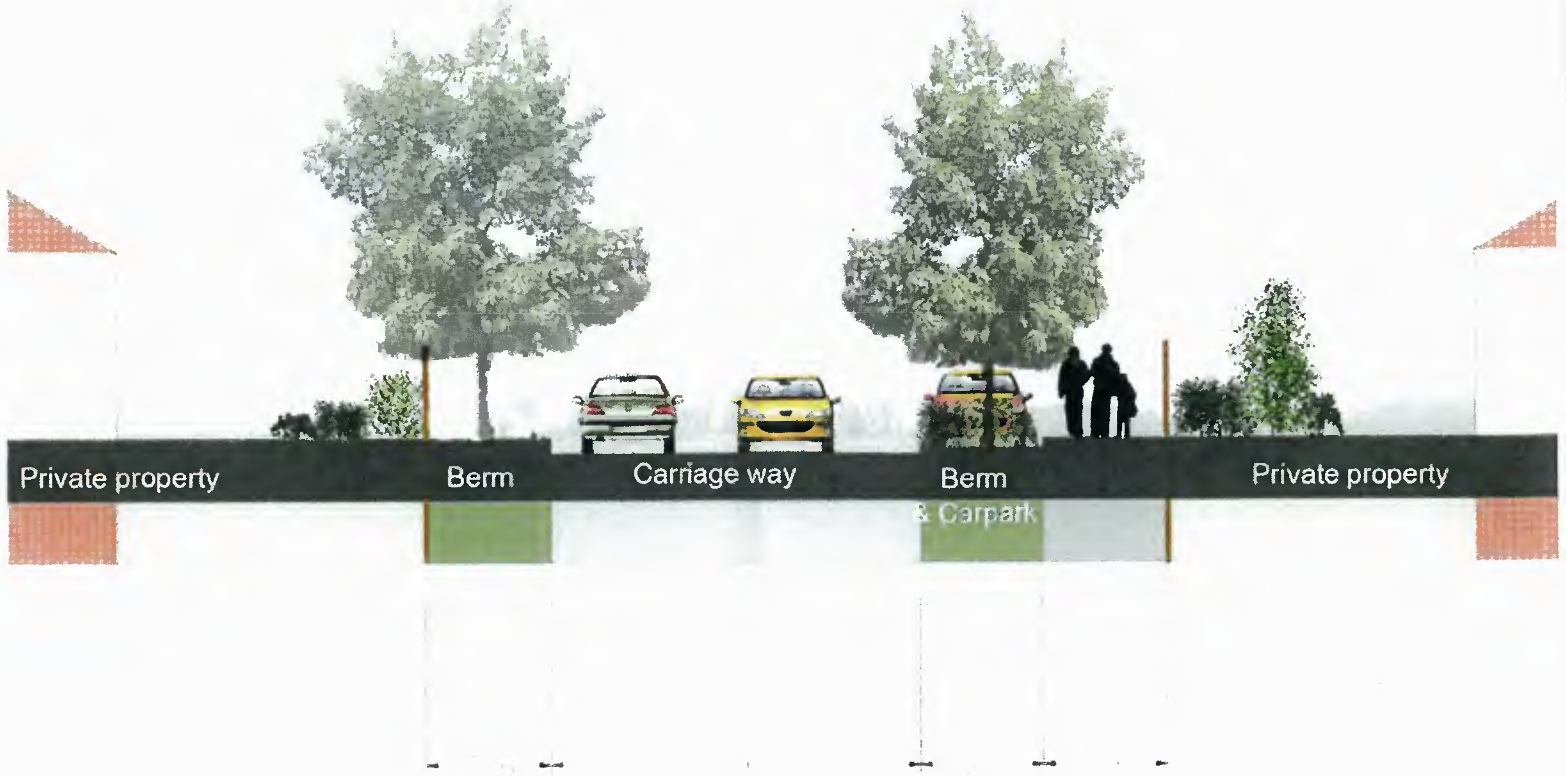
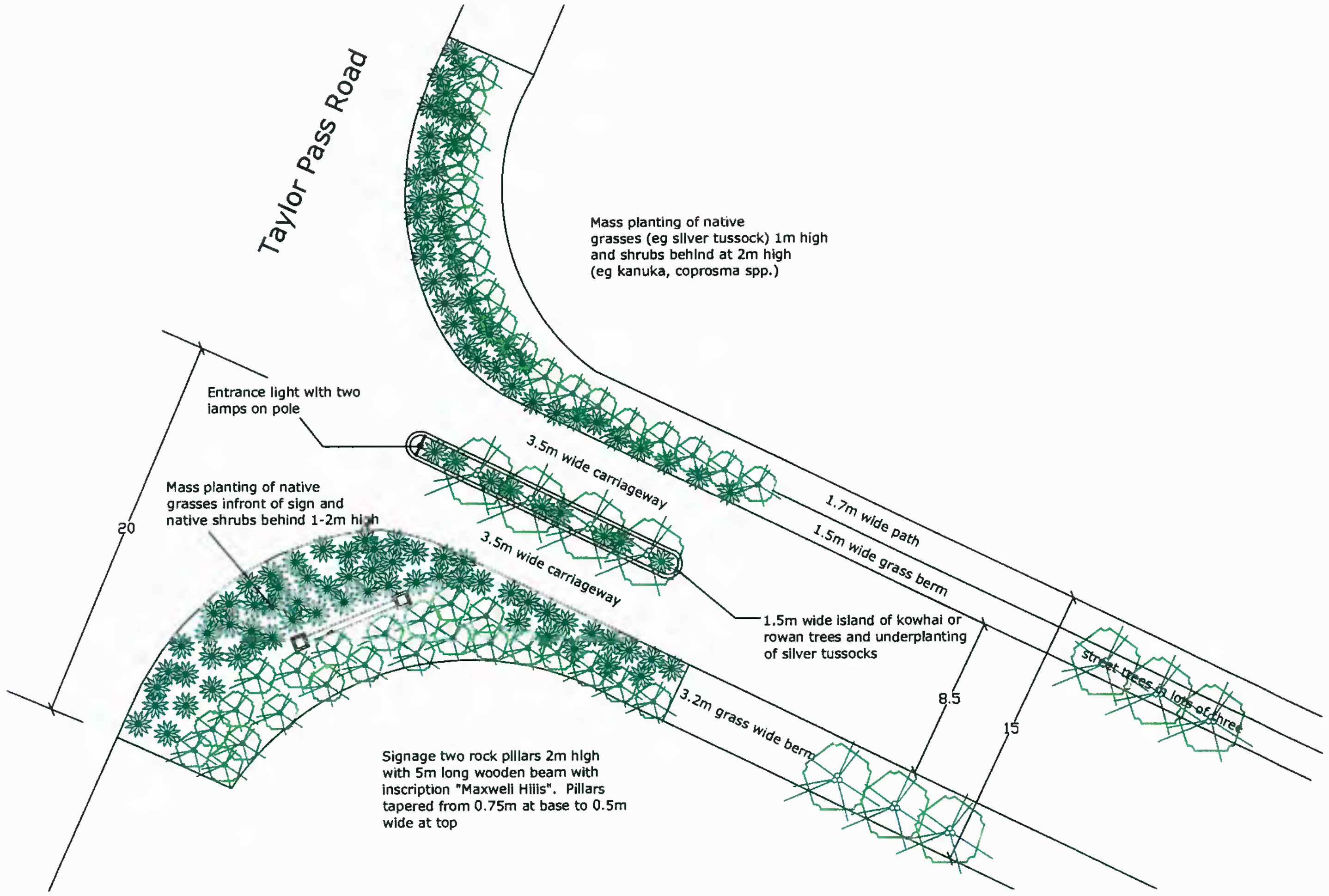
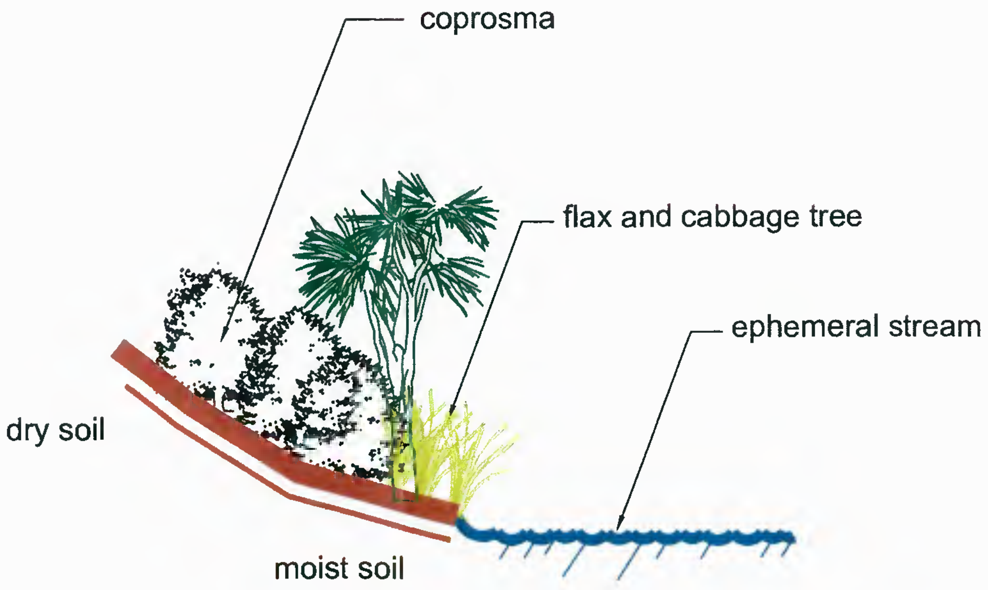
February 2011



