Waikaia Gold,
Waikaka Stream Mine.

Additional information relating to specific items
identified by Environment Southland (letter of 20th December 2024)
Ross Dungey, April 2025

Environment Southland requested further information on matters relating to freshwater ecology with the questions listed and answered below.

1.

i. Will diversions reduce the length, width, gradient, and natural character of ditches present? If yes, what length, width, gradient, and natural character will the resulting channels be?

The ditches are largely uniform channels with minor variation in habitat. Pools only develop where there is a concentrated flow at culverts. A similar length, width and gradient of ditch is expected to be reinstated as they are necessary for drainage. The ditches provide marginal habitat and have a low degree of natural character.

ii. What mitigation or offsetting is proposed to ensure no net loss of these species and associated habitat occurs? Will fish salvage in the ditches be undertaken, and where will fish be released? Is increased predation of Gollum Galaxias fry anticipated, why, and how would this be avoided?

Yes, fish salvage in the ditches will be undertaken. A staged schedule of ditch removal and reconstruction will allow salvaged galaxiids to be placed in existing ditch habitat. Upon reconstruction the new ditch habitat will be used to relocate other salvaged galaxiids from existing ditches in the mine path. This will be a gradual process occurring over the life of the mine so there will always be habitat to release galaxiids into.

The only species to be released back into the reconstructed ditches will be the galaxiids and their main predator (eels) will eventually arrive by "self-introduction". Therefore, there will be an initial reduction of predation pressure on the galaxiids and by the time eels arrive the elements of cover/refuge from stream vegetation, will have established and shelter from predators be readily available. The numbers of eels and galaxiids in the ditches was very low.

Mitigation in relation to the ditch habitat includes fish salvage and progressive replacement of the ditches. No offsetting is considered necessary in relation to the ditches. The ditches have very low value habitat, and no net loss will be achieved by the protection of aquatic species and the replacement ditch habitat.

2. *Are freshwater mussels (Echyridella menziesii) (Declining) present in the reaches to be diverted? Confirm whether it is proposed to collect and release freshwater mussels and koura (Paranephrops zealandicus) (Declining) (Grainger, et al., 2018).*

No freshwater mussels were located during the aquatic surveys.

3. *Freshwater species upstream and likelihood of need to migrate through this reach is not mentioned in the ecology report. Please provide a fish passage and migration timing assessment and description.*

Trout and eels in the Waikaka are the species that have migratory behaviour that needs to be catered for. Because the river will always flow either through a diversion channel or the existing river channel there will always be passage available for fish to move upstream and downstream. Eels preparing to breed migrate downstream in autumn (April-June). This is the same time period that brown trout will be migrating upstream to find spawning grounds. Trout spawn in April-June. The eggs stay in the gravel and the young (fry) emerge October/November. The trout will drop back downstream over winter and spring to their original adult habitat. Fish passage is required particularly in autumn, winter, and spring and will be available continuously. The time to minimise disturbance to a channel is therefore winter-spring if spawning is present. Spawning can be assessed in the winters prior to the diversion in Waikaka Stream. There will be continuous flow in a channel at all times so there will not be a barrier to migration.

4. *What time of year are diversions proposed to occur? This is relevant to the migration timings of the fish potentially present and the spawning timings of fish known to be present.*

The diversions will be scheduled to minimise possible disruption to spawning migrations and spawning. The best time is summer as spawning and the migrations to spawning grounds occur in autumn and winter. In spring juvenile fish are still developing their mobility and capacity to move around and therefore limited in their ability to avoid hazards. A summer schedule also suits earthmoving works as drier material is easier to work with (pers comm Noel Becker)

5. *Provide details on restoration and habitat creation methods proposed in the diversion channels and the reinstated channel sections, so that the appropriateness of the proposal can be assessed. This may include, but not be limited to:*
    i. *An assessment of the current number and size of pool, run, riffles within the Waikaka Stream, Shepherds Creek, and unnamed ditch reaches to be diverted. Confirm how many will be established in the temporary diversion channels and the restored channels, method, and reasoning.*
    ii. *An assessment of the current number of undercut banks in the Waikaka Stream, Shepherds Creek and unnamed ditch reaches to be diverted. Confirm how many will be established in the temporary diversion channels and the restored channels, method, and reasoning.*

