WALLBRIDGE GILBERT AZTEC

Kinetic Environmental Consulting Limited

Effects of McPherson Quarry Expansion on Groundwater

TECHNICAL REPORT

Job No. 202334 / Rev A
19 November 2020

Revision History

Rev	Date	Issue	Originator	Checker	Approver
A	19/11/2020	Kinetic Environmental	BAS	CHO	CHO

CONTENTS

Tables

Figures

Appendices

1 INTRODUCTION

1.1 BACKGROUND

McPherson Resources Limited (McPherson) has applied for resource consents authorising the continuation of existing operations and future expansion of McPherson Quarry. McPherson Quarry is located on McPhersons Road, off State Highway 2 in the vicinity of Pokeno (Figure 1). Kinetic Environmental Consulting Limited (Kinetic) has documented the projected environmental effects of the proposed quarry expansion in an Assessment of Environmental Effects (Kinetic 2019).

Following lodgement of the consent application with the Waikato Regional Council, submissions were sought with respect to the application. One of the submissions raised concerns with respect to the potential effects of the quarry on groundwater resources and spring flows at 219 SH2. The Hearing Commissioners have therefore requested an assessment of "*the depth of groundwater at and in the vicinity of the existing and proposed quarry and any effect on groundwater levels on neighbouring properties of the existing and proposed quarrying including reference to expected or likely effects on spring flow within no. 219 SH2*".

1.2 SCOPE OF WORK

Kinetic has retained Wallbridge Gilbert Aztec (WGA) to:

1. Review information available on the groundwater system at and around McPherson Quarry.
2. Assess the available information to address the request from the Commissioners.

This report summarises the reviewed information and the results of the assessment.

1.3 QUARRY LAYOUT

The existing quarry has been extracting weathered greywacke on a relatively small-scale for over 60 years (Kinetic 2019). The quarry currently covers an area of approximately 8.5 ha, with the pit cut at grade into the low greywacke hills to the north of SH2 at Pokeno.

The proposed stages of quarry expansion (Figure 2) are (Kinetic 2019):

- Stage 1 with a footprint of approximately 10 ha and a total cut design volume of approximately 10,495,000 m^3.

- Stage 2 with a footprint of approximately 9 ha and a total cut design volume of approximately 8,251,000 m^3.

- Stage 3 with a footprint of approximately 12 ha and a total cut design volume of approximately 12,124,000 m^3.

- A combined overburden/cleanfill storage area that is expected to operate throughout the life of the above quarry stages is planned to be located to the south of the existing quarry and have a footprint of just under 12 ha.

A detailed plan of the staged quarry layout is provided in Appendix A to this report.

The existing pit floor is at an elevation of approximately 41 m above mean sea level (mRL), which is similar to the ground level at the quarry entrance. In effect, the existing quarry has not been developed below the level of the alluvial deposits to the south of the quarry (refer Section 3.1).

The planned Stage 1 expansion will deepen the floor of the quarry to a final finished level of approximately 0 mRL. Quarry Stages 2 and 3 will maintain the final finished pit floor level at 0 mRL through the planned life of the quarry (Kinetic 2019). At the close of operations, the highest pit wall (the northern wall) will be approximately 172 m in height.

1.4 WATER TAKE CONSENTS

Two existing resource consents that support McPherson Quarry operations were granted in 2007 (Kinetic 2019). These consents authorise the abstraction of water (AUTH116085.01.01) and the discharge of water (AUTH116015.01.01). The water abstracted is derived from a spring at the northern end of the quarry and rainfall run-off from the quarry faces. The existing water take consent authorises a water abstraction rate of 50 m^3 per every 24 hours. Any excess water accumulating in the quarry is diverted by gravity flow via drains out through the quarry entrance and discharged to a settling pond.

Mount William Spring Water Limited holds three consents authorising the abstraction and use of water from a spring at 219 SH2:

- AUTH123205.01.01 is a land use consent to construct a water intake on the bed of a spring, with the commencement date of 4 October 2011.
- AUTH122976.01.01 is a surface water take consent to take water from an unnamed tributary of the Waipunga catchment with the commencement date of 4 October 2011.
- AUTH122977.01.01 is a permit to use water from unnamed tributary of Waipunga catchment with the commencement date of 4 October 2011.

