

**IN THE MATTER** of the Resource Management  
Act 1991

**AND**

**IN THE MATTER** of an application by Meridian  
Energy Limited for resource  
consents for the Mokihinui Hydro  
Project

---

**STATEMENT OF EVIDENCE OF RONALD WILLIAM FLEMING ON  
BEHALF OF MERIDIAN ENERGY LIMITED**

---

---

**ANDERSON LLOYD**  
LAWYERS  
DUNEDIN

Solicitor: Stephen Christensen/  
Philippa Jones

Level 10, Otago House  
Cnr Moray & Princes Street,  
Private Bag 1959,  
DUNEDIN 9054  
Tel 03 477 3973  
Fax 03 477 3184

## 1. **QUALIFICATIONS AND EXPERIENCE**

- 1.1 My full name is Ronald William Fleming.
- 1.2 I have the following qualifications and professional memberships:
  - a. Bachelor of Engineering (Civil);
  - b. Member of the Institution of Professional Engineers of New Zealand (MIPENZ)
  - c. Chartered Professional Engineer (CPEng)
  - d. International Register of Professional Engineers (IntPE)
- 1.3 I am a Senior Principal with URS New Zealand Ltd (URS), who assessed the construction activities and their associated effects for the Mokihinui Hydro Proposal ("MHP").
- 1.4 The majority of my 37 years of experience has been on hydro electric power development and irrigation schemes, some 18 years as a construction engineer, and approximately 15 years working on the feasibility or design of such schemes. This work has included dams, tunnels, powerhouses and associated structures.
- 1.5 Examples of my experience specifically relevant to the Construction Effects assessment carried out on the MHP are:
  - a. Resident Engineer on the construction of the Clyde Dam and Power Station, which comprised extensive rock excavation and concrete construction in close proximity to the township of Clyde.
  - b. Construction Manager on the Clyde Landslide Remedial works, which involved construction planning and implementation of the works.
  - c. Feasibility study level construction planning for the Second Manapouri Tailrace Tunnel, located in the Fiordland National Park, followed by involvement in the design and construction process.
  - d. Construction planning and design input into the Matahina Dam Strengthening Project.

- e. Assisting the contractor with construction planning for the Khlong Tha Dan dam in Thailand, the largest Roller Compacted Concrete (RCC) dam in the world at 2.7 km long and 93 m high.
  - f. Design and construction support of four major irrigation dam upgrades in Victoria, Australia.
  - g. Involvement in the tender design of the Burnett River Dam, a major new RCC dam in Queensland.
  - h. Current involvement in the upgrade and raising of the Hinze Dam in Queensland, a major water supply dam. This included involvement in the design process and I am now a member of the three person Construction Review Panel, formed to progressively review the construction to ensure compliance with all site constraints and technical specifications.
- 1.6 In preparing this evidence I have for completeness, had to refer to some aspects of the work that are outside my specialist field of expertise. Such work includes: waste water treatment, traffic studies and noise level modelling. I do have considerable practical experience in construction noise mitigation measures and will provide comment as such where relevant. Other specialist team members have addressed these areas in the study and these experts have been referenced in my evidence where appropriate.
- 1.7 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.
- 1.8 I have been involved in the following work in relation to Meridian Energy Limited's (Meridian's) MHP:
- a. Preliminary planning of the construction methodology for each activity associated with the project's construction and the assessment of the effects from the construction on the surrounds;
  - b. Author of Section 2, Construction Activities of the report entitled Mokihinui Hydro Proposal, Construction Effects and Management Report, URS New Zealand Ltd (Oct 2007);
- and I have prepared my statement of evidence in reliance on this work.
- 1.9 I have also reviewed:

- a. The reports and statements of evidence of other experts giving evidence on behalf of Meridian relevant to my area of expertise, including:
  - i. Mr Cliff Tipler
  - ii. Mr Andrew Whaley
  - iii. Dr Stephen Chiles
- b. Mokihinui Hydro Proposal Construction Effects and Management Report, URS New Zealand Ltd (30<sup>th</sup> October 2007).
- c. Mokihinui Hydro Proposal, Project Engineering Description, DamWatch services Ltd (October 2007).
- d. The Assessment of Environmental Effects December 2007.
- e. Relevant submissions of others, namely:
  - i. AJ and DG Coleman
  - ii. GD and J Stowell
  - iii. K and J Maltesen, and S Barrowman, and
  - iv. TR Kirker, H Te-Awa and MM Dixon

## 2. **SCOPE OF EVIDENCE**

- 2.1 I have been asked by Meridian to prepare evidence in relation to the actual and potential effects on the environment of the construction of the MHP within the Mokihinui Gorge.
- 2.2 My evidence includes a description of construction activities required as part of the MHP including those associated with the construction of the various elements of the dam, the power station, dam site road network, and the vegetation clearance from the site and reservoir.
- 2.3 I describe construction effects related to vegetation clearance, fuel use on site and light spill. Whilst I broadly touch on other construction effects while describing specific activities, these are covered in detail by the evidence of others. The noise effects caused by the above mentioned activities and the mitigation measures which could be implemented are dealt with by my colleague Stephen Chiles. Traffic

effects on existing roads are discussed in the evidence of Andrew Whaley and dust effects, water quality, site clearance, monitoring and management plans are discussed in the evidence of Cliff Tipler.

### **3. EXECUTIVE SUMMARY**

- 3.1 The construction process involves clearing the staging area, river diversion works, excavation of rock, vegetation clearance, establishing a concrete batching facility and other facilities on-site, construction of the dam and power station, rehabilitation of sites not required for operation of the dam and re-instatement of tracks. A transmission line will be constructed and this is discussed in the evidence of Ray Brown.
- 3.2 In my opinion the most significant construction effects will be: an increase in road traffic past Seddonville, the clearance of trees/vegetation from the dam site and reservoir; the rock excavation for the river diversion and dam foundation; aggregate processing; and the batching and placing of the concrete to form the dam. I will describe these activities in detail below, except for the traffic effects which will be discussed by Andrew Whaley, and the noise effects which will be discussed by Stephen Chiles.
- 3.3 Fuel storage and use on site and light spill are not expected to result in any adverse effects through the controls set out in the proposed Environmental Construction Management Plan (and associated Plans set out within it) and monitoring.

### **4. THE PROPOSAL**

- 4.1 I confirm that my evidence is based on the project proposal as described in the Assessment of Environmental Effects, brief details of which are described in Appendix 1.

### **5. OVERVIEW OF CONSTRUCTION ACTIVITIES**

- 5.1 In this section of evidence I will provide an initial overview of the construction activities, with subsequent sections covering the scope of the specific construction activities to be carried out on site in more detail.
- 5.2 I will describe the various activities and associated construction effects under the following headings:

- a. Construction Overview
- b. Vegetation Clearance
- c. Staging Area and Site Roads
- d. Temporary Construction Facilities
- e. Excavations and River Diversion
- f. Dam Construction
- g. Powerhouse Construction
- h. Site Rehabilitation
- i. Public Access

5.3 I have included a description of the probable construction methodology including type of construction plant envisaged under each category and options for these have been identified where they can be clearly defined. However, I point out that subject to compliance with the resource consents or concession conditions, and subject to detailed design requirements, the contractor will be responsible for the final choice of methodology, plant and equipment. Therefore some variation in the methodology which I present could occur from that stated.

#### ***CONSTRUCTION OVERVIEW***

- 5.4 I have summarised the main elements of the construction below, with a more detailed description being provided in subsequent sections:
- 5.5 Figure 1 (Appendix A) provides a site plan which shows the extent of the “footprint” of the construction staging area and the permanent structures for MHP.
- 5.6 Clearance of trees and vegetation and the removal of all soil and organic material to the extent required for construction will be required within the site footprint at commencement of the works.
- 5.7 Selected clearance of large trees will be undertaken around the reservoir perimeter before and immediately after lake filling when barge access to final lake level for tree removal is possible.
- 5.8 The construction staging area downstream of the dam will accommodate the temporary construction facilities such as: offices; workshops; stores building and stores yard; aggregate winning,

processing and storage; concrete batching plants; access roads, construction services and other temporary facilities.

