WAIHAO DOWNS IRRIGATION SCHEME

CONSTRUCTION METHODOLOGY

Fish Barrier, Intake, Pond and Pipeline

Version 1 Draft

Waihao Downs Irrigation Limited

Index

1. Overview of Construction 4
   1.1. Introduction 4
   1.2 General 4
   1.3 Major Activities 6
      1.3.1. Earthworks 7
      1.3.2. Concrete Construction 9
      1.4. Sequencing and Duration of Headworks 10
      1.5. Workforce Numbers 11
2. Component Construction 12
   2.1 Intake (Waitaki River below Pub Road) 12
      2.1.1. General 12
      2.1.2. Sequence 12
      2.1.3 Temporary River Control Measures 13
   2.2. Fish Barrier 15
      2.2.1. General 15
      2.2.2. Sequence 15
   2.3. Pump House 16
      2.3.1. General 16
   2.4 Earthworks 16
      2.4.1 General 16
      2.4.2. Construction 16
      2.4.3. Equipment Required 19
      2.4.3. Dust Control 20
      2.4.4. Unsuitable Material 20
   2.5. Flood Management 20
   2.6. Road Crossings 21
      2.6.1. General 21
3. Ancillary Construction Requirements 21
   3.1. General 21
   3.2. Hours of Work 22
   3.3. Site Construction Roading 22
   3.4 Hazardous Materials Handling and Storage 23
      3.4.1 Fuel Storage and distribution 23
   3.5. Traffic to Site 24
   3.6 Public Safety 24
   3.7. Disposal Sites 24
   3.8. Concrete Production 25
   3.9 Armour Rock 25
   3.10 Temporary Site Facilities 25
      3.10.1 Office Staff Amenities 25
      3.10.2 Plant Maintenance Facility 26
   3.11 Temporary Utilities 26
      3.11.1. General 26
      3.11.2. Water Supplies 26

3.11.3 Power 27
3.11.4. Sewerage and Waste Water 27
3.12. Erosion and Sediment Control of Storm water 28
3.13. Dewatering and Groundwater Control 30
3.13.1 General 30
3.14. Lighting 31
3.14.1 Lighting Requirements for Construction 31
4.0 POND OPERATION 32
5.0 AUTOMATION 33
6.0 OPERATION 33

1. Overview of Construction

1.1. Introduction

This document has been prepared for Waihao Downs Limited to outline the methodology that will be used in the construction of the key headwork's components for the Waihao Downs Irrigation Scheme. This irrigation scheme will supply water to 6800 hectares of land on the northern side of the Waitaki River below Black Point.

This scheme involves the abstraction of 3.06 cumecs from the Waitaki River into a pressurised pipe reticulation system.

This document is intended to identify key construction issues that are expected. It will also outline construction activities, sequencing of operations and that the construction works, shall be managed to avoid or minimise any environmental impacts.

1.2 General

This document describes the proposed works for the various components of the WDIL scheme with the following overview

- Construction methods
- Resources required
- Sequence of work
- Duration of construction

The Waihao Downs Irrigation Scheme will generally be constructed in accordance with this overview. It should be noted that this is a "living" document and will be reviewed continually and updated when necessary.

It is possible that during the construction phase, changes to this document may become necessary in order to ensure that the environmental impacts are avoided or mitigated.

The circumstances which will trigger revision (but will not be limited to) are:

- Feedback from stakeholders
- Updated information on site conditions
- Weather and river conditions
- Resource consent requirements
- Refinement of construction methods and detailed design
- Resources required
- Sequence of work
- Duration of construction
- Likely environmental effects / monitoring
- Mitigation measures
- Contingency plan

1.3 Major Activities

The works described comprise the headworks from the intake on the river through to storage ponds. Fig 1 is the general schematic diagram of the headworks and shows the components comprising the headworks. Detailed plans will be provided as a supplementary document prior to commencement of construction.