All three consents are linked to a spring adjacent to a stream that flows onto 219 SH2 from the west and then turns toward the north to leave the property (Figure 1).

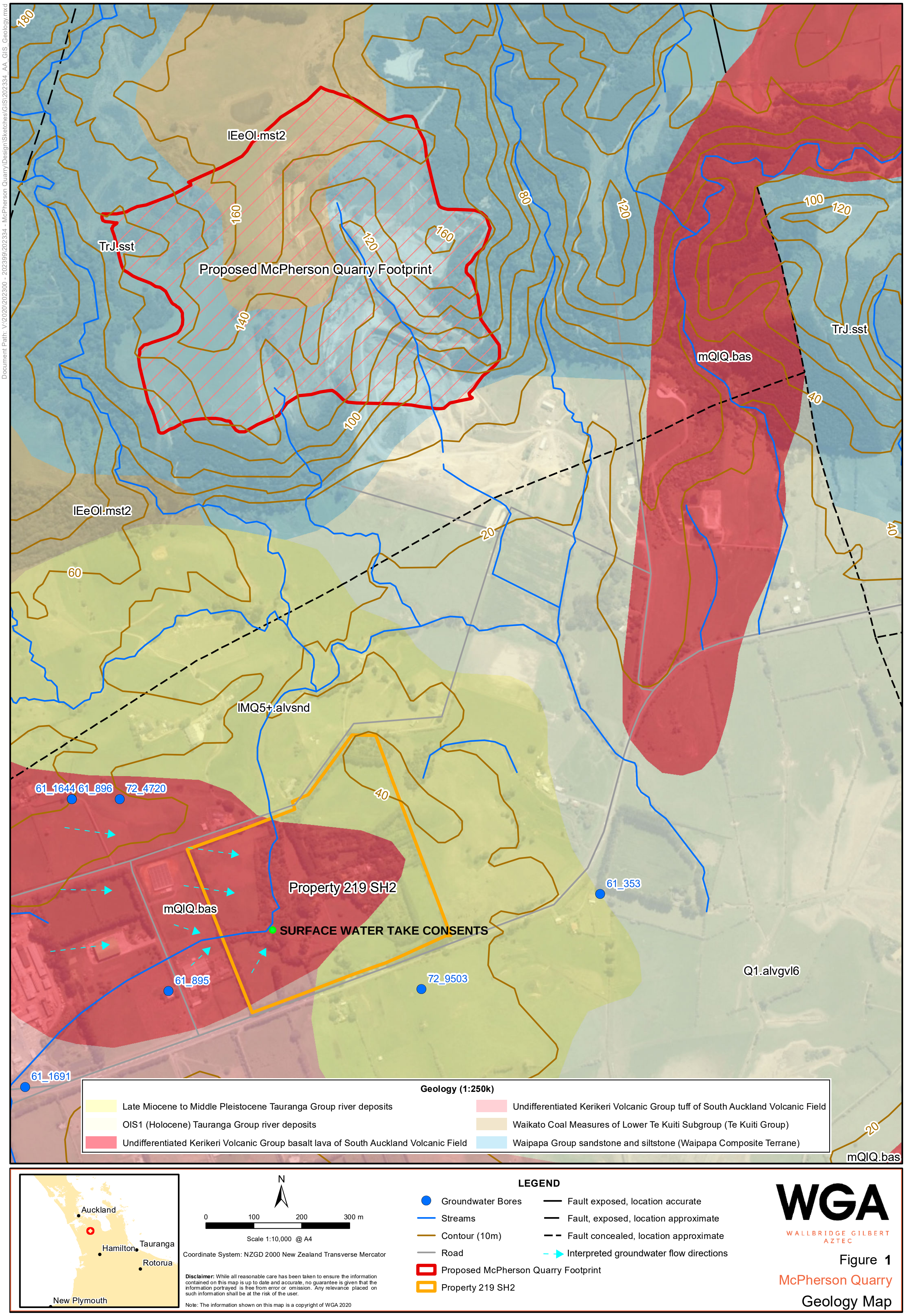


Figure 1
McPherson Quarry
Geology Map

Figure 2. McPherson Quarry staging plan (Kinetics 2019).

