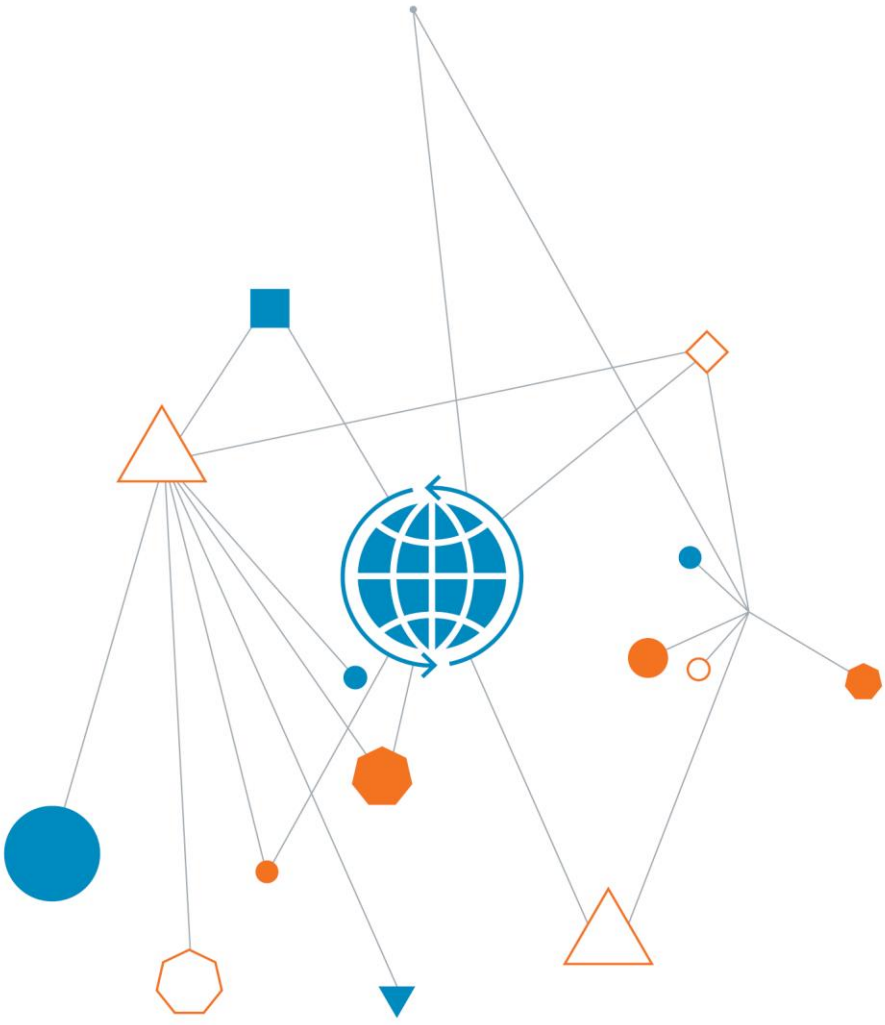
Matamata Piako District Council

Geotechnical Assessment for Zoning Plan Change

10 February 2016



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Geotechnical Assessment for Zoning Plan Change

Prepared for
Matamata Piako District Council

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1. Introduction

Coffey Geotechnics (NZ) Limited (Coffey) has been engaged by Matamata Piako District Council (MPDC) to carry out a geotechnical assessment of five sites within Matamata, Morrinsville and Te Aroha.

This scope of this report includes combining the findings of our desktop study and site observation to assess the adequacy of the sites for land-use changes. The report has been prepared in general accordance with the agreed Coffey Geotechnics services proposal[1] and is considered to be appropriate for use as one of the supporting documents for a Plan Change application.

2. Scope and Objectives

We understand that MPDC require a preliminary geotechnical assessment to support a plan change of the following five sites:

1. Tui Road, Te Aroha (Rezoning from Rural Residential to Residential)
2. Stirling Street, Te Aroha (Rezoning from Rural Residential to Residential)
3. Tower Road, Matamata (Rezoning from Rural to Residential)
4. State Highway 24 (Tauranga Road), Matamata (Rezoning from Rural to Industrial)
5. Horrell Road, Morrinsville (Rezoning from Rural to Rural Residential)

With this purpose, the scope of the work was to:

- undertake a desktop study to review available Council information on hazards and geotechnical data, Council plan maps and any other information available;
- undertake a site observation from the perimeter of the five sites;
- assess the potential geotechnical constraints to the development of the sites;
- prepare a plan change report in line with MPDC requirements.

[1] *"Geotechnical Services Proposal for District Plan Review"*, dated 10 December 2015, Reference: GENZTAUC16120AA-AA

3. Data and References

MPDC provided Coffey with the following council records for the assessment:

LIM Reports

- Land Information Memorandum for 47 Tui Road Te Aroha 3320, Reference: 05311/478.00-8469, dated 6 June 2012.
- Land Information Memorandum for 121 Horrell Road RD 4 Morrinsville 3374, Reference: 05305/313.02-26239, dated 11 April 2012.
- Land Information Memorandum for 107 Horrell Road RD 4 Morrinsville 3374, Reference: 05305/313.04-33674, dated 20 July 2012.
- Land Information Memorandum for 2997 State Highway 26, RD4, Morrinsville, Reference: 05305/305.00, dated 30 March 2001.
- Matamata-Piako District Council LIM Checklist, Document Number: 6376.

Landslip Hazard Surveys

- Land Stability and Flood Hazard Survey, R M Rankine Borough Engineer, dated 16 February 1988.
- Landslip Hazard Rating Survey, Te Aroha Borough Council, Mark T. Mitchell, dated 13 April 1981.
- Landslip Hazard Rating Survey, Te Aroha Borough Council, Mark T. Mitchell, dated December 1985.

Coffey also used the following information to perform geotechnical assessment of the five sites:

- Site observation by Scott Higginson, undertaken on 5 January 2016.
- Geology of the Auckland Area, Institute of Nuclear Sciences, 1:250,000 Geological Map, dated 2001.
- Geology of the Rotorua Area, Institute of Nuclear Sciences, 1:250,000 Geological Map, dated 2001.
- Structural Design Actions, Part 0: General Principals, Australian/New Zealand Standard AS/NZS 1170.0:2002.
- Matamata-Piako District Council Maps and Geographic Information System (GIS), https://www.mpdc.govt.nz/our-services/maps-and-gis
- Waikato Regional Maps and Data Catalogue, http://giswrcmaps.waikatoregion.govt.nz/wrcmaps/?variant=Groundwater
- Aerial images sourced from Google Earth.
- S-Map Online, http://smap.landcareresearch.co.nz/home
- New Zealand Active Faults Database, http://data.gns.cri.nz/af/

- Te Aroha Earthquake, 9 January 1972, R.D Adams, M.G Muir and R.J Keen.
- 1:50,000 Broadscale River flood hazard map, Te Aroha.
- 1:300,000 Broadscale River flood hazard map, Matamata-Piako District.
- 1:50,000 Broadscale River flood hazard map, Morrinsville.
- Te Aroha Topographical Map 1st Edition, 1943, The University of Waikato
- Matamata Topographical Map 4th Edition, 1971, The University of Waikato

4. Geotechnical Assessment

4.1. Site 1 – Tui Road, Te Aroha

4.1.1. Site Description

Figure 1: Site Location Plan[2]