16.1 Elevation of typical streetscape on flat sites



16.2 Entrance Detail



16.3 Indicative Riparian Treatment

APPENDIX E
Geotechnical Assessment Report - Riley Consultants Limited

RILEY
CONSULTANTS

MAXWELL HILLS RURAL RESIDENTIAL ZONE PROPOSED PRIVATE PLAN CHANGE GEOTECHNICAL ASSESSMENT

Engineers and Geologists

RILEY CONSULTANTS

Engineers and Geologists

MAXWELL HILLS RURAL RESIDENTIAL ZONE
PROPOSED PRIVATE PLAN CHANGE
GEOTECHNICAL ASSESSMENT

Report prepared for:	Kapiti Views Trust	
Report prepared by:	Simon Orgias, Engineering Geologist	
Report reviewed by:	Brett Black, Director, CPEng	
Report reference:	04819/6GT-A	
Date:	11 February 2011	
Copies to:	Kapiti Views Trust	1 copy
	CPG Global	1 copy 1 electronic copy
	Riley Consultants Ltd	1 copy

Issue:	Details:	Date:
1	Geotechnical Assessment	11 February 2011

Contents

Appendices

MAXWELL HILLS RURAL RESIDENTIAL ZONE PROPOSED PRIVATE PLAN CHANGE GEOTECHNICAL ASSESSMENT

1.0 Introduction

Riley Consultants Ltd (RILEY) has prepared the following geotechnical assessment report at the request of Kapiti Views Trust. This report describes our geotechnical feasibility investigation and recommendations for the proposed development. It is intended to support a plan change application to Marlborough District Council (MDC).

The plan change region covers the lower terraced area of the larger lots (Lot 1, DP 9518, Section 2, SO 7014 Lots 1-3, DP357141) held by Kapiti Views Trust.

The report presents the following information:

- A summary of the geotechnical considerations for the development based on results of both surface mapping and subsurface investigations.
- Identification of the distribution of active geological processes at the site, and the current level of geotechnical hazard associated with each. Hazards include areas of rock fall, shallow-seated slope instability, and tunnel gully erosion, along with an assessment of seismic hazards.
- General recommendations for development including future building platforms and roading development.

To ensure development is sustainable and suitable, an assessment of engineering aspects has been provided by RILEY. This report should be read in conjunction with the following RILEY documents.

Planning Variation	RILEY Reference Number
Flooding Assessment	04819/6FL-A
Wastewater Servicing	04819/6WW-A
Stormwater Design	04819/6SW-A

2.0 Field Investigation

The field investigation was undertaken as part of an overall feasibility study for the property and involved:

- Geological and engineering geological mapping.
- Excavation of 73 mechanically excavated test pits positioned to provide coverage of the entire property, with 19 located within or adjacent to the current development area.

Disturbed bulk and hand samples of representative soils and rock were collected for reference and for dispatch to a geotechnical laboratory for classification and compaction testing.

In-situ density/consistency tests were completed using a Scala penetrometer. Undrained shear strengths were derived, where appropriate. A Clegg hammer was locally used on cohesive and fine granular soils to gain a measure of the in-situ density.

Hand auger boreholes, and non-cored machine boreholes (for the installation of piezometers) were also carried out.

Laboratory tests listed in Table 2.1:

Table 2.1: Summary of Specified Laboratory Tests

Material	Hole No.	Depth (m)	Test			
			Particle Size Distribution (PSD)	Atterberg Limits	NZ Standard Compaction	Laboratory Soaked CBR
Colluvium (silt)	TP104	1.8	✓	✓	✓	✓
Colluvium (gravely sandy silt)	TP118	2	✓	✓	✓	-
Hillersden Gravel	TP130	3	✓	-	-	-

Locations of exploratory holes are shown on Dwg: 04819/6GT-1. Test pit and borehole logs are attached.