- 5.9 Public access will not be permitted within the defined site boundaries for safety and security reasons and the site will be fenced to exclude the public. Alternative access around the site will be provided during construction, including an appropriate viewing area.
- 5.10 Rock excavation on the dam site will be undertaken to form the diversion channel and to shape the dam foundation, as well as minor excavations required to construct site access roads
- 5.11 To permit the dam to be constructed across the existing riverbed, the river will be diverted through the diversion channel, which will be excavated through the rock along the left bank of the river.
- 5.12 A section of the dam across the diversion channel will be constructed as a concrete box culvert, with steel gates installed at the upstream face to be closed to commence lake-filling on completion of the dam.
- 5.13 Concrete aggregate for the dam and powerhouse construction will be excavated from within the staging area boundaries and processed on site using a screening and crushing plant. Some minor concrete construction such as dam facing panels, dam galleries or powerhouse architectural panels may be constructed off-site and transported in.
- 5.14 All stormwater runoff from the site and construction wastewater will be discharged through a retention pond settlement system to remove sediment, before being discharged to the river.
- 5.15 The concrete dam will be constructed using Roller Compacted Concrete (RCC) methodology, which was developed in the 1980s and has since gained worldwide acceptance as the preferred methodology for constructing mass concrete dams for a number of reasons, which include its lower cost, rapid construction and strength. As explained later in my evidence this ideally involves construction 24 hours a day.
- 5.16 The powerhouse will be a conventional “surface” powerhouse similar to many other New Zealand powerhouses such as on the Waitaki, Clutha and Waikato Rivers. It will be located immediately downstream of the dam on the true left bank of the river.
- 5.17 A switchyard will be located downstream of the powerhouse, connecting to the transmission lines.

- 5.18 Following completion of construction, all cleared areas that are not required for the power station operation will be restored and planted. Permanent roads will be sealed and a boat ramp will be established at the top of the dam on the left bank to provide permanent maintenance access to the lake.
- 5.19 Walking tracks would be reinstated and a permanent car park will be provided for the general public. A potential layout of these features has been included in Figure 2 (Appendix A).
- 5.20 The proposed 110 kV transmission line route is described in a separate report prepared by LineTech. More detail on the transmission line is provided in the evidence of Mr Ray Brown.
- 5.21 The following sections describe the above elements in more detail.

## 6. VEGETATION CLEARANCE

- 6.1 The vegetation within the valley is typical of the many forested valleys of the West Coast. The forest canopy is dominated by beech with scattered mature rimu present throughout the valley. In one area, known as Andersons Flat, the topography is much flatter and mature rimu is the dominant species in this area. A number of slips have also occurred throughout the valley. The vegetation on the slip areas and in most of the proposed staging area comprises regenerating species. A detailed description of the specific vegetation is provided in the evidence of Ruth Bartlett.

### *Site Clearing*

- 6.2 Clearance of all vegetation within the footprint of the dam site and staging area, including all trees and bush, will need to be undertaken at commencement of site establishment to permit development of the site for the temporary facilities and for the permanent structures. (Refer Figure 1, Appendix A). This includes site roads and any widening or realignment.
- 6.3 The 26 ha staging area to be cleared of vegetation is outlined by the blue dashed line on Figure 1, which includes the staging area, site roads, dam construction footprint and an access road and platform for the permanent station water supply reservoir. A 20 m wide buffer zone of trees and bush will be retained along the river bank adjacent to the

staging area. This is to retain the character of the river bank and to avoid any construction effects encroaching on the river bank or bed, except where required for the diversion and tailrace channels. Cliff Tipler will describe the environmental benefits of this buffer zone further in his evidence.

- 6.4 Vegetation clearance of the staging area, site roads and footprint of the permanent structures will likely be carried out using mechanical equipment such as excavators, dozers, scrub crushers, front end loaders and off highway trucks to remove the material to stockpile. All tree stumps will be removed to stockpile and some of the steeper slopes may require manual work. The end use of the larger trees will be determined in consultation with the land owner. The scrub will be crushed, mulched and stockpiled along the western boundary of the site at the location labelled "Waste Fill Storage Area" on Figure 1, for later re-use in site rehabilitation.
- 6.5 The site clearance work will be carried out during daylight hours only over a period of about a month, and will progress initially ahead of and then concurrently with the staging area development and site road formation as described later in my evidence.

### ***Reservoir Clearance***

- 6.6 The proposed reservoir in the Mokihinui valley has a range of existing vegetation types, including heavily wooded forests through to recovering slip areas.
- 6.7 The valley is a steep gorge. Access around the reservoir is limited by this steepness and is currently confined to the existing high level walking track that runs along the true left bank of the river. The sections of this walking track below the reservoir clearance zone will be reinstated above lake level. No access currently exists along the true right river bank.
- 6.8 Where practicable to do so, construction access tracks will need to be formed up the Gorge to provide machine access for the reservoir clearance stage that will take place prior to lake filling. These access tracks will be located within or below the clearance zone described below but may need to circumvent some of the steeper slopes by crossing the river or sidling around ridges.

- 6.9 The normal maximum operating level of the reservoir will be RL 100 m, corresponding to the spillway crest level. The proposed operating range is 3 m (i.e.: RL 97 m to 100 m). Flood flows will rise above RL 100 m. Meridian proposes that all trees (or parts of trees) that extend between 92 m and 102 m RL will be removed to improve the safety of the lake margin for recreational users on the lake and for visual appearance. This will ensure that no trees will be within 5 m of the lake surface at minimum operating level.
- 6.10 The most efficient means of removing the tree stems extending above 92m RL is to fell them from the ground where ever possible. Felling these trees from the ground also minimises the hazards associated with underwater spars once the lake is filled. On this basis, the clearance zone for the mature canopy trees has been increased to between 70m and 102m RL, with mature trees being in the order of 20m tall. Within the 70m to 92m RL boundary, only the canopy trees extending above 92m would be felled. Within the 92m to 102m zone, all trees would be removed.
- 6.11 Maps 1 to 6 in Appendix B show the extent of reservoir clearance required between RL 70 m and 102m, divided into steep areas (>40 degrees slope) and flatter areas (<40 degrees slope). The total area of vegetation submerged by the reservoir will be 266 ha, of which the area to be cleared will be 191 ha.
- 6.12 The steepness and inaccessibility of the reservoir for construction equipment will dictate that clearance will be carried out by a combination of manual and mechanical methods. Flatter areas will be cleared prior to lake filling will be cleared using similar equipment as that used for the staging area. For safety reasons, the use of chainsaws requires good footing, which may preclude their use on the steeper slopes. It is expected that these steep areas will need to be cleared after reservoir raising, using a barge mounted operation.
- 6.13 One possible barge mounted method of cutting underwater trees from a barge is the use of a machine called a "saw fish". I understand from discussions with a forestry expert that this is a remote controlled, submersible machine that is able to cut through trees several metres below the surface, using a submerged chainsaw. I understand that the "saw fish" has been used successfully in Canada. Another barge mounted method involves a modified excavator fitted with a tree felling head. Explosives may be used but are believed to be too slow.

- 6.14 Felled trees will either float downstream or may remain submerged once waterlogged indefinitely. Any floating trees and vegetation will be allowed to float down to a log boom positioned upstream of the dam. Alternatively, the contractor may choose to remove some trees by helicopter.
- 6.15 In terms of timing, the clearance of the flatter areas will be carried out during the estimated 3 year dam and power station construction period. The removal of trees from the steeper slopes will commence as the reservoir rises to the minimum operating lake level. This barge operation could take up to 24 months to complete after lake filling.
- 6.16 Generation will be able to commence once the lake has been filled, independent of the reservoir clearing operation.

## **7. STAGING AREA AND SITE ROADS**

### ***Staging Area***

- 7.1 Following on from site clearing, approximately 0.5 m of the surface material will be excavated over the whole staging area to remove all topsoil and organic matter. This material, which will comprise a mixture of roots, vegetation, topsoil and gravel, will be used to construct a temporary bund or stockpile along the western boundary of the staging area, which will also include mulched vegetation from the site. This has been shown at the location labelled "Waste Fill Storage Area" on Figure 1. The stockpile will be compacted to stabilise the material and will be enclosed within a silt fence and surrounded with stormwater collection drains leading into the settlement pond to prevent any sediment entering waterways. On completion of construction, this stockpiled organic material will be re-spread over the site to facilitate site rehabilitation.
- 7.2 The DamWatch drawing attached as Figure 2 in Appendix A shows a construction staging area layout within the site clearance boundary defined in Figure 1. This is a typical layout of temporary facilities and buildings for such a project, but it should be noted that the actual layout will depend on the contractor's choice of buildings, facilities and the location of these within the defined site clearance area.
- 7.3 The staging area development will comprise excavation of the upslope batters and formation of level platforms typically at RL 50 m and RL 40 m as shown in Figure 2. The upper platform is envisaged for use as

office, store (shown as “warehouse” on the drawing) and workshop space. The remainder of the staging area will be developed to suit the contractor’s aggregate extraction and processing plant and the accommodation of the various other construction facilities required. The excavations will be designed to provide stable batters long term, which will be top soiled and vegetated once the establishment works have been completed.