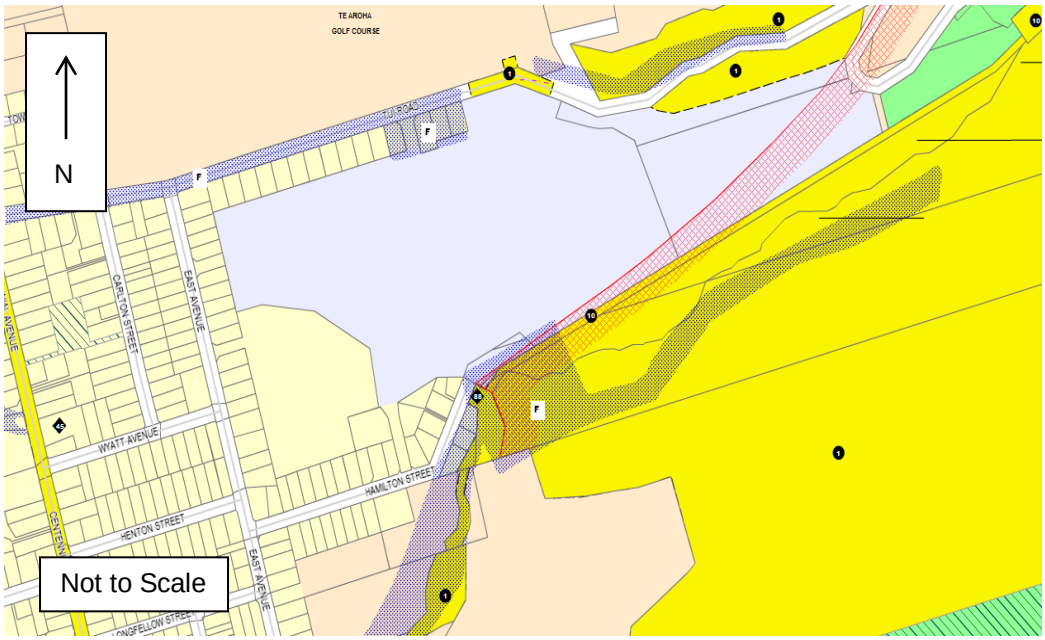
Site 1 is located between Tui Road, East Avenue and Hamilton Street in Te Aroha (refer to Figure 1). The MPDC online database[3] (GIS) indicates that the site has the legal description 'Lot 1, DPS 62595' and covers an area of approximately 16.2ha.

The site is largely occupied by open paddocks and contains moderate to steep slopes. The landform steepens significantly to the east of the site, towards the Kaimai Ranges. A mountain stream, the Tunakohoia Stream, is located near the southern boundary of the site and flows westwards into the Waihou River.

The site is currently designated on the GIS as 'Rural Residential' (refer to Figure 2), and is generally surrounded by 'Residential' land to the north, west and south. Sections of the site have also been designated as a 'Flood Hazard', and a 'Fire Hazard Buffer' extends along the southern edge of the site. To the east of the site, the land has been designated as 'Water and Soil Conservation', and 'Water Supply Catchment and Pipeline'. An historic building, the Te Aroha Power House, is situated at the end of Hamilton Street at the southern edge of the site.

[2] Aerial image sourced from Google Earth, retrieved 18 January, 2016
[3] http://maps.mpdc.govt.nz/gisp2/framesetup.asp

Figure 2: Council Zoning Map[4]



4.1.2. Site History

Historical aerial photographs of the site are not readily available. The LIM report[5] for 47 Tui Road indicates that an application for building permit was lodged to the Te Aroha Borough Council as early as 1950. Historical topographical maps[6] of Te Aroha indicate that there has been development next to the site (along Hamilton Street and East Avenue) since at least 1943. The conditions shown in the Landslip Hazard Rating Survey[7], prepared in 1985, appear to be similar to the current site conditions.

Google Earth aerial photographs show that the site and surrounding area has remained virtually unchanged since at least 2007.

4.1.3. Geology

The local geology map[8] describes the site as being underlain by alluvial and colluvial deposits, consisting of pumice sands, silts and gravels. The raised land to the east is likely comprised of the Waiwawa Subgroup, consisting of Andesite, dacite and rhydacite flows, and domes with intercalated tuff, tuff breccia and volcaniclastic sediments, which is part of the Coromandel Group Formation.

Available soil maps[9] classify the soil as Typic Orthic Allophanic from an Alluvium parent material, and the depth to hard soil is classified as deep. The maps indicate that the soil has a moderate to high

[4] http://maps.mpdc.govt.nz/gisp2/framesetup.asp
[5] "*Land Information Memorandum for 47 Tui Road, Te Aroha 3320"* Reference 05311/478.00-8469, dated 6 June 2012.
[6] Te Aroha Topographical Map 1st Edition, 1943, The University of Waikato
[7] *"Landslip Hazard Rating Survey", Mark T. Mitchell, dated December 1985*
[8] "*Geology of the Auckland Area*", Institute of Geological and Nuclear Sciences, 1:250000 geological map
[9] http://smap.landcareresearch.co.nz/home

moisture content and rapid permeability. These soils generally coincide with the materials encountered from previous works undertaken by Coffey in the area.

The most recent significant earthquake in Te Aroha was a 5.1 magnitude earthquake occurring on 9 January 1972. The earthquake damaged some homes, but most of the damage was confined to chimneys and the contents of buildings[10].

The nearest active fault listed on the New Zealand active faults database[11] is the Kerepehi Fault, situated approximately 7km to the west of the site and running north-south. The fault has a recurrence level of 2,000 to 3,500 years, with a low slip rate (0.2 to 1.0 mm per year) and was active within the last millennium. In addition, the local geology map shows the Mangakino Fault located approximately 4km to the east of the site, running north-south, and the Hauraki Fault located approximately 400m west of the site, running north-south through the centre of Te Aroha. The Hauraki Fault is a concealed fault and is often shown in different locations on different geological maps, including running through the site on the Te Aroha Borough Council Land Hazard Survey[12] (refer to Figure 3). We recommend that a geological assessment is undertaken prior to development to verify whether this fault extends through the site.

4.1.4. Liquefaction

A summary of how this report defines liquefaction is included in Appendix B.

An on-site geotechnical investigation would need to be undertaken before a detailed liquefaction assessment could be performed. The Importance Level of buildings and Site Class would also impact the liquefaction assessment. Based on the available geology information given in Section 4.1.3 however, it is likely that the site is underlain by relatively loose alluvial sands with a high moisture content, and a water table potentially near the ground surface in some areas.

Based on these assumed subsurface properties, it is considered that the site is potentially susceptible to liquefaction. As such, we recommend that an on-site geotechnical investigation and a more detailed liquefaction assessment are undertaken prior to development.

