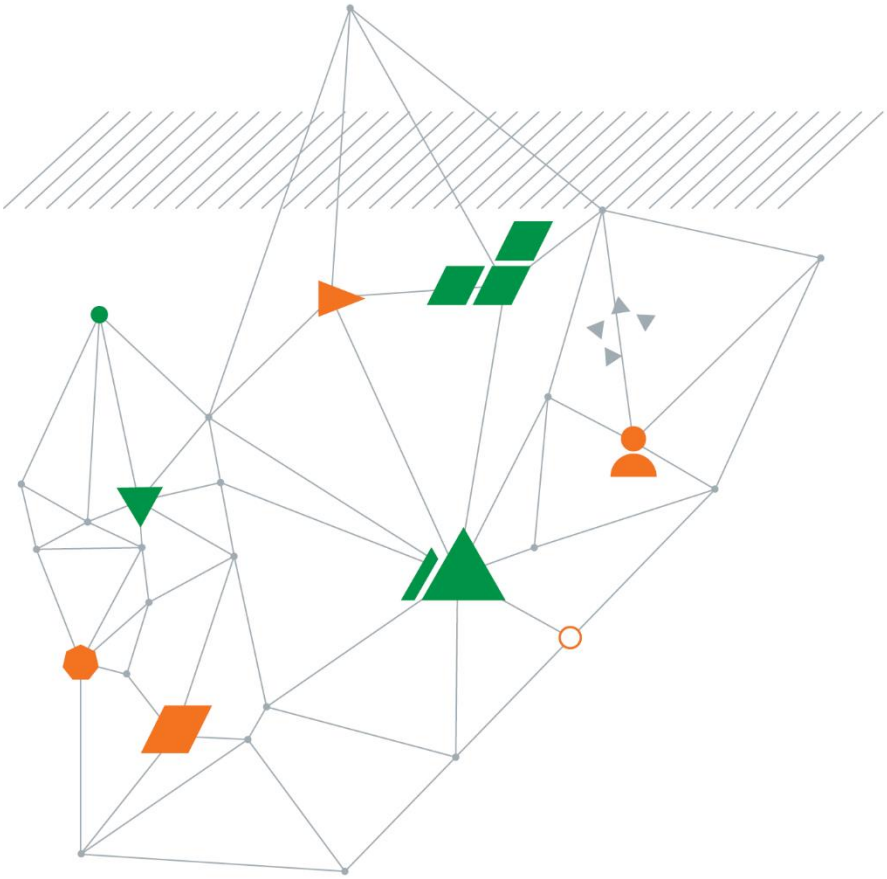
Upper Hutt City Council
Residential & Rural Chapter Review
773-WLGGE225406AB

6 March 2020



Real
potential
is uncovered
only when
you scratch
beneath
the surface

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Residential & Rural Chapter Review

Prepared for
Upper Hutt City Council

Prepared by
Coffey Services (NZ) Limited
Level 5, 150 Willis Street
Wellington
6011 New Zealand
t: +64 4 385 9885 f: +64 4 385 3066
NZBN 9429033691923

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Rev4- Slope hazard update

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Rev4	Slope Hazard Update	06/03/2020	S. Martin	R. Beetham	S. Martin

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Rev4	1	<PDF>	Ike Kleynbos (UHCC)	06/03/2020

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EXECUTIVE SUMMARY

UHCC has identified the need for district-wide geotechnical assessment to be undertaken to inform its review of the District Plan. The geotechnical assessment is required to evaluate the geotechnical suitability of selected Areas, as well as the Existing Urban Area, for continued or new residential development.

This geotechnical assessment covers nine selected areas across the Upper Hutt District, including the established urban area. The assessment Areas are:

1. Gillespies Road Area;
2. Maymorn Area;
3. Mangaroa Valley Area;
4. Kingsley Heights Extension;
5. Lower Cannon's Point Area;
6. Whitemans Valley Area;
7. Trentham/ Prison Area;
8. St Patricks Estate; and
9. Established Urban Area – noted as "Urban Rural Boundary (Iteration 2)".

More general, high-level assessments were made of the Kaitoke Valley and South Whitemans Valley – Blue Mountains areas. A slope hazard assessment is also presented for the Akatarawa Valley, Moonshine Valley and Remutaka Hill areas.

Hazards assessed are liquefaction, slope stability and soft and/or peaty soil conditions. Flooding erosion and faulting hazards are being considered separately.

Each of the nine Areas were assessed based on available desktop study information such as maps and available geotechnical investigation data. As well, a site walkover was conducted.

The liquefaction hazard across most of Upper Hutt was considered none or negligible, due to the soil conditions typically being dense, gravelly, elevated and/or greater than 10,000 years old. The exception to this was an area in Trentham which has historically been considered medium/high liquefaction hazard. Further investigation to determine liquefaction status is needed in this area

After careful consideration and in the interests of a simple, readily applicable classification, the slope stability hazard was assessed using just two categories, low and high. Low hazard is assigned for slopes less than and including 26 degrees and high hazard for those slopes greater than 26 degrees. Those slopes assessed as high hazard will require a specific geotechnical assessment, the nature of which should be determined by a geo-professional based on the nature of the site and the proposed development. We have developed general slope setbacks for the top and toe of steep slopes categorised as high hazard. These are considered to generally be conservative and may be refined and possibly reduced based on a site specific geotechnical assessment.

Areas identified as no, low or negligible hazard are considered generally suitable for residential development from a geotechnical perspective. The shallow foundation recommendations as per NZGS Module 4 Guidelines are anticipated to be applied. Site specific shallow geotechnical investigations are recommended to confirm suitable ground at each site in line with NZGS Module 2. As noted, high hazard areas may be able to be subdivided, but require further geotechnical assessment.

Small areas of perched or ponding groundwater and stormwater were noted in places in the study area, especially where steep hills meet flat alluvial terraces. The perched water is anticipated to be limited to the upper ~0.5 metre. Where surface water or shallow perched groundwater is apparent, treatment such as drainage will be required as part of development. Additional shallow investigation may be required to determine the extent of the issue.

Areas identified as having the better geotechnical suitability are the existing residential Upper Hutt, St Patricks Estate, Maymorn, Gillespies Road and Mangaroa. Whiteman's Valley, Kingsley Heights

Extension and Lower Cannon's Point have the most geotechnical challenges or the greatest proportion of high geotechnical hazard land.

Glossary

CPTs: Cone penetrometer test

DCPs: dynamic cone penetrometers also referred to colloquially as scalas

fa: Alluvium including Taita Alluvium (Begg J. G., 1996)

GNS: Geological and Nuclear Sciences

GWCR: Greater Wellington Regional Council

IL: Importance level

lg: Alluvium including subsurface Waiwhetu Artesian Gravel; solifluxion deposits; loess; swamp sediments; minor tephra, principally Kawakawa Tephra (Begg J. G., 1996)

MASW: Multichannel analysis of surface waves

MBIE: Ministry of Business, Innovation & Employment

MfE: Ministry for the Environment

MM: Modified Mercalli scale

NZGD: New Zealand Geotechnical Database

NZGS: New Zealand Geotechnical Society

NZS: New Zealand Standards

PGA: Peak ground acceleration

Q1a: Well sorted floodplain gravels (Begg J. G., 2000)

Q2a: Poorly to moderately sorted gravel with minor sand or silt underlying aggradational and degradational terrace (Begg J. G., 2000)

SED: Specific Engineering Design

SPTs: Standard penetrometer test

UHCC: Upper Hutt City Council

1. Introduction

Upper Hutt City Council (UHCC) is reviewing chapters within the Upper Hutt District Plan 2004 relating to rural and residential development. The result will be Proposed Plan Change 50 (PC50) to the District Plan in 2022, and the process will evaluate all land use and subdivision controls which manage residential and rural development activities across the Upper Hutt District.

UHCC has identified the need for district-wide geotechnical assessment to be undertaken to inform its review of the District Plan. The geotechnical assessment is required to evaluate the geotechnical suitability of selected Areas, as well as the Existing Urban Area, for continued or new residential development.

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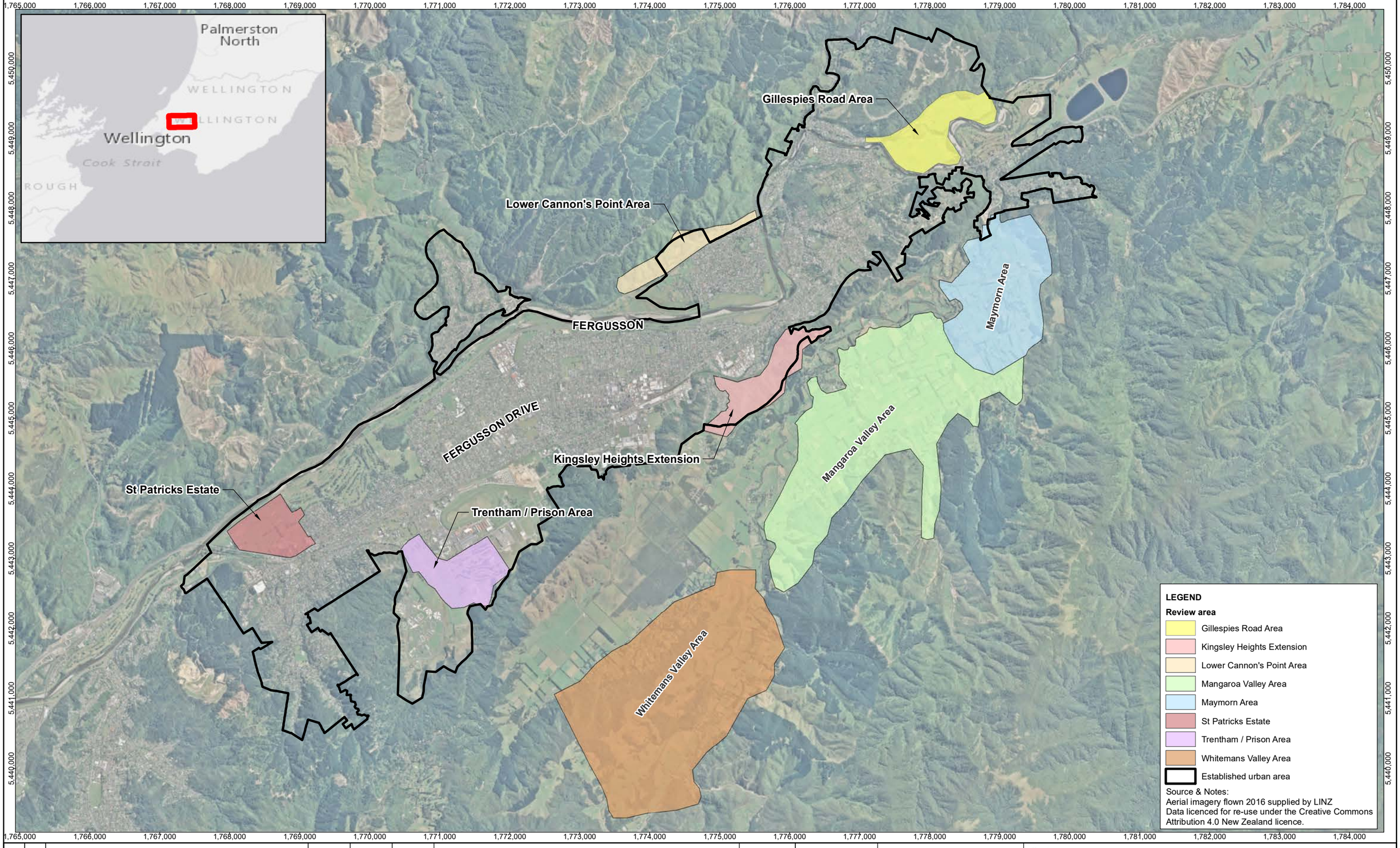
9. Established Urban Area – noted as "Urban Rural Boundary (Iteration 2)".

An aerial photo of the Upper Hutt District showing the locations of these study Areas is shown in Figure A - 0 (below and in Appendix A and Figure G- 0 in Section 3.10). UHCC commissioned Coffey Services (NZ) Ltd to complete a geotechnical hazard assessment of each Area. This report presents the results of those assessments.

In addition to this, UHCC requested we provide a more general, high level geotechnical assessment of the wider Upper Hutt area including the south Whitemans Valley/ Blue Mountains area and the Kaitoke Valley area.

In early 2020, UHCC requested that the slope hazard mapping be smoothed to provide a more user-friendly slope hazard map and that the assessment be extended further to include the Akatarawa Valley, Moonshine Valley and Remutaka Hill areas. A brief analysis of these areas has also been undertaken based on the slope hazard assessment. Slope setbacks have also been refined and mapped for well-defined slopes.



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1.1. Geology Summary

The established urban areas of Upper Hutt City, along with St Patricks Estate, Trentham Prison Area, Lower Cannons Point Area and Gillespies Road Area are located in the alluvial Upper Hutt River Valley/basin that has been formed by tectonic movements of the north-east trending Wellington Fault, which passes along the western side of the valley.

Whitemans Valley, Mangaroa and Maymorn Areas are alluvial terraces in another parallel valley some 100m higher than Upper Hutt and separated by a low, narrow range of greywacke hills on which the Kingsley Heights subdivision and extension are located.

2. Methodology

Each of the nine identified study Areas are being geotechnically assessed as appropriate for residential development for the following natural hazards:

- Slope stability (Landslip)
- Liquefaction (Earthquake induced Subsidence)

In addition, where information allows, an indication of suitable foundation types and suitability for subdivision have been provided.

Generalised, conservative rules for setbacks at the crest and toes of steep slopes are provided for both rock and soil slopes. It is anticipated that these setbacks may be reduced following a site-specific assessment by a geo-professional. For boulder-gravel terrace riser slopes up to approximately 10m high in generally flat alluvial areas, such as Gillespies Road and Lower Cannons Point, our maps show a generalised setback of 5m from the crest of the slope and half the height of the slope from the toe. Again, these setbacks are generalised and indicative, and should be formally assessed by a geo-professional, before subdivision.

Items that are outside of the scope of this report include flood hazard, fault-band mapping and fault setbacks, geo-environmental contamination, stream bank erosion and other engineering considerations such as access and services.

2.1. Hazard Assessment Rationale

2.1.1. Definitions

The words **Hazard** and **Risk** are often interchanged and used loosely in conversation. In this report we use the following well accepted definition:

Risk = (Probability of) Hazard x Vulnerability [x cost]

Where **Hazard** = the probability of a damaging event occurring; for example, for this report it would be a natural hazard, such as an earthquake, storm and flood. We note that following big wildfire events near Blenheim, the Christchurch Port Hills and north-west Nelson, wildfire may be considered as a real hazard in both rural areas and where urban development is close to forest-clad hills.

We recognise that in our every-day lives we manage numerous man-made hazards, such as travelling by car, flying, crossing roads, etc. and generally regard the risks involved as acceptable.

Vulnerability (and cost) = the susceptibility of assets to damage by the hazard and the total damage caused.

As an illustration, there may be a high probability of a strong, shallow earthquake occurring in the centre of a large desert. However, because the desert is flat and dry, and occupied by only a few nomadic people who live in tents, the vulnerability to damage and injury is very low, and thus the risk is very low. On the other hand, if the probability of a strong, shallow surface rupture earthquake

occurring on the Wellington Fault through the centre of the city is the same as the earthquake in the desert, the earthquake hazard would be the same at both places, but the risk in Wellington is very high because of the vulnerability of the buildings and infrastructure, the probability of injury and death, [and high cost of repairs].

Slope Setbacks Slope setbacks are required in an urban setting to avoid development at the crest or toe of steep, potentially unstable slopes. An example are the Banks Peninsula cliffs where houses were built along the crest of high cliffs because of the spectacular views. However, the cliffs collapsed in places, shedding damaging rockfalls in the Christchurch earthquakes, destroying houses at the crest and base of the cliffs. In that case, bigger setbacks at both the crest and the toe of the cliffs would have been appropriate. The setback is made from the point where there is a change in slope from flat or gently sloping ground to a steep slope, and as noted, may be along the top or at the toe of a steep bank. General recommended setbacks have been provided for Upper Hutt in Section 4.3 below. A specific geotechnical assessment is recommended for affected areas to better define the setbacks.

2.1.2. Hazards

Landslip

The natural hazard landslip (slope instability) can be identified by a few key components, notably slope angle and slope type (soil or rock). Although it is difficult to quantify, field evidence shows that the probability of landslip hazard occurring on steep vulnerable slopes increases with high intensity rainfall and strong earthquake shaking.

Slope angle

In a rural and urban setting, sloping ground with gentle to moderate slopes up to a slope angle of 26 degrees, a slope of 2m horizontal to 1m vertical, is regarded as low hazard for instability. In the interest of having a simple, easily applicable classification system, we have defined high hazard slopes as being greater than 26 degrees. All natural soils and rock within Upper Hutt District are regarded as generally stable up to a 26 degree slope angle. For natural slope angles greater than 26 degrees slope instability might occur, with increasing likelihood of instability as the slope angle increases. Slopes up to 26 degrees would not require a specific site stability assessment or a set-back. However, ground with slope angle greater than 26 degrees would require a specific stability assessment from a geo-professional prior to development.

The stability ranking of slopes has been assessed generally based on static, saturated and strong earthquake shaking conditions. Those slopes that are identified as a high hazard will require additional geotechnical assessment which would specifically address static, saturated and seismic conditions appropriate to the specific slope being assessed.

For slope less than 26 degrees, development can lead to instability where cut/fill batters, stormwater/surface water or detrimental loading is not properly managed. Developments on any slope need to follow NZ Standards, best practice and current guidelines.

Slope type

For this report we have divided slopes into **soil slopes** and **rock slopes**. Rock slopes in Upper Hutt area are all Wellington greywacke. When unweathered greywacke is a strong, indurated sedimentary rock that is bedded with varying thicknesses of light-grey sandstone and dark grey/black argillite, a clayey mudstone rock. Close to the surface greywacke rock is typically variably weathered to a brown colour and weathering reduces the strength of the rock. The rock mass is typically closely jointed and sheared by past tectonic processes. The jointing and shearing of the rock mass allow the entry of water and air promoting weathering near the surface, so that the rock mass may be covered by completely weathered rock and soils. The depth of colluvial soils and completely weathered rock on top of the greywacke rock mass can be variable from thin to very thick. The thickness of the soil layer on top of the rock will control the stability and behaviour of a slope. Therefore, if the thickness of soil on the rock mass is unknown, or more than 2m deep, the slope is regarded as a soil slope, even though there is greywacke rock underlying it.

Soil slopes are slopes consisting of soils and gravels (former terrace risers and river banks). If soil slopes have a slope angle greater than 26 degrees, they are regarded as steep and potentially unstable without further geotechnical assessment and investigation that might show otherwise. For the purposes having a simple, easily applicable classification system, we have defined high hazard slopes as being greater than 26 degrees. In an urban setting high hazard slopes will require geotechnical assessment and investigation before they can be developed, and they will require residential building line setbacks at their crest and toe. Soil slopes with a low hazard rating have a slope angle less than 26 degrees. These slopes do not normally require any setbacks.

Rock slopes with a high hazard rating have a slope angle greater than 26 degrees. As rock is typically stronger than soil, a rock slope may be stable at steeper angles. However, the rock mass may contain discontinuities such a crush and shear zones with soil-like properties and may be covered with a variable depth of soil. In this case we consider it to be good practice for rock slopes greater than 26 degrees, rated as high hazard, to be assessed geotechnically prior to development. As noted, steep rock slopes with slope angle greater than 26 degrees are rated as high hazard. Rock slopes less than 26 degrees are classed as low hazard and do not require setbacks. It is anticipated that in Upper Hutt, most slopes, including those mapped as rock will have a mantle of soil overlying the rock of variable thickness. Therefore, the rock slope case is not expected to be common within Upper Hutt.

Liquefaction (Earthquake Induced Subsidence)

Liquefaction typically occurs in susceptible weak soils due to strong earthquake shaking. It has become well-known nationally with publication of dramatic images of liquefaction and its damage following the Christchurch earthquakes. Liquefaction occurs due to an increase in pore water pressure to such an extent that soil particles can easily move relative to each other causing the ground to behave as a liquid. This reduces the ability of the soil to support structures such as building foundations and underground services and significant ground deformations can result. Ejecta such as sand boils typically can occur on the ground surface at liquefied sites. Liquefaction can result in lateral spreading where permanent ground displacements towards waterways or free face occurs.

Key ground conditions that increase the potential for liquefaction are shallow groundwater, loose single grain-size sandy/silty soils. Liquefaction for this assessment has been assessed for strong shaking conditions relating to earthquakes generating shaking stronger than MM7 intensity on the Modified Mercalli scale intensity, or peak ground acceleration (PGA) > ~0.3g. The liquefaction potential is assessed based on the slope angle, geology and soil type, ground model and groundwater information.

Areas that are expected not to liquefy are classed as having No Liquefaction potential. These are areas mapped as rock, on ground sloping >10 degrees, comprised of older soils and where the groundwater table is greater than 5 metres below ground level.

Areas with a negligible liquefaction potential are not anticipated to be susceptible to liquefaction based on the broad characteristics of the soil and previous studies. However, due to the geologically young age of these soils and the variable nature of alluvial deposits, there may be small lenses of material in isolated areas that may liquefy under strong shaking. This may result in negligible deformation of the ground surface and associated small settlements.

For both the no and negligible liquefaction potential areas, no specific geotechnical investigation or assessment is required to address the liquefaction hazard. Standard ground investigations for development would apply.

A medium liquefaction potential area is identified mainly in Trentham Prison area. It is potentially susceptible to liquefaction based on previous investigations that have identified a liquefaction hazard. The original investigations data is unavailable, and the area requires further investigation to better characterise the liquefaction potential. With additional geotechnical investigation and assessment, the area might be reclassified as negligible hazard.

No areas of high liquefaction potential were identified within the study area. Additionally, areas with specific lateral spreading hazard were not identified within the study Area.

Other Hazards

A large area of swampy/ peat ground is mapped to the north west of Whitemans Valley Area. This mapped peat is mostly outside of the study Areas, other than some fingers encroaching the north-western boundary of Whitemans Valley Area. These areas have been identified specifically as “swamp / peat area” and are classified as having a high geotechnical hazard. This is because they are anticipated to be soft and organic rich and may result in ground settlement. Unlike the liquefaction and slope hazards discussed above, this hazard is not dependent on an event (such as an earthquake) occurring but surface settlement could result from structural loading by a building. Deep intrusive geotechnical investigations would be recommended in these areas prior to development. Specific engineering design would likely be required (depending on the outcome of the intrusive investigation).

Several small areas of perched and ponding groundwater were noted across the study Area. Areas of soft ground may be associated with these wet areas. The areas have been identified primarily based on field observations. They were noted in Maymorn and Mangaroa Valley Areas on the north-west side of Mangaroa Valley Road. Wet ground is also likely in similar geomorphological areas across Upper Hutt. Key geomorphic and geological conditions where this may occur are areas which are low lying, adjacent to shallow streams, and where steep hills (particularly with a large catchment) meet flat ground. The perched water and any associated soft ground is anticipated to be limited to the upper ~0.5 metre. Where surface water or shallow perched groundwater is apparent, treatment such as drainage will be required. Additional shallow investigations may be required to determine the extent of the issue.

The areas of perched and ponding groundwater are not included on the hazard maps as they were identified based on field mapping which is concentrated near key roads. In addition, they may be transient in nature and depend on the season and recent weather. They can be identified and managed during a more detailed subdivision assessment.

3. Area descriptions

3.1. Gillespies Road Area

3.1.1. General description

Gillespies Road Area is predominantly rural grassed farmland on the northern side of the Hutt River in north eastern Upper Hutt. (see Figure A - 1 in Appendix A and Figure G - 1 below).

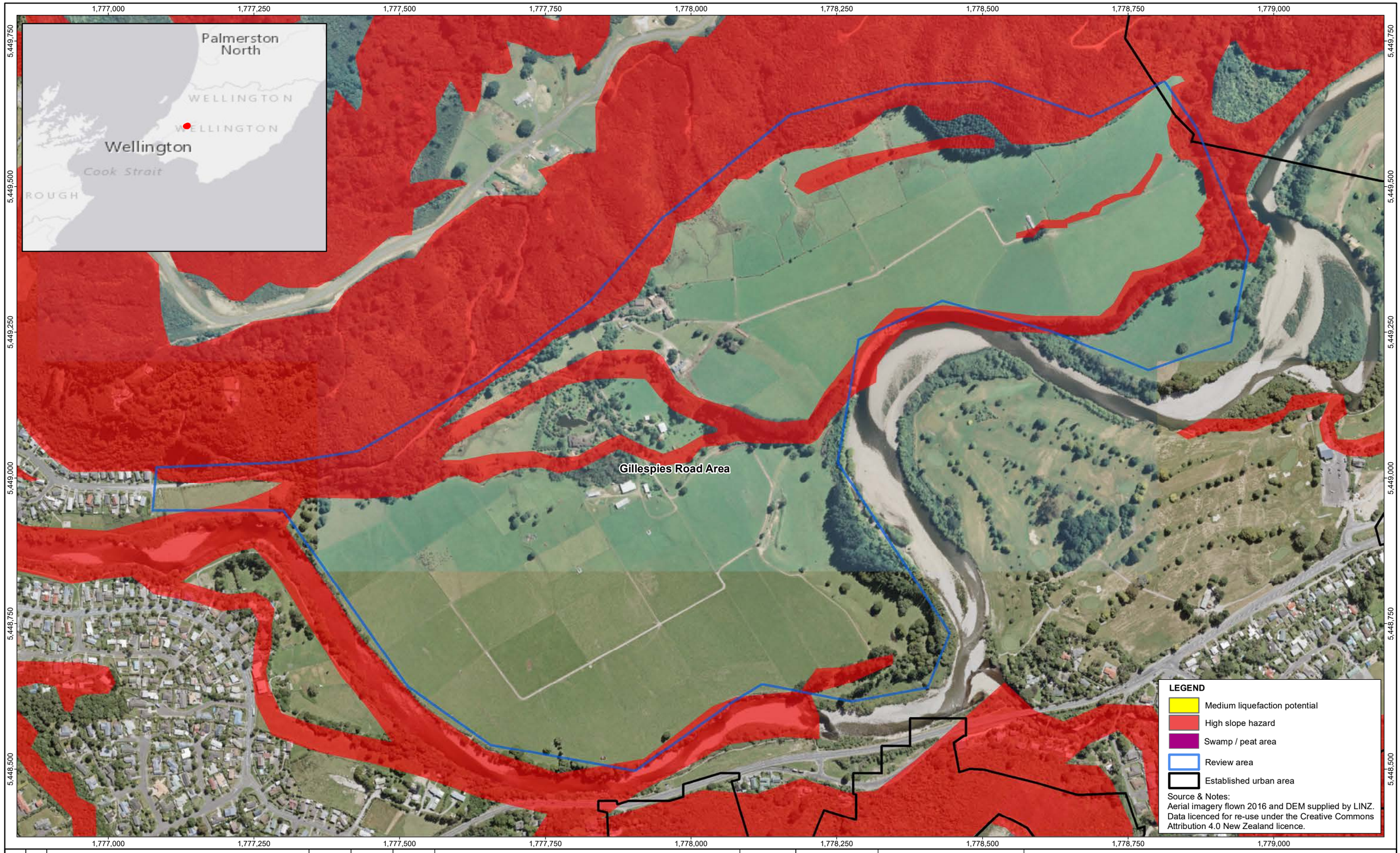
The Area is accessed at the eastern end of Gillespies Road and is bounded to the south by the Hutt River and to the north by greywacke hills.

The Area is relatively flat but includes the toe of the hills to the north. A series of old river terraces and channels are evident on the flats.

The Area is typically elevated above the Hutt River ~5 to 10m with steep boulder-gravel alluvium banks. A series of old river terraces are evident at the north east end of the Area which are up to 20m high and have 26 to 45+ degree slope terrace risers separating the flat terrace surfaces. These risers step up to the north towards the hills and away from the present river channel.

A stream runs west to east through the centre of the site which is within the mapped flood extent (Greater Wellington Regional Council, 2019). Some small streams also run off the hills at the north and dissipate on the flat area. A series of drainage ditches are also apparent within this part of the area. There may be soft alluvial sediments in this area.

Birchville, on the opposite side of the Hutt River, and to the west along Gillespies Road, are currently developed residential areas which are in a similar geomorphic and geological environment to the Gillespies Road Area. These areas have 1 to 2 storey residential dwellings which are setback from the 1 in 100 year flood boundary.



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title: GEOLOGICAL HAZARD OVERVIEW MAP - GILLESPIES ROAD AREA

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3.1.2. Geology

The Gillespies Road Area is mapped as alluvial terraces (Q1a and Q2a) which comprise alluvial gravel with minor sand or silt (Begg J. G., 2000). The hills at the north are mapped as Greywacke bedrock (Begg J. G., 2000) (refer to Figure B0 Appendix B). During our site visit, outcrops along the steep Hutt River banks showed dense alluvial gravel with cobbles and boulders in a silty/sandy matrix overlying bedrock at 1 to 5m depth. Gravel was also apparent on the ground surface in places.

Based on a search of New Zealand Geotechnical Database (NZGD) and the UHCC archives, there is no publicly available geotechnical data within this Area. The nearest borehole was ~400m south east. This and other boreholes indicate 8 to 10m of alluvial gravel and cobbles overlying Greywacke bedrock.

It is therefore anticipated that the site is underlain by gravel alluvial terraces overlying Greywacke bedrock. The hills are anticipated to be Greywacke bedrock potentially with colluvial soil and weathered rock overburden. An indicative cross section through this site is shown in Figure I - 1 in Appendix I.

3.1.3. Hazards

Liquefaction is anticipated to be a negligible hazard due to the elevated nature of the site and the gravelly composition of the soils.

Slope stability; please refer to the Gillespies Road area slope angle map (Figure E - 1 in Appendix E), which clearly shows locations with slope angle greater than 26 degrees as orange and red.

The site is typically flat to undulating with some terrace risers. There is potential slope instability of the steep terrace risers, although they appear to have remained stable under intense earthquake shaking during the most recent ruptures of the Wellington Fault, which passes through the Area. Building setbacks will be required from the crest and toe of the steep terrace risers and from the trace of the Wellington Fault. Standard slope setbacks are provided in Section 4.3. For soil slopes, recommended setbacks are 26 degrees plus 5m for slope crests and half the slope height for toe setbacks. For the terrace risers the setbacks will be 5 metres from the terrace crests and 2.5 to up to 10 metres from the toe, varying with the specific geometry of the terraces. The toe of the hill slopes to the north are steeper than 26 degrees and will also require setbacks. These setbacks have been developed for the Upper Hutt area and so are general in nature. It is recommended that geotechnical assessment of high hazard slopes is carried out prior to development and as a consequence these setbacks may be able to be reduced. Setback from the Hutt River due to slope instability and erosion potential will be required and is being assessed by others.

Soft ground is not anticipated to be a concern, however standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures.

We note that some of the area is within the flood extent (Greater Wellington Regional Council, 2019). The Wellington Fault trace runs through the Area.

3.2. Summary

- Slope stability. The majority of Gillespies Road Area is flat. The toe of the greywacke hills along the north are steep, greater than 26 degrees and will require geotechnical assessment prior to development. The steep terrace risers will require setbacks and geotechnical assessment to determine setback width at their crest and toe.
- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat alluvial gravel terraces are likely to be covered with a layer of silt. Normal house foundation investigations, as required on other flat areas of Upper Hutt City, are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements.
- Suitability for subdivision and development. Gillespies Road Area is 5.5km in a direct line north-west from Upper Hutt City Centre. Of the total 100 Ha land area available, approximately 90% is

currently assessed as having a low geotechnical hazard. Considerations are the presence of the Wellington Fault which passes through the Area, similar to Totara Park. Restrictions in accordance with MfE Guidelines (Kerr, 2003) are recommended.

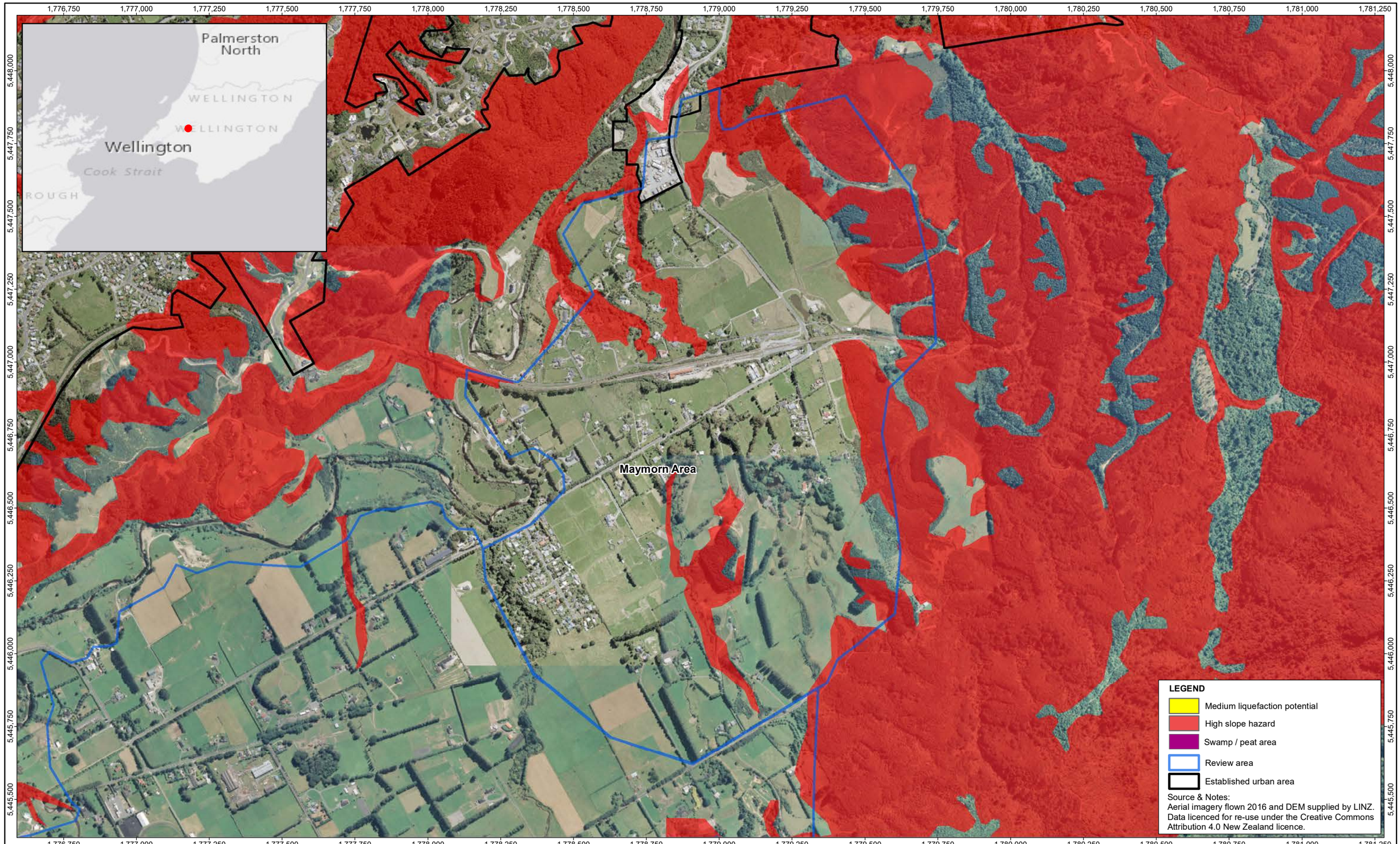
3.3. Maymorn Area

3.3.1. General Description

Maymorn is an approximately 250 Ha, largely rural area in north-eastern Upper Hutt District located some 5.6 km in direct line east north-east from Upper Hutt City centre (see Figure A - 2 in Appendix A and Figure G - 2 below). It has the Wellington – Wairarapa train line running east-west through it with the Maymorn Station already operational. It includes the small McLaren Street residential area.

The Maymorn, Mangaroa and Whitemans Valley Areas are located in a basin/valley separated from Upper Hutt basin/valley by a low, north-east trending range of greywacke hills. The Mangaroa Valley is at an approximately 100m higher elevation than Upper Hutt. The Mangaroa/Maymorn Area is accessed by Maymorn Road from SH2 at Te Marua in the north, by Mangaroa Hills Road and Wallaceville Road into Upper Hutt to the south-west, and Whitemans Valley Road through Blue Mountains to Silverstream in the south.

The Area comprises a mainly flat alluvial terrace with gently sloping fans from the greywacke hills grading onto it. There are low greywacke hills in the south-east, east and north-east. Several north-flowing streams flow in steeply incised channels across the Area from the greywacke hills. The toes of the steeper greywacke hills are present along the eastern side of the Maymorn Area.



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3.3.2. Geology

Maymorn Area has the toes of greywacke hills and low spurs along its eastern side. There is also a low, rounded, north-trending greywacke spur rising out of the alluvial terrace in the centre of the Area. The remainder of the Area is predominantly an old flat alluvial terrace made up of dense, bouldery alluvium (lg) covered with a layer of silty soil (Begg J. G., 1996). This is dissected by active stream channels and associated young (Holocene) alluvial soil (fa) immediately adjacent to the streams (refer to Figure B - 1 Appendix B) (Begg J. G., 1996).

From a search of NZGD, UHCC archives and Coffey files, there is no geotechnical investigation data available for the Maymorn Area. A borehole is available ~160m north of the Maymorn Area within an area mapped as Holocene alluvium. This borehole shows gravel with a silt and sand matrix dominates the profile. A study on the erosion hazard of the Mangaroa River on a site on Parkes Line Road immediately west of the Maymorn Area discusses the geology of this area as a series of alluvial terraces comprising over-consolidated silty gravel and silt.

During the site walkover in July 2019, road cuts were noted that indicate silt and silty gravel alluvial soils. These were typically steep and appeared over consolidated.

It is therefore anticipated that the geology in Maymorn Area comprises predominately gravel alluvial soils, mostly elevated, older, over consolidated terraces. The eastern hills and central ridgeline comprise greywacke bedrock overlain by variable thickness of overburden soil (colluvial or residual soil).

3.3.3. Hazards

Liquefaction is anticipated to be a negligible hazard due to the elevated nature of the site, the dense gravelly composition of the flat terrace soils, and the presence of greywacke bedrock in places.

Slope stability; please refer to the Maymorn Area slope angle map (Figure E - 2 in Appendix E), which clearly shows locations with slope angle greater than 26 degrees as orange and red.

