

STOCKTON PLATEAU HYDRO SCHEME

S92 REQUEST FOR ADDITIONAL INFORMATION

West Coast Regional Council Information Request

Responses refer to the scheme plans and the schematic of the scheme below and are to be read in conjunction with the application and supporting documents.

Section A - General Information

1. WCRC Request:

The proposal includes comment that HDL are applying for a land swap with DoC. The land proposed for the land swap appears to offset the terrestrial ecology effects of the proposal. One of the major effects of the proposal is the effect to the loss of heritage values. Has similar offset been considered in terms of a land swap (see also heritage information request as overlap)

Provide an update on land swap with Doc or concession.

1.1 HDL Response

The Westport area office have completed their report assessing the values of the land to be exchanged, with this assessment encompassing historic values. The area office report is currently being assessed by DoC technical staff in Hokitika. Once finalised, assessment of the land exchange proposal will continue, with DoC advising that the final decision can be expected by June (Ian Gilbertson. pers.comm).

The project's effects on the formation of the electric loco are the only effects which can be described as loss of heritage value. The project will affect 3% of historical waypoints noted on the site, will destroy 3% of the formation of the electric loco line and will inundate 10% of the formation. The effects are minor, not major as stated. The application provides offset of the minor effects by improvements in adjoining sections of the formation not affected by the project.

2. WCRC Request:

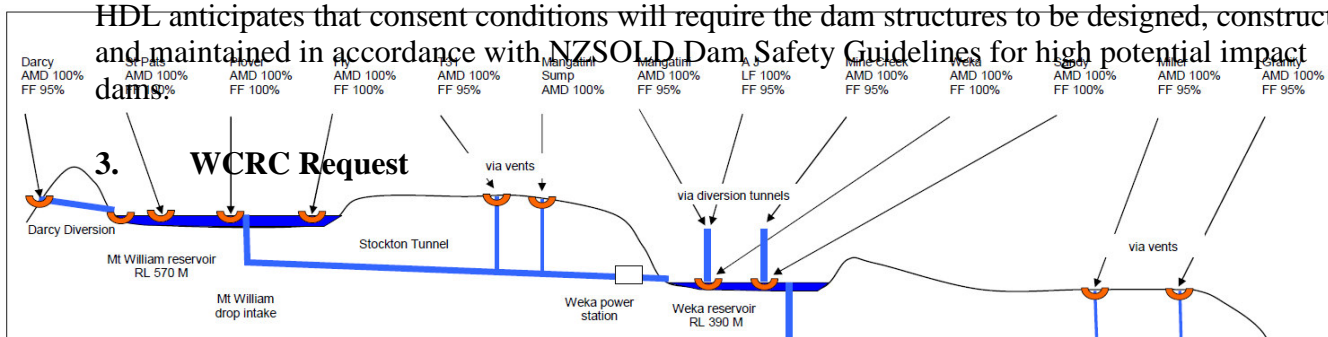
Some mitigation such as relocating Charming Creek walkway have not been mentioned in the application or AEE yet are in the supporting technical documents (Appendix J).

Is the applicant proposing that the mitigation included in the technical reports be included in the application? Provide clarification about what mitigation is proposed. This may be best provided by way of draft conditions which the councils can consider.

2.1 HDL Response:

The application and AEE defines the mitigation that is proposed. Suggested mitigation measures in the technical supporting documents have been considered by HDL and adopted where appropriate. In the first instance, HDL has re-designed the hydro scheme to mitigate effects on users of the Charming creek walkway and residents at Hector/Ngakawau townships. Potential adverse effects have been avoided by the selection of rolled compacted concrete (non erodible) dam construction materials.

HDL anticipates that consent conditions will require the dam structures to be designed, constructed and maintained in accordance with NZSOLD Dam Safety Guidelines for high potential impact dams.



Granity Water Supply - Granity has no formal community water supply scheme with most allotments connecting into private water supplies from creeks coming of the escarpment. The BDC is uncertain as to which properties are associated with the scheme that may be affected by the proposal. The AEE states that an alternative water supply would be supplied.

Confirmation of the properties that would be affected if an alternative water supply would be required. What are the options for alternative sources given the AEE states that there would be no interruption of supply for parties concerned?

3.1 HDL Response

Approximately 20 properties are served by the water supply that feeds into the header tank on the Millerton track, commencing on the seaward side with S Chorley's property (94 Torea St) and Drifters Cafe (97 Torea St) on the landward side, down to the Granity Fire station on both sides of Torea Street.

The water supply is fed by one of the numerous springs that arise from the slope debris along the escarpment behind Granity. These springs have been tapped into by Granity residents for domestic water supplies for as long as the settlement has been established. Intakes are located in response to changes in flow and are the subject of dispute within the community.

HDL will capture a spring in a similar manner and will establish a storage tank to supply water for tunneling purposes. The raft of consents sought includes water permits to take and use water from numerous watercourses including Granity Stream but HDL also requests that this permit be extended to include springs within the vicinity of the Granity construction area.

There are no construction works to be undertaken in the immediate vicinity of the water supply header tank on the Millerton Track or any other intake. The construction activity referred to in the AEE that may impact on the Millerton Track supply is construction of the Granity Tunnel. There is a possibility that construction of the portal may alter spring flows in the immediate vicinity of the portal. In this event HDL will ensure that alternative water supply arrangements are made involving provision of potable water by means of water tanker while connection to an alternative intake is established. Therefore ensuring no disruption to residents water supplies.

The following condition of consent is proposed:

In the event that construction activity at Granity impacts on any of the private water supplies informally established on DoC estate, the Consent Holder shall arrange at their cost, a similar alternative water supply from the same catchment. The Consent Holder shall ensure that an alternative potable supply by means of water tanker delivery is provided until connection to the alternative water intake is established.

4. WCRC Request

Disposal of silt from the silt traps at the reservoirs is likely to be to SENZ's waste dump sites. Sediment removal from the collector tunnels is to be disposed of initially in the SENZ area and it is suggested that when they have closed down there will be little sediment deposited. While that may

4.1 HDL Response

The source of sediment is from mining activities or from land disturbances caused by natural events. Undisturbed land and rehabilitated mining areas do not produce significant quantities of suspended sediment in other than extreme events.

Silt traps at the schemes diversions will collect sediment that has bypassed the sediment controls

established to control the effects of mining, which are subject to performance based conditions of consent. SENZ has indicated that it will accept this material back into the active overburden dumps after drying at the silt storage sites specified in the application. The volumes are insignificant compared to total material dumped during active mining operations.

Mine closure is conditional on mine rehabilitation achieving acceptable water quality, including total suspended sediments. The sediment storage areas included in the application are expected to provide sufficient volume to store sediment captured in the traps post mine closure (c 2030).

In the unlikely event that SENZ refuses to dispose of their captured sediment the following options are available for silt disposal:

1. Sediment is contained in the reservoirs – this is not a favoured option given the loss of storage volume.
2. Removal of sediment for use in rehabilitating the numerous abandoned mine sites on the Plateau. Should this prove necessary additional resource consents would be sought.

5. WCRC Request

The AEE states that any temporary stormwater control measures will be designed for a 2 year event however, it is not clear how stormwater from permanent access roads will be managed.

Confirm how stormwater from access roads will be managed. What is the rationale for designing stormwater control measures to cope with a 2 year event only?

5.1 HDL Response

Stormwater control from all construction activity will be managed in accordance with Auckland Regional Council's TP 90 "Erosion & Sediment Control Guidelines". The 2 year design criteria is appropriate for temporary diversion drains within a construction site where the effects of overtopping are contained within the site.

Post construction, stormwater from the project's permanent roads will be directed into water tables and into the project's sediment traps and reservoirs with no effect on waterways. Stormwater from DoC or SENZ roads used by the project will be directed to the existing stormwater controls already established for this purpose.

6. WCRC Request

Level of assessment undertaken on the impacts of putting emergency discharge into Granity Creek if the ocean outfall cannot be used. The AEE states that an emergency discharge would be up to 9m³/s, smaller than freshes that pass down the creek. Is there any potential effects of scouring of riverbanks and bridge supports. It is noted that the northern end of Granity beach erodes along the river mouth in certain wave patterns and that erosion protection was required.

What information is there to prove the discharge would be smaller than a fresh? What measures does HDL propose to ensure that the discharge does not cause scour or erosion in the creek? What would be the effects of an emergency discharge if Granity Creek was already in high flow during high tide?

6.1 HDL Response

The following table (KML 2006) details the flood hydrology of the Granity Stream tributaries, Upper Miller Stream and Upper Granity Stream. The peak flow from the emergency outfall is less than the annual flood of either tributary and as stated in the AEE will be similar to the small freshes which occur each year.

Flood flows which exceed the annual flood determine stream bed armouring, geomorphology and bank and pier scour. The peak flow from an emergency spill will not disturb the natural armouring of Granity stream channel and will be contained within the stream bed.

The probability of emergency discharge at the same time as the passage of the flood peak is extremely low and is considered insignificant, adding around 10% to the flow volume over a short duration. Tidal effects do not extend above high water during flood flows.

Extreme circumstance that the main outfall pipeline became blocked or damaged in any way. Should this occur, there will be a time lag before flows through the Granity power station can be shut down up at the reservoirs and scheme diversions on the Plateau.