3.0 Geological Setting

The geological map of the area (Geology of the Wellington area, 1:250,000 scale, 2000), indicates the site is underlain at depth by Mesozoic (ca 248Ma to 65Ma) poorly bedded sandstones. These rocks are commonly referred to as greywacke or Torlesse greywacke.

The greywacke is unconformably overlain by a sequence of late Pliocene (ca. 3.6 Ma to 1.8 Ma), terrestrial gravels to boulders, mapped as Hillersden Gravel (HG). The gravels were deposited in fault-bounded depression(s) originally extending over many square kilometres up to hundreds of metres deep. Subsequent to the deposition of these Hillersden Gravels, the region geology was tectonically uplifted and tilted (up to 20^o) to the north.

Wind blown glacial silt, clay and minor fine sand (loess) has been deposited on the Wither Hills. Loess has been recorded up to 7m in thickness on the lower Wither Hills slopes. Most of the in-situ loess has been re-worked to a variable cover of colluvium, containing subordinate fractions of the underlying Hillersden Gravel or weathered bedrock.

Alluvium (Late Quaternary to Recent) underlies the Maxwell Pass and Taylor River valley flats.

The geological map indicates a number of steeply inclined faults to cut the bedrock around and at the site. A number of active faults (i.e. shown to rupture Late Quaternary alluvial surfaces younger than 125,000 years) occur through the bedrock and Hillersden Gravels north-east of the site; one trace terminates against the boundary of the site.

The geology encountered during our investigation is generally consistent with that anticipated from the published geological map. The distribution of each of these units is indicated on the attached engineering geological map and cross sections, Dwgs: 04819/6GT-2 and -3.

4.0 General Topography and Geomorphology

The subject site is predominately located on the narrow, 50m to 200m wide area of alluvial flats (RL 65m to 85m) at the base of the moderate to steep slopes of the adjacent hill country, refer Figure 1.

The slopes above the alluvial plains form a herringbone drainage pattern which typifies the Hillersden Gravels at the site, and throughout the Wither Hills. Streams issuing from the hills have locally incised (less than 5m) the river flats.

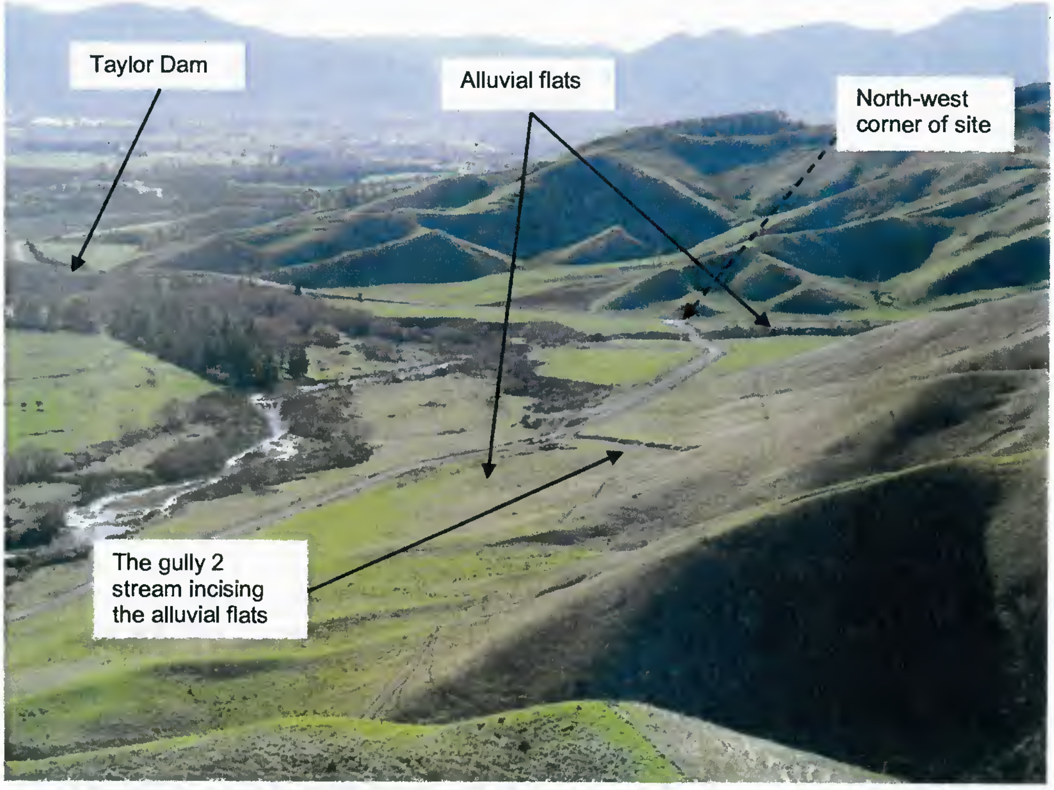


Figure 1: Looking north down Taylor Valley towards the alluvial flats along the western and northern margins of the property.

5.0 Encountered Geology

5.1 Greywacke Bedrock (GW)

Bedrock comprises greywacke sandstone, typically poorly bedded, variably weathered and moderately strong. Near surface defects are typically closely to very closely spaced (i.e. 20mm to 200mm) irregularly orientated tight joints. The material is generally highly to completely weathered within 1m of rockhead, where it is covered by soils. Weathering is likely to decrease, while defect spacing is likely to increase, with depth.

5.2 Hillersden Gravel (HG)

The Hillersden Gravel generally comprises a massively bedded, very dense, silt and sand matrix supported by medium to coarse gravel with cobbles and locally boulders of moderately weathered, locally highly weathered, moderately strong to moderately weak, sub-rounded sandstone. One laboratory particle size distribution test (PSD) completed on Hillersden Gravel from test pit TP130 in the south-east corner of the property, classifies the material as poorly graded cobbly gravel with some silt and sand.

5.3 Quaternary Alluvium (AL)

Quaternary alluvium underlies terrace flats in the Maxwell Pass valley and locally along the western margin of the site. Alluvium is exposed in embankments adjacent to the Maxwell Pass Stream and where alluvium is incised by gully 2, refer Dwg: 04819/6GT-2, attached, and was encountered in test pits TP18, TP32, TP41 and TP42.

The alluvium observed is compositionally varied and interbedded. Stiff dry sandy silt, up to 1.5m, typically underlies the ground surface. This material is generally underlain by tightly packed, massively bedded, poorly-graded, sub-angular to sub-rounded sandstone gravels, and locally cobbles, with varying proportions of silt and sand. Scala penetrometer tests completed in finer grained sequences of alluvium typically recorded blow counts of 2 to 11 per 50mm. This classifies the material as stiff to very stiff. Most shear vane tests attempted in alluvium refused. Locally sub-vertical desiccation cracks were evident in the surficial silt to 1.5m (TP36).

The slope bases adjacent to the alluvium terraces are likely to comprise sequences of variable and interbedded alluvium and colluvium soils. In test pits TP17, TP18, TP31 alluvium is overlain by 2m of colluvium. The source of much of the alluvial material is considered to be Hillersden Gravel that underlies the adjacent hills.