The site is typically a flat terrace with steep stream banks. There is potential slope instability of the steep stream banks, although they appear to have remained stable for thousands of years, including under intense earthquake shaking, most recently during the Magnitude 8.2 Wairarapa earthquake in 1855. Building setbacks will be required along the crest of the steep terrace risers. The setbacks provided in Section 4.3 can be applied initially. A specific geotechnical assessment is recommended prior to development to better determine required setbacks. Potential erosion and slope instability along banks of the streams and Mangaroa River will require setbacks. These are being assessed by others.

The toes of the hill slopes to the east are steeper than 26 degrees in places and will require geotechnical assessment prior to development.

Soft ground is not anticipated to be a concern. However standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures.

3.3.4. Summary

- Slope stability. The majority of Maymorn Area is flat. The toe of the greywacke hills along the east are in places steeper than 26 degrees and will require geotechnical assessment prior to development. The steep stream banks will require setbacks and geotechnical assessment to determine setback width at their crests.
- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat alluvial gravel terraces are likely to be covered with a layer of silt. Normal house foundation investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 requirements.

- Suitability for subdivision and development. Maymorn Area is 5.6km in a direct line east-northeast from Upper Hutt City Centre. Of the total ~280 Ha land area available, approximately 80% is assessed as having a low geotechnical hazard in its current form. Considerations are the presence of deeply incised streams through and along the north-west side of the Area.

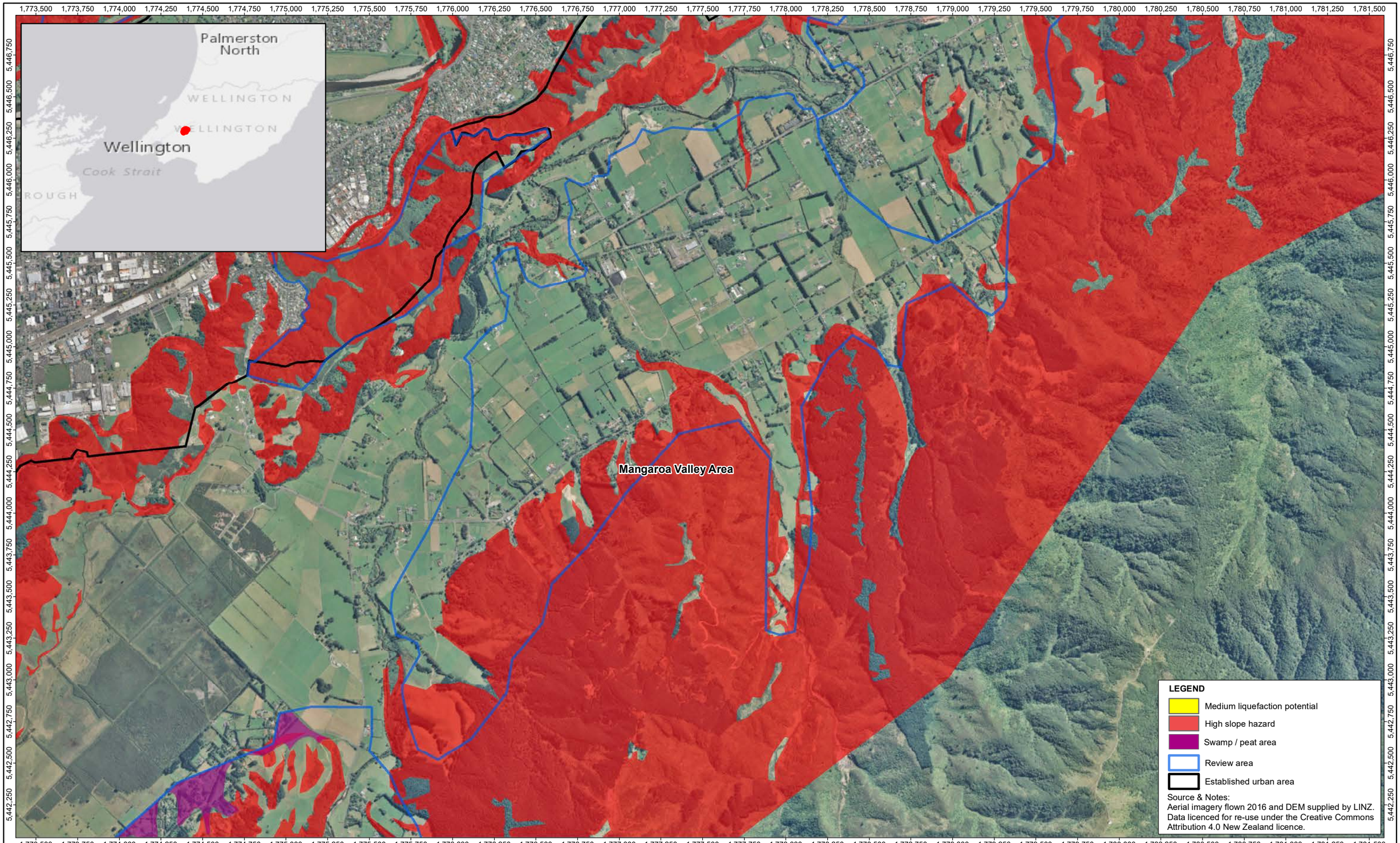
3.4. Mangaroa Valley Area

3.4.1. General description

Mangaroa Area is a large, predominantly flat rural block of 580 Ha (see Figure A - 7 in Appendix A and Figure G - 7 below). When measured on a direct line, Upper Hutt City centre is just 3.4 km to the west over a narrow range of low greywacke hills. Steep greywacke rock hills of the main North Island axial ranges border the south-east margin of the Area. The steeper slopes of the toes of these hills and the flat alluvial valleys of streams from them are included in Mangaroa Area.

The Mangaroa Area is accessed by Maymorn Road from SH2 at Te Marua in the north, by Mangaroa Hills Road and Wallaceville Road into Upper Hutt to the south-west, and Whitemans Valley Road through Blue Mountains to Silverstream in the south.

The Area comprises mainly flat alluvial terraces (approximately 80%) with gently sloping fans from the greywacke hills grading onto it. There are greywacke hills along the south-east margin of the Area. Several north-flowing streams issue from the greywacke ranges and flow in meandering channels across the alluvial terrace which slope gently to the north-west. The toes of the steeper greywacke hills are present along the south-eastern side of the Area.



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3.4.2. Geology

The Mangaroa Area is mapped mainly as an old alluvial terrace with greywacke bedrock hills along the south-east margin and recent alluvial (fa) stream channels in the small greywacke valleys and across the older alluvial terrace (lg) (Begg J. G., 1996) (refer to Figure B - 1 Appendix B). During our site visit, outcrops along the steep stream banks showed dense alluvial gravel with cobbles and boulders in a silty/sandy matrix. Immediately to the north-west of Colletts Road and Mangaroa Valley Road, areas of wet ground and standing water were observed. This corresponds to the base of the ranges to the south-east and where these meet the flatter alluvial terraces.

From a search of NZGD, UHCC archives and Coffey files, there are eight geotechnical investigation points within the Mangaroa Area covering the recent alluvial (fa) and the older alluvial terrace (lg). These indicate gravel dominate profiles with silty/ sandy matrix and with some silt or clay layers up to 3m thick. Noted water levels were between 9.5m and 13.8m below ground level.

Under the old alluvial terrace there are expected to be dense boulder gravels to tens of metres depth overlying greywacke rock.

It is therefore anticipated that the flat terrace surfaces are underlain by dense gravel alluvium overlying Greywacke bedrock. The hills are anticipated to be Greywacke bedrock potentially with some colluvial soil and weathered rock overburden. The wet areas identified are likely areas of shallow perched water associated with run off from the south-east ranges. This is anticipated to be isolated to the upper ~0.5 to 1 metre as groundwater information from the wider Mangaroa Area indicates that groundwater is significantly deeper.

3.4.3. Hazards

Liquefaction is not possible in greywacke rock and is anticipated to be a negligible hazard on the terraces due to the elevated nature of the site and the gravelly composition of the soils.

Slope stability; please refer to the Mangaroa Area slope angle map (Figure E - 7 in Appendix E), which clearly shows locations with slope angle greater than 26 degrees as orange and red.

The site is typically undulating (flat) with some steep stream banks. There is potential slope instability of the steep stream banks, although they appear to have remained stable under intense earthquake shaking, most recently during the very strong shaking of the M8.2 Wairarapa Earthquake in 1855. Building setbacks will be required along the crests of steep steam banks and consideration of potential flooding will be required where the streams have low banks.

The toe of the hill slopes to the south-east are steeper than 26 degrees in many places and will require geotechnical assessment prior to development.

For most of the Mangaroa Area, soft ground is not anticipated to be a concern, however standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures. Soft ground may be associated with the wet areas discussed in section 3.4.2 above. As this is expected to be a shallow feature, shallow ground investigations such as hand augers, dynamic cone penetrometers (DCPs) or test pits are anticipated to be sufficient to further investigate these areas. Site specific identification of these areas and treatment if required by installation of drainage is anticipated to be appropriate remediation.

3.4.4. Summary

- Slope stability. The majority of Mangaroa Area is flat. The toe of the greywacke hills along the south-east of the Area are steep, greater than 26 degrees in many places and will require geotechnical assessment prior to development. Steep river banks will require setbacks and geotechnical assessment to determine setback width at their crest and toe
- Liquefaction potential of the Area is negligible.

- Foundations for construction. The flat alluvial gravel terraces are likely to be covered with a layer of silt. Normal house foundation investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements.
- Suitability for subdivision and development. Mangaroa Area is 3.5km in a direct line east from Upper Hutt City Centre. Of the total ~580 Ha land area available, approximately 75% is assessed as having a low geotechnical hazard under current conditions. Considerations are the presence of streams crossing northwards through the Area and wet areas near the base of the south-east ranges.

3.5. Kingsley Heights Extension

3.5.1. General Description

The Kingsley Height Extension Area is predominantly a forested steep area on the hills between Clouston Park and Mangaroa Valley. Access to the site is off King Charles Drive from the west and Mangaroa Hill Road to the north east (refer to Figure A - 3 in Appendix A and Figure G - 3 below).

The Kingsley Heights subdivision immediately west of this Area is a small currently developed subdivision in a similar geomorphic and geological environment. It has 1 to 2 storey residential developments on flat to gently sloping building platforms on the ridgelines and valley floors. Timber post retaining walls at slope toes and between properties are common. Steeper slopes are vegetated and undeveloped.

3.5.2. Geology

The geology of the Kingsley Height Extension Area is mapped as predominantly Greywacke bedrock with some older alluvium (lg) in valleys at the base of the hills along the northern boundary of the Area (Begg J. G., 1996) (refer to Figure B - 1 Appendix B).

During our site walkover, observed outcrops near a ridgeline showed soil slopes up to 3m high comprising gravelly silt colluvium and rock slopes up to 5m high. The rock is highly to moderately weathered and fractured greywacke. The slopes are typically ~45 degrees. Some small streams and water channels were also observed.

Based on a search of NZGD, the UHCC and Coffey archives, there are no publicly available geotechnical data within this Area. The nearest borehole was from ~380m west of the Area. This borehole indicates 30m of gravel and clay soil over rock, despite being mapped as greywacke rock. No groundwater information is available.

The geology at the Kingsley Height Extension Area is anticipated to be greywacke bedrock with overburden soils comprising silty/gravelly colluvium and potentially completely weathered to residual greywacke soil. The thickness of the overburden soils is likely variable and is anticipated to be thicker within the valleys. The alluvial valleys at the northern edge of the Area are anticipated to be gravel dominant soils.

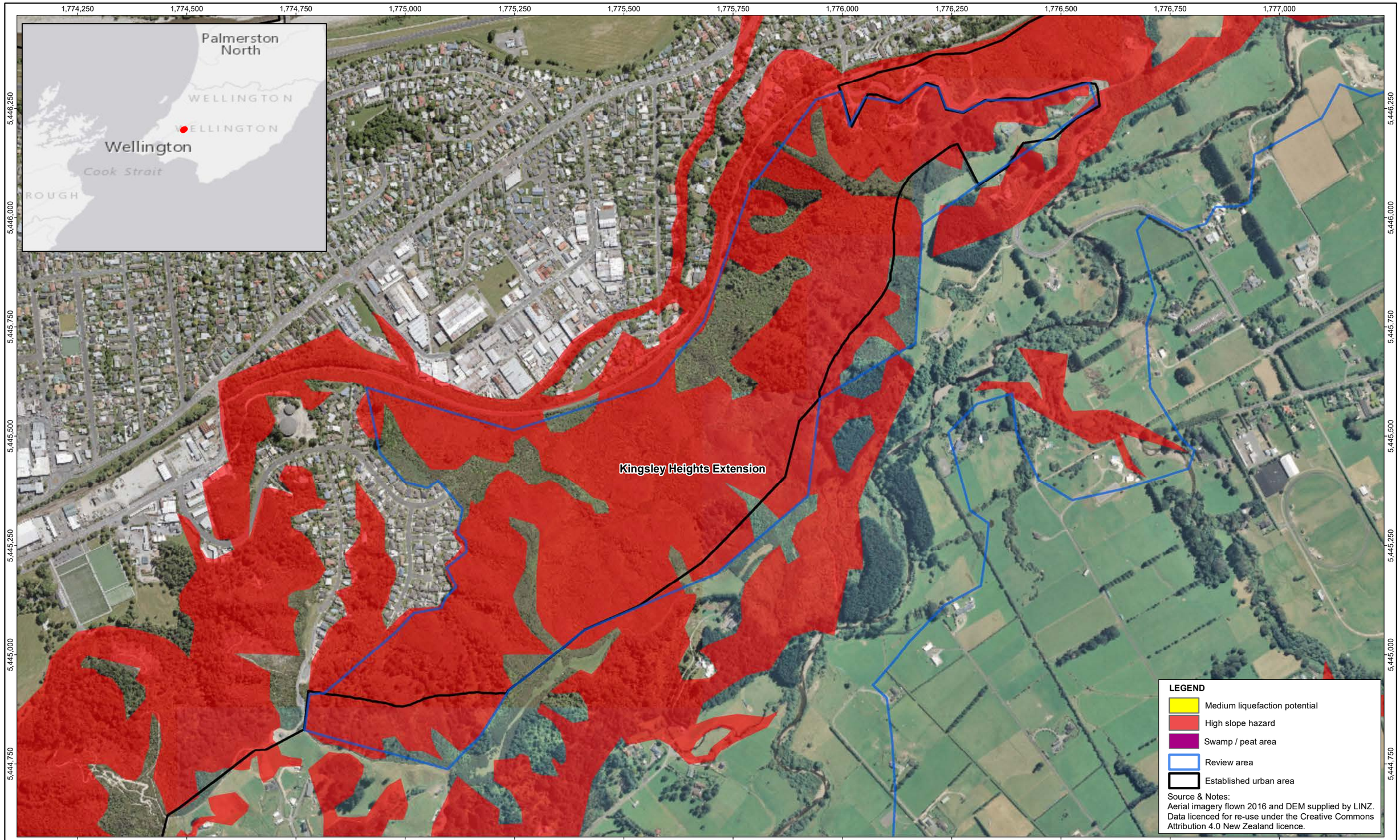
3.5.3. Hazards

Liquefaction is anticipated to be a none to negligible hazard as rock does not liquefy and the soil units are gravelly in nature, older and elevated.

Slope Stability; please refer to the Kingsley Height Area slope angle map (Figure E - 3 in Appendix E) which clearly shows locations with slope angle greater than 26 degrees as orange and red.

The site is typically steeply sloping with most slope angles 26-45 degrees. These will therefore require geotechnical assessment prior to development. Areas on ridgelines and valley floors are flatter (typically <10 degrees) and provide good opportunity for development. Setbacks from the crest and toe of the slopes will be required. Some earthworks to further flatten these areas would increase the available area.

Soft ground is not anticipated to be a concern, however standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures in low hazard areas.



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3.5.4. Summary

- Slope stability. The majority of Kingsley Height Extension Area is hilly with slopes greater than 26 degrees. Much of the Area will require geotechnical assessment prior to development. The steep slopes will require setbacks and geotechnical assessment to determine setback width at their crest and toe
- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat valley floors and ridge crests where recommended setbacks are observed, would be suitable for normal house foundations. Investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements. For the steeply sloping ground, geotechnical investigation and specific engineering design would be required. A key item to determine on the sloping sites will be the depth to bedrock, which would have a significant effect on the stability of the slopes, the foundation options and associated costs. Typical foundations would be piles and/or retaining walls.
- Suitability for subdivision and development. The Kingsley Heights Extension Area is very close to Upper Hutt city centre (~1km to the east in a direct line). Of the 85 Ha available, around 30% of the area is assessed as having a low geotechnical hazard.
- The main considerations for developing this site are the steeply sloping ground and the management of stormwater runoff. Development along the crests and ridges similar to how the existing Kingsley Heights subdivision has been developed, may be appropriate. To make the most of the land, earthworks would be required, as well as construction of retaining walls, in particular to extend the ridgelines and valley floors, and for roads into the development. The extent of the earthworks would depend on the amount of land to be opened up and the costs willing to be spent. The steeper hill slopes will require geotechnical investigation and assessment prior to any development.

3.6. Lower Cannon's Point Area

3.6.1. General Description

The Lower Cannon's Point Area is a long narrow area immediately north of Totara Park (Figure A - 8 in Appendix A and Figure G - 8 below). It includes a series of terraces 5 to 15m high with typical slopes of the terrace risers of 26 to 45 degrees. These terraces are currently grassed farmland. The northern part of the site incorporates the lower slopes of the greywacke ranges to the north, which are forested. These slopes are typically 26 to >45 degrees. The eastern end of the site is bounded by the Hutt River. A transmission line runs south-west to north-east through the site.

The site is elevated at least 15m above the Hutt River.

3.6.2. Geology

The geology of the Lower Cannon's Point Area is mapped as Holocene Alluvial soils (fa) along the southern, lower portion of the site. The hills at the north side are mapped as Greywacke bedrock and the immediate strip as older alluvium (lg) (Begg J. G., 1996)(Figure B - 10 Appendix B). A cross section showing a representative section through this Area is included in Figure I - 2 in Appendix I.

During our site walkover, we noted that gravel was exposed on the edges of the terraces. Some of this gravel appeared to be loose.

Based on a search of NZGD, the UHCC and Coffey archives, there are no publicly available geotechnical data within this Area. The nearest available borehole is ~500m south of the Area within an area mapped as fa alluvium. This borehole indicates the subsoil profile in this area is typically gravel with some silt. No groundwater information was available.

Based on the above information, it is inferred that the terraces comprise gravelly soil and that the hill slopes are underlain by greywacke bedrock with a variable thickness of overburden soils. The groundwater table is anticipated to be at 10m depth or more based on the elevation of the site.

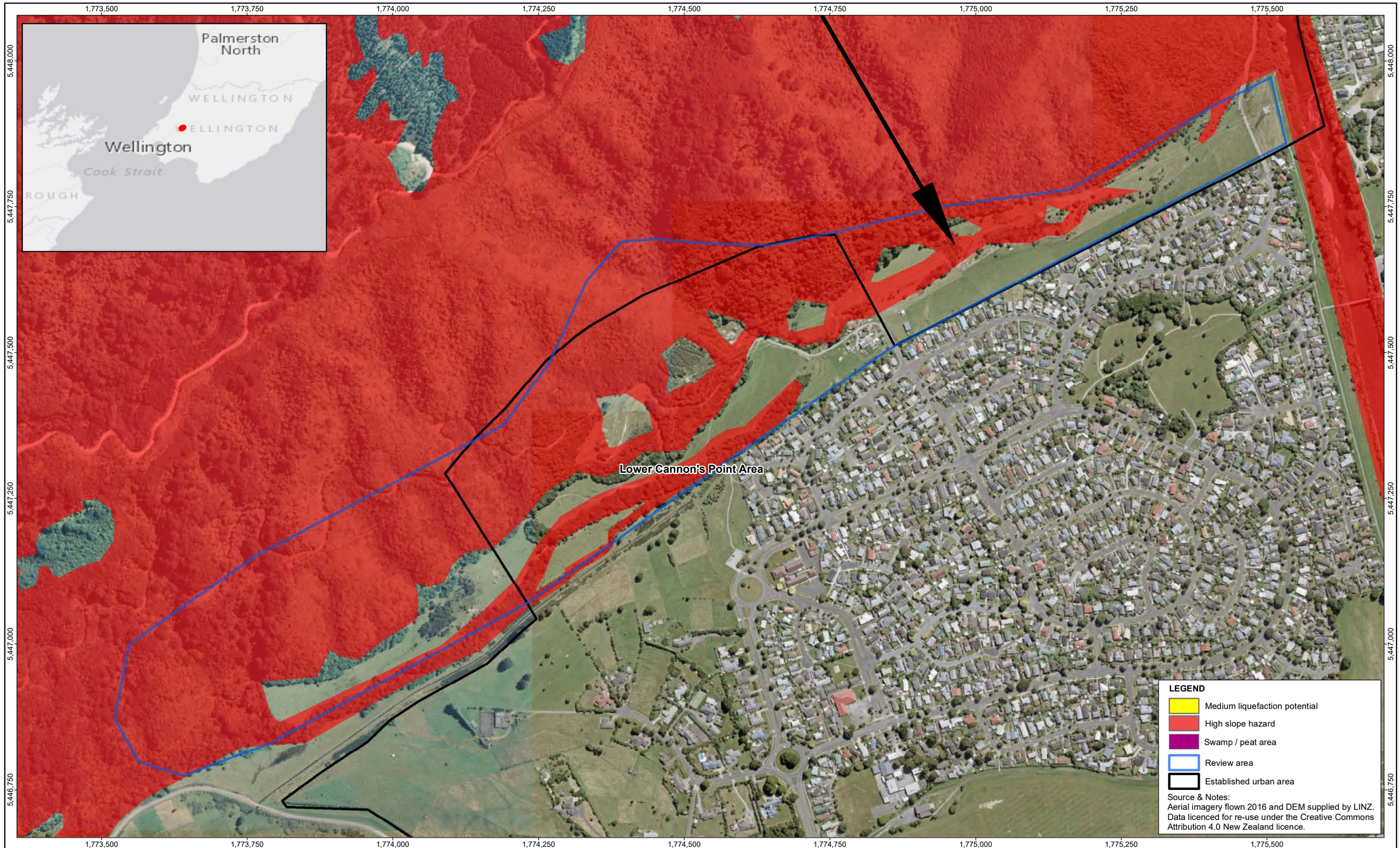
3.6.3. Hazards

Liquefaction is anticipated to be a none to negligible hazard as rock does not liquefy and the soil units are gravelly in nature and elevated, and the water table is deep.

Slope Stability; please refer to the Lower Cannons Point Area slope angle map (Figure E - 8 in Appendix E), which clearly shows locations with slope angle greater than 26 degrees as orange and red. The site is variable with some flat (<10 degrees) terraces with steeper terrace risers (26 to 45 degrees) separating them. There is potential slope instability of the steep terrace risers, although they appear to have remained stable under intense earthquake shaking during the most recent ruptures of the near-by Wellington Fault, which passes just south of the Area. Some ongoing fretting of these risers is apparent. Building setbacks will be required from the crest and toe of the steep terrace risers.

The toe of the hill slopes to the north are steeper than 26 degrees and will require geotechnical assessment prior to development.

Soft ground is not anticipated to be a concern, however standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures.



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3.6.4. Summary

Slope stability. The majority of Lower Cannon's Point Area is steeply sloping. The toe of the greywacke hills along the north are steep, greater than 26 degrees and will require geotechnical assessment prior to development. The steep terrace risers will require setbacks and geotechnical assessment to determine setback width at their crest and toe.

- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat alluvial gravel terraces are likely suitable for shallow foundations. Normal house foundation investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements. Geotechnical assessment and specific engineering design will be required for development on the hill slopes at the north of the site and for development within the standard setback areas discussed in Section 4.3 below.
- Suitability for subdivision and development. Lower Cannon's Point Area is 2km in a direct line north from Upper Hutt City Centre. Of the total 55 Ha land area available, approximately 40% is assessed as having a low geotechnical hazard without land modifications. Due to the morphology of the site, the low hazard areas suitable for subdivision and development in their current form are the flat terraces which are quite narrow with a typical width of ~50m. A ribbon type development where a road and services run along the toe of a terrace with one or two rows of houses coming off the road on that terrace would be an appropriate form to develop this land.

3.7. Whiteman's Valley Area

3.7.1. General Description

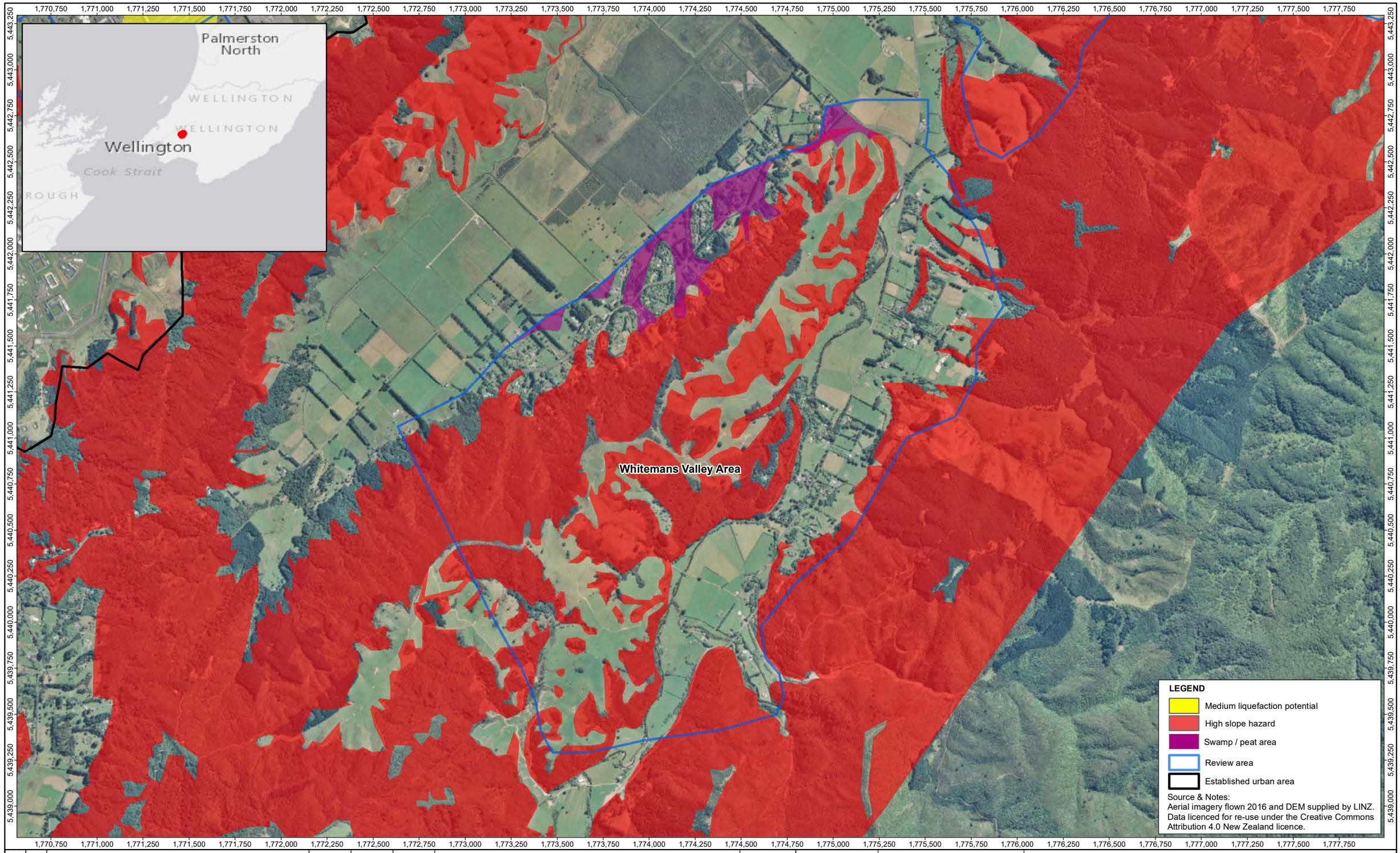
The Whitemans Valley Area is distinctive in that it has a mix of low greywacke rock hills and spurs, and small stream valleys, the biggest of which is the Whitemans Valley through which the Mangaroa River runs (Figure A - 4 in Appendix A and Figure G - 4 below). Approximately one third of the Area is relatively flat and two-thirds is steep hills with slopes often greater than 26 degrees. The slope angle map of the Area (Figure E - 4 in Appendix E) illustrates the areas that are flat (blue) and low angle slopes (yellow), while the orange and red areas are steep.

Whitemans Valley Area is a large, predominantly hilly rural block of 650 Ha. When measured on a direct line, Upper Hutt City centre is 4.7 km to the north over the upper Mangaroa Valley and a narrow range of low greywacke hills. The steep greywacke rock hills of the main North Island axial ranges border the south-east margin of the Area, and there is a low greywacke ridge occupying the centre of the Area. The steeper slopes of the toes of these hills form the margins of Whitemans Valley, and the margin of Mangaroa Valley to the north.

The Whitemans Valley has numerous low stream terraces on stream flood plains. These small flat alluvial valleys of streams form most of the flat land.

As is the case for Maymorn and Mangaroa Areas, the Whitemans Valley Area is accessed by Maymorn Road from SH2 at Te Marua in the north, by Mangaroa Hills Road and Wallaceville Road into Upper Hutt to the south-west, and Whitemans Valley Road through Blue Mountains to Silverstream in the south.

Whitemans Valley itself comprises mainly undulating, flat alluvial terraces formed by the meandering stream, with sloping fans and rock spurs from the greywacke hills grading onto it. There are greywacke hills along both sides of the Valley.



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3.7.1. Geology

The Whitemans Valley Area is mapped as greywacke rock hills with recent alluvial stream channels in the small valleys in the greywacke hill topography (Begg J. G., 1996). The greywacke hill valleys appear to generally contain gravel alluvium, except those along the north-west boundary of the Area, which appear to have a swampy infill with peat. Immediately north-west of the Area is flat ground mapped as peat. While this is outside of the area of assessment, some peat is mapped as running into the small valleys along the north-west boundary of this Area along Katherine Mansfield Drive (Begg J. G., 1996) (Figure B - 1 Appendix B and Figure G4 above).

During the site walkover, stream banks and beds were typically gravelly, often with up to 1m of silt at the surface. Some areas of wet ground were observed adjacent to streams. This corresponds to the base of the ranges to the south-east and where these meet the flatter alluvial terraces.

Based on a search of NZGD, the UHCC and Coffey archives, there are four geotechnical investigations available within this Area. These indicate that the alluvial soils are typically gravel in a silt/ sand matrix with bands of silt up to 0.7 to 2.7m thick in the upper profile.

One borehole south of Katherine Mansfield Drive in a small gully encountered 4.5m of organic rich soil overlying silty clay to 9.5m. Beneath this, silty gravel dominated the profile.

An investigation done at the toes of the eastern ranges and observations from road cuts along Whitemans Valley Road indicate a significant thickness of overburden soil over the mapped bedrock. This overburden was typically silt and up to 2-4+m thick. In some road cuts seepage and slumping of the soil was observed.

Groundwater information from previous investigations indicates water levels at 4.5 to 8.5m depth.

Based on this information, the alluvial valley floor is anticipated to be predominately gravelly with some silt bands. The hills are anticipated to be Greywacke bedrock with variable thickness of colluvial soil and weathered rock overburden. The small valleys along the north-west boundary of the Area (on the south-eastern side of Katherine Mansfield Drive) are anticipated to be variable, with some peat and organic soils anticipated.

3.7.2. Hazards

Liquefaction is not possible in greywacke rock and is anticipated to be a low to negligible hazard on the terraces due to the elevated nature of the site and the gravelly composition of the soils.

Slope stability; please refer to the slope angle map (Figure E - 4 in Appendix E) which clearly shows locations with slope angle greater than 26 degrees as orange and red. The site is typically hilly with many steep slopes greater than 26 degrees that will require specific investigation prior to development.

The main valley is mapped within the flood hazard zone (Greater Wellington Regional Council, 2019) and the small alluvial valleys may be flood prone on their stream flat areas. The stream banks may be susceptible to erosion and wet, possibly soft ground may be associated with the low lying areas next to streams. These areas will also require specific assessment prior to development.

Some areas of soft ground are anticipated in the small stream valleys along the north-west Area boundary flowing north into the mapped peat area. Site specific geotechnical investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures in these places.

3.7.3. Summary

- Slope stability. The majority of Whitemans Valley Area is hilly with slopes greater than 26 degrees that will require specific geotechnical assessment prior to development. Stream valley flats are flat/undulating but may be flood and or erosion prone and will also require specific assessment.

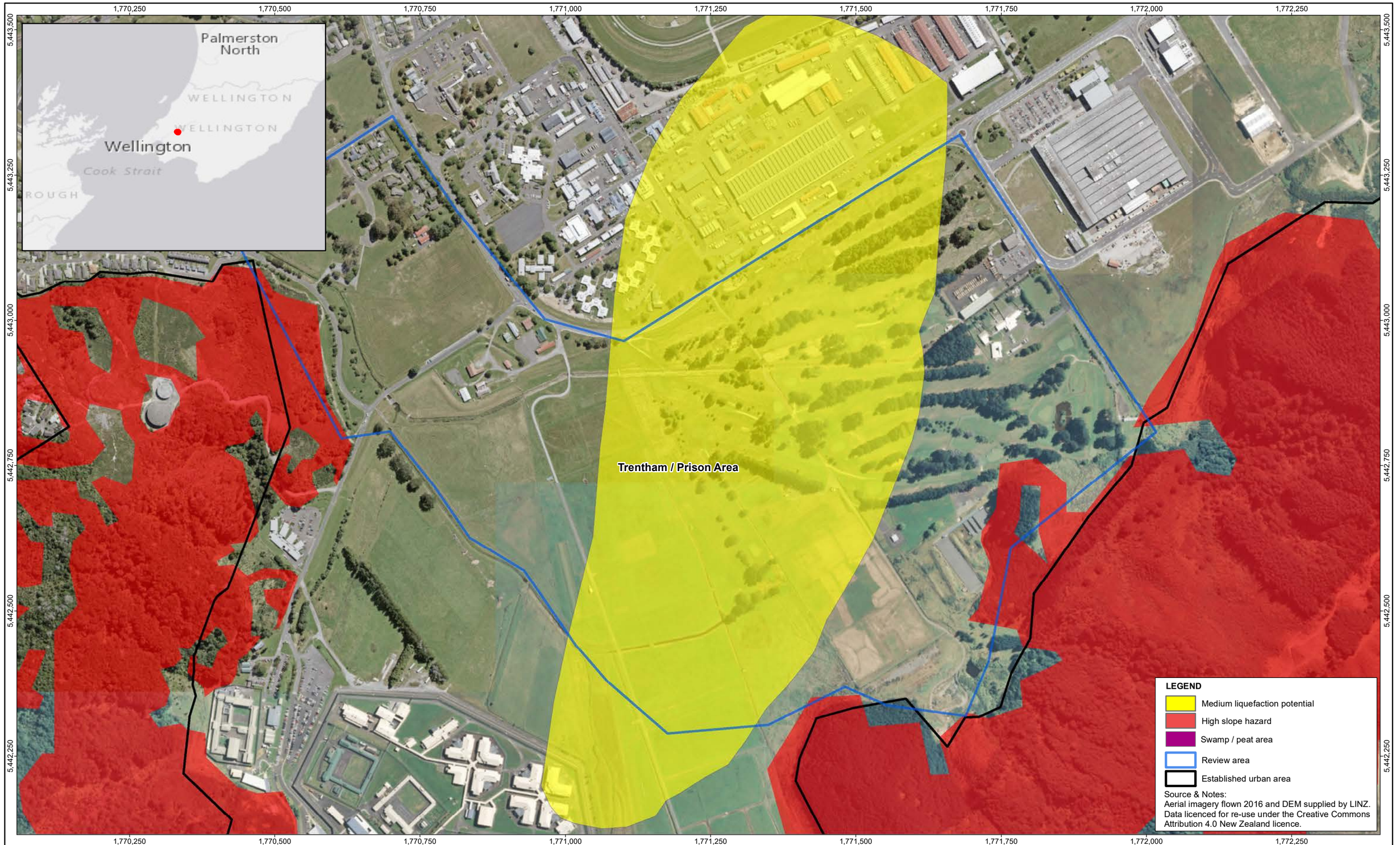
- Liquefaction potential of the Area is assessed as generally negligible.
- Foundations for construction. The greywacke hills and the flat alluvial gravel terraces are likely to be covered with a layer of soil. Specific geotechnical investigations will be required for the design of house foundations.
- Suitability for subdivision and development. Although Whitemans Valley Area is 4.7km in a direct line south from Upper Hutt City Centre It will be difficult and costly to develop for subdivision because of its hilly topography and potentially flood-prone valleys. Of the total ~660 Ha land area available, approximately 50% is assessed as having a low geotechnical hazard in its current form. Considerations are the presence of many small streams in the hilly terrane, which would make any subdivision difficult and restricted to small areas

3.8. Trentham/ Prison Area

3.8.1. General Description

The Trentham /Prison Area is located at the southern end of the of Upper Hutt basin. It backs onto the Blue Mountains to the east and to Rimutaka Prison to the south. The land is predominantly defence force land as part of Trentham Military base. It also includes Trentham Camp Golf Club and Davis sports field. To the north of the site is Trentham Racecourse and residential dwellings.

The Area is relatively flat and grassed (Figure A - 5 in Appendix A and Figure G - 5 below).



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3.8.2. Geology

The Area is mainly a flat young alluvial terrace of the Hutt River (fa) (Begg J. G., 1996). To the south-east and west there are low angle alluvial fans onto the terrace from the surrounding greywacke hills (Figure B - 1 Appendix B).

Based on a search of NZGD, the UHCC and Coffey archives, there is one publicly available geotechnical investigation within this Area. This indicates a gravel dominate profile with silty/sandy matrix to at least 20m depth. Nearby geotechnical investigations ~300m from the Area indicate a similar profile and a groundwater level of ~7m depth. Alluvial soils of variable composition and consistency were identified in one report. This variability may result in localised thin layers of potentially liquefiable soil. These are not considered a significant hazard due to the thin and discontinuous nature of potentially liquefiable lenses.

During the site walkover, stream banks observed were typically gravelly to silty. Some areas were low lying and a number of small water courses run through the site.

3.8.3. Hazards

Liquefaction: Previous work (Kingsbury, 1993) some time ago has categorised the central section of this Area as having a high liquefaction hazard based on intrusive investigation data. However, the intrusive investigation data on which this assessment was made is not yet available. This previous liquefaction assessment also applies to part of the existing developed urban area and requires further assessment in due course.

