▪ report

# Waikaka Gold Limited – Technical Assessment of Proposed Groundwater Take and Discharge


ΣA Environmental Associates Ltd

▪ report

# Waikaka Gold Limited – Technical Assessment of Proposed Groundwater Take and Discharge

Prepared for

Waikaka Gold Limited

By

Environmental Associates Ltd

December 2022 and Updated March 2024

Environmental Associates Ltd
70 Macandrew Road
P O Box 2079
South Dunedin 9044
Telephone +64 03 777 3546

# Revision History

| Revision Nº | Prepared By | Description | Date |
|---|---|---|---|
| A | Tom Heller | Draft AEE Report | March 2022 |
| Final | Tom Heller | Final Draft AEE report | September 2022 |
| Final A | Tom Heller | Final AEE Report | December 2022 |
| Final B | Tom Heller | Final AEE Report | March 2024 |
| | | | |

# Document Acceptance

| Action | Name | Signed | Date |
|---|---|---|---|
| Prepared by | Tom Heller | TH | Mar 2024 |
| Reviewed by | Tom Heller | TH | Mar 2024 |
| Approved by | Tom Heller | TH | Mar 2024 |
| | **Environmental Associates Ltd** | | |

## Table of Contents

## Appendices



## List of Tables



## List of Figures

# 1 Introduction

The following report provides analysis and assessment of a proposed (medium-term) temporary non-consumptive groundwater abstraction for mine pit (pond) dewatering from an aquifer(s) at Waikaka, and discharge (including treatment) of any excess pond dewatering water to land, whereby it may enter local groundwater and surface water (Waikaka Stream).

The proposed Waikaka Gold Limited (WGL) groundwater abstraction comprises temporary medium-term construction dewatering for the purpose of establishing an excavated mine pit containing an active mine pond. The primary aim of the groundwater abstraction is to maintain the local water level at desired levels to allow temporary (transient) excavation and mine operation. Within the quantum of water that is expected to be pumped from the active mine pond, some additional use of the water includes wash processing and possibly some site dust suppression and rehabilitation. Although any water use for dust suppression and rehabilitation will be within permitted activity rates for water use. Excess groundwater from the dewatering process will be discharged to land, where any turbid water may be temporarily contained and treated including potential flocculation, then discharged as some seepage to the local water table aquifer, with the balance (majority) of the treated discharge water to the Waikaka Stream.

This report specifically addresses the following matters with respect to the proposed groundwater take and discharge activities:

- The location, environmental setting and dewatering/discharge targets (levels and responses) required for the proposed activity,
- An assessment of aquifer hydraulic parameters from site-aquifer testing data,
- Assessment of required site dewatering and discharge flows to maintain optimum water levels to enable the mining activity,
- Analysis and discussion of abstractive effects of the groundwater take activity which focuses upon desired (internal) site water level reduction and expected external water level reduction and stream depletion over time and distance,
- Analysis and discussion of effects of the discharge activity, with a focus upon effects of the resultant discharge-seepage to groundwater and discharge to surface water,
- Discussion of any potential effects upon stream flow – groundwater connections with respect to temporary river diversions (note that the temporary river diversion activities are separate to groundwater take and discharge, and are presented in Hall, 2024), and
- Suggested conditions of resource consent for the proposed groundwater take and discharge, and particularly to address matters of monitoring and compliance/reporting for the activities.

This report has also been updated to reflect the most recent changes to mining methodology to be employed by Waikaka Gold Limited at the site. The changes made (in terms of groundwater take for mine dewatering and discharge of treated dewatering water to the Waikaka Stream), are mainly bought about by the reduced scale of final mine void area. Although, for the purposes of the assessments contained within this report, the initial mine void size/area has been retained.

The following section of this report presents the general environmental setting and proposed activities in relation to groundwater take and discharge for the WGL Waikaka mining proposal.

## 2 Location and Environmental Setting

The proposed WGL groundwater take (and discharge) referred to within this report is for (medium-term) temporary non-consumptive mine pit (pond) dewatering from an aquifer(s) associated with the Waikaka River valley. The proposed groundwater abstraction comprises temporary medium-term construction dewatering for the purpose of establishing an excavated mine pit containing an active mine drainage pond/sump for water abstraction purposes. The primary aim of the groundwater abstraction is to maintain the local water level at desired levels to allow temporary (transient) excavation and mine operation. Figure 2.1 below shows the generalised location and extent of the proposed mining area. Note that for purposes of consistency, accurate mine location plans are provided within the WGL Application Report (Town Planning Limited, 2024), which should be referred to in conjunction with this technical report.

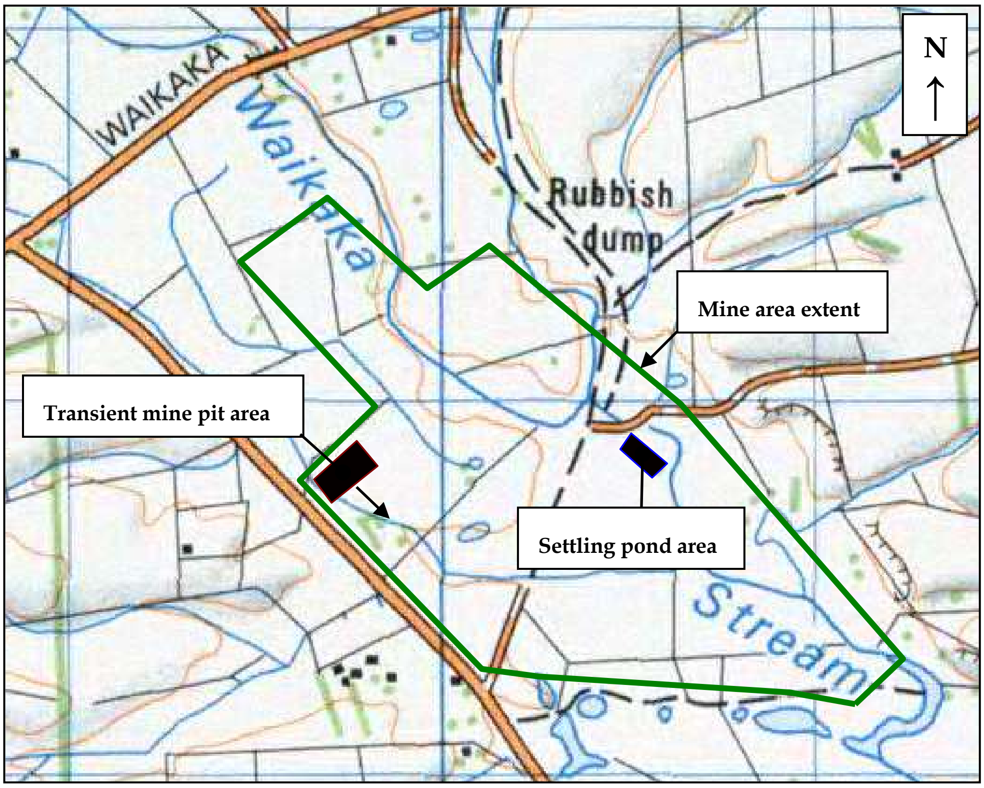


**Figure 2.1 General Location of Proposed Mine Extent**

The generalised mine area (shown within the green outline on Figure 2.1), approximates the maximum extent of the mining operation for resource consent purposes, which is inclusive of all mine excavation and dewatering activities. There are some areas outside of the mine footprint that may contain stockpiles and infrastructure/formwork. The proposed initial settling-infiltration pond area is provided consistent with Town Planning Limited, (2024).

An example of the advancing transient mine pit and pond area (for dewatering purposes) is as shown on Figure 2.1, with initial advancement to the southeast. The mine pit dimensions, advancement and implications for dewatering are discussed further (below) within Section 4 this report.

The initial mine dewatering discharge settling and treatment area (Figure 2.1) provides for a location whereby any net abstracted groundwater (containing sediment), from the advancing mine pit may be discharged to land. The discharge encompasses treatment such as initial settling, polishing and filtration. Some of the discharge may seep to local groundwater with the balance (majority) of the treated mine dewatering (water) being discharged to surface water (Waikaka Stream) via surface drain(s).

*Hydrology*

The proposed activity is located in the Waikaka Stream sub-catchment of the Mataura River. This location is within the Mid-Mataura Surface Water Resource Zone, which extends from Nokomai to Gore. The Waikaka Stream has some recreational values and supports a locally and relatively important brown trout fishery. The Waikaka Stream is a perennial tributary of the Mataura River, which supports trout spawning and other in-stream ecology. The Waikaka Stream catchment is not protected under the Mataura River Water Conservation Order (1997). Environment Southland provides Waikaka Stream flow monitoring information for the Willowbank site. This site includes for the majority of catchment flow and has a catchment area of 318 km$^2$. A summary of Waikaka Stream flow characteristics is provided below in Table 2.1, along with correlated (synthetic) flow statistics derived for the Waikaka Stream at the WGL mine site (from catchment specific flows).

**Table 2.1**

**Waikaka Stream at Willowbank and the WGL Mine Site**

**Hydrological Statistics**

| Statistic | Waikaka Stream at Willowbank (L/s) and (L/s/km$^2$) | Waikaka Stream at WGL Mine Site (L/s) and (L/s/km$^2$) |
|---|---|---|
| Mean /S-Mean | 3,345/10.5 | 2,016/11.2 |
| Median /S-Median | 1,783/5.6 | 1,070/5.9 |
| 7-Day MALF/SMALF | 461/1.4 | 277/1.5 |
| Catchment Area | 318 km$^2$ | 180 km$^2$ |

In Table 2.1 above, the flow estimates for the Waikaka Stream at the WGL mine site have been obtained from the specific flow statistics for the Waikaka River at Willowbank, with adjustment and apportioning of specific flow in relation to relative sub-catchment area and elevation. The flows derived for the Waikaka Stream at the WGL mine site however, remain as estimates for the purposes of presenting sub-catchment stream flows.

***Hydrogeology***

The hydrogeology of the aquifer(s) that exists within and surrounding the identified mine site extent may be broadly described as a low yielding fragmented and separated aquifer system, consisting of a thin water table aquifer, a thin and intermittently discontinuous intermediate confined aquifer and a moderately thick continuous deep confined aquifer. The project area is relatively flat and is within the Waikaka Stream valley floor, which does not appear to occur within any designated groundwater zone and nor does it occur within any mapped aquifer occurrence. It is as above, situated within the Waikaka Stream catchment, a sub-catchment of the Mataura River.

The majority of the mine site extent has been previously mined and evidence of this is apparent from the historic dredging and workings that occurred over most of the local Waikaka Stream valley floor at the site. The historic and relatively shallow dredging operation, targeted deposits that occurred within and locally underlying, Quaternary alluvium or recent gravels. The WGL mining operation targets the deeper placer gold deposits that occur at depth and within the Tertiary "wash" associated with the continuous deeper aquifer extent.

The type, distribution and occurrence of strata has been informed by previous investigation reporting (of AquaFirma Limited, 1998), provided as **Appendix A** and more recent investigation drilling, and aquifer testing and reporting by WGL (**Appendix B**). The representative site strata profile (including aquifers), may be described as:

- Upper water table aquifer – consisting of consolidated Quaternary alluvium and Recent gravels. Additionally, historic (shallow) dredge tailings occur locally and may be mixed with alluvial deposits. In some cases, alluvium and/or dredge tailings may be absent and occur as clay or clayey silts. The overall thickness of these deposits can vary up to approximately 5 m below land surface (BLS). However, the saturated thickness of the upper deposits (where saturation is evident), is only up to approximately 2 m. Water levels measured within the upper water table aquifer are generally at about 1.5 to 2.5 m BLS. The upper deposits do not appear to contain any significant groundwater yield and may be described as being relatively poor from a groundwater resource perspective. Although, in relative proximity to, and where a possible connection exists to the Waikaka Stream, sufficient aquifer yield may be apparent for a viable water supply.