- The fish barrier is porous rock bank 80 metres long which runs parallel to the river. Water percolates through the rock to the intake structure. The barrier made of rocks excludes fish from entering the intake. This is similar at both of the possible intake location

Intake Option at Morven Glenavy

- The intake is a gated structure which controls flow into the main existing race at the Redcliffs intake site at stonewall.

- The existing main race is a canal which conveys the water through culverts under roads to pumping site.

Intake Option at Waitaki River below Pub Road

- The buffer pond is a shallow storage ponds which are linked. They are buffer areas which are formed by earthen embankments. This adjoins the Waitaki River and is fed through the fish barrier. The pumps for this option are located at the northern edge of the pond.

To complete the headworks, earthworks and construction will be required. The following sections describe these works.

1.3.1. Earthworks

This project involves earthworks. The material types and earthworks processes drive the construction methodology associated with the earthworks.

a) Material Types

There are three main types of material expected to occur at this site:-

- Topsoil may overlay the whole area to a depth of 100-300 mm. This will need to be removed from the project footprint as it is unsuitable as a construction material. Some topsoil will be retained for reinstatement on embankment areas and rehabilitated land.

- Silt may underlie the topsoil. Silt material is unsuitable as a construction material on its own but limited amounts will be utilized for producing a sealing layer in the canals and buffer pond. It will most likely be blended with gravel material for this sealing purpose. Overall we do not see a surplus of silt from the construction process.

- Gravels underlie the silt layer and are the main material to be used for the construction of the embankments, canal section and storage pond. The gravels will contain a range of stones/cobbles within the sandy/gravely base. Some screening may be carried out to win the larger cobbles from the gravel mix before the gravel is used for construction. The larger cobbles will be used as an armouring layer in some areas of the channels and canals. Overall there is a surplus of gravel available from excavations within the scheme. The actual volume of surplus materials will be determined when final design details are completed.

b) Earthworks Processes

Some processing of the excavated material from the borrow areas will be carried out before it is incorporated into the embankment construction. There will be two main processes – ***screening*** and ***blending.***

- Screening will be likely carried out to extract/win the larger cobbles and stones from the gravels. These cobbles will be used for 'armour' layers in areas of the canal where the water velocities or turbulence are higher to prevent any scouring of the channels and embankments. It is expected that the screening plant will be set up in excavated areas on site. The cobble material may be further screened to sort out the larger material (say 300mm up).

  This larger material is used for heavier duty protection applications.

  If concrete is batched on site, then aggregates for concrete production will be produced as a by-product of the screening operation.

- Blending will be carried out to prepare suitably graded material for the lining layer of the canals and ponds to reduce or prevent leakage of water from the system. The lining layer will likely comprise silt mixed with screened gravel. The silt contains much finer silty/sandy particles that combine with the sandy gravels to create a near impervious layer. Further work is required to determine the best composition of the lining layer and the best method to prepare.

- There are two main options for blending: –

i. either set up a blending plant/mill where measured quantities of the each component are (conveyor) fed into a mixing plant,

ii. or else the earthmoving plant can be used to spread out measured layers of the constituent materials and then mix them by a combination of grading in situ, and picking up and laying down the material or blending by "rotary hoeing" laid down selected materials and compacting into an impervious layer e.g Lake Hood.

1.3.2. Concrete Construction

There are several main concrete structures – the control gate, road culverts and pump houses.

For each of these discrete structures, the construction activities are similar and involve initial excavation to the required foundation level. The construction of the structures follows a bottom up approach, with the floors poured first followed by the walls and superstructures.

The formwork and reinforcing steel is set up for each concrete element and the concrete is placed using either concrete pumps or a crane and skip.

Pour sizes are expected to range from $5m^3$ to $20m^3$ on any given day. Concrete will be delivered to the construction area by 5 m^3 capacity agitator/mixing trucks either from a certified existing supplier.