The processes of scour at the stream mouth are determined by flood flows and wave action and will not be affected by an emergency discharge.

		Upper Mine Creek	Mine Creek @ Ngakawau	Upper Miller Stream	Upper Granity Stream
		MI-F4	MC1	MI-F2	MI-F1
Factor	m ³ /s/km ²	12.2	10.5	10.5	10.5
Catchment area	km ²	1.609	6.665	1.37	2.928
Annual flood	m ³ /s	19.6	69.9	14.3	30.7
1:5 AEP flood	m ³ /s	23.7	84.7	17.4	37.2
1:10 AEP flood	m ³ /s	26.8	95.7	19.6	42.0
1:20 AEP flood	m ³ /s	28.9	103.1	21.1	45.3
1:50 AEP flood	m ³ /s	33.0	117.8	24.2	51.7
1:100 AEP flood	m ³ /s	36.1	128.9	26.4	56.6

In the extremely unlikely event that the outfall pipeline became blocked or damaged in any way, the emergency outflow would only be operated until the intake tower and scheme diversions could be shut down. Within the AEE it was stated that this is expected to occur within 24 hours, however, it is anticipated that flows would cease within a matter of hours as the intakes will be controlled through an automated system.

HDL does not believe any mitigation is required for an emergency discharge and proposes the following condition of consent.

The consent holder shall ensure that peak flow from an emergency spill will not disturb the natural armouring of Granity stream channel and will be contained within the streambed.

7. WCRC Request

A number of temporary and permanent structures and diversions are required to enable construction of the project, for example: temporary diversions in Darcy Stream, Mangatini Stream and Mine Creek and temporary culverts in Weka and St Patrick Streams; and permanent culverts in Sandy Creek. No design criteria (eg. culvert sized for 1 in 10 year event) have been provided to demonstrate that they will be of sufficient capacity.

Confirm design parameters of the structures and diversions.

7.1 HDL Response

The AEE states that the culverts under the dams required for temporary diversion of the Weka and St Patrick Streams during dam construction will have a capacity for a 10 year flood event (see Section 8.9.1 of AEE)

The temporary diversions associated with the installation of the intake structures within Darcy Stream will be required for no more than the few days required to install precast intakes onto the raise bored intake tunnels (drilled from inside the tunnel). The installations will take place during dry conditions when stream flows are low and there is a clear weather forecast. The temporary diversion will be formed from sandbags that will divert low flows to one side of the stream channel.

The weirs within Mangatini Stream and Mine Creek incorporate a sluice culvert which will pass 5 cumecs. This flow is exceeded less than 10% of the time in Mangatini Stream and less than 5% of the time in Mine Creek. The weirs will be built during the Stockton dry season (Feb/March). The installations will take place during dry conditions when stream flows are low and there is a clear weather forecast. Stream flows will be temporarily diverted around the sluice using sandbags that will divert low flows to one side of the stream channel.

The culvert that passes Sandy Creek beneath the realigned haul road will be designed to pass 30 cumecs, which is the maximum flow expected to be diverted through Mine Creek diversion, (approximately 20 year flood in Upper Mine Creek and exceeding the 100 year flood in Sandy Creek).

8. WCRC Request

Ocean Outfall - The AEE notes that the probability and extent of the plume cannot be predicted by the model and that field trials would be required to determine if a plume would be visible from Granity. Section 107(1)(c) means that the council cannot grant a discharge permit that after reasonable mixing will give rise to certain effects. The extent of the plume needs to be determined to enable the effects on the receiving environment to be assessed.

Comment on how, in the absence of modelling information, a reasonable mixing zone can be determined?

8.1 HDL Response

Some general discussion on mixing zones may help answer this query. Below is a modified excerpt from the NZ Wastewater monitoring guidelines (Barter & Forrest 2002) which deals with mixing zones in general, followed by some specific comments on the HDL outfall.

Some general discussion on mixing zones may help answer this. Below is a modified excerpt from the NZ Wastewater monitoring guidelines (Barter & Forrest 2002) which deals with mixing zones in general, followed by some specific comments on the HDL outfall, prepared by Cawthron.

Mixing Zones

The RMA requires that any standards imposed through classification or section 107 is met after “reasonable mixing”. Zones of reasonable mixing are areas of transition within which classifications do not apply. They are effectively zones of non-compliance. From a practical viewpoint standards can only apply after reasonable mixing of any contaminant or water with the receiving water, disregarding the effect of any natural perturbation. The area within which this mixing occurs is called a “zone of reasonable mixing” or “zone of initial dilution (ZID)”. This “zone of reasonable mixing” provides for the mixing of discharges with receiving waters. Some further mixing could still occur outside of the zone as long as the effects in section 107(1) of the Resource Management Act 1991 do not occur and the relevant water quality classification standards are met.

In general, it is not intended that the size of a zone of reasonable mixing be tailored to the volume and nature of a discharge, but rather that the volume and nature of a discharge fit the standards and criteria in accordance with regulatory framework (e.g. Regional Council's Coastal Plan). The zone of reasonable mixing depends on:

- the rate of discharge and concentrations;
- the physical configuration of the outfall or structure from which the discharge is emitted;
- the depth, current velocity and direction, and the rate of turbulent mixing of the receiving water; and
- Ambient concentrations in the receiving water.

The general requirements for the zone of reasonable mixing are outlined in "Resource Management Ideas No 10 – A discussion on reasonable mixing in water quality management." (Rutherford, et al 1994) as follows:

- the size of the zone of reasonable mixing should be minimised;
- any adverse effects should be confined to within the zone of reasonable mixing; and
- any adverse effects within the zone of reasonable mixing should be no more than minor

It is anticipated that a discharger, altering the extent to which contaminants or water are discharged into the receiving environment, can control the size of the zone of reasonable mixing. For example, lowering the volume or improving the level of treatment or mixing characteristics, even by a small degree, can produce marked changes in mixing zone specification.

HDL Mixing Zone

In the case of the HDL mixing zone, several factors have yet to be determined (e.g. final effluent pH) which would allow a quantitative assessment of the mixing zone size. Nevertheless, there are a number of ambient environmental factors which, by their nature, constrain the maximum size of a mixing zone in this area. For example, a fundamental aspect of setting mixing zones for coastal environments is that the mixing zone itself should not contact the shoreline. This is usually used in conjunction with a safety factor of some kind (e.g. 2:1) which helps reduce effects from the surf zone among other things.

In the case of the proposed HDL discharge, the diffuser is situated 600m from shore, which would, incorporating the 2:1 factor, equate to a maximum 300m radius mixing zone. This 300m size is commensurate with the volume of the discharge and is similar to other recently consented coastal discharges. For example, in 2005 the Fonterra Clandeboye coastal outfall was granted a 300m mixing zone for an open coastal discharge. In our experience, most of the recently consented coastal outfalls have had mixing zones from 100m to 300m radius and we see this outfall as being no different.

Therefore; the maximum mixing zone size we envisage is 300m from the point of diffusion, but this could be minimized when more detailed effluent quality/quantity information and final diffuser design details becomes available. This is in keeping with the general guidelines (Rutherford et al. 1994) outlined above. Similarly, if it transpires that relevant water quality guidelines cannot be met within this distance, then additional treatment or an alternative diffuser design would be required to ensure that standards can be met.

Section B - Hydrology Information

The context for the hydrological analysis and assessment of effects is summarized below. Responses to the questions on hydrology follow.

Context for Hydrological Analysis

The Stockton Plateau Hydro Project has been designed to create a hydrological barrier between the upper catchments of the Stockton Plateau that are affected by mining, and the lower catchments that are pristine.

The objective for the scheme is to capture all run-off from the upper catchments to prevent ongoing contamination of the Ngakawau River and to maximise water available for power production.

The scheme will detain peak flows of the upper catchments. The use of hydrological mean values is therefore appropriate for assessing the hydrology and operation of the hydro scheme within the upper catchments.

The hydrology of the truncated catchments downstream of the scheme has been assessed by reference to the hydrological records that are available for Stockton (assuming no spill from the upper catchments). Standard methods for determining the hydrology of sub catchments by reference to the hydrological records for the wider catchment, adjoining catchments or regional analysis have been used.

Overview of Assessment of Effects

The assessment of environmental effects of the truncated catchments down stream of the scheme's dams and diversions has conservatively assumed that no spill from the scheme will occur. This will be true most of the time. Some spillage will occur from the dam spill ways during infrequent extreme events. Some flow will be lost at the small stream intakes as these are cross flow, drop intakes with silt screens fitted. However, the total volumes lost in bypass spill is expected to be less than 5% of total flow at these intakes.

Both the flood flows and flood frequencies for the truncated catchments will be modified as predicted in the supporting documents. There is unlikely to be any change in stream morphology. The stream channels downstream of the scheme are deeply incised in bedrock as they fall hundreds of metres to the Ngakawau river. Some coarse bedload is deposited in small pools but there are no substantial alluvial deposits. The stream morphology will revert to premining undisturbed catchment condition with vegetation and animal populations re-established in the stream channel and on the stream banks.

The stream ecology will revert to premining conditions as AMD, coal fines and silt generated by mining activities will be contained by the hydro scheme. While the rate and nature of reversion is uncertain there is no dispute that this will occur.