- Underlying and containing the upper deposits, and occurring in variable thicknesses, is relatively thick clay and clayey silt strata of Tertiary age. These clays are massive, consolidated and separate the three main identified aquifers that occur within the mine site extent. The clays may be described as being relatively impermeable and act as a confining layer(s) for deeper groundwater occurrence. The clays that initially occur below any water table aquifer are generally about 4 to 6 m in thickness.
- An intermediate intermittently discontinuous stratified and unconsolidated silty-gravel aquifer of varying thickness occurs within the clays (when apparent), between the upper water table aquifer, and the Tertiary wash aquifer at greater depth. The intermediate aquifer is of Tertiary age and is quite thin (only to 3 m generally), and may occur as either one unit or multiple units in vertical with intervening clays. The head or potentiometric surface measured from this aquifer is generally above that of the associated water table aquifer, to approximately at or just above land surface. This aquifer may be described as being low yielding and very poor from a groundwater resource perspective. This aquifer generally (centrally) occurs at up to depths approximately equivalent to about two-thirds of the depth to the top of the Tertiary wash aquifer.
- As above, clays and clayey silts occur within and separate the intermediate confined aquifer from the deeper wash aquifer. Thicknesses of continuous clay strata ranges from approximately 4 m up to and in excess of 10 m.
- The Tertiary wash aquifer layer (as above) is the target for the deeper placer gold deposits by WGL. The layer consists of silty quartz gravels and is relatively consolidated. Depths to the deeper confined aquifer are approximately between 15 m to 30 m BLS depending upon location. Aquifer head measured within this layer is generally at or just above local land surface. The thickness of the strata is relatively consistent at about 10 m and a low potential groundwater yield is available from the aquifer. However, from a groundwater resource perspective, this aquifer would be described as being poor to low yielding.

It should also be noted that from previously reported information (AquaFirma Limited, 1998), and more recent investigation drilling and reporting by WGL, the relative depth (from BLS), to the Tertiary wash aquifer layer increases from about 15 m in the southeast quadrant of the mine site extent, to approximately 30 m in the northwest quadrant of the mine site. However, whilst overall profile depths increase in a north-westerly direction, the consistency in strata profile as described above, generally remains, with additional thicknesses of clay and clay-silt occurrence. Additional reporting for aquifer hydraulic parameters is contained in Section 3 of this report (below).

Recharge to the aquifers located at or adjacent to the mine site (as described above), is most likely to be dominated by rainfall infiltration, particularly to the unconfined water table aquifer. However, given the limited aquifer saturated thickness and the extent of local land drainage, it is unlikely that significant amounts of stored groundwater volume exist within the water table aquifer for any period of time. Rainfall recharge to the greater catchment area (outside of the unconfined aquifer footprint), is expected to be intercepted by surface drainage features and form part of the catchment specific yield for the Waikaka Stream. Some surface water interaction between the Waikaka Stream and the local water table aquifer may be plausible. However, it is expected that the Waikaka River forms a groundwater sink, effecting predominantly a groundwater discharge to the stream from the adjacent water table aquifer.

The occurrence and extent of the Tertiary confined aquifers is not accurately known. This is due to the depth to the formations outside of valley floors, and the extent of faulting in the general area. Some deeper wells in vicinity of the WGL mine area are expected to intersect the Tertiary formation for water supply purposes, which is typically for stock water and/or dairy shed use. The potential extent of the Tertiary confined aquifer formation (Figure 2.2), is shown based on the Institute of Geological and Nuclear Sciences (GNS) QMAP 20, (2003) which provides basement, formation outcrop and faulting extents.

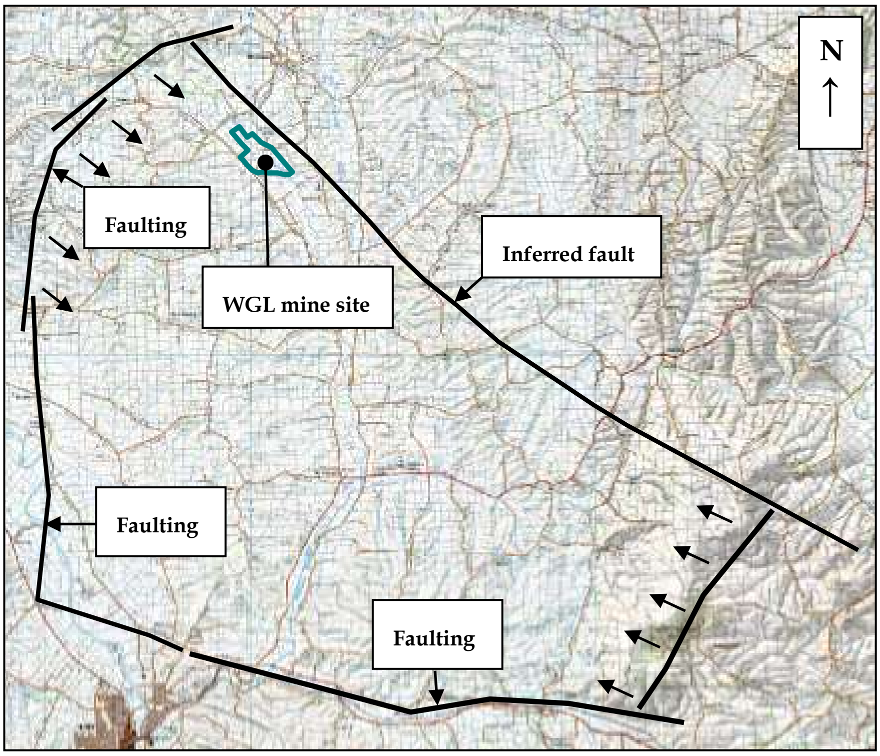


**Figure 2.2 Map of Tertiary Formation Extent (from GNS, 2003)**

**Note: Arrows indicate recharge zones.**

From Figure 2.2, the mapped extents of the Tertiary confined aquifer formation occur within faulted areas and laterally between formation outcrop areas. The inferred fault to the northeast of the WGL mine site is consistent with GNS (2003) mapping, which also marks the lateral extent of Tertiary outcrop to the northwest and southeast. Recharge zones for the formation are only expected to occur consistent with formation occurrence outcrop in the northwest (via faulting) and southeast (exposure). Recharge to the confined aquifer(s) will most likely be solely from rainfall infiltration to the aquifer outcrop areas, and/or at the extents of the formation outcrop where faulting and vertical seepage occur. Given the occurrence and thickness of clay strata confinement of the deeper aquifers, there is most unlikely to be any surface water interaction and consequently any recharge component originating from surface waters for those aquifer units. Aquifer outflow for the formation is most likely to be diffusely upward over a large area (with positive potentiometric head), into upper (shallower and surface connected) units.

In Figure 2.2 the WGL mine site is shown to be located within the Tertiary aquifer extents, albeit in the northerly quadrant of the formation. The Tertiary formation is laterally extensive, and consistent with the findings in AquaFirma (1998), it may extend beyond 10 km, to approximately 18.6 km from the site at its farthest location. The findings in this report in relation to the mapped Tertiary aquifer extent, appear consistent with the AquaFirma (1998) discussion of formation boundaries due to outcrop and faulting occurrence.

A composite piezometric surface map of local aquifer water levels in vicinity of the mine site was mapped and reported within AquaFirma Limited, (1998), and has been reproduced in Figure 2.3 below. The piezometric surface map consisted of water levels taken from all known investigation wells at that time, and of which is considered to still be reflective of the current local groundwater environment. The groundwater contours (Figure 2.3) show a general direction of groundwater flow from the Northwest to Southeast, approximately parallel to flow in the Waikaka Stream. Whilst it is not overly apparent, there is some indication from the groundwater contours that groundwater discharge to the Waikaka Stream occurs over the reach of stream associated with the proposed WGL mine site.

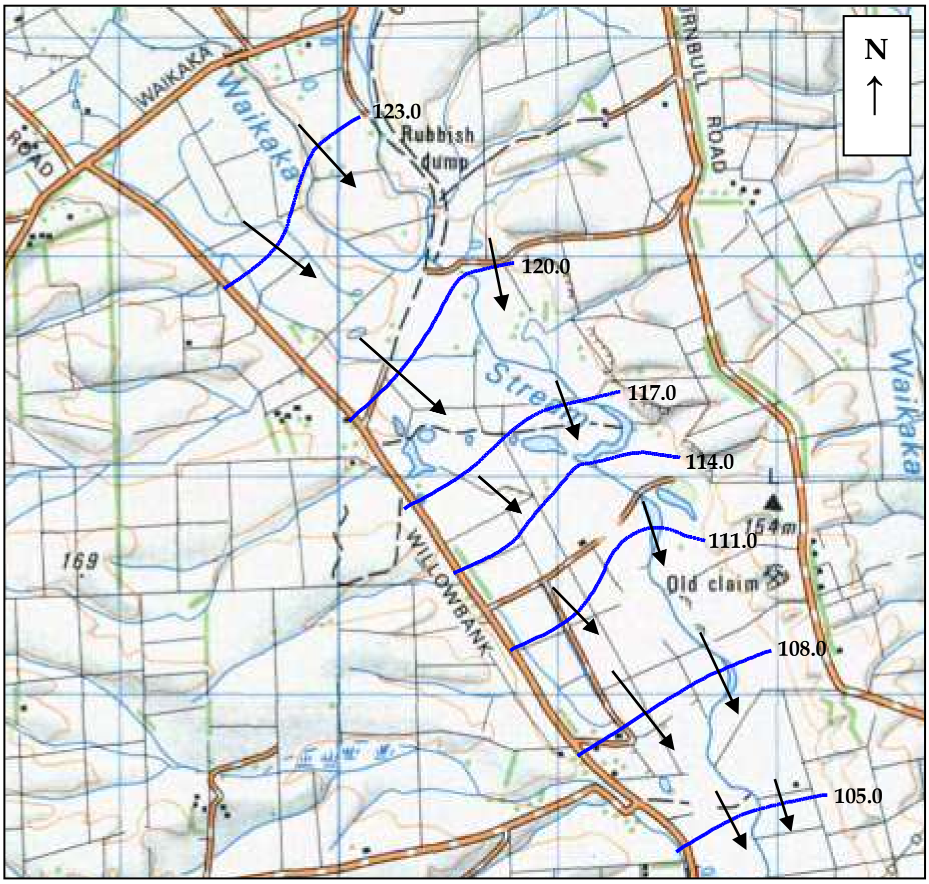


**Figure 2.3 Piezometric Contour Map (from AquaFirma Ltd, 1998)**

**Notes: Piezometric contours at relative datum and 3 m intervals.**

**Arrows infer direction of groundwater flow.**

There is some identified groundwater use from local aquifers that occur in the Waikaka Stream catchment and in proximity of the WGL mine site. Local water wells identified include a predominant use of water for stock watering and dairy use. There are a handful of water takes associated with some deeper wells within approximately 6 km of the mine site. Also, there does not appear to be any authorised surface water takes at or immediately upstream of the WGL mine site, and/or within 5 km downstream of the site. Further analysis and assessment of wells and water takes that may be associated with the proposed WGL activity, is contained within Section 5 of this report.

### *Proposed Activity*

The proposed WGL mine pit dewatering activity essentially occurs in two stages:

- An initial (start-up) dewatering activity is required where a starting pond is excavated and progressively dewatered to the target dewatering depth or level. This process is likely to incur the greatest short term peak dewatering rates and volumes to overcome the initial stored volume within the mine pit pond and to initially lower the water level within the aquifer.

