Waikaia Gold, Revised Diversion Plan
Waikaka Stream Mine.

Comments on the effects of this revision on aquatic habitat.
August 2024.

Fish Salvage.

The original plan was to include a substantial stream diversion of about 2km. The revision in the Methodology Report (August 2024) plan is for a staged approach where 4 diversions would occur starting in year 3 of the project, and finishing in year 8. Distances and diversion schedule from table 5 of the Methodology Report (August 2024) are reproduced below.

Figure 32 of that report shows the locations of those diversions.

I have added some analysis of the reduction in habitat using metres of stream as an index of the potential effect of the diversion.

Table reproduced from the Methodology Report (August 2024) with "percent reduction in channel length and years diverted" added.

Diversion	**Diversion Length**	**Diverted Length**	**Year Diverted**	**Year Reinstated**	**Percent reduction**	**Years Diverted**
Waikaka Stream						
Div Channel 1	420	470	3	4	11	1
Div Channel 2	500	630	4	6	20	2
Div Channel 3	230	700	6	7	66	1
Div Channel 4	450	550	7	8	18	1
Sub-total Waikaka	1870	2350				
Shepherds Creek	400	590	4	5	32	1
Total	**2250**	**2940**				

Simply on the basis of channel length there is an 11-66% reduction in available channel length but with the exception of diversion 2 this is only for 1 year. The diversions are staged over a 5 year period and cover distances of 470-700m. Total stream length through the mine site is approximately 2.5km. In most years from year 3 there will be 1 diversion being created and another reinstated to river channel. The mean length of diversion is 590m and the total length of stream is approximately 2500m. This gives a value of "disturbed" channel being approximately 24% of the total during the mining operation.

In general, this staged approach should reduce the intensity of impact of habitat loss on the aquatic ecosystem by spreading that impact over several years and having shorter distances disturbed in any one year rather than all at once.

Positives that accrue from this approach are that fish salvage and relocation puts less pressure on available habitat as additional fish will be released into already occupied habitat. If for example fish salvaged from say 100m can be released over 500m of existing habitat the crowding pressure will be less severe than if the release site was only 100m of stream. In

addition there will be shorter sections of stream in the rehabilitation phase which will not be as productive as stable established stream. It will take time for the new channels to stabilize and rise to production levels of the original stream.

The shorter distances of stream to be salvaged will also reduce stresses on the fish as release sites will be closer at hand and therefore less transport required. Elevated water temperature and diminishing oxygen levels during transport would be stressful for fish but this can largely be avoided when short travel distances to release sites are involved.

The attention to the detail of stream habitat reconstruction still apply but the staged approach gives additional time for new channels (post mining) to stabilize and production capability to rise to natural channel levels. In this scenario fish would be released into habitat that has food available rather than an environment devoid of food, a very important consideration for the salvage and restoration to be successful.

Shorter diversions in the staged approach also gives a chance to monitor the effectiveness of the salvage and release operation and the progress of habitat restoration initiatives.

On page 44 of the Methodology Report (August 2024), methods of channel construction are discussed. The 6th paragraph in particular refers to channel sinuosity, a flood plain, gravel and rock lining, and pool riffle structures. Recognition of these features will be critical in reinstating aquatic habitat. Back up the page there is reference to stockpiling unsuitable spoil. Attention to these details is very important. Having the fine sand/mud component, for example, isolated from the river channel maintains the clean gravels critical to quality fish and invertebrate habitat. Another important point to be emphasised is consideration of ground water levels relative to stream channel depth and the need or not to line the channel to prevent leakage to groundwater. There is the potential to create a new channel but for water to disappear underground thus creating dry river bed and a break in channel connectivity and therefore fish passage.

Habitat Reconstruction Post Mining

An additional point of discussion was habitat reconstruction, replanting, boulder and cobble habitat components.

Planting

To provide habitat in a timely manner, and maximise channel stability, I recommend hybrid willows. These have numerous advantages,