The noticeable effects of the construction of the scheme will be similar to the effects downstream of the natural rockfalls which truncate or dam watercourses throughout the West Coast coastal mountain ranges. Over time the channels immediately downstream of the scheme will revegetate and adapt to the lower volumes of clean water. Frequency of flooding will not change as this is determined by climatic conditions. While these effects will be the result of construction of the scheme they will not be unnatural or out of place in this environment.

In summary:

- The hydrology of the affected catchments downstream of the scheme is based on the recorded responses of natural catchments at Stockton. This is appropriate given that there will be no spills from the upper catchments.
- Hydrological means for the upper catchments captured by the scheme are used for assessment of hydro power potential and assessments of water quality at the outfall. This is appropriate given the detention effects of the reservoirs and the hydrological data that is available.
- The future ecology has been assessed by considering the frequency and variability of flows from the truncated catchments. The assessments have taken into account the final design objective to eliminate spills from the upper catchment but have also taken account of the frequency of spills from the scheme to the downstream catchments predicted by the modeling of the scheme concept design, in the event that total containment cannot be achieved.
- The current ecology of the streams has been marginalised by AMD and silt loads. It has been assessed that the future ecology of the streams will naturally evolve into a healthy diversified ecology typical of the pre mined Stockton Plateau that is in balance with improved water quality and modified flow regimes.
- 2006 flows record was used for hydro power modeling as it is the most complete, highest quality record. Subsequently, the 2006 series was replaced in the model with the other years of flow recordings (2003 – 2005) with the finding that 2006 represented a “wet year” for hydro generation, as discussed in the scheme modeling report. Environmental effects of the truncated catchments have been assessed based on long term records that are not affected by the selection of record for hydro modeling.
- Climate change scenarios have been considered. The scenarios influenced the decisions to opt for tunnels with surplus hydraulic capacity and maximise storage at each reservoir site. The operating regime for the outfall has been designed to cope with extended periods of drought. Climate changes are expected to be sufficiently gradual for the ecology of the truncated catchments to adapt.
- Flow variability and hydrology within the truncated catchments is reflected in the longer term catchment data used to assess the effects of truncation. The effects on ecology has been based on the expectation that the stream ecology will recover to a condition similar to adjoining catchments that have been unaffected by mining or diversions.
- During final design, hydrological recording network will be established for the purposes of hydro scheme operation (the current network is set up for the purposes of managing the effects of mining). This will improve the hydrological data available for scheme final design and operation. However, it is relevant that the use of tunnels, with effectively unlimited hydraulic capacity, means that the only hydro components significantly affected by uncertainty in the hydrological analysis are the spillway design and the selection of turbine size. Dams have been specified with the maximum storage volume that can be reasonably constructed on the sites. Spillway are physically unconstrained and will be specified at upper levels of prediction. Installed capacity requires an unusual level of duplication to allow machines to be taken out for service more regularly than normal due to the acidic environment and hence selection is not critical on the quality of hydrological analysis.
- The use of mean water quality for all in flows in the water quality model is a highly conservative approach, predicting lower water quality at the outfall than is expected to occur most of the time. This approach has been taken because existing records are not suitable to determine a relationship between water quality and flow, although there is sufficient data to indicate that a strong relationship exists. Hence, no account has been taken of higher quality runoff into the reservoirs and dilution effects in the reservoirs. During final design the hydrological network will be developed and field trials undertaken to establish the relationship between water quality and flow rates for the contributing catchments. It is

expected that the concept design will be conservative and that actual water quality at the outfall will fall well within ANZECC guidelines.

- The deficiencies in the hydrological records are accepted, but this said, Stockton Plateau is one of the most intensely monitored catchments in New Zealand. Monitoring has focused on the environmental effects of mining which are now well understood. HDL has had full access to all hydrological records and analysis. SENZ staff have reviewed the hydrology, scheme modelling and water quality reports to ensure consistency with current work undertaken for SENZ. The hydrology that supports this application has supported previous consent applications by SENZ for diversion and hydraulic structures on the same tributaries and has been found appropriate for the purpose. The hydrological methods applied by HDL are the same as applied by SENZ, which are subject to international peer review under conditions of consent held by SENZ.
- A precautionary approach has been taken to the design and economic analysis, whereby when faced with uncertainty, the project team have selected inputs which lead to potentially greatest effects, not least effects. The result is that there are layers of conservatism built into the concept design, as is appropriate for assessment of environmental effects at this stage of development.

1. WCRC Request

When discussing the effect of the proposed scheme on the tributary and main channel flows it is important that its effect over the entire flow regime is considered; not just its effect on average flow conditions. It is likely that the mean is in effect representative of very little in terms of the actual flow regime. The median flow would have been a better measure – at least from the hydrological perspective. For the statistical summary and analysis to be placed in context it is critical that a full analysis of the flow records and consequently the flow regimes is presented.

Given the nature of the flow regime in the affected catchments, with short high intensity events interspaced by periods of low flow, how appropriate/relevant is the use of mean conditions?

What is the nature and variability of the flow regime? What other measures (e.g. medians) might have been more appropriate from an environmental perspective?

1.1 HDL Response

The mean is considered an appropriate measure for the feasibility design of the hydro components of the project. The water courses are all in bedrock. The ecology of the streams is dominated by water quality not variable flow regimes. The ecological changes that will occur downstream of the diversions are expected to be positive in response to changes in water quality and the reduction in sediment laden flood flows as reported in Appendix D.

2. WCRC Request

The short 4-year periods of hydrometric record from the project area needs to be placed in the wider temporal context. While the application makes no claims that 2006 was average, or even what conditions it represented, this is actually critical when assessing the potential impact of the scheme. Given the strong focus, and more in-depth analysis, of the hydrometric data from 2006 it is critical that this year is placed in context. It would also allow the significance and relevance of 2006 to be highlighted; and therefore whether this was a typical year.

Provide a detailed analysis of the long term flow record for the Ngakawau catchment.

What conditions does 2006 represent?

- How did the rainfall during 2006 compare to other years?
- How typical was 2006?

- Was it distinctive in any way?
- How might this distinctiveness affect the results and conclusions reached?

Compare both the rainfall and flow records from 2006 (perhaps using the Ngakawau records) with the long term temporal record. This would allow more confidence to be placed in the conclusions derived from the analysis of this particular year.

2.1 HDL Response

The 2006 record was selected for hydro generation modeling purposes because it was the most complete, highest quality annual record. 2006 is a comparatively wet year as discussed in Appendix I. This has been taken into account in the scheme economic analysis. **All available hydrological data** has been considered in determining the hydrological effects of the proposed diversions.

3. WCRC Request

The comparison of synthetic and actual flow data, even using daily average data, shows that the relationship is not good. It is essential, given the extensive use and potential significance of the synthetic flow records that the potential impacts of this rather poor relationship is explored. While it is likely that little can be done to avoid the 'error', it must be recognised; as must its potential effect on the results and conclusions.

Provide comment on the potential effect on the results and conclusions on having used synthetic data.

3.1 HDL Response

Use of synthetic data is required to model hydro potential and the uncertainty has been taken into account in the design of the scheme. Use of synthetic data has no material effect on the conclusions with respect to residual flows and environmental effects.

4. WCRC Request

In the Water Quality and Hydrologic Modelling report when discussing hydrological verification it is stated that the difference is 50%. In fact, the difference is 100% with the modelled data being twice the measured data. This is a significant difference. Its effect on the results and conclusions must be addressed.

Discuss the effect on the results and conclusions due to the difference in the measured and modelled data.

4.1 HDL Response

The design of the project has been based on risk based scenario analysis. Uncertainty in the modeling is recognized and has been taken into account in the design of the project, which has been designed to ensure compliance with ANZECC water quality guidelines at the ocean outfall under a range of likely scenarios. The application further provides for the final design of the outfall to be based on field trials and improved accordingly.

5. WCRC Request

The hydrometric data record is not considered of high quality. Of the three sites discussed missing data account for 14%, 13% and 24% of the record. Of critical importance is 'which part of the record is actually missing'? It is likely that the missing record biases the data by disproportionately missing either the high flows (most likely) or low flows.

What is the effect of these missing data on the statistics derived?

How does it affect the means derived from the analysis?

What are the potential effects of this on the conclusions?

5.1 HDL Response

The hydrometric data record has focused on addressing water quality issues and is less complete and less accurate for higher flows. The effect will be to predict less volume of water available for hydro-generation and to suppress the assessment of base load. Both effects are conservative and have been taken into account in the design of the project.

6. WCRC Request

After providing some discussion of the rainfall and flow variability across the project site it is then argued that gaps in the rainfall record can be filled by substitution. No justification is provided for this approach.

Provide justification for filling gaps in the rainfall record by substitution.

6.1 HDL Response

Substitution of data does not effect the assessment of environmental effects of the proposed diversions. The data will not be used to determine final hydro operating regimes or the specification of hydraulic components of the scheme.

7. WCRC Request

Given the uncertainty of the hydrometric data sets, it is essential that the application (or an Appendix) provides a detailed analysis and quantification of the errors inherent in the analysis. This must then extend to an attempt to quantify the potential effect of these errors on the results and the conclusions. There is considerably more uncertainty regarding the hydrologic impacts of this proposal than suggested in the application. This uncertainty must be quantified if at all possible. At the least it must be recognised and acknowledged.

Provide a detailed analysis and quantification of the errors inherent in the analysis.