  The initial dewatering invert level as assessed within this report is associated with approximately a 30 m reduction in the groundwater level over the start-up mine pit area. The rates and volumes of groundwater abstraction assessed for this dewatering stage are provided in Section 4 of this report, and
- On-going transient dewatering is required to maintain the local groundwater level over the advancing mine pit area, progressing up to an assessed approximate level of 40 m below the initial static water level prior to start-up. The rates and volumes of groundwater abstraction during the transient progression of the mine pit pond are expected to be lower (over the medium and long term), compared to initial start-up abstraction rates. However, given the variability in depth and the progression and size of the mine pit, there is expected to be some short to medium term variation in dewatering rates over time. Some variability in basement or target depth is anticipated during the progression of the mine, in which short-term variability in abstraction rates may likely occur. However, it is expected that short term variation in abstraction rates will not exceed expected start-up abstraction rates, and that medium-term or annualised volumes of abstraction would be more moderated. The maximum short-term and medium-term transient dewatering rates and volumes are assessed and provided in Section 4 of this report.

Discharge of the transient mine pit dewatering water will be required to be continually undertaken to land at the designated discharge settlement pond area. The discharge will essentially contain only suspended sediment from the mine pit pond which will settle out in the settlement pond treatment area, before some seepage occurring through the local alluvial gravels, with the majority of the discharge occurring to the Waikaka Stream via designated drains. Similar to the dewatering rates, the discharge rates are expected to be initially higher than in the medium to longer term. Sufficient size, depth, seepage and retention time is provided for in the design of the designated settlement pond area.

Consideration of required dewatering to the target mine pit levels below initial static water level in the aquifer does provide some expected conservatism in the required yield or volume of abstraction. This is due to the progression of the mine pit from start-up and that resultant dewatering rates are also a function of the previously cumulative dewatering undertaken. The effects of the water level lowering and the discharge of the abstracted groundwater are discussed in Section 5 of this report.

# 3 Aquifer Hydraulic Parameters

Aquifer testing, along with investigation drilling at the WGL mine site, had been performed with previous investigations as reported by AquaFirma Limited, (1998) for L and M Mining Limited. Additionally, and alongside the previous aquifer testing conducted at the site, WGL have more recently undertaken test drilling and aquifer testing to confirm aquifer hydraulic parameters and the extent of groundwater resources (aquifers) at the mine site. Figure 3.1 below identifies a total of 5-sites that have been investigated with aquifer testing procedures to determine aquifer hydraulic properties, within or adjacent to the proposed WGL mine site.

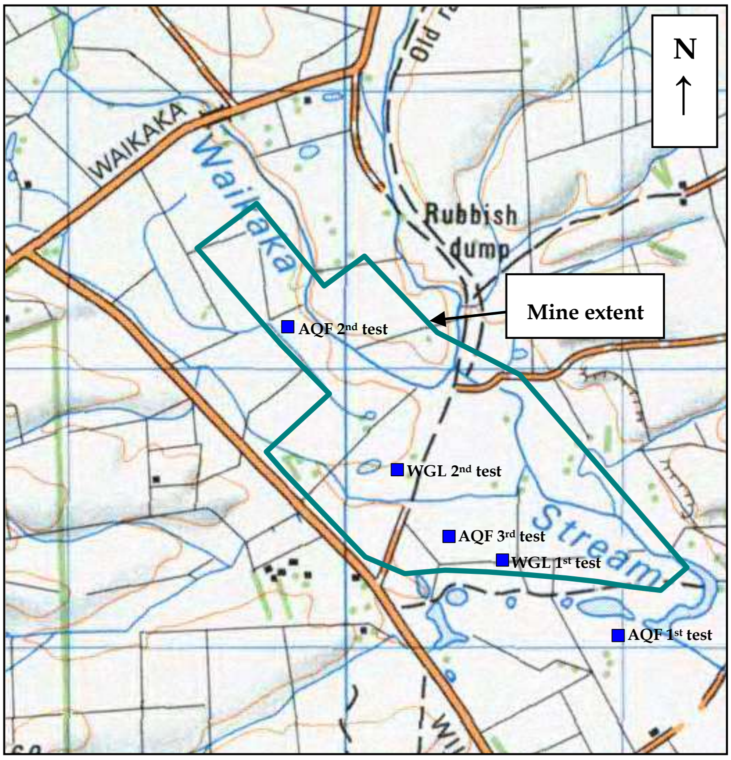


**Figure 3.1 Location of Aquifer Test Wells**

Originally, three aquifer tests were undertaken by AquaFirma (AQF) to characterise and predict potential dewatering flows required for mine site development and operation. A further two sites were tested by Waikaka Gold Limited (WGL) that essentially occur within a transect running Southeast to Northwest, along the broad line of mine progression (Figure 3.1). During (aquifer) test well placement, and consistent with other investigation holes drilled within and adjacent to the proposed WGL mine site extent, the upper water table aquifer and intermediate confined aquifer were consistently found to be of such a small saturated thickness and low yield, that no conventional aquifer testing was able to be undertaken within those formations.

Essentially, there was insufficient water and aquifer hydraulic capacity to support any meaningful aquifer test rate required to determine aquifer hydraulic properties. The extent of investigation drilling also supports the premise of the upper water table aquifer and intermediate Tertiary aquifer being of very low yield and hydraulic capacity. This was also eluded to within the AquaFirma Limited (1998) report. Both the previous aquifer testing of AquaFirma and the more recent aquifer testing of WGL solely managed to conventionally and adequately test the deeper Tertiary wash aquifer layer, due to its greater saturated thickness and access for a submersible pump. Notwithstanding the limitation on aquifer testing, maximum aquifer test rates achieved for the lower wash layer were only within the range of 0.6 L/s to 3.3 L/s.

It is plausible that slug testing of the upper water table aquifer and intermediate confined aquifer may have provided some results for aquifer hydraulic properties of the two layers. However, given the low saturated thicknesses and irregular discontinuous nature of the formations, together with the low head able to be achieved by slug testing, it would be most unlikely that any meaningful test results would have been able to be achieved at the test well, let alone at any placed satellite piezometers. The aquifer testing undertaken for WGL was of a similar nature to the previous testing undertaken for L and M Mining. The testing comprised of constant rate pump well abstraction (from the wash layer), with aquifer displacement measured in satellite piezometers and the pump well. The more recent testing was designed by Environmental Associates Ltd, and Southdrill contractors undertook piezometer placement, pump placement and operation, installation of monitoring equipment and monitoring during the test. To ensure that no recirculation of water occurred during the test, the test discharge was reticulated via a lay-flat pipe to a drain that discharged to the Waikaka Stream. As mentioned, during the aquifer test, water level readings were taken at the pump well and in adjacent piezometers located within the pumped aquifer placed at variable distances from the pump well. Monitoring of intermediate and upper water table aquifers was also performed with levels obtained from shallower representative piezometers. The aquifer test data for both the AquaFirma and WGL aquifer testing is contained within the associated excel spreadsheet files: **Aquifer Test 01_AQF Data.xls**, **Aquifer Test 02_AQF Data.xls**, **Aquifer Test 03_AQF Data.xls, Aquifer Test 01_WGL Data.xls, and Aquifer Test 02_WGL Data.xls.**

Initial analysis of the resulting test data (representative time series plots for WGL 1st test Figure 3.2 and Figure 3.3), indicates that drawdown occurred rapidly in the pumping well and with relatively low abstraction rates employed. The pumping rate had to be adjusted to avoid lowering the water level below the pump during the test. Within the piezometers, water levels or head reduced consistently over time and tended to flatten toward the end of the test period. Importantly, it was found that no displacement occurred in the upper aquifers as a response to testing the lower aquifer. From the recovery data, it appears that there is an immediate initial response to the previously pumped displacement, with water levels then gradually recovering to a lowered pre-test water level.

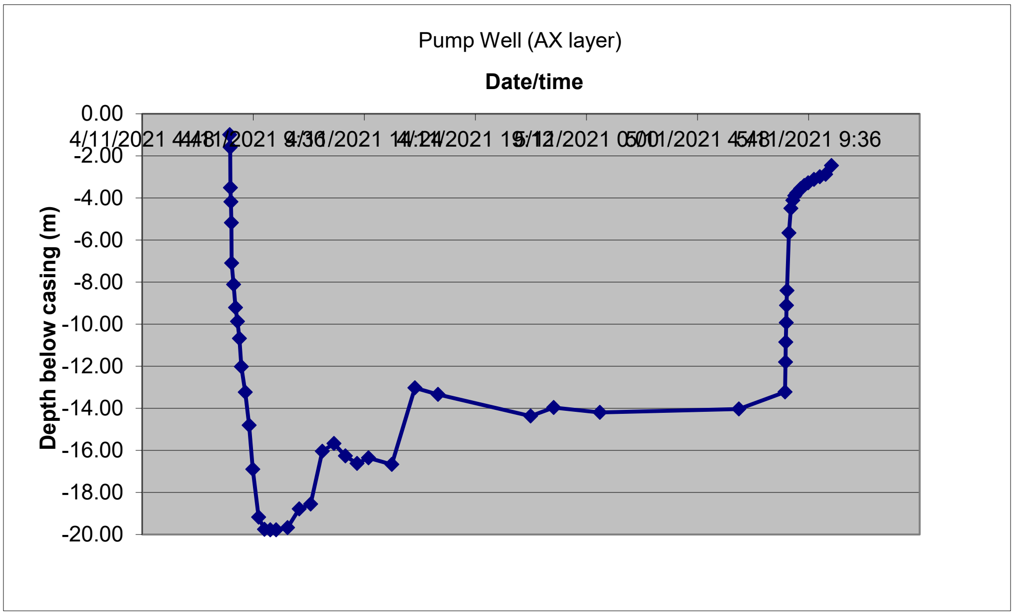


**Figure 3.2 Example Pumped Well Time Series**

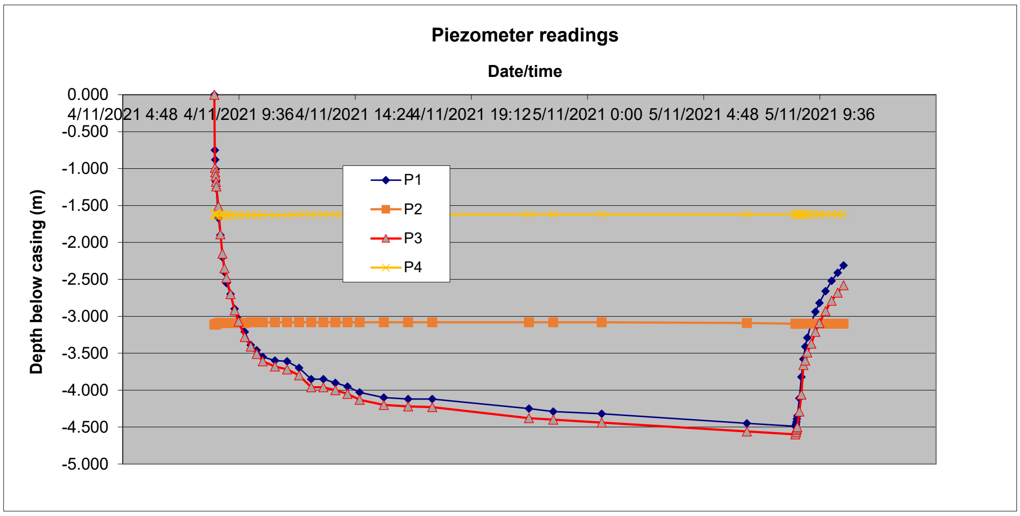


**Figure 3.3 Example Piezometer(s) Time Series**

Analysis of the WGL aquifer test constant rate data, along with re-analysis of the AquaFirma aquifer test data has been performed within the AQTESOLV PRO (Hydrosolve Inc, 2010) aquifer test software package, utilising the Confined Theis model. The test solutions are contained within **Appendix C** and encompasses (where appropriate) automated curve matching for appropriate models in respect of sufficient data and reasonable hydraulic parameters obtained. Table 3.1 (below) provides a summary of the reliable (fitted) estimates of aquifer parameters obtained.