Each structure will be contained within an excavated hole. Any sediment laden water from within these excavations will be directed to sediment detention ponds or containment areas. These sediment detention ponds will be sited and

constructed prior to excavation or we will utilize constructed sections of race which are isolated by bunds.

Mechanical components are typically fitted at a late stage with some final secondary concrete work to complete the construction.

1.4. Sequencing and Duration of Headworks

Preliminary construction planning indicates that, following an assumed site establishment of one month, the total construction time to complete the main works is approximately 12 to 18 months with an additional three months for minor works, testing and commissioning activities.

At this stage, the critical path for the project appears to be pipe line supply and installation rather than structures although it should be noted that timely completion of structures will be driven by the availability of labour resources and materials.

There are several programme constraints and drivers within the project, namely:-

- The pond areas involve extensive earthworks and an unknown amount of lining or blending of materials. On-site analysis and further detailed design will refine these issued with respect to timing.

- In-river works will be undertaken when river conditions are suitable and best.

- Structures and main race excavation must be sequenced so works are not exposed to flooding.

- Surplus material from the main race excavation must be disposed of in suitable areas.

The construction of the fish barrier will be undertaken when suitable river conditions exist along with the in river works.

River protection works will be required around the fish barrier. This means the placement of rock protection works either side of the gallery system. This may require follow up work due to initial damage from freshes or floods until it settles in.

It will be necessary to have construction work underway on several of the civil structures at the same time to meet the project programme. While several aspects of the project are occurring simultaneously the monitoring of environmental effects will be carefully monitored by the project manager and mitigated.

1.5. Workforce Numbers

The estimated peak workforce requirement shown is approximately 20.

The workforce will commute daily to and from the worksite. No specific project accommodation will be developed.

Daily transportation will be provided to bring the majority of workers to the site from a catchment extending from Waimate, Oamaru and Timaru.

2. Component Construction

While earthworks and concrete works are required throughout the headworks project, this section details the construction methodology required for the specific component of the headworks.

2.1 Intake (Waitaki River below Pub Road)

2.1.1. General

The river intake for the scheme comprises a rock fish barrier screened gallery running parallel with the river, a small buffer pond, a pump house set back from the river and above the present ground level.

Construction of the pond will begin early on in the project along construction for the pump house. Because of its proximity to the river, groundwater control will be required to limit the inflows to the fish barrier excavation to manageable quantities that can be pumped. If pumping is required, it will be discharged into soak pits adjoining the area.

2.1.2. Sequence

The construction of the intake area will be undertaken in three stages. The first stage is the construction of the buffer pond; these works will be done without any connection to the river.

The second stage involves the construction of the fish barrier and protection banks. Some works for stage one and stage two can be undertaken at the same time. The river may be temporarily diverted away during this stage.

The third stage involves the connection of the completed buffer pond to the completed fish barrier and the diversion of the river back against the fish barrier.

2.1.3 Temporary River Control Measures

River Diversion Work

Construction of the fish barrier requires that part of the river flow to be diverted away from the bank adjacent to the intake.

The river diversion will be created using ECAN River Engineering advice and consulting help in line with normal diversion practice. If necessary, temporary gravel cofferdams will be constructed immediately around the intake work site. This work will be undertaken when river flows are lowest.

It is inevitable that, during diversion (and during other work in the river), the water downstream from the work will become temporarily discoloured. This discolouration is created by the disturbance of silt particles within the existing river bed materials. Where possible, excavations will not be carried out in running water.

Cofferdams

Temporary cofferdams may be required for protection of the intake site and to divert any residual flow after the temporary river diversion has been constructed.

Construction of the cofferdams will use gravel from the riverbed. Complete dewatering of the works at this stage will not be necessary and some seepage through the cofferdams is anticipated. Downstream coffer dams will serve to contain the discharge of sediment laden water from the site during the excavation activities required to lower the intake channel to riverbed level and lay the armour rock protection.