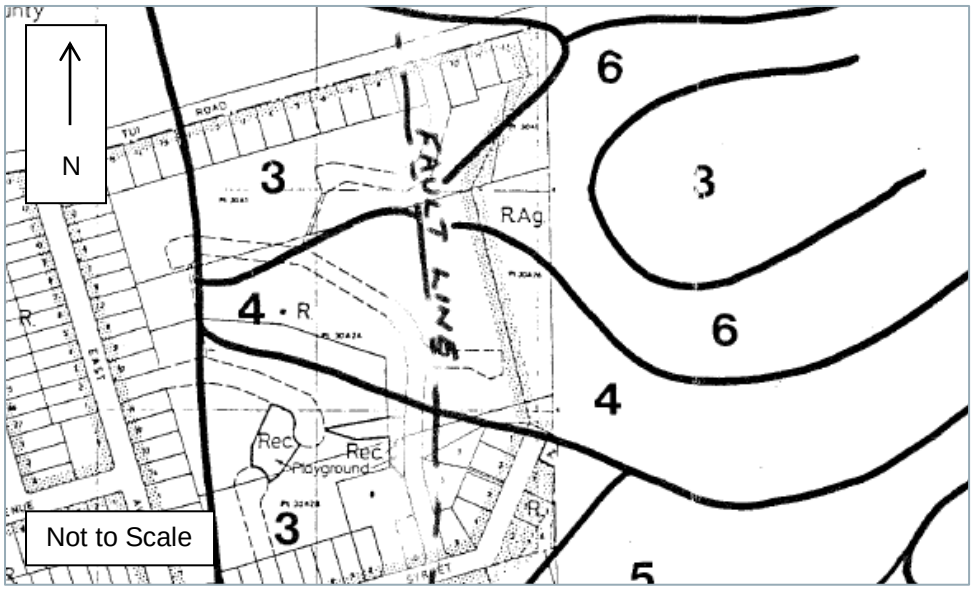
4.1.5. Flooding Hazard

A land hazard and flood hazard survey was undertaken for the Te Aroha Borough Council (the predecessor of the MPDC) to assess the flood hazards within Te Aroha. The hazard zones are defined in Appendix B.

The survey indicates that the lower, western section of the site generally lies within hazard zone 3, with a section running east-west through the site defined as hazard zone 4. The raised eastern section of the site generally lies within hazard zone 3, with a curve-shaped section beneath identified as hazard zone 6 (refer to Figure 3).

[10] *"Te Aroha Earthquake, 9 January 1972*" R.D Adams, M.G Muir and R.J Kean
[11] http://data.gns.cri.nz/af/
[12] "*Land Stability and Flood Hazard Survey",* R M Rankine Borough Engineer, dated 16 February 1988

Figure 3: Flood Hazard Survey Map



These ratings indicate that the western section of the site is generally at a slight risk of inundation from floodwaters (zone 3), but also contains land within the general floodplain of a tributary stream coming off the hillslope to the east (zone 4). Under peak flooding within these zones, the streams are expected to be contained within their existing stream bed locations. However, if a landslide was to occur from the hills to the east of the site and temporarily dam the stream, widespread flood damage could be expected within this section of the site when the temporary dam is breached. Debris flow is known to have impacted Te Aroha during the flood of 1985, although it is unknown if the site was impacted.

The site is generally not designated as a flood hazard on the council GIS (refer to Figure 2), excluding some minor areas at the northern and southern fringes of the site. Additionally, the site is not shown to be within the River flood hazard zone on the Waikato Regional Council Flood Hazard map[13]

As such, we consider that the site is generally at a low risk of flooding. However, more detailed flood analyses should be undertaken prior to development, including assessing the effects of landslip debris potentially damming existing streams.

[13] 1:50,000 Broadscale River flood hazard map, Te Aroha

4.1.6. Slope Stability

Evidence of past land instability was observed during the site visit, as well as on topographical maps. This includes boulders scattered across the site (refer to Appendix A), and a relatively steep, curved feature towards the east of the site. Aerial and topographical images also show similar features across the western foothills of the Kaimai Ranges, nearby to the site.

As mentioned in Section 4.1.5 above, the Land Stability and Flood Hazard survey[14] indicates that the lower portion of the slope is designated as hazard zones 3 and 4, and the upper portion as hazard zones 3 and 6. Zone 6 is defined in the survey as land within the foothills area which could be susceptible to near-surface sliding, and is generally in excess of 20º. Zones 3 and 4 are defined as gently sloping ground. Other localised areas at the site show possible saturated areas that may have localised slips and soil creep.

Given the presence of relatively steep slopes on and near the site, we recommend that a detailed slope stability and debris flow analysis be undertaken prior to the development of the site. This would include an assessment of landslide debris potentially inundating the western section of the site.

4.1.7. Site Observation

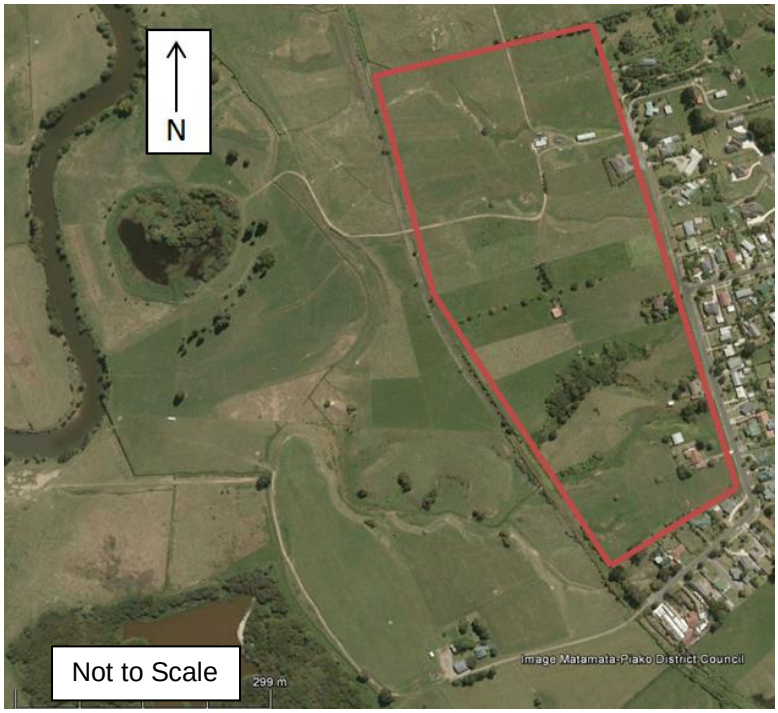
Coffey observed the site and adjacent areas on 5 January 2016 from public vantage points. Photographs taken of the site are included in Appendix A. The observations made on site were generally in accord with the observations obtained during the desktop study.

[14] "*Land Stability and Flood Hazard Survey",* R M Rankine Borough Engineer, dated 16 February 1988

4.2. Site 2 – Stirling Street, Te Aroha

4.2.1. Site Description

Figure 4: Site Location Plan[15]



Site 2 is located to the west of Stirling Street and east of the Hauraki Rail Trail in Te Aroha (refer to Figure 4). The GIS indicates that the site covers an area of approximately 20ha and contains the following six properties:

- Legal Description Lot 1 DP 384910, approximately 12.4ha site.
- Legal Description Lot 2 DP 384910, approximately 0.1ha site.
- Legal Description Lot 2 DP 60531, approximately 2.0ha site.
- Legal Description Lot 3 DP 60531, approximately 2.0ha site.
- Legal Description Lot 4 DP 9294, approximately 1.9ha site.
- Legal Description Lot 5 DP 9294, approximately 1.7ha site.

