Geological description of two groundwater bores in the northern Galatea plains region, Whakatane District

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BIBLIOGRAPHIC REFERENCE

EXECUTIVE SUMMARY

Rock chip samples from groundwater bores “Galatea-1” and “Galatea-3” drilled in the north-central part of the Galatea plains region for the Bay of Plenty Regional Council have been examined to identify the geological formations and provide lithological detail of the units.

The sequences intersected by the bores represent alluvial deposits that partly fill the Galatea basin. Although no ignimbrite units were intersected shallower than the 167-m maximum drilled depth, the Matahina Ignimbrite is very likely to be present in the central Galatea plains area.

The youngest and thinnest of the alluvial materials are pumice-rich pebbly alluvium derived by erosion and fluvial transport of various rhyolitic pyroclastic deposits from sources to the west, most likely in the Okataina Volcanic Complex. The underlying materials are older (late Pleistocene) unconsolidated deposits of pebbly alluvium (gravels), interlayered with clayey silt and some sand. These comprise locally-sourced greywacke sandstone and argillite (Jurassic age Kaweka terrane), transported from the Ikawhenua Range. Within the greywacke alluvium, there are also several metres thick intervals (>10 m in Galatea-1) of pumice gravel and sand. This material is very likely to be reworked pyroclastic material erupted from sources in the Okataina Volcanic Centre 30–40 km northwest of Galatea, but correlation of the material with specific volcanic units of known age has not been possible.
1.0 INTRODUCTION

This report provides descriptions and identification of the geological units intersected by groundwater bores “Galatea 1” and “Galatea 3” that were drilled in 2017 approximately 50 m apart on a Horomanga Road farm property in the northern part of the Galatea plains region. The property is located 5 km northeast of Galatea township and 11 km northeast of Murupara (Figure 1.1 and Table 1.1). The bores were completed for the Bay of Plenty Regional Council (BOPRC) and later were selected for this study by BOPRC (pers. comm. D. Harvey), who provided GNS Science with boxed drill-chip samples collected at 1 m intervals from surface to the completion depths at 167 mBGL [metres below ground level] (Galatea-1) and 74 mBGL (Galatea-3).

![Map of Galatea groundwater bores](image.jpg)

Figure 1.1 Location map for Galatea groundwater bores examined in this study. Topographic base map from Land Information New Zealand Topo50 map BF39 Galatea.

<table>
<thead>
<tr>
<th>Location</th>
<th>Bore name</th>
<th>Bore number</th>
<th>East (NZTM)</th>
<th>North (NZTM)</th>
<th>Bore depth (mBGL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horomanga Road</td>
<td>Galatea 1</td>
<td>BN17-0048</td>
<td>1931098</td>
<td>5746050</td>
<td>167</td>
</tr>
<tr>
<td>Horomanga Road</td>
<td>Galatea 3</td>
<td>BN17-049</td>
<td>1931057</td>
<td>5746084</td>
<td>74</td>
</tr>
</tbody>
</table>

Table 1.1 Location and depth information for Galatea plains groundwater bores examined in this study (mBGL refers to metres below ground level). Bore numbers are BOPRC reference numbers.
2.0 GEOLOGICAL BACKGROUND

The Galatea plains are the surface expression of a long-lived sedimentary basin located at the eastern margin of Taupo Volcanic Zone. The basin is bounded on the east and southeast by active faults along which the basin and its volcanic and sedimentary fill are downthrown against the greywacke basement rock of the Ikawhenua Range. To the west and north, the basin margin is delineated by the plateau formed mostly in the 322,000-year-old Matahina Ignimbrite (Leonard et al. 2010) and now covered by plantation forest. It is likely that the edge of the ignimbrite is also a fault scarp, but one that is inactive. The Rangitaiki River (Figure 1.1) meanders northwards against the dissected edge of the ignimbrite and for millennia has been largely confined to that path by prograding coalesced alluvial fans that slope north-westwards from their apices at the foot of the Ikawhenua Range. The Horomanga River and other tributary streams are directed from their catchments in the Ikawhenua Range, north-westwards across the plains to the Rangitaiki River.