Construction of cofferdams involves pushing up gravels using a bulldozer or excavator.

If inflows through cofferdams are to be reduced to modest amounts, it may be necessary to place a blanket of low permeability gravel on the river side of the cofferdams.

Flood Risks

As with any works undertaken within the environs of a riverbed, the work site and structures will be at risk from floods while under construction. It is proposed that the river protection be designed and constructed to match the existing stop bank level. Bunds will be left in place between the fish barrier and the buffer pond until the pump house is completed and the control gates are installed.

Construction Equipment

The intake construction will involve the use of traditional construction equipment including; hydraulic excavators, dump trucks, bulldozers, pumps, tracked and mobile cranes.

Concrete will be delivered by road truck to the intake site and either pumped into the structure or lifted in with crane and skip.

Construction materials such as formwork materials, reinforcing steel and steel mechanical components will be delivered to the intake site by road truck.

An electrical supply will be required for the operation of the completed pump house. This supply connection may be installed at the start to provide electricity for the construction works. If this is not achievable, diesel generators will be utilized to provide electrical power for dewatering pumps and other site requirements.

2.2. Fish Barrier

2.2.1. General

The fish barrier is a gallery type barrier which is a bank of sorted rocks over mesh pipe screens. The river side of the rock bank is protected with larger rock to protect against erosion.

Access is available across the top of the barrier for maintenance. The nature of a rock barrier in an active river such as the Waitaki means that the barrier will need to be inspected regularly particularly after significant floods and rock repair is necessary.

Banks will also be constructed up-stream and downstream of the fish barrier to provide protection to the barrier and ensure the barrier is not outflanked. The protection bank may initially be constructed up-stream and down-stream for 50 meters but a zone extending 300 metres either side is allowed for should it be necessary in consultation with Ecan River Engineers.

2.2.2. Sequence

The fish barrier is constructed by excavation of the riverbed, the mesh pipes are installed then the sorted clean stone placed under, around and over the pipes to create the bank. The large rock may be placed on the outside face of the stone bank. The rock is keyed in under the existing bed level.

The diversion and coffer dam will divert most of the water away from the site during construction. Seepage water is unlikely to present any problems during the installation of the fish barrier.

2.3. Pump House

2.3.1. General

The pump house is required to house approximately 10 pumps. This will be a concrete block building constructed alongside the buffer pond.

2.4 Earthworks

2.4.1 General

The canal enlargements and ponds will predominantly involve construction in gravels and are essentially an earthmoving operation of removing material from cut sections or borrow areas and hauling and laying it in compacted embankments.

The canals are not expected to be lined but areas of unsuitable material will be under cut and suitable material substituted.

Buffer ponds may require lining and this will be undertaken with silt, blending and appropriate processing. The pond embankments are homogeneous using the materials excavated from the construction of the ponds. The need for lining will be assessed as construction proceeds and placed as suitable material is found.

2.4.2. Construction

The initial work involves stripping topsoil and other unsuitable material (mainly silt) from within the footprint and forming a return haul road outside the canal or pond.

The formation of embankments will involve placing the gravel based material in layers 300mm-500mm thick. As the silt content is low, the placement is unlikely to be greatly affected by wet weather and there should be few difficulties in continuing excavation and placement through winter. Compaction will be

undertaken on any substantial embankments by heavy vibrating rollers. On these low embankments twin engine scraper may be used to achieve satisfactory compaction.

The following sets out, in broad terms, the construction methodology and sequence envisaged to form each individual canal or buffer pond:-

1. The site of works will be progressively cleared of trees, fences, vegetation, buildings, etc and, if required, a site boundary fence erected. Bulldozers, excavators and trucks will be used to carry out this operation. The waste material will be stockpiled for disposal or destruction. This will be placed away from any river berm area..