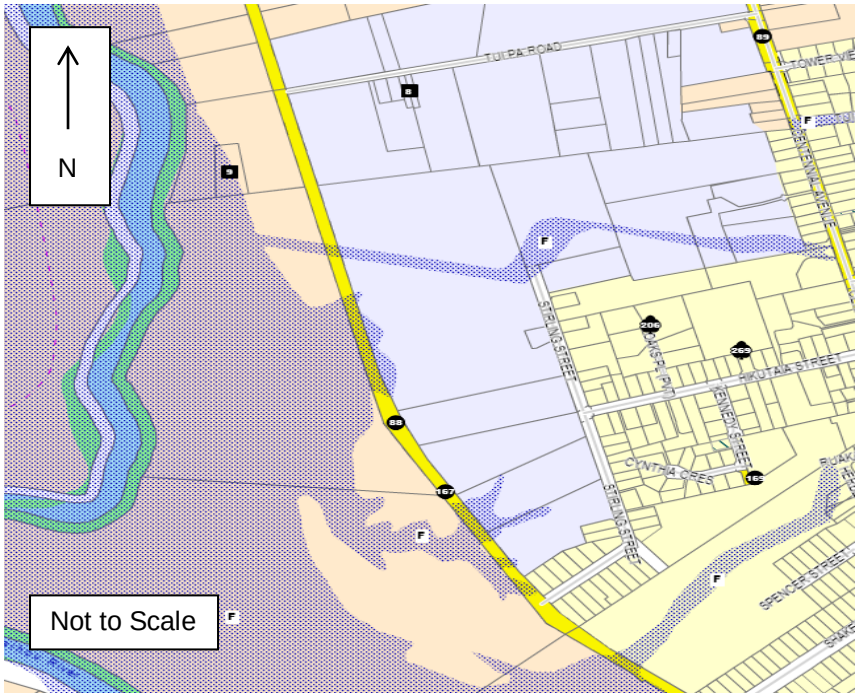
The site is generally occupied by residential properties with open paddocks, and contains topography which slopes gently to the west. Several streams flow westward across the site and into the Waihou River, forming valleys with relatively steep slopes.

[15] Aerial image sourced from Google Earth, retrieved 18 January, 2016

The site is currently designated on the GIS as 'Rural Residential' (refer to Figure 5), and is generally surrounded by 'Residential' land to the north, east and south, and 'Rural to the west. The site is bordered on the west side by the Hauraki rail line. A Maori reservation is situated near the northern edge of the site, as well as a cemetery reserve.

Sections of the site have also been designated as a 'Flood Hazard' on the GIS, which appears to be associated with the floodplain of the Waihou River and local streams.

Figure 5: Council Zoning Map[16]



4.2.2. Site History

Historic aerial photographs of the site are not readily available. Historical topographical maps[17] of Te Aroha indicate that there has been development along Stirling Street since at least 1943. Google Earth aerial photographs show that the site and surrounding area has remained virtually unchanged since at least 2007.

4.2.3. Geology

The local geology map[18] describes the site as being underlain by alluvial and colluvial deposits, consisting of pumice sands, silts and gravels. This subsoil material is typically found in the Hauraki Plains.

Available soil maps classify the soil as Typic Orthic Allophanic from an Alluvium parent material, and the depth to hard soil is classified as deep. The maps indicate that the soil has a moderate to high

[16] http://maps.mpdc.govt.nz/gisp2/framesetup.asp
[17] Te Aroha Topographical Map 1st Edition, 1943, The University of Waikato
[18] "*Geology of the Auckland Area*", Institute of Geological and Nuclear Sciences, 1:250000 geological map

moisture content and moderate to rapid permeability. These soils generally coincide with the materials encountered from previous worked undertaken by Coffey in the area.

The most recent significant earthquake in Te Aroha was a 5.1 magnitude earthquake occurring on 9 January 1972. The earthquake damaged some homes, but most of the damage was confined to chimneys and the contents of buildings[19].

The nearest active fault listed on the New Zealand active faults database is the Kerepehi Fault, situated approximately 6km to the west of the site and running north-south. The fault has a recurrence level of 2,000 to 3,500 years, with a low slip rate (0.2 to 1.0 mm per year) and was active within the last 1,000 years. In addition, the local geology map[5] shows Mangakino Fault located approximately 4.5km to the east of the site running north-south, and the Hauraki Fault located approximately 200m west of the site, running north-south through the centre of Te Aroha. The Hauraki Fault is a concealed fault and is often shown in different locations on different geological maps.

4.2.4. Liquefaction

A summary of how this report defines liquefaction is included in Appendix B.

An on-site geotechnical investigation would need to be undertaken before a detailed liquefaction assessment could be performed. The Importance Level of buildings and Site Class would also impact the liquefaction assessment. Based on the available geology information given in Section 4.2.3 however, it is likely that the site is underlain by relatively loose alluvial sands with a high moisture content, and a water table near the ground surface.

Based on these assumed subsurface properties, it is considered that the site is potentially susceptible to liquefaction. As such, we recommend that an on-site geotechnical investigation and a more detailed liquefaction assessment are undertaken prior to development.

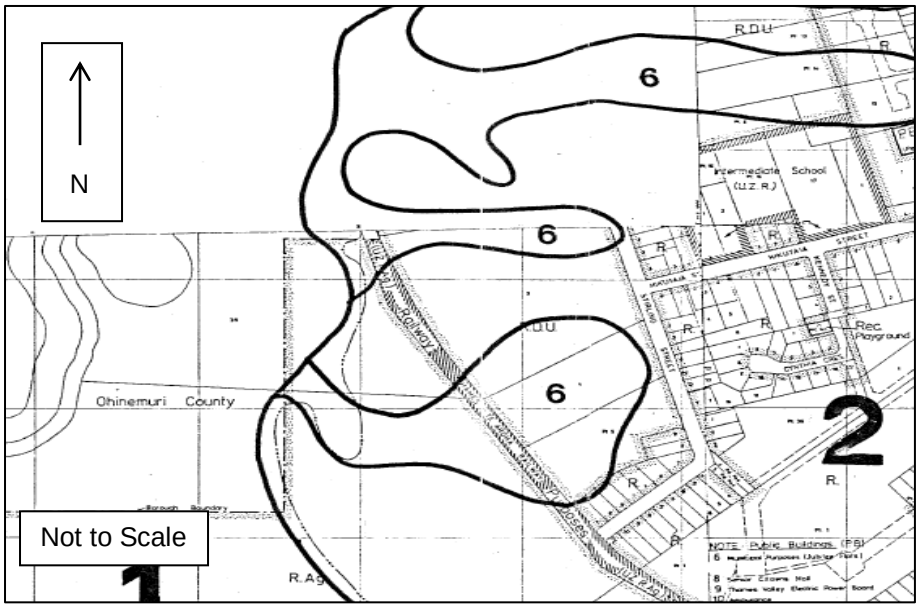
4.2.5. Flooding Hazard

A land hazard and flood hazard survey was undertaken for the Te Aroha Borough Council (the predecessor of the MPDC) to assess the flood hazards within Te Aroha.

The survey indicates that the site generally lies within hazard zone 2, with sections of the western side of the site defined as hazard zone 6 (refer to Figure 6). The area to the west of the site, near the Waihou River, is defined as hazard zone 1.

[19] *"Te Aroha Earthquake, 9 January 1972*" R.D Adams, M.G Muir and R.J Kean

Figure 6: Flood Hazard Survey Map



These ratings indicate that the site is gently sloping and generally above the level of likely flooding (zone 2). However, there are areas of the site situated within the flood plains of tributary streams flowing from the mountains to the east (zone 6). Within these areas, there could be the potential for structural damage to buildings where a high rainfall intensity results in the overtopping of the streams. In the event where slope instability results in the temporary containment of the stream, the widespread flood damage could be expected across the site when the temporary dam is breached. The land immediately west of the site (zone 1) is essentially flat land of the Hauraki Plains and is within the floodplain of the Waihou River.

The site has some flood hazard areas on the council GIS (refer to Figure 5) towards the western edge of the site, and a stream flowing east-west through the northern section of the site. The Waikato Regional Council Flood Hazard map[20] also indicates that western edge of the site is designated as a flood hazard. As such, we recommend that specific flood considerations should be made for future development consents.

4.2.6. Slope Stability

The site was observed to be generally gently sloping, with some isolated steeper sections present along the side slopes of the streams flowing across the site.