5.4 Loess

In-situ loess may locally overlay bedrock or Hillersden Gravel at the site, and may be interlayered with colluvium. Loess is not differentiated in this assessment; rather it is included with colluvium as it is considered the material properties and distribution of the two are generally similar.

5.5 Colluvium

Colluvium is a general term for deposits on slopes or at the base of slopes that have been transported chiefly by mass flows. Colluvium, which includes local in-situ loess deposits, generally comprises clayey silt with some sand and up to some (5% to 20%) gravel and locally cobbles (e.g. TP104, TP109, TP31, TP39, TP12, etc). Colluvium may become interbedded with alluvium (e.g. TP2).

Coarser colluvium containing gravels and cobbles is typically encountered only on the upper slopes, generally outside the area of proposed development; there are, however, localised deposits of granular colluvium, comprising silty sandy gravel and locally cobbles (e.g. TP140).

Colluvium forms a variable cover over Hillersden Gravel and bedrock, where it is generally less than 1.5m thick on mid-slopes and may be in excess of 4m deep in gully heads and toward the base of slopes (e.g. TP17).

Vertical fissures are common in colluvium between 0.5 and 1m depth. The fissures are very closely to closely spaced (i.e. 20 to 150mm), may be open by 5 to 10mm, locally have bleached surfaces, and are orientated sub-parallel and sub-perpendicular to the ground surface. The fissured zone is most prominent beneath north and west-facing slopes, which have the aspect to produce seasonal desiccation cracks.

5.5.1 Topsoil

Topsoil thickness was typically 0.2 to 0.3m and it generally consisted of loose, dark brown, silty sand or sandy silt, with organics and locally with coarse gravel to cobbles clasts.

5.6 Groundwater

Groundwater was not encountered in the Hillersden Gravel or colluvium. Free water was locally encountered below approximately 2m in test pits excavating colluvium, with minor groundwater seepage encountered in test pits TP15a at a depth of 0.5m in the north-eastern corner of the development.

Limited monitoring of standpipe piezometers in boreholes BH1 and BH2 has been undertaken during the summer of 2007. No groundwater was recorded in either of the standpipes in BH1 (i.e. toe depth 17m and 30m below ground level), while the water table in BH2 was approximately 7m below ground level. In BH2, the water level corresponds roughly to the level of the adjacent streams in gullies 6 and 7.

The main gullies at the site have ephemeral streams. Minor springs occur in the gully heads. Groundwater is not considered to spring from the Hillersden Gravel; rather gully head springs is water confined to the surficial colluvium soils by the underlying low permeability Hillersden Gravel.

6.0 Geotechnical Assessment

6.1 Active Geological Processes and Geotechnical Hazards

A number of active geological processes identified at the site are summarised below:

6.1.1 Rock Fall and Rock Roll

Sources of rock fall and run out are associated with over-steepened greywacke slopes, and from large clasts within in the Hillersden Gravel located on steeper slopes. These areas are located outside the current proposed area of development, with proposed lots on the lower slopes a sufficient distance away to provide adequate run out to mitigate this hazard.

6.1.2 Shallow Landslides

The following points summarise the geology and geomorphology of landslides mapped at the site, with the majority of slides indicated on Dwg: 04819/6GT-2:

- Shallow sliding events of the upper slope are likely to occur quickly and without warning. Recent scarps evident at the site indicate that the process is still active.
- The potential for debris run out inundating lower residential lots is generally considered low. This is due to the relatively small volumes of debris material, the confining shape of the gullies, and the lower building platforms (in moderate to low hazard categories) which are generally not considered to be located in any primary debris run out zone.

6.1.3 Slumps and Soil Creep

Small rotational slumps, less than 6m wide, were observed in the colluvium-covered slope south of gully 2. These have not been investigated by the subsurface investigation as they are considered a low hazard and outside the area of proposed development.

Soil creep is the very slow, downslope movement of soils due to gravitational forces, and produces the hummocky ground surface. It is most apparent on the south facing slopes of gullies 1 and 2. Soil creep typically occurs within the surficial layer (i.e. less than 1m depth) where direct infiltration of rainfall can result in periodically high moisture contents that allow the soils to 'deform' plastically. Soil creep generally occurs episodically following periods of elevated ground moisture, and may be associated with seasonal changes in ground moisture. Soil creep is considered a minor hazard, which can be effectively mitigated by using the following techniques:

- Retaining walls to stabilise cuts.
- Installing foundations into underlying competent material.
- Installing surface drains and subsoil drains to minimise groundwater levels.
- Planting dense shrub vegetation in soil creep areas to help dewater the slope and increase stability through root-binding effects.

6.1.4 Tunnel Gullies and Surface Erosion

Erosion of loess soils is an ongoing process at the site and noted throughout the Wither Hills. Erosion is typically by progressive tunnel gully processes. This initiates with seasonally induced desiccation cracks, which generally terminate above a hard fragipan layer. The cracks allow infiltration of surface water in wet periods down to dispersive layers at depth. Small tunnels, running parallel to the slope direction, form at the base of the cracks and, with time and continued erosion, enlarge until the crown becomes unstable and either sags or completely collapses. Following collapse, the open gully may widen or cut through the fragipan and deepen.

Tunnel gully erosion generally occurs within the colluvium covered slopes (i.e. typically comprising reworked loess) with north and north-west aspects at the site. Areas of affected gullies are indicated on Dwg: 04819/6GT-2 and generally occur in minor to moderate hazard zones, refer Dwg: 04819/6GT-4, attached. Substantial areas of erosion occur on the slopes in the north-west corner of the site. Such slopes are prone to the highest seasonal moisture variation and the development of desiccation cracks. The largest gullies have eroded the entire thickness (less than 2m) of colluvium to the underlying Hillersden Gravel.

Unexposed tunnels are possible in areas adjacent to collapsed gullies. As a result, moderate hazard ratings are generally applied to steeper colluvium slopes, even when collapsed gullies are not present.

Surface rilling of colluvium caused by overland flow runoff is considered a minor hazard.

Implications on Development and Remedies

While tunnel gully erosion at the site appears significant, it is not considered to preclude residential development in affected areas. Two main hazards result from the tunnel gully erosion. Firstly, foundations for dwellings, roads and structures may be undermined and damaged. Secondly, eroded material creates surface instability in downslope deposition areas. Foundation undermining is considered the more severe of these two consequences. However, we note that environmentally sensitive developments have been successfully completed in erosion prone (loess) soils in other areas (e.g. Christchurch Port Hills). In fact, we consider that residential development, and the associated surface and groundwater control, rehabilitation planting and retention measures, would substantially reduce the erosion and improve the long term stability of tunnel gully affected areas.