<u>Pools/riffles/runs.</u>

The number of each habitat type in Waikaka Stream, has been recorded (see Table 1 below). There is an abundance of run habitat so some additional riffles/pools could occupy some of this space to provide for more food production and enhance the carrying capacity of the rehabilitated stream channel. The reconstructed channels will include pools riffles and runs but with greater emphasis on pools and riffles to maximise food production and cover habitat. Pools are particularly valuable as thermal refuges from the summer temperature extremes.

Table 1, habitat types in the Waikaka Stream.

Type	Length(m)	Percent	Number
Pool	2153	49.4	37
Riffle	496	11.4	45
Run	1603	36.8	58
Rapid	107	2.5	6

Attached are several diagrams which show the concept design for rehabilitation of the Waikaka Stream.

Shepherds Creek has a well-developed pool/riffle/run structure with roughly equal proportions of these habitat types. If the new channel post diversion is of similar sinuosity, substrate, and gradient this same habitat structure will be fine-tuned by floods which will ultimately control habitat. Rehabilitation of Shepherd's Creek can mirror the existing pool/riffle/run structure.

The ditches are largely uniform channels with minor variation in habitat. Pools only develop where there is a concentrated flow at culverts. Replacement ditches will be constructed to the same depth, width and gradient as existing. Addition of occasional pools will add to the habitat value of the ditches.

Diversion channels will be created in accordance with the engineering diagrams and will be shorter than the diverted reach. This has a benefit in that a reduced residence time in the diversion channel will minimise elevated temperature impacts. As diversion channels are expected to only be in place for approximately one year, the creation of pools runs and riffles is not considered necessary as the benefits would not be realised in the short time that the diversions are in place.

Undercut Banks

The length of undercut bank was assessed in December 2024. The method employed was to use a range finder to measure the distance between landmarks/features on the river bank and then to visually estimate the percent of each bank on that river reach that was undercut. Each diversion stretch was assessed and the percent undercut bank ranged from 57-72% over the 4 sections. The mean was 66.5%. Undercut banks provide shade and refuge cover for fish and their development is facilitated by the willow root mats. This feature can be created with rock rip-rap and large woody debris (LWD) until the channel stabilises and undercut banks develop and is a "cost effective" method of improving habitat quality and ensuring "no net loss" of habitat.