As mentioned in Section 4.2.5 above, the Land Stability and Flood Hazard survey generally denotes the site as hazard zones 2, indicating that the land is gently sloping. Towards the west of the site the topography is designated as hazard zone 6, indicating that the land is subject to near-surface sliding, and that development should only proceed if it can be demonstrated that the land is stable.

We recommend that a detailed slope stability analysis be undertaken prior to the development of the site, particularly near the stream valleys and gullies.

[20] 1:50,000 Broadscale River flood hazard map, Te Aroha

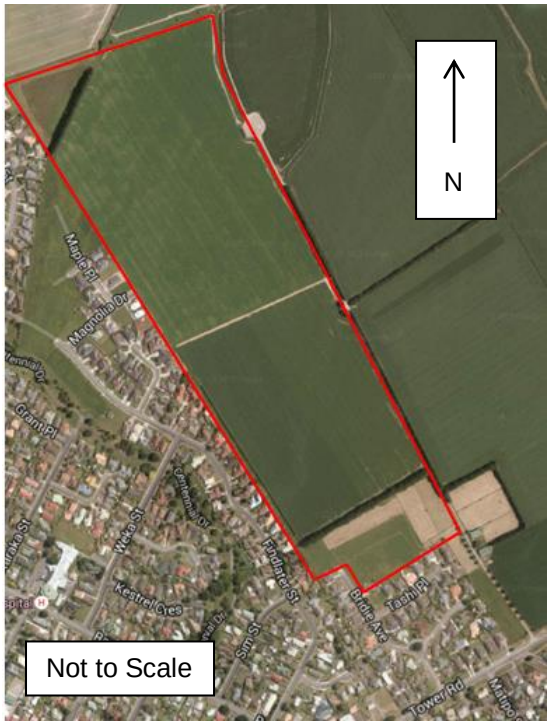
4.2.7. Site Observation

Coffey observed the site and adjacent areas on 5 January 2016 from public vantage points. Photographs taken of the site are included in Appendix A. The observations made on site were generally in accord with the observations obtained during the desktop study.

4.3. Site 3 – Tower Road, Matamata

4.3.1. Site Description

Figure 7: Site Location Plan[21]



Site 3 is located to the north of Bridie Avenue and the west of Magnolia Drive in Matamata (refer to Figure 7). The GIS indicates that the site covers an area of approximately 77ha and contains the following two properties:

- Legal Description Lot 56 DP 316350, approximately 76.0ha site.
- Legal Description Lot 1 DPS 35822, approximately 1.5ha site.

The site is generally flat and dominated by open paddocks. Reviews of the aerial photos indicate that possible historic drains running in a north-south direction, particularly on the eastern portion of the site.

The site is currently designated on the GIS as Rural (refer to Figure 8), and is generally surrounded by 'Residential' land to the west and south, and 'Rural' to the north and east. A stormwater retention pond is located in the north-western section of the site, and a small section of the site next to it has been designated as a 'proposed stormwater retention pond'. The site is also bound to the east by land designated as a proposed bypass between Tauranga Road and State Highway 27.

[21] Aerial image sourced from Google Earth, retrieved 18 January, 2016

Figure 8: Council Zoning Map[22]

4.3.2. Site History

Historical aerial photographs of the site are not readily available. Historical topographical maps[23] of Matamata indicate that the development to the south and west of the site generally occurred after 1971. Google Earth aerial photographs show that the site has remained virtually unchanged since at least 2003, although significant development has occurred to the west and south of the site over the past decade.

4.3.3. Geology

The local geology map[24] describes the site as being underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash.

Available soil maps classify the soil as Typic Orthic Allophanic from a tephra or alluvium parent material, and the depth to hard soil is classified as deep. The maps indicate that the soil has a high moisture content and moderate to rapid permeability. These soils generally coincide with the materials encountered from previous works undertaken by Coffey in the area.

The Waikato Regional Groundwater Map[25] shows that a borehole was drilled by Brown Brothers Ltd near the northern boundary of the site in 2007. The borehole encountered sandy clay to a depth of

[22] http://maps.mpdc.govt.nz/gisp2/framesetup.asp
[23] Matamata Topographical Map 4th Edition, 1971, The University of Waikato
[24] "*Geology of the Rotorua Area*", Institute of Geological and Nuclear Sciences, 1:250000 geological map
[25] http://giswrcmaps.waikatoregion.govt.nz/wrcmaps/?variant=Groundwater

1.5mbgl, overlaying layers of sands and gravels. A layer of peat was encountered between 4.3mbgl to 4.6mbgl.

The nearest active fault listed on the New Zealand active faults database is the Kerepehi Fault, situated approximately 2km to the east of the site and running north-south. The fault has a recurrence level of 2,000 to 3,500 years, with a low slip rate (0.2 to 1.0 mm per year) and was active within the last 1,000 years. In addition, the local geology map shows a concealed and inferred fault is located approximately 5km west of the site running north-south.

4.3.4. Liquefaction

A summary of how this report defines liquefaction is included in Appendix B.

An on-site geotechnical investigation would need to be undertaken before a detailed liquefaction assessment could be performed. The Importance Level of buildings and Site Class would also impact the liquefaction assessment. Based on the available geology information given in Section 4.3.3 however, it is likely that the site is underlain by a thin layer of clay above relatively loose alluvial sands and gravels with a high moisture content, and a potentially high water table.

Based on these assumed subsurface properties, it is considered that the site is potentially susceptible to liquefaction. As such, we recommend that an on-site geotechnical investigation and a more detailed liquefaction assessment are undertaken prior to development.

4.3.5. Flooding Hazard

The site and surrounding areas are generally flat and are not situated within the floodplains of any streams or rivers. Additionally, the site is not shown to be within a River flood hazard zone on the Waikato Regional Council Flood Hazard map[26].

As such, we consider that the site is generally at a low risk of flooding. However, more detailed flood analyses should be undertaken at the development stage, including assessing the adequacy of the stormwater retention ponds at the north-west of the site.

4.3.6. Slope Stability

The site was observed to be generally flat, and slope instability can be dismissed as a geotechnical concern for this site.

4.3.7. Site Observation

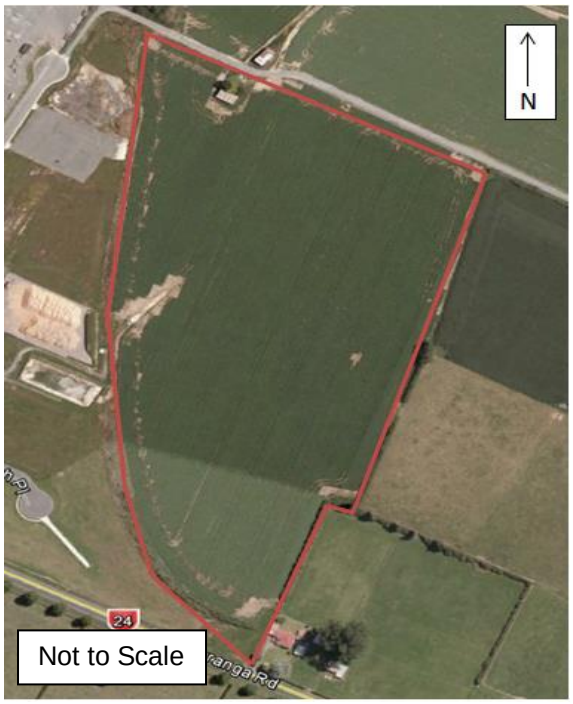
Coffey observed the site and adjacent areas on 5 January 2016 from public vantage points. Photographs taken of the site are included in Appendix A. The observations made on site were generally in accord with the observations obtained during the desktop study.