Surficial layers, particularly near the Rangitaiki River and Horomanga River, are young (Holocene) pumiceous alluvium derived by erosion and fluvial transport of various rhyolitic pyroclastic deposits from sources most likely dominated by those of the Okataina Volcanic Complex. On the eastern side of the basin, the pumiceous material is thinner than in the west or is absent across some fan surfaces. Across the plains, the thickest materials are older (late Pleistocene) deposits of pebbly alluvium, interlayered with clayey silt and some sand. These are locally sourced rock (Jurassic age Kaweka terrane, greywacke sandstone and argillite), transported from the Ikawhenua Range. Generally, the gravels and silts are loose, but in some areas of the basin they are described as well consolidated, and locally are cemented by carbonate minerals. Within the greywacke alluvium, there are intervals of pumice gravel and sand several metres thick.

A substantial number of investigation bores were drilled from the mid-1950s to mid-1960s for the Ministry of Works and Development Upper Rangitaiki hydro-power project and these provide some geological insight to the Galatea plains region. Logs of bores drilled for prospective dam sites near Murupara and ~4.5 km downstream (northeast) of the Aniwaniwa dam (Figure 1.1) have not been examined in detail for this project, but many of the bore logs record pumiceous alluvium cover on Matahina Ignimbrite, and bores terminated in underlying strata of siltstone, sandstone and volcanic conglomerate known as “Luke’s Farm beds”. Matahina Ignimbrite is mapped to the north, west, and south (Leonard et al. 2010) of the plains.
3.0 SAMPLES AND DESCRIPTION

The stratigraphy of bores Galatea-1 and Galatea-3 in the Galatea plains local area is represented by drill chips collected from both bores at 1 m intervals. No cores were cut. The depths referred to in this report are those labelled on the sample boxes, and are taken to be metres below ground level at each bore site. A geological boundary reported here is the sample depth at which fragments of the different underlying unit first appear. The accuracy of unit boundaries relies on the accuracy of drilling-depth measurement and recording, minimal downhole mixing during drilling, and sample collection and labelling at each nominal depth.

The description of volcanic and sedimentary materials from the bores follows standard terminology of McPhie et al. (1993), Burns et al. (2005), and White and Houghton (2006). The colour names for drill chips are in field-moist condition and are guided by Munsell soil colour charts and nomenclature (Munsell 2009). Reference to regionally extensive stratigraphic units is consistent with Group and Formation nomenclature of the QMAP Rotorua geological map (Leonard et al. 2010).
4.0 STRATIGRAPHIC SUMMARIES

Table 4.1 and the following sections summarise the geological character of materials drilled by each of the bores. Digital images of drill cuttings are provided in Appendix 1.

Table 4.1 Generalised lithostratigraphic units (Tauranga Group) drilled in Galatea-1 and Galatea-3 bores. EOH = end of hole; mBGL= metres below ground level.