7.1 HDL Response

The hydrometric data sets have been exhaustively analysed by SENZ hydrological consultants over many years. HDL has benefited from this work. While the data sets are far from complete they provide an excellent resource to inform the design of the project as regards assessment of environmental effects.

The hydrological impacts of this proposal are clearly stated. The project will capture up to 100% of all runoff from the catchments affected by the diversions. Residual flows will derive from the unaffected catchments downstream of the diversions.

Uncertainty in the prediction of the residual flows and associated environmental effects is dominated by rainfall distribution and catchment response and will not be resolved by further analysis of the data sets that are available.

HDL believes that the results presented in the supporting documents provide for a conservative assessment of hydro potential and environmental effects.

8. WCRC Request

While considerable emphasis is given to the available flow records no discussion is provided of the accuracy and reliability of the data.

How accurate are the hydrometric data?

Consider:

- how accurate are the rating curves?
- how stable are the curves?
- how do the distribution of gaugings from which the rating curves were derived relate to the flow regime? That is, what were the highest and lowest gauged flows? How do these compare to the highest and lowest flows on record?

8.1 HDL Response

Rating curves are poorly verified at high flows with the result that the stated hydro potential is conservative.

9. WCRC Request

While areal scaling has been used to derive flows for un-gauged catchments it would appear that a straight proportioning approach has been taken. It has been shown, and extensively documented in New Zealand, that areal scaling should involve $A^{0.8}$ rather than area alone. If no justification is provided to the contrary, then a similar approach should have been adopted in the current study.

Provide any justification or use areal scaling that involves $A^{0.8}$ rather than area alone.

9.1 HDL Response

Area alone was considered appropriate given the effects of rainfall distribution.

10. WCRC Request

The application contains very little on the effect of the proposed scheme on the high flow events. It is the extreme events or occurrences, rather than the normal or average conditions that have a critical effect on the stability of the system, potential stress, or the potential for change.

How will the scheme impact on the frequency of flooding and the magnitude of floods? What is the likely effect of this with increasing distance downstream? Will this have a significant affect on the environmental processes downstream?

What is the nature of the flood regime of the various tributaries? How will the scheme impact on these regimes?

10.1 HDL Response

The stream channels downstream of the diversions are all gorges in bedrock descending to the Ngakawau river gorge. The effect of reducing flood flows downstream of the diversions will be similar to the natural effects of rockfalls on streams throughout the West Coast lowland forests. The vegetation adjacent to the active channel will dominate as forest trash is retained and as acid water affected ecology recovers.

Flood regimes will reduce but not necessarily in proportion to an areal factor. Flood flows from the Stockton Plateau are dominated by areal variations and extent of rainfall.

11. WCRC Request

While some weight is given to the flood mitigating effect of the proposed reservoirs, this effect will reduce over successive floods; unless the storage capacity of the dam is restored between events.

While there will be some attenuation of flood events caused by the reservoir, this may be offset by the reduced travel time of any flood wave. This does not appear to have been considered. The potential effect of the reservoirs could be better reviewed by considering the frequency and occurrence of storm events, and how this pattern of storm activity will interact with the operating regime for the reservoirs and power schemes.

How will the pattern of storm activity interact with the operating regime for the reservoirs and power schemes?

11.1 HDL Response

The scheme operating regime will be managed to spill the least volume to maximise power generation but also to minimise AMD reporting to the Ngakawau River. The scheme will be operated by predictive modeling which will include rainfall, reservoir stage, sump capacity and market inputs.

12. WCRC Request

There is no discussion provided as to the effect of the proposal on the low flows of the tributaries, and in particular the effect of flow retention within the reservoirs on the periods and duration of low flows. While short periods of low flow may not be critical to environmental processes, extended periods of low flow can certainly have a significant effect. Of particular importance is the significance and impact of the scheme on the duration and magnitude of periods of low flow. The use of, and focus on, mean flows tends to downplay the potential significance of the scheme on low flow conditions.

Provide comment on the effect of flow retention within the reservoirs on the periods and duration of low flows.

12.1 HDL Response

There is no provision to release reservoir storage to augment low flows. There is very little freshwater ecology in the streams affected by the project. The ecology that recovers as a result of the diversions will be adapted to the low flow regimes resulting from the diversions.

13. WCRC Request

There is very limited analysis of the potential impact of the scheme on channel morphology. No attempt appears to have been made to link changes in morphology to changes in the flow regime of the various streams.

What are the potential effects of the scheme on channel morphology?

13.1 HDL Response

None, refer to Response 10.1 above. The streams flow through bedrock.

14. WCRC Request

While the potential impacts of the proposal will be less with increasing distance downstream, this has not been quantified. It is important that the full potential impact of the proposal is assessed. This includes the dissipation of effects with increasing distance from the site.

What are the effects of the increased flood flows in the Mangatini Stream?

How might these increased flows affect the morphology of the channel? How might this affect downstream users?

14.1 HDL Response

The project does not increase flows in the Mangatini Stream.

15. WCRC Request

The application makes the conclusion that one effect of the scheme may be that the 1:50-year event could become the 1:100-year event. This claim appears to be unsubstantiated. It is, however, highly likely that low flow events will become much more common, and their duration will also increase as a result of the diversion of flow into the scheme.

Provide comment on why the 1:50-year event could become the 1:100-year event.

Note: if it is demonstrated that the scheme would appropriately ameliorate flood flows, it is likely that responses to the above questions would reflect this.

15.1 HDL Response

The effect is that the project will not increase flood risk. The possible reduction in frequency is based on a simplistic analysis and would be storm specific, for the reasons discussed in Section 8.8.3 of the AEE.

The nature of the Ngakawau catchment and distribution of forest to the north and barren coal measures to the south suggests that the effects of the scheme on Ngakawau River low flows will not be as great as proposed in the application. During periods of drought all streams flowing from the Stockton Plateau dry up for extended periods. This is an issue for hydro generation which has led to conservative assessment of base generation.

16. WCRC Request

Given the life expectancy of the scheme, the potential effect of any climate change needs to be considered. The AEE states that more extreme patterns of rainfall will need to be managed and that this will be done by providing storage and increasing power production. However it is not clear whether the reservoir area proposed has accounted for this.

Confirm how potential storage requirements due to climate change have been accounted for within the reservoir areas.

16.1 HDL Response

The application is for the maximum storage that can be practically built at the given locations and incorporates tunnels that have hydraulic capacity far greater than the planned installed generation. This increases cost significantly and would be suboptimal under adverse climate change scenarios.

17. WCRC Request

In terms of sediment control, both during construction and during tunneling, there is no discussion on the nature of the sediment load, its character, size, and volume. Likewise, there is no discussion as to how this differs from the natural load in the rivers and streams.

Given the limited hydrometric data available, how will the sediment control structures be designed, and what are the contingencies should failure occur?

What would be the potential impact of this material if it was to become 'uncontrolled'?

17.1 HDL Response

Appendix I of the application covers a brief discussion on sedimentation issues. There is a great deal of knowledge on the characteristics of sediment movement resulting from mining activities,

overburden dumps, rehabilitated land and undisturbed land. SENZ is required under conditions of consent to retain the sediment within the coal mining licence area. HDL has included silt traps at all reservoir inputs as a contingency against failure of SENZ's controls. It is not feasible for coarse sediment to reach the tunnel intake towers.

The sources of sediment are almost exclusively sandstone (exception in upper St Pats) which exhibits very high settling rates.

18. WCRC Request

The sources of sediment within the project area are not discussed in either the application, or any of the appendices. If the sources, volume and character of the sediment changes as a result of the scheme this could impact on channel stability and morphology.

What are the sources of sediment within the project area?

How will the proposal impact on these sediment sources?

Will the proposal create new sources? How will these be managed?

What is the reliability of these management strategies?

18.1 HDL Response

Refer to Response 17.1 above.

19. WCRC Request

Given that most of the sediment moving downstream will be intercepted by the reservoirs this impact on sediment sources and transport processes downstream needs to be considered.

How will this impact on sediment sources and transport processes downstream?

Is the trapping of sediment likely to increase bank erosion downstream?

Does this have any potential to affect the integrity of the dam via head-wards migration?

19.1 HDL Response

Refer to previous responses regarding sources and morphology. Streams of the Stockton Plateau are incised in bedrock. Natural sediment loads are low.

20. WCRC Request

Considerable discussion is provided on turbidity values, and therefore the derived suspended solid concentrations. However, no data are provided as to the reliability of the conversion from turbidity to suspended sediment; and the potential effects of any error in the calibration on the conclusions reached. Given the likely high concentrations of coal within the flow, this may have a significant effect, and a distinctive effect, which does not appear to have been considered.

With regard to the sediment analysis it would appear that only suspended load is considered.

What is the reliability of the suspended load data – especially given the comment regarding the high percentage of coal; and the reliability of any turbidity to suspended sediment calibration?

How does suspended load relate to total load?

What is the nature and significance of any bedload?

How will the scheme impact on bedload movement?

20.1 HDL Response

The streams are steep mountain streams in bedrock.

The diversions are designed to transport bedload originating upstream of the diversions to the silt traps where it will be recovered. As a result bedload in the streams downstream of the diversions will be interrupted. This will be offset by bedload movement downstream of the diversions as peak flows are reduced.