[26] 1:300,000 Broadscale River flood hazard map, Matamata-Piako District

4.4. Site 4 – State Highway 24 (Tauranga Road), Matamata

4.4.1. Site Description

Figure 9: Site Location Plan[27]



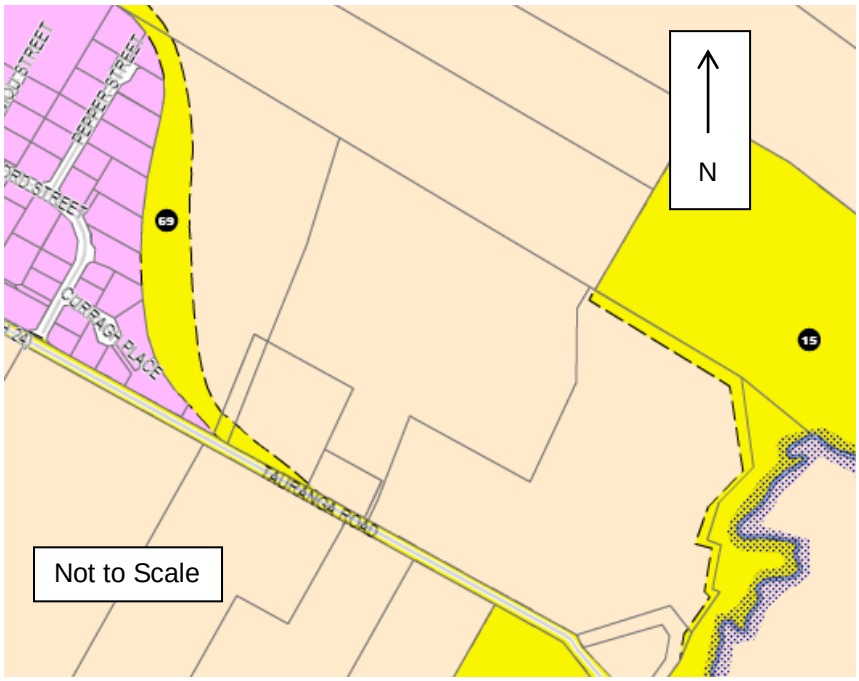
Site 4 is located to the north of State Highway 24 (Tauranga Road) and east of Curragh Place in Matamata (refer to Figure 9). The GIS indicates that the site covers an area of approximately 12ha and has the legal description Lot 200 DP 414828. The site is generally gently sloping and occupied by with open paddocks.

The site is currently designated on the GIS as 'Rural (refer to Figure 10), and is generally surrounded by 'Industrial' land to the west, and 'Rural' land to the north, east and south. The southern fringe of the site is located on the northern side of State Highway 24. The Mangawhero Stream, a tributary of the Waihou River, flows towards the north-east approximately 900m east of the site.

The western section of the site has been designated on the GIS as land reserved for a proposed bypass between State Highway 24 and State Highway 27. The GIS also indicates that land has been designated as 'Sewage Treatment and Buffer' approximately 600m east of the site, and 'Landfill' approximately 500m south-east of the site. The nearest 'Flood Hazard' designated on the GIS is located approximately 850m east of the site, comprising the floodplain of the Mangawhero Stream.

[27] Aerial image sourced from Google Earth, retrieved 18 January, 2016

Figure 10: Council Zoning Map[28]



4.4.2. Site History

Historical aerial photographs of the site are not readily available. Historical topographical maps[29] of Matamata indicate that the industrial land to the west of the site was developed at some stage after 1971.

Google Earth aerial photographs suggest that the site was subdivided sometime between 2003 to 2008, with the western part of the existing property being developed as industrial land. The eastern part of that existing property (forming the current site) has generally remained unchanged since the subdivision. The proposed bypass road buffer zone (refer to Section 4.4.1) can be seen on Google Earth from as early as the 2008 aerial image.

4.4.3. Geology

The local geology map[30] describes the site as being underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash. More recent alluvial soils are likely to be encountered east of the site near the Mangawhero Stream.

Available soil maps classify the soil as Typic Orthic Allophanic from a tephra or alluvium parent material, and the depth to hard soil is classified as deep. The maps indicate that the soil has a high moisture content and moderate to rapid permeability. These soils generally coincide with the materials encountered from previous works undertaken by Coffey in the area.

[28] http://maps.mpdc.govt.nz/gisp2/framesetup.asp
[29] Matamata Topographical Map 4th Edition, 1971, The University of Waikato
[30] "*Geology of the Rotorua Area*", Institute of Geological and Nuclear Sciences, 1:250000 geological map

The Waikato Regional Groundwater Map shows that a borehole was drilled by Benson and Son Ltd approximately 200m from the southern boundary of the site in 1998. The borehole encountered sandy silt to a depth of 0.9mbgl, overlaying sand.

The nearest active fault listed on the New Zealand active faults database is the Kerepehi Fault, situated approximately 1.3km to the east of the site and running north-south. The fault has a recurrence level of 2,000 to 3,500 years, with a low slip rate (0.2 to 1.0 mm per year) and was active within the last 1,000 years. In addition, the local geology map shows a concealed and inferred fault is located approximately 7km west of the site running north-south.

4.4.4. Liquefaction

A summary of how this report defines liquefaction is included in Appendix B.

An on-site geotechnical investigation would need to be undertaken before a detailed liquefaction assessment could be performed. The Importance Level of buildings and Site Class would also impact the liquefaction assessment. Based on the available geology information given in Section 4.4.3 however, it is likely that the site is underlain by relatively loose sands with a high moisture content, and a potentially high water table.

Based on these assumed subsurface properties, it is considered that the site is potentially susceptible to liquefaction. As such, we recommend that an on-site geotechnical investigation and a more detailed liquefaction assessment are undertaken at the development stage.

4.4.5. Flooding Hazard

The site and surrounding areas are generally flat to gently sloping, and the site is not shown to be within the River flood hazard zone on the Waikato Regional Council Flood Hazard map[31].

As such, we consider that the site is generally at a low risk of flooding. However, more detailed flood analyses should be undertaken at the development stage.

4.4.6. Slope Stability

The site was observed to be generally flat, and slope instability can be dismissed as a geotechnical concern for this site.

4.4.7. Site Observation

Coffey observed the site and adjacent areas on 5 January 2016 from public vantage points. Photographs taken of the site are included in Appendix A. The observations made on site were generally in accord with the observations obtained during the desktop study.

[31] 1:300,000 Broadscale River flood hazard map, Matamata-Piako District

4.5. Site 5 – Horrell Road, Morrinsville

4.5.1. Site Description

Figure 11: Site Location Plan[32]

Site 5 is located in Morrinsville and is bound by Horrell Road and State Highway 26 to the south, Horrell Road to the east and the Piako River to the west. The GIS indicates that the site covers an area of approximately 80ha and contains the following 19 properties:

- Legal Description Lot 2 DPS 67689, approximately 8.0ha site.
- Legal Description Lot 1 DPS 77977, approximately 2.0ha site.
- Legal Description Lot 1 DP 319308, approximately 1.2ha site.
- Legal Description Lot 2 DP 319308, approximately 10.1ha site.
- Legal Description Lot 2 DPS 89221, approximately 8.2ha site.
- Legal Description Lot 1 DPS 89221, approximately 0.4ha site.
- Legal Description Lot 3 DPS 83070, approximately 1.4ha site.
- Legal Description Lot 2 DPS 83070, approximately 0.7ha site.
- Legal Description Lot 1 DPS 83070, approximately 5.7ha site.