## Table 3.1

## Aquifer Test Analysis Summary and Results for Aquifer Conditions (for the Confined Theis Model)

| Pumping Test ID and Date | Radius (m) | Pumping rate (L/s) | Aquifer type | Transmissivity (T – m²/day) | Saturated thickness (b -m) | Hydraulic conductivity (K – m/day) | Storage (S) |
|---|---|---|---|---|---|---|---|
| Aquafirma 1st test P2 18 Feb | 20 | 1.25 | Confined | 5.63 | 10 | 0.6 | 0.00014 |
| Aquafirma 1st test P3 18 Feb | 40 | 1.25 | Confined | 6.33 | 10 | 0.6 | 0.00016 |
| Aquafirma 2nd test Q2 2 Mar | 19.3 | 0.6 | Confined | 4.89 | 10 | 0.5 | 0.00044 |
| Aquafirma 2nd test Q3 2 Mar | 60.5 | 0.6 | Confined | 4.07 | 10 | 0.4 | 0.000054 |
| Aquafirma 3rd test R1 7 Apr | 10.2 | 3.3 | Confined | 15.39 | 10 | 1.5 | 0.00022 |
| Aquafirma 3rd test R2 7 Apr | 19.4 | 3.3 | Confined | 16.52 | 10 | 1.7 | 0.00022 |
| Aquafirma 3rd test R3 7 Apr | 39.75 | 3.3 | Confined | 15.89 | 10 | 1.6 | 0.00023 |
| WGL 1st test P1 4 Nov | 20.71 | 1.45 | Confined | 12.49 | 10.2 | 1.2 | 0.00017 |
| WGL 1st test P3 4 Nov | 22.18 | 1.45 | Confined | 12.49 | 10.2 | 1.2 | 0.00017 |
| WGL 2nd test P1 15 Nov | 19.71 | 1.75 | Confined | 12.66 | 10.6 | 1.2 | 0.00015 |
| WGL 2nd test P3 15 Nov | 20.32 | 1.75 | Confined | 12.66 | 10.6 | 1.2 | 0.00015 |
| **MEAN** | | | | **10.82** | **10.14** | **1.06** | **0.00019** |

The results of the re-analysis of AquaFirma test data and analysis of the WGL test data (Table 3.1), are consistent with the range of aquifer hydraulic parameters presented within AquaFirma Limited (1998). Albeit, that a slight increase to the mean Transmissivity of the lower wash aquifer was found. Assessment of the aquifer test data indicates that overall, the lower aquifer exhibits relatively low hydraulic properties of which displays a correspondingly low hydraulic capacity or yield. In characterisation of the typical 3-aquifer occurrence or layers present at the WGL mine site, assessment of the aquifer test results alongside investigation well data has been undertaken to conservatively assign nominal aquifer hydraulic parameters for the purposes of determining dewatering rates and for environmental effects assessment. Table 3.2 provides the assessed nominal aquifer hydraulic values assigned to each aquifer layer as resulting from aquifer test analysis and in consideration of investigation well data.

**Table 3.2**

**Assessed Nominal Aquifer Hydraulic Parameters**

| Aquifer | Aquifer Transmissivity ($m^2$/day) | Aquifer Storage | Aquifer thickness (m) |
|---|---|---|---|
| Unconfined water table aquifer | 20 | 0.1 | 2 |
| Confined intermediate aquifer | 10 | 0.002 | 3 |
| Confined lower (wash) aquifer | 20 | 0.0002 | 10 |

The conservatively adopted hydraulic parameters gained from the aquifer testing, and as assessed for each aquifer layer present within the WGL mine site (Table 3.2), reflects invariably an overall low hydraulic capacity. However, in terms of assessed aquifer Transmissivity(s), the total maximum T-value of all aquifers present (of 50 $m^2$/day), is reflective of a similar value provided for within AquaFirma Limited (1998), in assessment of potential mine pit dewatering rates and the corresponding environmental effects of the activity. Additionally, there was also no detection of any water level displacement in upper aquifer layers as a result of abstraction of groundwater from the lower wash aquifer. This is not unexpected as the significant clay intervening layer between aquifers is present in almost all investigation holes. In the absence of information suggesting otherwise, on this basis the aquifer layers may be treated as discrete, with no apparent interconnection. It is expected that the upper water table aquifer may have some limited connection with the Waikaka Stream, if only as the stream serves as a groundwater sink. The intermediate and lower aquifers present at the site (in their natural state), have no connection to or with surface water resources.

# 4 Required Site Dewatering and Discharge Flows

This section provides an assessment of required mine pit dewatering flow rates and volumes to achieve target on-site drawdown in order to enable construction, and to maintain resource recovery activities. The target flow rates are also conservatively indicated as a potential discharge flow that may be required to be removed from the site and discharged to surface waters (Waikaka Stream). The aquifer(s) hydraulic parameters utilised for the assessment are consistent with the nominal hydraulic values as identified by aquifer testing and assessment as presented in Section 3 of this report.

As identified in Section 2 of this report, dewatering is required to reduce internal water levels within the mine pit to a nominal maximum of between 20 m BLS to 40 m BLS depending upon the location of the active mine pit. The maximum depth of mine pit areas initially decreases from 30 m BLS to 20 m BLS, then increases from 20 m BLS up to 40 m BLS as the mine location moves from a southerly location, toward the Northwest. Initially, a start-up mine pit of approximately 100 m X 50 m in size will be developed, which over time progresses to an effectively sized mine pit (for dewatering purposes), of approximately 500 m in length and 100 m wide. There is some variability in the actual dimensions in time and space over the operational mine life. However, for the purposes of dewatering rate assessment the effective maximum dewatering area of the mine pit is specified as up to 50,000 $m^2$. Within the developed mine pit, dewatering would initially comprise abstraction of ponded water from a mine pit pond or sump, and over time as the mine pit increases in size, internal drainage may convey intercepted water to the mine pit pond or sump for the purposes of dewatering abstraction. For the purposes of mine pit dewatering the active mine pit area (irrespective of internal drainage and water conveyance), remains the primary consideration for analysis of dewatering flow rates.

The methodology used in calculation of required dewatering rates uses the Theis solution to identify required cumulative abstraction rates from the three in-situ aquifers present within the mine area, to maintain drawdown over time within the mine pit. That is, the target water level reduction at the conservatively represented effective radius of the mine pit is attributed to an abstraction rate (from a single central abstraction well), over the required dewatering period (in order to achieve the required drawdown). The dewatering analysis is then able to identify an abstraction component for dewatering from each individual aquifer, particularly for the purposes of considering any potentially required mitigation and/or effects assessment for the proposed activity. The use of the Theis methodology is also in preference to other modelling methodologies, as the overall aquifer hydraulic properties are invariably low, there is discrete separation of all three aquifers on site, and the methodology is considered to be suitably transparent and conservative for consideration of dewatering rates and for the purposes of assessment of environmental effects of the activity.

Assessment of mine pit dewatering has been made in three parts, namely:

- Short term peak dewatering upon initial start-up and establishment for the mine. This considers the start-up location and conservatively hosted mine pit dimensions. It is expected that the short term peak dewatering, considering mine progression and storage removal over time, will be the maximum instantaneous and daily volume required for resource consent purposes.
- Medium term or maximum monthly dewatering, considering mine pit development and progression is expected to conservatively achieve a maximum of 90% of the short term rate and daily volume over time. This considers maximum potential mine progression within the envelope of dewatering required for initial start-up and development.
- Maximum long term or annual steady state dewatering, considering location and mine pit configuration over the entire mine site project.

Additionally, as the mine pit location is transient, the progression of the mine pit and associated dewatering over time serves to reduce abstraction as a result of storage volumes already removed from the aquifer. The assessment of short term, medium term and long term dewatering rates do not fully account for accumulated storage removal. Additionally, target aquifer boundary and recharge fluxes are not modelled as the Theis methodology assumes an infinite aquifer extent. These considerations invariably result in the dewatering assessment overall being of a conservative nature.

Table 4.1 contains the resulting outcomes for groundwater (dewatering) yield requirements for an initial 30 m maximum dewatering of a 100 m X 50 m mine pit start-up or established configuration, considering expected development duration and in-situ aquifer conditions.

**Table 4.1**

**Initial Peak Dewatering Rate for Mine Pit Start-up**

| Aquifer | Radius (m) | Required drawdown* at radius (m) | Establishment duration (days) | Required dewatering rate to achieve drawdown (L/s) |
|---|---|---|---|---|
| Water table aquifer | 39.9 | 2 | 7 | 6.2 |
| Intermediate confined aquifer | 39.9 | 15 | 1 | 10.8 |
| Deeper confined aquifer | 39.9 | 30 | 1 | 17.7 |
| **TOTAL** | | | | **34.7** |

*Required drawdown level commensurate with base of aquifer unit

The dewatering outcomes for each aquifer in Table 4.1 are for the required drawdown at the effective radius of 39.9 m (for initial mine pit development). The dewatering rates associated with drawdown in each aquifer (Table 4.1) increase with depth (notwithstanding dewatering duration). The establishment duration (Table 4.1) considers the conservative time period over which potential maximum dewatering may be required. The delay in excavation progress means that the maximum cumulative dewatering rate does not occur until such time that all three aquifers are intercepted and a mine pit is established. The required dewatering level to the base of the intermediate confined aquifer is established as 0.5-times the maximum dewatering level for the deeper confined aquifer. This is based upon existing well log information of aquifer occurrence.

Table 4.2 contains the resulting outcomes for the maximum annual groundwater (dewatering) yield requirements for a fully established mine pit configuration (500 m X 100 m), with a maximum 40 m internal water level lowering. This scenario replicates the largest mine pit configuration associated with the deepest expected internal water level lowering.

**Table 4.2**

**Maximum Annual Peak Dewatering Rate for Mine Pit Progression**

| Aquifer | Radius (m) | Required drawdown* at radius (m) | Establishment duration (days) | Required dewatering rate to achieve drawdown (L/s) |
|---|---|---|---|---|
| Water table aquifer | 126.2 | 2 | 365 | 2.5 |
| Intermediate confined aquifer | 126.2 | 20 | 365 | 5.3 |
| Deeper confined aquifer | 126.2 | 40 | 365 | 13.7 |
| **TOTAL** | | | | **21.5** |

*Required drawdown level commensurate with base of aquifer unit

As shown in Table 4.2, the required maximum annual cumulative mine pit dewatering yield reduces from the initial dewatering mine start-up period, to that required in an annual time period or as close to a maximum steady state dewatering. However, required dewatering rates for the deep confined aquifer do remain relatively consistent. This is due to the low storage value and timing (or duration) assessed for the abstraction. In practise, there will be variability in mine pit dewatering over the period of mine progression. However, the rates and volumes modelled as per Table 4.1 and Table 4.2 are the expected maximums for short term (daily) and longer term (annualised) time periods, over the expected mine area progression.

Table 4.3 provides a summary of required dewatering rates and volumes for resource consenting purposes, which includes that of any discharge of the mine pit dewatering water. The required rates are considered to be suitably conservative to allow for the initial and on-going dewatering phases associated with maintaining appropriate mine pit water levels to allow the mining activity to efficiently operate. The final dewatering rates also include for rainfall contribution to the mine pit area, and a nominal 30% contingency in allowance for any ongoing site variability in groundwater and climatic conditions.