2 TOPOGRAPHY AND DRAINAGE

2.1 TOPOGRAPHY

The McPherson Quarry expansion is to be developed into a ridge that rises to an elevation of approximately 170 mRL immediately to the north of the quarry footprint. The ridge is aligned to approximately north-south and its crest rises in elevation further to the north (WRC 2020a).

To the east and west of the proposed quarry are two stream gullies that are deeply incised into the surrounding hills (Figure 1). The gully inverts for these southward flowing streams are at elevations of between 50 mRL and 80 mRL along their reaches that most closely approach the quarry and both streams exit the range of hills at an elevation of approximately 40 mRL. The gullies of two shorter and less deeply incised streams have either been excavated during past quarrying operations or will become part of the expanded quarry (WRC 2020a).

To the south of the quarry the topography becomes much gentler, ranging in elevation from 15 mRL to 40 mRL. As the planned floor of the quarry is at an elevation of 0 mRL (refer Section 1.3), the lowest ground elevations to the south of the quarry are still substantially higher in elevation than the quarry floor.

2.2 SURFACE WATER DRAINAGE SYSTEM

All streams arising from the hill country within 1.9 km to the west of the quarry and 900 m to the east of the quarry flow southwards to join an unnamed tributary of the Waipunga catchment. This tributary flows generally toward the East, parallel to the southern edge of the hill country, until it reaches its closest approach to the quarry at which point it turns towards the south. The same tributary enters the property of 219 SH2 from the west, turning toward the north to leave the property before again turning toward the east (Figure 1).

As noted in Section 2.2, the gully inverts for the two streams that pass McPherson Quarry to the east and west are at elevations of between 50 mRL and 80 mRL along their reaches that most closely approach the quarry. Both streams exit the range of hills at an elevation of approximately 40 mRL. In comparison, the streams that cross the lower-lying country to the south of the quarry and north of SH2 are generally at elevations between 40 mRL and 10 mRL (WRC 2020a).

The stream that crosses the property 219 SH2 is at an elevation of approximately 26 mRL where it enters the property and 22 mRL where it leaves the property toward the north. The spring on the property of 219 SH2 is expected to be at an elevation of approximately 25 mRL.

3 HYDROGEOLOGY

3.1 GEOLOGY

The hill country into which the McPherson Quarry is developed consists primarily of highly faulted and fractured Waipapa Group greywacke basement rock (Figure 1). Locally the greywacke is unconformably overlain by discontinuous areas of Waikato Coal Measures siltstones belonging to the Te Kuiti Group. The southern edge of the range of hills is marked by a fault, which is down-thrown to the south (Edbrooke 2001).

The gently sloping country to the south of the hills is underlain predominantly by alluvial deposits of the Tauranga Group. These alluvial deposits date from the late Miocene through to the present and have been differentiated into several Formations. These deposits, which fill the valleys eroded between higher areas of greywacke and Te Kuiti Group rocks, are very heterogeneous and include gravels, sands, silts, clays and peats. Drillhole records available through the Waikato Regional Council website (WRC 2020b) indicate the Tauranga Group sediments filling the valley to the south of the quarry are dominated by silts and clays.

Eruptive volcanism from the South Auckland Volcanic Field also took place during the deposition period of the Tauranga Group. Early Pleistocene age basalts of the South Auckland Volcanic Field have been mapped at surface to the east and southwest of the quarry (Figure 1) as:

- Undifferentiated massive basalt lava flows, basaltic gravels and scoria deposits, and
- Undifferentiated tuffs that may also contain scoria deposits.

These basaltic deposits overlie the older alluvial deposits and are in turn overlain by the younger sediments of the Tauranga Group. As the basaltic lavas are more resistant to erosion than the fine grained alluvial deposits, these lavas are commonly exposed at the surface after the younger alluvium has been eroded away.

One area of undifferentiated basaltic lava and gravels extends eastward from Great South Road and Razorback Road and terminates at the property of 219 SH2 (Figure 1). These basalts extend beneath the undifferentiated tuffs shown at the southern edge of Figure 1 and have been intersected at depths from 8 m to 15 m below ground level in drillholes 72_9503 and 61_353 shown in the same figure. Interpretation of the geological map of the area together with the drillhole logs indicates the basalt lava forms a continuous layer underlying the surficial Tauranga Group valley fill deposits to the south of McPherson Quarry. This lava deposit may connect to a separate lava flow located to the east of the quarry footprint (Figure 1). However, there is no indication that these combined lava deposits extend as far as the current or future footprints of McPherson Quarry (Edbrooke 2001, WRC 2020b).