Section C - Engineering Information

1. WCRC Request

The dam breach assessments have been prepared as a preliminary assessment and are based on dam levels that are lower than those given in later documents (Weka as RL 390 compared to RL 382-384 used and for Mt William RL 575 compared to RL 565-570). The dam breach studies have also been carried out assuming that earth dams will be built where as now it is proposed to use RCC dams. The derived classifications for the earth dam structures is that they are in the high potential impact category and this is not likely to change in any new analysis using the higher lake levels and RCC dam break mechanisms. The dam breach report does not identify the level of effects from the proposed dam heights.

Confirm that, given the differences between the assessment and what is proposed, whether the effects (eg. on the area flooded) would be different from that supplied in the application.

1.1 HDL Response

The dam break study was commissioned at the commencement of the reservoir selection process to determine the potential effects of the release of volumes of water from the Weka and Mt William reservoir sites and to determine the NZSOLD impact category that should apply to dam design.

The study reports the predicted flood effects in the lower Ngakawau River and estuary resulting from sudden removal of a dam. For the purposes of the analysis the sudden removal of the dam has been modeled as rapid erosion of an earth embankment. HDL has concluded that such an event would place users of the Charming Creek walkway at unacceptable risk and would lead to property damage within Hector settlement, similar to that caused by high natural flood flows. As a result, HDL directed that the design and specification of the dams should be based on roller compacted concrete (RCC) which are most resistant to catastrophic collapse.

The dam break report provides a range of possible outflow hydrographs from dams of varying sizes and predicts the flooding that would result at Hector. The upper end of the range (570M fast discharge from Mt William) predicts an extreme flood in the Ngakawau River (>PMF). Of significance (discussed in the report and shown in the plots in Appendix B), is that the modeling of this extreme breaches becomes unstable showing that the results of the mathematical modeling are indicative at best.

It could be argued that it is conceivable, although an extremely rare event, for a breach scenario that results in the central portion of the RCC structure being instantly removed and that this could theoretically create a more extreme outflow hydrograph. This would require an earthquake of such magnitude that rockfall would be expected in the gorges downstream of the dams.

The existing modeling has shown that modeling of such an event would be unlikely to provide any more information that would be useful to the assessment of effects:

- The model instabilities at the breach will be more pronounced in larger events – results will be as indicative as existing extreme breach modeling.
- The existing extreme event modeling shows a 30 % reduction in peak from the breach to Ngakawau river, showing that channel hydraulics, not the nature of the breach, are becoming dominant for very large events.
- The model could not meaningfully represent changes in the conveyance of the river systems resulting from landslides. Note that the existing extreme case modeling is conservative and takes no account of rockfalls.
- The predicted effects at Hector are unlikely to be substantially different as flood levels at extreme stages are controlled by lateral flow to the north and south.
- Effects on users of the lower sections of the Charming Creek walkway are unacceptable for existing modeling and will remain unacceptable for higher flows.

The conclusion from additional modeling will be identical to that which can be drawn from the existing analysis and will result in the same response by HDL to manage potential effects.

Breach of the reservoirs is unacceptable. The dam designs must ensure that the risk of breach is reduced to an insignificant level. To achieve this the design covered by the consent application includes the following features:

- All embankments, including shoulder dams, will be built using RCC which is recognized as the most robust dam design option for this environment.
- Shoulder dam foundations will extend through BCM to Granite ensuring that toppling of the shoulder dams is inconceivable.
- The sections of the dams which are built within the stream channels (the higher section with theoretically the greatest risks of block displacement) are massive structures founded on granite. No ancillary structures (outlets, sluices, spillways), which establish discontinuities within the structure, will be built in the higher sections of the dam built within the stream channels. The outlets and sluice are at the outlet tower which is not part of the dam. The spillways are cut into natural ground (Weka) or over the lowest section of the shoulder dam (Mt William).

For these reasons HDL believes that the dam break modelling submitted in support of the application provides for the assessment of effects.

2. WCRC Request

The extent of the construction areas (ie footprint) is not clear from the concept drawings. The scale of disturbance beyond the structures (eg. Dam, reservoir, tunnel portal) footprint is necessary to understand the effects of the activities. For example, at the Granity portal the footprint is necessary to determine the potential for instability.

Provide plans showing the extent of disturbance beyond the dam, reservoir and portal structures. Provide a schematic plan that shows the major hydraulic controls of the proposal showing such things as inlets, tunnels, intake tower controls, dewatering sluices, spillways, power stations and sea outfall.

2.2 HDL Response

The majority of disturbance is focused within the upper level of inundation of Weka and Mt William reservoirs. As described in the AEE, additional aggregate will be sourced from excavations within the reservoir footprint, the silt traps will be contained within the reservoirs at the point of entry of waterways and the diversion tunnel portal excavations will be contained within the inundation area. The silt storage areas are immediately adjacent to the reservoirs, as detailed in Plans C-002 and C-004, with run-off to drain into the respective reservoirs. The new roading proposed is approximately 2150m and will be in the order of 6m wide including water tables. The approximately 800m section of the haul road will be built to the same standard as the current haul road. The extent of works at Granity is detailed on Plan C-006 and described in sections 5.9 and 5.10 of the consent application.

There will be some minor disturbance along the outside edge of the embankments required to contain both Weka and Mt William reservoirs and the access roads and silt trap footprints. It is anticipated that the extent of the disturbance will be no more than 2-3 metres beyond the immediate footprint of these structures. The disturbed margins will be rehabilitated by means of direct vegetative transfer, whereby stripped vegetation from within each of the reservoirs will be utilised.

As discussed in the AEE, development of comprehensive engineering designs at the outset of a project is not feasible where the project is one of considerable scale and complexity. In these circumstances it is accepted practice to develop the project to the stage where the effects on the environment can be fully described and assessed, this has been done for the present proposal. The major hydraulic control components of the scheme are all contained within the footprints described in the AEE and are not relevant to the assessment of environmental effects.

3. WCRC Request

No mention is made of the likely operating regime of the new reservoirs, the water level range and the likely annual movement. This will have some impact on shoreline erosion from wave action which should be assessed. This information will also be required for landscape assessment and ecological assessment.

Provide comment on (i) the likely operating regime the water level range and the likely annual movement and (ii) the potential for erosion as a consequence.

3.1 HDL Response

The URS Scheme Modelling Report includes graphs showing modeled variation in water levels in Weka and Mt William reservoirs as applied to the 2002- 2005 and 2007 data for different scheme scenarios. Scenario 13 is most representative of the application.

The perimeters of both reservoirs will be exposed sandstone or granite generally at slope of 10:1 or less, other than a section of the eastern perimeter of Mt William which is formed of sandstone slope debris. This section will be lined with granite or sandstone riprap excavated from within the Mt William reservoir. There is no risk of wavelap erosion or instability caused by varying water levels.

4. WCRC Request

Excavation of Granite within the inundation area is a practical thing to do. However, there is no indication of how much material is going to be required and if the potential resource can supply the required volumes. Typically one would prove a source with at least 1.5 to 2 times the volume required.

Demonstrate that the potential resource can supply the required volumes.

4.1 HDL Response

The URS Concept Design Assessment (Appendix B) states the volume of material required for the project dams and embankments. Figure 5.7 displays an embankment volume curve for Mt William Dam, with a dam level of RL 575 requiring approximately 250,000m³ of material. Figure 5.3 displays an embankment volume curve for Weka Dam, with a dam level just below RL 390 requiring approximately 100,000m³ of material. On this basis approximately 350,000m³ of material will be required to construct all the scheme dams and embankments.

The tunnels will provide approximately 100,000m³ of granite aggregate. Excavation of granite in the bed of the reservoirs to ensure all water drains to the intake towers will provide the remaining aggregate, these borrow areas are shown on the project plans. The borrow areas depicted cover over 235,000m² and have the potential to supply far more granite than is required for the project, in excess of the proposed multiplier of 2.

5. WCRC Request

The hydraulic structures are all in the preliminary design stage and may change as the final design is worked through. The concepts for the Mt William and Weka dams are satisfactory showing a low level sluice for emergency dewatering and possible use as a diversion structure during construction. For these structures given the nature of the acidic water impounded it is prudent to allow for the reservoirs to be drained should some defect show up sometime in the future requiring the water level to be lowered below the hydro outlet level. This is a fundamental dam safety issue. Designing such facilities that will have a long life in that environment will be a challenge.

Confirm if dewatering of the reservoirs, either in an emergency or for maintenance or repairs, is included in the consents being sought for discharge of tailwater.

5.1 HDL Response

The construction sluices on the dams will be permanently sealed at completion of dam construction. The intake towers will be the lowest point within the reservoirs and will be used to drain the reservoirs when required. The scheme can be configured by operation of intake valves, sluice valves at tunnel bulkheads, diversion weir gates, and spillways to drain the reservoirs to the base of dam foundations and to drain the tunnels for inspection and maintenance at any time.

6. WCRC Request

Construction of the dams using RCC is a good choice for this high rainfall site as they are less affected by rainfall and can be overtopped without dire consequences. They will however need to show that the dams can safely contain the acid water over the life of the dam (100yrs) without any significant reduction in stability. Leakage through dam joints in this situation has far greater consequences than for a RCC dam retaining normal water. The building consent will need to address these issues and require an adequate monitoring programme to monitor these aspects.

Show that the dams can safely contain the acid water over the life of the dam (100yrs) without any significant reduction in stability.