**Table 4.3**

**Required Dewatering Rates and Volumes**

| Rate or Volume | Quantity | Effective rate | Basis |
|---|---|---|---|
| Maximum instantaneous rate | 50 L/s | 47.3 L/s | Peak short term rate as modelled + average rainfall contribution + 30% contingency |
| Maximum daily volume | 4,086 $m^3$ | 47.3 L/s | Maximum volume with peak rate employed |
| Maximum monthly volume | 114,635 $m^3$ | 42.8 L/s | Maximum monthly rate as 90% of daily rate modelled + average monthly rainfall contribution + 30% contingency |
| Maximum annual volume | 952,387 $m^3$ | 30.2 L/s | Maximum 365-day rate modelled + average annual rainfall contribution + 30% contingency |

Referring to rainfall contribution in Table 4.3, the average annual site rainfall of 1,070 mm occurring to the maximum sized mine pit area (as an instantaneous flow of 1.7 L/s), has been included for consideration of pumped water rate and volumes from the mine pit. Additionally, a 30% contingency has been provided for to conservatively account for any short or long term variability in site environmental conditions and/or climate. The resulting dewatering yield and duration from the unconfined water table aquifer for the purposes of assessment of potential stream depletion upon the Waikaka Stream (inclusive of contingency), is as follows:

- 7-day rate = 8.1 L/s,
- 30-day rate = 7.3 L/s, and
- 365-day rate = 3.3 L/s.

The annual maximum groundwater take (rate and volume), for dewatering sourced from each of the three in-situ aquifers for the purposes of effects assessment (inclusive of contingency), is as follows:

- Unconfined water table aquifer = 3.3 L/s continuous and 104,068 $m^3$.
- Confined intermediate aquifer = 6.9 L/s continuous and 217,598 $m^3$.
- Confined deeper aquifer = 17.8 L/s continuous and 561,340 $m^3$.
- <u>Total groundwater take</u> = <u>28.0 L/s</u> continuous and <u>883,006 $m^3$</u>.

In relation to the maximum expected seasonal dewatering flows that may be encountered during the operational period for the mine, considering application of rainfall contribution and contingency, seasonal variability in discharge flows for the purposes of effects assessment, is as follows:

- Short term/daily = 34.7 L/s low flow, and 47.3 L/s median to high flow, and
- Long term/annual = 21.5 L/s low flow, and 30.2 L/s median to high flow.

  By comparison, the predicted maximum and average required dewatering (and discharge), flows identified within AquaFirma Limited (1998), ranged from 29.7 L/s to 55.4 L/s and 19.7 L/s to 32.1 L/s respectively. Whilst there are some differences in the applied mining (and dewatering) methodology used in AquaFirma Limited (1998) to that of the current WGL proposal, overall the dewatering flows should most likely be of a similar scale.

The above partitioned flows have been provided from the modelling and assessment of required dewatering flows, and are identified solely for the purposes of effects assessment (refer to Section 5 of this report). In relation to maximum predicted dewatering flows, there is expectation of potentially much lesser flows for the majority of the mine activity, particularly in consideration of potential cumulative storage removal and boundary effects over time. The required dewatering rate and volume values remain conservative maximums for resource consenting purposes.

# 5 Effects of Mine Pit Dewatering and Discharge

Given the above mine pit dewatering proposal and information regarding aquifer hydraulics, consideration of the potential environmental effects of the proposed activity (for the abstraction of groundwater for dewatering, and the discharge of that water to land whereby it may enter water), has been undertaken in the following section.

*Effect of Water Level Decline upon Local Wells*

The Theis drawdown model has been used to predict the potential reduction in groundwater levels external to the transient WGL mine pit progression. This is a function of the required dewatering rates to achieve desired water levels within the mine pit area.

The predicted mine pit external drawdown (Table 5.1) has been calculated on the basis of the maximum mine pit configuration dewatering rates as identified in Section 4 of this report (above) over an annual time period inclusive of contingency. The derived aquifer Transmissivity and Storage values (see Section 3 of this report), have been applied to the requested annual volume of abstraction to conservatively predict the maximum drawdown external to the mine pit at any point in time. It should be noted however, that as the mine is transient and temporary, the predicted maximum external drawdown will be of a variable and temporary nature, and only occur to the predicted quantum, when the mine pit traverses to within vicinity of the extremities of the mining area.

Additionally, as the three aquifer systems located at and beyond the WGL mine site are separate for the purposes of considering effects upon surface water, and indirectly, considering effects of drawdown or displacement in each pumped (dewatered) aquifer (refer to Section 2 and Section 3 of this report), Table 5.1 presents the drawdown effect of the WGL dewatering activity specific to each aquifer receiving environment. In terms of potentially affected wells by drawdown or displacement at distance from the mine site boundary, consistent with statutory documents for Environment Southland, the limit of acceptable effect (drawdown) is assessed as:

- Within the unconfined water table aquifer = 0.1 m,
- Within the confined intermediate aquifer = 50% of head above the upper limit of aquifer occurrence, which is conservatively 3.5 m, and
- Within the confined lower aquifer = 50% of head above the upper limit of aquifer occurrence, which is conservatively 5.0 m.

**Table 5.1**

**Predicted Mine Pit External Drawdown from Dewatering**

| **Aquifer** | **Pumping rate (L/s)** | **126.2 m at mine pit radius (m)** | **500 m external of mine pit (m)** | **1000 m external of mine pit (m)** | **2000 m external of mine pit (m)** | **5000 m external of mine pit (m)** | **10000 m external of mine pit (m)** |
|---|---|---|---|---|---|---|---|
| Water table | 3.3 | 2.71** | 0.14 | 0, 0.1 = 554 m | 0 | 0 | 0 |
| Intermediate confined | 6.9 | 26.34** | 11.39 | 6.35 | 2.07, 3.5 = 1539 m | 0.03 | 0 |
| Lower confined | 17.8 | 52.30** | 32.71 | 25.56 | 17.92 | 8.02 | 2.28, 5.0 = 6908 m |

*Resultant from 365-days abstraction with no recharge or boundary effects.
*Modelled with mine pit effective radius of 126.2 m. Drawdown exceeds required level due to inclusion of contingency.

It is noted that drawdown at the mine pit effective radius of 126.2 m (as shown in Table 5.1) is greater than the maximum drawdown requirement within the mine pond. The reason for this is the annual rate utilised includes for additional contingency, and thus whilst affords a degree of flexibility, it also provides additional conservatism in the effects assessment contained within this report.

From Table 5.1, the effects of drawdown upon the water table aquifer are relatively localized (at up to 554 m), and whilst due primarily to the significantly lower storage value for the intermediate and lower confined aquifers, displacement in the lower confined aquifer within an acceptable quantum may potentially promulgate out to 6.9 km from the mine site. Although, given the tenuous horizontal connections associated with the confined aquifers, this finding is considered to be very conservative.

To identify potentially affected wells from the requested WGL mine dewatering (groundwater take) activity, consideration of the potential radius of acceptable drawdown or displacement (Table 5.1), and the occurrence and extent of aquifers (as detailed in Section 2 of this report), has been made. Additionally, a filter for wells potentially located within the lower confined Tertiary aquifer has been applied on the basis of minimum well depth of 10 m and the maximum depth of wells occurring to an elevation of below 110 m (and as previously discussed, located within fault barrier occurrence as shown on Figure 2.2).

This filter appropriately identifies wells that may potentially abstract groundwater from the lower confined Tertiary aquifer associated with the proposed WGL mine pit dewatering. It is most likely however, that very few wells actually occur to the lower confined aquifer on the basis of the required (larger) drill depth outside of the Waikaka Stream valley floor.

The Environment Southland on-line GIS Wells and Consents database was queried for well(s) and consents information that fit both search area (distance) and search criteria. Within the water table aquifer there are two (in total) possible wells that may be affected by the proposed WGL activity in the GIS search radius. There were two wells external to the WGL mine site by up to 554 m which may incur a maximum drawdown of greater than 0.1 m:

- F45/0650 – stock water supply, no depth detail, and
- F45/0235 – no use or depth detail.

Within the intermediate confined aquifer, there were no further wells located at up to 1,539 m external of the mine site, with a potential displacement of greater than 3.5 m:

- Nil additional to the above.

Within the potential extent and occurrence of the lower confined aquifer at up to a 6,908 m radius external of the mine site, and incurring a potential displacement in excess of 5.0 m, the following 11 wells were identified by the GIS search:

- F45/0214 – dairy shed use, 108 m depth, water permit AUTH 302750 – 03,
- F45/0618 – dairy shed use, 95 m depth, water permit AUTH 301096,
- F45/0223 – dairy shed use, 53 m depth,
- F45/0204 – domestic stock water and dairy shed use, 35 m depth, water permit AUTH 302677,
- F45/0238 – domestic use, 27.4 m depth,
- F45/0237 – stock water and dairy shed use, no depth detail, water permit AUTH 20202437 – 02,
- CF12/5072 (previously F45/0622) – stock water and dairy shed use, 106 m depth, water permit AUTH 301414,
- F45/0543 – dairy shed use, 26 m depth,
- F45/0183 – stock water and dairy shed use, 88 m depth,
- F45/0541 – stock water and dairy shed use, 102 m depth, and
- F45/0553 – stock water and dairy shed use, 27 m depth, water permit AUTH 20181736-02.

The above wells are identified as being potentially affected by a more than minor basis, and it is contended that in this instance the assessment appears to be highly conservative. Particularly when considering the significant potential radius of displacement associated with the lower confined aquifer.

It is suggested that in the first instance, where wells are deemed to be potentially affected by the WGL mine dewatering proposal, if any well owners are concerned by the potential effect, additional measurement, verification and quantification of any displacement effect upon the well may be made. In the extreme case where any well water supply may be temporarily compromised by the WGL proposal, alternative water supply arrangements are able to be accommodated and may be arranged and agreed with individual well owners by WGL.

***Effect of Stream Depletion***

The only perennial natural surface water resource which is apparent, is the nearby Waikaka Stream, which currently occurs within the mine area extent. Notwithstanding any arrangements to temporarily relocate any local Waikaka Stream reach, the initial or maximum mine pit extents are proposed to be not located within 50 m of the stream. Additionally, given the mine pit configuration, it is conservatively assessed that the centroid of any mine pit dewatering would not occur within 40 m of the mine pit extent. Thus, in terms of super-position for any WGL groundwater take, the minimum distance that conservatively occurs from the effective groundwater take to any connected surface waters (Waikaka Stream), is 90 m for the purposes of short term and longer term assessment of potential stream depletion.

Additionally, as presented in Section 2 and Section 3 of this report, the upper water table aquifer (where it exists), is separated from the intermediate and lower confined aquifers. Essentially, there is no impact of abstraction of groundwater from the intermediate and lower confined aquifers, upon the water table aquifer or any surface waters (including Waikaka Stream). Thus, stream depletion assessment for the WGL proposal incorporates the predicted WGL mine pit dewatering abstraction attributable to the upper water table aquifer inclusive of any weighted contingency for the take (as a conservative measure).

The stream depletion assessment upon the adjacent Waikaka Stream has been conservatively carried out by applying the Hunt (1999) approach (**Appendix D**). This is a similar approach to the Theis-Jenkins methodology, although Hunt (1999) utilises stream bed conductance to appropriately dampen short term stream connections. It is shown from the physical site data that the water table aquifer and stream connection is relatively poor, with significant clay silt matrix surrounding the waterway and within the mine site area. A standardised approach has been made with respect to Hunt (1999), with the use of a stream bed conductance of 100 m/day as a typical default which has been previously accepted by Environment Southland.

It should however be noted that the Hunt (1999) approach is similar in outcome to the Theis-Jenkins model over the longer term groundwater take scenario.

The predicted stream depletion effect (Table 5.2) of the proposed mine pit dewatering, models the maximum 7-day, 30-day and 365-day groundwater abstraction (as requested), on the basis that hydraulic connection exists between the dewatered water table aquifer and the Waikaka Stream. As above, a hydraulic connection is plausible, although for the relatively small head reduction associated with the requested activity, it is most likely to be limited.