- 7.4 Once the areas have been levelled to grade, the surface of areas to be occupied by buildings or roads will be covered with hardfill and compacted to provide a suitable foundation. Some areas such as car parks may be sealed, at the contractor’s discretion, to reduce maintenance, avoid erosion and the adverse effects of either dust or mud on the establishment areas and buildings.
- 7.5 The majority of heavy construction plant will remain on site during construction and would be stored at various locations within the staging area when not in use. Light vehicles would generally be parked adjacent to the offices or workshops when on site, and a number of these will travel daily between Westport and site to transport personnel and small goods.
- 7.6 A buffer zone of bush approximately 20m wide will be retained along the riverbank adjacent to the main staging area to prevent any encroachment of the works on the river bank. A low stop bank will be constructed along the downstream section of river bank adjacent to the buffer zone to provide flood protection to the site and to allow access to the lower lying section of the borrow area.
- 7.7 A 5 m wide buffer zone will also be established around the remainder of the staging area clearance, including along the western boundary between the temporary vegetation stockpile and the bush, by erecting a wire netting security and catch fence 5 m in from the bush clearance line. This fence will define the boundary of the contractor’s work area as well as preventing encroachment of construction debris into the bush beyond. The buffer zone will provide a weed control zone, enabling periodic spraying as required.
- 7.8 The boundary fence will allow the site to be secured against unauthorised entry and for safety reasons, it will ensure the public cannot wander onto site and be exposed to the construction activities and potential hazards. The entrance to the site will have security gates

and appropriate signage warning of the site hazards and preventing unauthorised entry onto the site.

- 7.9 A stormwater collection swale or catch drain will be constructed around the perimeter line of the staging area on completion of the clearance to capture any runoff from slopes outside the area and return the water to the river following treatment in retention ponds. The staging area development will be undertaken using similar plant as the vegetation clearing.

### **Site Roads**

- 7.10 This section describes the construction roads that will be required on site. Off-site road and traffic effects are covered in evidence presented by Mr Andrew Whaley.
- 7.11 A number of roads will be required around the dam site to provide access for plant and equipment for construction of the works, with some of these roads remaining as permanent roads on completion. Two temporary bridges will also be required on site to provide access across the diversion channel. I would expect the roads and bridges required on-site to include:
- a. An access road from the western boundary of the site into the downstream toe area of the dam. This will be used to access the lower staging area, the diversion works, the lower dam foundation level, the powerhouse and tailrace channel. It will be nominally 15m wide to accommodate vehicles using it as the main site access road and off-highway dump trucks using it as a haul road.
  - b. An access road from the staging area to the true left abutment dam crest, which may also need to be of haul road width (15-30 metres) should the contractor choose dump trucks to place RCC rather than conveyors. This road will provide construction access to the initial left abutment vegetation clearance, dam excavation and foundation preparation works, and final construction access to the dam crest for concrete construction. Post construction this road will provide permanent access to the lake boat ramp, debris removal area and the reinstated walking track.
  - c. One or more intermediate level access roads to the dam left abutment which will be required for vegetation clearance, dam excavation and foundation preparation work, followed by plant and

equipment access for the RCC operation. These roads will be removed and rehabilitated on completion of the dam construction.

- d. An upstream access road will be required to provide access from the heel of the dam area to the true right abutment dam crest for vegetation clearance, excavation and foundation treatment of the abutment from the top down, ahead of RCC placement. This road will be below final lake level and will only be a dozer track width, but relatively steep.
  - e. A temporary access bridge will be required across the excavated diversion channel upstream of the dam, to provide access to the upstream cofferdam and to the right abutment works.
  - f. A second temporary access bridge will be required across the excavated diversion channel downstream of the dam, to provide access to the downstream cofferdam and to the riverbed excavation following diversion.
  - g. A walking access track will be required on the true left bank upslope of the dam crest for the installation of long term access to the reservoir.
- 7.12 The access road construction will be undertaken using traditional road construction plant in parallel with the staging area formation work described previously. The plant will generally comprise dozers, excavators, front end loaders, graders and 6WD articulated dump trucks (Moxy or similar) for the road excavation. Some blasting may be necessary on the steeper slopes where the road needs to sidle around ridges, which will require percussion drills and shot-firing. Final formation will require the spreading and compaction of suitable base course and top course road aggregates, which will be sourced either from the borrow area, or may be imported from a commercial supplier. The plant for this final formation would consist of traditional road construction plant.

## **8. TEMPORARY CONSTRUCTION FACILITIES**

- 8.1 In this section I will describe the various construction facilities that will need to be located in the staging area to service the construction works. The final layout and details of these facilities will primarily be the contractor's choice, subject to complying with resource consent, concession and building consent conditions.

- 8.2 These construction facilities are all temporary buildings or facilities and as such, will be removed on completion of the project.
- 8.3 Potable water supply for all buildings will be reticulated from the site water supply.
- 8.4 Wastewater from all buildings and facilities will be disposed of as described in the evidence of Mr Cliff Tipler.

### ***Site Buildings***

- 8.5 A possible layout of the temporary site buildings is shown on Figure 2. This is diagrammatic only, intended to give an indication of the typical buildings that will be required on site, rather than their exact size, number of buildings or location.
- 8.6 Offices for the Contractor's and Engineer's senior personnel, including meeting rooms, reception, lunchrooms, toilets and showers will be required on site and are shown located at RL 50m on Figure 2. The offices will be equipped with telephone and data lines. The buildings are likely to be standard portable modular buildings commonly utilised on construction sites, in a single or double storey arrangement.
- 8.7 In addition to the main offices, there will be a number of small portable workgroup buildings located adjacent to the main work areas on site. These will likely be combinations of standard 6 m x 3 m portable construction type buildings comprising a supervisor's office, a kitchen/lunchroom, a toilet/washroom and a small tools building sized to accommodate individual workgroups of 5 to 10 people. They would normally be self contained buildings with chemical toilets or retention tanks, although they may be connected to the site water supply and power supply.
- 8.8 Other small buildings and facilities required may include for example, a substation, water treatment facilities, compressor shed, pump shed and others.

### ***Workshops***

- 8.9 Workshops for mechanical, electrical and carpentry trades will be required to service the works. These would be used to maintain and repair site plant and to produce small steel fabrication items and site formwork. These buildings would typically be of steel portal framed construction on a concrete floor, clad in corrugated iron of a size to suit

the specific purpose. The mechanical workshop would normally be the largest building, which would need to accommodate repairs to large earthmoving plant and could be say 350 m<sup>2</sup> in area and about 10 metres high. Large buildings would normally be assembled on site.

### ***Reinforcing Steel Shop***

- 8.10 A reinforcing steel fabrication shop may be required to store incoming reinforcing steel and to cut and bend the steel to the required detail. This would normally comprise a small building, perhaps 50 m<sup>2</sup>, adjacent to a partially covered work area for fabricating the steel. Alternatively, the contractor may choose to sub-contract this work outside and have the fabricated steel delivered to site ready for use.

### ***Site Store and Yard***

- 8.11 A secure stores building and stores yard will be required for storage of all incoming supplies and goods for both temporary works and permanent installations. These include items such as spare parts for equipment, hand tools, pumps and other miscellaneous equipment and materials used in the construction. This may be a large steel portal framed building, similar in size to the mechanical workshop, to accommodate shelves for small tools and materials which cannot be stored outside.
- 8.12 One or more hazardous substance stores would be located in this complex, together with facilities for temporary storage of hazardous waste while awaiting collection for disposal off site. For hazardous liquids which could be subject to spillage, storage areas would be fully bunded for spill protection. Strict provisions will be included in the Environmental Construction Management Plan for the handling, storage and use of all hazardous substances, including monitoring and spill contingency plans.

### ***Fuel Storage***

- 8.13 A fuel store, storage tanks and pumps for dispensing petrol, diesel and oil to construction plant will be required on site. All fixed fuel storage tanks would be contained within impermeable bunded areas to capture accidental spillage and constructed to industry standards. Mobile plant such as trucks and small vehicles will re-fuel at this facility.

- 8.14 The semi-mobile plant on site such as crawler cranes, dozers, excavators, generators, hydraulic drills and compressors will need to be re-fuelled at their worksite. A small fuel tanker truck similar to an aircraft re-fueller and permanently located on site would normally be used for this purpose.
- 8.15 Strict provisions are included in the Environmental Construction Management Plan for the handling and use of fuels and oils, including monitoring and spill contingency plans for cleanup in the event of a spill occurring. Re-fuelling over water or adjacent to stormwater drains will not be permitted. This will not preclude re-fuelling of equipment on the dam itself during construction where this cannot be avoided, however the contractor will be required to include appropriate measures in the Environmental Construction Management Plan to ensure that any spills are intercepted and treated before reaching the river.

#### ***Pre-cast Concrete Facility***

- 8.16 A pre-cast concrete yard and workshop for constructing any pre-cast concrete units may be required on site, depending on whether the contractor chooses to sublet this work to an off-site manufacturer or construct these units on site. These units may include dam gallery units, upstream and downstream facing units for the dam as well as a number of pre-cast concrete units in the powerhouse such as superstructure cladding panels. Should the contractor choose to sub-contract this work off-site, some storage for the completed units will be required on the site, most likely in the aggregate borrow area.