[32] Aerial image sourced from Google Earth, retrieved 18 January, 2016

- Legal Description Lot 2 DPS 43552, approximately 5.1ha site.
- Legal Description Lot 1 DPS 43552, approximately 2.0ha site.
- Legal Description Lot 1 DPS 47312, approximately 4.3ha site.
- Legal Description Lot 2 DPS 47312, approximately 3.9ha site.
- Legal Description Lot 3 DPS 43552, approximately 0.4ha site.
- Legal Description Lot 2 DPS 68866, approximately 6.8ha site.
- Legal Description Lot 1 DPS 68866, approximately 5.1ha site.
- Legal Description Lot 1 DPS 41624, approximately 3.7ha site.
- Legal Description Lot 2 DPS 41624, approximately 3.7ha site.
- Legal Description Lot 1 DPS 35142, approximately 7.1ha site.

The site is generally flat to gently sloping, with a relatively steep slope along the western boundary into the Piako River. The site is occupied by open paddocks and rural housing.

The site is currently designated on the GIS as 'Rural (refer to Figure 12), and is generally surrounded 'Rural' land to the north, east and south, and 'Residential' land to the west over the Piako River. A railway line runs east-west approximately 100m south of the site. The western fringe of the site has been designated on the GIS as 'kaitiaki (conservation)' and as a 'flood hazard'. Flora of significance have also been identified near the site on the GIS, including Common Beech and European Oaks.

Figure 12: Council Zoning Map[33]

[33] http://maps.mpdc.govt.nz/gisp2/framesetup.asp

4.5.2. Site History

Historical aerial photographs of the site are not readily available. The LIM report[34] for 2997 State Highway 26 indicates that an application for building permit was lodged to council as early as 1962. Google Earth aerial photographs show that the site and surrounding area has remained virtually unchanged since at least 2008.

4.5.3. Geology

The local geology map[35] describes the site as being underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash. More recent alluvial soils are likely to be encountered west of the site near the Piako River. Sections of the site may also be underlain by older Tauranga Group alluvium, consisting of pumiceous fine-grained sand and silt, with interbedded peat, pumiceous gravelly sand, diatomaceous mud, and non-welded ignimbrite.

Available soil maps classifies the majority of the site soil as being Typic Orthic Allophanic from a tephra or alluvium parent material, and the depth to hard soil is classified as deep. The maps indicate that the soil has a high moisture content and moderate to rapid permeability. Along the western fringe of the site, the soil is classified as being Typic Recent Gley from an alluvium parent material, and the depth to hard soil is classified as deep.

The GIS indicates that the majority of the site is underlain by peat soils.

The Waikato Regional Groundwater Map indicates that numerous boreholes have been drilled within and nearby to the site. The boreholes are summarised below:

Table 1: Records of boreholes drilled within and near Site 5

Approximate Location	Depth (m)	Description	Driller and Year Drilled
Centre of site	0 – 5.2 5.2 – 7.7	Peat Siltstone	Geo Hutchinson Ltd, 2005
Southern section of site	0 – 6.1 6.1 – 7.9	Peat and clay Clay	Weldec Drilling and Exploration, 1990
Southern section of site	0 – 9.1 9.1 – 24.4	Peat Silt	Weldec Drilling and Exploration, 1990
30m east of the site boundary	0 – 6.0 6.0 – 9.0	Clay Peat	Barham United Welldrillers Ltd, 1994
240m east of the site boundary	0 – 6.1 6.1 – 8.2	Peat White clay	Geo Hutchinson Ltd, 2005
270m east of the site boundary	0 – 7.5 7.5 – 8.0 8.0 – 12.0	Peat and clay Pumice Peat	Ken Garnett Drilling Ltd, 2000

[34] "*Land Information Memorandum for 2997 State Highway 26, RD4, Morrinsville*" Reference: 05305/305.00, dated 30 March 2001.
[35] "*Geology of the Rotorua Area*", Institute of Geological and Nuclear Sciences, 1:250000 geological map

The nearest active fault listed on the New Zealand active faults database is the Kerepehi Fault, situated approximately 10km to the east of the site and running north-south. The fault has a recurrence level of 2,000 to 3,500 years, with a low slip rate (0.2 to 1.0 mm per year) and was active within the last 1,000 years. In addition, the local geology map shows a concealed and inferred fault is located approximately 4km east of the site running north-south.

A newspaper article available on the Australian online database 'Trove'[36] has an account of a damaging earthquake in the Morrinsville area in 1924.

4.5.4. Liquefaction

A summary of how this report defines liquefaction is included in Appendix B.

An on-site geotechnical investigation would need to be undertaken before a detailed liquefaction assessment could be performed. The Importance Level of buildings and Site Class would also impact the liquefaction assessment. Based on the available geology information given in section 4.5.3, it is likely that the site is underlain by peat, which is generally not prone to liquefaction. However, there are also likely to be layers of sand or silt above or below the peat layers, with a potentially high moisture content. These materials are prone to liquefaction during an earthquake, and as such it is considered that the site is potentially susceptible to liquefaction.

We therefore recommend that an on-site geotechnical investigation and a more detailed liquefaction assessment are undertaken prior to development.

4.5.5. Static Settlement

The proposed development plans will need to be prepared and an on-site geotechnical investigation undertaken before static settlement could be assessed. Given the geology information in Section 4.5.3 however it can be assumed that effects of static settlement will need to be addressed prior to development, due to the weak and compressible nature of the peat likely to underlie the site. This would likely involve significant earthworks, or deepened foundations through the peat.

4.5.6. Flooding Hazard

The Waikato Regional Council Flood Hazard map[37] indicates that the western section of the site, near the Piako River, may be prone to flooding during a significant rainfall event. We recommend that a more detailed flooding analysis is undertaken prior to development.

4.5.7. Slope Stability

The site was observed to be generally flat, and at a low risk of slope instability. The slope along the western boundary may be prone to instability, and as such we recommend that a detailed slope stability analysis be undertaken prior to the development of the site.

[36] http://trove.nla.gov.au/ndp/del/article/34405264
[37] 1:50,000 Broadscale River flood hazard map, Morrinsville

4.5.8. Site Observation

Coffey observed the site and adjacent areas on 5 January 2016 from public vantage points. Photographs taken of the site are included in Appendix A. The observations made on site were generally in accord with the observations obtained during the desktop study.

5. Summary

The geotechnical assessments undertake for this report are summarised below:

Site 1 – Tui Road, Te Aroha

- The site is likely to be underlain by alluvial and colluvial sands. The nearest active fault is located approximately 7km west of site, and a concealed is potentially located approximately 400m west of site. This concealed fault is shown in different locations on different maps, including through the site on a map shown on Figure 3. Prior to development we recommend that an assessment is undertaken to establish whether the fault runs through the site.
- We consider that the site is potentially susceptible to liquefaction, and recommend that a more detailed liquefaction assessment is undertaken prior to development.
- We consider that certain areas of the site may be prone to flooding, and recommend that a more detailed flooding assessment is undertaken prior to development.
- We consider that the site is prone to slope instability and debris inundation, and recommend that a more detailed slope stability and debris flow assessment is undertaken prior to development.

Site 2 – Stirling Street, Te Aroha

- The site is likely to be underlain by alluvial and colluvial sands. The nearest active fault is located approximately 6km west of site, and a concealed fault is potentially located approximately 200m west of site.
- We consider that the site is potentially susceptible to liquefaction, and recommend that a more detailed liquefaction assessment is undertaken prior to development.
- We consider that certain areas of the site may be prone to flooding, and recommend that specific flood considerations should be made for future development consents.
- We consider that certain areas of the site may be prone to slope instability, and recommend that a more detailed slope stability assessment is undertaken prior to development.