2. Topsoil from the site of works and haul road will be progressively stripped and placed in stockpiles, or alternatively, in a row adjacent to the canal section being worked. This will be achieved by using motor scrapers supplemented with tracked bulldozers, excavators and trucks when necessary. It is not considered necessary for topsoil stockpiles to be sown in grass to prevent dust migration as the topsoil will be progressively placed back over the canal and ponds batters when these are completed.

3. Cut to fill and cut to waste activities will then commence. For the canal this involves excavating (cutting) material from the sections in cut. This is done by using scrapers or excavators loading the material onto dump trucks. The dump trucks will haul the material to the fill areas (cut to fill) or to waste site (cut to waste). It is expected that two scrapers will be operating and up to two excavators will load a fleet of up to 4 dump trucks at one time.

4. The pond construction is achieved through a combination of excavation and filling. The excavated material (gravels) from the pond is used for the

construction of the embankment and this is sourced from inside the pond area. The material for the embankments will be selected according to where in the embankment it is to be placed. Suitable material with a good grading including fines will be placed through the centre of the embankment. The courser graded material will be laid along the outside faces of the embankment. Compaction of the embankments with heavy rollers will be carefully monitored by our on site technicians, utilising nuclear densometers to ensure optimum compaction and guarantee our quality management plan is not compromised.

5. The dump trucks and scrapers will tip their payloads of soil either at disposal sites or fill areas. At disposal sites the material will be stockpiled initially and when disposal areas are available, levelled and shaped by bulldozer. At the construction/fill areas the dumped spoil will be spread into a nominal 500mm layer thickness.

6. The canal fills will be built in 500mm nominal layers to the required formation level. Trimming and compaction to the final shape will be undertaken by small excavators, graders and compaction rollers.

   If the pond is to be lined, this may be carried out in conjunction with the cut to fill operations. This will be done using equipment similar to the cut to fill operation described previously but may also involve stabilising equipment to condition the lining material.

7. On completion of the bulk earthworks, the stockpiled topsoil will be re-spread back on to the fill batters using scrapers, trucks and graders. It will then be levelled and grassed down using conventional agricultural equipment.

2.4.3. Equipment Required

The materials to be excavated and placed during canal construction should be readily excavated and placed using conventional earthmoving plant. For the purposes of this methodology the use of scrapers, hydraulic excavators and dump trucks have been assumed. Bulldozers will also be required for levelling and shaping at the placement areas, compactors required for compaction and graders and water carts required for haul road, fill areas maintenance and conditioning of the construction materials.

The current lining concept provides for lining material to be placed on both the pond invert and side slopes using dump trucks or scrapers. Compaction of lining could use static protruding foot compactors and or vibrating rollers. Final shaping of the canal and pond is likely to utilize graders and excavators.

For the purposes of this methodology, the total major plant requirement for canal and pond construction is estimated to be as follows:-

Table 1-1 Summary of Earthmoving Plant Requirements

Plant Type	Number Required
Dozers – Tracked	1
Graders	1
Excavators	2-3
Motor scrapers	1-2
Dump trucks	2
Water Tankers	1
Compactors	1
Loaders	1

It should be noted that as final design plan and construction documents are prepared, this information may need to be revised.

Generally the excavators and loaders listed above will work in two groups with each group including an excavator and a varying number of trucks. The number of trucks with each excavator will depend on the haul distance.

2.4.3. Dust Control

If dust from the construction activities becomes problematic during periods of dry weather, haul roads and other trafficked areas can be kept damp by the application of water from water carts. Water carts will be available for use when required on site for the duration of the construction project.

2.4.4. Unsuitable Material

Along the whole canal footprint it will be necessary to remove the topsoil and underlying silt layer as this is generally unsuitable for embankment construction. Some of this unsuitable material will be retained alongside the canal fill and pond embankments sections to be reused as a top layer on the completed embankments. Surplus top will be spread and grassed down at project completion. Silt will be used for pond sealing.