3.2 GROUNDWATER SYSTEM

There are two main aquifers present within the area presented in Figure 1:

- The fractured greywacke of the hill country and at depth beneath the area from the hills to SH2.
- The basaltic lava deposits.

3.2.1 Greywacke Aquifer

The fractured greywacke, which underlies the hill country is expected to act as a low to moderately permeable aquifer. This expectation reflects our experience of the hydrogeological behaviour of the greywacke to the east of the quarry at Mangatangi (Golder 2012) and in the coal mining areas around Huntly.

Flows in the streams discharging from the hill country have not been monitored in the area of the quarry. However, experience gained from measuring stream flows at Mangatangi (Golder 2012), combined with observations made at the McPherson Quarry, indicates:

- The deeply incised streams to the east and west of the quarry are likely to carry permanent flows, supported by groundwater discharges from the greywacke aquifer.
- The less deeply incised stream located immediately to the west of the existing quarry is unlikely to intersect the groundwater system of the greywacke hills and is unlikely to carry permanent flows.
- The existing floor of the quarry, at an elevation of approximately 40 mRL, intersects the greywacke groundwater system as demonstrated by the presence of a spring at the northern end of the quarry.

The greywacke aquifer is recharged by rainfall across the hill country. Groundwater from the greywacke aquifer discharges to the deeply incised streams that flow out of the hill country. Additionally, small springs and seeps are likely to be present along the southern toe of the hills, marking points where groundwater from the greywacke aquifer discharges to surface.

Hydraulic testing and groundwater modelling work has been undertaken to support the application for consents authorising the development of a proposed coal mine at Mangatangi, approximately 10 km east of McPherson Quarry. The documented work (Golder 2012) indicates the bulk hydraulic conductivity of the greywacke in this area is within the range from 1×10^{-6} m/s to 1×10^{-8} m/s. Our experience from the northern Waikato indicates this range is reasonably representative of unweathered greywacke bulk rock permeability. The bulk hydraulic conductivity of the weathered greywacke around McPherson Quarry is likely to be at least an order of magnitude less than the values presented above due to the accumulation of clay in the fractures.

Greywacke basement rock extends to the south from the hill country, at depth beneath the alluvial deposits. However, bores drilled to up to 120 m below ground within 1.5 km of the quarry have not intersected the basement greywacke. Therefore, the depth of burial of the greywacke basement beneath the property 219 SH2 is interpreted to exceed 120 m.

Groundwater levels within the greywacke aquifer in the area of the proposed McPherson Quarry expansion are controlled by rainfall recharge and the elevations of the streams to the west and east of the quarry. The groundwater table along the streams will correspond to the stream gully inverts. In the area between the two streams the groundwater table elevation will fluctuate seasonally in response to variations in rainfall.

Under natural conditions we would expect the groundwater table within the proposed McPherson Quarry footprint to be a subdued reflection of the overlying topography. The groundwater table elevation beneath the ridge within the footprint is expected to be to be at an elevation ranging from 100 mRL to 150 mRL, dropping off steeply toward the streams on either side. However, the groundwater table is also likely to have been drawn down steeply toward the floor of the existing quarry, with this drawdown evidenced by the presence of a small spring at the northern edge of the quarry at an elevation of approximately 40 mRL.

3.2.2 Basalt Aquifer

The basaltic lava deposits are relatively thin compared to the greywacke rock mass. However, they are expected to be characterised by higher permeability and consequently represent a significant localised groundwater resource. The basaltic lavas are also exposed at surface, with groundwater from these discontinuous aquifers discharging as springs at the down-gradient ends of the exposed flows.

The basalts are recharged from rainfall where the basalts are exposed at surface. Where the lavas have been deposited in pre-existing gullies in the greywacke hill country, such as the basalt flow to the east of McPherson Quarry (Figure 1), they may receive additional recharge from the hillside run-off and from groundwater discharges from the greywacke. In the case of the basalt flow under property 219 SH2, WGA expects the recharge to be predominantly derived directly from rainfall, with little contribution from run-off or from the underlying greywacke aquifer. The spring on property 219 SH2 is interpreted as being a discharge point for groundwater flowing eastward within the basalts (WRC 2012).