All filling in loess/colluvial soils should utilise chemically stabilised fill, and underfill drainage with suitable backfill to maximise internal erosion.

The risk of new gully erosion structures forming can be significantly reduced through the planting of low-lying shrubs or woody vegetation in selected areas to reduce the seasonal moisture variations in erodible soils on north aspect slopes. Vegetation helps prevent seasonal desiccation cracks and thereby stops a principle infiltration route for surface water to the dispersive subsoil layers.

6.1.5 Seismicity and Faults

The site investigation has not identified any active faults. An inactive fault is mapped through the north-facing hills side of greywacke (i.e. the south-west corner of the site). An inactive fault is also considered to trace below the Maxwell Pass valley and offset downthrown Hillersden Gravel to the south from bedrock, just to the north of Maxwell Pass Road.

Geological and Nuclear Sciences (GNS) maintain the active faults database for New Zealand. GNS were requested to provide a specific desktop assessment of the hazard posed by the near-site faults. This concluded that although the structures within 15km of the site are noted as active, the currently available data suggests that they have a return period of between 7,500 and 10,000 years. These recurrence intervals, when assessed against the proposed development, lead GNS to conclude that these structures pose a low hazard to dwellings within the development, and that no further investigation was necessary.

6.2 Geotechnical Hazard Zones

Four geotechnical hazard zones differentiated at the site are discussed below. This assessment is based on our engineering geological investigation, summarised on Dwg: 04819/6GT-2 and our geotechnical experience with similar geology. The hazard zones are indicated on Dwg: 04819/6GT-4. It should be noted that the geotechnical assessment does not address flooding issues, which are covered by a separate RILEY report. The limits of the zones are interim and may be slightly refined with further investigation. Mitigation and remedy techniques for the hazards have been discussed in preceding sections. The hazards zones are:

6.2.1 Low Hazard Zone

This zone occurs on the flat to gentle sloping ground along the north and west of the site. There are no significant geotechnical issues affecting this area. Residential development within this zone will generally require minimal earthworks and limited remedial works (if any) to provide suitable building platforms. Adequate bearing capacity is likely to be provided by the surficial alluvium and colluvium soils. However, specific investigation and design may be required to ensure foundations are located below any possible zone of seasonal shrink/swell movement. Buildings should be appropriately set back from river banks and terraces to avoid local instability (e.g. between gullies 1 and 2, and along Maxwell Pass Stream).

6.2.2 Minor Hazard Zone

The zone includes gentle to moderate sloping areas around the base of the hill country and a corridor along some ridgelines. Slope instability and rock fall are low hazards in this zone, although the zone is affected by minor tunnel gully erosion. Limited works are likely to remedy the tunnel gullies.

The areas around the base of the western and northern slopes are generally considered geotechnical appropriate for rural residential development.

6.2.3 Moderate Hazard Zone

These areas are typically associated with a low landslide hazard, minor rock fall hazard, and moderate erosion hazard.

6.2.4 High Hazard Zone

These areas have substantial geotechnical hazards, and are generally located outside the plan change area, with the exception of land adjacent to the localised incised steep slopes associated with gullies 1, 2 and 3.

It is recommended that proposed building platforms and accessways are set back from over-steepened slopes adjacent to incised gullies.

6.3 Foundation Conditions for Structures, Services and Roads

6.3.1 Ground Conditions for Founding Structures and Services

We recommend all roads or dwellings on slopes within the moderate risk zones be founded on competent underlying Hillersden Gravel or bedrock below surficial colluvium, due to the potential for shallow soil movement and erosion in most colluvium soils. Such materials will provide adequate bearing capacities and acceptable settlements. The bearing capacity of the material should be determined at subdivision consent stage. We anticipate that specific investigation and design will be required on all sloping sites within the minor and moderate geotechnical hazard zones.

Augered foundations for dwelling piles or embedded retaining walls are not considered feasible for either Hillersden Gravel or bedrock. Shallow foundations are best for this hard and coarse granular material (e.g. shallow socketed piles or beams, slab on grade, or strip foundations).

Near the base of hills and in colluvium areas of the minor hazard zones, specifically designed foundations may be required. Foundation solutions should look to bear on competent soils beneath any desiccation or fissured zones in loess soils (i.e. greater 1m). Possible solutions include over-excavation and slab on grade, driven or augered piles, and any investigation should assess the need to found below possible desiccation crack zones.

Shallow-type foundations should generally be suitable for dwellings in the low hazard zones. However, local desiccation cracks in surficial alluvial silt (TP 36) to depths of 1.5m suggest that the silts may be prone to seasonal shrinkage and swell. Implications of possible foundation heave and differential settlement on foundations should be assessed at subdivision stage. Such issues may be overcome by a combination of specifically designed stiffened slab-type foundations, and founding below the zone of seasonal moisture variation (i.e. approximately 1 to 1.5m). The ground conditions and any recommendations for specific site investigation and foundation design should be determined at subdivision stage.

6.4 Retaining Walls

Mass gravity retaining walls are most suited to the site, as augered foundations for the likes of pole walls are considered unfeasible in Hillersden Gravel and bedrock. Timber crib or gabion structures are possible solutions, with the preferred solution likely to be dictated by landscaping preferences. In the case of the battering option, local shoulder failures are still expected after such mitigation measures, due to variability in ground and groundwater conditions at the site.

6.5 Earthworks

6.5.1 General

All earthworks should be designed and constructed so as to maintain or improve slope stability. Any design and construction should appreciate that colluvium is prone to internal erosion, and instability under high groundwater conditions. To reduce this problem a primary consideration of any design and construction should attempt to follow existing topography in order to reduce earthworks volumes.

Local re-contouring of the site is envisaged as part of the future subdivision development. Local filling, particularly around the base of the hill slopes is expected, in order to reduce the ground gradient in this area, and to dispose of excess cut.

Remedy re-contouring of the tunnel gullied slopes may be undertaken, although this work should be carefully designed and staged to minimise erosion before re-establishment of vegetation cover.

Any fill placed on slopes greater than 1V:3H shall be appropriately benched into solid underlying ground (i.e. Hillersden Gravel, bedrock, or as determined on site) once topsoil or any soft compressible material is stripped.

Underground service trenches in loess/colluvium on sloping ground shall be appropriately backfilled with chemically stabilised selected as-dug loess/colluvium. This practice avoids making the trench a conduit for groundwater.

Subsoil drains laid in the direction of the ground slope can be used to maintain drainage paths and limit the rise in groundwater. These drains should utilise suitable drainage material to minimise erosion of soil into the drains.

6.5.2 Cut and Fill Slopes

Preliminary cut and fill batter slopes intended for preliminary design purposes are listed below:

Colluvium Cut Slopes

We generally recommend that surficial loess and colluvium soils be cut at a maximum gradient of 1V:1.5H. Where practical, all cut faces should be re-vegetated to limit erosion.