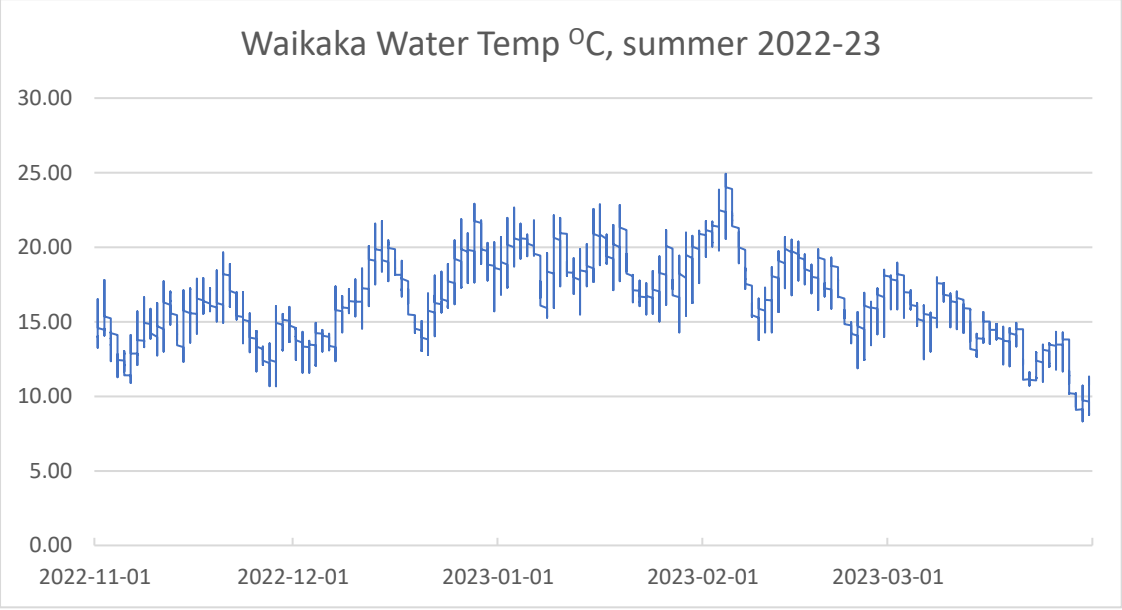
When the river channel is rehabilitated after diversion it will take some time for features such as undercut banks to establish as river processes fine tune the new channel. In particular this will apply to undercut banks. They are currently a feature facilitated by compacted substrate supported by riparian vegetation, in particular willow root systems. Their essential feature is that they provide overhead cover. Newly planted willow hybrids will take 3 or 4 years to begin to provide this feature. In the interim large woody debris (LWD) can fulfil this role. During the diversion large willow logs could be saved and later used to be tied in place against the new channel bank in the water. Fish will use these as overhead-cover for shade

and refuge from predation. Other management options include rip-rap corner protection, cobbles in riffle areas, and plantings to provide shade and temperature control.

Undercut banks are not planned for the ditches, these are essentially "V" shaped channels with a flat bottom. The limited flow meanders within this shape and with vegetation creates its own habitat suited to galaxiids and eels. The banks are too steep and of poorly consolidated material to allow for undercut banks. This "design" ensures the habitat is unsuitable for trout hence the presence of galaxiids. Maintaining these design features is critical to ensuring trout are not resident in this galaxiid habitat.

6. *Riparian shading – Describe management actions, mitigations, or offsetting proposed for removal and delay in growth of effective riparian shading and associated warmer water temperatures in the temporary diversion channels and the restored channels.*

A HOBO recorder logged water temperature in the summer of 2022-23 where water temperatures reached 24.9ºC and were regularly in excess of 20 ºC. Shading (as provided by predominantly willows) is very important to limit thermal stress on the aquatic ecology and is a major part of the channel rehabilitation plan. A max/min thermometer has been installed to check the highest temperature for this summer.



Effective shading over diversion channels is difficult to achieve given they are temporary. The most effective method of minimising any temperature increases is to minimise the length and duration of diversions and for the five diversions to be staged (as is planned). The length of each diversion is very small in the context of the Waikaka Stream and any temperature increases are expected to be small given the short residence time in the diversion channel compared to the remainder of the stream. In addition most of the diversion channels are oriented roughly north-south so exposure to direct sunlight is less than if they were east/west.

Planting of shrub willows will be important for fast restoration of channel shading in the restored channels. Shrub willows do not propagate like crack willows and therefore do not

require maintenance trimming/clearing. These species are relatively quick and easy to establish and provide shade and channel stability in only a few years.

7. *Diversion length – Will the temporary loss of stream length and associated habitat be addressed by offsetting or other actions? Please describe.*

The temporary reduction of stream length (through shorter diversion channels) is mitigation to ensure minimal temperature increases in the diversion channels. The flow through the Waikaka Stream and diversion channels will be continuous.

As noted above, the restoration includes additional riffle habitat and planting, providing an overall improvement in habitat value.

8. *Wetlands appear to be present on the true left of the Waikaka River, no wetland delineation or assessment in relation to wetland effects has been made. Please provide delineation and ecological assessment of the wetland areas on the site, and planning assessment.*

An additional site investigation was completed in December 2024 to assess areas potential wetlands according to EIANZ guidelines and RMA and SRC policy. I have used the term ponds to describe still open water bodies to differentiate from stream, while their status is determined. These "ponds" are probably old dredge ponds and therefore date back to the gold rush of the 1860's.