#### ***Explosives Magazines***

- 8.17 The transport, safe storage, handling and use of explosives on construction sites will be in compliance with the relevant Acts and Regulations. Two magazines, one for explosives and one for detonators will be located on site in an appropriate secure position, away from inhabited buildings. These magazines are special steel containers, constructed to specific standards.
- 8.18 A very strict security control system will be set up, to satisfy the Acts and Regulations which will be required to be managed by a qualified quarry manager, and to ensure that the hazardous chemical storage areas comply with all appropriate standards, guidelines and consents. This procedure is covered by the Hazardous Substances Management Plan.

**Laboratory**

- 8.19 An aggregate and concrete testing laboratory will be located adjacent to the batching plants, to house the quality control testing equipment and the technicians responsible for carrying out the aggregate and concrete sampling and testing.

**Aggregate Processing**

- 8.20 An aggregate processing plant will be established within the staging area to supply concrete aggregates for RCC and conventional structural concrete on the project. The location of this plant will be determined by the contractor and it is likely to be moved from one part of the site to another to maximise the area to be worked as a borrow area.
- 8.21 The plant will be mainly fed from the gravels underlying the lower levels of the staging area from approximately RL 40 m and below, down to the underlying rock surface or to an economic depth of recovery below the water table. These gravels will be supplemented with additional gravel or excavated rock from the site excavations.
- 8.22 The aggregate source material will be excavated from the alluvial borrow areas or rock excavations using front end loaders or hydraulic excavators loading into dump trucks. The material will then be transported by dump truck to a feed hopper at the aggregate plant. It will then pass via conveyors through the plant, transferring through a series of crushers, screens, washers, centrifuges and sand classifiers to break the material down to the final products.
- 8.23 The final products comprise a number of separate sizes of coarse aggregate and sand, plus waste material of various sizes. The production materials will be discharged by stacking conveyors to a number of separate surge piles at the aggregate plant for quality testing. Once confirmed as acceptable, each product will be uplifted by front end loader and carted to storage stockpiles on site. Material will be removed from stockpile to the batching plant aggregate bins as required, and thence into the batching plants for processing into the various concrete mixes required for the project.
- 8.24 A percentage of the aggregate will be unusable waste material, which will be utilised to progressively backfill the excavated areas to final levels.

### **Concrete Batching Plants**

- 8.25 Two concrete batching plants will likely be required on site, one for conventional concrete (CC) and the other for RCC production. The CC plant is expected to be nominally of 50 m<sup>3</sup>/hr capacity, and the high capacity continuous-mix RCC batching plant, commonly called a “pug mill” would be in the order of 200 to 300 m<sup>3</sup>/hr capacity. The final capacity will be the contractor’s choice, depending on the rate of CC and RCC placement required to achieve the programme.
- 8.26 The two plants would normally share common facilities, such as aggregate bins, cement and fly ash silos, water supply, concrete additive dispensers, wash down facilities and discharge water control. The plants may also be combined into a single structure, with a central, common control room. The final configuration and layout of the two plants will be chosen by the contractor; however the following description provides an indication of what may be expected:
- a. Aggregate delivered from the aggregate plant will be stored in a number of separate aggregate bins for the respective aggregate size ranges, each of sufficient reserve capacity to permit 24-48 hour concrete batching and placement. The aggregate bins for the MHP would have an automatic “reclaim” system, commonly comprising a pre-cast concrete tunnel running underneath each bin, with a conveyor running through the tunnel, which collects the aggregates and transports them up into the storage bins in each batching plant. The aggregate is discharged from the bottom of the main aggregate bins onto the conveyor by mechanical feeders or gates, which are automatically controlled by the batching plant operator through an electronic control panel.
  - b. The cementitious materials, cement and fly ash, will be stored in bulk silos located adjacent to the batching plants. These will be delivered to site in standard cement type bulk road tankers, from Westport or the nearest railhead, depending on the source of supply.
  - c. The two types of cementitious materials will be transferred from the tankers to the silos in a closed pipe system using compressed air. Subsequent transfer of these materials from the silos into the batching plants is done electronically at a prescribed dosage rate from the control panels.

- d. The batching plants will be large structures, normally required to be several stories high to accommodate silos, storage hoppers, weighing hoppers, admixture dispensing, water supply, mixers and control room, with the plant normally having sufficient headroom underneath to allow agitator and dump trucks to be loaded. They are typically steel framed structures or enclosed buildings, clad with a suitable noise deadening material.
  - e. Concrete may be delivered from these plants to the various structures by agitator truck, concrete buckets on flat deck trucks, dump truck or conveyor. The method will be chosen by the contractor but will be dependent on which structure the concrete is being placed in at the time, the type of concrete and the method being used to place the concrete in the forms. RCC is commonly transported by conveyor or dump truck up onto the dam. Conventional concrete will normally be transported by agitator truck and discharged into concrete buckets or a concrete pump for placement.
- 8.27 The batching plants will generally be operated intermittently, but for large RCC pours this could be up to 24 hours a day, 7 days per week over a period of some 15-18 months.

### ***Electricity supply***

- 8.28 A construction electricity supply will be required on site to provide power to buildings, pumps, lighting, aggregate plant, concrete batching plant, and other construction facilities. The actual power demand will depend to a large extent on the contractor's choice of construction methodology and equipment, (for example, use of electric powered conveyors compared with diesel powered trucks to transport concrete), however, the load is expected to be in the order of 3 – 4 MW.
- 8.29 The existing 33 kV transmission line extends through close to Seddonville, where it changes to an 11 kV overhead line through to the Rough and Tumble Lodge. This line has limited spare capacity and could only be relied on to provide about 500 kW to the construction site.
- 8.30 The balance of power required would be supplied by diesel generators to be provided by the contractor.

***Water supply***

- 8.31 A water supply is required for the site to provide water for domestic use on site, toilets and fire fighting, aggregate production, concrete production, concrete water blasting, drilling and other general construction uses. This is discussed in the evidence of Mr Cliff Tipler.

***Wastewater disposal***

- 8.32 Most facilities described above will have toilets, lunchrooms, washrooms and in some cases showers. This is discussed further in the evidence of Mr Cliff Tipler.

***Lighting***

- 8.33 The major construction works associated with the diversion structure, the dam and the powerhouse civil works will be performed as a 24 hour operation, requiring general site lighting and more specific lighting in individual work areas.
- 8.34 The general site lighting will comprise low level lighting along site roads and around the exterior of buildings, security and safety lighting. This will be of typical street lighting intensity, with illuminance in the order of 20 lux.
- 8.35 In individual work places during construction only, a higher level of localised lighting, typically about 50 lux illuminance, will be required where work is being carried out at any point in time. This localised lighting will be moved about the site as workplaces change.
- 8.36 The Buller District Plan limits light spill to an illuminance of 10 lux as measured 2 metres inside the adjacent property boundary. The nearest property is the Preserve subdivision, as shown on Figure 1 in Appendix A, which is located approximately 1.2 km from where the higher lighting levels will be used, and is mostly screened from direct line of sight by vegetation and topography.
- 8.37 Illuminance from a light source reduces in an inverse square relationship with distance and therefore any light that is visible from the Preserve or Seddonville will be of very low illuminance and well within the Buller District Plan limitations. Based on my experience I therefore believe that light spill from the site will not result in any adverse effect on nearby residences.

### **Compressors**

- 8.38 Compressed air will be required at a number of locations on site including the workshops, batching plant, and all construction areas to power air tools and equipment.
- 8.39 In workshops and on fixed plant these would be expected to be small fixed electric compressors, but on site, mobile diesel compressors are more likely to be used by the contractor. Modern diesel powered mobile compressors are efficiently silenced and will not be a significant noise source on site.
- 8.40 Alternatively, the contractor may choose to install a larger central compressor facility, which could be electric or diesel, and reticulate compressed air around the site. Central compressors would be housed in a building clad with sound attenuating material.

### **Site cranes**

- 8.41 A number of mobile and fixed cranes will be required on site. These would typically comprise at least one crawler lattice crane (approximately 100-200 tonne capacity), several truck mounted mobile hydraulic cranes of about 30-50 tonnes capacity, and fixed tower cranes where a long reach is required. The latter will be likely to be needed for the spillway and powerhouse construction. The majority of construction lifts are less than ten tonnes, hence larger capacity cranes are not usually required on a dam site.
- 8.42 The permanent powerhouse equipment such as turbines, generators and transformers require a heavy lift capacity crane, however these lifts are carried out once the powerhouse superstructure has been completed and the permanent powerhouse crane has been installed, which is late in the civil construction programme.

## **9. EXCAVATIONS AND RIVER DIVERSION**

### **General**

- 9.1 Following completion of the staging area clearance and formation, and construction of access roads into the dam site, excavation for the diversion channel and dam will get underway. Construction of the cofferdams and river diversion will follow the diversion channel excavation and completion of the diversion culverts. The work will

comprise of removing overburden down to the rock surface, and then excavation of the rock to the design profiles using drill and blast techniques. The DamWatch drawing attached as Figure 3 in Appendix A shows a plan and elevation of the dam and diversion excavations.