As we have been unable to access/find this data we are unsure what identified this as a higher hazard than the surrounding area. From the information we have been able to review and from site walkover, we do not anticipate that there is a higher liquefaction hazard than surrounding areas, such as the current subdivision at the old Wallaceville research centre. However, in the absence of additional information and our not having viewed the initial intrusive investigation data, we have provisionally kept a medium liquefaction potential in this area. We therefore recommend that this part of the Trentham/Prison Area have site specific geotechnical investigation and assessment prior to design and construction of any additional dwellings.

This is an area where we recommend further geotechnical investigation to allow for re-assessment of the ‘medium’ liquefaction hazard. 2-3 days of Cone Penetrometer Testing (CPT) work would provide sufficient coverage for planning purposes.

Alternatively, developments within this area will require specific investigation and design.

NZGS Module 2 (NZGS & MBIE, 2016) provides sufficient guidance for further investigation as a requirement before developing sections or subdividing.

Slope stability; the site is mostly less than 26 degrees and is typically flat. The toes of the hills at the south-east and south-west of the site are small areas generally steeper than 26 degrees and as such are assessed as a high slope hazard. These areas will require geotechnical assessment prior to development.

There may be wet or soft ground at the southern end of the Area near the base of the hills, where run off from the hills may pond.

3.8.1. Summary

- Slope stability. The Area is mostly flat and slope instability is not an issue except for a couple of isolated areas.
- Liquefaction potential of the Area is assessed as generally negligible although there is a question of historic assignment of medium liquefaction potential that needs resolution.

- Foundations for construction. Because there is a question of historic liquefaction potential that is unresolved, specific geotechnical investigations are recommended for the design of house foundations unless the potential liquefaction issue is resolved.
- Suitability for subdivision and development. A subdivision in this Area is expected to be quite similar in development requirements to the Wallaceville subdivision which is currently in progress. Surface drainage is a consideration, especially with runoff from the hilly margins to the south east and west.

3.9. St Patricks Estate

3.9.1. General Description

The St Patricks Estate Area is at the western end of Upper Hutt on the recent flood plain of the Hutt River. It is bounded to the north west by the Hutt River, to the west by Country Lane, to the south by Fergusson Drive and to the east by residential properties and Wellington Golf Club (Figure A - 6 in Appendix A and Figure G - 6 below).

The site is generally flat to undulating and grassed (<10°). At the south end of the site is St Patrick's College Silverstream and at the south-east is the St Joseph's Home of Compassion.

The southernmost part of the site where the buildings within this block are (St Patrick's College and Home of Compassion) is elevated ~5m from most of the area to the north.

A couple of streams run across the northern section of the Area. Most of the site is typically ~2m above the water level of these streams. Although there are some low-lying sections immediately adjacent to the streams.

The site is typically ~4m above the Hutt River level.

Most of the site is within the Flood extent area of the Hutt River, except for south eastern, elevated section encompassing St Patrick's College and the Home of Compassion (Greater Wellington Regional Council, 2019).

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MXD ref: 225406_02_G_3

3.9.2. Geology

The geology of the St Patricks Estate is mapped as Holocene alluvial soils of the Hutt River (fa) (Begg J. G., 1996) (Figure B - 1 Appendix B).

The Wellington Fault is mapped ~80m north west of the St Patricks Estate Area along the Hutt River.

During the site walkover, the stream beds were predominantly gravelly. Where the soil profile was exposed in stream banks, rabbit burrows and track cuts, these typically indicated silty gravel sometimes with up to 1.0m to 1.5m of silt or sand overlying this.

There are two existing geotechnical investigation points within the St Patrick's College area. These indicate sandy and silty gravel dominate profiles with gravelly silt and silt bands up to 4.5m thick in the upper profile. Groundwater was encountered at 7.6m depth near the Sports Pavilion and wasn't encountered in the 3.3m deep test pit investigation for the new gymnasium.

There are a number of other boreholes available from south and west of the Area such as Fergusson Drive (~100 to 350m south) and the Silverstream Bridge. (~250 to 450m west). These indicate gravel dominated soil profiles with rock encountered beneath the gravel towards the hills to the south. The depth to rock decreases to the south.

Based on the above information, the geology at the St Patricks Estate is anticipated to comprise silty gravel with bands of silt and sand up to 1.5m thick underlain by Greywacke bedrock at depth dipping down to the north (towards the Hutt river and Wellington Fault). Groundwater is anticipated at ~4 to 8m depth, with potentially shallower water levels in lower lying areas immediately adjacent to stream channels.

3.9.3. Hazards

Liquefaction is anticipated to be a negligible hazard due to the elevated nature of the site and the gravelly composition of the soils.

Slope stability; the site is less than 26 degrees and is typically gently undulating. It thus has low slope stability hazard.

Soft ground is not anticipated to be a concern, however standard investigations to confirm bearing capacity and ground profile should be undertaken prior to the construction of any structures.

Consideration will need to be given to streams and overland flow paths through the site. Setbacks from stream banks due to erosion potential will be required. We note that most of the undeveloped area is within the mapped flood extent (Greater Wellington Regional Council, 2019).

3.9.4. Summary

- Slope stability. Most of the St Patricks Estate Area is flat and without unstable slopes.
- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat alluvial gravel terraces are likely to have bands of silt and sand. Normal house foundation investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements.
- Suitability for subdivision and development. Most of the Area is relatively flat. Of the total 68 Ha land area available, approximately 95% is assessed as having a low geotechnical hazard as it is. Considerations are the flood hazard and overland flow paths. Approximately 85% of the site is within the flood extent for the Hutt River (Greater Wellington Regional Council, 2019). Consideration of the many existing streams and overland flow paths will be required as well as the potential for erosion along the stream banks.

3.10. Established Urban Area of Upper Hutt City

3.10.1. General Description

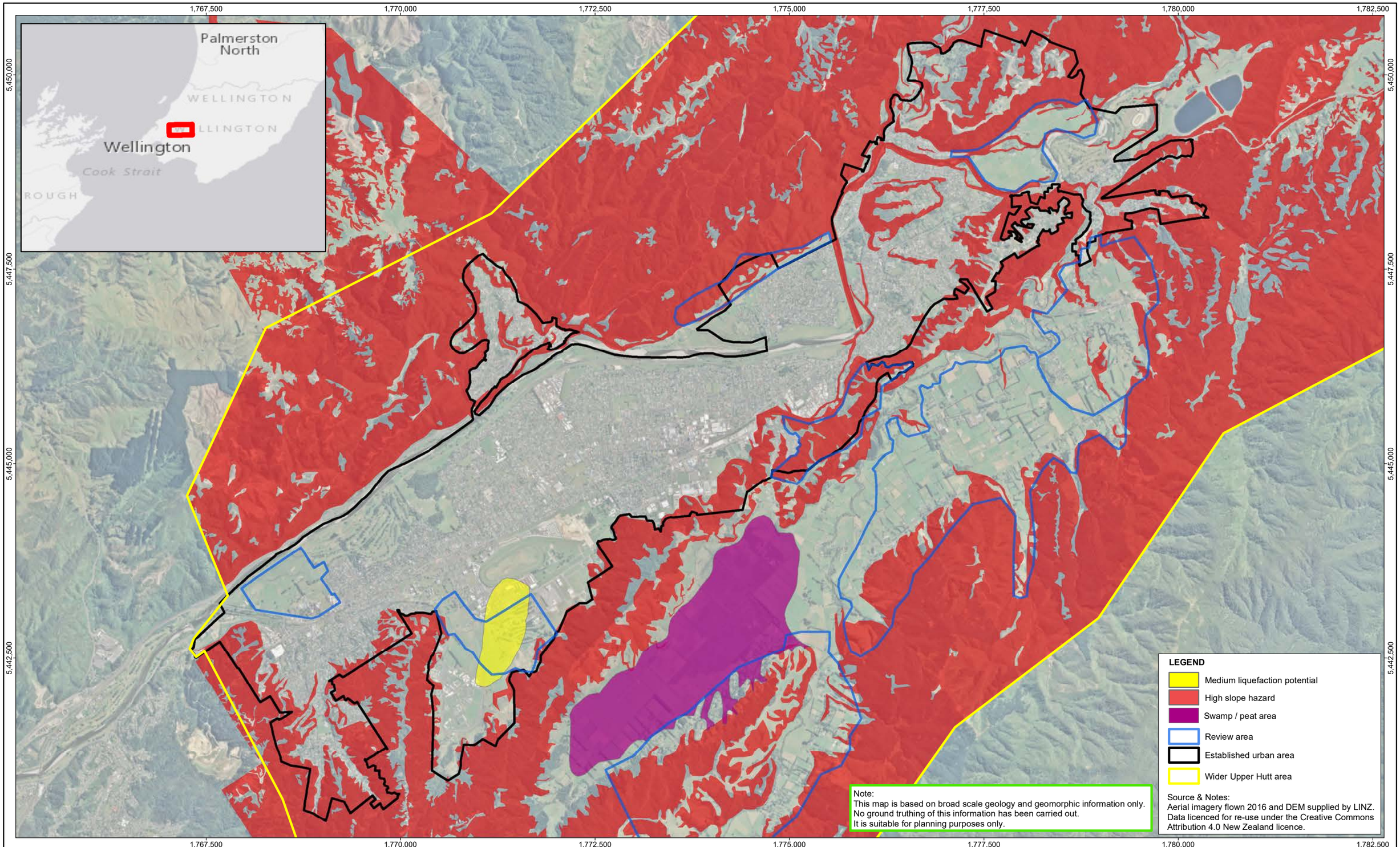
Areas where continued residential development and/or infill housing is considered are generally low hazard. As shown of the slope map (Figure E-0 in Appendix E and in Figure G-0 below) the majority of the area is flat (blue) with only small peripheral areas with slopes greater than 26 degrees (orange and red).

3.10.2. Geology

The flat (blue) area is mainly the Holocene flood plain terrace of the Hutt River. At Totara Park it has older, more elevated terraces uplifted by the Wellington Fault which passes through the area along California Drive. At Silverstream and Pinehaven there are alluvial valleys in the greywacke hills. At Riverstone Terraces there are ancient river terraces, also uplifted by the Wellington Fault.

The orange and red areas in Figure E0 are generally the greywacke hills where there is a thickness of colluvium and weathered rock soils. As their slope angle is greater than 26 degrees, these areas will require specific geotechnical assessment prior to development taking place.

There is a scattering of geotechnical investigations records across the Area. It would be useful for UHCC and future developers if UHCC made it a requirement for all investigation records for all Areas to be placed on the NZGD prior to granting a building consent.



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3.10.3. Hazards

Liquefaction hazard is regarded as negligible due to the dense gravels in the river terraces and the greywacke rock hills. Small areas of shallow soft surficial soils on the river terraces, if any, are expected to be located when doing normal investigations such as hand augers and DCPs.

Slope instability may occur on the steep greywacke hill slopes. These areas being greater than 26 degrees slope angle require a specific geotechnical assessment by a geo-professional prior to development.

Flooding. Much of the Upper Hutt Holocene Alluvial terrace is potentially susceptible to flooding by the Hutt River and is protected by substantial stopbanks. Secondary flooding by runoff from hill slopes onto the flat areas is a hazard that requires careful consideration.

Faulting. As noted, the Wellington Fault trace passes northwards up the Hutt River north bank, through Totara Park, Harcourt Park, Emerald Hill, Gillespies Road Area, and past Te Marua lakes.

3.10.4. Summary

- Slope stability. The peripheral steep greywacke hill areas require geotechnical assessment for development and slope instability.
- Liquefaction potential of the Area is negligible.
- Foundations for construction. The flat alluvial gravel terraces are likely to have bands of silt and sand. Normal house foundation investigations as required on other flat areas of Upper Hutt city are appropriate with design to NZS 3604 (Standards New Zealand, 2011) requirements.
- Suitability for subdivision and development. The Established Urban Areas of Upper Hutt are considered to be the most suitable for urban development densification and renewal. Most of the Area is relatively flat with gravelly soils. Consideration of the existing streams and overland flow paths will be required as well as potential for erosion along stream banks.

Table 1: Established Urban Area – hazard summary by suburb

Suburb	Liquefaction	Slope Stability	Other Geotech Hazards	Comments
Silverstream	negligible	Low	Flood hazard	
Pinehaven	negligible	Low to high	Flood hazard	Much of the Area are steep slopes along the edge of the valley floor. The valley floor is within the Hutt River flood extent
Heretaunga	negligible	Low		
Trentham	negligible -medium	Low	Flood hazard	Liquefaction hazard near the race course is currently mapped as medium hazard.
Wallaceville	negligible	Low		
Riverstone Terraces	negligible	Low to high		
Kingsley Heights	negligible	Low to high		Some extension along the existing ridgeling and valley features can continue in the same manner at fairly low hazard. However, development of the steeper slopes will require additional investigation. A key consideration of any development on these slopes is depth to bedrock.
Maoribank	negligible	Low		
Totara Park	negligible	Low	Wellington fault Flood hazard	
Timberlea	negligible	Low		
Brown Owl	negligible	Low		
Birchville	negligible	Low to high	Wellington fault Flood hazard Bank erosion	
Te Marua	negligible	Low to high	Wellington Fault	
The Plateau	negligible	Low to high		
Akatarawa	negligible	High		

3.11. Wider Upper Hutt Area

The wider Upper Hutt Area includes additional rural places that may be considered for subdivision and development in the future (refer to Figure A-9 in Appendix A and Figure G - 9 below). We have specifically carried out a high-level geotechnical appraisal of South Whitemans Valley/Blue Mountains and Kaitoke Areas. Our appraisal is based on local knowledge, known geology, hill-shade, slope angle and over-all hazard maps, which are included in the report. We have not carried out specific site walkovers of these areas. This Wider Upper Hutt Area has been assessed in a more general sense compared with the other nine Areas discussed above to provide general, high level information to inform queries about the wider Upper Hutt Area.

3.11.1. South Whitemans Valley / Blue Mountains Area

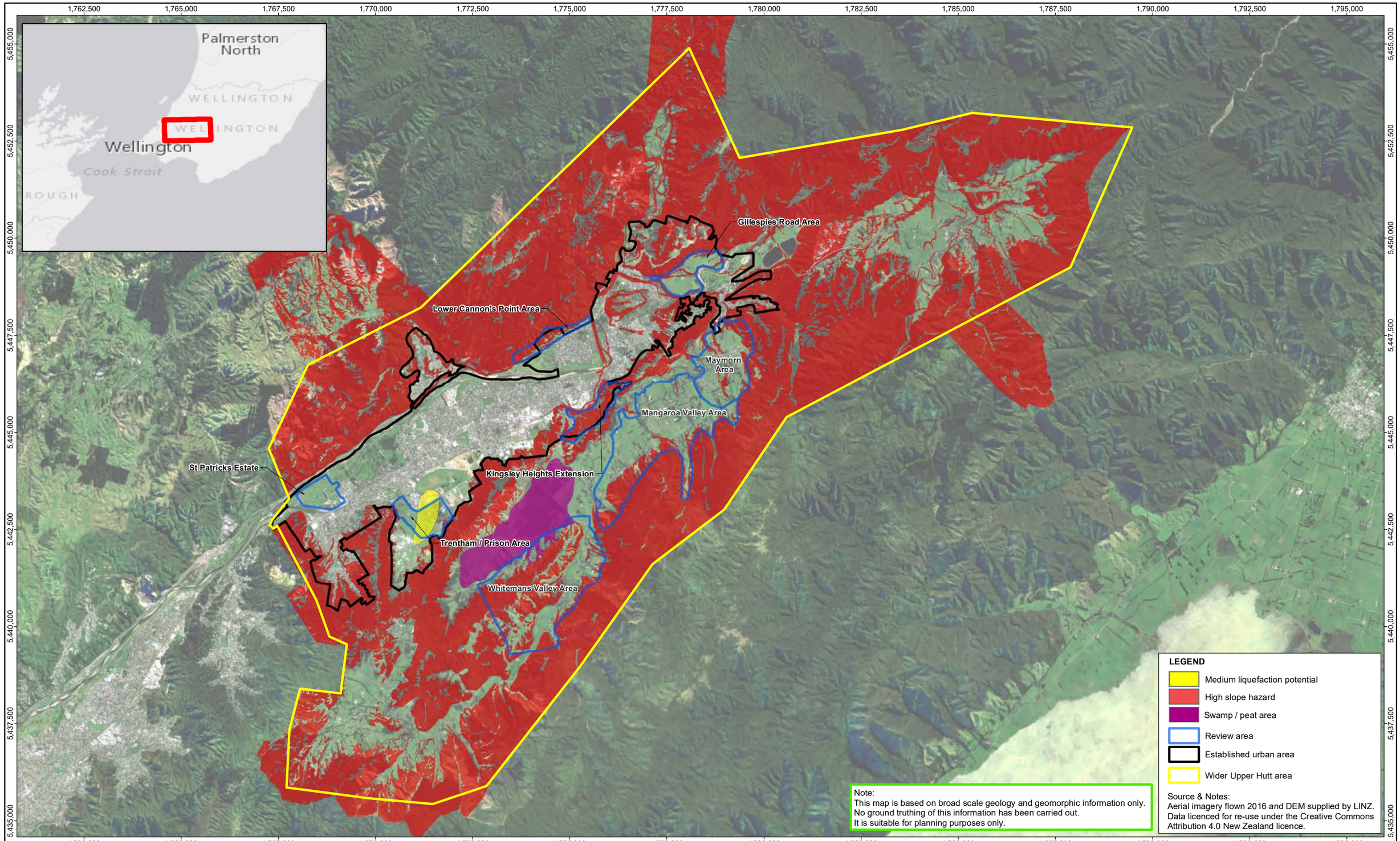
General Description

The South Whitemans Valley/Blue Mountains Area comprises a large (~700 Ha) rural area in the western greywacke (Remutaka) ranges located approximately 9km directly to the south of the city centre. The Area is farmed/grazed grassland with patches of plantation forest. The hills are moderate to steep greywacke rock covered with thick colluvium and weathered rock soils. The flat areas are old alluvial gravel terraces and recent stream channel flats. Gentle fan slopes grade onto the flat terraces and stream channels from the hills. (Begg J. G., 1996)

Geology and Topography

The moderate to steep hills shown in Figure E - 9 in Appendix E (the yellow, orange & red) are greywacke rock that is covered by a variably thick layer of colluvial and weathered rock soils.

The flat areas (blue) are old alluvial terraces and recent stream channels.



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Hazards

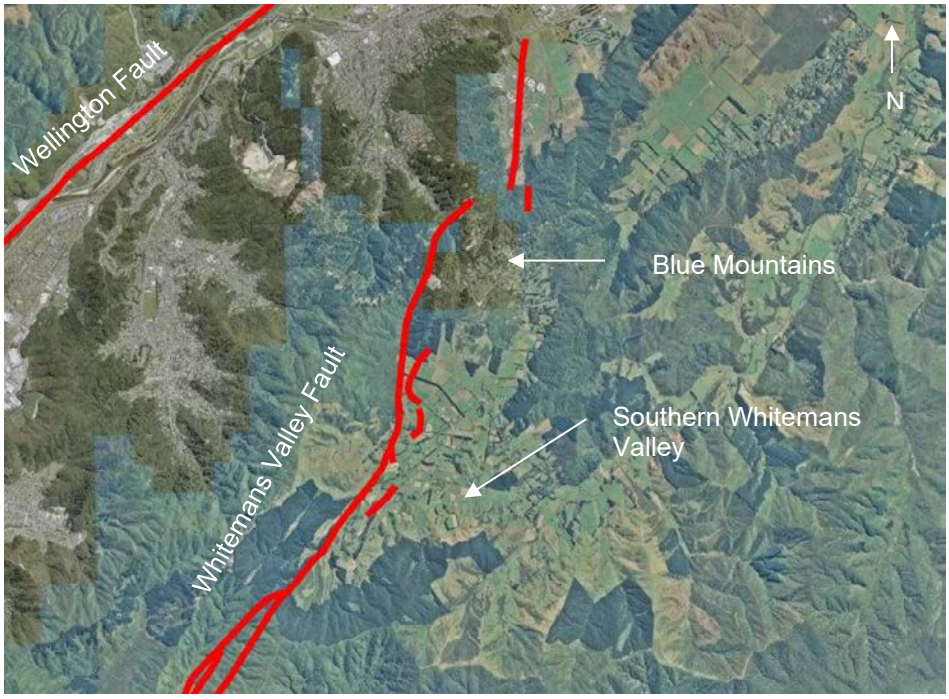


Plate 1: *Red, mapped fault traces in the Area from GNS Active Fault Database* (Geological and Nuclear Sciences, 2009)*. In the top north-west corner the active Wellington Fault is trending along the Taita Gorge. In the centre is the much less active Whitemans Valley Fault.*

On a preliminary assessment without field verification and based on similarities with the nine better assessed Areas, liquefaction is expected to be a negligible hazard in the Area.

The mapped Whitemans Valley Fault is assessed by GNS as having last ruptured in the Holocene (the last 10,000 years) (R. Van Dissen, 2005). It has an estimated recurrence interval of ~15,000-20,000 years and as such, is much less active than the Wellington Fault (R. Van Dissen, 2005). Therefore, based on the MfE Guidelines, this fault wouldn't preclude residential development (Kerr, 2003).

Slope instability is a hazard for the steep hills. Although these steep hill slopes are not obviously unstable with visible present-day landslides, they will require investigation and geotechnical assessment for subdivision planning.

Summary

Slope stability. Some 50% of the Area is hilly with slopes greater than 26 degrees that will require specific geotechnical assessment prior to development. The remaining old terraces and recent stream valley flats are flat to undulating. The recent stream valleys may be flood and/or stream bank erosion prone and will also require specific assessment.

The liquefaction hazard is none on the hills and assessed as negligible on the flats.

Foundations for construction. The greywacke hills and the flat alluvial gravel terraces are likely to be covered with a layer of soil. Normal geotechnical investigations will be required for subdivision and for the design of house foundations.

Suitability for subdivision and development. The South Whitemans Valley/Blue Mountains Area is ~9km in a direct line south from Upper Hutt City Centre and appears to be generally suitable for subdivision, with allowance for areas of hilly topography and potentially flood-prone valleys.

3.11.2. Kaitoke Valley

General Description

The Kaitoke basin is a depression formed by the Wellington Fault in the steep greywacke Remutaka Ranges. The basin has been filled in the past by very thick, dense, alluvial gravel deposits that form low eroded hills to the east of Te Marua Lakes and within the basin itself. The basin is surrounded by the steep greywacke ranges. Greywacke spurs border the basin on all sides and rivers or streams channeled by the spurs form incised channels across the basin. All these streams coalesce to form the Hutt River flowing past Te Marua.

The rural Kaitoke Basin is largely grassed farmland with areas of native forest park, regenerating native bush, and areas of plantation forest around its margins. The arterial SH2 passes through the centre of the basin heading east over the Remutaka Ranges as the Remutaka Hill Road to the Wairarapa, and west some 12km to Upper Hutt centre on a direct line.

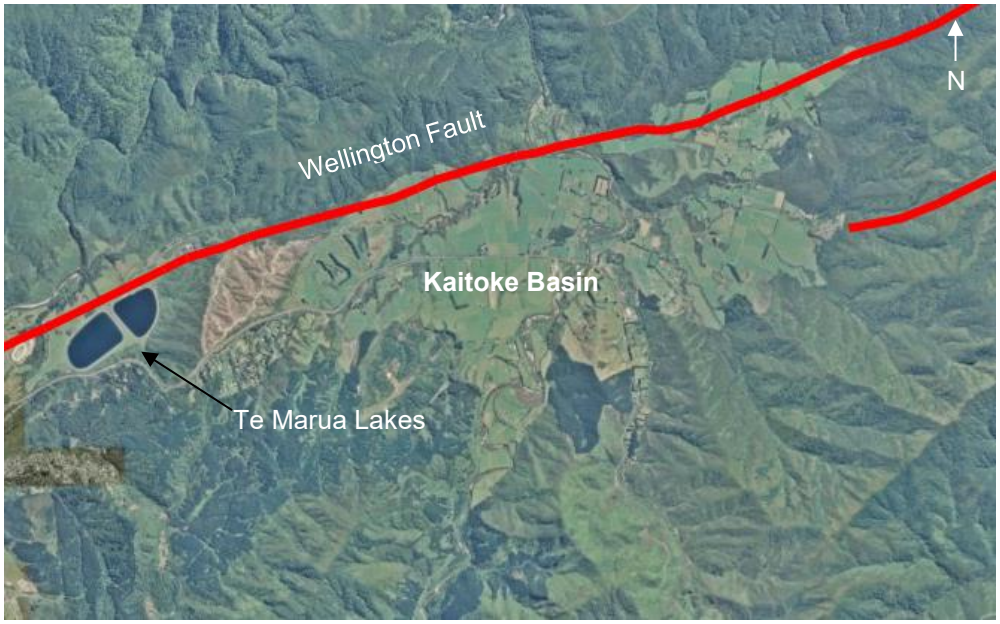


Plate 2: *The Wellington Fault trace passes Te Marua Lakes and along the north side of the Kaitoke basin. Another (eastern) trace of the Wellington Fault is mapped by GNS as entering the south-eastern end of the Kaitoke basin* (Geological and Nuclear Sciences, 2009).

Geology and Topography

Most of the ~1,000 Ha Kaitoke Basin is flat (blue in Figure E - 9 in Appendix E), comprising old terraces with incised recent alluvial river and stream channels. Some of the old terrace risers are steep as are some of the stream banks. These steep alluvial terrace risers and stream banks will require setbacks. The stream banks will require assessment for erosion potential and the river and stream flats may be flood-prone. The steep hill slopes will require geotechnical assessment prior to subdivision.

Hazards Summary

Active traces of the Wellington Fault are mapped in the Area. These will require assessment and consideration.

Potential flooding and stream bank erosion require assessment and consideration in low-lying stream channel areas. Kaitoke is a high rainfall area, and any developments will require assessment of overland flow and ponding, especially where a development is close to hill-slopes.

Slope stability. Most of the Kaitoke Basin is flat with only small areas of steep terrace risers and river banks that require setbacks and specific geotechnical assessment. The marginal areas are hilly with slopes greater than 26 degrees that will require specific geotechnical assessment prior to development.

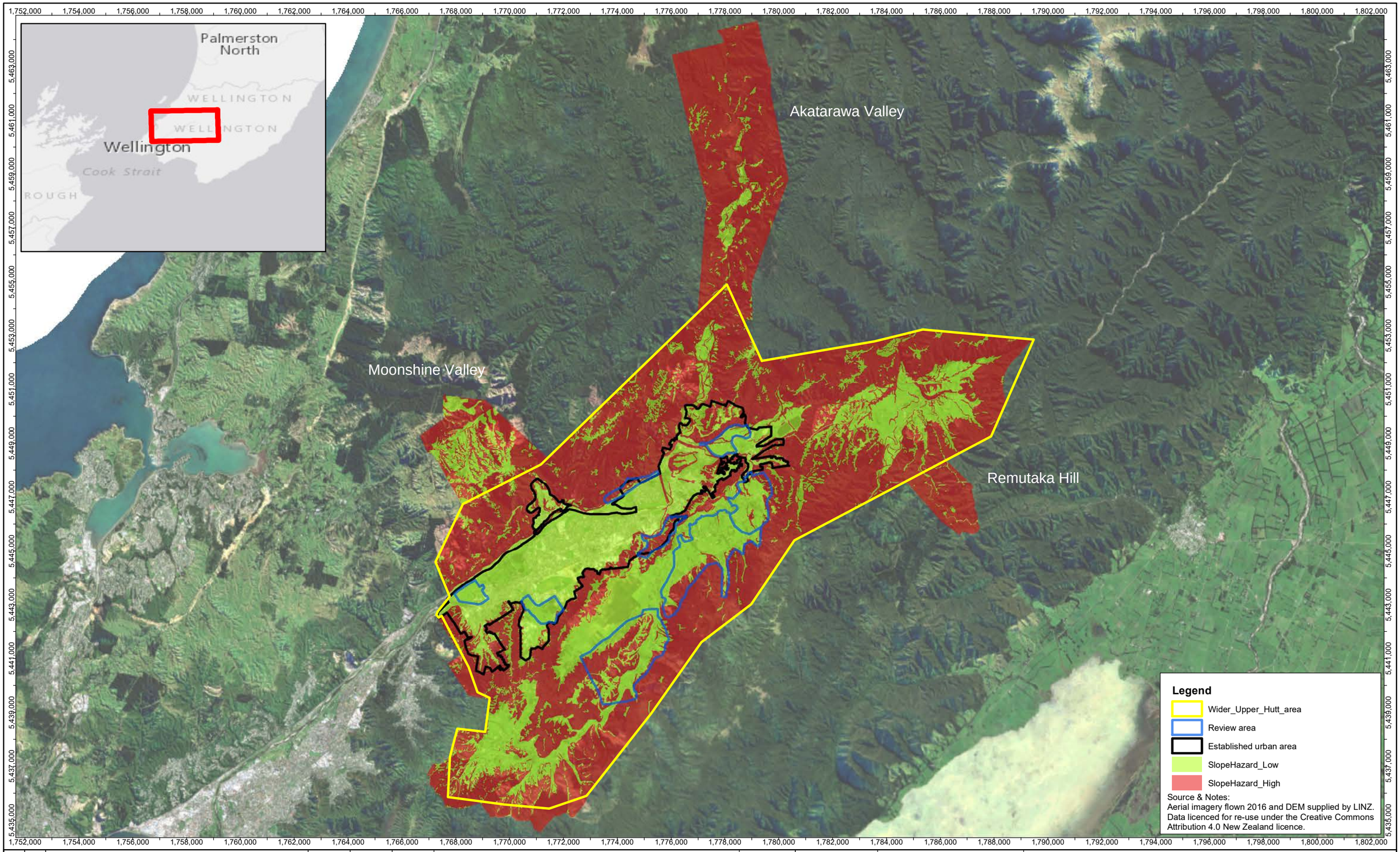
The liquefaction hazard is none on the hills and negligible on the flats.

Foundations for construction. The greywacke hills and the flat alluvial gravel terraces are likely to be covered with a layer of soil. Basic geotechnical investigations will be required for subdivision and for the design of house foundations, which are expected to be with design to NZS 3604 (Standards New Zealand, 2011) requirements.

Suitability for subdivision and development. The Kaitoke Area is ~12km in a direct line east from Upper Hutt City Centre. The Area appears to be generally suitable for subdivision with allowance for marginal areas of hilly topography and some potentially flood-prone valleys.

3.12. Slope Extension – February 2020 Update

We have carried out a high-level assessment of the slope hazard for the Akatarawa Valley, Moonshine Valley and Remutaka Hill areas after the initial reporting was completed. The slope assessment is based on local knowledge, known geology and slope angle maps. We have not carried out specific site walkovers of these areas.



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3.12.1. Akatarawa Valley

The Akatarawa Valley is a rural area extending north from the Birchville area along the Akatarawa River. The area comprises predominantly steep sided, forested greywacke hills. The Akatarawa River runs through the centre of this area forming a flatter river valley with a series of river terraces. The valley is mapped as Holocene alluvium (Q1a) with some older (Q2a and Q6a) alluvial terraces (Begg J. G., 2000). These are anticipated to comprise of gravel with some sand and silt lenses.

Slope instability is a hazard for most of the Akatarawa Valley area due to the steep, hilly nature of the area. Most of the Akatarawa Valley area is steep-sided hills greater than 26 degrees. These hills are likely greywacke rock with an overburden of colluvium of unknown thickness.

These slopes will require investigation and geotechnical assessment for subdivision planning or further development. The presence and thickness of any overlying colluvial soil will be a key consideration in any slope assessment.

Some of the ridgelines are sufficiently flat and wide to be potentially suitable for development as long as sufficient investigations are carried out to properly assess setbacks from the steep slopes.

Most of the valley floor and alluvial terraces do not pose a slope stability hazard. There are steep terrace risers associated with the older alluvial terraces. These will require setbacks and geotechnical assessment for development.

3.12.2. Moonshine Valley

The Moonshine Valley is a rural area to the north-west of Riverstone Terraces. The area is mapped almost entirely as greywacke bedrock with a small isolated area of recent alluvium associated with streams (Begg J. G., 2000). The hills in the Moonshine Valley are grassed and typically gentler and more rounded than in other areas of Upper Hutt (such as the Akatarawa Valley). These are regularly dissected by a series of steeper, vegetated gullies with small streams and water courses at the base.

At the northern and eastern edges of this area, the hills are steeper and the associated slope failure hazard is considered high.

The low hills are generally less than 26 degrees and considered a low slope hazard. Appropriate setbacks from steeper gully features should be observed. The steeper hills to the north and east will require further investigation and assessment prior to development.

3.12.3. Remutaka Hill

The Remutaka Hill area to the east of the Kaitoke includes State Highway 2 and the valley this road is in. The valley is steep sided and forested with a narrow flatter valley floor. The area is mapped as greywacke bedrock (Begg J. G., 2000).

The majority of this is area is steep and has a high slope hazard. Isolated flatter areas are identified within the valley floor and along a few ridgelines. A specific geotechnical assessment would be required for most of this area. Those shown as having a low slope hazard could be developed if they are sufficiently setback from the adjacent slopes.

4. Hazard Outcomes

4.1. Low/Negligible hazard

For Areas that have been identified as having negligible, low or no hazard, shallow foundations are likely to be suitable. These areas are on flat ground with firm ground conditions anticipated. The shallow foundation requirements as per NZGS Module 4 Guidelines (NZGS & MBIE, 2016) are anticipated to be met.

Site specific shallow investigations to confirm suitable ground will be required for each site in line with NZGS Module 2 (NZGS & MBIE, 2016). Investigations should be to a depth of ~3 metres below ground level.

Where site specific walkover or assessment identifies other areas of concern, deeper investigations may be prescribed. It is anticipated that a more detailed assessment including a site-specific walkover would identify wet areas or areas of perched groundwater that may require further investigation.

The primary purpose of the shallow investigations is to determine bearing capacity of the soils and check for the presence and thickness of fills.

Shallow investigations using methods such as hand augers, dynamic cone penetrometer (DCP) testing, test pits and window sampler boreholes are appropriate for the negligible and low hazard areas. Test pits are likely the most appropriate for most of Upper Hutt due to the gravelly nature of the soils.

4.2. Medium hazard

For the Area identified as medium hazard, further investigation is likely required for development in these areas. Specific engineering design may be required, pending the outcome of the additional investigation. It is anticipated that Specific Engineering Design (SED) outcomes may include options such as the below or similar:

- TC2 type waffle slab foundations that have sufficient stiffness to withstand expected future ground movements (MBIE Guidance Part A (Ministry of Business Innovation & Employment (MBIE), 2012))
- Dig out and replace of unsuitable ground

4.3. High hazard

For Areas identified as high hazard, further investigation is required, and specific engineering design will likely be required. The nature of the investigation should be determined for a site by a qualified geo-professional based on the nature of the site and the proposed development.

Those areas identified as swamp / peat would require further investigation to determine the presence, depth, thickness and characteristics of any peaty, organic rich or soft ground conditions. Specific engineering design of foundations would be required if this type of material was encountered.

Site specific quantitative slope stability modelling for static, seismic and wet ground conditions will be required for sites identified as having a high slope hazard. We have provided general (conservative) setbacks from the crest and toe of steep slopes as follows, and as shown in Plate 4:

- A setback for a house at the crest of a high hazard “soil” slope is typically 26 degrees up from toe of slope +5m.
- For bouldery-gravel terrace risers up to approximately 10m high, a setback of 5m from the crest of the slope has been applied. This gives an effective slope angle from the toe of the slope to the back of the setback of ~34 degrees, a stable angle for these gravel terraces which have an angle of friction of at least 40 degrees.

- A setback for a house at the crest of a high hazard rock slope is typically 45 degrees up from the toe of slope +5m.
- The setback for a house at the toe of a high hazard slope may typically be half the slope height from toe.
- These setbacks could be changed with a geotechnical assessment and properly designed engineering works, such as retaining walls and/or slope protection.

Note that many slopes mapped as rock have a soil overburden layer. In these cases, the soil slope setback would apply.

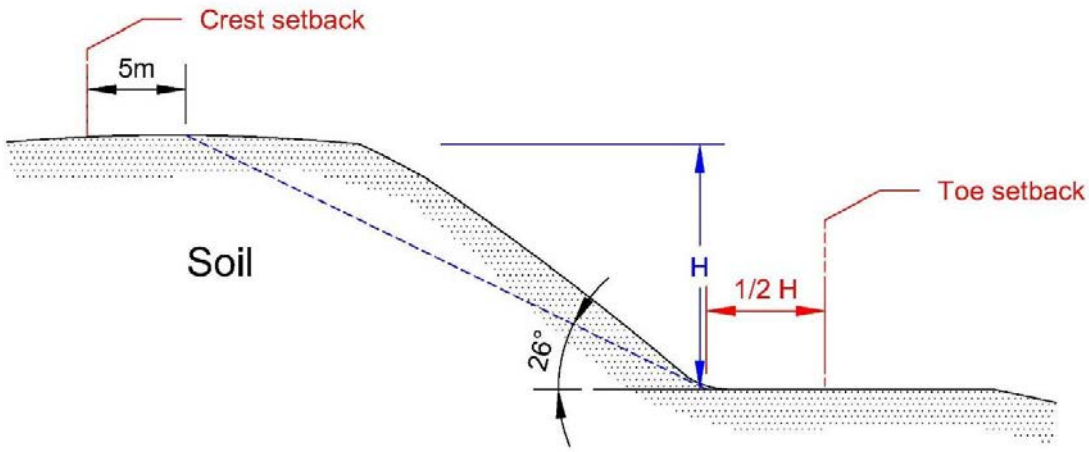

Plate 3: Diagram showing an example of the recommended soil case setback

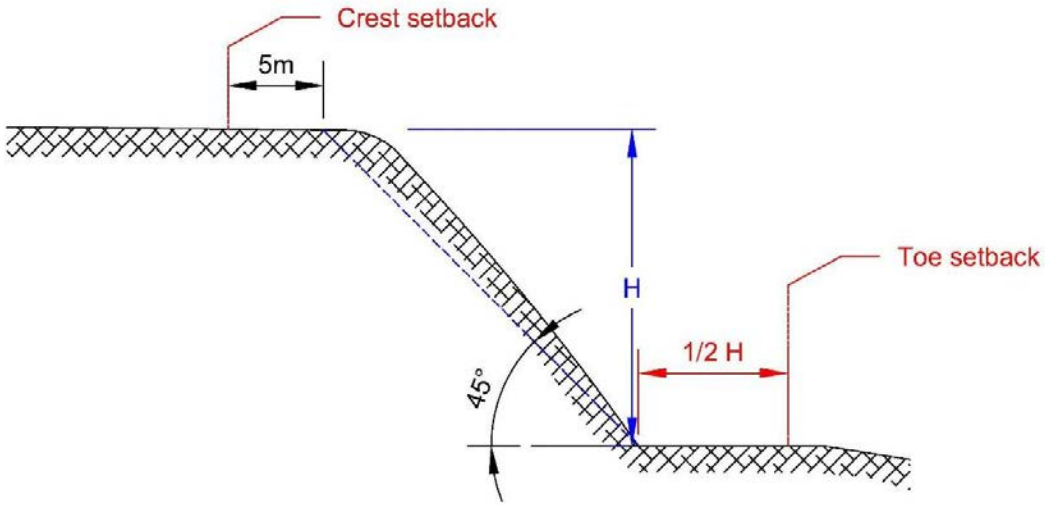

Plate 4: Diagram showing an example of the recommended rock case setback

These setbacks are generalised in order to be applied to the entire Upper Hutt area. It is anticipated that in many areas, these are conservative. The setbacks could be refined further on a site specific case, based on a geotechnical assessment. Examples of how the setbacks would be applied to

Gillespies Road and Lower Cannons Point Areas are shown in Figure I - 1 and Figure I - 2 in Appendix I. Foundation options may include piles, or shallow foundation options with earthworks or structures such as retaining walls, soil nailing, or mechanically stabilised earth.