"Ponds" within the project area, figure 1 were checked to identify potential wetlands. The characteristics of these water bodies were recorded and matched against wetland criteria to determine their status with regard to RMA and Environment Southland policy definitions, Table 2. Some have connections to the river while others are isolated except in times of floods. All these water bodies were dealt with in my initial report and shown in Figure 1, p13. The presence of obligate wetland plants or animals and the connections to the river are shown in the table below. All except pond 5 have willows present. There is a channel connection from ponds 3 and 4 to pond 2 and then to the river but this connection is only likely to be present during high water levels and not during low summer flows. This provides intermittent access for the eels to and from the river.

According to drawing WK0574a15kA4 in which the resource boundary is outlined in yellow ponds 3,4,5 & 8 are outside the "resource boundary" and may therefore not be altered.

Table 2, obligate wetland plants and/or animals, type of river connection (permanent or flood) for "ponds". Pond 1 is the big L&M dredge pond. Red = maybe unaffected.

Pond	Obligate Species.	Permanent connection	Flood only	Fish	Plants
1	yes	Y		Lf eel	Potamogeton, Elodea
2	yes		Y	SF eel	Willow (Salix)
3	yes		Y	SF eel	Carex secta
4	yes		Y	SF eel	Raupo
5	Plants only		Y	No fish	Glyceria
6	yes	Y		LF & SF eel	Elodea
7	yes		Y	SF eel	Elodea
8	Plants only		Y	No fish	Carex secta