- 9.2 The river diversion will be on the critical path to dam completion and hence the contractor will very likely wish to work 24 hrs a day, 6 or 7 days per week. This would however be subject to complying with the noise limitations of NZS 6803:1999, Acoustics, Construction Noise for night time operations. It is possible that drilling and excavation work will comply with this standard. Blasting, which is subject to different limitations as described by Stephen Chiles and discussed further below, will only be permitted during daylight hours.
- 9.3 Overburden will be removed using tracked excavators loading into dump trucks, for cartage to stockpile in the staging area for future re-use during site rehabilitation. The type of plant used and the environmental effects will be the same as those identified above for the staging area formation.

### ***Blasting***

- 9.4 Rock excavations in the diversion channel, the dam foundation and abutments and in some sections of the staging area will require drilling and blasting to achieve the design profiles, due to the hardness of the rock.
- 9.5 Blasting is a cyclic operation, where a series of blast holes (a paddock) are drilled usually vertically, or inclined to achieve a sloping batter. The paddock is loaded with explosive and fired. In a repetitive, well defined blasting operation such as for the diversion channel, the size of each paddock would coincide with a daily blast, usually at the end of the working day. Then, while the loose rock is being excavated and removed to disposal, the drilling would continue ahead and the blasting process would be repeated each day.
- 9.6 The rock excavations will have two additional noise effects when compared to the staging area formation: drilling and shot firing.
- a. The drilling would be carried out using track mounted hydraulic percussion rock drills, which are moderately noisy, but quieter and faster than the older pneumatic percussion drills. Modern

drills are self contained and have diesel motors which are effectively silenced.

- b. Drill holes will be loaded with explosives, with the type usually being chosen by the contractor, and fired in a delay sequence designed to achieve an accurate excavation profile and good breakage for ease of removal by the excavator. The delay sequence means that the total charge in any one excavation is fired in a number of shots, usually tens of milliseconds apart. The total blast time is usually less than two seconds long, depending on the size of the blast. Apart from being conducive to a good blast result, these delays spread out the blast so that the total effect of the blast is much less in terms of both noise and vibration.

- 9.7 Depending on how many excavation areas the contractor chooses to work concurrently, there could be one or more blasts each day, however, these blasts would be carried out over a set period of the day (e.g.: from 4 pm to 5 pm), to simplify the warning and site clearance system and to minimise the time lost in other work areas.
- 9.8 Prior to blasting, a defined blast clearance zone, typically of 300-500 m radius from the blast, is cleared of all personnel and then secured before each blast is authorised to proceed. This securing of the blast zone is a strict procedure to ensure compliance with Occupational Health & Safety requirements and normally involves sentries being stationed at each access point into the defined blast zone to prevent unauthorised persons entering the zone. For blasting on the Mokihinui dam site, sentries would be located upstream and downstream of the dam site on the public access track in addition to clearing site workers to outside the blast clearance zone.
- 9.9 Warning notices would be placed on the public access track detailing the blast times and procedures. This will not preclude use of the access tracks by trampers, except that during blasting they will be prevented by the sentries from crossing through the blast clearance zone above the site.
- 9.10 As set out in the Noise Management Plan, residents at the Preserve and in Seddonville will be kept fully informed through mail drops and newsletters as to when blasts will be occurring during different phases of the project. Prior to each blast, a warning siren will be used to clear

the blast zone of site personnel and warn the public and residents of the blast. Typically the warning siren would sound 15 minutes prior to blasting occurring, then immediately before each blast, followed by an all-clear or completion siren. This allows people to be pre-warned and lessens any adverse effects on residents.

- 9.11 While warning practices will vary in the blasting industry, this procedure is typically used on construction sites to clear the blast zone, as well as pre-warning residents of the impending blast. As an example, the procedure was used on the Clyde Dam diversion and foundation excavation where the excavations were typically 500 to 800 metres from the Clyde township. Whilst the siren could be considered noisy, we found at Clyde that the residents preferred to have prior warning of blasts.

#### ***Diversion channel excavation***

- 9.12 The diversion channel will be excavated in the rock along the true left bank of the river, as shown on Figure 3, leaving a rock ridge between the existing riverbed and channel to provide separation between the channel and the dam foundation excavation during floods. This rock ridge may require an additional concrete topping wall to be constructed to ensure the flood flows are retained in the diversion channel. The channel will be approximately 450 m long, 20 m wide at the base and up to 20 m high. Apart from the section of the channel through the diversion structure, the rock sides of the channel will remain unlined unless any poor rock conditions are found requiring rock bolts and/or shotcrete stabilisation.
- 9.13 It is anticipated that excavation by drill and blast will commence at the dam section, and progress concurrently on upstream and downstream faces. This provides efficiencies in terms of utilising resources, but will also provide early access for construction of the diversion culvert structure as soon as the central part of the channel through the dam has been excavated. I will describe the construction of the diversion culvert structure below.
- 9.14 Following completion of the culvert construction, the channel excavation will be completed with the removal of the final rock “plugs” at the upstream and downstream end of the channel, allowing the channel to be flooded.

***Left abutment dam foundation excavation***

- 9.15 The left abutment excavation and foundation treatment may be carried out in parallel with the diversion excavation, depending on the contractor's programme. This will involve commencing excavation at the top of the completed dam crest road and removing weathered or fractured surface rock down to a sound rock surface. Depending on the competency of the rock exposed, this may only require relatively shallow rock excavation to achieve the required standard of substrate rock on which to place the concrete.

***Right abutment dam foundation excavation***

- 9.16 Compared with the left abutment excavation, which is relatively gently sloping, the stripping and excavation of the steep right abutment is expected to be difficult and slow.
- 9.17 Removal of bush, overburden and weathered and fractured rock will commence at a point above the crest, accessed from the right abutment upstream road. A tracked excavator will construct a working bench at the top, gaining a "foothold" to carry out the work. The working bench would be approximately 5 m wide and will extend several metres upstream and downstream of the dam footprint.
- 9.18 The work will likely comprise removal of vegetation and excavation of rock down to a sound surface for the dam foundation. Depending on the condition of the rock, some rock bolting and shotcreting may be required to stabilise localised areas of fractured rock or overhangs.
- 9.19 The contractor will probably choose to excavate this abutment by progressively excavating down the abutment, depositing the material over the edge of the bench and for any rock stabilisation to be carried out progressively from the excavated bench as it advances down slope. Access to the bench for plant will be cut off as the crest road is left behind, so any drilling, blasting and rock bolting may need to be carried out using hand held equipment. A rough terrain crane may be stationed on a formed platform at the top of the abutment to provide crane and access coverage. Shotcrete may be required for temporary rock stabilisation. Excavation will not be able to commence until the diversion has been completed as the vegetation and rock will fall into the existing riverbed or dam foundation.

- 9.20 The noise effects from this work will be similar to other work, although being at a higher elevation; this area will be more exposed to the Preserve and Seddonville. The use of relatively small plant and equipment as dictated by the difficult confined space work area will however result in only low levels of noise from this work, which I understand from the evidence of Dr Chiles will comply with the Buller District Plan noise limitations. The size of blasts will be small in comparison to the diversion channel excavation. Dr Chiles provides specific details of the noise effects of dam construction on the Preserve and Seddonville in his evidence.
- 9.21 This work is most likely to be carried out during daytime hours due to the relative difficulty of the task and potential safety concerns for a night time operation.

#### ***Powerhouse Substructure and Tailrace Excavation***

- 9.22 Excavation for the powerhouse sub-structure and the tailrace channel connecting with the diversion channel may be carried out concurrently with the diversion channel excavation to allow these works to be completed in the dry before the diversion becomes flooded. This excavation work will be similar to the diversion channel excavation except that the powerhouse substructure will be excavated to more intricate detail to accommodate the machine pits, pump room, drainage galleries and draft tubes.

#### ***River Diversion***

- 9.23 The purpose of river diversion is to allow the riverbed through the dam footprint to be excavated to foundation level and then the dam to be constructed through this riverbed section. River diversion would be achieved in four stages as follows, with reference to Figure 4 in Appendix A:
- 9.24 Stage 1 works for river diversion comprises the excavation of the diversion channel beside the existing riverbed as previously described, while the river is retained in its current bed, and construction of the reinforced concrete box culvert structure in the newly excavated diversion channel occurs. During Stage 1 works, an upstream and downstream temporary bridge would be constructed across the new diversion channel to provide construction access to the cofferdams and dam foundation described below.