The groundwater table within the basalts underlying and to the west of property 219 SH2 is expected to range upward from the elevation of the stream (22 mRL to 26 mRL) to approximately 30 mRL. A higher groundwater elevation within the basalt would simply lead to surface ponding and increased surface run-off.

As noted in Section 3.1, the information available on the local geology provides no indication that the combined lava deposits shown in Figure 1 extend as far as the current or future footprints of McPherson Quarry. Furthermore, there is no indication of a direct hydraulic connection between the greywacke aquifer in the area of McPherson Quarry and the basalt aquifer under the property 219 SH2. It should also be noted that the spring is located upstream from the stream reaches that most closely approach the quarry.

4 EFFECTS ON GROUNDWATER

4.1 GROUNDWATER DRAWDOWN IN GREYWACKE AQUIFER

Groundwater discharges into the existing and proposed McPherson Quarry are derived from seepage through the greywacke aquifer as described in Section 3.2.1. Currently, groundwater in the greywacke aquifer around the proposed McPherson Quarry expansion discharges to the deeply incised streams to the east and west of the quarry, or into the base of the existing quarry.

The proposed expansion of McPherson Quarry will not change the overall local groundwater flow pattern in the greywacke aquifer as described above. However, deepening of the quarry and expansion of the quarry footprint will lead to groundwater drawdown of greater extent and magnitude under the surrounding hillsides. The groundwater drawdown is unlikely to extend beyond the nearest streams to the west and east of the quarry as the permanent water flows in these streams will act to limit drawdown of the groundwater beyond the stream inverts.

Groundwater drawdown to the north is unlikely to extend beyond a distance of approximately 400 m from the quarry. This distance is half the distance between the deeply incised streams to the west and east of the quarry.

4.2 EFFECTS ON SPRING WATER FLOWS

Groundwater flows to the spring at property 219 SH2 are derived from seepage from the west through the basalt aquifer, as described in Section 3.2.2.

As noted in Section 3.2.2, there is no indication of a direct hydraulic connection between the greywacke aquifer in the area of McPherson Quarry and the basalt aquifer under the property 219 SH2. The two aquifers receive recharge from sources that are spatially and hydraulically separate. WGA does not expect the greywacke aquifer around McPherson Quarry to be contributing significantly to groundwater flows in the basalt features to the south or east of the quarry.

Groundwater pressure in the greywacke to the south of the quarry may be drawn down due to the deepening of the quarry. However, this possible drawdown of groundwater pressure in the greywacke beneath the alluvial deposits of the Tauranga Group is unlikely to affect flows in the basalt aquifer due of the lack of hydraulic connection between the two aquifers.

If it is conservatively assumed that a hydraulic connection between the two aquifers does exist close to the southern edge of the exist quarry, despite lack of evidence for such a connection, an initial approximation for flows between the two aquifers in the area of the quarry can be calculated. This approximation is based on the use of the Darcy equation to calculate the flows through a specified cross section of an aquifer. In this case, the flows between the unnamed tributary of Waipunga catchment and the quarry have been approximated in Table 1. The approximation indicates that the greywacke aquifer in the area of the quarry contributes, at most, between 0.2 L/s and 0.02 L/s to the flow in the stream, and by extrapolation to flows in the basalt aquifer. The reversal of the hydraulic gradient due to the deepening of the quarry would result in a flow of between 0.08 L/s and 0.008 L/s from the stream or the basalt aquifer to the quarry.

Table 1: Production Bore and Observation Bore construction details.

Parameter	Units	Current		Projected	
Hydraulic conductivity	m/s	1×10^{-7}	1×10^{-8}	1×10^{-7}	1×10^{-8}
Flow path width	m	600	600	600	600
Flow path width	m	20	20	20	20
Groundwater table in greywacke	mRL	80 (1)	80(1)	0	0
Stream elevation	mRL	25	25	25	25
Head change along flow path	m	55	55	-25	-25
Distance from quarry to stream	m	400	400	400	400
Groundwater flow rate	m^3/s	2×10^{-4}	2×10^{-5}	-8×10^{-5} (2)	-8×10^{-6} (2)
	L/s	0.2	0.02	-0.08 (2)	-0.008 (2)

Note: 1) Elevation of 80 mRL for greywacke groundwater level does not take into account drawdown generated by existing quarry.