6.1 HDL Response

Specification of acid resistant materials will be included in the building consent application. Suitable products can be sourced locally from Holcim in Westport.

The underground concrete dams built throughout Millerton Mine over the period of 1910 – 1930s show no sign of chemical erosion with average pH levels of 3. Similarly, the historic St Patrick dam built in the 1950s displays no evidence of significant chemical erosion of the dam structure.

7. WCRC Request

There is a coal seam near the true right abutment of the Weka reservoir.

Provide comment on the potential for and effects of leakage through coal measures/workings. If there is a leakage potential, what procedures would be put in place to manage this? What confidence does HDL have that there are no other coal measures in both reservoir footprints?

7.1 HDL Response

The entire project footprint has been extensively mined over the last 100 years and in more recent times extensively drilled by SENZ. At the outset of the project HDL formed an information sharing relationship with SENZ and had access to all exploration drill information. Hence HDL is confident of the accuracy of the statement in the AEE “...that the project will not constrain future mining operations within SENZ coal mining licence nor will it isolate any coal reserves”.

There are no coal outcrops in Weka reservoir. Coal outcrops in Mt William reservoir above the maximum levels of inundation. There is no possibility of leakage through coal seams or workings.

The interface between granite foundations and Brunner Coal Measures (BCM) occurs less than 10m below maximum levels of inundation in the shoulder dams of both Weka and Mt William dam. This interface is well logged and contains clays. At this stage of design HDL has allowed to extend cutoff excavations for the shoulder dams into granite below the BCM interface. This will also preclude leakage through bedding layers within the BCM.

8. WCRC Request

All sediment traps – Confirm whether the sediment traps shown on the plans and discussed in the AEE (eg. pg 39 Darcy Diversion) are the ones to be used during construction or if other temporary ones are proposed?

8.1 HDL Response

As depicted in the project plans and discussed in the AEE permanent silt traps are to be constructed within the reservoirs at the point of entry of waterways feeding into the reservoirs. These are to contain sediment and to ensure abrasive material does not enter the generation system.

Temporary sediment traps will also be utilised where required to control stormwater run-off from roads and any other construction activities near waterways. These areas will be managed in accordance with Auckland Regional Councils TP 90 guidelines.

De-watering of groundwater seepage during tunnel construction will also be directed into temporary sediment traps/settling ponds to ensure minimal impacts on receiving waters.

9. WCRC Request

During micro tunneling extensive dewatering is required and with the potential for poor ground conditions there is a real risk of effects on adjacent properties and infrastructure. There is a need to ensure long term stability of the tunnel and not just during monitoring. The pipe size will be slightly smaller than the tunnel, allowing some possible displacement.

What measures will be implemented to minimise the potential for settlement on building and utilities (e.g. road, rail)?

What monitoring during excavation is proposed? What criteria are proposed for acceptable levels of settlement?

What contingency measures would be implemented if settlement levels are exceeded?

How long will monitoring occur for and what mitigation is proposed long term should subsidence become an issue?

9.1 HDL Response

The detailed geotech investigations required to confirm the feasibility of micro tunneling will also establish the potential for settlement that could arise through the micro tunneling process, and tunnel levels and positions that will minimise the effects. Appropriate limits of settlement can then be established to suit these conditions. Ground level monitoring along the tunnel alignment will be carried out until the work is complete.

Dewatering is generally only required around the access shaft to ensure dry access inside the tunnel. Away from the shaft, the tunnel can advance irrespective of water levels, and indeed beneath the seabed.

The mismatch of tunnel and liner pipes is overcome by the pressure injection of drilling mud into the small annulus outside the concrete liner. This has the dual purpose of preventing settlement by filling the space, and providing lubrication for the forward movement of the tunnel segments through the ground.

10. WCRC Request

During construction of the outfall vibration monitors should be set up to actually monitor the effects as well as an initial ground survey so that any ground settlement can be identified.

Confirm what monitoring is proposed.

10.1 HDL Response

The following comments were provided by Paul Cooper of Harker Underground Construction Ltd:

“A typical Tunnel boring machine has a very smooth operation as they are highly engineered pieces of equipment which if you hold a hand against the machine while operating you would barely detect the motors running. In rock conditions you can get some vibration as the tunnel boring machine gnaws through the ground but this is easily controlled by reducing the rate of progress. Even so we have never had an issue with vibration and micro tunnelling through rock. The only times we have had any issue with vibration was during traditional drill and blast tunnelling. The amount of vibration was then controlled by changing the blasting charge, firing sequences and progress rates”.

Tunneling vibrations are considered very unlikely to affect the stability or structural integrity of timber structures. Cosmetic damage (eg cracking of plaster and masonry) is the first indicator of vibration damage. This can be difficult to identify or attribute to any particular occurrence as such minor cracking is often present due to other causes.

Refer to Response 6.1 of Section D of BDC material. Detailed building surveys will be carried out to identify before and after differences and HDL will undertake monitoring of initial micro-tunneling to ensure the set limits for vibration as specified in DIN 4150-3 (1989) are not exceeded.

As regards ground settlement, a survey will establish a network of bench marks and control marks around the perimeter of the construction site on stable ground beyond the micro tunnel alignment. Survey instruments (GPS, Total Stations and Precise Levels) will be used to monitor survey pins above the micro tunnel to monitor movement both vertically, rotationally and x and y co-ordinates. Any detectable subsidence noted in the vicinity of the road or rail networks will be repaired at the

HDL's cost.

Section D – Ecological Information

1. WCRC Request

Appendix D - *Allisoniella scottii* is a liverwort with a threat classification of Nationally Critical, and *Blindia lewinskyae* is a moss that is range restricted (based on limited data). At the site visit *Blindia* was observed in Weka Creek.

What is the distribution of these bryophytes within the footprint of the proposal?

Will the *Hennediella sp* population be affected by the proposal?

1.1 HDL Response

Two reports by NIWA (Suren & McKerchar, 2001 and Suren & Glenny 2002) that refer to bryophytes, have been undertaken for the Stockton Plateau streams and Upper Waimangaroa Valley respectively. The Cypress Mine Resource Consent application and associated AEE (Solid Energy, December 2003) also summarises these studies.

The NIWA (2001) study included several sites on Mine Creek, one site on the Mangatini River and several sites on the Ngakawau River itself, two of these sites (Mine Creek Middle and Mangatini) were within the project footprint. Mine Creek Middle is located at E2416938, N5950584 and Mangatini at E2417833, N5949755. *Blindia lewinskyae* was found in the Mine Creek Mid site inside the proposed development area. *B. lewinskyae* has been found in Weka Creek (NIWA, 2001) however this was a *pers obs* siting and GHD have been unable to confirm whether the site was within the proposed development footprint.

NIWA (2001) survey observed no aquatic bryophytes within Mangatini Creek or the Ngakawau River.

The only recording of *Hennediella sp* to date has been during the NIWA 2001 survey and this was at Mine Creek West, which is outside the proposal footprint area. Therefore it is not considered that this population will be affected by the proposal.

The NIWA (2002) study surveyed 14 streams in the upper Waimangaroa and St Patricks Stream, all of which were outside the footprint of the proposed development area. Results of this study indicated that the waterways supported a rich diversity of bryophytes. *B. lewinskyae* was common throughout the area and found in 7 sites, 4 of which are affected by acid-mine drainage and not subject to the affects of the proposed scheme.

This study also observed the rare liverwort, *Allisoniella scottii*, in the mid and upper St Patrick Stream site (above the dam). This species is known only from streams flowing from the Tin Range on Stewart Island, and from Mt Euclid in the Paparoa Range. This observed population is outside the proposed development footprint. No records of this species have been recorded within the proposed development footprint. This moss has also been recorded in the L75 Stream, also outside the proposed development footprint.

Therefore in conclusion, *B. lewinskyae*, and to a lesser extent, *A. scottii* are relatively common within the Plateau streams outside of the proposed development footprint area. They are currently present in streams that are mine-impacted and appear to be tolerant of acidic conditions, and able to deal with the often large, frequent floods that characterise the Plateau streams. *A. scottii* has not

been recorded within the proposed development footprint and *B. lewinskyae* has only been recorded at one site (Mine Creek Mid). To date, *Henediella sp* has not been recorded from within the proposal footprint. Therefore it is not considered that this population will be affected by the proposed development.

2. WCRC Request

NIWA reports have noted both species in the general area, but their investigations have not specifically defined the range of these bryophytes within the footprint of the proposal. NIWA also reported a possible new species of *Henediella* in the west branch of Mine Creek.

The applicant proposes to undertake a pre-construction baseline study, and if necessary offset any habitat losses by protecting other habitat for these taxa or by relocating plants to areas outside the footprint of the proposal.

Provide information on the proposed method of relocating these plants; including how the success of the relocation will be monitored and contingency plans if relocation is unsuccessful.

Identify areas outside the footprint of the proposal that could be protected as an offset for habitat loss, and describe the mechanism and details of how this will be achieved, for example land-ownership, covenant proposals etc.

2.1 HDL Response

Section 2.3 of the AEE details that the Ngakawau Ecological Area boundary was amended to accommodate future hydro development. This was done on the basis that the area has negligible ecological value and/or values that were already well represented and under protection. This supports the view that the ecological values, including aquatic bryophytes within the proposal footprint are not significant and are represented or protected elsewhere. Habitat loss is unlikely to be significant and no habitat offset is proposed.