2.5. Flood Management

It is recognized that in a major flood, water flows from the Waitaki River could flood the area adjoining the river.

The construction of the works must be staged and protected such that in the event of a major flood water is able to continue down its normal flood path.

The link from the fish barrier to the buffer pond will be blocked by a bund until the pumps are installed and the buffer pond completed.

2.6. Road Crossings

2.6.1. General

There are several road crossings within area:-

These crossings will be crossed with pressurised pipelines installed in accordance with the attached irrigation scheme construction guidelines and Waimate District Council requirements.

3. Ancillary Construction Requirements

3.1. General

In addition to the specific construction described above, the following ancillary aspects need also to be considered:

- Hours of work
- Site construction roading
- Hazardous substances – handling and storage
- Traffic to and from Site
- Public Safety
- Borrow and Disposal sites
- Concrete production
- Armour rock
- Temporary site facilities
  - ❖ Offices and laboratories
  - ❖ Staff amenities
  - ❖ Plant maintenance facility
- Temporary Utilities
  - ❖ Water

- ❖ Power
- ❖ Sewerage and wastewater

- Erosion and sediment control
- Dewatering and groundwater control
- Lighting.

3.2. Hours of Work

It is envisaged that the normal construction hours will be a single day shift that will be up to 12 hours – generally based around available daylight hours, up to seven days a week.

There may be a need to extend working hours for specific activities but these occasions will be limited in number unless significant difficulties are experienced with the programme.

In view of the reasonably remote location of the site, it is not expected that there will be any restriction to site working hours.

3.3. Site Construction Roading

Temporary construction roading within the project site area may be required. Access will generally be along the pipe line alignment to allow for the installation of the pipes

The roads will be formed by stripping topsoil and laying down suitable material and, where necessary a gravel trafficking layer. Surface water drainage from the road surface will be run off to a swale on the side of the road. If natural water courses are crossed, temporary culverts will be installed. Neither temporary nor permanent access berms will obstruct the natural river flood paths or act as barriers.

3.4 Hazardous Materials Handling and Storage

The hazardous materials used and stored on the site during construction are typical construction site materials including:-

- Fuel (mainly diesel) and oils
- Hydraulic fluids
- Concrete additives, jointing and formwork compounds
- Paints and paint solvents

Storage facilities and handling procedures will follow accepted construction site practice and will be detailed in the Project Management Plan.

3.4.1 Fuel Storage and distribution

To cater for the mobile plant on the site, a fuel storage facility of up to 40,000 litres will be established on the site.

The daily fuel consumption is estimated to be up to a maximum of 2000 litres per day.

The fuel facility will be established in a central location on the site. The storage tank/s will be located within a bunded area with an impervious compacted silt layer surface. The contractor will maintain a spill kit on site.

Road tankers will fill the storage tank/s from within the bunded area. The storage tank/s will be self contained Puff tanks (double skinned – inner and outer skins) , the bunding is self contained in the tank itself.

Wheeled mobile plant will typically refuel directly from the storage facility. Tracked mobile plant will be refuelled around the construction site from a mobile tanker.

3.5. Traffic to Site

An estimate of traffic to the site has been prepared.

Vehicle Type	Average Daily	Maximum Daily
Light Vehicles	10	20
Heavy Vehicle	10	20

The light vehicles comprise mainly daily staff transportation and work force commuters.

The heavy vehicles include concrete trucks, fuel tankers, construction supplies such as steel and form work, construction plant delivered to site, portable buildings, special equipment loads such as control gates, mesh screens culvert sections and pipes and pumps.

3.6 Public Safety

Public access will be restricted during the construction period.

There will be no public access to the construction sites.

For public safety, measures will be implemented to advise and warn the public and, where necessary, restrict access from the river. This will involve temporary fencing and storage. Where public lands are involved the appropriate consents will be obtained from the appropriate authorities e.g. Traffic Management plans from WDC – Transit.