- 9.25 Stage 2 comprises the flooding of the diversion channel by removing the rock “plugs” at each end of the channel, allowing the river to flood the diversion channel and diversion structure.
- 9.26 Stage 3 involves closing off the existing river channel with an upstream cofferdam (a temporary dam), which diverts the full flow through the diversion channel.
- 9.27 Stage 4 comprises the downstream cofferdam construction, sealing of the cofferdams and dewatering of the old riverbed between the two cofferdams to permit the dam foundation to be excavated and the dam to be constructed in the dry.
- 9.28 A period of low river flow would be chosen to push out the cofferdams and the work would be planned to be completed very quickly, preferably within one day during daylight hours to minimise the amount of erosion to the cofferdams and minimise the amount of sediment being discharged into the flowing water.
- 9.29 Due to the underlying river gravels on which they are founded and largely uncompacted material, cofferdams can be inherently leaky. If the leakage is able to be controlled through pumping and is not excessive, and the cofferdam stability is satisfactory, no action may be deemed necessary to seal the cofferdams further. This was the case with the Clyde Dam cofferdams.
- 9.30 However, if the leakage is excessive, some means of sealing the leakage needs to be implemented. At the Mokihinui site, some 20 metres depth of river gravels and boulders underlies the river level through the dam foundation. This will probably need some form of leakage control or cut-off barrier through the cofferdams to control leakage. The cut-off would be constructed after the cofferdam closure has been achieved. The possible forms of cut-off barrier include the following:
- a. A blanket of fine material deposited upstream of the cofferdam (or on the river side in the case of the downstream cofferdam), to reduce seepage through the dam.
  - b. Installation of a cement grout curtain through the dam, by drilling close centred holes through each cofferdam dam crest down to rock level and injecting a thick cement grout into the gravels.

- c. Installation of a heavy sheet pile cut-off wall instead of the grout curtain.
  - d. Installation of a bentonite slurry cut-off wall.
- 9.31 The overall duration of the cofferdam work is relatively short, and I expect this period to be less than a month.
- 9.32 On completion of the cofferdams, some form of overflow erosion protection such as RCC will be required on the exposed surfaces of these dams. This is to provide erosion protection in the event that the diversion capacity is exceeded during construction of the dam and the flood overtops the cofferdams. The effect of cofferdam construction on water quality is discussed by Cliff Tipler in his evidence.

### ***Dam Foundation Excavation through the Riverbed***

- 9.33 Once the cofferdams have been completed and sealed, pumping out of the section of river between the two cofferdams will take place in conjunction with excavation of the river gravels down to rock.
- 9.34 The rock foundation through the dam footprint will be exposed and an assessment made of the rock condition. It is probable that some rock excavation will then take place to remove irregularities and produce an even foundation on which to place concrete. Any loose or poor quality rock will need to be removed.
- 9.35 Downstream of the dam, the spillway plunge pool will be excavated in the dewatered riverbed. The plunge pool will be a deepened section of river channel immediately downstream of the dam, where the spillway will discharge back into the river, to provide a means of energy dissipation and erosion prevention during high flood flows. This will require a deep excavation through the river gravels possibly into the basement rock.

## **10. DAM CONSTRUCTION**

- 10.1 The concept design for the dam has been based on the use of RCC, which is a type of concrete construction developed to provide a cost effective, faster and more efficient method of construction when compared to the traditional formed mass concrete gravity dams such as the Roxburgh or Clyde Dams. Some elements of the dam such as the

intake structure, the spillway flip-bucket and training walls will be constructed using conventional concrete (CC).

- 10.2 RCC can be considered analogous to a roading earthworks operation, where material is laid down in continuous 300 mm thick layers and compacted with rollers, except that the RCC material is a relatively dry concrete mix rather than gravel. The concrete is not formed and poured in “blocks” as for a conventional concrete dam such as the Clyde Dam. The only formwork required is along the upstream and downstream faces, internal galleries, intakes and spillway.
- 10.3 Once started, the RCC construction is ideally a continuous, 24 hour/7 day process, requiring aggregate production, cementitious materials (cement and fly ash), admixture supply and concrete production to be geared up to meet the production demand. The 24 hour/7 day operation permits successive layers of RCC to be placed without requiring the delays and cost associated with surface preparation of the preceding layer of concrete, which are inherent in conventional concrete methodology.
- 10.4 Fly ash (a form of pozzolan) is a by-product from coal fired power stations, typically used in mass concrete construction to replace up to 50% of the cement. It is a fine grained, grey powder similar to cement, is non-toxic and largely non-hazardous if treated with the same precautions as when handling cement. Fly ash provides many beneficial properties to concrete and for MHP is expected to be sourced either from the Huntly Power Station or from Australia, depending on availability and cost.
- 10.5 The cement and fly ash will be transported separately to site in enclosed bulk tankers, stored in enclosed silos and then combined during the concrete production process.
- 10.6 RCC dams are suited to sites with sound rock foundations and a nearby source of suitable aggregate material. The rapid construction technique significantly reduces the project duration when compared with a traditional concrete dam and is also of benefit in terms of reduction in construction risk in areas of high rainfall and/or high river flows during construction, which are characteristics of the Mokihinui River site.
- 10.7 The main elements of the dam comprise the following:
  - a. The diversion structure and channel.
  - b. The main dam structure.

- c. An environmental flow pipe and control valve located above the diversion structure. The main use of this discharge pipe is to maintain minimum flows in the river during lake filling.
- d. Spillway.
- e. Intakes and penstocks.
- f. Foundation drainage galleries, grout curtain and under drains.

10.8 I will discuss the above elements further in the following sub-sections, with reference to Figure 3 in Appendix A:

### ***Diversion Structure and Channel***

- 10.9 The purpose of the diversion structure and channel is to provide an alternate channel for the river to flow through while construction of the dam takes place across the existing riverbed.
- 10.10 For a CC or RCC dam, the consequences of overtopping are not as severe as for an earth embankment dam, as the concrete will withstand the flow without failure and little silt or debris from the construction should be released downstream from the works.
- 10.11 However, overtopping of the partially completed RCC dam is still undesirable, as a flood will still put at risk temporary works such as formwork and plant and cause delays and extra costs as the construction site is re-established.
- 10.12 Choosing the diversion design flood flow is therefore important and the concept design of the diversion structure for Mokihinui Dam is based on about a 1 in 5 year return period flood of 2,000 cumecs. This design flood will be reviewed during detailed design.
- 10.13 The diversion structure comprises a CC twin barrel box culvert structure constructed through the base of the dam as shown on Figure 3.
- 10.14 Each diversion culvert barrel will incorporate a vertical steel gate at the upstream face of the dam, which will facilitate closing off the river flow when ready to commence lake filling. These are “temporary” gates, which remain in place following lake filling and do not include provision for re-opening them. Following lake filling and once all commissioning has been completed and satisfactory operation has been confirmed, the diversion culverts would normally have concrete plugs constructed inside them to permanently close them off.

- 10.15 In my opinion the construction effects from the diversion structure construction will be relatively minor, comprising of normal CC construction effects associated with formwork erection, reinforcing steel placement and pouring of concrete.
- 10.16 The work is likely to be carried out on a 24 hour basis. Noise sources will not exceed the limits for night time noise at the Preserve or in Seddonville as stipulated in the Buller District Plan.

### ***RCC Dam***

- 10.17 The dam is an 85 m high structure with a crest length of about 280 m as shown in plan and elevation on Figure 3. The crest level has been provisionally set at RL 108.5 m. The main body of the dam will be constructed of RCC, with a vertical upstream face and sloping, stepped downstream face.
- 10.18 The RCC operation is geared for rapid construction, only limited by aggregate supply, the output of the batching plant and the preparatory work that has to be carried out on the dam ahead of each pour. On large projects, average placement rates up to 10,000 m<sup>3</sup>/day would be expected. On the MHP, the batching plant capacity may be in the order of 200 - 300 m<sup>3</sup>/hour, which would give a theoretical maximum daily placement over a 20 hour working day of 6,000 m<sup>3</sup>, and an average daily placement rate of about 4,000 m<sup>3</sup>.
- 10.19 The concrete is preferably placed across the full length of the dam in a continuous operation, although until the foundation work and diversion has been completed placement may be piecemeal.
- 10.20 The upstream and downstream faces may be formed by timber forms, pre-cast concrete or slip formed concrete kerbs, typically 900 to 1,500 mm high. These kerbs are made ready ahead of the concrete placement and if planned properly, will not hold up the concrete operation.
- 10.21 RCC may be transported from the batching plant to the dam by conveyors or by dump trucks and deposited in layers about 300 mm thick on a prepared rock foundation or on the previously compacted concrete surface. The layers are spread and levelled by bulldozer or excavator and compacted using a smooth wheeled vibrating roller as in a typical road formation operation.
- 10.22 Each 300 mm thick layer is followed by a subsequent layer as quickly as concrete supply permits. If stoppages can be avoided and the next layer

is placed within a defined time, typically 12 hours, no joint preparation of the previous surface is required, which results in a very rapid, continuous concrete placement operation. Periodic stoppages will occur during rain storms unless the contractor is able to cover the concrete operation.