Greywacke Cut Slopes

Although steep greywacke exposures are generally located outside the area of proposed development, if encountered, cut heights for the moderately to slightly weathered greywacke should not exceed 6m, with the cut slope depending on a site by site assessment of the local geology. Where cuts of more than 6m are required, they should be appropriately benched. The minimum bench width should be 50% of the individual batter height. These benches may be designed to receive landscape vegetation as the greywacke cut slopes are generally too steep to hold topsoil.

Hillersden Gravel Cut Slopes

We recommend that any unsupported cuts be battered at a maximum slope of 1:1, with a maximum cut height of 3m.

Cut faces should be well-vegetated (grassed) to minimise the visual impact of the excavations and to reduce erosion. Where cuts of more than 3m height are required, they should be benched.

Cuts in Hillersden Gravels may also be supported by specifically designed gravity retaining walls (e.g. crib or gabion structures). For preliminary design purposes, we recommend a maximum cut height of approximately 4.5m.

Road Embankment Fills

Fill embankments beneath roads on slopes within moderate to high risk zones, should either be constructed as geotextile reinforced slopes or be supported by specifically designed retaining walls. These structures should found on competent material (greywacke or Hillersden Gravel).

Where subgrade founds on colluvium within the minor risk zones such as in slope base areas, road cuts are unlikely to be deep enough to fully over-excavate this material. This situation requires assessment of the hazard posed by tunnel gullies below formation level. Over-excavation of tunnel gullied areas may be required with Hillersden Gravel backfill. Alternatively, large-scale 'rotomixed' chemical stabilisation may be feasible in loess soils. The feasibility of this option should be assessed at subdivision stage.

Stability modelling indicates reinforced fill slopes with a batter gradient of 1V:1H may be constructed to a maximum height of 6.5m. Fill slopes of up to 4.5m height may be supported by gravity retaining walls.

Lot Access

Lots within the plan change area are typically located on the alluvial flats with the internal margins extending over the moderate slopes. It is envisaged that access to the lots at no steeper that 1 in 6 can be achieved through earthworks.

General

As with other geotechnical structures, adequate and careful stormwater control will be an important factor in the long-term performance of the above features. Where practicable, benches should include stormwater drains to intersect and collect runoff from large cut or fill slopes. Underfill drainage should be included in the specific designs to prevent erosion and undercutting.

Homogeneity in geological units, especially at the relatively small-scale mapping undertaken to date for this project, is very unlikely. As such, all parties involved in the project should be aware that local slope failures might occur during the works, due to local heterogeneities. The design process should identify the risk associated with a particular failure.

6.5.3 Bulk Filling

Earthworks are anticipated to involve local filling around the base of the hill slopes in order to reduce the ground slopes in this area, and to dispose of excess cut from the low hill slope roads and building platforms.

Generally, filling is not recommended on slopes greater than 1V:3H without the involvement, and approval, of a suitably experienced geotechnical engineer.

All surplus fill should be appropriately disposed of during the development, and effects of fill on slope stability and long-term groundwater level considered. Uncontrolled spilling of fill down slopes is not recommended.

Fills on slopes should incorporate appropriate drainage to limit the raising groundwater level within the fill. Suitable drainage material should be selected to minimise the risk of possible internal erosion of finer materials into the subsoil drains.

Fill sites should be the subject of specific engineering design and completed in accordance with best practice standards, e.g. NZS 4431: *Code of practice for earth fill for residential development.*

6.6 Pavement Design

For the purposes of preliminary pavement design a CBR value of 4% is recommended for colluvium and alluvium, and 35% and 50% for moderately to slightly weathered greywacke and Hillersden Gravels respectively.

Specific subsoil drains are recommended beneath sidling fills on slopes at the base of the ridges. Subsoil drains may also be required on alluvium flats. Drains should be specifically designed to prevent migration of subgrade fines, and all intercepted water appropriately discharged to avoid erosion or slope instability.

Although it is envisaged that roading aggregate is most likely import to site (i.e. AP65 for road sub-base and AP40 for road basecourse aggregate), from the observations made during the ground investigation it is possible that appropriate road aggregate can be sourced on site. Both the bedrock and Hillersden Gravel encountered have a limited extent of highly weathered material, and typically are moderately to slightly weathered with moderately strong to strong. High quality wearing coarse aggregate may still need to be imported.

Possible use of either Hillersden Gravel or bedrock for roads, or specialist fills, should be the subject of further investigation. This may involve large-scale excavations in both the gravel and rock with bulk samples (i.e. 15m^3 of each material) collected and taken for a crushing trial, and appropriate road aggregate laboratory tests.

6.7 Gully Crossings

Limited crossings of main gullies by the roads will be required. Subject to the final design flows from the stormwater assessment we expect that culverts will be suitable for gully crossings. These should be designed to prevent scour through the use of head wall structures and, if necessary, erosion protection downstream. Confirmation of suitable foundations for culvert fills is required.

6.8 Stormwater

Stormwater control is critical to limiting the activity of tunnel gully erosion, shallow landslides, small slumps and soil creep processes. Specific stormwater and flooding assessments having been completed by RILEY, and should be read in conjunction with the following comments, which raise some geotechnical items related to stormwater management.

Gully discharge points may require energy dissipation structures to minimise scour. Selected material from the Hillersden Gravel would be suitable as armour stones for this purpose.

Individual on-site soakage pits may be possible in the alluvium terraces. These should load the coarse gravel beds below any surficial silt. The feasibility of soak pits should be confirmed at engineering approval stage. They should be designed and located so that slope stability is not reduced.

7.0 Conclusions and Recommendations

The proposed private plan change for future development is considered suitable given the encountered site conditions and suitable building platforms can be achieved providing the founding and site development recommendations outlined below and contained within the body of this report are followed.

- Surface Mapping and subsurface investigations have identified main geotechnical hazards (excluding flooding) for the current proposed development is shallow creep movement and the tunnel gully erosion associated with surficial colluvium materials.
- Gully erosion adjacent to incised gullies is a slow progressive process, which is not likely to lead to either sudden or progressive foundation collapse. An appropriate setback for building platforms from incised gullies slopes is recommended.
- Care will need to be taken with stormwater to avoid uncontrolled discharge that may contribute to local slope failure and erosion.
- Shallow-type foundations should generally be suitable for dwellings in the low hazard zones. However, local desiccation cracks in surficial alluvial silt to depths of 1.5m suggest that the silts may be prone to seasonal shrinkage and swell.
- Earthworks are anticipated to involve local filling around the base of the hill slopes in order to reduce the ground slopes in this area, and to dispose of excess cut from the low hill slope roads and building platforms.
- Remedy re-contouring of the tunnel gullied slopes may be undertaken, although this work should be carefully designed and staged to minimise erosion before establishment of the vegetation cover.
- Design and construction should appreciate that colluvium is prone to internal erosion, and shallow slides under elevated groundwater conditions.
- The planting of trees and shrub vegetation is recommended on sloping areas of the site to enhance long term stability and reduce erosion. This helps with root binding effects and by dewatering slopes to prevent development of desiccation cracks in erodible soils.