**Table 5.2**

**Predicted Stream Depletion (Hunt, 1999)**

| **Stream depletion scenario** | **Water table aquifer abstraction rate (L/s)** | **Stream depletion proportion (%)** | **Stream depletion rate (L/s)** |
|---|---|---|---|
| Stream depletion after 7 days | 8.1 | 9 | 0.7 |
| Stream depletion after 30 days | 7.3 | 41 | 3.0 |
| Stream depletion after 365 days | 3.3 | 81 | 2.7 |

The predicted stream depletion (Table 5.2) from the Hunt (1999) model, suggests that up to 3.0 L/s may potentially be depleted from the adjacent Waikaka Stream during when mine pit dewatering is in close proximity and has occurred for a moderate to reasonable length of time. The predicted maximum stream depletion is 1.1% of the 7-day MALF for the Waikaka Stream at the WGL mine site, and would otherwise not be measureable by open-channel flow measurement techniques. Also, the medium to long term stream depletion rate predicted is 41% to 81% respectively of the net water table abstraction rate, which is highly conservative given the above discussion of head reduction and connection of the aquifer to any surface water resource. Additionally, full discharge of any net dewatering flow is required to be made to surface waters (Waikaka Stream) within the reach of the WGL mine site. The discharge over time will more than offset any potential stream depletion component and occur over/adjacent to the same reach that may incur any stream depletion effect. This will serve to offset any stream depletion effect that may occur, and is in regard to the non-consumptive nature of the requested groundwater take.

There are no other surface water takes located at the WGL mine site or within 5 km downstream of the site. Considering the level of potential stream depletion and the non-consumptive and temporary nature of the requested activity, the effect upon stream depletion is considered to be no more than minor.

***Effect upon Groundwater Connection for Temporary River Reach Diversions***

Whilst this report does not specifically address the design and physical nature of the proposed WGL temporary Waikaka Stream reach diversions for resource access (as referred to in Hall, 2024), the following discussion presents the anticipated outcomes for stream-groundwater interconnection for the activity. Identifiable potential effects of the temporary stream reach diversions (in relation to groundwater connection), are assessed as change to stream-bed invert levels and consequent change to existing gaining and in particular, losing reaches. On the basis of the discussion and assessment provided in Section 2 of this report, the Waikaka Stream appears to naturally gain flow from groundwater input over the length of reach associated with the proposed WGL mining activity. Essentially, the Waikaka Stream acts as a sink for groundwater that would otherwise flow parallel to the watercourse. Artificially elevated stream-bed invert levels may likely promote flow losses to groundwater and result in lesser surface flows than would otherwise occur naturally.

However, on the basis of the temporary stream diversion(s) proposal (Hall, 2024), any (temporary) modified stream reaches are intended (or designed) to maintain similar stream-bed inverts and watercourse dimensions to that of the existing stream. This will maintain the stream as a potential groundwater sink and ensure that any incidental stream flow losses to groundwater are very minimal (if any). This in turn will maintain a similar distribution of water table head or level in vicinity of the Waikaka Stream to that which occurs naturally. Additionally, the reinstatement of the original stream reaches will be undertaken in a similar manner, recreating the original stream-bed inverts and watercourse dimensions.

Considering the above discussion, the WGL proposal to temporarily modify (divert) Waikaka Stream reaches for the purpose of resource access (as presented in Hall, 2024), is assessed as having a very small and not measureable effect upon groundwater connection for the watercourse. Similar stream-groundwater interconnection is able to be maintained by design and implementation of temporary stream reaches (as per Hall, 2024), to that which occurs naturally for the existing stream configuration.

### *Effect upon Groundwater Allocation*

The unconfined water table aquifer present at the WGL mine site area has a modest saturated thickness and is of variable occurrence. However, the water table aquifer has some (limited) connection to the Waikaka Stream, of which is considered to be predominantly a discharge sink. The requested WGL annualised groundwater take from the water table aquifer for dewatering purposes of 3.3 L/s (inclusive of 30% contingency), essentially either intercepts natural groundwater flow, or promotes stream depletion of the Waikaka Stream. The annualised stream depletion rate is considered to be 2.7 L/s or 81% of the steady state WGL groundwater take from the water table aquifer (refer to Table 5.2). WGL then facilitates return of the water to (in part) the water table aquifer, and in general to the receiving Waikaka Stream surface waterbody via discharge.

Whilst there is no identified groundwater allocation from the local water table aquifer, considering the stream depletion component (discussed above), the net abstraction from the localised aquifer is in the order of 0.6 L/s. Rainfall recharge to the water table aquifer containing and surrounding the WGL mine site (at 25% annual average rainfall contribution), is estimated as an annual steady state rate of 25.4 L/s for the relatively small 300 ha compartment of the total Waikaka valley floor alluvium. Thus, considering the predicted stream depletion component, the WGL abstraction of groundwater from the water table aquifer is a small component (2.4%) of local rainfall recharge to the valley floor alluvium. As above, the groundwater taken is not used for any consumptive means (e.g. irrigation). The dewatering abstraction is essentially returned to the receiving waterbody (the water table aquifer and the Waikaka Stream), within a very short timeframe and in a location and stream reach consistent with the overall natural aquifer discharge to surface waters.

The Tertiary confined aquifers consist of the intermediate confined and the lower confined aquifers, which are separated from the unconfined water table aquifer by very low permeability clays. As discussed in Section 2 above, the Tertiary formation is extensive and solely receives recharge by rainfall in faulted outcrop or exposed outcrop zones (refer to Figure 2.2). Recharge for the Tertiary aquifer system (containing both intermediate and lower confined aquifers), is estimated by the Environment Southland through-flow approach as follows:

- Aquifer(s) combined bulk Transmissivity = 30 $m^2$/day,
- Gradient of groundwater flow in recharge zone = 0.01 (conservative estimate at outcrop elevation), and
- Width of groundwater flow = conservative width of recharge outcrop zones being of 8.8 km and 7.3 km respectively.

The associated recharge through-flow considering the above components for the Tertiary aquifer(s) as a steady state quantum is 55.9 L/s. This recharge quantum is considered to be conservative on the above basis that it is limited to solely outcrop recharge occurrence, and that conservative values have been adopted.

The requested maximum annual rate of groundwater take for the WGL mine pit dewatering from the Tertiary aquifer(s) amounts to 24.7 L/s as an annualised quantum (inclusive of 30% contingency). As discussed above, there are existing wells located within the extent of the Tertiary formation that may abstract groundwater from the Tertiary aquifer(s) system. However, these are considered to be very few in number and the uses of the groundwater are for relatively small annualised rates for stock water and dairy shed purposes. The annualised groundwater take from these wells is estimated at 5.5 L/s, giving a conservative total abstraction from the Tertiary aquifer(s) of 30.2 L/s (with inclusion of the requested WGL groundwater take). The WGL Tertiary aquifer(s) groundwater take in isolation represents 44% of aquifer through-flow (or recharge). However, in combination with other consented groundwater takes, the abstracted proportion of aquifer through-flow (recharge) may be up to approximately 54%.

The above recharge through-flow proportions are very conservative on the basis of recharge calculation and considering the maximum requested WGL groundwater take from the Tertiary aquifer(s) inclusive of contingency for resource consenting purposes. It is most likely that the upper limit of steady state groundwater abstraction by WGL from the Tertiary confined aquifer(s) would be closer to 19 L/s as an annualised rate (refer to Table 4.2). Considering the more likely steady state WGL abstraction rate from the Tertiary aquifer(s), the total cumulative abstractive proportion of through-flow works out to be 44%, less than half of the annualised aquifer(s) recharge component.

The requested WGL groundwater take activity is essentially non-consumptive. Nonetheless, in terms of groundwater allocation, the activity fits within recognised groundwater allocation criteria for both the unconfined water table and Tertiary confined aquifers. Considering the non-consumptive and temporary nature of the requested activity, the effect upon overall groundwater allocation is considered to be no more than minor.

*Effect on Aquifer Integrity*

The proposed dewatering of the mine pit is anticipated to be for a nominal maximum lowering of the immediate water level within the mine pit area of approximately up to 40 m. This is to allow access for excavation of materials at depth for minerals processing.

The unconfined water table aquifer is expected to be dewatered (adjacent to the mine pit), by 2 m, representing the saturated thickness of the aquifer. The associated drawdown serves to reduce the water table level by up to 2 m, and to a much lesser extent in areas located away from the mine pit. On this basis the lowering of the unconfined aquifer water level presents a nil to low risk of any aquifer compression or loss of potential storage capability in that regard.

The existing average saturated thickness of the Tertiary gravels and silts that make up the main lower confined aquifer is approximately 10 m, which is overlain by up to 30 m of low permeability sediments and gravels at the WGL mine site. The nominal potentiometric head associated with the aquifer is at about land surface. Similarly the intermediate confined aquifer is 3 m thick and is overlain by up to 17 m of overburden materials. The potentiometric head for that aquifer is also at or about land surface level. Whilst the required (nominal) aquifer displacement of approximately 40 m and 20 m is required for dewatering of the lower confined and intermediate confined aquifers respectively (to the base of each aquifer), as shown in Table 5.1 above, displacement at 500 m external of the WGL mine pit area is at about or above that of the upper extent of the formation sequence in each case. The overburden (confining layers) consists mostly of clays and clay-silt materials that are relatively impermeable, and the aquifer materials consist of a silt-gravel matrix also containing clay materials that are of low permeability. Any potential lowering of head within the overburden and aquifer formations (considering the modelled displacement for dewatering purposes), is most unlikely to result in any formation compression or loss of potential storage capability. Given the short-term and transient nature of the mine pit progression and commensurate groundwater abstraction, any plausible aquifer compression on the above basis would be of a small and limited extent, and present a low risk of any associated environmental effect.

It is impractical and inefficient (regardless of difficulty), to replace all of the in-situ materials in exactly the same position as excavated as part of the mining process. Materials excavated will however, be able to be stockpiled in general depth sequence, with top soil and overburden being able to be replaced as part of the site remediation process. The lower (deeper) materials including in-situ gravels will be replaced as the mine pit progresses, providing most likely for a modified aquifer(s) sequence that is potentially of greater thickness, although containing a lower average permeability due to the mixing of gravels with adjacent clay matrix materials. Overall, due to the materials replacement process the aquifer(s) integrity and hydraulic nature (Transmissivity) may be of a similar order to that previously encountered, prior to mining.

An additional effect of the transient mine pit excavation and dewatering activity, is that sediment-laden groundwater is constantly abstracted to sediment settling ponds prior to final discharge. The abstraction of the sediment-laden groundwater removes finer (silty) materials from the aquifer(s) and deposits these materials onto the land surface (above the water table aquifer).

This has a small effect of reducing the silt content within the saturated aquifer strata, increasing the pore spacing between larger deposited gravels, and improving (albeit slightly) the storage capability within the aquifer. This effect, whilst is seen as positive, represents no more than a minor change to potential storage capability within the aquifer(s).

Overall, whilst there is an obvious modification to the local aquifer(s) environment from the mining process itself, the temporary drawdown or displacement from dewatering and materials replacement from the mining activity, will result in no obvious change to the general hydraulic nature and functioning of the aquifer(s) and adjacent materials, and incur no effect upon any use of the aquifer or any environmental value.

*Effect of Dewatering upon Aquifer Water Quality*

The implications for aquifer water quality change resulting from the proposed mine pit dewatering are limited to contaminants associated with excavation and water abstraction. Excavation of the mine pit and then for transient advance of the mine, results in sedimentation of the final mine pit pond. No other contaminants are envisaged to be introduced to the mine pit pond through excavation, apart from the potential use of biodegradable flocculants to address sedimentation within the abstraction pond. Some storm-water from the immediate mine footprint may enter the mine and be routed by internal drainage to the abstraction pond, however, the volume of stormwater introduced is considered to be small compared to the required dewatering volume over time.