<table>
<thead>
<tr>
<th>Grouped lithology</th>
<th>Depth (mBGL) in Galatea-1</th>
<th>Depth (mBGL) in Galatea-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumiceous gravelly sand</td>
<td>0–5</td>
<td>0–5</td>
</tr>
<tr>
<td>Greywacke gravel with some sand</td>
<td>6–8</td>
<td>6–19</td>
</tr>
<tr>
<td>Sandy silt with some gravel</td>
<td>9–11</td>
<td>-</td>
</tr>
<tr>
<td>Sandy greywacke gravel with some silt</td>
<td>12–42</td>
<td>20–39</td>
</tr>
<tr>
<td>Sandy silt with some clay</td>
<td>43–44</td>
<td>40–42</td>
</tr>
<tr>
<td>Sandy silt with some gravel</td>
<td>45–47</td>
<td>-</td>
</tr>
<tr>
<td>Sand with some gravel</td>
<td>48–51</td>
<td>-</td>
</tr>
<tr>
<td>Sandy greywacke gravel with some silt</td>
<td>-</td>
<td>43–48</td>
</tr>
<tr>
<td>Silty sand</td>
<td>52–62</td>
<td>-</td>
</tr>
<tr>
<td>Sandy silt with some clay</td>
<td>49–68</td>
<td></td>
</tr>
<tr>
<td>Greywacke gravel with some sand</td>
<td>63–85</td>
<td>69–74 (EOH)</td>
</tr>
<tr>
<td>Silty clay</td>
<td>86–88</td>
<td></td>
</tr>
<tr>
<td>Sandy greywacke gravel with some silt</td>
<td>89–106</td>
<td></td>
</tr>
<tr>
<td>Silty clay</td>
<td>107–111</td>
<td></td>
</tr>
<tr>
<td>Pumice-crystal sand</td>
<td>112–120; 122–142</td>
<td></td>
</tr>
<tr>
<td>Greywacke gravel with pumice-crystal sand</td>
<td>143–167 (EOH)</td>
<td></td>
</tr>
</tbody>
</table>

4.1 Galatea-1: Summary of Stratigraphy

The shallowest sample from this bore is a fine gravel mixture of pumice and rock fragments with some modern soil fragments (including rootlets). The pumice pebbles are stained by organic matter and iron oxide-hydroxide, as would be expected in the soil profile. At 2–5 m, crystal-rich pumiceous coarse sand is the dominant material; greywacke sandstone pebbles are common at 3 m and 4 m. Crystal sand grains are mainly colourless quartz and translucent feldspar, with conspicuous flakes of dark brown biotite.

Rounded, fine to medium pebbles (and angular broken fragments of them) of brown and brownish grey, moderately weathered greywacke sandstone, with some sand, make up the 6–8 m material. This is separated from deeper pebble alluvium by a 3-m interval of light grey and brownish yellow sandy silt with some small pebbles.

At 12–25 m, the greywacke fine sandstone pebbles are mostly rounded and slightly weathered, with colours of light to dark shades of brown and grey. A few granules of black argillite occur
and there are minor amounts of sand and silt. Between 27 m and 36 m, there is a notable increase in the amount of argillite granules and the silt content is greater than in the previous interval, but white, rounded pumice pebbles and quartz-feldspar sand are the more conspicuous elements.

Samples from 37 m to 112 m are greywacke gravels with some intervals of silty or sandy material. Pumice was observed as small white grains throughout this depth range, but this is regarded as downhole wash, because the sand resembles greywacke source material more than it does young volcaniclastic sediment.

At 43–44 m and 46–47 m there are intervals of pale olive, sticky, plastic clay with small pebbles of greywacke. Similarly, at 52–55 m there is silt with some small greywacke pebbles and some clay, collectively in shades of olive grey. The fine sediment recovered from 56–63 m is sand grade or silt, with varied clay content. Continued fine to coarse pebbles were drilled through to 66 m, with an interval of distinctly brown pebbles and medium sand encountered at 65–66 m.

At 67 m, there is an apparent minor change in source material. The gravel is still mostly greywacke fine/medium sandstone, but this is very dark grey and is cross-cut with conspicuous veinlets of a white silicate mineral. Black to very dark grey argillite pebbles are also relatively more abundant in the 67–91 m interval. Pebby strata are separated by a 3 m to 4 m thick layer at 86–89 m that is light olive grey, sticky, plastic silty clay.

Rounded pebbles and angular pebble fragments (greywacke fine sandstone) are the major constituent at 92–102 m. Occasionally, there are also pebbles of very dark grey argillite and of sandstone conglomerate veined with a red mineral. Samples at 103–106 m include greywacke pebbles, but there is a substantial proportion of dark grey, crystal-rich coarse sand, and some pumice grains. This marks a substantial change in source material that becomes very apparent below 112 m.