Site 3 – Tower Road, Matamata

- The site is likely to be underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash. The active Kerepehi Fault is located approximately 2km east of the site.
- We consider that the site is potentially susceptible to liquefaction, and recommend that a more detailed liquefaction assessment is undertaken prior to development.
- We consider that the site is at a low risk of flooding. However, we recommend that a more detailed flooding assessment is undertaken prior to development.

- We consider that the site is at a low risk of slope instability, and can be dismissed as a geotechnical concern.

Site 4 – State Highway 24 (Tauranga Road), Matamata

- The site is likely to be underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash. The active Kerepehi Fault is located approximately 1.3km east of the site.
- We consider that the site is potentially susceptible to liquefaction, and recommend that a more detailed liquefaction assessment is undertaken prior to development.
- We consider that the site is at a low risk of flooding, and can be dismissed as a geotechnical concern.
- We consider that the site is at a low risk of slope instability, and can be dismissed as a geotechnical concern.

Site 5 – Horrell Road, Morrinsville

- The site is likely to be underlain by the Hinuera Formation, consisting of laminated fluvial sands and gravels, and containing fragments of pumice and ash. Previous borehole information indicates that the site is also underlain by significant amounts of peat. The active Kerepehi Fault is located approximately 10km east of the site. An inferred fault is located approximately 4km east of the site.
- We consider that the site is potentially susceptible to liquefaction, and recommend that a more detailed liquefaction assessment is undertaken prior to development.
- We consider that certain areas of the site may be prone to flooding, and recommend that a more detailed flooding assessment is undertaken prior to development.
- We consider that certain areas of the site may be prone to slope instability, and recommend that a more detailed slope stability assessment is undertaken prior to development.

6. Conclusion

With additional on-site geotechnical investigation and assessment, as well as appropriate engineering measures, we consider that the identified geotechnical conditions which form the basis of this preliminary assessment should not constrain the land changes stated in Section 2.

The provisions of the District Plan should prevail and it is considered that the future subdivision scheme or development plans will need to be subject to site specific geotechnical investigation, as well as site specific completion reporting following earthworks.

7. Limitations

This report has been prepared solely for the use of our client, Matamata Piako District Council, their professional advisers and the relevant Territorial Authorities 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. All future owners of these sites should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

This document should always be read in its entirety and in conjunction with the previous reports provided for this project. It is not to be split for further distribution.

Factual evidence given in this report has been obtained solely from the sources listed in Section 3. As on-site geotechnical investigations were not included within the scope of this report, there may be special conditions pertaining to the sites which have not been taken into account in the report. Further discussion on the uses and limitations of this report are presented in the attached document entitled "Important Information about your Coffey Report".

For and on behalf of Coffey

Scott Higginson
Geotechnical Engineer

Appendix A - Photographs

Photograph 1: Site 1 from Hamilton Street, looking north-east

Photograph 2: Site 1 from Tui Road, looking south

Photograph 3: Boulders at Site 1 from Hamilton Street, looking north

Photograph 4: Tunakohoi Stream near Site 1, looking south-west

Photograph 5: Site 2 from Stirling Street, looking west

Photograph 6: Site 2 from Stirling Street, looking west

Photograph 7: Site 3 from Maple Place, looking south-east

Photograph 8: Site 3 Stormwater retention pond, from Maple Place looking east

Photograph 9: Site 4 from Curragh Place, looking east

Photograph 10: Site 4 from Pepper Street, looking east

Photograph 11: Site 5 from Horrell Road, looking west

Photograph 12: Site 5 from Horrell Road, looking west

Appendix B – Definitions

- Liquefaction Definition
- Flood Hazard Zone Definitions

Appendix B - Liquefaction

Cyclic liquefaction is a phenomenon in which loose, saturated, cohesionless soils are subject to temporary but essentially full loss of stiffness due to pore pressure build-up as a result of earthquake shaking.

While in this condition (and for a time afterwards), the soil is susceptible to vertical and lateral deformations. The magnitude and mode of deformation is governed by landform, spatial continuity of the liquefiable material, soil density and the intensity and duration of shaking.

Although not susceptible to “classic” cyclic liquefaction, under the right conditions of cyclic load intensity and duration, fine-grained cohesive soils can undergo strength loss during an earthquake event. This phenomenon is referred to as cyclic softening. In general, deformations caused by cyclic softening tend to be less than those caused by liquefaction.

For simplicity, this report refers to both cyclic liquefaction and cyclic softening as simply “liquefaction” to describe a loss of soil stiffness due to seismic loading.

Appendix B – Flood Hazard Zones [38]

Zone 1 Consists of the essentially flat land of the Hauraki Plains and within the flood plain of the Waihou River. Landslip hazard is negligible, except in the immediate vicinity of the banks of the river where erosion and scouring may occur. There is some risk of inundation by floodwaters, even beyond the 100 year flood level location as shown on Drawing No.

Zone 2 This zone consists of gently sloping land occupying much of the northern part of the Borough. This area was originally formed as an alluvial fan, but with time, the surrounding streams have become entrenched through downcutting to leave the land in this zone above the level of likely flooding.

Zone 3 Is a zone similar to Zone 2, except that the land is gently sloping. Much of this area is situated upon alluvial fans, landslide and other river-laid debris, but the ground is now considered to be essentially stable. Some minor ground creep and surface settlements may occur in isolated areas and basement excavations could encounter minor subsurface streams and groundwater concentrations. There is slightly more risk of inundation by flood waters or by avalanche debris than in Zone 2.

Zone 4 Contains land within the general flood plain of a tributary stream coming off the hillslope to the immediate east of the Borough. In an extreme event, it can be expected that flooding and some damage from avalanche-type debris may occur. Under peak flooding, say which may occur every five years, the streams are expected to be contained within, or close to existing stream bed locations. However if a landslide in the hills beyond the Borough was large enough to cause a temporary blockage of one of the streams, extensive damage in this zone may occur. If a temporary dam of this type were to breach, the volume of earth, water and other debris released would be sufficiently extensive to cause widespread damage within this zone.

Zone 5 Contains land within the immediate flood plain of a tributary stream coming off the steeper hillslopes. A hazard to life and structural damage to buildings is presented where high intensity rainfall causes flooding of a magnitude likely to result in the overtopping of stream banks. The flood waters in this zone are expected to be of a magnitude and intensity as to cause structural damage to buildings. In the event of a major landslide causing a temporary containment of a stream upstream, the subsequent avalanche of debris following breaching of the dam is likely to cause major destruction in this zone.

Zone 6 Consists of land within the foothills area which could be susceptible to near-surface sliding. Generally land which has a slope in excess of 20 degrees is included. Development should only proceed if it can be demonstrated that the area in question is stable, and that there is little or no risk of the land being affected by instability of the slopes above the area.

Zone 7 Contains land which is generally within 30 metres of the base of the steeper slopes which overlook the Borough. The location of the lower boundary line has been generalized, but is taken to represent the approximate extent to which a landslide having its origin in the upper steeper slope might flow onto the flatter slopes below.

Zone 8 Consists of the land within the steep slopes to the immediate east of the Borough. Removal of vegetation from this land should be controlled so that some measure of protection to the built-up area below is provided at all times. Any mining should be controlled so that spoil piles and related mine or investigation workings do not pose a hazard to the areas downslope.

[38] "*Land Stability and Flood Hazard Survey",* R M Rankine Borough Engineer, dated 16 February 1988