As a mine pit operational requirement, constant pumping of the abstraction pond is required to maintain the pond at a desired water level (the level of internal drainage), thus essentially providing a positive head within the aquifer(s) toward the mine pond. The abstraction of the sediment-laden mine pit pond waters (including possible flocculent - to settling ponds), is replaced by recharge from the aquifer, and this process occurs over time and provides regulation of abstraction rates consistent with desired dewatering levels. As sediment laden waters are pumped, clean groundwater is introduced into the mine drainage system, and this process ensures that a positive head or flow toward the mine (pond) is achieved at all times. Such that with this process occurring, there is no potential for any of the sediment-laden mine water, or stormwater, to be introduced into the aquifer, or contribute to any flow within the aquifer that regresses away from the mine pit.

A small amount of sediment laden water my progress into the aquifer at the conclusion of the mining activity at the final terminal mine pit pond area. However, this can be overcome by continuation of water abstraction during infilling to again provide a positive head toward the mine pit (pond) and to remove the majority of any sediment-laden water.

Under these circumstances, it is considered that the potential environmental effect upon aquifer water quality as a result of the proposed activity will be no more than minor.

*Effect of Discharge upon Groundwater and Surface Water Quality*

Any obvious water quality change resulting from the proposed mine pit dewatering discharge will be essentially limited to suspended sediments contamination within the identified discharge to land area, local water table aquifer and the Waikaka Stream receiving environment. The majority of suspended sediment is expected to be settled out within the discharge settling pond area(s) and with including the use of flocculants. Some associated residual turbidity is most likely to locally infiltrate where possible to the upper unconfined water table aquifer. However, due to the relatively low permeability of the water table aquifer, the majority of the final (treated) discharge will be to the Waikaka Stream.

The proposed WGL discharge settling pond(s) are designed to accommodate and retain the mine pit dewatering flow for a sufficient period of time to enable any suspended sediment and ionic content to remediate through gravity and oxygenation processes, effectively resulting in a clear relatively neutral discharge to surface water (Waikaka Stream). As above, some flocculants may be introduced to assist with suspended sediment removal and also result in some neutralisation of the groundwater (for total and dissolved parameter species). Whilst the discharge settling ponds are not expected to discharge to the local water table aquifer (via seepage), some limited interaction with natural groundwater may occur in final polishing areas and within conveyance (drains) to the Waikaka Stream. This interaction will be localised and result within a limited extent of the water table aquifer immediately surrounding discharge polishing areas and discharge conveyance drains. Given the relatively low permeability of the water table aquifer, and that the polished discharge will be of similar content (water quality) to that of the natural groundwater, any effect is most likely to be not measureable. With the limited hydraulic nature of the water table aquifer, WGL expect some (limited) discharge seepage to occur. However, this would be of a diffuse and intermittent temporary nature as the vast majority of the discharge is intended to be mixed with Waikaka Stream flow as discussed below. Any associated water table aquifer (overburden materials), would invariably be compromised (excavated) by the mine pit progression over the WGL mining area in any case. The potential effect of the mine pit dewatering discharge upon groundwater is thus assessed as being of a De-Minimis nature.

To assess the potential impact of the WGL mine dewatering discharge upon Waikaka Stream, a parameter concentration and flow balanced mixing model has been utilised to compare upstream and downstream (below discharge), parameter concentrations for low flow and median-higher flow discharge scenarios.

The available water quality monitoring results for groundwater sampling and Waikaka Stream sampling, including water quality data contained in AquaFirma Limited (1998), have been utilised to reflect groundwater discharge quality and receiving water (Waikaka Stream) quality (**Appendix E**). Table 5.3 shows the respective parameter water quality results assessed as reflective of a conservative groundwater discharge (prior to any treatment), and the Waikaka Stream, and which have been utilised for mixing model purposes.

**Table 5.3**

**Representative Median Groundwater and Surface Water (Waikaka Stream) Quality**

| Parameter | Groundwater concentration | Waikaka Stream concentration |
|---|---|---|
| Electrical conductivity (us/cm) | 213.5 | 85 |
| Calcium (mg/L) | 10.2 | 7.0 |
| Magnesium (mg/L) | 6.14 | 2.3 |
| Potassium (mg/L) | 1.29 | 0.92 |
| Nitrate – N (mg/L) | 0.21 | 0.70 |
| Dissolved iron (mg/L) | 7.15 | 0.79 |
| Arsenic (mg/L) | 0.0068 | 0.0004 |
| Ammonia (mg/L) | 0.04 | 0.04 |
| Total Phosphorus (mg/L) | 0.0875 | 0.055 |

Table 5.4 (below) provides the representative seasonal groundwater discharge flows (from Section 4 of this report), and the corresponding seasonal Waikaka Stream flows (from Section 2 of this report), used in comparison of discharge and receiving water parameter concentrations within the mixing model. The lower discharge flows for either short term or long term periods are associated with drier climatic and catchment conditions reflective of lower stream flows. Whilst the higher or maximum presented dewatering discharge flows are most likely to be associated with at least median or greater (higher) flow periods for Waikaka Stream.

**Table 5.4**

**Groundwater Discharge and Stream Flow Scenarios for Water Quality Assessment**

| Discharge/flow scenario | Discharge from groundwater (L/s) | Waikaka Stream flow (L/s) | Total resulting stream flow (L/s) |
|---|---|---|---|
| Short term daily at low flow | 34.7 | 277 | 311.7 |
| Long term/annual at low flow | 21.5 | 277 | 298.5 |
| Short term daily at median or greater flow | 47.3 | 1,070 | 1,117.3 |
| Long term/annual at median or greater flow | 30.2 | 1,070 | 1,100.2 |

The resulting outcomes for the mixing model are shown graphically in **Appendix F**. Parameters identified that may be of environmental interest and/or at any significant levels are assessed and discussed in turn below. The results and discussion also identify where any water quality outcomes exceed levels for the lowland hard bed water quality classification (Environment Southland, 2023). Otherwise, any differences exceeding 10% of the natural upstream (above discharge) water quality are presented. Note that suspended solids and turbidity have not been sampled as the actual mine pit dewatering would most likely contain much higher levels of those parameters than natural groundwater (from physical excavations). Additional discussion of suspended solids and turbidity is provided below. Also, parameters such as faecal coliform bacteria, *e.coli*, temperature and pH within the discharge, are moderated (or altered) by the proposed WGL buffer pond(s) and treatment. These parameters and the implications of treatment are also discussed as below.

***Electrical conductivity*** (EC) or total dissolved solids in Waikaka Stream is shown to increase by greater than 10% upon WGL discharge to the waterway (from 85 us/cm to almost 100 us/cm), for the most extreme low flow scenario. For the balance of the flow scenarios, EC does not increase by any more than 10%. However, it is expected that EC will be moderated by the discharge to land and subsequent settlement of suspended solids, commensurate with neutralisation of metals and other dissolved species such as Iron and Phosphorus. Given the existing levels of EC, and that treatment processes accommodate the discharge, any final treated discharge to the receiving Waikaka Stream is most unlikely to pose any environmental risk of elevation of EC within the environment or to receiving water quality.

***Calcium*** concentrations are predicted to marginally increase in Waikaka Stream below the WGL discharge. However, the concentration increase is within 10% for all flow scenarios and is not of any environmental significance.

***Magnesium*** in the WGL discharge exceeds an increase of 10% to the receiving water concentration at both low flow scenarios. However, within the receiving water, the final concentrations of Magnesium do not pose any concerns over receiving water quality.

***Potassium*** concentrations are predicted to marginally increase in Waikaka Stream below the WGL discharge. However, the concentration increase is within 10% for all flow scenarios and is not of any environmental significance.

***Nitrate- Nitrogen*** concentrations within the receiving water are predicted to marginally decrease with the proposed WGL discharge over all flow scenarios.

***Ammonia*** concentrations within the receiving water are not expected to change with the proposed WGL discharge over all flow scenarios. Additionally, within the range of Waikaka Stream pH of 6.5 to 9 pH units, the Ammonia concentration within the stream will not exceed 2.46 mg/L to 0.18 mg/L respectively (for the lowland hard bed classification).

***Total Phosphorus*** concentrations are predicted to marginally increase in Waikaka Stream below the WGL discharge. However, the temporary concentration increase is within 10% for all flow scenarios and does not appear to be of any environmental significance.

***Dissolved iron*** may increase the receiving water concentration significantly upon discharge as resulting from the mixing model results. For all flow scenarios, Dissolved Iron increased downstream of the proposed WGL discharge by more than 10%. The maximum increase found was for the extreme low flow scenario, where concentrations of Iron in the Waikaka Stream may increase from 0.79 mg/L to almost 1.5 mg/L. This level of Iron does not however pose any environmental, water quality or health risk, apart from any short term and limited extent of visual impact of staining. However, not unlike and commensurate with EC, Iron concentrations within the discharge will reduce significantly upon settling and treatment, particularly with application of flocculent. The resulting discharge of Iron to the Waikaka Stream is not expected to be of any environmental significance.

***Arsenic*** concentrations were modelled to increase significantly upon WGL discharge to the Waikaka Stream, and particularly at low flow scenarios where the current stream Arsenic concentrations were predicted to increase by up to approximately 275% (from 0.0004 mg/L to 0.0011 mg/L). However, Arsenic concentrations are also expected to be moderated by the settling and treatment processes that WGL will employ to remove suspended solids and turbidity from the final discharge water to Waikaka Stream. The conservatively predicted Arsenic concentration resulting to the Waikaka Stream (by the conservative mixing model results), is however an order of magnitude lower than the MAV of 0.01 mg/L in the NZDWS Regulations (2022).

As discussed above, ***Turbidity and Suspended Solids*** are obvious and potentially elevated water quality parameters within the mine pit dewatering, that are able to undergo treatment prior to discharge to the receiving environment (Waikaka Stream). It is envisaged that any elevated Turbidity and Suspended Solids from mine pit dewatering would be sufficiently remediated by subsequent pre-treatment and polishing, to a level that is not considered to be of any measureable impact upon surface waters. Together with the proposed WGL discharge treatment system, monitoring and compliance functions within suggested conditions of resource consent (refer to Section 6 of this report), are imposed to restrict any discharge to the Waikaka Stream (containing any levels of Turbidity and Suspended Solids), to that of the permitted baseline. This restricts any effect of the discharge to the limits associated with the relevant permitted activity. The required monitoring and compliance for the discharge includes for monthly water sampling for Turbidity and Suspended Solids within the final treated discharge, in Waikaka Stream within 10 m upstream of the discharge, and at 60 m downstream of the discharge in Waikaka Stream (the calculated mixing zone for the discharge, being 10-times the nominal stream width). The resulting water quality within Waikaka Stream is not expected to exceed +10% of upstream water clarity or sediment total/load at the downstream edge of the mixing zone.

***Faecal Coliform Bacteria and e.coli*** are not expected to exceed 1,000 cfu/100 mL and 130 cfu/100 mL respectively within the discharge (these are the relevant limits for the lowland hard bed classification). The source of the discharge is mainly confined groundwater with a small inclusion of water table and rainfall inputs. The mining activity itself does not materially introduce pathogens to the discharge as it is either sourced from a drainage level below that of excavation, and/or the mining methodology incurs limited potential for biological contamination of water.

The ***Temperature*** of the proposed WGL discharge is not expected (at least on balance) to materially change the temperature of the Waikaka Stream. Given the nature of the source of the discharge (mainly deeper groundwater), and the proposed WGL pond(s) buffering and treatment, it is most unlikely that Waikaka Stream temperatures may increase by more than 1 degree Celsius (for the lowland hard bed classification).

The ***pH*** within the final discharge to the Waikaka Stream will be moderated by the proposed WGL buffer pond(s) and treatment. The discharge itself is expected to have a pH level of within 6.5 to 9 pH units, and moreover the pH of the receiving Waikaka Stream will undergo no measureable change due to the discharge. The lowland hard bed classification requires pH in relevant natural waterbodies to be within 6.5 to 9 pH units.