More detailed analysis of the available literature has confirmed that *Henediella sp.* has only been found in the West Branch of Mine Creek (sample site located south of Stockton Road), outside of the proposal footprint (NIWA, 2001). *B. lewinskyae* and *A. scottii* are known to occur in streams draining the Stockton Plateau area, in the Waimangaroa River and its tributaries. However within the proposal footprint *B. lewinskyae* has only been recorded at Mine Creek Mid and *A. scottii* has not been recorded at all.

Prior to site works commencing at Weka and Mt William reservoirs, surveys of aquatic bryophytes will be carried out within the reservoir footprint areas. Bryophyte % cover will be estimated at 3 transects placed randomly across sections of each stream. Any aquatic bryophytes found will be identified on site where possible, photos taken and if required a sample collected and frozen pending identification to species (where possible) using standard keys, in the laboratory. If the rare species, *Henediella sp.*, *B. lewinskyae* or *A. scottii* are recorded within the footprint area relocation will be considered. There are limited means of relocating aquatic fauna and translocation trials are one possible means. However, little work has been carried out on aquatic bryophytes in NZ or around the world in this regard and as such the likely success of such trials is unknown. Such work if required would need to be carried out with extensive consultation with an expert in this field.

3. WCRC Request

Appendix D – Page 8-10: Combining of Mangatini, Weka and Sandy Creek for the purposes of assessment. The NIWA reports do not investigate these streams. Sandy and Weka Creek may not be AMD impacted and may provide an important source of colonists to other streams.

The Mangatini Stream arises in a different part of the plateau than these streams so assessing them as a single site provides insufficient resolution. Weka Creek and Sandy Creek have considerably different in-stream morphology to Mangatini Stream and should have been assessed separately.

Provide an assessment of the potential environmental effects on Sandy Creek and Weka Creek, given their potential importance as representative remnants unaffected by AMD.

3.1 HDL Response

Sandy and Weka Creeks are not un-affected catchments. Both watercourses receive run-off from the haul road and have done so since Stockton mine opened. Run-off containing high silt loads and oil/fuel contaminants from the many vehicles that utilise the haul road drain into both Weka and Sandy Creek. In addition, the haul road is constructed from sandstone which gives rise to AMD contaminated run-off.

Further, section 3.2.3 of the GHD report notes that invertebrate communities in both Weka and Sandy Creeks are dominated by chironomids, oligochaetes and ceretopogonid midges, reflective of the relatively poor water quality, low pH, sedimentation and variable flow in these waterways, features common to mine-affected waterways. From the existing available literature and surveys conducted at these sites no macro invertebrates, fish or aquatic fauna species of significant value have been found within these waterways.

4. WCRC Request

It is likely that the changes in the flow regime will lead to an increased growth of algae under the imposed low flow regime. Such an effect has been observed in other 'managed' river systems in New Zealand. While it is recognised that the period between freshes is seldom going to be really long enough to accumulate a high biomass of material it is not clear whether this has been considered.

Confirm what consideration has been given to the effects of increased growth of algae under the imposed low flow regime.

4.1 HDL Response

Consideration has been given to the effects of increased algae growth under the imposed low flow regime. It has been determined that given the environmental conditions present on the Plateau (high rainfall events and freshes) and stream characteristics (reasonably steep catchments with flowing water), the period between freshes and the period and extent of areas displaying slow water flows (enough for substantial algal growths to accumulate) is seldom going to be long enough to accumulate high algal biomass.

It is expected that at times there may be an increase in algae growth given the significant reduction in flows immediately downstream of the reservoirs. However, as discussed in the AEE it is expected that removal of sediment laden water and AMD contaminated flows from the affected catchments will give rise to improvement in water quality and hence recovery of aquatic habitats adopted to the new flow regime. It is expected that an ecosystem will evolve that meets the new hydrology dominated by natural water quality conditions.

5. WCRC Request

In a number of areas baseline surveys are proposed. It is not clear what is proposed and what the management response to the surveys would be.

Describe what baseline surveys are proposed and what the management response to them would be. Alternatively indicate whether it is proposed to draft consent conditions prior to the s42a report being prepared so that it can be considered at that time.

5.1 HDL Response

The AEE included reference to an Aquatic Ecology Management Plan which included baseline surveys and a monitoring programme for a whole range of aspects. This inclusion in the AEE was based on the recommendations contained in GHD's report. However, on receipt of the Councils S92 request these recommendations were discussed in more detail with GHD who stated that these were merely standard recommendations for large scale projects that had significant environmental effects. GHD have acknowledged that HDL's proposal is unique, in that the sub-catchments affected by the proposal have poor water quality and minimal fish life and operation of the scheme is expected to enhance environmental values in the area. In these circumstances GHD support the approach that baseline surveys should focus on bryophytes and the other monitoring recommendations in their report are unnecessary.

Section E - Geochemistry Information Request

1. WCRC Request

Appendix K – Page ES2: Statement in the Executive Summary needs clarification. It is noted that “Water quality in Mt William reservoir quality will improve ... due to increasing dominance of Mangatini waters...”

Please clarify whether or not Mangatini Stream will contribute to Mt William Reservoir (cf. for example, Table 5-1).

1.1 HDL Response

The sentence should refer to Weka Reservoir.

2. WCRC Request

Appendix K – Pages 5-1 to 5-3: The limitations of the input data for modelling are acknowledged. However, insufficient information is provided to determine just how representative the data being used is likely to be. Therefore it is not possible to judge the reliability of the modelling.

For each of the sites in Table 5-1, please specify the number of data points (“n”) used in the derivation of the mean value shown, the range of data (min-max), and the year represented by the data (i.e., 2007/08, or previous).

2.1 HDL Response

This information is provided in the following tables (inputs_Summarised_mins max.xls)

Table 1. Water quality inputs for scheme and non-scheme geochemical modelling **MAX VALUES**

Catchment Name	Main data points	pH	EC	SO4	Na	K	Ca	Mg	Al	Fe	Mn	Cu	Zn	As	Ni	Cl	n	Year			
<i>Mt. Williams Reservoir</i>																					
Upper St Pats	S16	4.6	48	121					13.00	1.07							300	07-08			
Darcy Headwaters	Darcy2 / Darcy3	3.7	43	129	2.4	0.70	1.22	0.70	4.79	2.89	0.034	0.0050	0.078	0.001	0.021			9	02-08		
T31 Stream	S3	5.7	12															14	07-08		
<i>Weka Reservoir</i>																					
T35 Streams	S3	5.7	12															14	07-08		
Mine Creek Upper	UM1	6.0	58															59	07-08		
Weka Catchment	S1	4.8	11															14	07-08		
Upper Mangatini - Untreated	S14 C	2.9	970	575	3.7	3.77	40.90	13.60	58.00	36.40	0.000	0.0650	1.570	0.016	0.327	3.8		4	08		
Upper Mangatini - Treated	S14 B	7.8	100	379	3.8	3.16	154.00	10.70	30.00	2.95		0.027	1.1200	0.005	0.244	3.6	113*	08	*n=2 for cations/anions except Al		
<i>Ngakawau River</i>																					
Erin Stream	Erin	6.5	35	2	3.2	0.41	3.03	0.35	0.12	0.08	0.004	0.0005		0.001	0.001	4.7		4	02-03		
Lower St. Pats	NR6	7.1	5	5															9	02	
Mid St. Pats	NR6	7.1	5	5																9	02
Ngakawau River @ NR6	NR6	7.1	5	5																9	02
St. Davids Catchment	NR6	7.1	5	5																9	02
Ngakawau Gorge	NR6	7.1	5	5																9	02
Charming Creek	CC1																				
Mangatini Lower	8W	7.7	73	2	2.6	0.60	0.62	0.32	0.19	0.20	0.005	0.0005	0.001	0.001	0.001	4.2		12	98-08		
Rome Creek	8W	7.7	73	2	2.6	0.60	0.62	0.32	0.19	0.20	0.005	0.0005	0.001	0.001	0.001	4.2		12	98-08		
Mine Creek Lower	8W	7.7	73	2	2.6	0.60	0.62	0.32	0.19	0.20	0.005	0.0005	0.001	0.001	0.001	4.2		12	98-08		

NOTES
 * Missing values have been derived from various summary reports and other catchments on table. Reports used include for data include:
 * Missing values have been derived from various summary reports including:
 Stockton Coal Mine Hydro-Geochemical Investigations Acid Rock drainage: Draft, Golders July 2002
 Table 3.2 Water Management Strategy overview for stockton site , October 2005, 16 April 2005- 24 June 2005
 Table 2.13 4 West Hydrology - September 2006
 KML Cypress Open Pit Water Geochemistry Report 03

Table 1. Water quality inputs for scheme and non-scheme geochemical modelling **MIN VALUES**