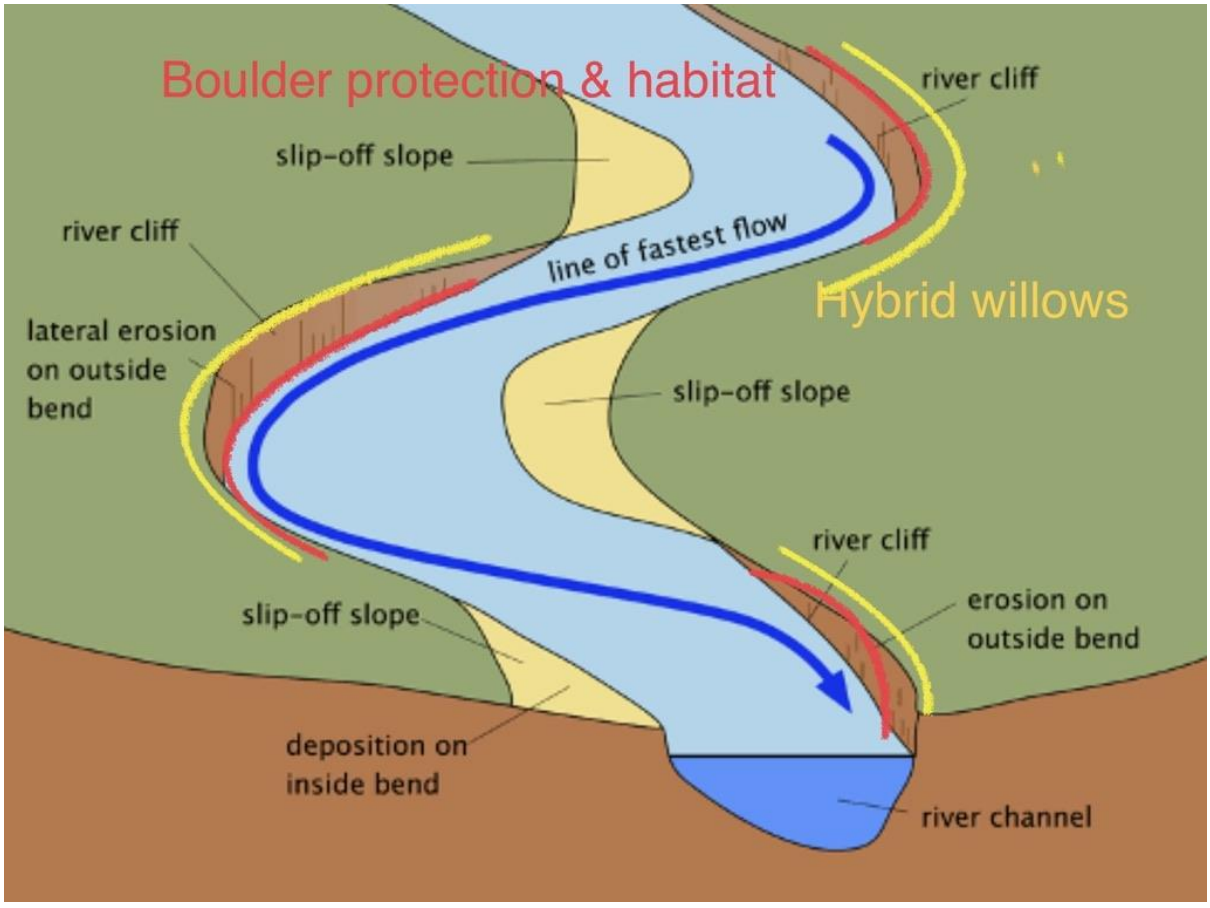
1. Ease of procurement
2. Ease of establishment
3. Rapid growth, 3 years to provide habitat
4. Maximum erosion resistance

Habitat Components

Boulders and cobbles salvaged during mining can have a major role in habitat reconstruction by providing

1. armouring at erosion pressure points
2. habitat for fish, large and small. Eels are abundant in existing boulder dominated habitats of the Waikaka Stream.
3. invertebrate habitat (food for fish). (cobbles are highly beneficial habitat as they provide shelter and food production surfaces).

The stylized diagram below outlines habitat components that the planting and boulders can be used to recreate. Location of hybrid willows is shown in yellow and the boulders for erosion protection and habitat in red. The willows have a dual role of providing exceptional erosion resistance and shading. Cobbles can also be placed across the channel perpendicular to flow to form riffles areas as are present in the existing channel. They provide habitat diversity, bed armouring and food production zones where algae and invertebrates flourish.



Salvage Schedule

The process of dewatering a channel, salvaging fish from a channel, and introducing fish successfully to a new channel can be assisted by developing a schedule. Ideally flow would be reduced in a staged manner from the channel to be dewatered. This allows a proportion of the fish population to depart of their own accord therefore reducing the numbers to be salvaged.

A newly constructed channel should also be flooded in stages, this allows algae to begin to establish thus providing food for the invertebrates which are in turn food for the fish. A freshly flooded channel will obviously lack this beginning to the food chain.

The diversion channels will provide some limited habitat but their value can be improved by allowing some flow prior to complete diversion for algal and invertebrate communities to begin to establish. Food would then be available when fish are released after salvage from a diverted section. These channels will be in place for 1-2 years and will be occupied by various fish species but at much lower densities than the existing channels that have more extensive and diverse habitat components. Ideally these diversion channels will also have some variation in depth so as to avoid long shallow sections that raise water temperatures for the river downstream, as the shading effects of riparian vegetation will be absent.

Summary

While there will be some loss of habitat the staged approach is likely to substantially reduce overall impacts and is a less disruptive approach than a single large diversion for the life of the mine. It will also provide additional opportunities to monitor the process of recovery and fine tune salvage operations and stream rehabilitation.

Ross Dungey
August 2024.