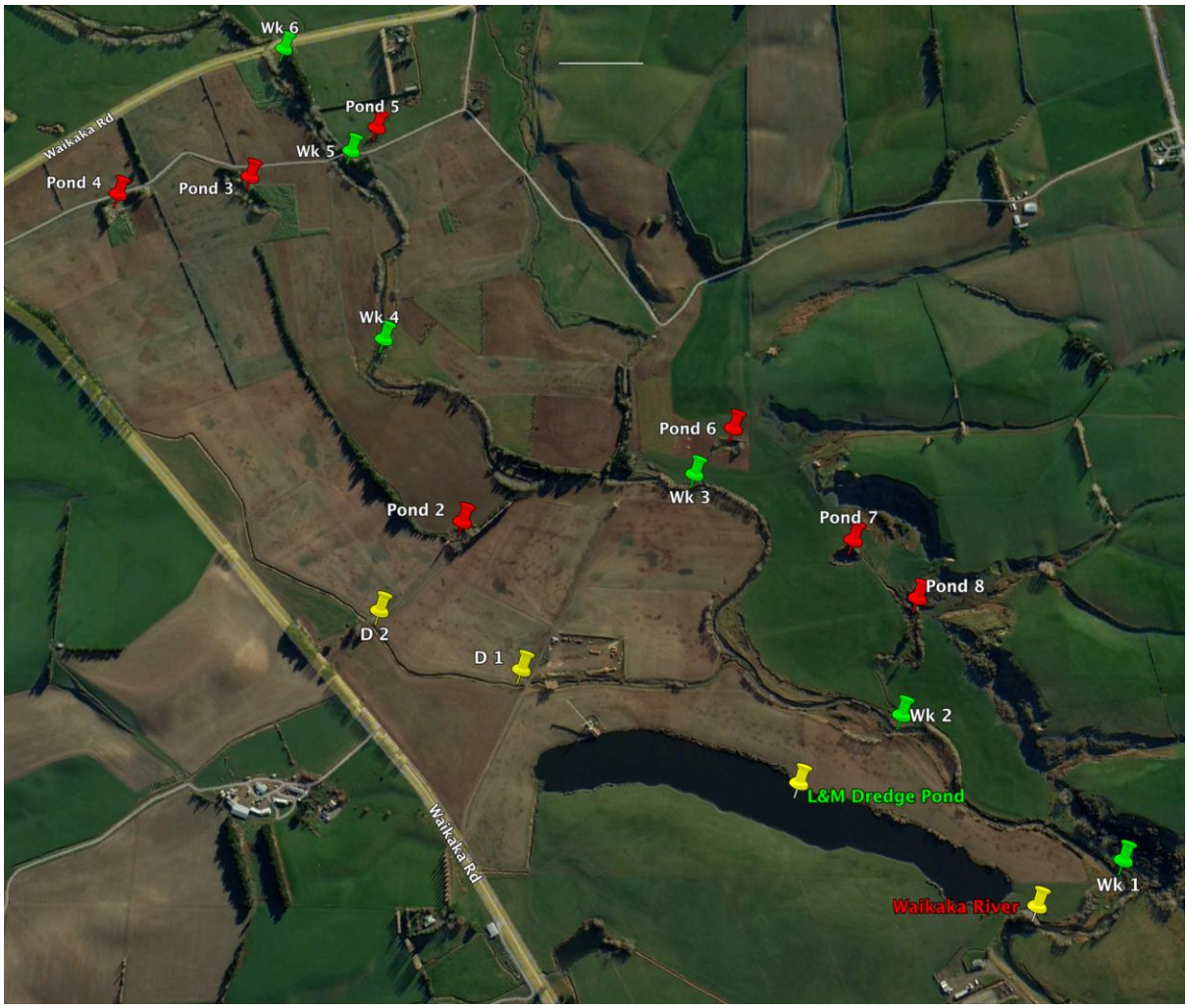


Figure 1, location of ponds and survey sites, Waikaka Gold Mine.

Using RMA criteria , …..*shallow water….that supports a natural ecosystem of plants and animals adapted to wet conditions*, particularly eels, then these ponds would qualify as wetlands. For the NPS-FM; *Not a wetland if it (c) is a wetland that has developed around a constructed water body*. For the ES Regional water plan, given that these ponds (except pond 8) are probably old dredge ponds and *therefore not strictly "natural wetlands"* they are more similar to farm dams and therefore excluded from the wetland category. However, if this type of habitat is to be largely removed by the mining operation it is relatively easy and inexpensive habitat to recreate post mining as exemplified by the large pond left by L&M. Eels are the main occupants and will quickly adopt this type of habitat if it were to be a relic of the new mine. Most of the ponds have maimais present and are fenced, planted, and maintained for duck shooting which is an important cultural event.

In summary, none of the waterbodies are 'wetlands' under the NPS-FM or Regional plans.

9. *The application proposes that a "better" standard in the rehabilitated channel be achieved. Describe how this will be achieved and measured.*

Achievement and measurement of a "better standard" in the rehabilitated channel can be achieved by incorporating a higher proportion of critical habitat features into the reconstructed channel, e.g. cobble riffles, LWD, strategic planting for shade and erosion control. Shade regulates temperature and limits nuisance algae growth in a nutrient enriched environment. The trees that provide shade also resist erosion thus limiting the supply of fine sediment that compromises riffle food producing and spawning habitat. Large woody debris, rock riprap, and willow planting are critical features of the existing stable stream channel and provide important "cover" habitat features for the fish species present. Measurement of the achieved standard can be accomplished by comparing population and habitat statistics in the rehabilitated channels with those recorded in the river pre-diversion.

In summary, mitigation and improvement is proposed to ensure *no net loss* of these species or habitat is achieved by

- Various stream rehabilitation methods are well documented in international literature.
- Strategic planting to maximise shade and cover.
- Increase the number of riffles and the proportion of cobbles in the substrate, for increased food production.
- Rock rip-rap provides very good habitat for eels and small fish.
- LWD (large woody debris) can provide overhead cover until undercut banks establish.
- Fenced to keep stock out.
- Fish salvage in channels to be diverted

Various rehabilitation methods can be very successful in maintaining the health and well-being of waterbodies