Catchment Name	Main data points	pH	EC	SO4	Na	K	Ca	Mg	Al	Fe	Mn	Cu	Zn	As	Ni	Cl	n	Year			
<i>Mt. Williams Reservoir</i>																					
Upper St Pats	S16	3.2	3	9					0.28	0.03								300	07-08		
Darcy Headwaters	Darcy2 / Darcy3	2.6	30	75	2.1	0.43	0.37	0.33	1.34	1.15	0.011	0.0016	0.056	0.001	0.008				9	02-08	
T31 Stream	S3	3.9	2																14	07-08	
<i>Weka Reservoir</i>																					
T35 Streams	S3	3.9	2																14	07-08	
Mine Creek Upper	UM1	2.6	43																59	07-08	
Weka Catchment	S1	3.9	4																14	07-08	
Upper Mangatini - Untreated	S14 C	2.8	946	464	3.3	3.06	31.20	10.40	45.00	32.00	0.000	0.0510	1.210	0.014	0.261	3.2		4	08		
Upper Mangatini - Treated	S14 B	3.3	18	312	3.4	2.65	127.00	8.30	0.05	2.01		0.0020	0.623	0.005	0.183	3.5		113	08	*n=2 for cations/anions except Al	
<i>Ngakawau River</i>																					
Erin Stream	Erin	5.1	23	1	2.7	0.28	0.55	0.26	0.07	0.04	0.001	0.0005		0.001	0.001	4.0		4	02-03		
Lower St. Pats	NR6	4.2	3	1																9	02
Mid St. Pats	NR6	4.2	3	1																02	
Ngakawau River @ NR6	NR6	4.2	3	1																02	
St. Davids Catchment	NR6	4.2	3	1																02	
Ngakawau Gorge	NR6	4.2	3	1																02	
Charming Creek	CC1																				
Mangatini Lower	8W	3.6	1	1	1.6	0.10	0.20	0.19	0.07	0.00	0.002	0.0002	0.001	0.001	0.001	2.9		12	98-08		
Rome Creek	8W	3.6	1	1	1.6	0.10	0.20	0.19	0.07	0.00	0.002	0.0002	0.001	0.001	0.001	2.9		12	98-08		
Mine Creek Lower	8W	3.6	1	1	1.6	0.10	0.20	0.19	0.07	0.00	0.002	0.0002	0.001	0.001	0.001	2.9		12	98-08		

NOTES
 * Missing values have been derived from various summary reports and other catchments on table. Reports used include for data include:
 Stockton Coal Mine Hydro-Geochemical Investigations Acid Rock drainage: Draft, Golders July 2002
 Table 3.2 Water Management Strategy overview for stockton site , October 2005, 16 April 2005- 24 June 2005
 Table 2.13 4 West Hydrology - September 2006
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3. WCRC Request

Appendix K – Page 5-1: Two major assumptions made for modelling; that TSS are not re-suspended, and secondary mineral precipitates are not re-dissolved, are effects that are likely to be very detrimental to water quality. It is usual to model worst case scenarios.

A brief sensitivity analysis of the likely effects of TSS re-suspension and precipitate re-dissolution on modelled water quality would be useful.

3.1 HDL Response

The modelling indicated very little potential for conditions that would result in precipitation of metals within the scheme and a sensitivity analysis is thus not warranted. TSS re-suspension is unlikely in such large reservoirs.

4. WCRC Request

Appendix K – Page 5-2: There is no information on whether or not the reservoirs are expected to develop vertical stratification. This would affect downstream water quality.

Please include a statement as to whether the possibility of stratification has been considered. If so,

can this effect be included in the modelling?

4.1 HDL Response

Stratification has not been considered and would be beyond the faculty of the current modelling. Intake towers will draw from the full water column.

5. WCRC Request

Appendix K - For the input data, cation or anion concentrations have been adjusted to ensure an ion balance. Changing the concentrations of some constituents could affect WQ predictions.

Please indicate which cations or anions were used to create an ion balance.

5.1 HDL Response

Cation/anion balance used the following: Ca, Mg, Na, K, Cl, SO₄, Fe, Mn, Al, Cu, Zn

6. WCRC Request

Appendix K - Waterways that are noted to contribute to the reservoirs elsewhere in the AEE documents are not listed in the input data in Table 5-1. For example: Plover, Fly, Sandy and AJ Streams.

Please clarify that the input of these waters has been included in the flow/chemistry of the streams that are listed in Table 5-1 or 5-2 (and which streams).

6.1 HDL Response

Plover and Fly Streams are included in analysis and were represented by S16 water quality data since they are located upstream of this monitoring station. AJ and Sandy Streams are located upstream of the S14a monitoring point and therefore they have also been accounted for.

7. WCRC Request

Appendix K – Page 5-3: Given the potential for Cd to bioaccumulate in benthic marine life, any information on likely Cd concentrations in the outfall would be useful.

If any data is available for Cd in the modelling input waters this should be included in the modelling process (e.g., Appendix C of this URS report shows Cd concentration significantly raised in ARD samples from Mangatini Creek (S14)).

7.1 HDL Response

Modelled Cd data is as follows (mg/l):

- Current Mt Williams-0.00014
- Closure Weka/Outfall Mt Williams- 0.00041/0.00014
- Weka Outfall-0.00047

These results mirror those of Table 5-3 of the report.

They were not reported initially as the Cd data is very limited and modelled concentrations will reflect this lack of data. In many cases distinct inputs are based on a single sample. In some cases 'donor' data has been used where no specific Cd data was known to exist.

8. WCRC Request

Appendix K – Page 5-4: Model validation against WQ monitoring for Ngakawau River is mentioned, but no results are shown.

Please include the data referred to at the end of Section 5.1.3.

8.1 HDL Response

Modelled results for location NR with no scheme in place were:

pH	4.549
Al	0.698782
Fe	0.25329

No calibration of other parameters could be undertaken due to lack of detailed data.

9. WCRC Request

Appendix K – Pages 5-4 to 5-8: There are major discrepancies between comments in the text, and the data presented in Tables 5-3 and 5-4. Some of these comments are reproduced in the main AEE document (p100).

Please clarify so that text and tabulated data are consistent.

For example, WQ in Weka Reservoir doesn't improve under high flow conditions (consider trace metal concentrations).

9.1 HDL Response

There are improvements in pH, Fe and Al levels. There are some increases between the two cases of trace metals.

10. WCRC Request

Appendix K – Pages 5-6 to 5-7: In Table 5.4, the modelled data for low, median and high flow scenarios are identical for the Mt William Reservoir. This table is reproduced in the AEE document (p100) also.

Please confirm that this is correct and, if so, include an explanation of why this occurs.

10.1 HDL Response

There is no change in the water quality for the range of flow events because the available data sets do not support a relationship between chemistry and flow – refer section 5.2.2. Determination of this relationship will be the focus of ongoing water quality monitoring. The assumption of no change in water quality with flow results in conservatively adverse predictions of water quality in Weka reservoir.

11. WCRC Request

Appendix K – Pages 5-8 and Figure 5-1: The discussion of Ngakawau River water quality is limited to pH, Al and Fe. It is unclear why modelled data for other trace metals is not discussed.

Please clarify why this data is so limited.

11.1 HDL Response

No calibration of other parameters could be undertaken due to lack of detailed data.

12. WCRC Request

Appendix C - Figure 1 does not include Fe, the precipitation of which is critical in this exercise.

Please add Fe data to Figure 1 of this appended report.

12.1 HDL Response

Appendix C is an SENZ report appended for reference at SENZs request following SENZ's review of the draft water quality report.

13. WCRC Request

Appendix K – Page 5-14: It is unclear how NTU or TSS units have been converted to units of clarity. Figure 5-5 is very difficult to interpret (e.g., what is the y axis on this figure?).

Please clarify.

13.1 HDL Response

Relationship developed within *KML (2005). Optical Water Quality Monitoring and Modelling at Stockton Site*. This report develops a relationship between turbidity and clarity as follows:

For measurements below 10NTU:

$$\text{Clarity} = (0.0105e^{(0.09961T)})^{-1}$$

For measurements above 10NTU:

$$\text{Clarity} = (0.0199e^{(0.0372T)})^{-1}$$

Regarding Figure 5-5 The y-axis is Clarity in cm. It shows the threshold of Good and Fair clarity as defined by NIWA. This is compared to the pre and post scheme clarity at station NR on the Ngakawau River. The graph shows a significant improvement in clarity post-scheme.

14. WCRC Request

Appendix L – Page 3: Worst case scenario effluent is noted to be 9m³/sec (2 x modelled median flow).

Please include an indication of how dilution modelling results will be influenced by the higher flow conditions.

14.1 HDL Response

The worst case scenario effluent flow is 9 m³/s (twice the modelled median flow). This regime will effectively double the flow conditions, and will therefore result in a halving of the dilution. It is noted, however, that the worst case scenario of effluent flow does not necessarily coincide with a worst case effluent quality. Poor effluent quality is expected to be associated with extended periods of drought. Higher flows will be directly correlated to full or rapidly filling reservoirs during higher rainfall events. Until both further benchtop studies and baseline field work improves our understanding of the water quality /dilution and dispersion relationships it is difficult to predict the events that represent an overall worst case scenario and the predicted change in dilution requirements in these circumstances. Conditions of consent will specify management actions that are to be taken when the dilution provided by the outfall is not adequate for the water quality recorded in Weka reservoir.

15. WCRC Request

Appendix L – Page 5: The summary bullet points appear somewhat contradictory. This is possibly because two different URS reports (2007 and 2008) are being referred to.

Please clarify, identifying the most recent, confirmed results of these previous studies.

15.1 HDL Response

The most recent URS water quality report (see Appendix K) refers to the assessment by Holman