At 107–111 m, there is another fine sediment layer that separates packages of coarser alluvium. The light grey silty material (with some fine sand) has sufficient clay to give a sticky consistency.

The sample at 112 m reveals a sharp change in lithology to volcaniclastic rhyolitic pebbly (pumiceous) sand, which is the main material through to 142 m. From 112 m to 120 m, the samples are greenish grey moderately sorted fine sand, which consists of volcanic quartz and feldspar with minor brown pyroxene crystals. There are also some very fine pebbles of white pumice and green/grey greywacke very fine sandstone. The layer of greyish brown clayey silt at 121 m is a clear boundary layer between crystal-pumice sand deposits. The immediately underlying material contains many mm-sized fragments of very dark brown wood amongst the quartz-feldspar-pyroxene sand. Pumice grains (granule to coarse pebble size) are relatively more abundant below 122 m, particularly from 127–131 m, and greywacke sandstone or argillite are less abundant than at 112–120 m.

Another sharp change in lithology is observed at 139 m. In this sample, and at 140 m, there are abundant granules of greenish-grey greywacke fine sandstone mixed with coarse crystal sand. Greywacke pebbles in these samples (and in the coarser pebbly alluvium at greater depths) have a distinctive green-white finely speckled appearance under magnification. Fragments of light olive brown tuffaceous fine sandstone and shards of brown volcanic glass are also notable components in several samples from 142–176 m. Rounded granules and sub-angular pebble fragments of greenish-grey greywacke at 143 m mark the first appearance of a thick package of pebbly alluvium, in which this bore was terminated. Pebbles (2 mm to 5 cm)
in this unit are noticeably more rounded than those in the shallower greywacke alluvium. Greywacke and minor black argillite are the main and the coarsest components, but these are supported in coarse sand of quartz, feldspar and pyroxene. Other lithologies are present, for example samples at 157–159 m include pebbles of quartzite, chert, welded ignimbrite, and rhyolite lava. Samples at 161–166 m include sub-cm fragments of siderite-cemented (iron carbonate) granule conglomerate.

4.2 Galatea-3: Summary of Stratigraphy

In this bore, the materials sampled from the top-most 5 metres are pumiceous pebbly sands with minor silt. The white or very pale brown sub-rounded pumice granules are mixed with medium- to coarse-sand sized pumice fragments and crystals of quartz, feldspar and biotite “flakes”. Biotite is a common mineral component of many pyroclastic units erupted from the Okataina Volcanic Complex and Rotorua caldera, so is not unique to one tephra unit.

From 6 m to 40 m, pebbles of greywacke are the most abundant component. Sizes in the samples range from granule (2–4 mm) to very coarse pebble (3–6 cm), and these are rounded to sub-rounded in shape. Sub-angular fragments are present in many samples. Nearly all pebbles are well-indurated fine sandstone that is moderately weathered and brownish grey at 6–12 m, but at greater depths is more typically unweathered and dark grey to greenish grey in colour. Pebbles of slightly weathered rock show some dark brown/brownish-yellow discoloration on fracture surfaces. Small quantities of black well-rounded argillite granules are present at 15–28 m.

From 29 m to 40 m the samples are a mixture of greywacke sediment and reworked volcanic deposits; a similar mixture to samples inspected at 27–36 m interval in Galatea-1. The volcanic (rhyolitic pyroclastic) deposits are represented by conspicuous sub-rounded fragments of white crystal-poor (~3% quartz, pyroxene, magnetite) pumice, and medium sand to coarse sand that comprises quartz, feldspar and brown pyroxene crystals. Some samples also contain a small fraction of sand-sized unweathered biotite crystals.

Samples below 40 m are interbedded pebbly and silty greywacke-derived sediment. Apart from a substantial fraction of the 47 m and 48 m samples, there is no volcanic crystal sand. Material at 40–42 m and 49–61 m, 65–68 m and 71 m is silt, with varied amounts of clay and sand and some small pebbles of greywacke sandstone. Samples between these intervals are pebble grade sediment. Generally, the silt materials are olive grey in colour and have slight stickiness and plasticity when re-moulded.