- 10.23 I recently observed RCC placement at the North Para Dam in South Australia, and can confirm that noise levels associated with the placement operation were comparatively low. The 6WD RCC delivery trucks were probably the most noisy plant items, although the placement of construction joints across the dam using a vibrating hammer on an excavator was relatively noisy for a short duration. I did notice that the RCC batching plant (pugmill) was noisy, however, with the nearest residences over 2 km distant, no effort had been made to silence the plant.
- 10.24 Conveyors were used instead of trucks at Saluda Dam (South Carolina) and Hickory Creek Dam (Georgia, USA), which being electric powered, would be considerably quieter than trucks.
- 10.25 As previously discussed, the night time operation will require flood lighting on the dam of moderate levels of illuminance, however the light spill from this as observed at the Preserve or Seddonville, will be well within the limits stipulated in the Buller District Plan.

### ***Spillway***

- 10.26 The 120 m wide spillway overflow section of the dam will be located on the right bank section above the existing river channel, as shown on Figure 3, with a crest level of RL 100 m, some 8.5 m below the main dam crest level. The spillway crest will be an ungated "ogee" type concrete free overflow crest, designed to pass the Probable Maximum Flood (PMF) which is estimated to be up to 7,200 cumecs.
- 10.27 The spillway slope on the downstream face of the dam is expected to be faced with CC to provide a smooth hydraulic surface. Concrete training walls each side of the spillway will contain the flow in the channel and the concept design includes a "flip bucket" concrete structure constructed near the bottom of the spillway, above the tail water level. This flip bucket is an energy dissipater which will be designed to project the water out into the plunge pool, which is estimated to occur for 2 to 3 percent of the time. The flip bucket will prevent erosion in the downstream river channel even under very high flows.

- 10.28 The spillway construction will be similar for other areas of conventional concrete work around site, comprising of erection of formwork, reinforcing steel and concrete placement. Cranage over the spillway will be required, likely being either a large mobile crane operating from the riverbed area downstream and later from the dam crest, or a tower crane.

### ***Intakes and Penstocks***

- 10.29 Two intake structures will be located at the upstream face of the dam on the left bank, feeding water into the twin penstocks for transfer into the turbines. The intake openings will be constructed using conventional concrete and will include vertical steel gates and stoplogs at the upstream face of the dam to permit closing off the intakes, and trash rack screens to prevent any logs or other debris entering the intakes. Provisions are allowed for the installation and removal of temporary fish screens.
- 10.30 A separate permanent floating log boom will be installed upstream of the dam to trap logs and vegetation debris and guide them to the left bank for removal and disposal. During lake filling, the log boom will be installed at lower levels to intercept logs and vegetation as the lake rises.
- 10.31 Once the RCC dam construction has reached the penstock level, the steel penstock sections will be transported on to the dam surface and welded together in place. The upstream section will be embedded into the concrete intake structure and the steel penstock will be encased in CC before being covered in RCC.
- 10.32 In terms of construction effects, these works will be similar to other CC activities on site, except that welding, sandblasting and painting of penstocks will be required. These activities will be screened from other works for OH&S reasons and will not have any effect off site.

### ***Dam Galleries***

- 10.33 Galleries or small tunnels will be formed within the RCC section above the foundation at about RL 34 m and partially up the abutments, to provide access for constructing a vertical grout cut-off curtain and downstream drainage drill holes across the dam foundation. A lower gallery may be constructed beneath the diversion structure for the same purpose.

- 10.34 The galleries act as collector drains for control of any leakage through the dam or foundations and as a means of access for permanent inspection and monitoring of the dam.

### ***Lake filling***

- 10.35 Lake filling is a controlled process that will take place following completion of dam construction, downstream channel works and reservoir clearance.
- 10.36 Once the permanent monitoring instrumentation has been installed in the dam and calibrated with base readings, lake filling will be authorised to commence. Monitoring of structural deformation of the dam and of leakage through the foundation will take place during lake filling to confirm that the behaviour is within the design parameters. This monitoring will continue throughout the life of the dam.
- 10.37 Lake filling will be initiated by lowering the two diversion gates to close off the river flow through the diversion. Following this closure, the environmental flow release pipe will continue to discharge a minimum flow of 16 m<sup>3</sup>/s during this lake filling and until power station operation commences.
- 10.38 Lake filling can be commenced independently of the powerhouse construction and depending on the sequencing and length of time required for lake filling, it may start ahead of powerhouse completion.
- 10.39 Lake filling will carry down some loose vegetation and debris from the catchment upstream. Prior to lake filling commencing, the log boom will be installed across the river to intercept this vegetation and allow it to be removed from the rising lake. Once lake filling has been completed the log boom will be permanently installed across the lake to intercept logs and debris to prevent them entering the intakes. The log boom will be designed to guide the logs to the true left bank into a log management area for removal by excavator.

## **11. POWERHOUSE CONSTRUCTION**

- 11.1 The powerhouse concept design is based on two nominally 40 MW Francis type turbines, with a smaller 13 MW unit to provide flexibility of operation at lower flows. The powerhouse, which is shown on Figure 3, will house the turbines, generators and associated mechanical and

electrical equipment. It will comprise: an unloading bay where heavy equipment can be brought into the powerhouse to be lifted by the powerhouse crane; the two machine bays; control room; mechanical and electrical stores and workshops; transformer bays; switchgear rooms; and a number of other spaces for ablutions, offices and meeting rooms.

### ***Civil Works***

- 11.2 The powerhouse civil construction is split into the substructure (below ground) and superstructure (above ground) components, with construction progressing longitudinally along the powerhouse from the unloading bay end.
- 11.3 The substructure typically comprises about four floor levels below the generator floor, which is normally located at ground level. The substructure houses the mechanical and electrical components of turbine and generator equipment and the majority of ancillary equipment. The substructure is all conventional reinforced concrete.
- 11.4 The superstructure encloses the powerhouse, providing a weather proof and secure building. It will be constructed either of reinforced concrete or steel, and architecturally designed to “soften” its functional appearance. The building would typically be clad in textured pre-cast concrete panels, which also reduce noise levels of the generating equipment as measured outside. The superstructure supports the heavy lift powerhouse gantry cranes which are used for installation and maintenance of the turbines and generators.
- 11.5 Assembly and installation of the turbine and generator cannot commence until the first machine bay and unloading bay substructure and superstructure has been completed, and the powerhouse crane has been installed.
- 11.6 Powerhouse construction will require construction crane coverage similar to any multi-storey building. This would normally be provided by one or more tower cranes.

### ***Mechanical and Electrical Installations***

- 11.7 Following completion of the unloading bay and erection of the powerhouse crane, assembly of the first turbine components, generator stator and rotor will take place on the unloading bay. These heavy

components will be delivered to site in sections by heavy transport from port.

- 11.8 Once assembled, the turbine will be installed, followed by the generator components. This will be repeated for the second machine once that machine bay becomes available from the civil construction.
- 11.9 In addition to the machines, there are other mechanical and electrical installations associated with the power station required to complete the work. These include: pumps and pipework, transformers, switchgear, switchyard, control equipment, penstock valves and building services.

## 12. **SITE REHABILITATION**

- 12.1 During the detailed design phase of the project and before construction commences a Landscaping and Rehabilitation Plan will be prepared for the completed site. The rehabilitation plan may include the earlier recovery of seed or stock from the site to a nursery for re-use in the site rehabilitation work.
- 12.2 On completion of all civil works the site rehabilitation will commence. As the site is relatively small, progressive rehabilitation may not be practicable, although some preliminary work may be possible in the aggregate borrow area and on the temporary dam access road. The rehabilitation management plan is discussed further in the evidence of Mr Cliff Tipler and Mr John Kyle.
- 12.3 All construction debris and temporary facilities will be removed offsite. Temporary concrete foundations and slabs will be demolished and removed from site or used as part of re-contouring the site. These are inert materials and as such would normally be simply buried with a nominal 2 metres of cover material.
- 12.4 The site area will be contoured to provide a natural grade to the river with all abrupt changes in grade being softened. The shape of the final landform will be dependent on the quantity of material excavated for the dam and the waste aggregate material returned to the pit.
- 12.5 The mulch, topsoil and surface material won from the site clearing operation as described earlier will be spread back over the site to assist re-vegetation and the area will be re-vegetated with appropriate native species.

- 12.6 The retention ponds will contain silt which will be progressively tested to ensure it contains no detrimental chemicals, before the silt is disposed of back in the aggregate borrow pit and buried. Should detrimental materials be found that could result in adverse environmental effects, these will be removed to a specifically designed lined landfill located on or off the site. Depending on the nature of the detrimental materials, possible treatment of the materials would also be considered.
- 12.7 These retention ponds will then be backfilled, contoured and planted as for the remainder of the site.