5. Site Investigation Requirements for Subdivision

It is envisaged that an application for subdivision would be submitted with contributions from recognized geo-professionals, CPEng and/or PEngGeol, and would be expected, in general, to contain the following items:

1. Desk study – including references to geology and soil maps, geomorphology and topography, existing land use and known or possible contamination, assessment of existing ground investigations from NZ Geotechnical Database and other sources, and known hazards, such as flooding, active faults, unstable areas.
2. Site walkover – conducted by an experienced geo-professional with local knowledge who uses their experience to make a preliminary assessment based on the desk study.
3. Plan and undertake site specific investigations that are tailored for a conceptual ground model of the site and the proposed development. The site investigations may be a mix of intrusive investigations, including drillholes with SPTs, CPTs (if feasible), test pits, window samples, hand augers and DCPs. The intrusive investigations may be supplemented with geophysical investigations, such as MASW, which provide profiles of useful ground properties related to shear wave velocity (ground modulus, density and liquefaction potential).
4. Review and refine the conceptual ground model and complete additional site investigations, if required.
5. All geotechnical hazards adequately investigated and qualified.
6. Finalise and issue the geotechnical model (descriptive and/or graphical) and issue a geotechnical investigations report.
7. Commence detailed engineering analyses and design. (Later confirm or modify the geotechnical model as appropriate during the construction phase).

Our report has made a broad overview of items 1 and 2, desk study and site walkover that is suitable for an initial planning appraisal of geotechnical suitability for subdivision. More detailed site-specific investigations are required for assessing an actual subdivision that may include roads, bulk earthworks, retaining walls, drainage and provision of services. The nature and complexity of site investigations will depend on the size of the subdivision and the terrane in which it is located. They are at the discretion and judgement of the geo-professional engaged to do the work.

In general, the scope, nature and complexity of specific site investigations would take into consideration the following documents:

- NZ ground investigation specification; Volume 0, commentary, introduction and guidance, April 2017 (Auckland Council, 2017);
- Module 2; geotechnical investigations for earthquake engineering: MBIE & NZ Geotechnical Society; November 2016 (NZGS & MBIE, 2016); and
- Upper Hutt City Council Code of Practice for Civil Engineering Works; revision 7 July 1998 (Upper Hutt City Council, 1998).

5.1. The NZ Geotechnical Database

The New Zealand Geotechnical Database (NZGD) is an online database that provides a searchable repository for new and existing geotechnical information. It builds on the resounding success of the Canterbury Geotechnical Database (CGD), which was developed for the Christchurch rebuild following the 2010/2011 Canterbury earthquake sequence. It also incorporates data previously held on the Auckland Geotechnical Database, which was initially set up by Watercare.

The NZGD is primarily aimed at providing more efficient access to geotechnical information. It can also be used for more strategic purposes such as assisting with natural disaster recovery, increasing resilience around New Zealand, catastrophe loss modelling, and informing land planning and regulatory processes. Unlike other databases around the world, the NZGD enables geotechnical information to be shared between the private and public sectors. As of September 2019, the NZGD holds approximately 36,765 CPT traces, 19,370 borehole log records, 1,000 piezometers with accompanying groundwater monitoring records, and over 4,000 laboratory test records. Because the NZGD draws on existing databases, geotechnical data held on the NZGD is currently concentrated in Canterbury, Hawke's Bay and Auckland. This will change as the NZGD expands to include other areas of New Zealand. Registered users can access the data via a web portal allowing them to search geographically for geotechnical information and then download data from the database. The portal also allows new data to be uploaded. The NZGD has been a great success in helping the recovery and rebuild of Christchurch, which is why it has been extended to all of NZ.

The NZGD is run via a voluntary Terms of Use, whereby registered users are able to download information for their project, but in return agree to upload new geotechnical information generated for their projects. The Terms of Use clarify that data providers do not attract any liability by those who use this data for their own projects.

We recommend that UHCC actively encourage geotechnical practitioners to upload all geotechnical information gathered in the District as part of their Building Consent requirements.

6. Recommended Further Investigations

Areas identified as having a medium or high hazard, will require additional geotechnical investigation and assessment as discussed in section 4 above.

It is generally assumed that this would be done at a master planning or concept design phase by an interested developer/ land owner. There are however, a few areas where the hazard classification is largely a function of insufficient information. In these areas it may be beneficial for intrusive investigations to be conducted at an earlier stage to better define the hazard prior to PC50 completion.

- Trentham/Prison Area: A medium liquefaction potential has been identified in part of the Trentham/Prison Area and adjacent urban area. This is based on previous studies that have identified this hazard based on "peaty soils". As discussed in section 3.8 above, based on the information available to us, we do not believe this area has an elevated liquefaction hazard. We have not been able to sight the original data this assessment is based on. As such do not have sufficient confidence to remove this medium hazard area without viewing the existing information or additional investigation in the area. An intrusive investigation of the order of 2-3 days CPT work (large truck mounted rig – 20 tons) to ~10 to 20m depth or refusal within this area would be sufficient to better characterise the liquefaction hazard.

7. Summary

Table 2 below presents a summary of the findings for the 9 Areas.

Table 2: Summary of geotechnical hazards and suitability

Area	Geotechnical Suitability*	Slope Stability	Liquefaction	Other hazards	Pros	Cons
Gillespies Road	2	Mostly low hazard. Toe of the hills and terraces risers are high hazard areas and will require setbacks	negligible	Wellington Fault runs through the Area Part of Area within the mapped flood extent	Most of the Area is suitable for shallow foundations	Some steep areas that would require setbacks
Maymorn	2	Mostly low hazard. Toe of the hills and terraces risers are high hazard areas and will require setbacks	negligible	-	Most of the Area is suitable for shallow foundations	
Mangaroa Valley	2	Mostly low hazard. Toe of the hills and terraces risers are high hazard areas and will require setbacks	negligible	Streams and overland flow paths	Most of the Area is suitable for development with shallow foundations	
Kingsley Heights Extension	2 - 3	Mostly high slope hazard	negligible	-	Opportunity for a lower intensity, high value subdivision	Some earthworks and retaining structures would be required for access and to extend the flatter ridge and valley areas. Lower intensity development would be recommended. Careful management of stormwater runoff is required.
Lower Cannon's Point	2 - 3	Toe of the hills and terrace risers are steep and require setbacks at the crest and toe. Additional investigation and specific design would be required for development in these areas. Terraces are flat, but setbacks from the steep areas will encroach on these.	negligible	-		Small portion of this area is available for development without SED as terraces are narrow and transmission towers run through the site
Whitemans Valley	3	Most of the site is high slope hazard	negligible	Small areas of possibly peaty ground Overland water paths and valleys that may be prone to flooding	Suitable for lifestyle block type development	Most of the land is a high slope hazard or within flood prone land. Some areas identified as peat. Areas suitable for development are fragmented

Trentham /Prison	2	Low	negligible to medium	Surface run off	Most of the land would be suitable for subdivision with shallow foundations	An area of historical medium liquefaction potential that would require further investigation and potentially more robust foundations
St Patricks Estate Development	1	Low	negligible	Most of the site is within the Hutt River Flood Extent Erosion along stream banks Stream channels and overland flow paths	Shallow foundations suitable for most of the site.	Most of the land is within the flood extent for the Hutt River
Existing residential Area of Upper Hutt	1	low	negligible	Surface runoff and ponding	Shallow foundations suitable for most of the site.	

* geotechnical suitability on a scale of 1 to 3 where:

1 – Development typically requires standard investigation and foundations

2 – Development of some areas require standard investigation and foundations; with some areas requiring additional investigation and specific design

3 – Development would likely require significant additional investigation, specific assessment and engineering works to deal with geotechnical hazards

8. Limitations

This assessment has been prepared solely for the use of our client, Upper Hutt City Council and their professional advisers in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity.

The opinions and comments given in this assessment are derived from published reports and our field observations. As such, there may be special conditions pertaining to the site that have not been disclosed or observed by Coffey.

The services were performed solely with respect to the specific geotechnical elements of the site work as discussed in this assessment. Such services do not relieve any party from fulfilling its responsibilities and obligations as part of this project. The services did not include sub-surface investigations or establishment construction lines or grades.

9. References

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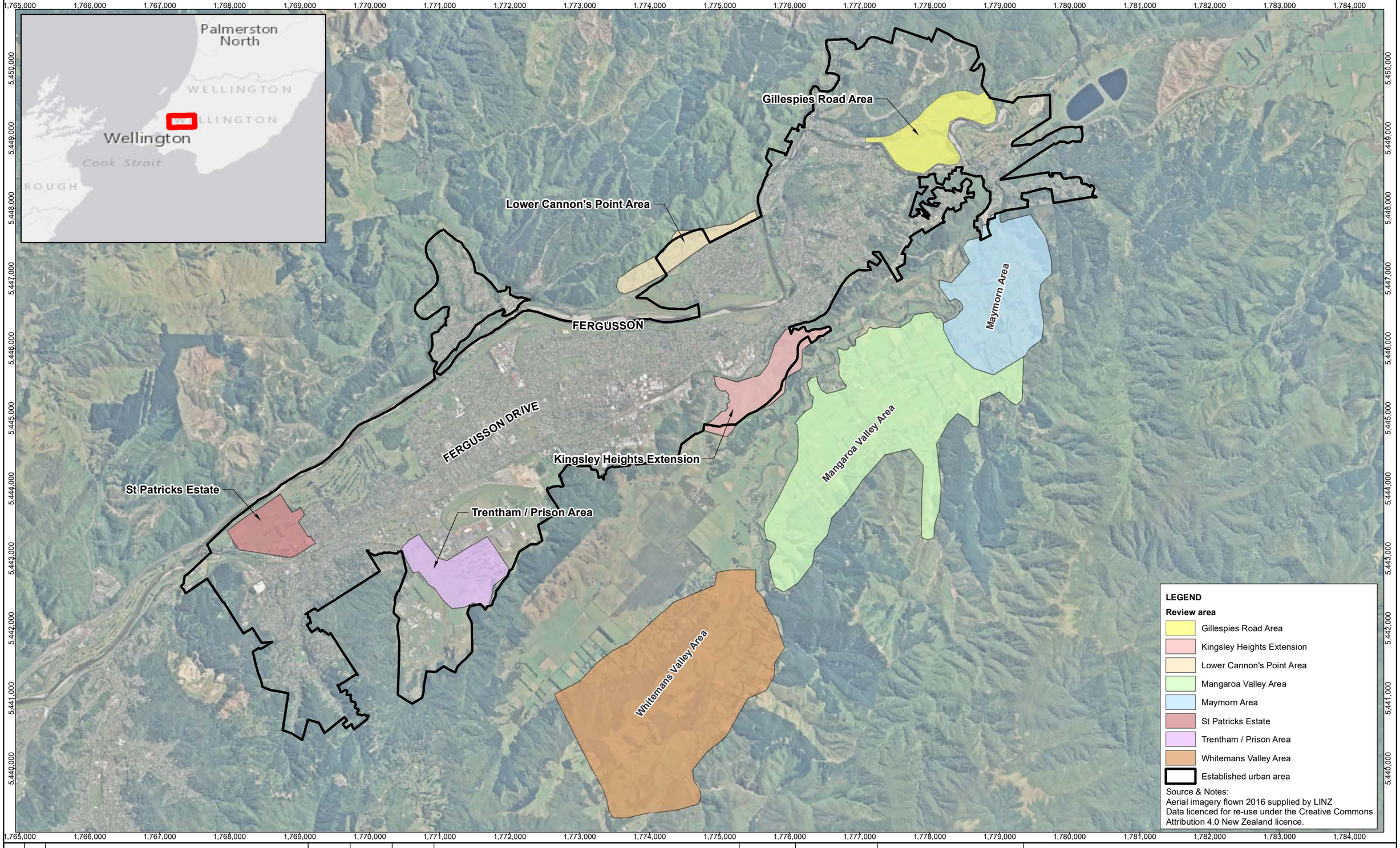
Appendix A – Site Plans



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drawn	RZ
approved	SM
date	11.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

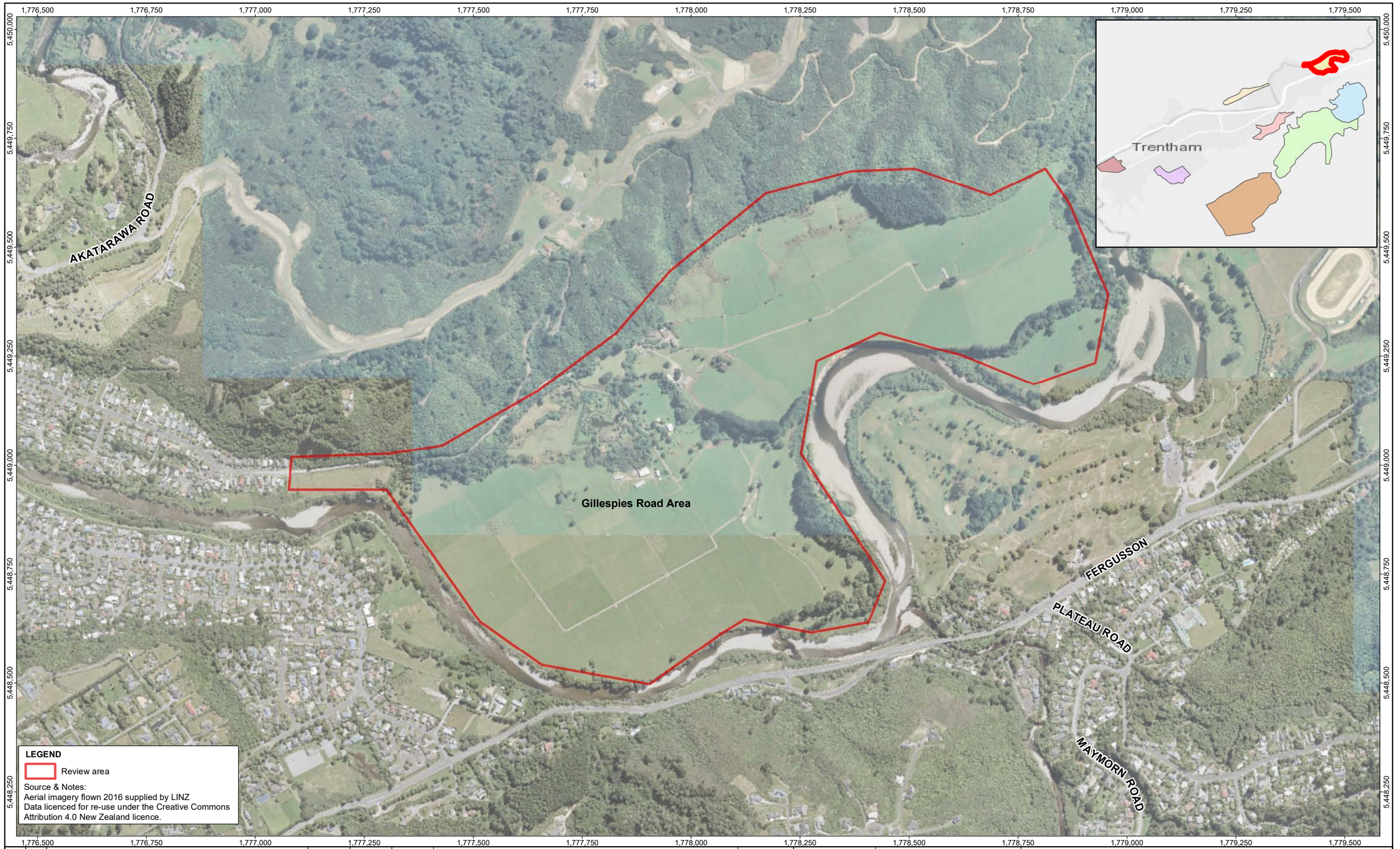
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITES LOCATION PLAN

project no: 773-WLGGE225406 | figure no: A0 | rev: A

MXD ref: 225406_02_A0_1



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drawn	RZ
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date	23.04.2019
scale	AS SHOWN
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coffey
A TETRA TECH COMPANY

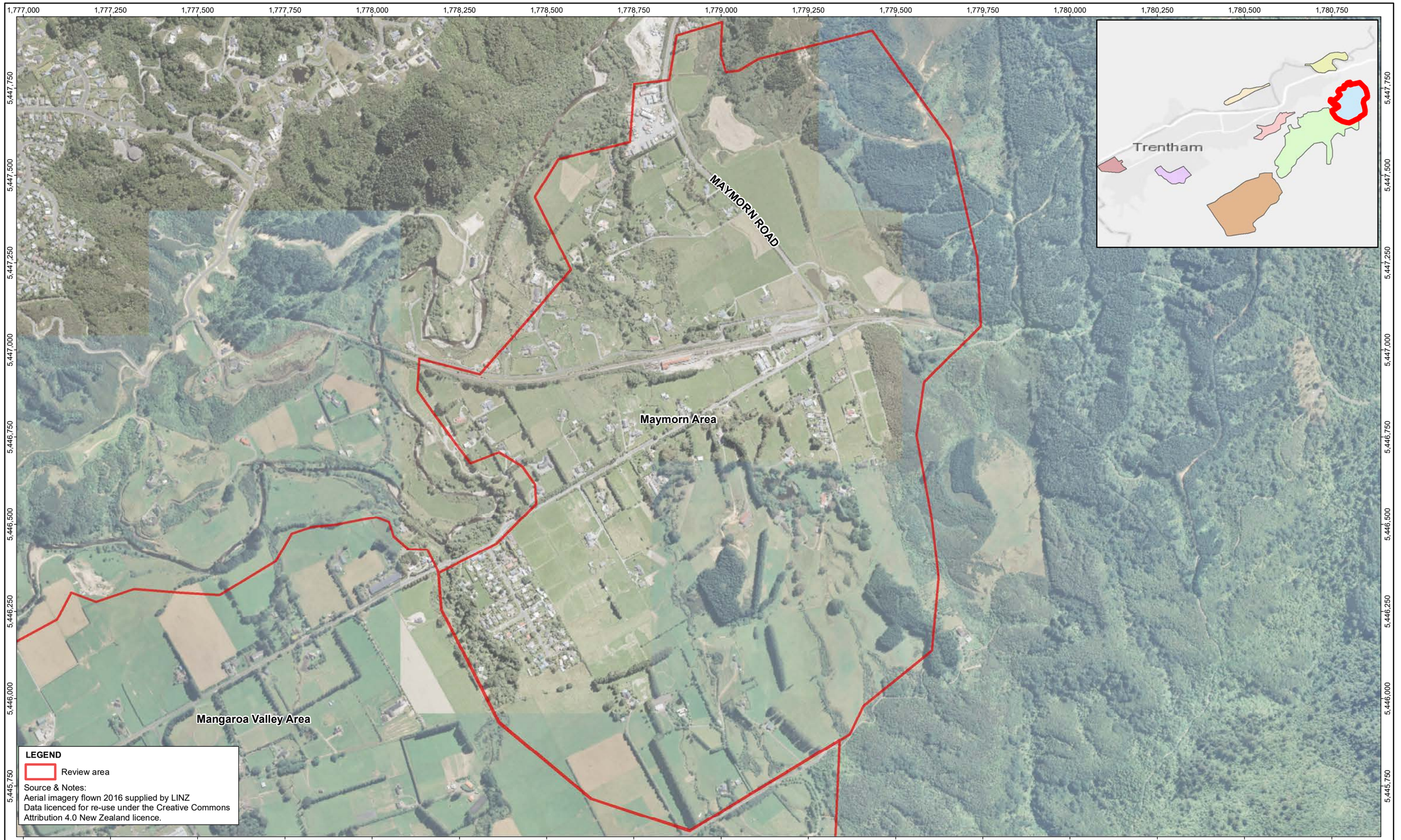
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - GILLESPIES ROAD AREA

project no: 773-WLGGE225406 | figure no: A - 1 | rev: A

MXD ref: 225406_00_GIS_A_1



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approved	SM
date	23.04.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - MAYMORN AREA

project no: 773-WLGGE225406 | figure no: A - 2 | rev: A

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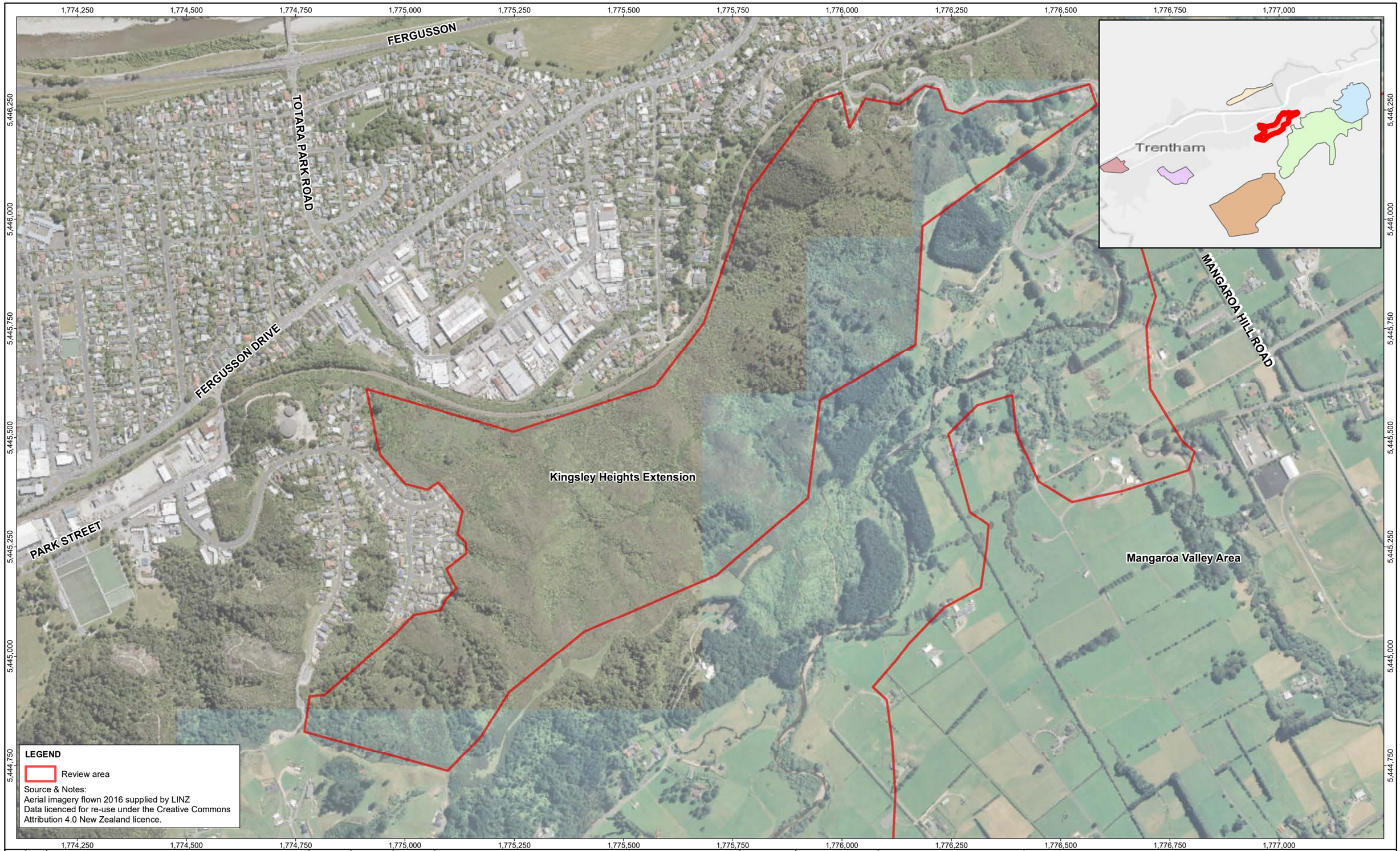

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approved	SM
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scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - KINGSLEY HEIGHTS EXTENSION

project no: 773-WLGGE225406 | figure no: A - 3 | rev: A

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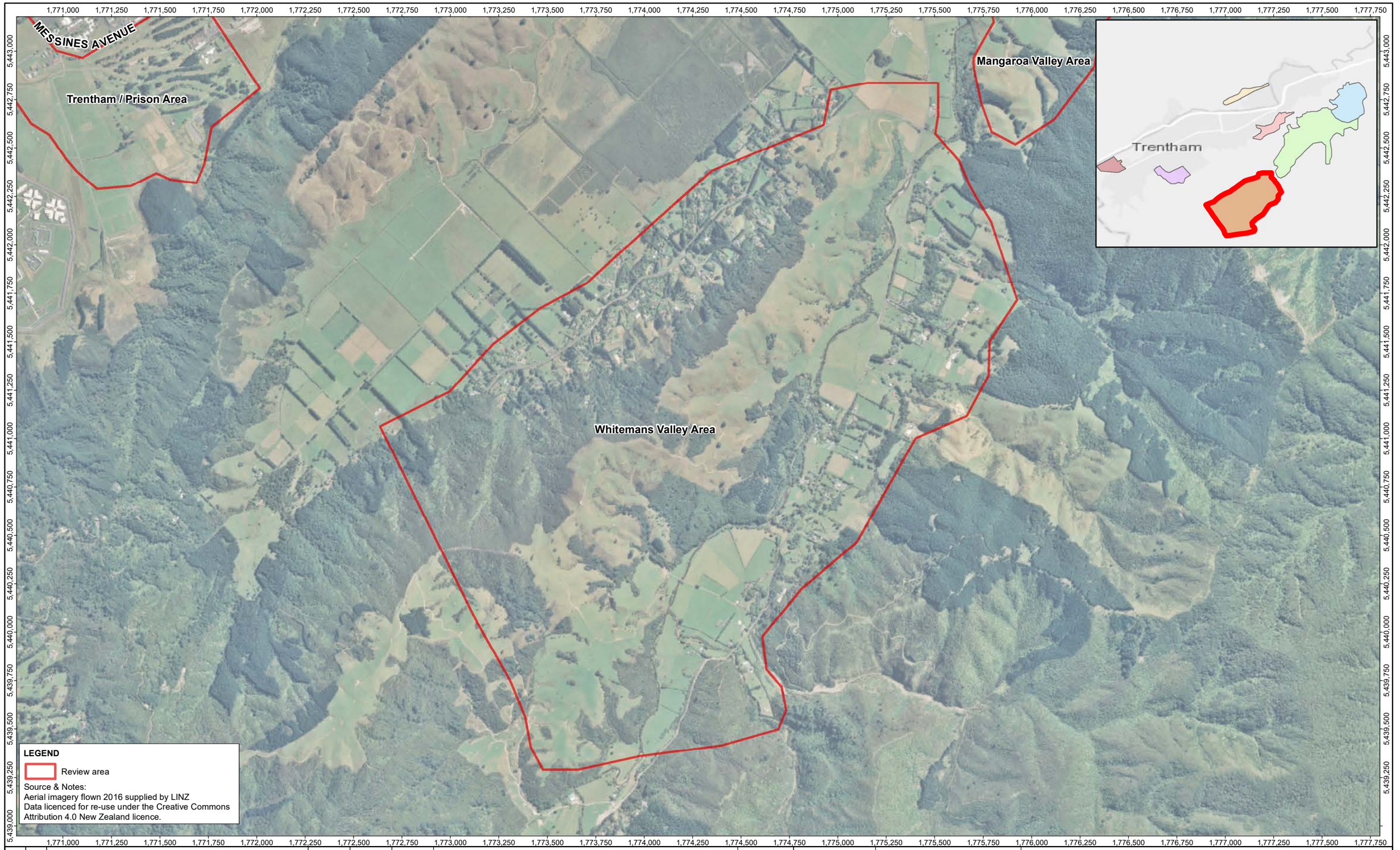

LEGEND

Review area

Source & Notes:
Aerial imagery flown 2016 supplied by LINZ
Data licenced for re-use under the Creative Commons Attribution 4.0 New Zealand licence.

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scale	AS SHOWN
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coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - WHITEMANS VALLEY AREA

project no: 773-WLGGE225406 | figure no: A - 4 | rev: A

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approved	SM
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original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - TRENTHAM / PRISON AREA

project no: 773-WLGGE225406 | figure no: A - 5 | rev: A

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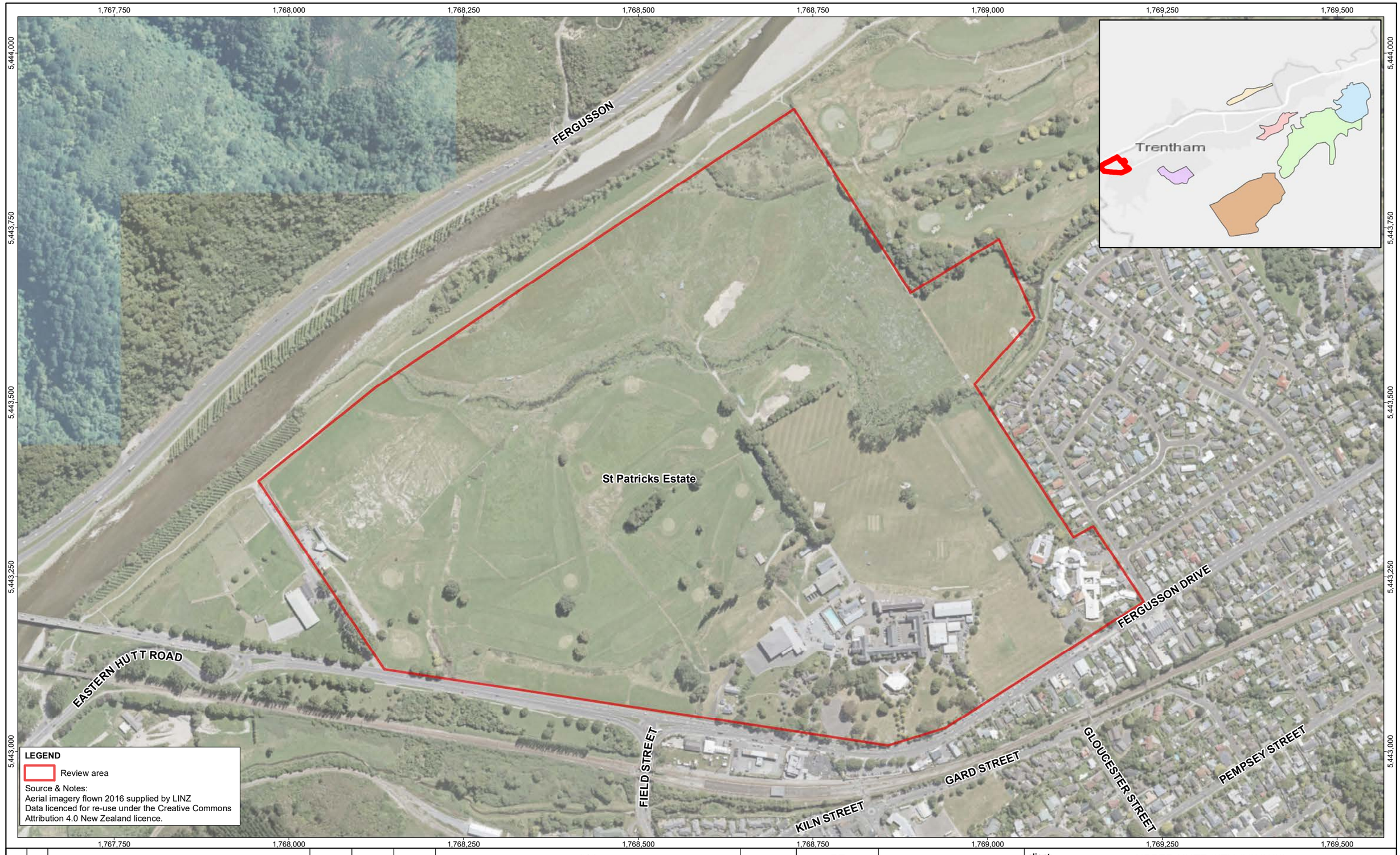

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coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

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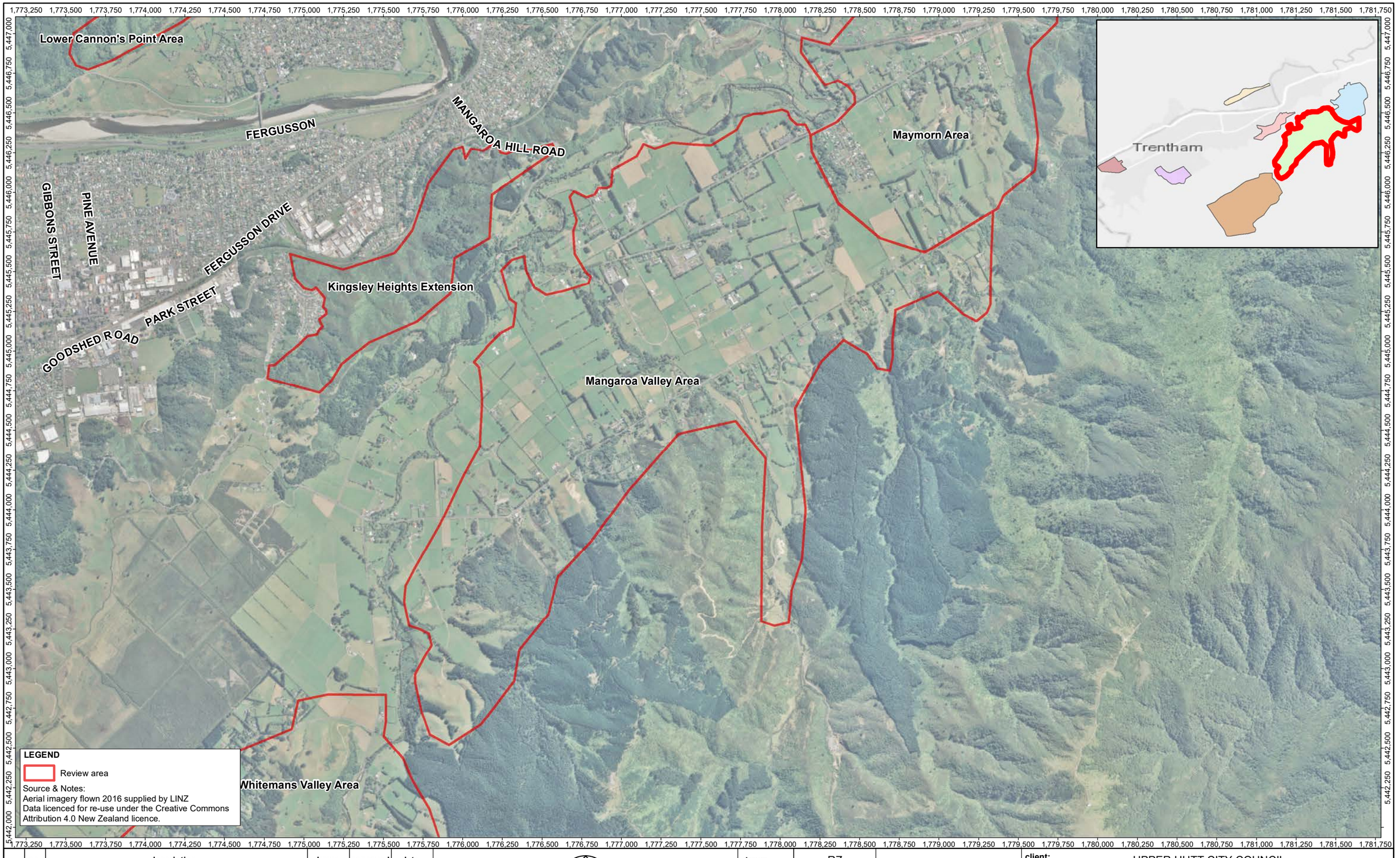