2) Negative flows indicate groundwater flow from the stream toward the quarry.

These approximations are considered to overstate both the groundwater flows that currently occur and the changes in flows that are likely to arise as the quarry is deepened. In practical terms, even these approximated flows are unlikely to make a detectable difference to flows in the stream. Furthermore, the spring at the property 219 SH2 is unlikely to be the sole discharge point for groundwater from the basalt aquifer. Any potential reduction in flows at the spring, even if a hydraulic connection to the greywacke aquifer does exist, is unlikely to be measurable.

5 CONCLUSIONS

McPherson Quarry is developed into the greywacke hill country to the north of SH2. The proposed quarry expansion would increase the footprint of the existing quarry by a total of approximately 31 ha. The floor of the quarry is also to be deepened from the current level of 41 mRL to 0 mRL. This expansion and deepening of the quarry will result in groundwater drawdown within the fractured greywacke aquifer that underlies the hill country.

Under natural conditions we would expect the groundwater table within the proposed McPherson Quarry footprint to be a subdued reflection of the overlying topography. The groundwater table elevation beneath the ridge is expected to be to be at an elevation ranging from 100 mRL to 150 mRL, dropping off steeply toward the steams on either side.

During operation of the expanded quarry, groundwater pressures at the quarry will be drawn down to a level matching the elevation of the floor of the quarry. Groundwater drawdown is unlikely to extend beyond the nearest streams to the west and east of the quarry as the permanent water flows in these streams will act to limit potential groundwater drawdown in these directions. Drawdown within the greywacke is also unlikely to extend beyond approximately 400 m to the north of the planned quarry extension.

The spring on property 219 SH2 is interpreted as being a discharge point for groundwater flowing eastward within the shallow basaltic lavas to the southwest of the quarry. This basalt aquifer is recharged by rainfall on surficial basalts to the west of the spring.

There is no evidence for a potential direct hydraulic connection between the greywacke and basalt aquifers. There is also no indication that the groundwater within the basalt aquifer could potentially be derived from the greywacke aquifer in the vicinity of the quarry.

Groundwater pressure in the greywacke deeply buried beneath at least 120 m of Tauranga Group alluvium to the south of the quarry may be drawn down due to the deepening of the quarry. However, this possible drawdown of groundwater pressure in the deep greywacke is unlikely to affect seepage flows in the basalt aquifer due of the lack of hydraulic connection between the two aquifers.

WGA concludes that the proposed expansion of McPherson Quarry will have less than minor effects on groundwater flows discharging from the spring on the property at 219 SH2.

6 REFERENCES

Edbrooke, S W (complier) 2001. Geology of the Auckland area. Institute of Geological and Nuclear Sciences 1:250 000 geological map 3. Institute of Geological and Nuclear Sciences Ltd.

Golder 2012. Mangatangi Mine hydrogeological assessment. Report produced for Glencoal Energy Ltd by Golder Associates (NZ) Limited. October 2012.

Kinetic 2019. Resource consent application & assessment of environmental effects – updated post-lodgement. Report produced for McPherson Resources Limited by Kinetic Environmental Consulting Limited. 12 December 2019.