8.0 Limitation

This report has been prepared solely for the benefit of Kapiti Views Trust as our client and Marlborough District Council in processing the plan change application with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction the site should be examined by an engineer or engineering geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design is based upon this report.

APPENDIX A

Test Pit and Hand Auger Logs

GEOTECHNICAL AND GEOLOGICAL INFORMATION

SOIL TYPES AND SYMBOLS

☒	FILL	▤	CLAY
▥	TOPSOIL	▨	PEAT
▦	SILT	▼	GROUNDWATER LEVEL
▩	SAND	⊥ 10,11,10	SCALA PENETROMETER LAST 3 NUMBER OF BLOWS PER 50mm INCREMENT
▩	GRAVEL		

ROCK TYPES AND SYMBOLS

▤	SANDSTONE	▨	BASALT
▦	SILTSTONE	▨	TUFF
▤	MUDSTONE	▨	IGNIMBRITE
▦	LIMESTONE	▦	GREYWACKE

SOIL STRENGTH CLASSIFICATION

FINE GRAINED COHESIVE SOILS

TERM	FIELD IDENTIFICATION	UNDRAINED SHEAR STRENGTH (KPa)
Very Soft (Vs)	Exudes between fingers when squeezed.	<12
Soft (S)	Easily indented by fingers.	12 - 25
Firm (F)	Indented only by strong finger pressure.	25 - 50
Stiff (St)	Indented by thumb pressure.	50 - 100
Very Stiff (VSt)	Indented by thumbnail.	100 - 200
Hard (H)	Difficult to indent by thumbnail.	200+

SPT and SCALA PENETROMETER RESULTS

TERM	SPT VALUE No. of BLOWS/300mm	SCALA PENETROMETER No. of BLOWS/ 50mm
very dense	>50	20+
dense	30 - 50	10 - 20
medium dense	10 - 30	3 - 10
loose	4 - 10	1 - 3
very loose	0 - 4	<1

ROCK STRENGTH CLASSIFICATION

TERM		FIELD IDENTIFICATION	UNCONFINED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Extremely weak	(EW)	Indented by thumbnail.	< 1
Very weak	(VW)	Cumbles under firm blows with point of geological hammer. Can be peeled with pocket knife.	1 - 5
Weak	(W)	Difficult to peel with pocket knife.	5 - 20
Moderately strong	(MS)	Cannot be scraped or peeled with pocket knife.	20 - 50
Strong	(S)	More than one blow of geological hammer to fracture.	50 - 100
Very strong	(VS)	Many blows of geological hammer to break.	100 - 250
Extremely strong	(ES)	Can only be chipped with geological hammer.	250+

MOISTURE CONDITION

Dry (D)	Looks and feels dry; powdery and friable.
Moist (M)	Feels cool; darkened in colour; no free water when remoulded.
Wet (W)	Feels cool; darkened in colour; free water forms on hands.
Saturated (S)	Free water is present on sample.

SAMPLE TYPES

■	UNDISTURBED
☒	MACHINE AUGER DISTURBED
D	HAND AUGER DISTURBED
▼	STANDARD PENETRATION TEST (solid cone)
▽	STANDARD PENETRATION TEST (hollow cone)

DRILLING METHOD

OB	OPEN BARREL
TT	TRIPLE TUBE
WB	WASH BORE
SH	UNDISTURBED SHELBY TUBE
RC	ROCK CORE
SPT	STANDARD PENETRATION TEST

FIELD TESTS

V	SHEAR VANE (corrected to BS:1377)
R	REMOULDED STRENGTH
P	POCKET PENETROMETER
CH	CLEGG HAMMER

RILEY
CONSULTANTS

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N.S.M.C.
AUCKLAND
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FAX. 09-4897873

Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2589078 mE – 5958480 mN
Surface Elevation	99m
Surface Conditions	Grass

LOG OF TEST PIT TP 2

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data			Groundwater	Comments & other Laboratory & Insitu Testing
							Samples	Shear Strength (kPa)	Water Content %		
	TOPSOIL										
COLLUVIUM	SILT; light brown, medium plasticity, small angular stone chips (<5% unweathered),firm							UTP			
	white layer, non homogeneous bands light brown with reddish mottles, hard					M D					
				1				UTP			
	medium plasticity, trace small gravel (<5%), lighter colour, horizontal bands of faint orange staining at 2 cm spacing			2							
ALLUVIUM	light brown sand (slightly weathered) gravel cobbles (rounded), trace silt.							UTP			
	E.O.P. @ 2.5m			3							
				4							
				5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:
- ☐ Target Depth
- ☐ Near Refusal
- ☒ Refusal
- ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/6/05
Logged By	TS/PR
Shear Vane No.	–

Shear Vane Testing based on BS 1377

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

RILEY CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588327 mE – 5958336 mN
Surface Elevotion	111.5m
Surface Conditions	TUNNEL GULLIES ABUNDANT

LOG OF TEST PIT TP 12

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data			Groundwater	Comments & other Laboratory & Insitu Testing
							Samples	Shear Strength (kPa)	Water Content %		
	TOPSOIL	⌇⌇⌇	OL			M					
LOESS	SILT; light brown, non plastic, breaks into blocks Field Strength S6	× × ×	ML			D					
COLLUVIUM	some gravels	⬡ ×		1							
HILLERSDEN GRAVELS	contact – dip 18° out of slope COBBLES, well graded, well compacted, fresh to slightly weathered sandstone and siltstone cabbles with occosianol greywacke cobbles, subhorizontal preffered arientatian of sediments.	⬡	GW	2							
	E.O.P. @ 2.5m (Refusal)			3 4 5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☐ Target Depth ☒ Refusal
☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Somple, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Sheor Vane
P	Hond Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/6/05
Logged By	TS/PR
Sheor Vane No.	–
Sheor Vane Testing based on BS 1377	

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

RILEY CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588329 mE – 5958245 mN
Surface Elevation	145m
Surface Conditions	Grass

LOG OF TEST PIT TP 12a

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data Samples	Sample Data Shear Strength (kPa)	Sample Data Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
COLL'M	TOPSOIL										
COLL'M	SILT; subrounded clasts – breaks with single blow with geo-hammer					D/M					
HILLERSDEN GRAVELS	GRAVELS/BOULDERS; in silt/clay matrix, light brown										
	andesite boulders, brown, xxx, fracture surface stained brown			1							
	continuous lenses of clay bonds, subrounded gravels										
	E.O.P. @ 1.9m (Refusal)			2							
				3							
				4							
				5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☐ Target Depth ☒ Refusal

☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/6/05
Logged By	TS/PR
Shear Vane No.	–

Shear Vane Testing based on BS 1377

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

RILEY CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588872 mE – 5958452 mN
Surface Elevation	93.5m
Surface Conditions	GRASSED

LOG OF TEST PIT TP14

SOIL/ROCK DESCRIPTION

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Samples	Shear Strength (kPa)	Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL		OL			D					
COLLUVIUM	SILT; trace sand; slightly plastic; white; stiff.		ML	1	H			V211+ UTP			
	SILT; occasional angular pebbles (disintegrates under finger pressure, CW); moderately plastic; light brown with orange mottles; some black staining down to 1.7m.			2 3				UTP UTP			
	ROCK E.O.T.P @ 3.8m (REFUSAL)			4 5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☐ Target Depth ☒ Refusal

☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/06/05
Logged By	PR/TS
Shear Vane No.	491
Shear Vane Testing based on BS 1377	

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

RILEY CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588767 mE – 5958368 mN
Surface Elevation	109m
Surface Conditions	

LOG OF TEST PIT TP15

Geol. Unit	SOIL/ROCK DESCRIPTION	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Samples	Shear Strength (kPa)	Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL	OL			D					
COLLUVIUM	white SILT, slightly plastic.	ML								
	brown with orange specks SILT; fine–coarse gravel (HW clasts) and cobbles; very fissured with evidence of erosion (see photo).			H			UTP			
	light brown SILTY GRAVEL with sand; cobbles and boulders (max size 400mm); very stiff.		1				UTP			
			2				UTP			
			3							
	E.O.T.P @ 3.5m									
			4							
			5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☒ Target Depth ☐ Refusal

☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/06/05
Logged By	PR/TS
Shear Vane No.	491
Shear Vane Testing based on BS 1377	

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

RILEY CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588739 mE – 5958371mN
Surface Elevation	103m
Surface Conditions	

LOG OF TEST PIT TP15a

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Samples	Shear Strength (kPa)	Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL.	⌇⌇	OL		St	D					
COLLUVIUM	SILT; white; low–medium plasticity; tunnel gully evidence of seepage; dry, stiff.	× × × ×	ML								
	SILT; light brown occasional sub-rounded gravels.	× × × × × × × ×		1							
	E.O.T.P @ 1.2m NOTE: 300mm ø tunnel gully located centre of pit with crown depth of 200mm			2 3 4 5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☒ Target Depth	☐ Refusal
☐ Near Refusal	☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/06/05
Logged By	PR/TS
Shear Vane No.	491
Shear Vane Testing based on BS 1377	

OBSERVATIONS:
UTP– unable to penetrate with shear vane.

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CONSULTANTS

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588463 mE – 5958454mN
Surface Elevation	81m
Surface Conditions	

LOG OF TEST PIT TP 17

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Samples	Shear Strength (kPa)	Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL		OL		H	D					
LOESS	light brown SILT (low–medium plasticity).		ML					UTP			
	brown SILT; medium plasticity; vertical fissures, mostly up slope but also doun slope; black staining and rootlets to 1.6m; white powder in slope fissures @ 1–1.5m (see photo).			1				UTP			
COLLUVIUM	cobbles and silt in voids up to 300mmø.			2		M					
	brown SILT; low/medium plasticity; occasional fine gravel, firm.			3 4							
	E.O.T.P @ 4.8m (TARGET)			5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☒ Target Depth ☐ Refusal
☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/06/05
Logged By	TS/PR
Shear Vane No.	491

Shear Vane Testing based on BS 1377

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588280 mE – 5958575 mNn
Surface Elevation	74m
Surface Conditions	GRASSED

LOG OF TEST PIT TP 18

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data: Samples	Sample Data: Shear Strength (kPa)	Sample Data: Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL		OL								
COLLUVIUM	SILT; light brown, firm	× ×	ML		F	M		UTP			
	light brown, fine/coarse gravel, angular clasts, very stiff	× ×		1	H	D					
	SILT; light brown; very stiff, no cobbles.	× ×						UTP			
	fine – coarse	× ×									
HILLERSDEN GRAVEL	GRAVEL; well graded, with some silt, sub horizontal contact with overlying material		GW	2				UTP			
	E.O.P. @ 3.0m (Target Depth)			3							
				4							
				5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☐ Target Depth ☒ Refusal
☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/6/05
Logged By	TS/PR
Shear Vane No.	–
Shear Vane Testing based on BS 1377	

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588144 mE – 5958418mN
Surface Elevation	71.5m
Surface Conditions	

LOG OF TEST PIT TP 19

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data: Samples	Sample Data: Shear Strength (kPa)	Sample Data: Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL		OL			M					
ALLUVIUM	SILT; light brown.	× ×	ML								
	GRAVELS, rounded; some silt; well graded.		GW		H			UTP			
	SILT; light brown; low–medium plasticity; stiff.	× × × × × × × × × ×		1				UTP			
	SAND, coorse grained; fine grovel (<5% silt).		SW	2							
	E.O.T.P @ 2.7m (TARGET)			3 4 5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☒ Target Depth	☐ Refusal
☐ Near Refusal	☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	28/06/05
Logged By	PR/TS
Shear Vane No.	491

Shear Vane Testing based on BS 1377

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

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Job No.	04819
Project	MAXWELL HILLS
Borehole Location	2588043 mE – 5957948 mN
Surface Elevation	90m
Surface Conditions	GRASSED, SLOPING

LOG OF TEST PIT TP 31

Geol. Unit	SOIL/ROCK DESCRIPTION	Graphic Log	Unified Symbol	Depth (m)	Consistency	Moisture Condition	Sample Data: Samples	Sample Data: Shear Strength (kPa)	Sample Data: Water Content %	Groundwater	Comments & other Laboratory & Insitu Testing
	TOPSOIL; dark brown.				M						
COLLUVIUM	SILT; slightly plastic							V192 R57			
	brown (greyish), non plastic, some rootlets, hard difficult to indent by thumb nail, Class S6.			1	D			UTP			
HILLERSDEN GRAVELS	SILT with subrounded gravels.			2				UTP			
	brown, sandstone clasts, closely fractured.										
	E.O.P. @ 3.1m (refusal)			3							
				4							
				5							

MACHINE TYPE: BACKHOE

TEST PIT TERMINATED AT:

☐ Target Depth ☒ Refusal
☐ Near Refusal ☐ Flooding

SAMPLE TYPE:

B	Bulk Sample
u100	Undisturbed Sample, 100mm ø
D	Disturbed Profile Sample

FIELD SHEAR STRENGTH:

V	Shear Vane
P	Hand Penetrometer
E	Estimate Only

TEST PIT SECTION

Date Logged	30/06/05
Logged By	PR/WSS
Shear Vane No.	491
Shear Vane Testing based on BS 1377	

OBSERVATIONS:
UTP= unable to penetrate with shear vane.

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