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original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SITE PLAN - MANGAROA VALLEY AREA

project no: 773-WLGGE225406 | figure no: A - 7 | rev: A

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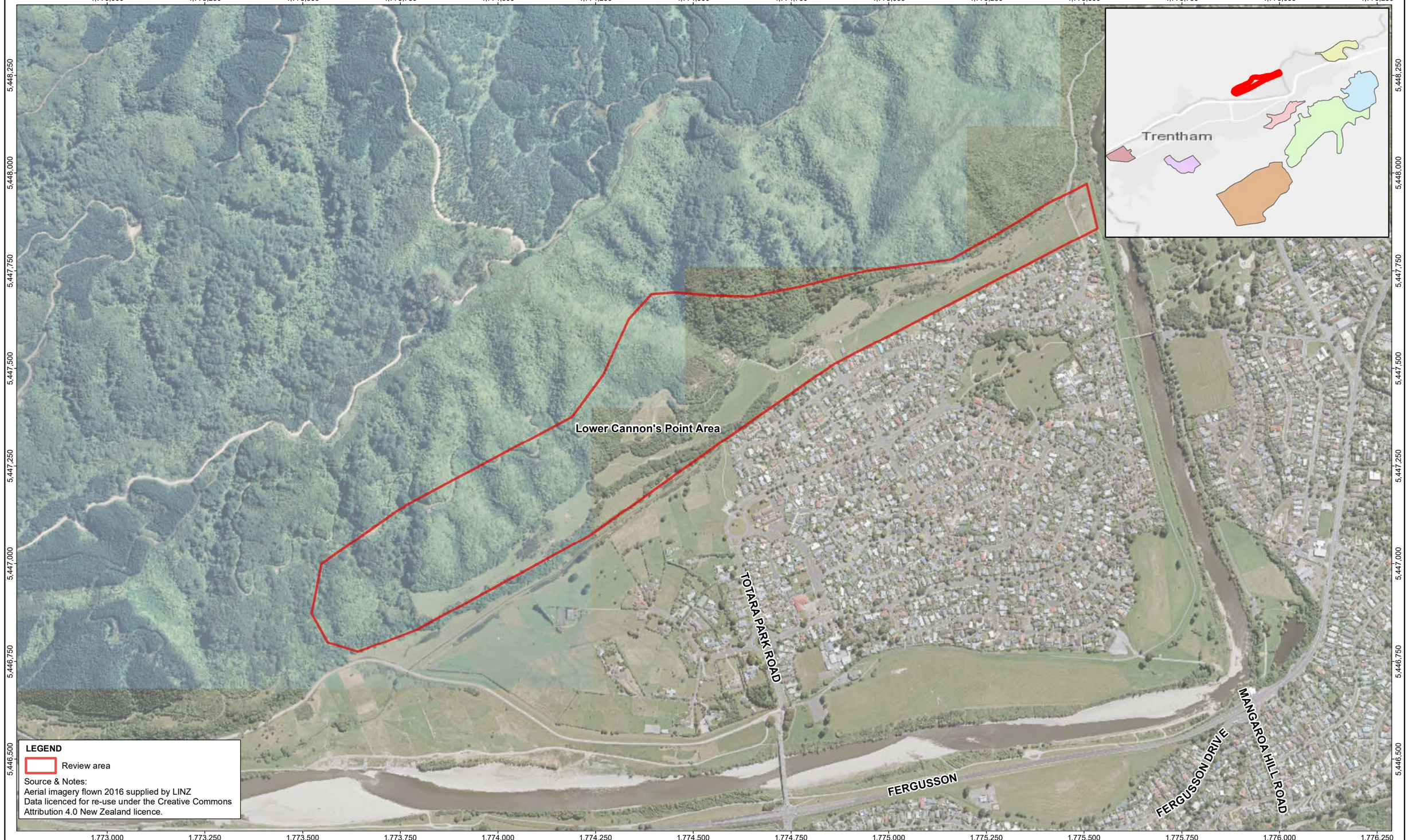

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coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SITE PLAN - LOWER CANNON'S POINT AREA
project no:	773-WLGGE225406
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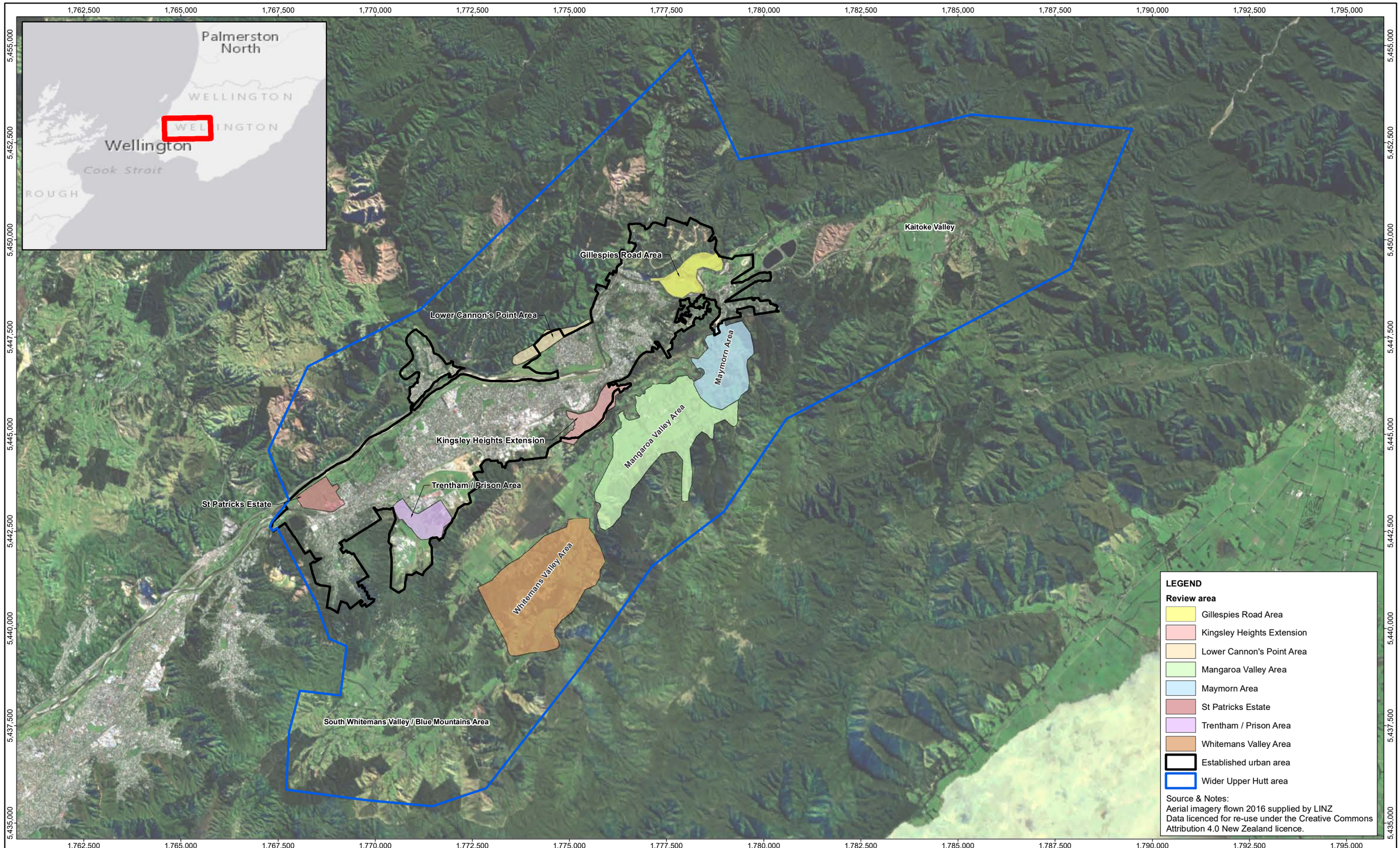

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coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

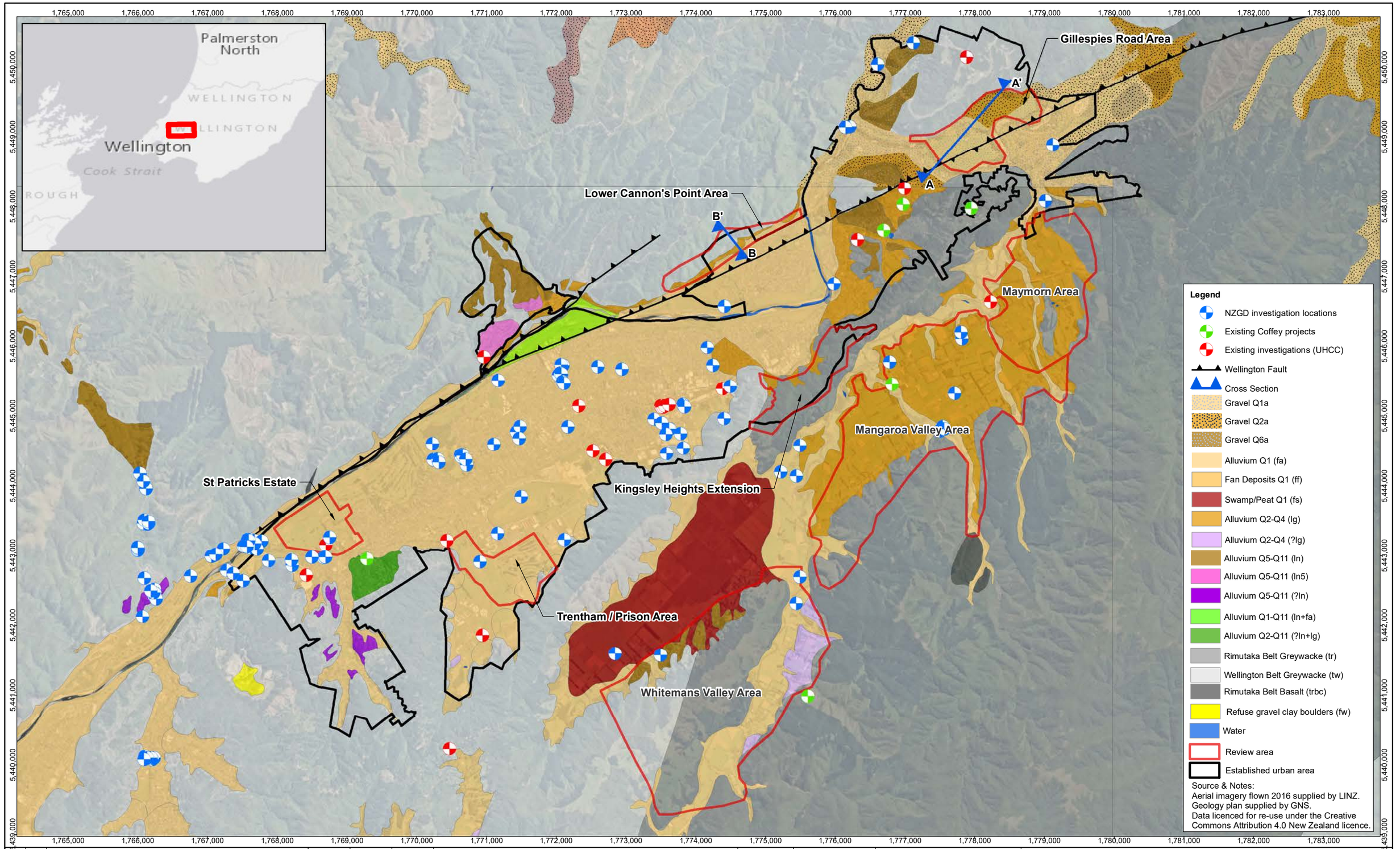
title: WIDER UPPER HUTT AREA – SITES LOCATION PLAN

project no: 773-WLGGE225406 | figure no: A9 | rev: A

MXD ref: 225406_02_A9_1

Appendix B – Geology and Investigation Location Plan

B - 0 Geology and Investigation Locations Plan
B - 1: Overall Geology Plan – Wider Upper Hutt Area



Legend

- NZGD investigation locations
- Existing Coffey projects
- Existing investigations (UHCC)
- Wellington Fault
- Cross Section
- Gravel Q1a
- Gravel Q2a
- Gravel Q6a
- Alluvium Q1 (fa)
- Fan Deposits Q1 (ff)
- Swamp/Peat Q1 (fs)
- Alluvium Q2-Q4 (lg)
- Alluvium Q2-Q4 (?lg)
- Alluvium Q5-Q11 (ln)
- Alluvium Q5-Q11 (ln5)
- Alluvium Q5-Q11 (?ln)
- Alluvium Q1-Q11 (ln+fa)
- Alluvium Q2-Q11 (?ln+lg)
- Rimutaka Belt Greywacke (tr)
- Wellington Belt Greywacke (tw)
- Rimutaka Belt Basalt (trbc)
- Refuse gravel clay boulders (fw)
- Water
- Review area
- Established urban area

Source & Notes:
Aerial imagery flown 2016 supplied by LINZ.
Geology plan supplied by GNS.

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

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Projection: NZGD 2000 New Zealand Transverse Mercator

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approved	SM
date	11.09.2019
scale	AS SHOWN
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coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	GEOLOGY & INVESTIGATION LOCATIONS PLAN
project no:	773-WLGGE225406
figure no:	B0
rev:	A

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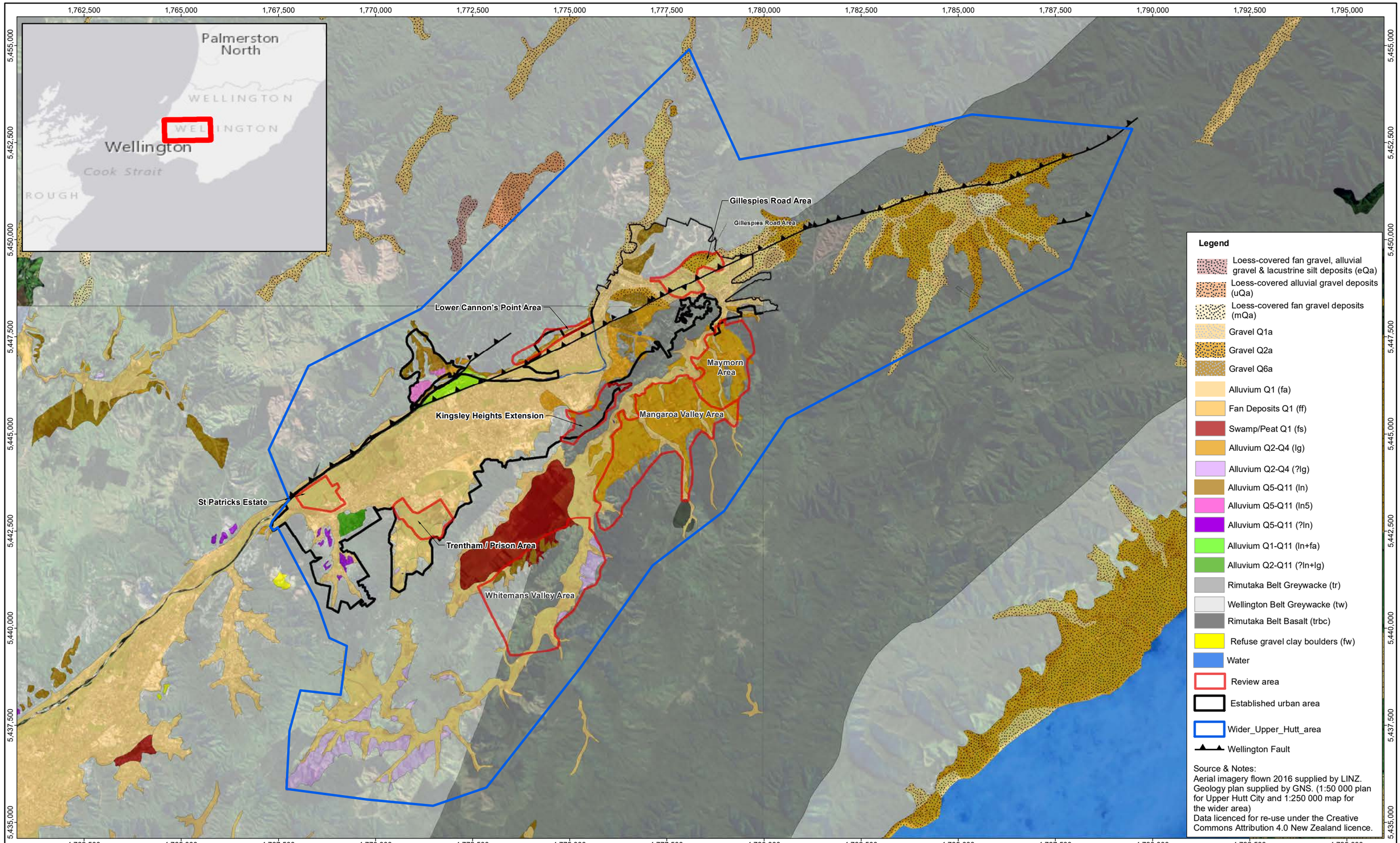

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Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	11.09.2019
scale	AS SHOWN
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coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

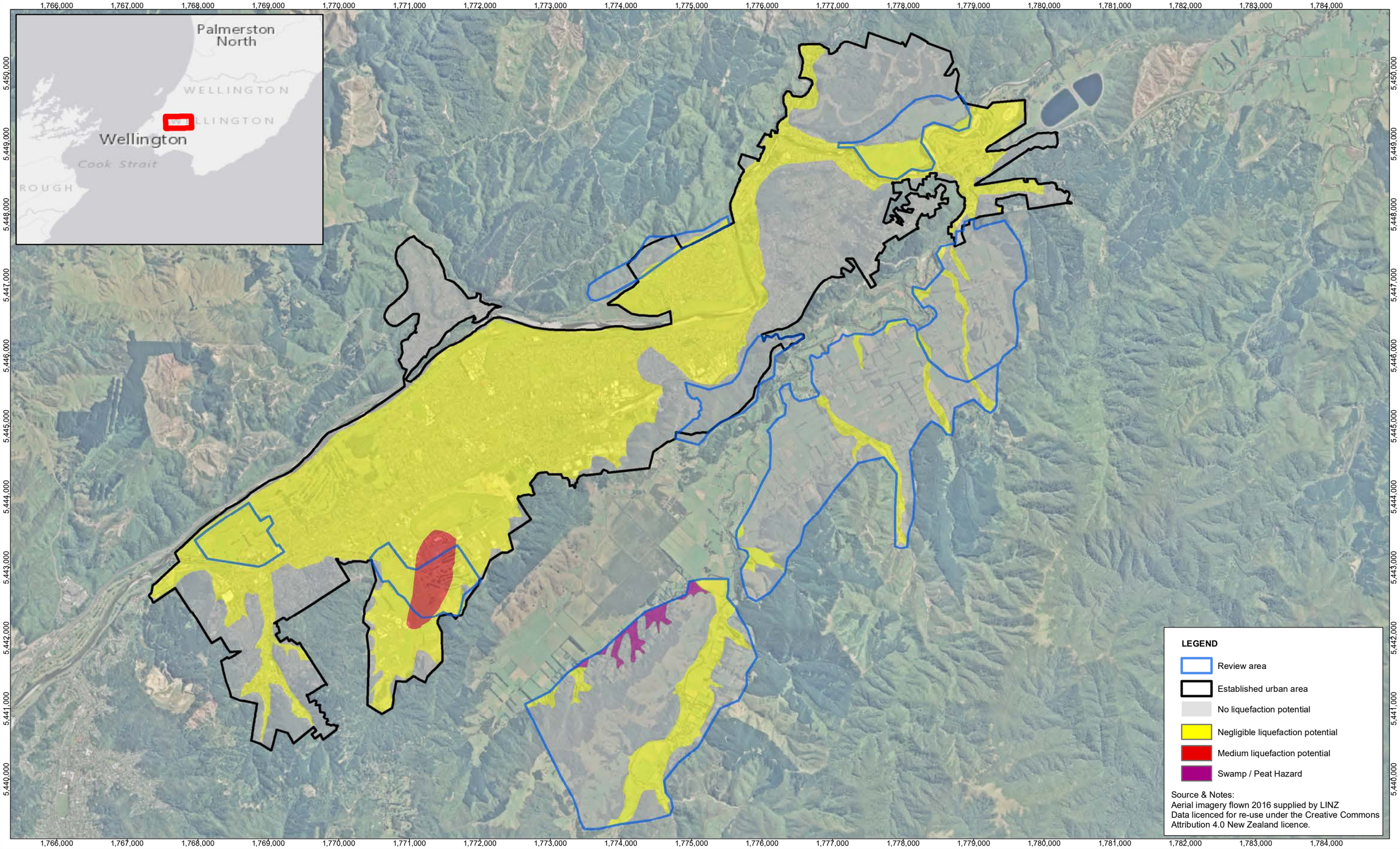
project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: OVERALL GEOLOGY PLAN - WIDER UPPER HUTT AREA

project no: 773-WLGGE225406 | figure no: B1 | rev: A

MXD ref: 225406_02_B1_1

Appendix C – Liquefaction and Peat Hazard Map



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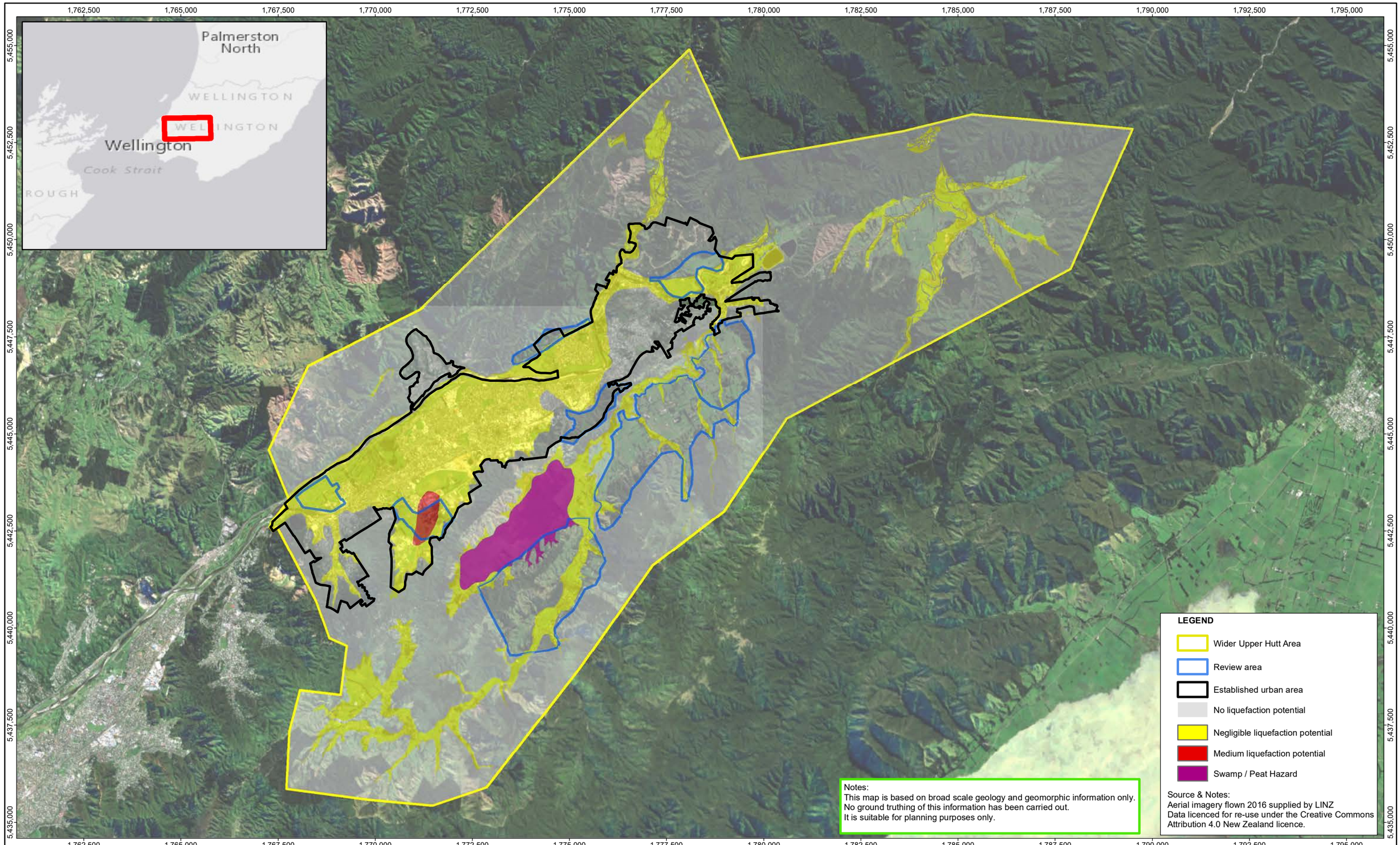
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	05.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	LIQUEFACTION AND PEAT HAZARD MAP
project no:	773-WLGGE225406
figure no:	C0
rev:	A

MXD ref: 225406_02_C0_1



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Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	09.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

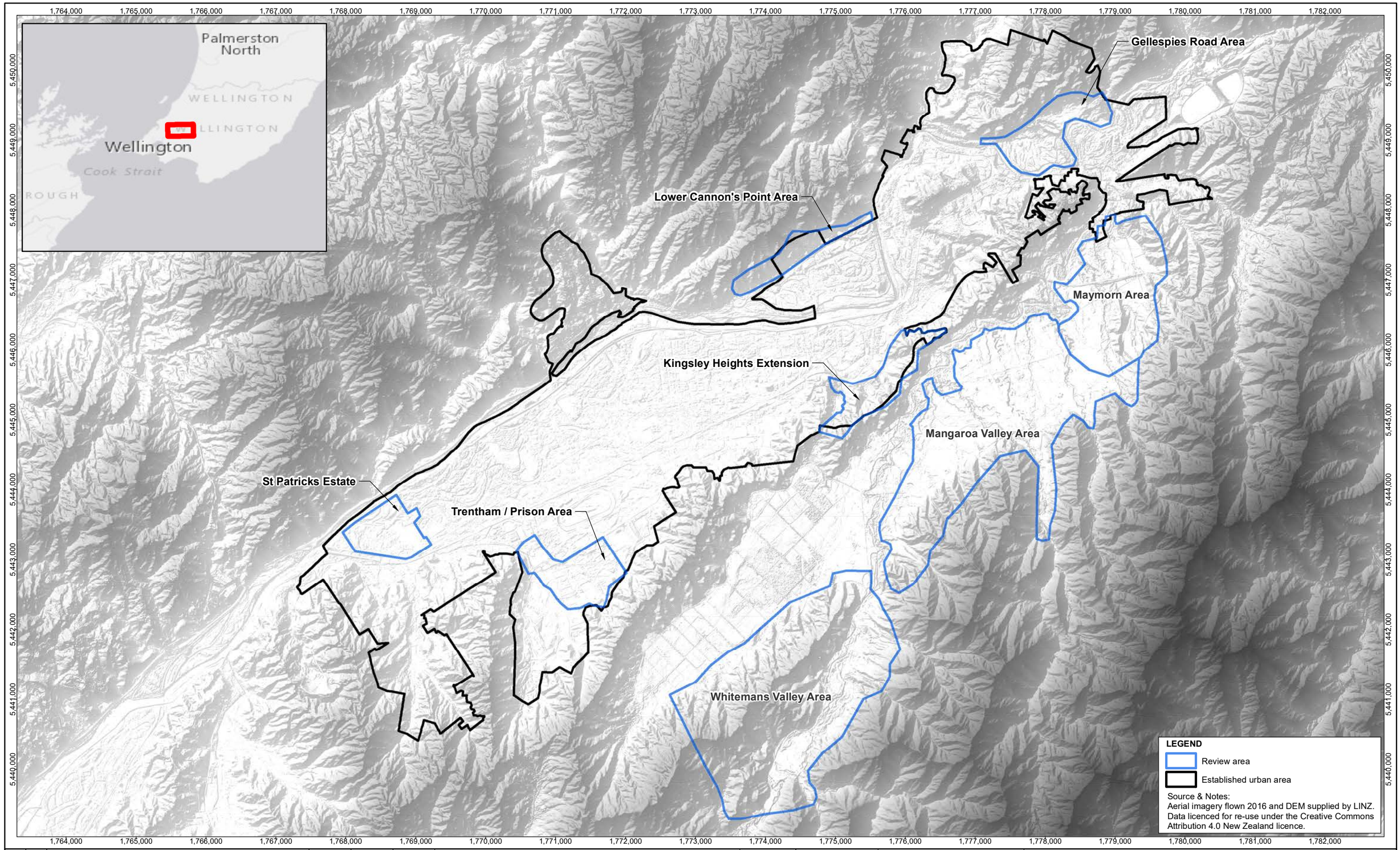
project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: LIQUEFACTION AND PEAT HAZARD MAP - WIDER UPPER HUTT AREA

project no: 773-WLGGE225406 | figure no: C1 | rev: A

MXD ref: 225406_02_C1_1

Appendix D – Hillshade Maps



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coffey
A TETRA TECH COMPANY

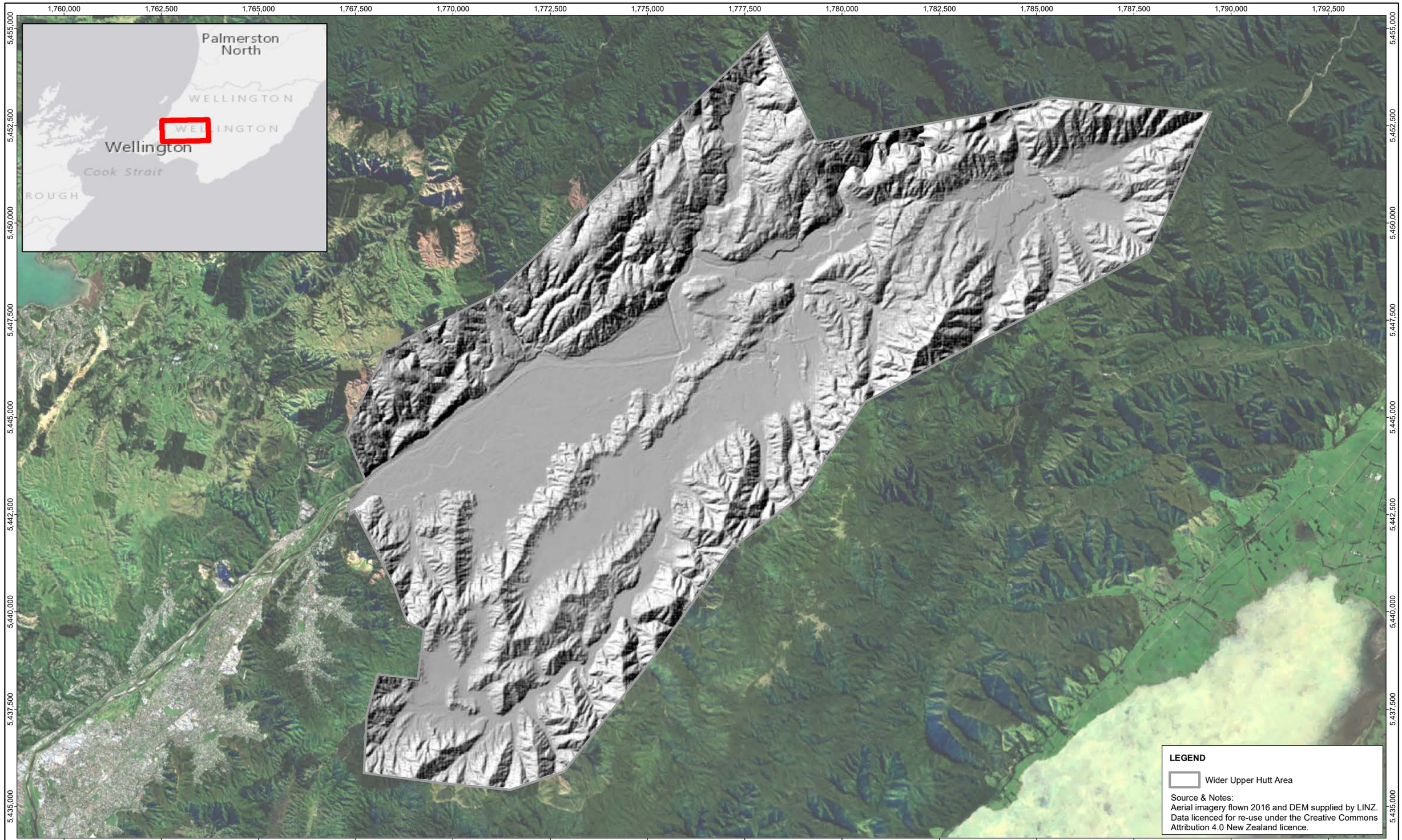
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: DIGITAL ELEVATION MODEL - HILLSHADE

project no: 773-WLGGE225406 | figure no: D0 | rev: A

MXD ref: 225406_02_D0_3



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	05.09.19

0 900 1,800 2,700 3,600
SCALE 1:90,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	05.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

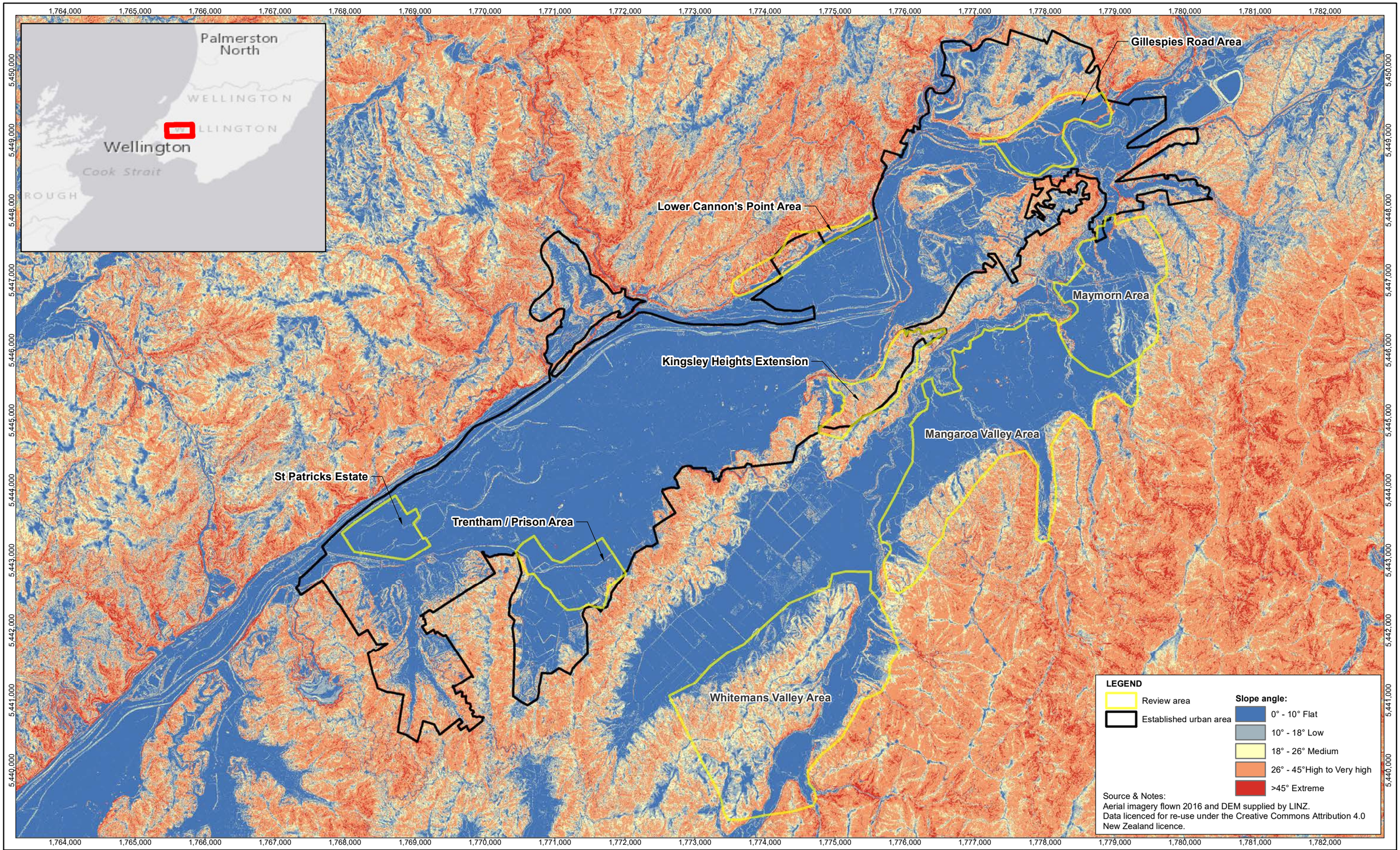
project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: DIGITAL ELEVATION MODEL - HILL SHADE - WIDER UPPER HUTT AREA

project no: 773-WLGGE225406 | figure no: D1 | rev: A

MXD ref: 225406_02_D1_3

Appendix E - Slope Angle Maps



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	11.09.19

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SCALE 1:50,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	11.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