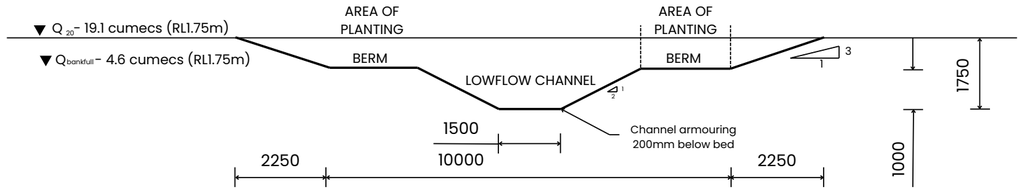
10. *Temporary effects – Please describe the temporary effects of the works on freshwater ecology. This should include, but not be limited to: time of temporary effect; level of effects; measures to be used to avoid, remedy, mitigate, or offset; and reasons for measures proposed to be used.*

Diversion of a section of stream will result in a temporary loss of habitat but the measures employed and outlined above will provide more and" as good as or better habitat" in the rehabilitated river channels. The fact that the diversions are consecutive over the life of the mine reduces their potential impact as only a relatively short section of the river is diverted at any one time. The rehabilitation measures proposed are internationally recognised means to restore and enhance aquatic habitat.

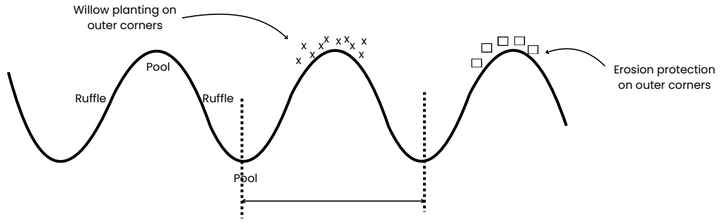
The majority of the river will always be in a natural or rehabilitated channel so salvaged fish can be relocated to suitable habitat and they will be a relatively small proportion of the total population. This schedule also applies to the ditches.

Ross Dungey
April 2025.

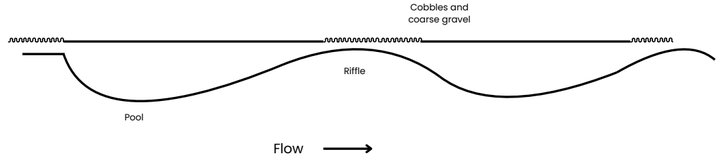
PLANTING SCHEMATIC FOR REHABILITATED WAIKAKA STREAM



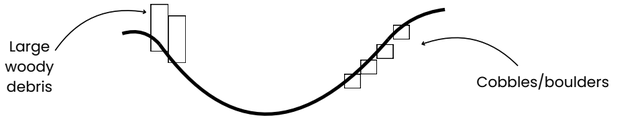
SCHEMATIC OF REBHABILITATION OF WAIKAKA STREAM

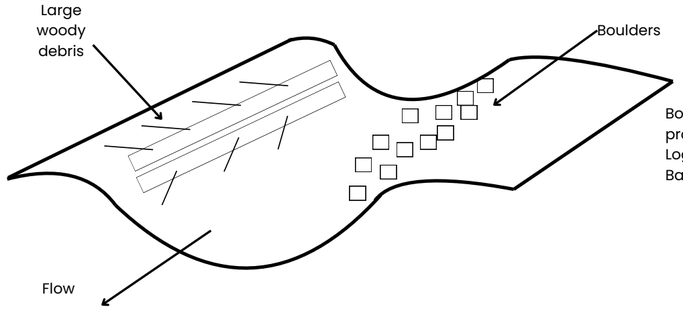


LONGITUDINAL SECTION
SCHEMATIC OF POOL-RIFFLE SEQUENCE IN REHABILITATED WAIKAKA STREAM



SCHEMATIC OF CROSS SECTION OF EROSION PROTECTION IN REHABILITATION OF WAIKAKA STREAM





Boulder reinforcement of bank also providing habitat.
Logs parallel to flow and tied in place.
Base of branches left to snag into bank.