Galatea-3 was terminated at 74 m below ground level, in pebble alluvium that comprises grey and very dark greenish grey sub-rounded granules and pebbles of fine greywacke sandstone. The sandstone has conspicuous very closely spaced, cross-cutting veinlets of a white silicate mineral, which are rare or absent in the shallower pebble-dominated samples. These veined pebbles have the same appearance as pebbly material drilled below 67 m in Galatea-1, and the two are very likely correlatives.
5.0 BOREHOLE INTERPRETATIONS

The stratigraphy of Galatea 1 and Galatea 3 bores is a clear reflection of the local geological setting. All materials drilled are alluvial deposits that are assigned to the Tauranga Group (Leonard et al. 2010).

Within the greywacke alluvium, there are intervals of pumice gravel and sand several metres thick (>10 m in Galatea-1). This material is very likely to be reworked pyroclastic material erupted from sources in the Okataina Volcanic Complex 30–40 km northwest of Galatea, but the inherently mixed cuttings and the <1 m thickness of mapped tephra units mean that correlation of the material with specific volcanic units of known age has not been possible in this project.

Logs of bores drilled for prospective dam sites near Murupara and ~4.5 km downstream (northeast) of the Aniwaniwa dam (Figure 1.1) have not been examined in detail for this project, but for the depth range equivalent to Galatea-1 and Galatea-3 (surface to 550 ft/167 m) many of the bore logs describe pumiceous alluvium on Matahina Ignimbrite, and strata of siltstone, sandstone and volcanic conglomerate known as “Luke’s Farm beds” beneath the ignimbrite. Matahina Ignimbrite crops out to the north, west, and south of the plains (Leonard et al. 2010), but neither it nor the Luke’s Farm sediment was intersected by the Galatea bores. Given the strength and hardness of the ignimbrite, its total removal from the basin by erosion in the past 322,000 years is very unlikely. Instead, the faulted structure of the Galatea basin suggests that Matahina Ignimbrite, 30–50 m thick (Bailey and Carr 1994) should be present in the central Galatea plains area.
6.0 CONCLUSIONS

The sequence of strata intersected by Galatea-1 and by Galatea-3 is entirely sedimentary. These strata are unconsolidated gravels and sands of fluvial origin, largely being alluvial fan sediments, but also including river/steam alluvium. Packages of gravels with slightly different lithology (e.g., different amounts of argillite; mineral veined sandstone) have been identified and reflect different deposition events or episodes, and slightly different provenance in metasedimentary facies within the Kaweka greywacke terrane. These packages are noted, but are unlikely to be of practical use as marker horizons for future drilling in the Galatea plains region.

In the shallow levels of both bores, pumice and crystal materials are mixed with greywacke sediments. The pumice and crystals are most likely to come from Okataina-sourced eruption deposits, but no pumice textures or crystal types were observed in the samples that might otherwise link with an eruption unit(s) and provide a chronostratigraphic marker for the borehole sequence. Given that Matahina Ignimbrite was not intersected by either bore, the entire sequence can be broadly inferred to be younger than 322,000 years old.

Ascertaining that no ignimbrite was intersected above 167 m below ground level, and resolving the geological characteristics and boundary depths for the materials, will incrementally improve existing hydrogeological models of the region. Clearly, a new bore in the Galatea-1/Galatea-3 area would need to be drilled deeper than 167 m to establish the depth to the top of Matahina Ignimbrite and its thickness, and ideally to provide at least some stratigraphy of units beneath it.

7.0 REFERENCES


APPENDICES
APPENDIX 1: DIGITAL IMAGES OF DRILL CUTTINGS

A1.1 Galatea-1 Sample Boxes
A1.2 Galatea-3 Sample Boxes