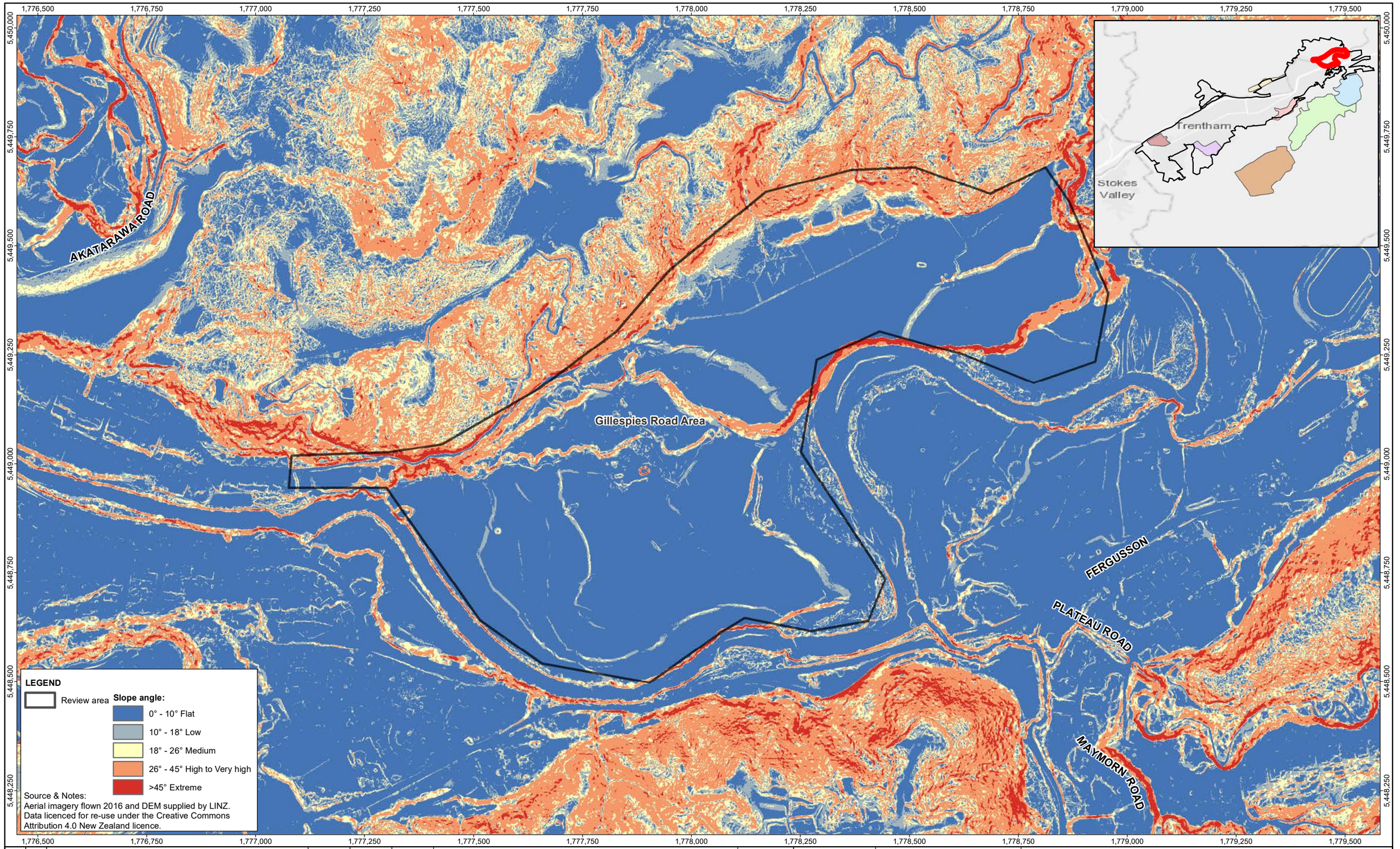
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP

project no: 773-WLGGE225406 | figure no: E0 | rev: A

MXD ref: 225406_02_E0_2



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	27.05.19

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SCALE 1:8,000 (A3) METRES

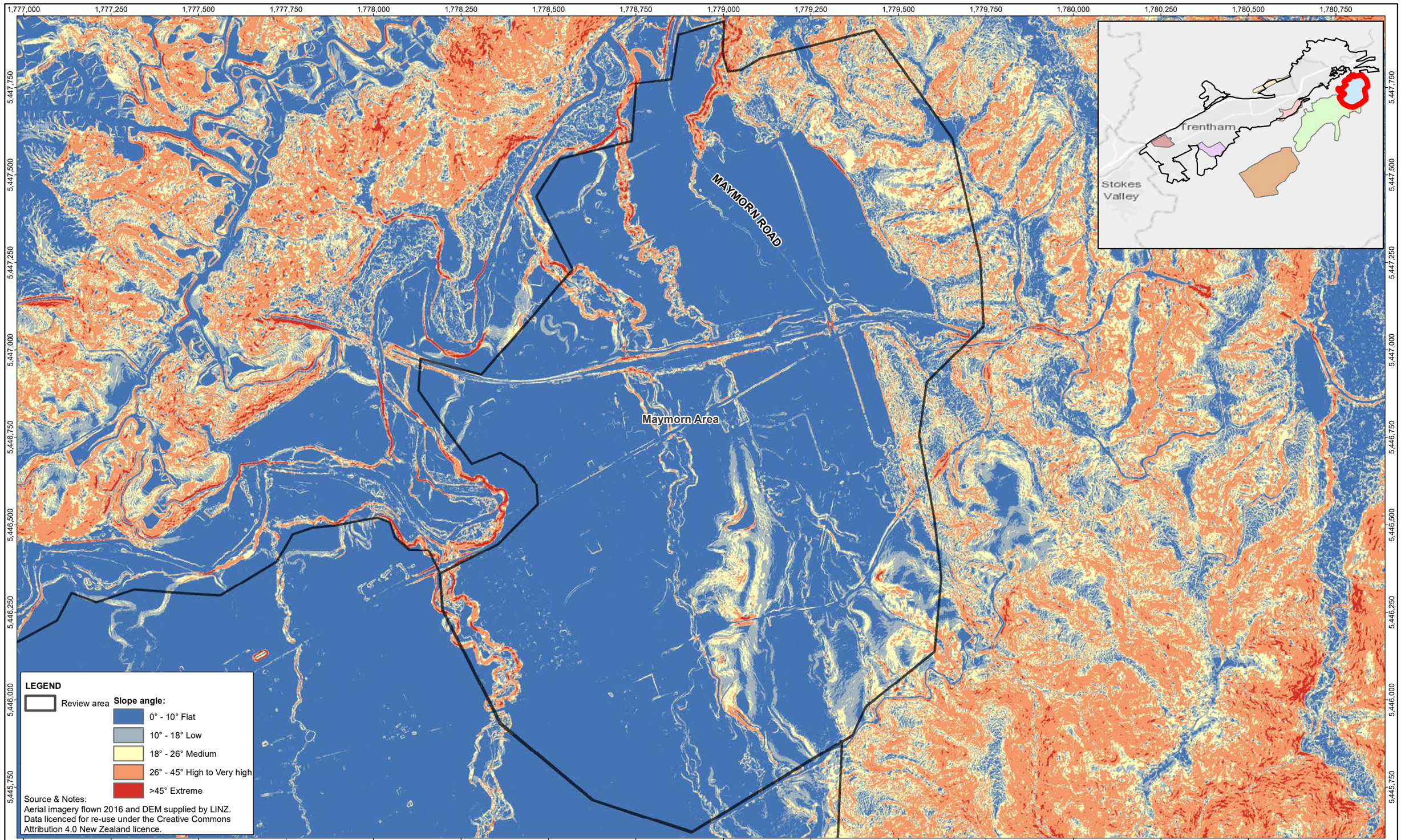
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE ANGLE MAP- GILLESPIES ROAD AREA
project no:	773-WLGGE225406
figure no:	E1
rev:	A

MXD ref: 225406_00_GIS_F_1



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	27.05.19

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SCALE 1:10,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

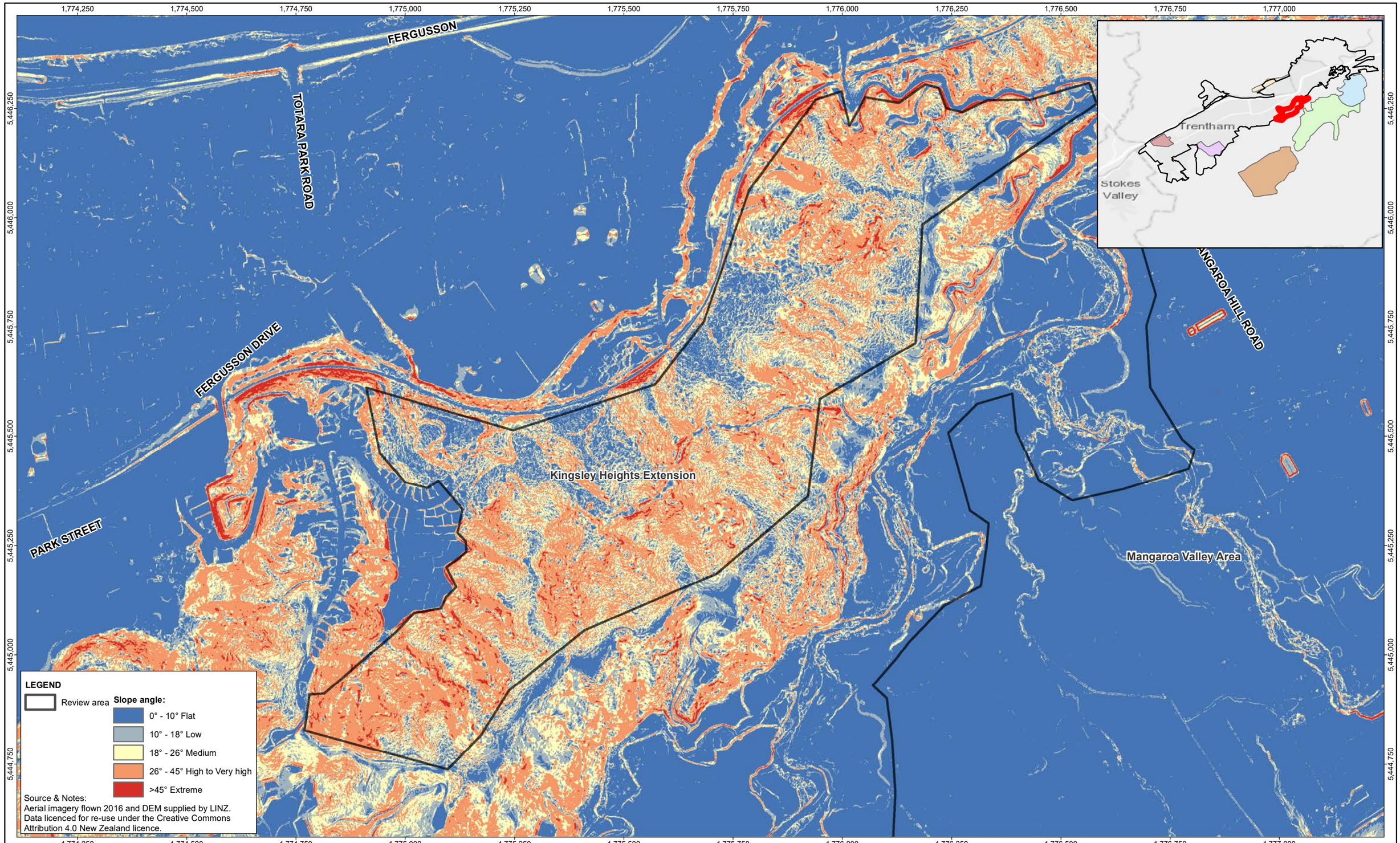
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- MAYMORN AREA

project no: 773-WLGGE225406 | figure no: E2 | rev: A

MXD ref: 225406_00_GIS_F_1



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	27.05.19

N

0 80 160 240 320

SCALE 1:8,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- KINGSLEY HEIGHTS EXTENSION

project no: 773-WLGGE225406 | figure no: E3 | rev: A

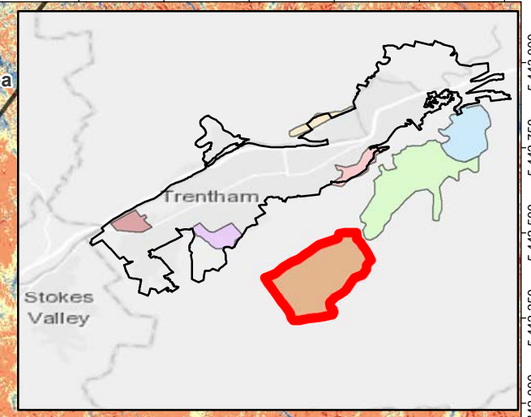
MXD ref: 225406_00_GIS_F_1

MESSINES AVENUE

Trentham / Prison Area

Mangaroa Valley Area

Whitemans Valley Area



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5,443,000 5,442,750 5,442,500 5,442,250 5,442,000 5,441,750 5,441,500 5,441,250 5,441,000 5,440,750 5,440,500 5,440,250 5,440,000 5,439,750 5,439,500 5,439,250 5,439,000

LEGEND

Review area

Slope angle:

- 0° - 10° Flat
- 10° - 18° Low
- 18° - 26° Medium
- 26° - 45° High to Very high
- >45° Extreme

Source & Notes:
Aerial imagery flown 2016 and DEM supplied by LINZ.

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	27.05.19

N

0 180 360 540 720
SCALE 1:18,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

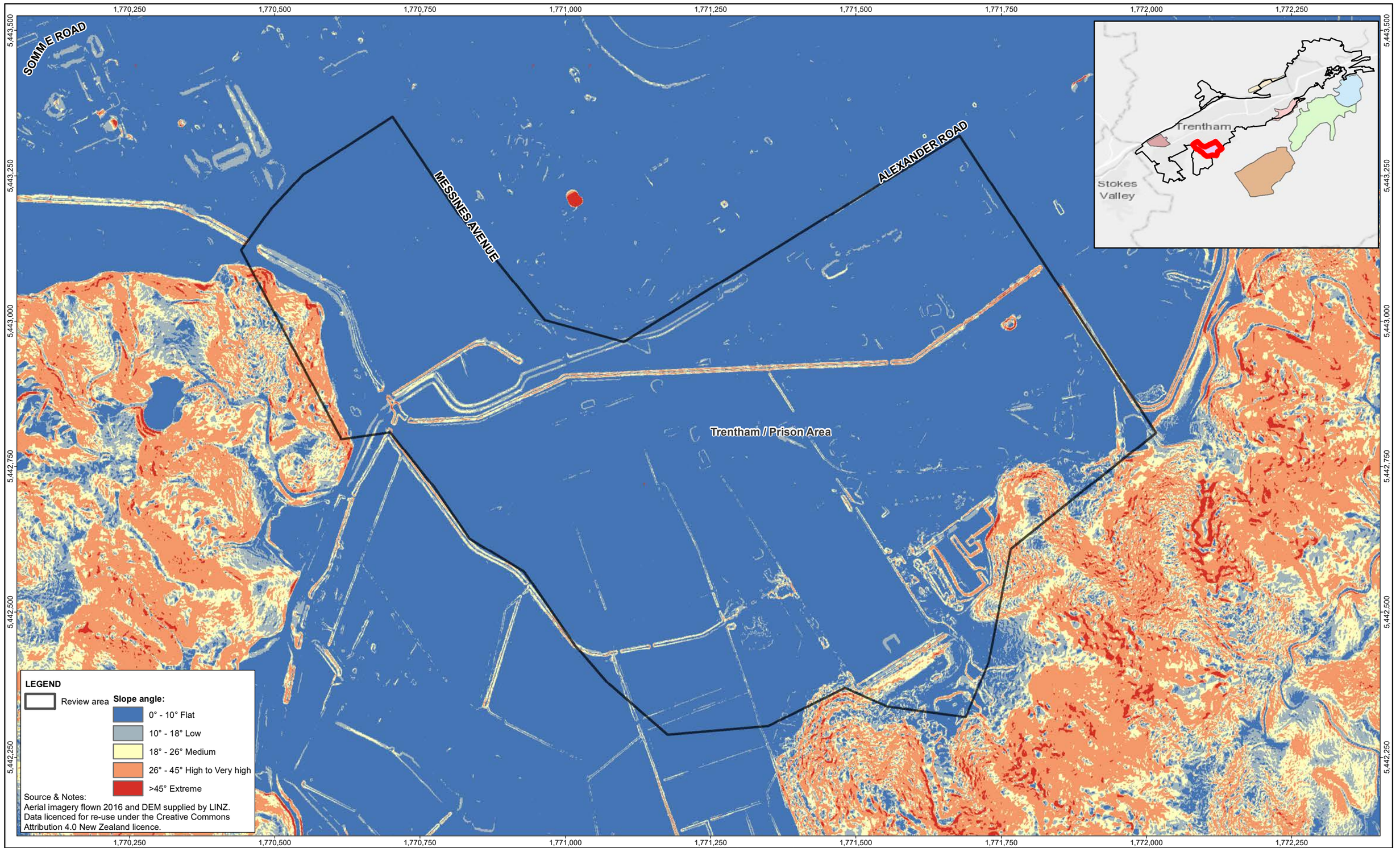
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- WHITEMANS VALLEY AREA

project no: 773-WLGGE225406 | figure no: E4 | rev: A

MXD ref: 225406_00_GIS_F_1



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	27.05.19

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SCALE 1:6,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

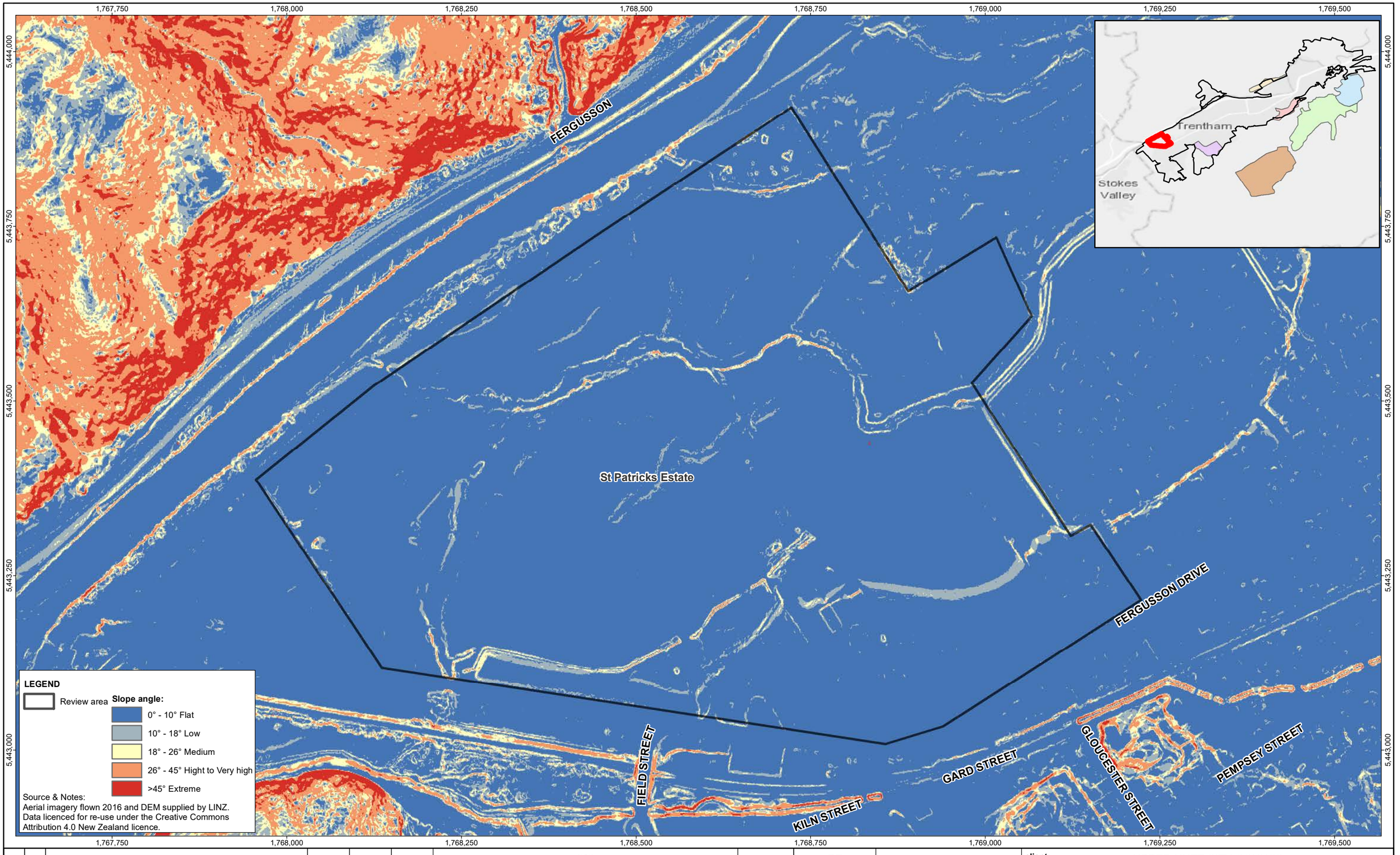
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- TRENTHAM / PRISON AREA

project no: 773-WLGGE225406 | figure no: E5 | rev: A

MXD ref: 225406_00_GIS_F_1



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	11.09.19

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SCALE 1:5,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	11.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

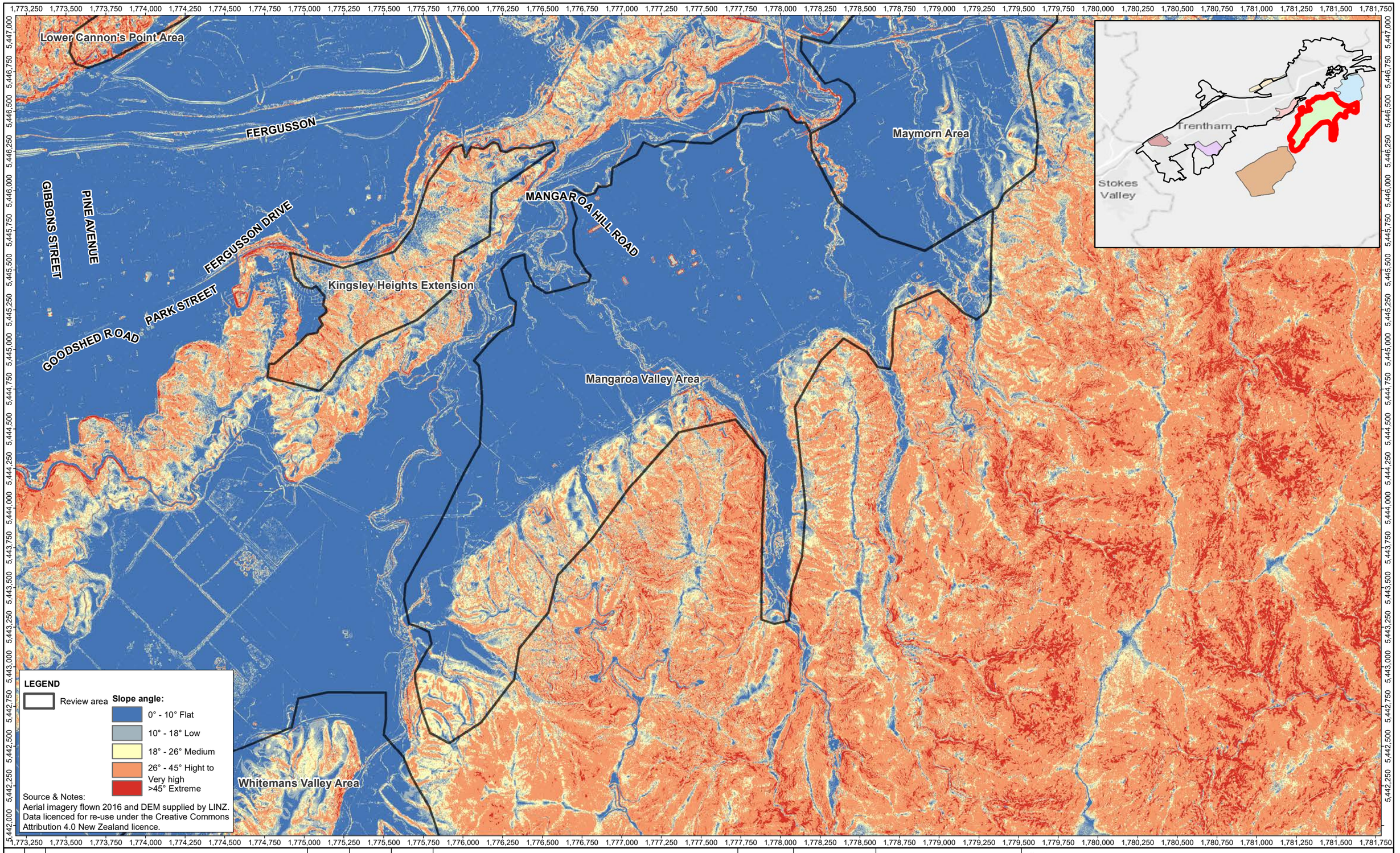
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- ST PATRICKS ESTATE

project no: 773-WLGGE225406 | figure no: F - 6 | rev: A

MXD ref: 225406_02_E_1



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	27.05.19

N

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SCALE 1:22,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- MANGAROA VALLEY AREA

project no: 773-WLGGE225406 | figure no: E7 | rev: A

MXD ref: 225406_00_GIS_F_1

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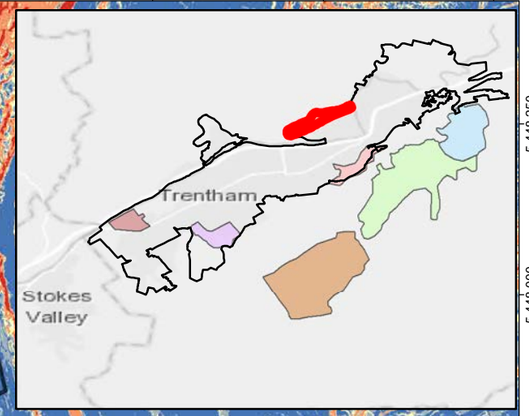


Lower Cannon's Point Area

TOTARA PARK ROAD

FERGUSSON

FERGUSSON DRIVE

MANGAROA HILL ROAD

LEGEND

Review area

Slope angle:

- 0° - 10° Flat
- 10° - 18° Low
- 18° - 26° Medium
- 26° - 45° High to Very high
- >45° Extreme

Source & Notes:
Aerial imagery flown 2016 and DEM supplied by LINZ.
Data licenced for re-use under the Creative Commons Attribution 4.0 New Zealand licence.

1,773,000 1,773,250 1,773,500 1,773,750 1,774,000 1,774,250 1,774,500 1,774,750 1,775,000 1,775,250 1,775,500 1,775,750 1,776,000 1,776,250

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	27.05.19

N

0 90 180 270 360

SCALE 1:9,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	27.05.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

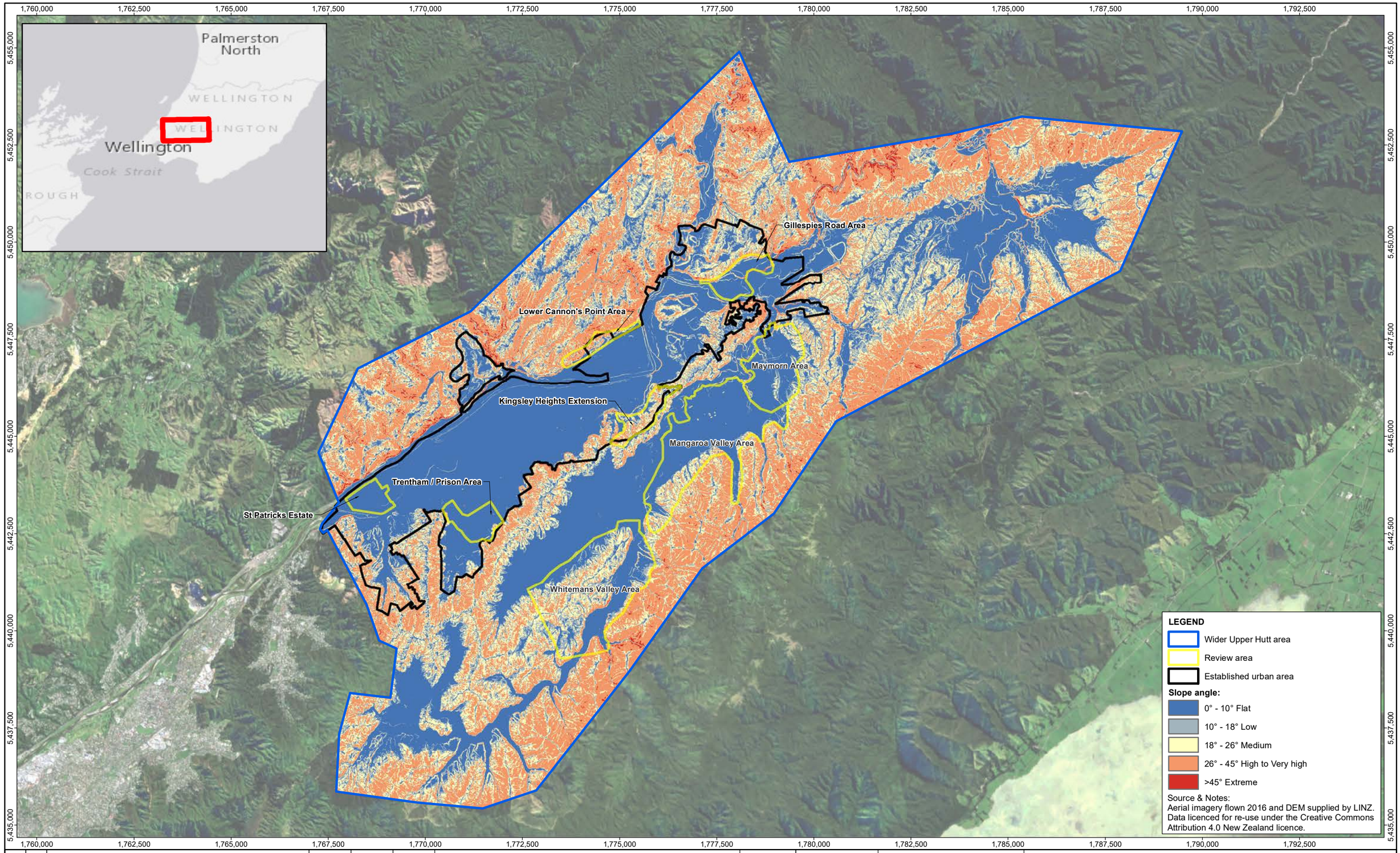
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE ANGLE MAP- LOWER CANNON'S POINT AREA

project no: 773-WLGGE225406 | figure no: E8 | rev: A

MXD ref: 225406_00_GIS_F_1



MXD ref: 225406_02_E9_2

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SCALE 1:90,000 (A3) METRES

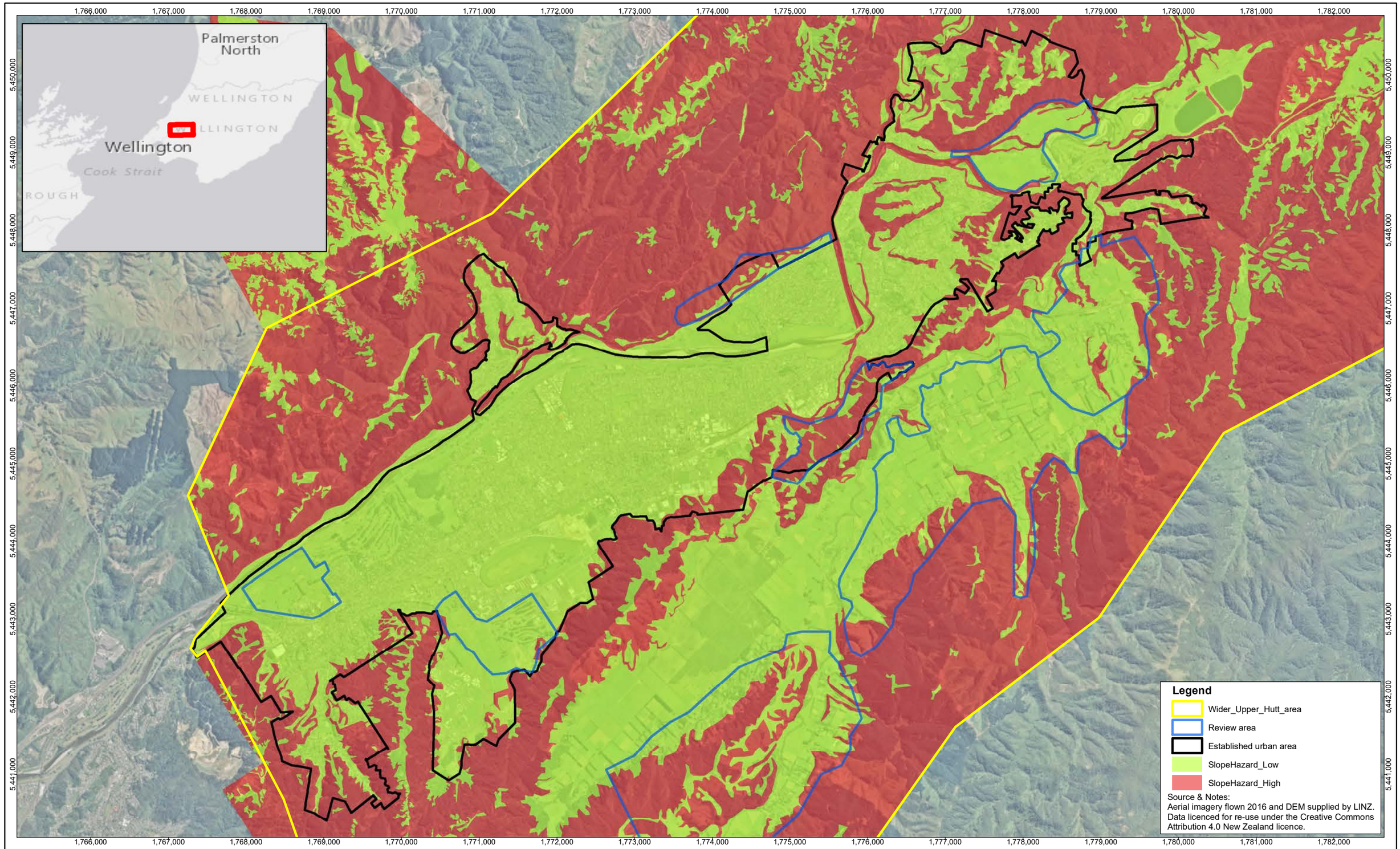
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	11.09.2019
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE ANGLE MAP - WIDER UPPER HUTT AREA
project no:	773-WLGGE225406
figure no:	E9
rev:	A

Appendix F – Slope Hazard Maps



revision no.	description	drawn	approved	date
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SCALE 1:45,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

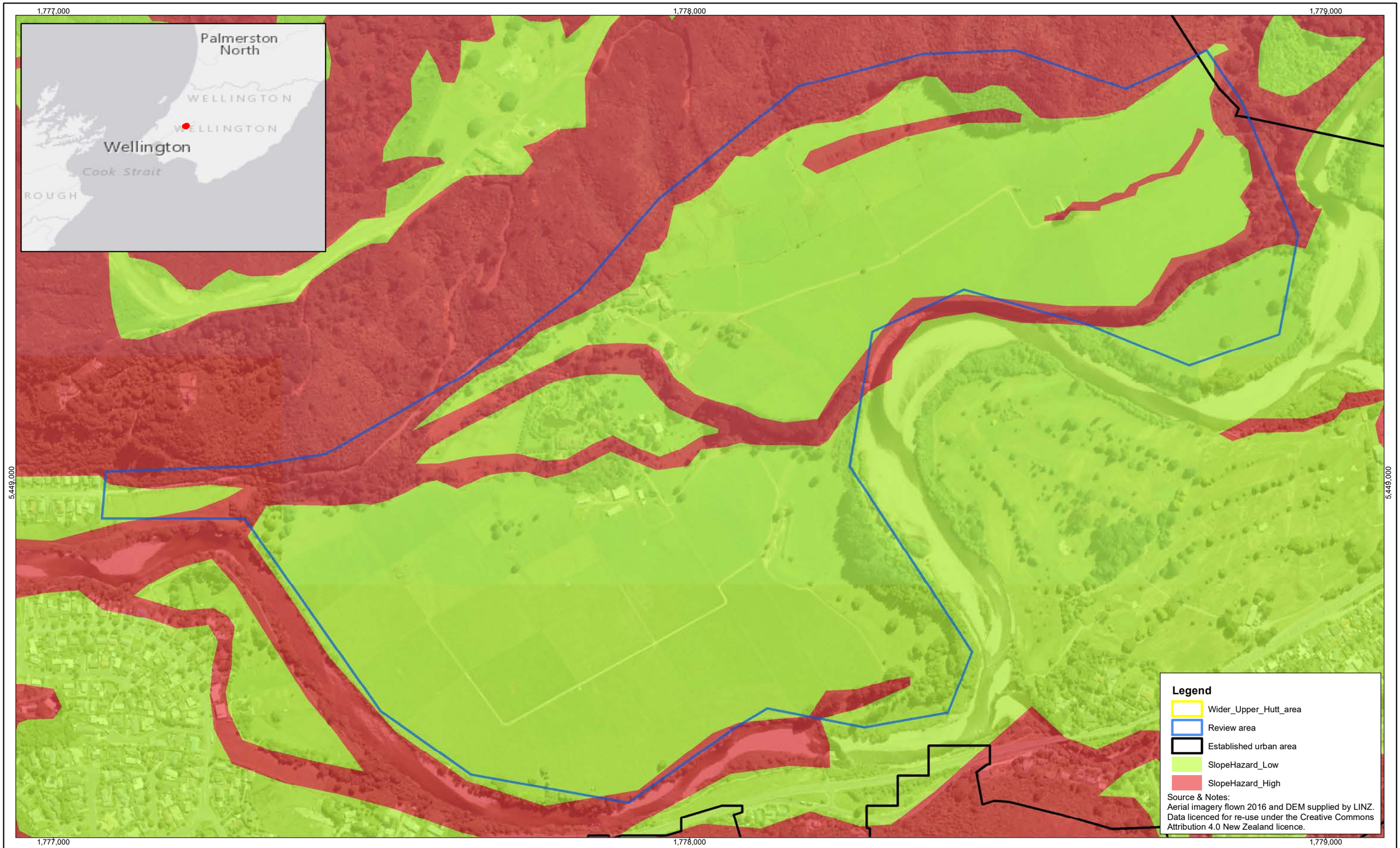
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD MAP - URBAN AREA

project no: 773-WLGGE225406AB | figure no: F0 | rev: A

MXD ref: 225406AB_01_F0_3



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	06.03.20

N

0 50 100 150 200

SCALE 1:5,500 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

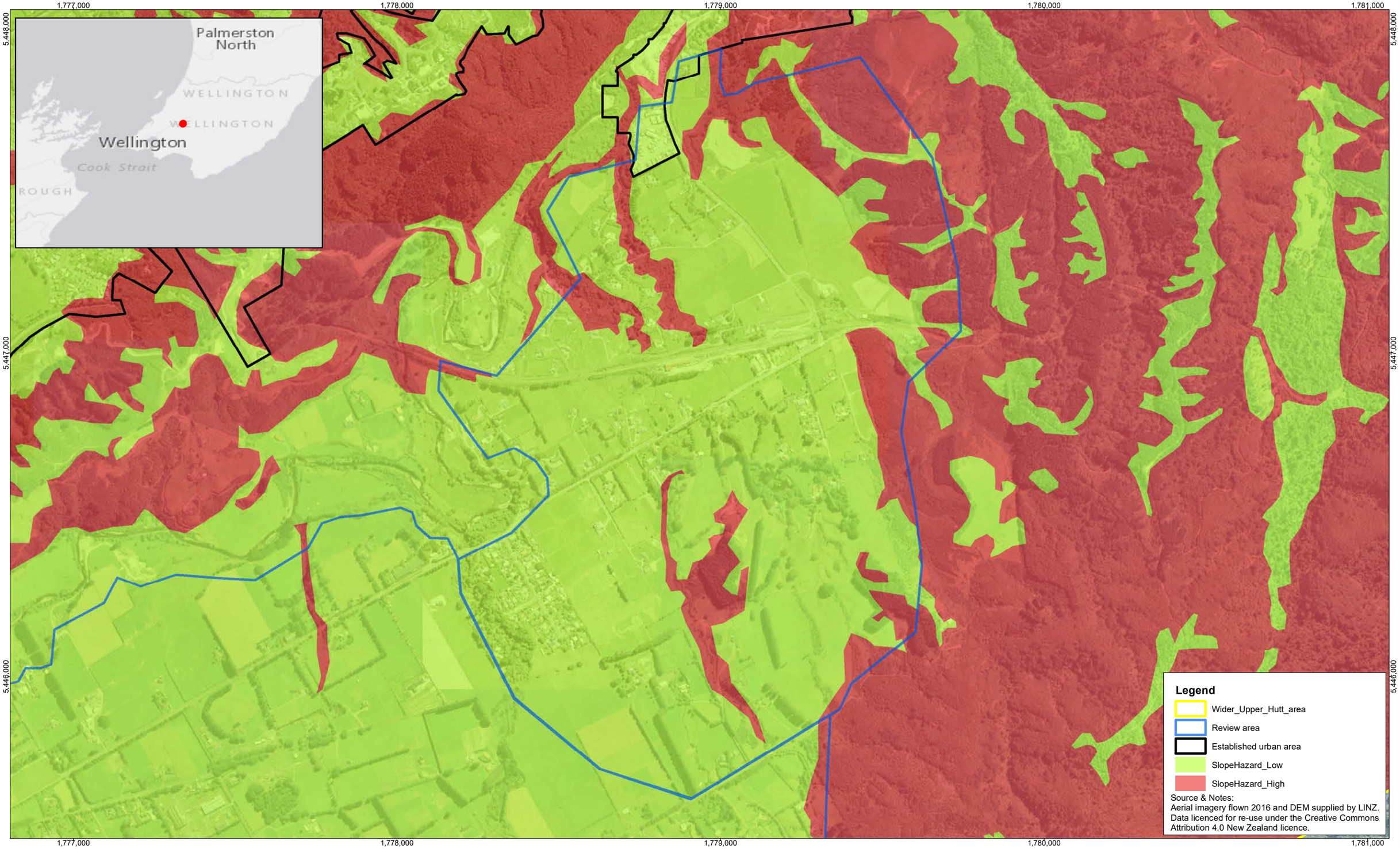
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD MAP

project no: 773-WLGGE225406AB | figure no: F1 | rev: A

MXD ref: 225406AB_02_F_3



revision no.	description	drawn	approved	date
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N