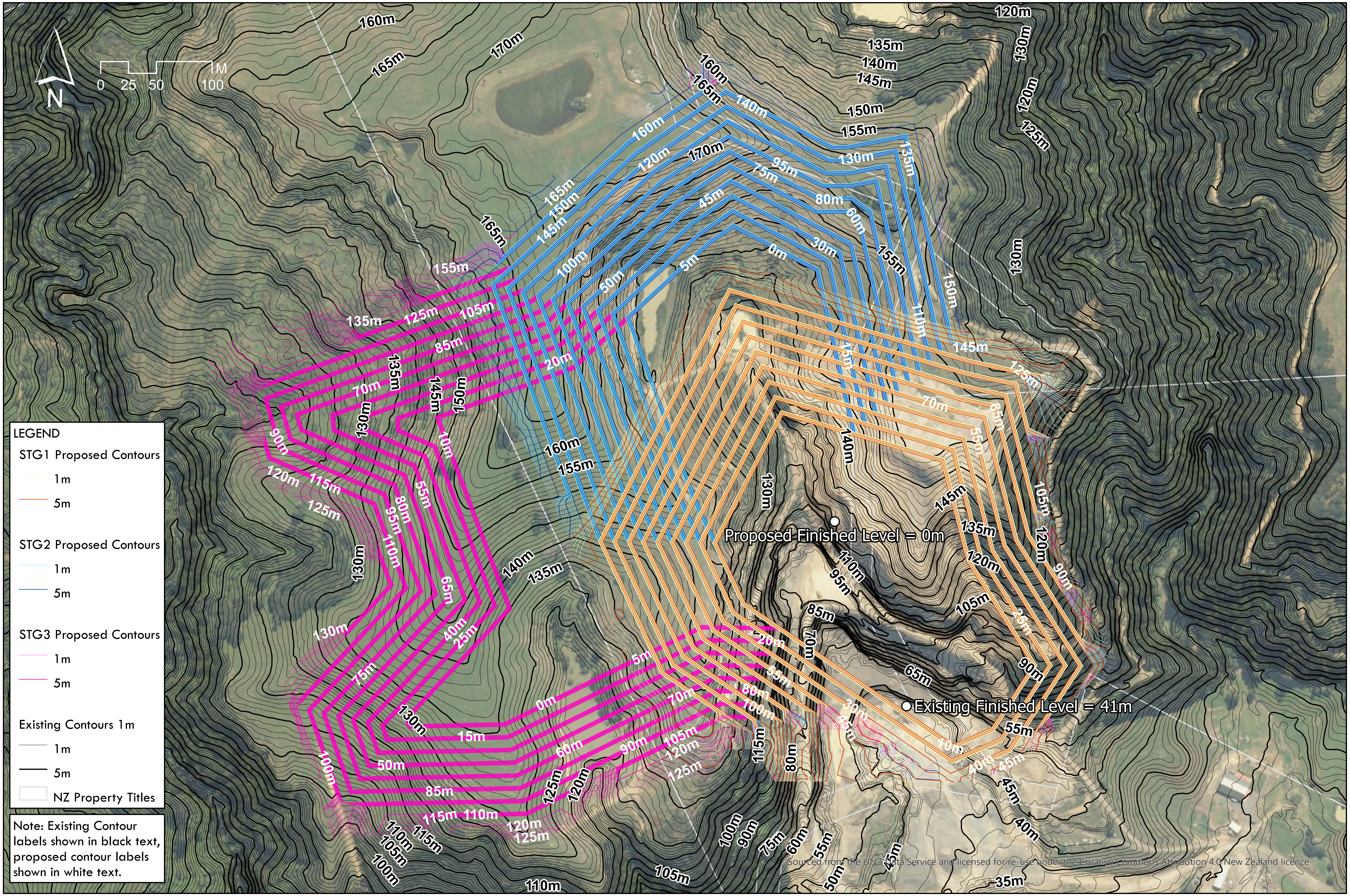
WRC 2012. Consent Evaluation Report. Mt William Spring Ltd application for a surface water take. RC9706. Evaluation report

WRC 2020a. On-line regional mapping facility for topographic contours provided by the Waikato Regional Council. Data downloaded from: https://waikatomaps.waikatoregion.govt.nz/Viewer/?map=8d6d6fda779b4e59951953ae97d0ec4a. 19 November 2020.

WRC 2020b. On-line groundwater regional mapping facility provided by the Waikato Regional Council. Data downloaded from: https://waikatomaps.waikatoregion.govt.nz/Groundwater/

APPENDIX A

MCPHERSON QUARRY PROPOSED LAYOUT



Existing & Proposed Contours (Stages 1-3) - Zoom A

McPherson Quarry | Scale 1:3,000 at A3 | November 2020 | R0

Brett Sinclair
PRINCIPAL HYDROGEOLOGIST

Telephone: +64 21 190 1605

Email: bsinclair@wganz.co.nz

CHRISTCHURCH
4 Ash St
Christchurch Central
Christchurch NZ 8011
Telephone: +64 29 201 2996

HAMILTON
Room 38 'The Homestead', 10 Bisley Rd
Hamilton NZ 3214
Telephone: +64 27 609 4618

AUCKLAND
2/2 Boundary Road,
Catalina Bay, Hobsonville Point
Auckland, NZ 0618
Telephone: +64 21 190 1605

WALLBRIDGE GILBERT AZTEC
www.wganz.co.nz
bsinclair@wganz.co.nz