### 13. **PUBLIC ACCESS**

- 13.1 Public access is currently available through the site to a high level walking track along the true left bank of the Mokihinui River. The current access through the site footprint crosses the dam's left abutment excavation and hence will not be accessible during the project construction period for safety and security reasons.
- 13.2 An alternative public walking track around the site staging area will be formed at the commencement of the works which will connect with the existing walking track, as shown on Figure 1. A public observation point with updated information on the construction will be set up at an appropriate vantage point for safely viewing the construction works.
- 13.3 A public car park would be provided during the construction period at a suitable location somewhere near the Burke Creek Bridge and provision would be made in the road design between Burke Creek and the site for trampers to walk safely beside the road.
- 13.4 On completion of construction and site rehabilitation, it is proposed that the construction office area would be converted into a public car park and trampers would walk up the true left bank road to the dam crest, to connect with a new walking track which will be constructed beside the reservoir above lake level. A boat ramp and jetty will be constructed to provide maintenance access to the lake immediately upstream of the dam on the true left bank. These are shown on Figure 5.
- 13.5 Public access to be dam crest would not be permitted for safety reasons; however a permanent public viewing area would be constructed above the dam crest with appropriate informational and warning signage.

13.6 It is my understanding that the public use of the boat ramp and lake is a matter to be decided by the Buller District Council, the West Coast Regional Council, the landowner and the local community. However any public use will need to take into account the inherent dangers around a dam. The permanent log boom or barrier will be installed across the lake immediately upstream of the dam will prevent public access by boat into the hazard zone around the dam, intakes or spillway.

#### 14. **ACTUAL AND POTENTIAL EFFECTS**

14.1 In the above sections I have described the various construction activities that will take place during the construction of the dam and power station. I will now briefly summarise the effects that will result from those activities, including on-site effects.

14.2 The main effects of the construction activities may be summarised as follows:

- a. Debris control during vegetation clearance on the dam site, staging area, and reservoir;
- b. Fuel management;
- c. The effects of light spill from night time dam construction work.
- d. Noise:
  - i. an increase in noise from the dam site, mainly from rock drilling and blasting, aggregate production, concrete production and the operation of heavy construction plant;
  - ii. an increase in noise on the road past Seddonville as a result of construction traffic movements;
  - iii. an increase in noise as a result of heavy construction plant on site;
- e. The effects on air quality including dust and vehicle emissions on the dam site; and
- f. The effects on water quality at the dam site.

14.3 The last three of the above effects are described in the evidence of Cliff Tipler, Stephen Chiles and Andrew Whaley. I will therefore restrict my comments to vegetation clearance, fuel management and light spill.

***Debris Control during Damsite and Staging Area Clearance***

- 14.4 Site clearance could result in organic material and sediment entering the river if it is not adequately controlled. Control will be achieved by appropriate sequencing of the work, installing silt fences, catch drains, river bank bunding and the main settlement ponds early in the site clearance operation, before the major clearance commences.
- 14.5 The majority of the staging area clearance area is located on gently sloping land, particularly adjacent to the river. In my opinion control of debris in this area will be straightforward and effective using the methods described above, in conjunction with the appropriate provisions included in the Environmental Construction Management Plan.
- 14.6 Similar controls of debris will be effective for the left abutment dam foundation clearance, which being on a relatively workable slope will be accessible to a normal land clearing operation.
- 14.7 The right abutment foundation clearance will be difficult to control because of its steepness and inaccessibility. This work will not be permitted until the cofferdams are in place and the riverbed beneath the clearance zone is dry in order to avoid debris entering the river.
- 14.8 Alternatively the right abutment foundation clearance could be started before the cofferdams construction was completed, by using bunding and /or debris fences to restrict material entering the river.

***Debris and Log Control during Reservoir Clearance***

- 14.9 Given the steep and inaccessible topography around the reservoir perimeter, it will not be practicable to ultimately avoid debris from the reservoir clearance operation from entering the river or reservoir. The extent of debris floating downstream will be somewhat dependent on the contractor's methodology and timing of the works. However, it will be also be dependent on the nature of the debris. Fine debris, vegetation and some logs will float downstream, with other logs remaining underwater.
- 14.10 To mitigate the effect on the river, initial reservoir clearance operations prior to commencement of lake filling will be restricted to the more accessible, gently sloping areas. Control measures similar to those put in place for the staging area will be required to prevent debris and sediment runoff from directly entering the river. These measures are likely to

include retaining a buffer zone of vegetation along the river perimeter where possible, silt fences and sediment ponds to control erosion.

- 14.11 For the steeper areas where debris would be expected to fall into the river, this operation will be delayed until after lake filling.
- 14.12 In order to trap the debris during this second phase of clearing, a log boom will be erected across the reservoir upstream of the dam to trap the floating material. The boom will be cleared periodically to remove the build up of the debris, with the debris being removed to the staging area. It is anticipated that the debris will be disposed of at the staging area, but the final destination of the logs will be decided in consultation with DoC.
- 14.13 Debris and log management during dam operation has been discussed in Mr Amos's evidence.

### ***Fuel Management***

- 14.14 The site re-fuelling facilities comprising a re-fuelling station for mobile plant, have been previously described. Bulk fuel will be delivered to site in normal road tankers from the fuel company.
- 14.15 The fuel storage will be bunded and appropriate interception tanks installed in accordance with best industry practice. Strict operational procedures would be put in place to avoid spills when transferring fuel, including the avoidance of any re-fuelling over water or adjacent to stormwater drains. This does not preclude refuelling of equipment on the dam itself during construction where this cannot be avoided.
- 14.16 A mobile truck mounted site fuel tanker will be required for re-fuelling semi-mobile plant such as tracked machines or fixed plant around the site. This fuel tanker would be subject to strict operational rules and will be required to carry a fuel spill kit at all times. As with all personnel on site, the tanker operators would be trained in preventing fuel spills and in the cleanup and reporting of spills should they occur.
- 14.17 Spill cleanup procedures and provisions to remedy any accidental spills are included in the Hazardous Substances Management Plan, as described by Cliff Tipler.

**Light Spill**

- 14.18 As previously described, a relatively low level of lighting is expected on the general site, apart from localised higher level lighting in specific localised work areas, such as on the dam and powerhouse construction areas.
- 14.19 The provisions of Section 7.9.4 of the Buller District Plan, stipulates a maximum light spill illuminance of 10 lux (horizontal and vertical) measured 2 metres inside the boundary of the adjoining property. The contractor will be required to use appropriate hoods or downward deflectors on the lights preventing any light spill towards the Preserve and Seddonville, however given the separation distance to the site and the effects of topography and bush cover in between; in my opinion the contractor will not have difficulty complying with this requirement.
- 14.20 Notwithstanding this, the contractor will be required to include light spill provisions in the Environmental Construction Management Plan in order to demonstrate compliance with the BDP.

**15. ISSUES RAISED BY SUBMISSIONS**

- 15.1 I have read the following submissions in preparing this evidence:
- a. AJ and DG Coleman
  - b. GD and J Stowell
  - c. K and J Maltesen, and S Barrowman, and
  - d. TR Kirker, H Te-Awa and MM Dixon
- 15.2 I consider that the issues raised by these submitters which are relevant to my evidence have been adequately covered by the evidence and that these effects can be mitigated to an acceptable level.

**16. CONCLUSION**

- 16.1 Peter Amos has described the permanent structures that makeup the MHP and the engineering assumptions behind the feasibility design.
- 16.2 In my evidence I have described the site and reservoir clearance, temporary works, plant and methodologies that will likely be used to construct these structures. In doing so, I have identified the effects on

the environment and on the nearest properties of fuel handling and light spill. For completeness, I have broadly touched on other effects where I feel qualified to comment, although detailed discussion of noise, water discharge, dust and traffic into the site has been described in the evidence of others.

- 16.3 Based on my experience in the design and construction of a number of large dams and power stations, the MHP is typical of many concrete dams and conventional power stations throughout New Zealand. Whilst the dam is of RCC design, the construction effects will not be markedly different to those experienced on conventional concrete dams such as the Clyde Dam, on which I have personal experience, or on any other heavy civil construction site. The one major difference between RCC and CC dams is the significantly shorter construction duration of RCC dams, which reduces the time of exposure of third parties to any construction effects.
- 16.4 The main construction effects during the project will be: an increase in traffic past Seddonville and the Preserve, an increase in noise levels from site plant and traffic, minor potential for some dust from the site works, and potential water quality effects on the river if not carefully managed.
- 16.5 In my opinion these effects can be satisfactorily managed by means of an appropriate Environmental Construction Management Plan, and a pro-active environmental monitoring and community liaison programme during the construction.
- 16.6 The Environmental Construction Management Plan will capture all imposed constraints and conditions, such that the effects can be identified, measured, avoided, remedied and mitigated prior to and throughout the construction period so that effects are no more than minor

## **Appendix A – Drawings**

Figure 1 – Site Plan

Figure 2 – Construction Site Layout (DamWatch drawing MLD461/20/16)

Figure 3 – Dam Site Major Features (DamWatch drawing MLD461/20/5)

Figure 4 – Diversion and Cofferdam Construction Stages

Figure 5 – Rehabilitation Plan

## **Appendix B – Maps**

Maps 1 – 6: Reservoir Clearance Zones between RL 70 m and RL 102 m