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SCALE 1:10,900 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

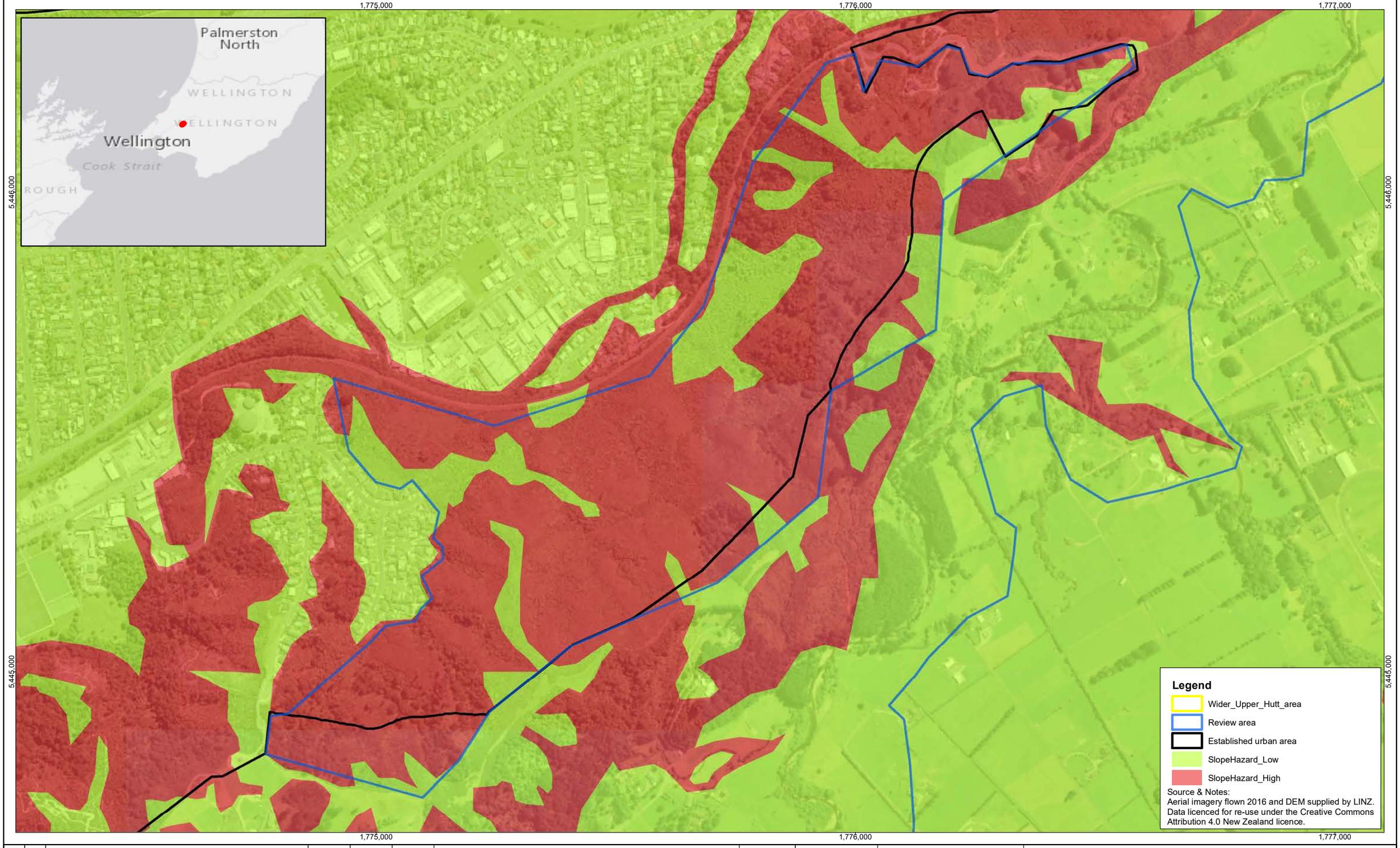
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD MAP

project no: 773-WLGGE225406AB | figure no: F2 | rev: A

MXD ref: 225406AB_02_F_3



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	06.03.20

N

0 70 140 210 280

SCALE 1:7,300 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD MAP

project no: 773-WLGGE225406AB | figure no: F3 | rev: A

MXD ref: 225406AB_02_F_3

revision	no.	description	drawn	approved	date
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0 160 320 480 640
SCALE 1:16,600 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE HAZARD MAP
project no:	773-WLGGE225406AB
figure no:	F4
rev:	A

MXD ref: 225406AB_02_F_3

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	06.03.20

0 40 80 120 160
SCALE 1:5,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE HAZARD MAP
project no:	773-WLGGE225406AB
figure no:	F5
rev:	A

MXD ref: 225406AB_02_F_3

revision	no.	description	drawn	approved	date
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SCALE 1:4,300 (A3) METRES

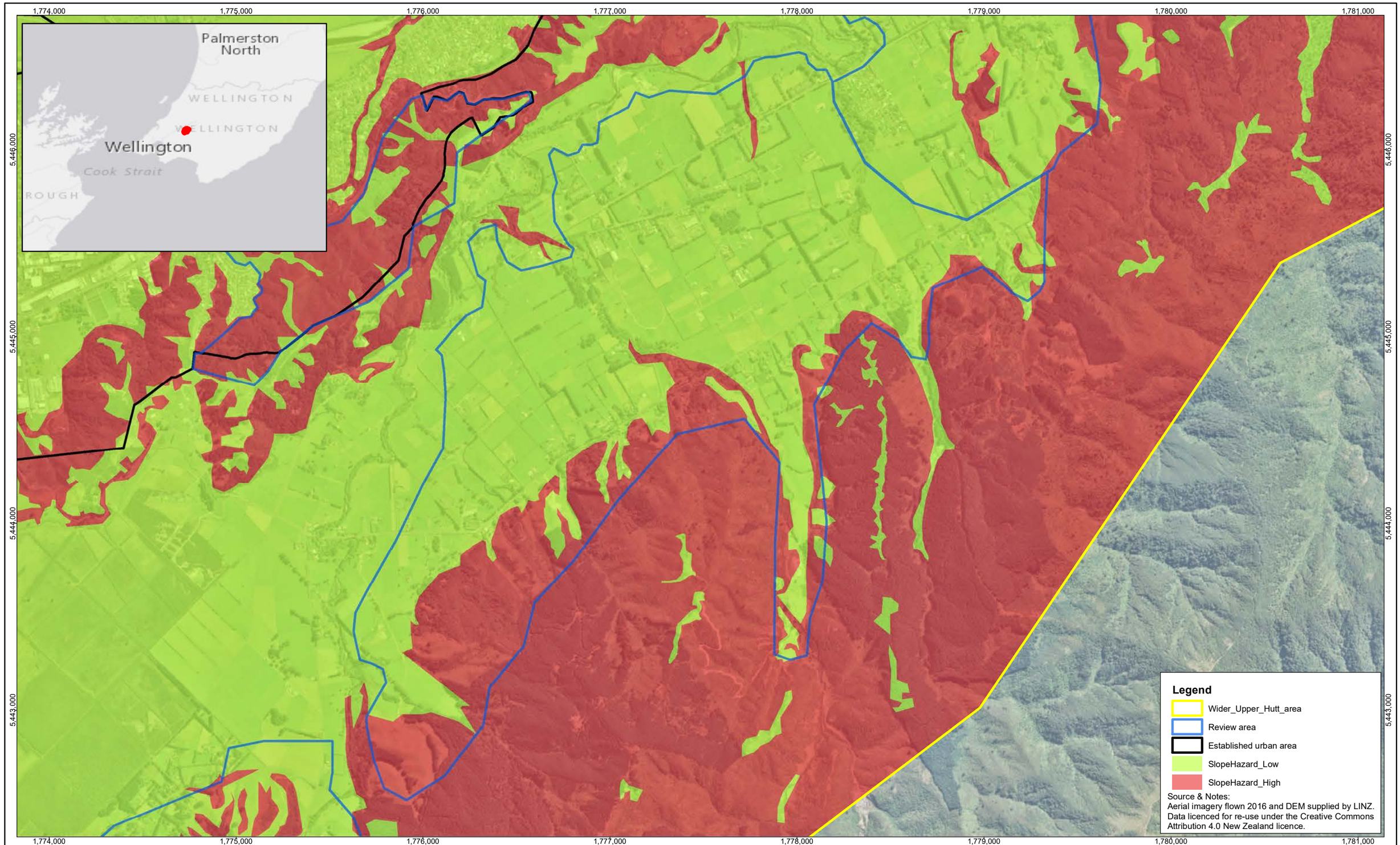
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE HAZARD MAP
project no:	773-WLGGE225406AB
figure no:	F6
rev:	A

MXD ref: 225406AB_02_F_3



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	06.03.20

0 180 360 540 720
SCALE 1:18,700 (A3) METRES

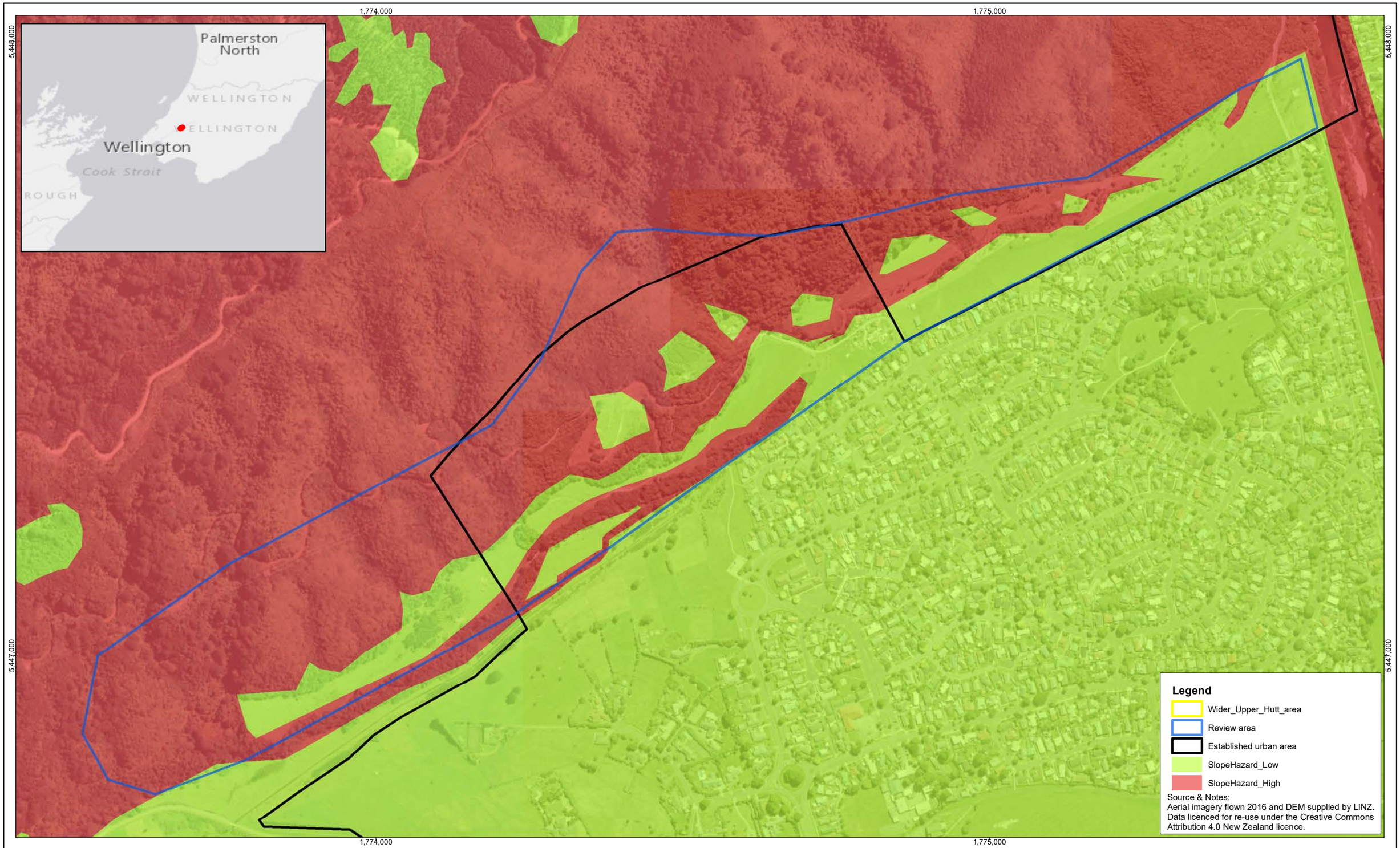
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	SLOPE HAZARD MAP
project no:	773-WLGGE225406AB
figure no:	F7
rev:	A

MXD ref: 225406AB_02_F_3



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	06.03.20

N

0 50 100 150 200

SCALE 1:5,700 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

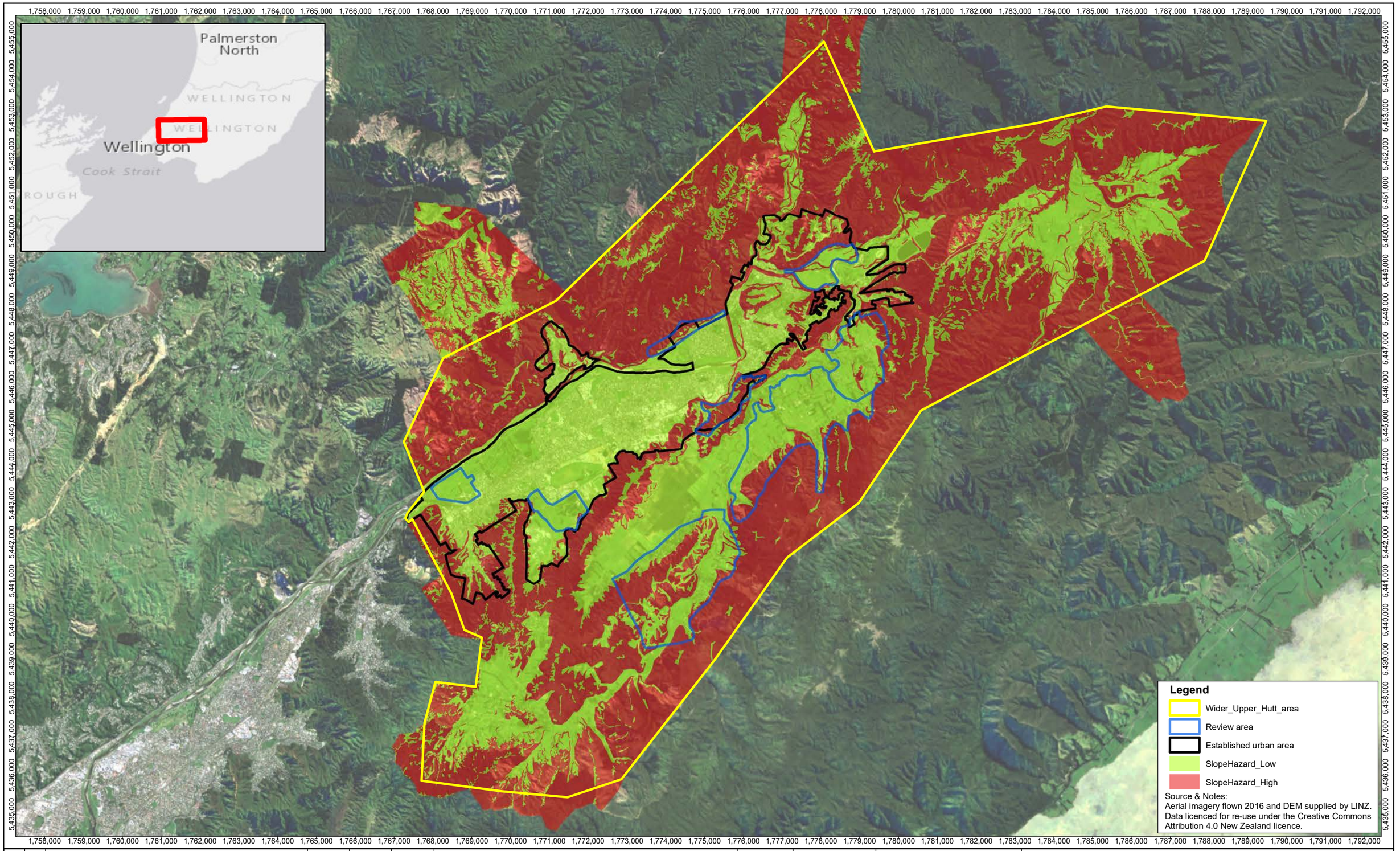
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD MAP

project no: 773-WLGGE225406AB | figure no: F8 | rev: A

MXD ref: 225406AB_02_F_3



revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE	RZ	SM	06.03.20

0 880 1,760 2,640 3,520
SCALE 1:90,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

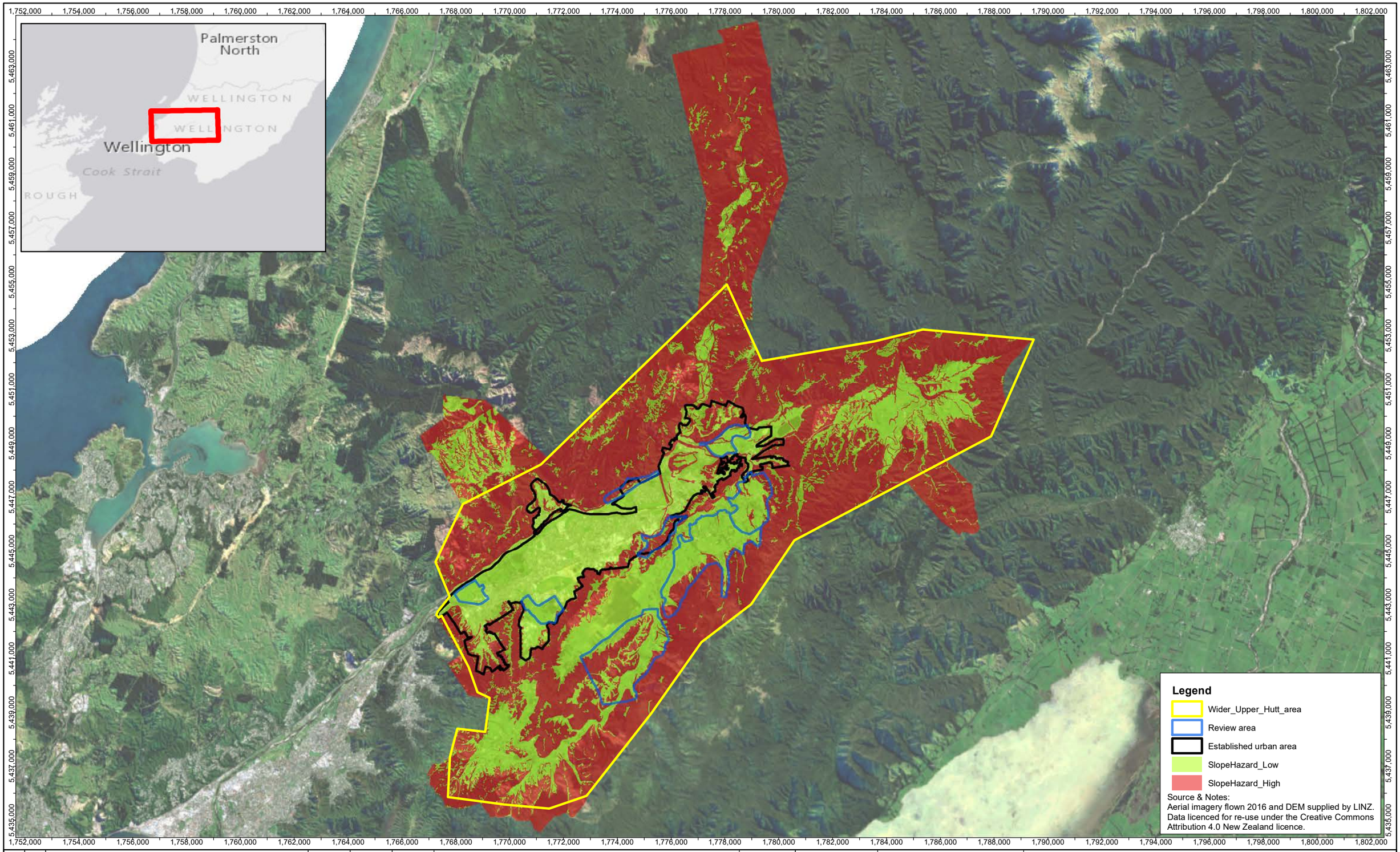
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD OVERVIEW MAP

project no: 773-WLGGE225406AB | figure no: F09 | rev: A

MXD ref: 225406AB_01_F09_3



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	SM	06.03.20

N

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SCALE 1:130,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

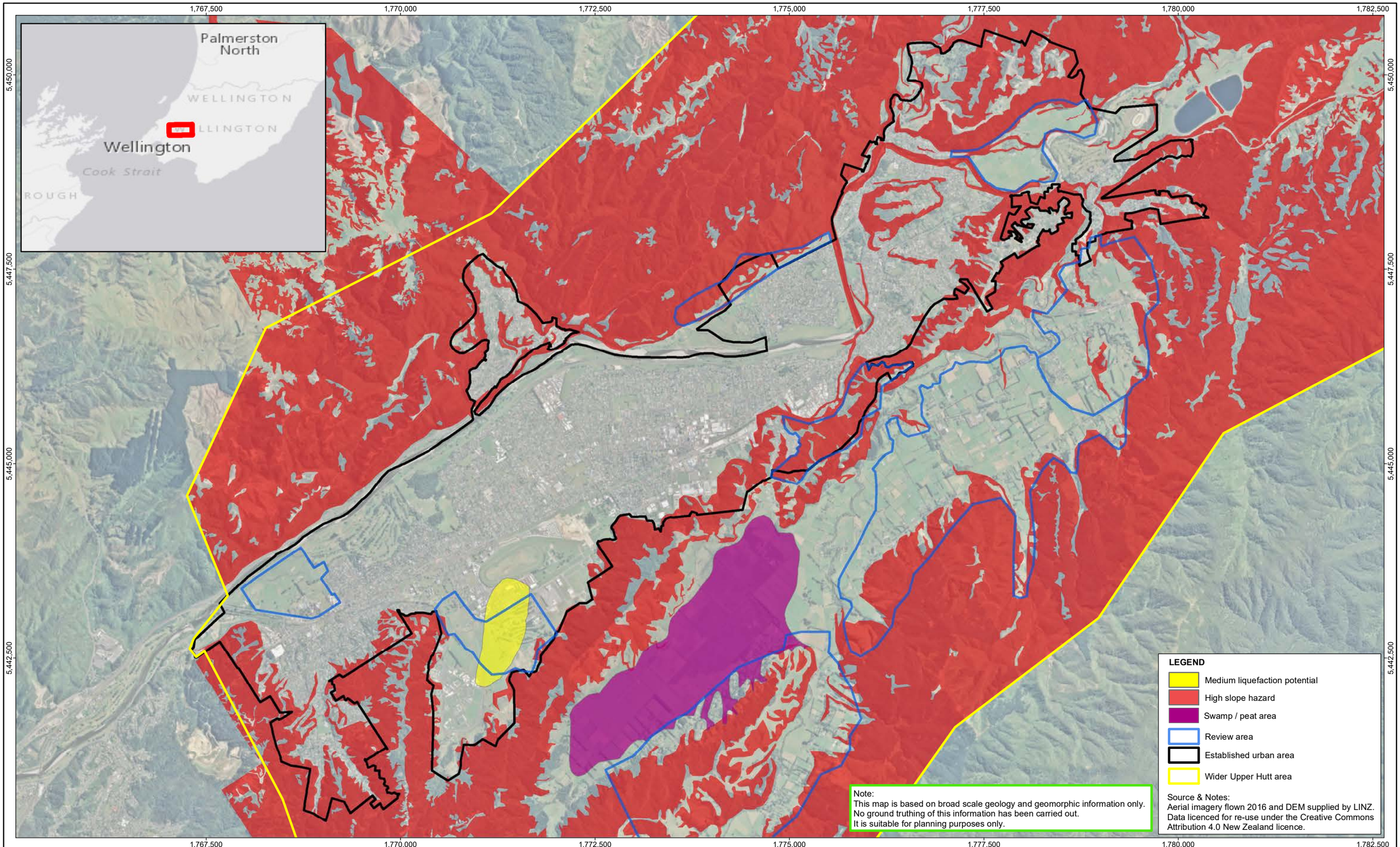
project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE HAZARD OVERVIEW MAP

project no: 773-WLGGE225406AB | figure no: F10 | rev: A

MXD ref: 225406AB_01_F_3

Appendix G - Geological Hazard Overview Map



revision no.	description	drawn	approved	date
B	SLOPE HAZARD UPDATED	RZ	SM	06.03.20
A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

0 500 1,000 1,500 2,000

SCALE 1:45,000 (A3) METRES

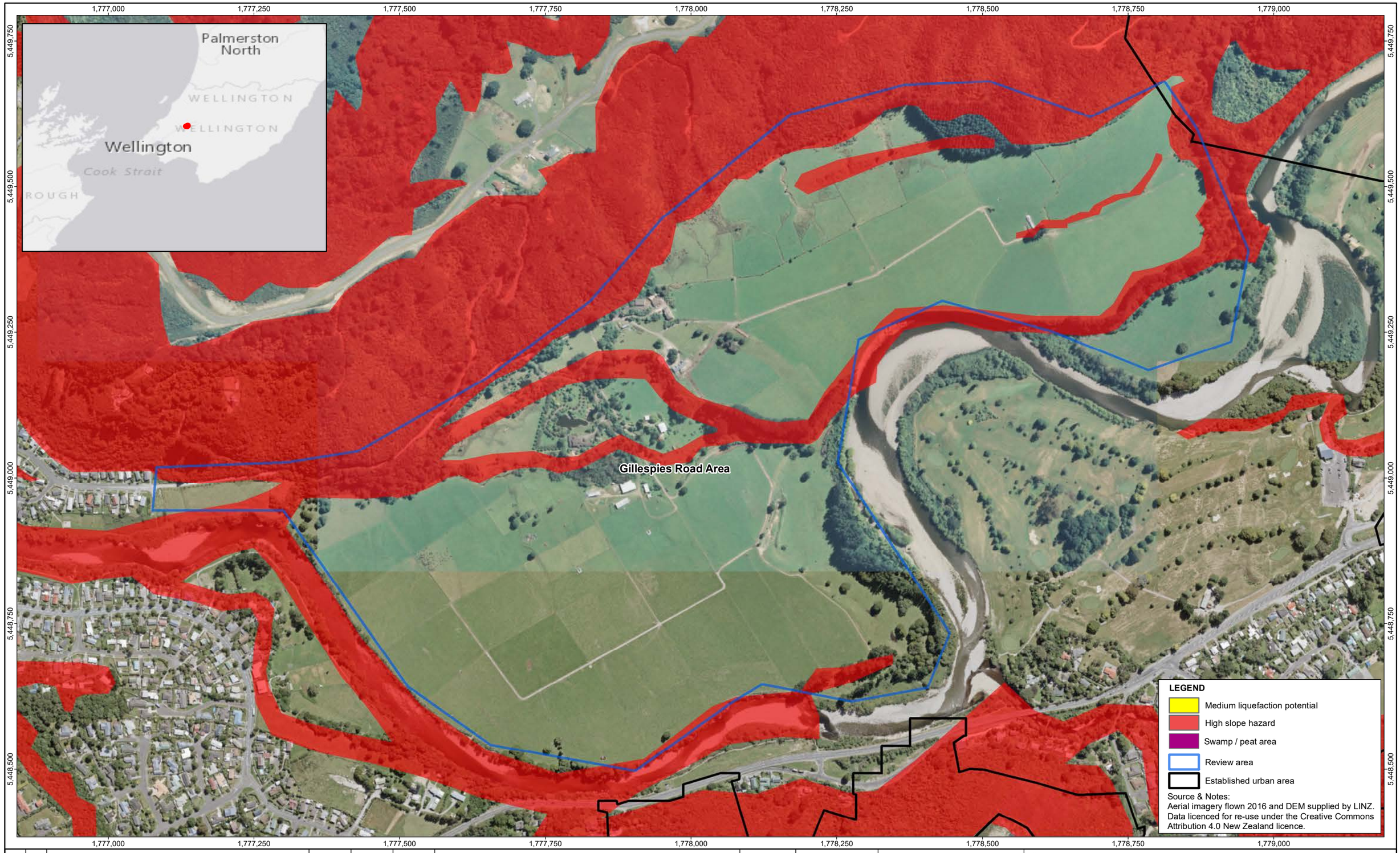
Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	UPPER HUTT CITY COUNCIL
project:	UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW
title:	GEOLOGICAL HAZARD MAP- URBAN AREA
project no:	773-WLGGE225406AB
figure no:	G0
rev:	B

MXD ref: 225406_03_G0_3



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	A	ORIGINAL ISSUE	RZ	SM	11.09.19

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SCALE 1:6,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

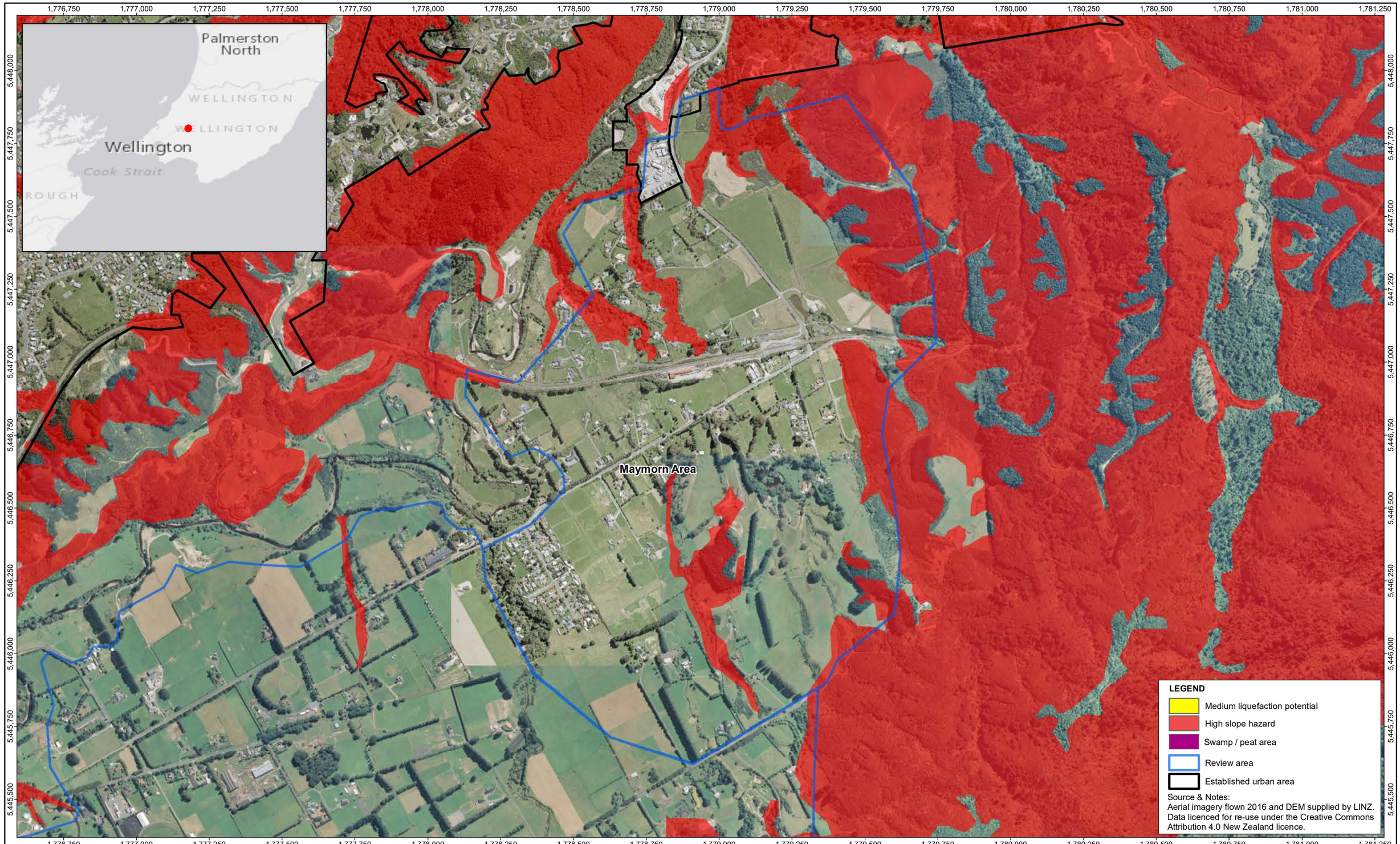
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - GILLESPIES ROAD AREA

project no: 773-WLGGE225406AB | figure no: G1 | rev: B

MXD ref: 225406_02_G_3



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	A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

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SCALE 1:12,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

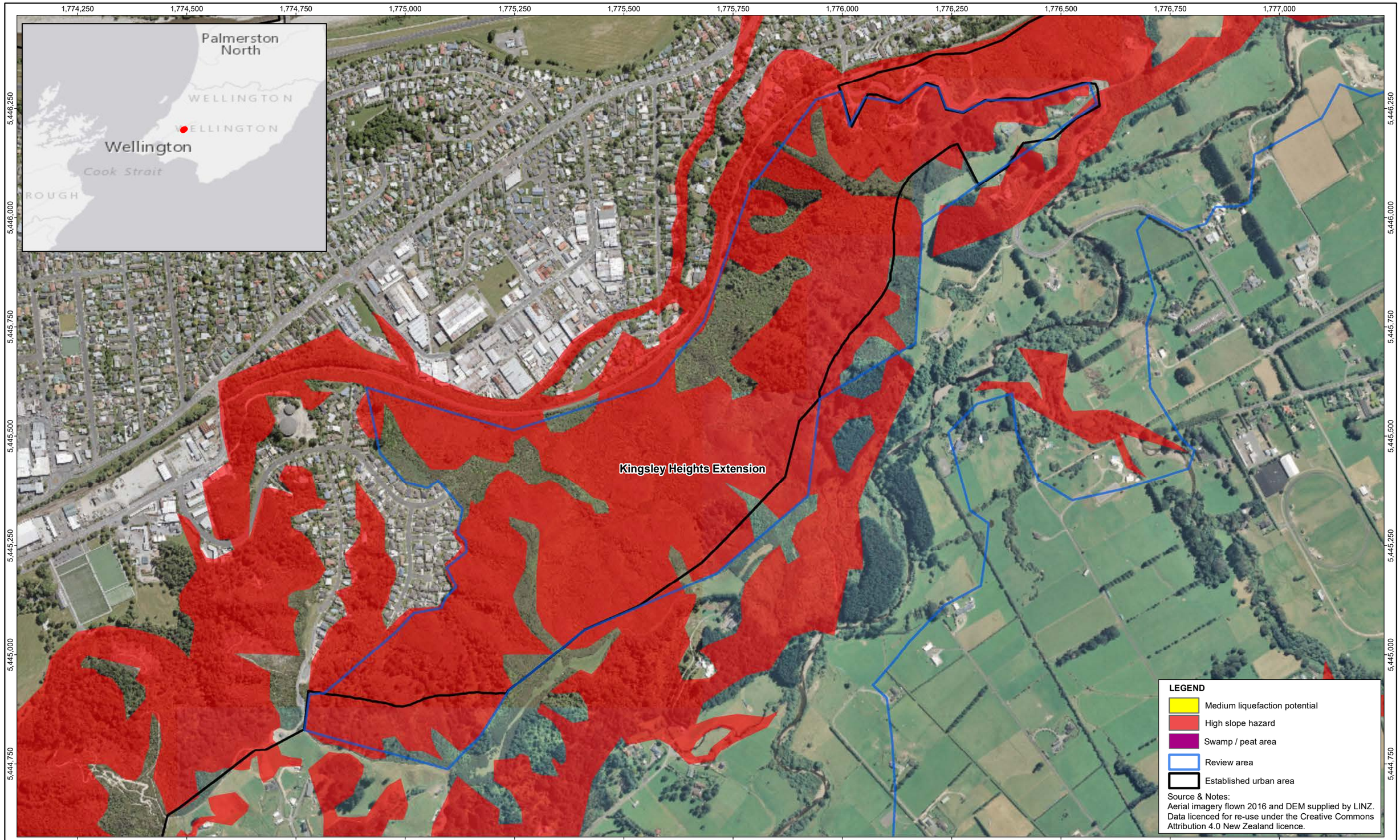
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - MAYMORN AREA

project no: 773-WLGGE225406AB | figure no: G2 | rev: B

MXD ref: 225406_02_G_3



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A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

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SCALE 1:8,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