The monitoring and compliance regime (as above) provides for a high level of measurement and compliance with environmental values, including any change to floatable or suspended materials, visual clarity, consumptive water quality and effects upon aquatic life (including substrate). Whilst there may be some variable and temporary effect of the discharge within the extent of the mixing zone, any effects beyond the mixing zone are envisaged to be no more than minor upon the receiving environment.

There are no registered or otherwise stream connected groundwater or direct surface water takes for water supply purposes either on or adjacent to the WGL mine site, or within the Waikaka Stream reach downstream of the site to the confluence with the Mataura River at Gore.

On the basis of the proposed WGL discharge of turbid groundwater to land, and subsequent treatment of any discharge to water, it is considered that the potential environmental effect upon aquifer and surface water quality as a result of the activity, will be no more than minor.

***Effect of Terminal Pond Creation***

At the conclusion of the proposed mining activity a terminal pond excavation will result from the void created over the duration of mining. The excavation void surface is expected to be in the order of up to 30,000 $m^2$ with a maximum depth potentially of up to 40 m BLS. The terminal pond excavation will be located distal (and be isolated), from the Waikaka River. As has been the case with other similar mining activities of this nature, typically the effects of the terminal pond creation are virtually nil in comparison to the active mining process.

As detailed above within this report, during the mining process, dewatering of the aquifer(s) creates a net head toward the mine pit (excavation), resulting in discharge (of mainly suspended solids), to surface waters with no apparent progression of mine pit water into any adjacent aquifer. A small amount of sediment laden water my progress into the aquifer at the conclusion of the mining activity at the final terminal mine pit pond area. However, this can be overcome by a relatively short continuation of water abstraction during infilling to again provide a positive head toward the mine pit (pond) and to remove the majority of any initial sediment-laden water.

The terminal pond head or water level will result to at or about land surface and thus there will eventually be a small continual seepage outflow (in steady state) from the confined aquifer(s), although the majority of water would be sourced from local rainfall and unconfined aquifer through-flow. Typically, from the hydraulic assessment contained above within this report, the majority of natural pond in-filling may take between 6 months to 12 months, to occur. Although, some acceleration of pond infilling may be achieved from modified local catchment area storm (flood) flows. The confined aquifer head in the expected location of the terminal pond is about 0.5 m to 1 m above land surface, and the final pond-full state is anticipated to be very close to that level. However, if any head differential exists, it will be relatively small and comprise a non-measureable component of outflow to that of natural water table through-flow and rainfall seepage within the shallow unconfined aquifer.

Water quality resulting in any seepage away from the terminal pond will be similar to existing groundwater quality and no greater (less contaminants than), the mine discharge assessment contained above within this report. Considering the low (small) mixed discharge potential from the terminal pond within the overall water balance for drainage through the water table aquifer to the Waikaka River, the effect of any diffuse discharge will not be measurable. Additionally, as above, any discharge seepage is not expected to materially change the existing shallow unconfined aquifer water quality. Any effect of stock grazing near the terminal pond and surrounds will also be no greater than any existing effect of stock grazing upon the local water table aquifer.

Overall it is considered that the potential environmental effects of the resulting terminal mine pit pond will be of a De-Minimis nature.

# 6 Conditions of Resource Consent

The following resource consent conditions templates are provided on the basis of the findings within this report, to assist with technical scope and scale, and to allow for appropriate monitoring and compliance-reporting for the requested groundwater take and discharge activities for the purposes of mine pit dewatering and groundwater level control.

- Consent 24.XXXX.XX, Waikaka Gold Limited.
- To non-consumptively take and use groundwater from an aquifer(s) for the purpose of site dewatering, to enable construction and operation of a transient mine pit.
- For a term expiring XX XXXX XXXX.

**Conditions**

***Specific***

1. (a) If this consent is not given effect to within a period of XX years from the date of commencement of this consent, this consent shall lapse under section 125 of the Resource Management Act 1991.

   (b) The taking of groundwater authorised by this resource consent shall be for the primary purpose of non-consumptive abstraction for transient mine pit pond dewatering, and shall occur on land at about and within grid coordinates NZTM E 1,289,861 m, N 4,904,746 m and E 1,291,415 m, N 4,903,428 m and as shown on the attached Plan 24.XXXX.XX which forms part of this resource consent.

2. The cumulative rate of abstraction for the purpose of transient mine pit dewatering shall not exceed:
   (a) 50 litres per second
   (b) 4,086 cubic metres per day;
   (c) 114,635 cubic metres per month;
   (d) 952,387 cubic metres between 1 July and 30 June the following year as a rolling average of any three consecutive years.

***Performance Monitoring***

3.
   (a) The consent holder shall install a water measuring station(s), consisting of a water measuring device and a datalogger with at least 24 months data storage, and shall maintain a continuous record of the cumulative rate of groundwater take and the date and time the water was taken. Flow rate shall be recorded at a minimum of 15 minute time increments to appropriate metering or measurement accuracy while the take is being exercised.

(b) Data shall be provided to the Consent Authority on an annual basis by 31 July each year and as requested in writing. The consent holder shall ensure data compatibility with the Consent Authority's time-series database.

(c) The water measuring station(s) shall be installed as close as is practicable to the cumulative point of take.

(d) The consent holder shall ensure the full operation of the water measuring station(s) at all times during the exercise of this consent. All malfunctions of the water measuring station(s) during the exercise of this consent shall be reported to the Consent Authority within 5 working days of observation and appropriate repairs shall be performed within 5 working days. Once the malfunction has been remedied, an appropriate Water Measuring Device Verification Form completed with photographic evidence must be submitted to the Consent Authority within 5 working days of the completion of repairs.

(e) The installation of the water measuring station(s) shall be completed to full and accurate operation prior to the exercise of the consent. The consent holder shall obtain and complete the appropriate Water Measuring Device and Datalogger Installation Form and Water Measuring Device Verification Form and submit them to the Consent Authority within 5 working days of the completion of installation and verification of the water measuring device and datalogger.

(f) The water measuring station(s) shall be calibrated by a suitably qualified operator applying International Standards methodology. Calibration documents shall be supplied to the Consent Authority by 31 July each year and upon request.

*Note: The water measuring station and datalogger unit should be safely accessible by the Consent Authority and its contractors at all times.*

*4.* (a) The consent holder shall monitor groundwater levels within the lateral boundaries of the advancing mine pit site. The consent holder shall monitor groundwater levels (at least) on a weekly basis, commencing one month prior to the commencement of any site dewatering. Once temporary site dewatering is complete, groundwater monitoring shall then be undertaken until such time that steady state conditions are reached and verified within the aquifer.

(b) Piezometric water level records as required by this monitoring condition, shall be provided to the Consent Authority on an annual basis by 31 July each year and as requested in writing.

**General**

5. Copies of the results of any water quality analyses or aquifer testing performed on the groundwater shall be forwarded to the Consent Authority within 10 working days of the analysis or testing being undertaken.

6. The consent holder shall take all practicable steps to ensure that as a result of the groundwater take:

   (a) There is no unintended leakage from pipes and structures;

   (b) There is no unintended run off of abstracted groundwater either on site or off site

   (c) There is no flooding of other person's property, including erosion, land instability, sedimentation or property damage.

7. Unless otherwise remedied, if as a result of the mine pit pond dewatering authorised by this resource consent, the direct drawdown effect upon any adjacent well that is utilised for the purposes of water supply, reduces the water level to the extent that the water supply is no longer viable, then the consent holder shall, at the request of any affected well owner(s), provide a satisfactory alternative water supply to users for those wells deemed to be affected. All affected wells requiring provision for alternate water supply shall be remedied by the consent holder in consultation with the Consent Authority.

8. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within 3 months of each anniversary of the commencement of this consent for the purpose of:

   (a) Adjusting the consented rate or volume of water abstracted, should applicable monitoring of the abstraction indicate that the consented rate or volume is inappropriate for the consented activity,

   (b) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage,

   (c) Ensuring the conditions of this consent are consistent with any National Environmental Standards Regulations, relevant plans and/or the Regional Policy Statement, and

   (d) Adjusting or altering the method of water take data recording and transmission.

**Notes to Consent Holder**

1. *If you require a replacement permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

- Consent 24.XXXX.XX, Waikaka Gold Limited.
- To discharge excess groundwater from site dewatering containing sediment onto or into land whereby it may enter water, to enable construction and operation of a transient mine pit.
- For a term expiring XX XXXX XXXX.

**Conditions**

***Specific***

1. This consent authorises the discharge of groundwater containing sediment to land, whereby it may enter water at about and within grid coordinates NZTM E 1,289,861 m, N 4,904,746 m and E 1,291,415 m, N 4,903,428 m and as shown on the attached Plan 24.XXXX.XX which forms part of this resource consent.

2. If this consent is not given effect to within a period of XX years from the date of commencement of this consent, this consent shall lapse under section 125 of the Resource Management Act 1991.

3. The cumulative rate of discharge for the purpose of transient mine pit dewatering shall not exceed 4,086 cubic metres per day.

4. No other contaminants (other than sediment or flocculants) shall be discharged to land under this resource consent whereby they may enter water.

5. There shall be no direct discharge, or run-off via tile or open drain, of any sediment laden groundwater from the site.

6. During any period of discharge to surface water (Waikaka Stream), from mine pond dewatering within the term of this consent, monthly monitoring (water sampling) for total suspended solids and turbidity shall be undertaken at the following sites:
    - Final settling pond discharge to Waikaka Stream,
    - Waikaka Stream at within 10 m upstream of final pond discharge, and
    - Waikaka Stream at 60 m downstream of final pond discharge.

7. All water sampling undertaken for Condition 6 of this resource consent shall be analysed by a suitably accredited laboratory and the results shall be forwarded to the Consent Authority within 10 working days of receipt.

8. At the boundary of the reasonable mixing zone for the Waikaka Stream (60 m), the discharge shall not give rise to any or all of the following effects:

   (a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or

   (b) Any conspicuous change in visual clarity; or

   (c) The rendering of freshwater unsuitable for consumption by farm animals; or

   (d) Any significant adverse effects on aquatic life.

9. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within 3 months of each anniversary of the commencement of this consent for the purposes of:

   (a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage,

   (b) Ensuring the conditions of this consent are consistent with any National Environmental Standards Regulations, relevant plans and/or the Regional Policy Statement, and

   (c) Determining any additional monitoring or compliance limits.

**Notes to Consent Holder**

1. *If you require a replacement permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

# 7 References


| | |
|---|---|
| AquaFirma Limited (1998) | *Waikaka Gold Prospect, Groundwater Inflow Feasibility Report.* |
| Environment Southland (2023) | *Proposed Southland Water and Land Plan. Court Version October 2023.* |
| Hall B (2024) | *Waikaka Stream Temporary Diversion Activities. Report for Waikaka Gold Limited.* |
| Hunt B (1999) | *Unsteady Stream Depletion from Groundwater Pumping.* |
| Hydrosolve Inc. (2010) | *AQTESOLV for Windows V4.5 Professional.* |
| Institute of Geological and Nuclear Sciences (2003) | *Murihiku Geological Map 20.* |
| New Zealand Government (2022) | *Water Services (Drinking Water Standards for New Zealand) Regulations 2022.* |
| New Zealand Government (1997) | *Water Conservation (Mataura River) Order 1997.* |
| Town Planning Limited (2024) | *Waikaka Gold Limited AEE Application Report.* |

# ▪ Appendix A

# Report of AquaFirma Limited (1998)

# ▪ Appendix B
# Well Logs and Aquifer Test Data

# ▪ Appendix C
# Aquifer Test Analyses

# ▪ Appendix D
# Stream Depletion Analyses

# ▪ Appendix E
# Water Quality Data

▪ Appendix F

# Water Quality Graphs