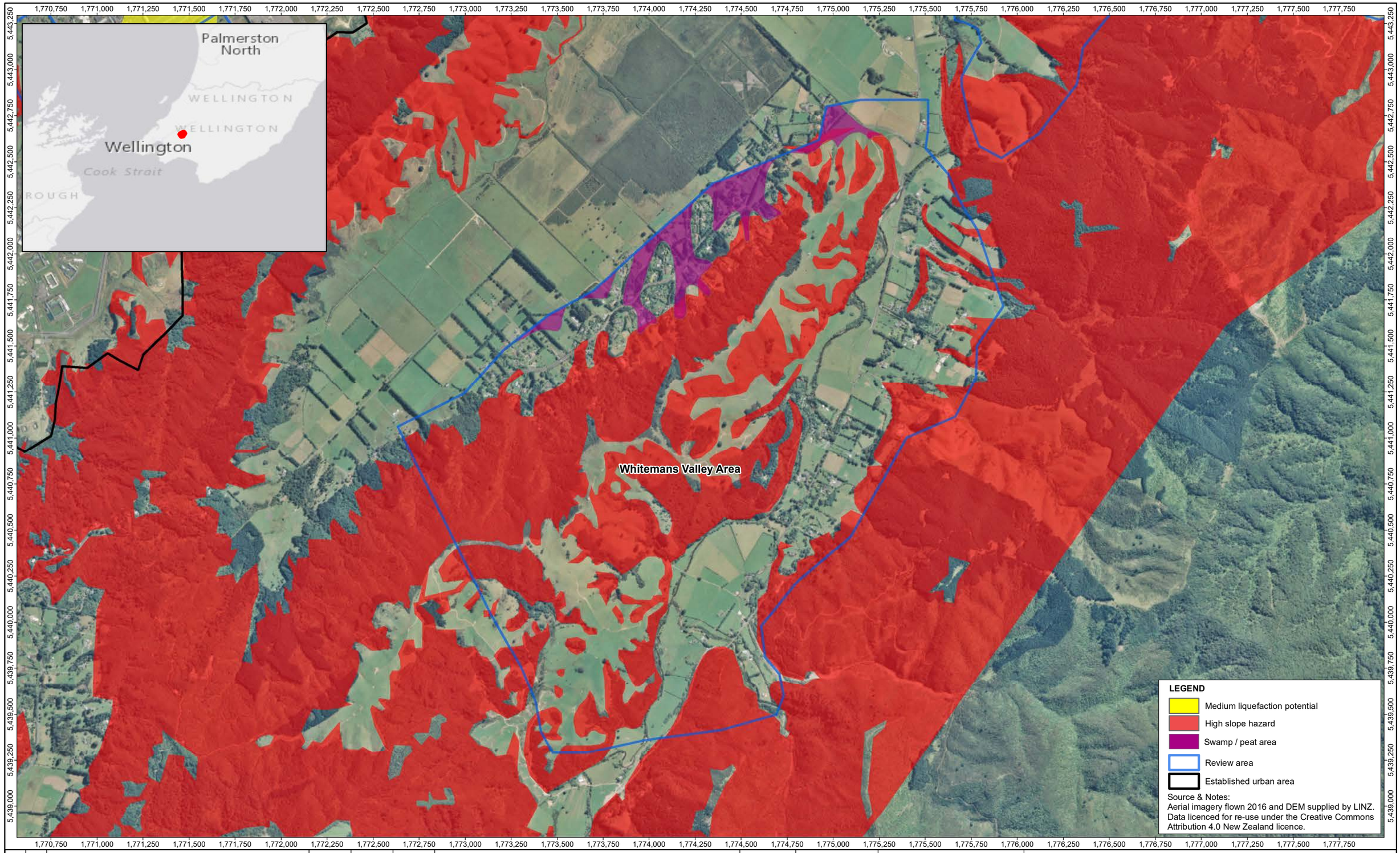
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - KINGSLEY HEIGHTS EXTENSION

project no: 773-WLGGE225406AB | figure no: G3 | rev: B

MXD ref: 225406_02_G_3



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A	ORIGINAL ISSUE	RZ	SM	11.09.19

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SCALE 1:19,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

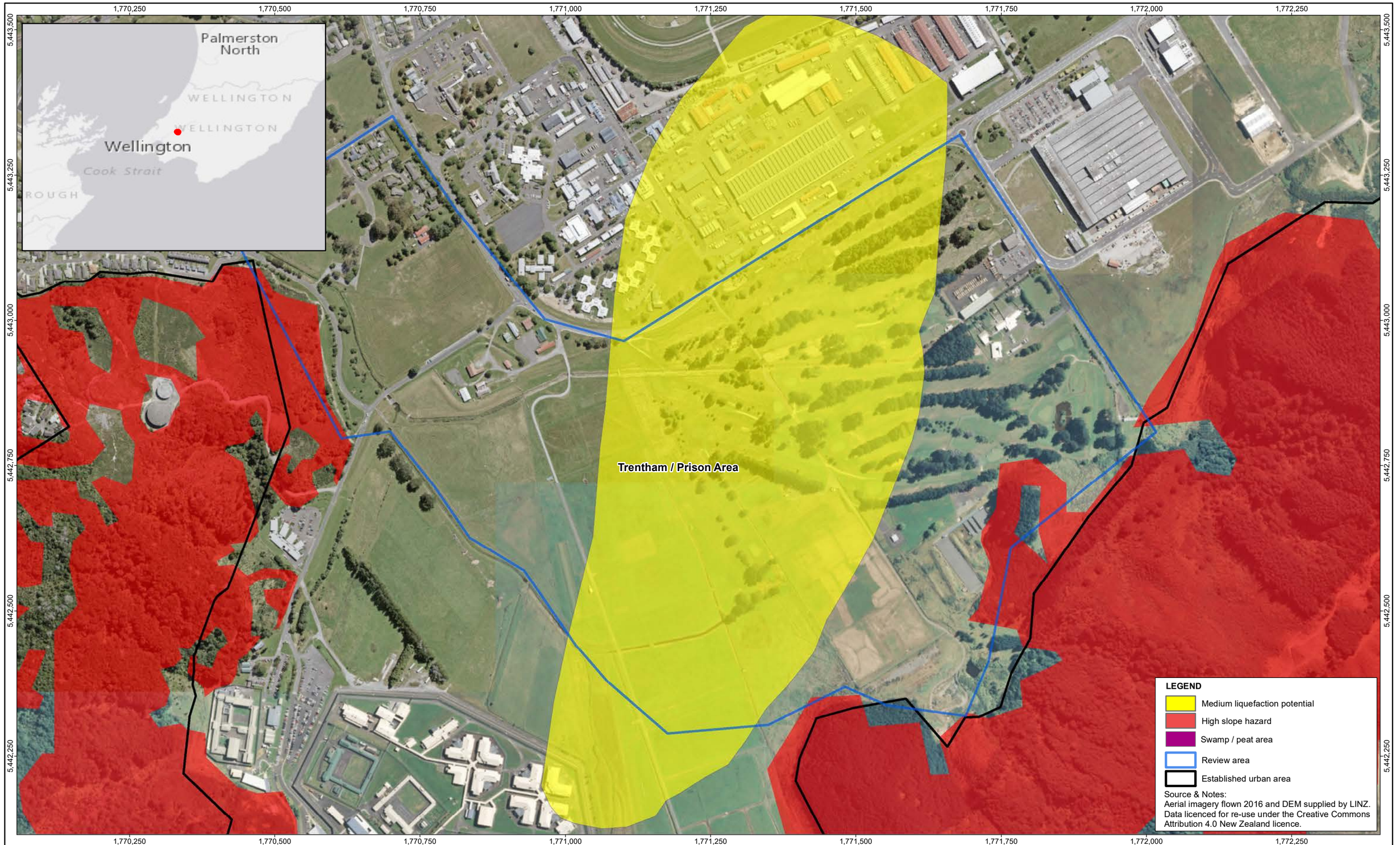
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - WHITEMANS VALLEY AREA

project no: 773-WLGGE225406AB | figure no: G4 | rev: B

MXD ref: 225406_02_G_3



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A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

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SCALE 1:6,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - TRENTHAM / PRISON AREA

project no: 773-WLGGE225406AB | figure no: G5 | rev: B

MXD ref: 225406_02_G_3

revision no.	description	drawn	approved	date
B	SLOPE HAZARD UPDATED	RZ	SM	06.03.20
A	ORIGINAL ISSUE	RZ	SM	11.09.19

N

SCALE 0 50 100 150 200 1:5,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - ST PATRICKS ESTATE

project no: 773-WLGGE225406AB | figure no: G6 | rev: B

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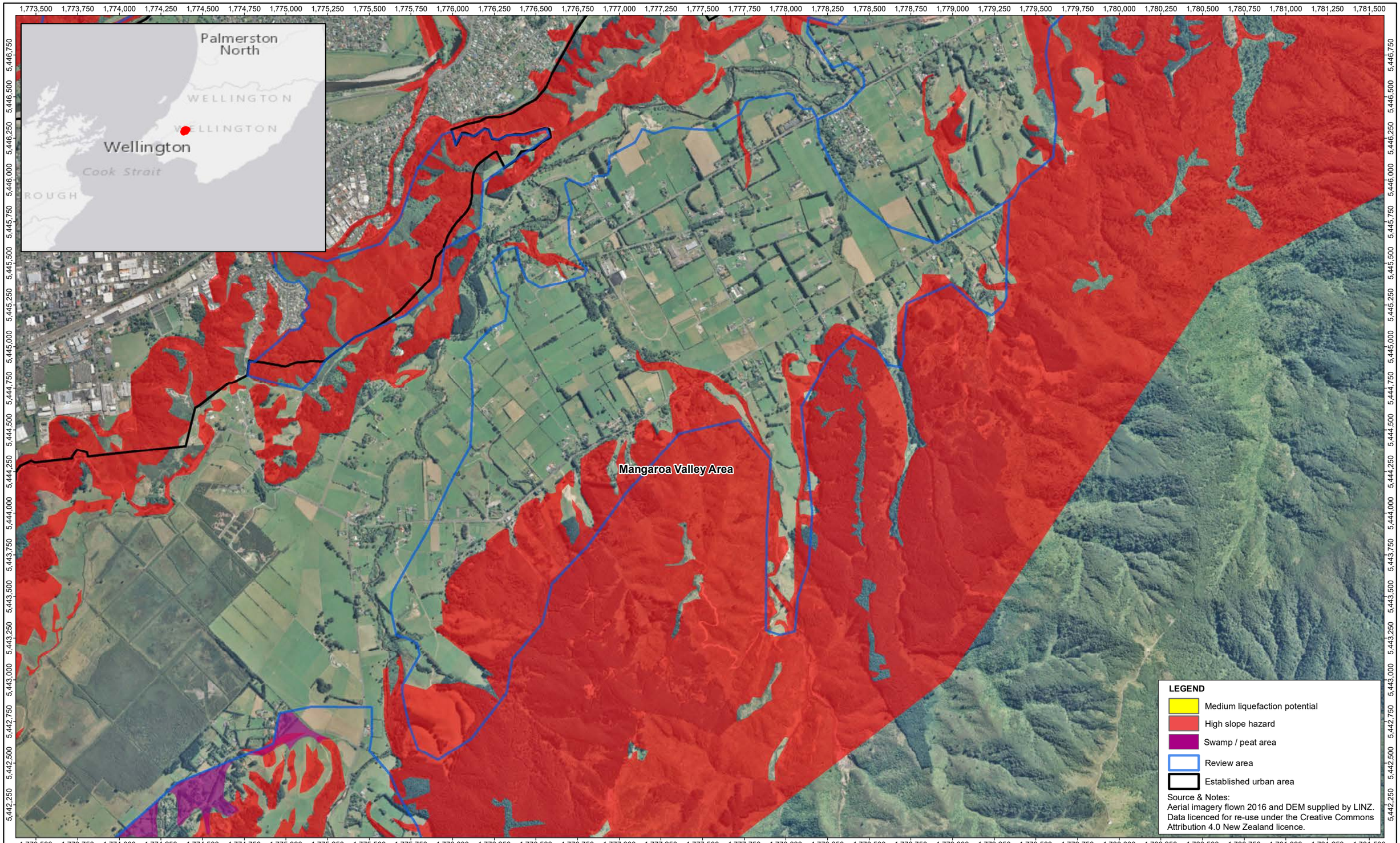

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Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

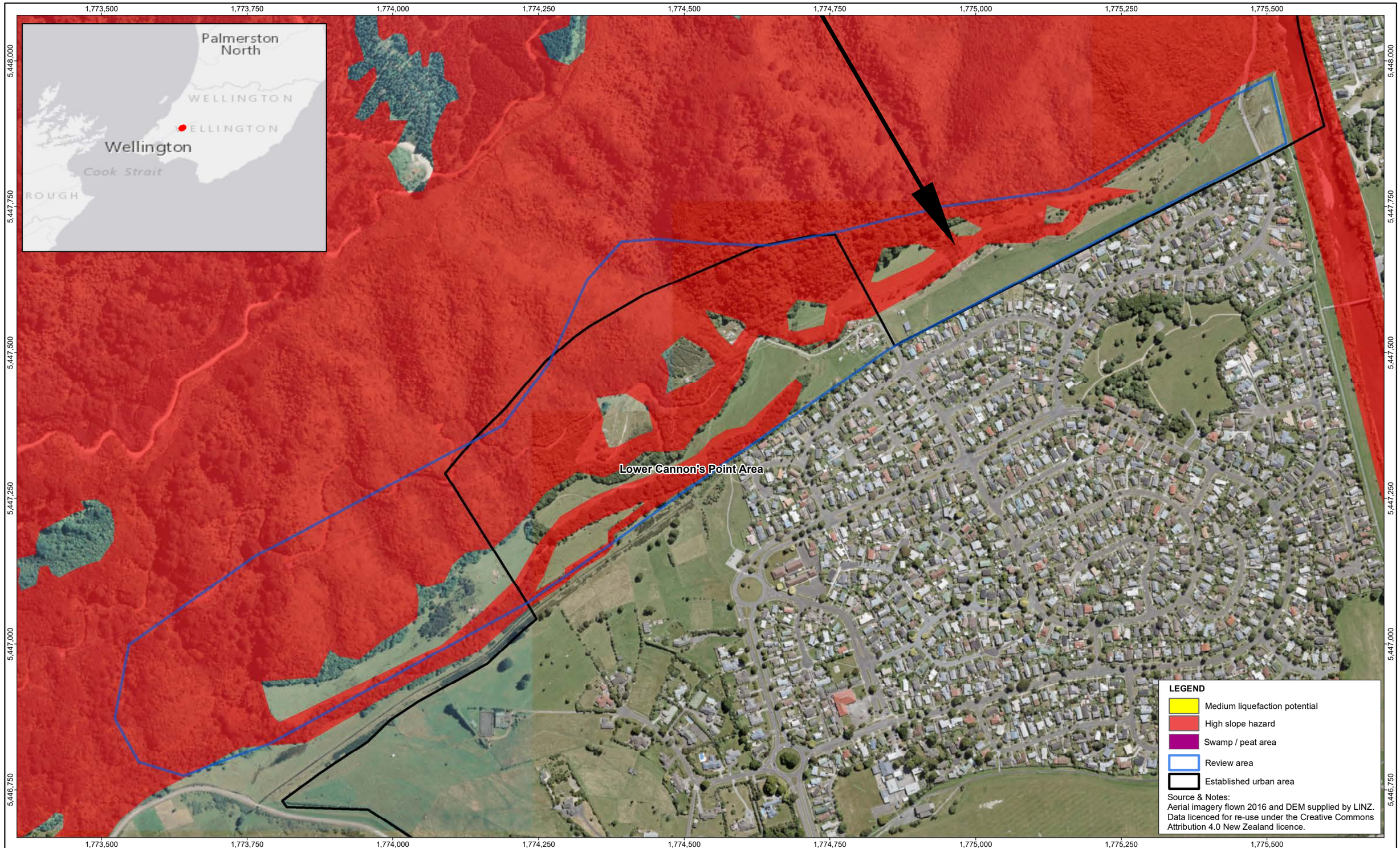
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - MANGAROA VALLEY AREA

project no: 773-WLGGE225406AB | figure no: G7 | rev: B

MXD ref: 225406_02_G_3



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A	ORIGINAL ISSUE	RZ	SM	11.09.19

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SCALE 1:6,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

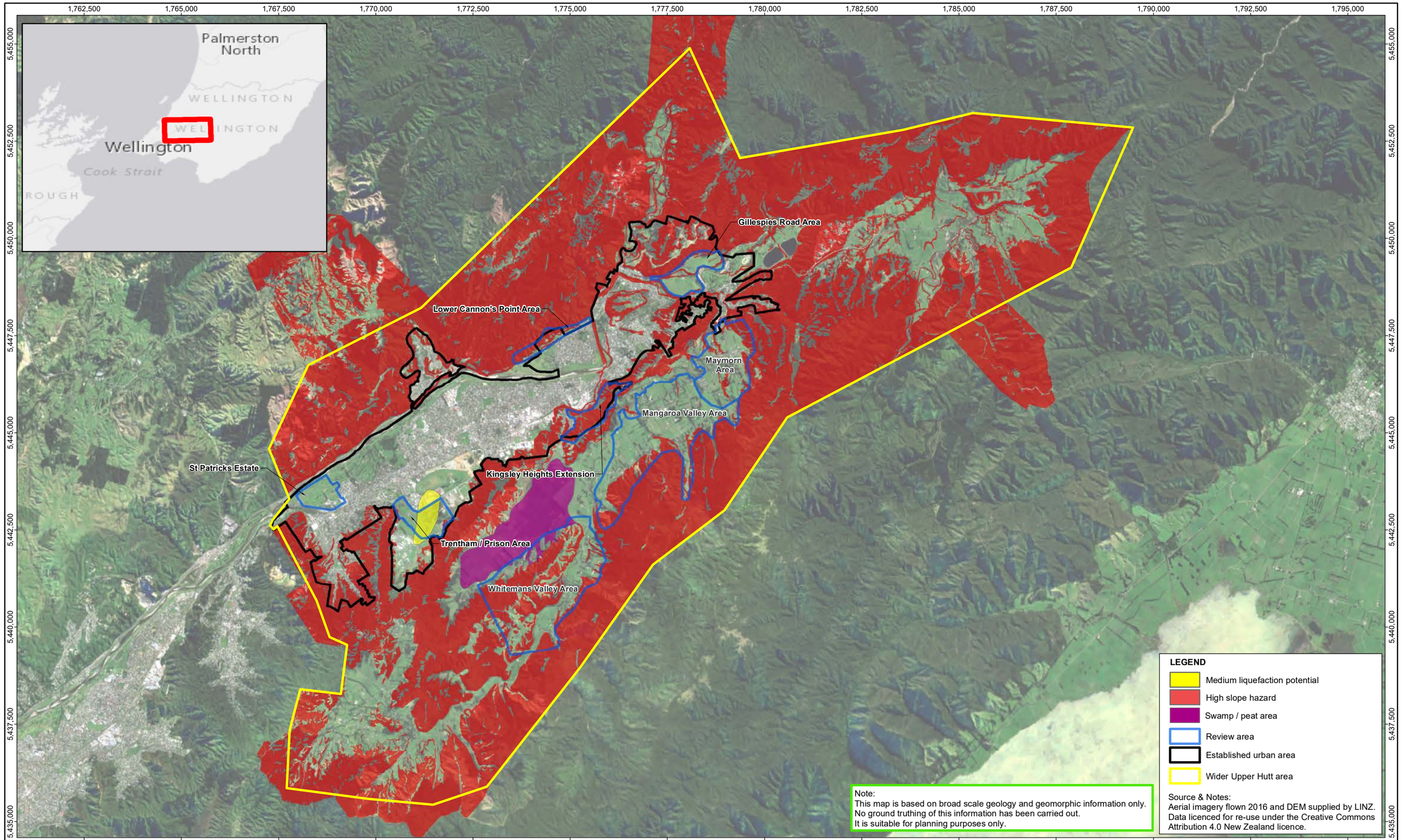
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP - LOWER CANNON'S POINT AREA

project no: 773-WLGGE225406AB | figure no: G8 | rev: B

MXD ref: 225406_02_G_3



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SCALE 1:90,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: GEOLOGICAL HAZARD OVERVIEW MAP

project no: 773-WLGGE225406 | figure no: G9 | rev: A

MXD ref: 225406_02_G9_3

Appendix H – Photofile

Photo 1: View across the Hutt River looking north onto Gillespies Road Area. Note the relatively flat grassed area with a series of terraces.

Photo 2: Looking south-east from Parkes Line Road across flat paddocks to the greywacke hills.

Photo 3: Photo of the sloping, gently undulating land on the south-western side of the Mangaroa area

Photo 4: Photo of Kingsley Heights Extension taken from Kingsley Heights showing the ridges and valleys of the slopes with high to very high slope angles and a flatter ridgeline on top.

Photo 5: Photo looking north-east along the Lower Cannon's Point area. Note the lower terrace in the foreground and the steep terrace riser on the left. The greywacke hills are in the background.

Photo 6: Photo of Whitemans Valley showing incised streams and gently undulating valley floor with bush-clad steep hills behind.

coffey
A TETRA TECH COMPANY

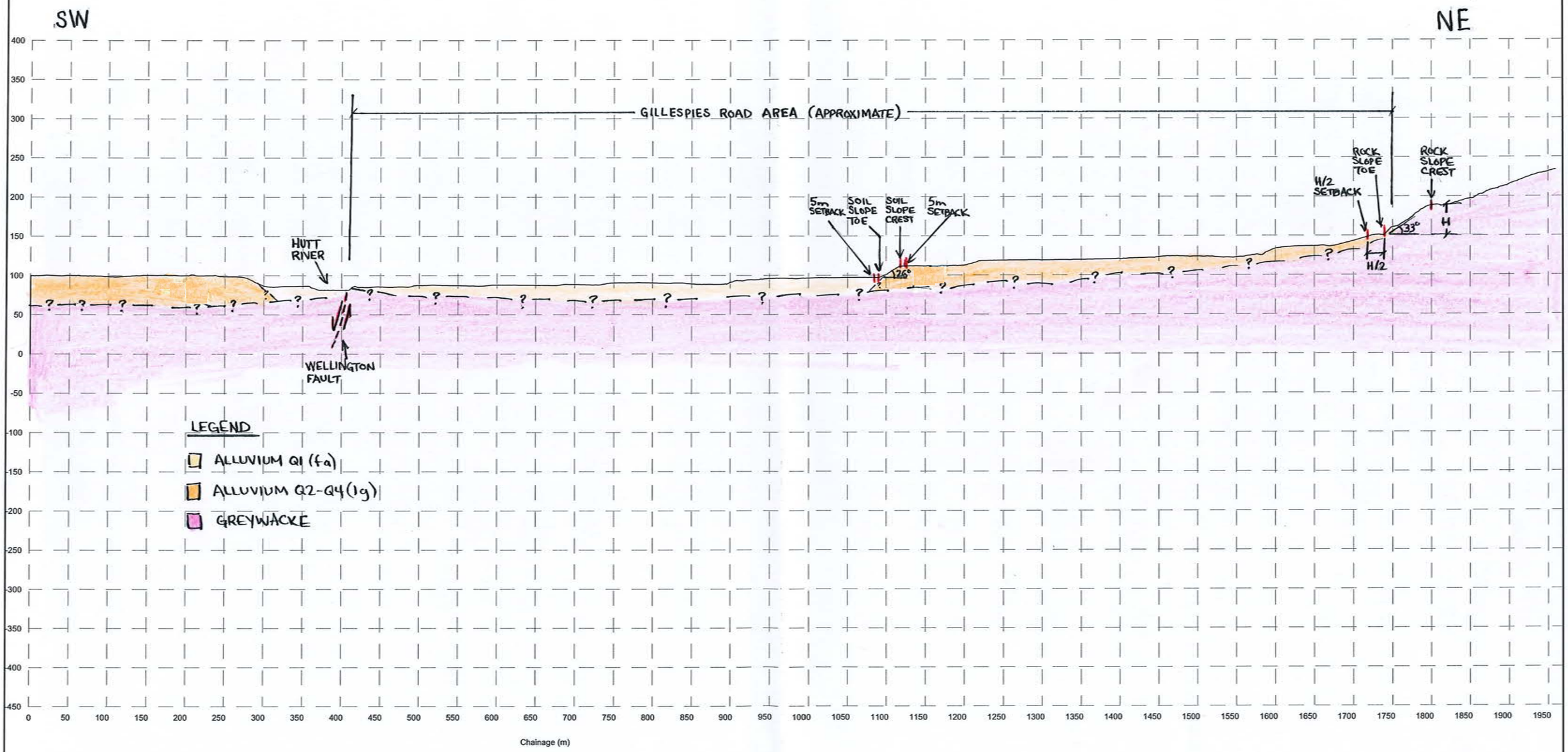
CLIENT:	PROJECT:	773-WLGGE225406	DESIGNED:	SM	FIGURE TITLE: Photofile 1
Upper Hutt City Council	DATE:	10/09/2019	DRAWN:	SM	PHOTOFILE NO: 1
PROJECT TITLE:	REVISION:	Rev 2	CHECKED:	NC	NOTES:
Upper Hutt City Council Residential & Rural Chapter Review	SCALE:	NTS	STATUS:	FINAL	

Photo 7: Photo looking south-east from Messines Avenue. Area is typically grassed and flat.

Photo 8: Looking across the St Pats Development Block. Area is typically flat, grassed with streams crossing it.

coffey A TETRA TECH COMPANY	CLIENT:	PROJECT:	773-WLGGE225406	DESIGNED:	SM	FIGURE TITLE:	Photofile 2
	Upper Hutt City Council	DATE:	10/09/2019	DRAWN:	SM	PHOTOFILE NO:	2
	PROJECT TITLE:	REVISION:	Rev 2	CHECKED:	NC	NOTES:	
	Upper Hutt City Council Residential & Rural Chapter Review	SCALE:	NTS	STATUS:	FINAL		

Appendix I – Cross Sections



Base drawing reference - Pattersons preliminary design dated March 2016

revision	rev	description	drawn	approved	date
	A	Final	CD	SM	5/9/2019

drawn	CD
approved	SM
date	5/9/2019
scale	as shown
original size	A3

coffey
A TETRA TECH COMPANY

client: Upper Hutt City Council

project: UHCC PC50 Residential and Rural Chapter Review

title: Cross Section - Gillespies Road Area

project no: 773-WLGGE225406 | figure no: I - 1 | rev: A

29/07/2019\\TTS808FS2.TT.LOCAL\S816\GENZ\9 773-WLGGE PROJECTS\225000 TO\773-WLGGE225406 - UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW\6 DRAWINGS\REQUIRED CROSS SECTIONS\SECTIONS TEMPLATE.DWG

SE

NW

LOWER CANNONS POINT AREA (APPROXIMATE)

H/2 SETBACK

SOIL SLOPE TOE

26° LINE FROM TOE

5m SETBACK

H/2 SETBACK

ROCK SLOPE TOE

ROCK SLOPE CREST

5m SETBACK

26°

H

H/2

45°

H

Elevation (m RL)

Chainage (m)

LEGEND

- ALLUVIUM Q1 (f_a)
- ALLUVIUM Q2-Q4 (f_g)
- WELLINGTON BELT GREYWACKE (t_w)

Base drawing reference - Pattersons preliminary design dated March 2016

revision	rev	description	drawn	approved	date
	A	Final	CD	SM	5/9/2019

drawn	CD
approved	SM
date	5/9/2019
scale	as shown
original size	A3

coffey
A TETRA TECH COMPANY

client: Upper Hutt City Council

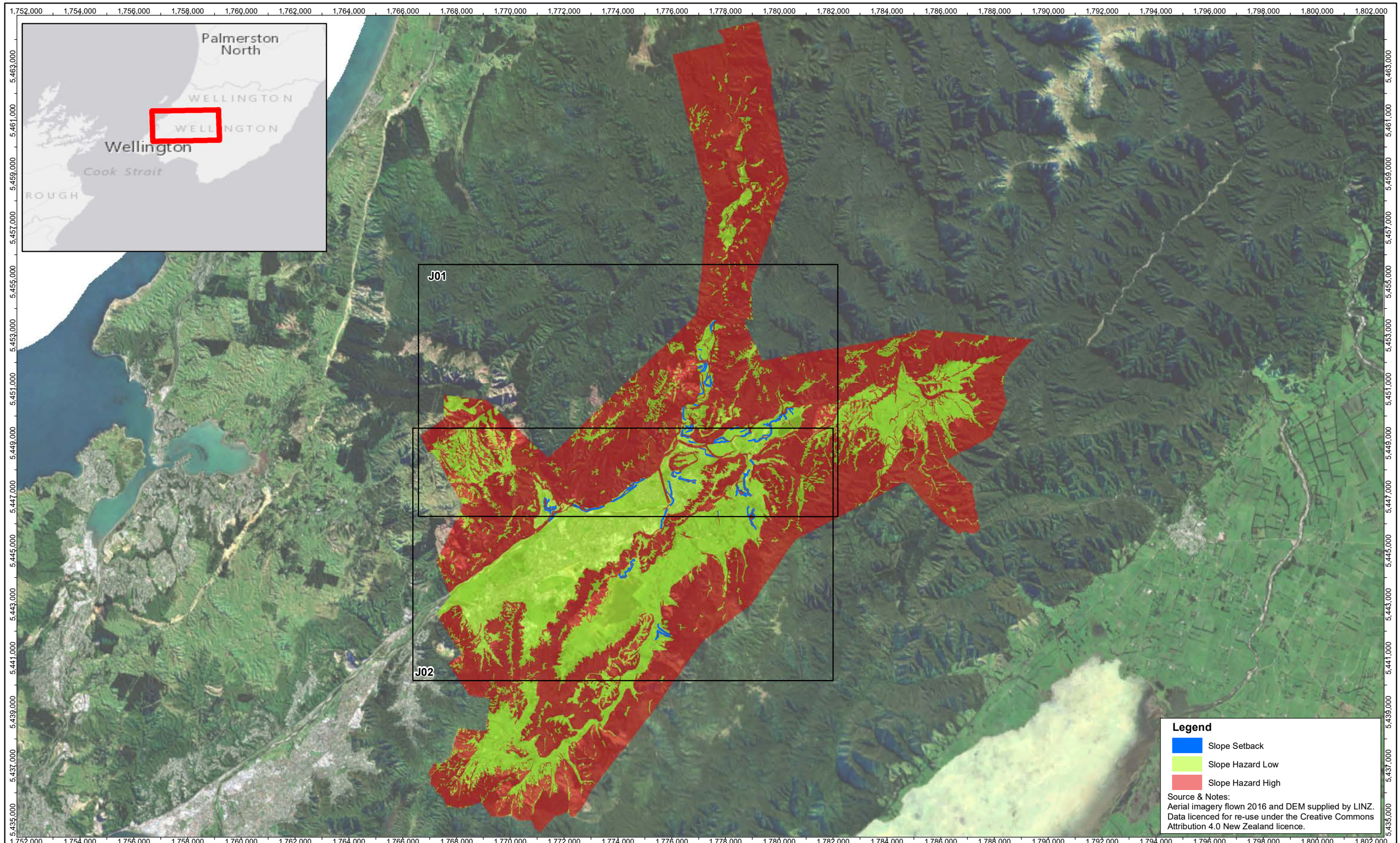
project: UHCC PC50 Residential and Rural Chapter Review

title: Cross Section - Lower Cannons Point Area

project no: 773-WLGGE225406 | figure no: I - 2 | rev: A

29/07/2019\\TTS808FS2.TT.LOCAL\S816\GENZ\9 773-WLGGE PROJECTS\225000 TO\773-WLGGE225406 - UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW\6 DRAWINGS\REQUIRED CROSS SECTIONS\SECTIONS TEMPLATE.DWG

Appendix J – Slope Setback Maps



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Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

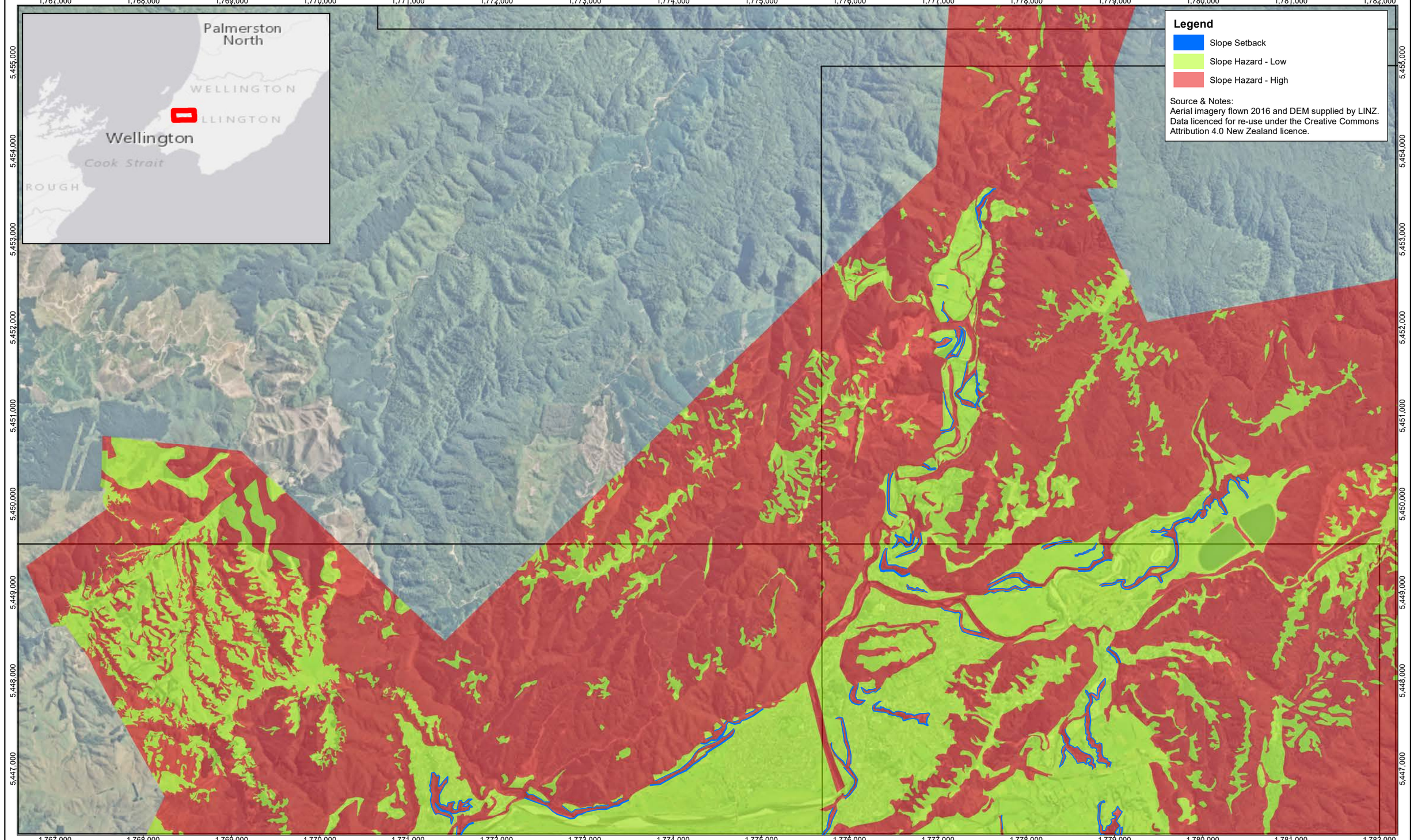
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE SETBACK MAP

project no: 773-WLGGE225406AB | figure no: J | rev: A

MXD ref: 225406AB_01_J_3



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Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	SM
date	06.03.2020
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

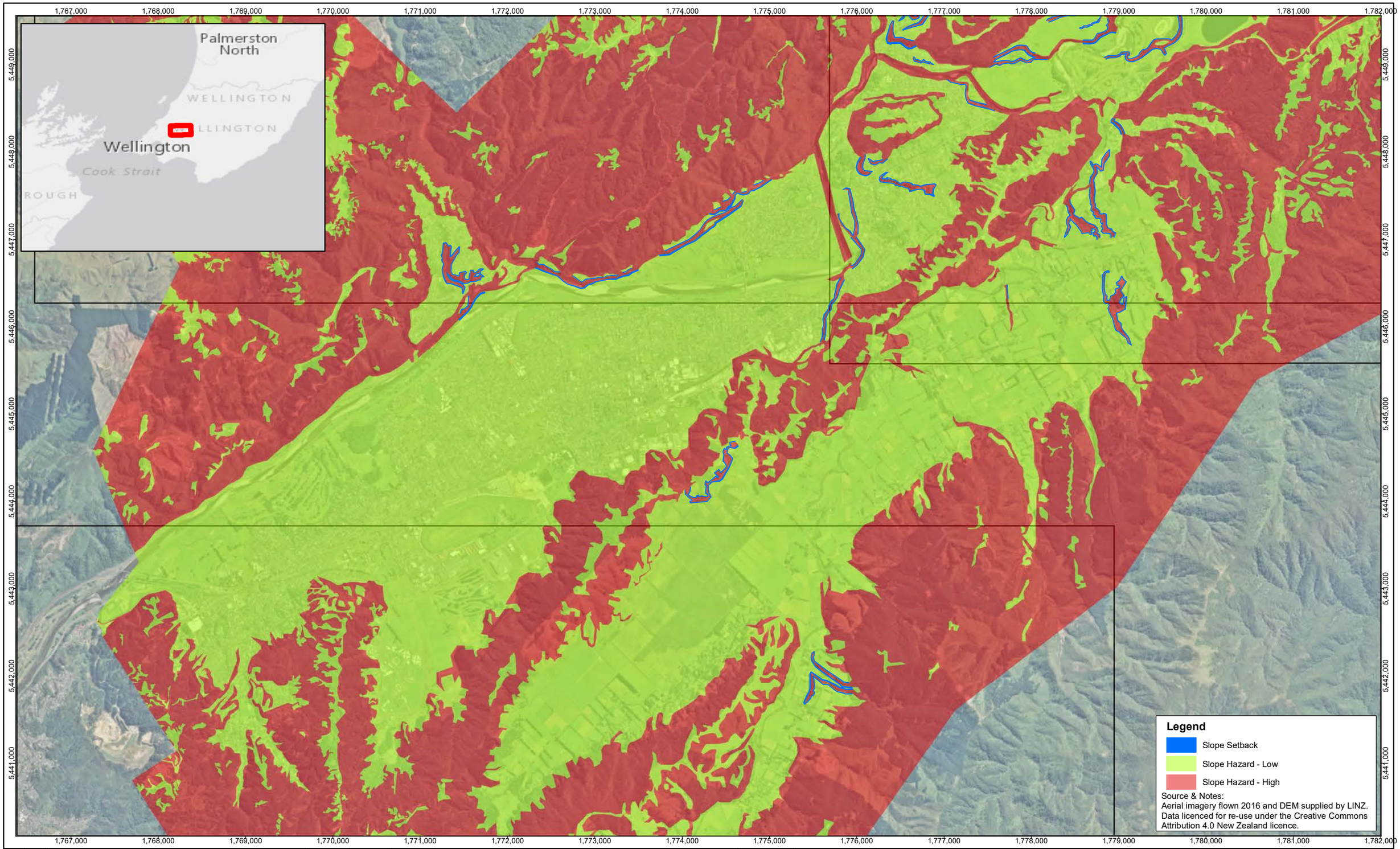
client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE SETBACK MAP

project no: 773-WLGGE225406AB | figure no: J01 | rev: A

MXD ref: 225406AB_01_J02_3



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Projection: NZGD 2000 New Zealand Transverse Mercator

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date	06.03.2020
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coffey
A TETRA TECH COMPANY

client: UPPER HUTT CITY COUNCIL

project: UHCC RESIDENTIAL AND RURAL CHAPTER REVIEW

title: SLOPE SETBACK MAP

project no: 773-WLGGE225406AB | figure no: J02 | rev: A

MXD ref: 225406AB_01_J002_3