3.7. Disposal Sites

Gravel material from pond excavation will be used to construct the pond embankments and there will be no surplus gravel to dispose of.

3.8. Concrete Production

All concrete works proposed for this job will either be pre-cast units constructed off-site or constructed in-situ using concrete sourced from pre-mix plants.

3.9 Armour Rock

If large armour rock is required for river protection works. This rock will need to be imported from off site. Ballast Stone for the fish screens may also be imported.

3.10 Temporary Site Facilities

3.10.1 Office Staff Amenities

Site office facilities may be established for project management personnel.
It is envisaged that the offices would be centrally located as part of or adjacent to the major earthworks. There may also be small staff units at specific work areas, in particular the intake area which would be relocated as necessary.

Temporary relocation buildings and caravans may be transported to site for the office and staff.

Staff facilities may be established on site for ablutions amenities or alternatively existing houses may be used. As well as centrally located facilities, small amenities may be established at the larger work areas, in particular the intake area.

Water for ablutions will utilise the existing water scheme on the properties.

Where existing septic tanks are not available to be used, sewerage will be contained in storage tanks or porta-loo utilized for regular removal from site by road tanker.

3.10.2 Plant Maintenance Facility

A designated area will be established for carrying out plant maintenance during the construction phase.

3.11 Temporary Utilities

3.11.1. General

The following utilities may be required at various sites during construction

- Water supplies
- Power supplies
- Telephone lines for phone, fax and computer connections
- Sewage treatment/disposal
- Waste water treatment and disposal

3.11.2. Water Supplies

Water supplies will be required at various locations for staff amenities and construction activities.

The key construction activities that will require water are:-

- Dust control – supply for water carts/tankers
- Concrete placing and formwork maintenance – at each of the civil structures.

Existing water supplies will be utilized if available, mainly for the staff amenities applications.

Where additional supplies are required, mainly for the construction activities, the existing irrigation bore and irrigation network will be used.

In some cases the deep excavations for the civil structures will act as galleries and the groundwater from these excavations will be used for construction activities in the vicinity.

3.11.3 Power

A permanent power supply will need to be installed for the project facilities for operation of gates, lighting and control and telemetry (SCADA) systems. If this supply system is available during the construction phase, it may be used for powering the construction equipment such as processing plant, pumps, air compressors, tools and lighting.

Alternatively, a temporary construction supply may be established for the works or else portable generators will be used at the work sites to supply electricity.

3.11.4. Sewerage and Waste Water

Existing septic tank systems will be used where they are available. For additional capacity and ablution facilities, if necessary storage tanks will be used for holding waste until it can be removed from site by road tanker.

The sewage loading, including grey water, has been estimated at approximately 180 litres per person per day for domestic design. For a construction site this could probably be reduced to 10 litres per person per day.
Note: Sewage and waste water disposal will comply with Council requirements or applications made for resource consent at a later date when requirements, methods and any required discharge points are known more accurately.

3.12. Erosion and Sediment Control of Storm water

Erosion and sediment control will be managed by generally following the guidelines and principles contained in the Erosion and Sediment control Guidelines Environment Canterbury for the soil conditions and runoff expected for a 5% AEP event at the site. Sediment ponds will be built where surface runoff is expected from the construction area.

Land Type

This is flat pastoral land adjoining the Waitaki River. It is intercepted by old river channels. Or gentle rolling hills surrounding the Waihao River

Drainage Patterns

The intake sites adjoins the Rangitata River. The hydrology is dominated by the adjoining river and any surface flow from the site or adjoining farm land is intercepted by the historic old river channels and channelled back to the river. These are all heavily vegetated along the river berm and will be retained at the sites boundary to effectively "scrub" the run off if any.

Erosion and sediment control requirements will be minimised by:

- Cutting off and diverting run off and storm water away from disturbed construction areas.

- Keeping exposed and stripped areas to the minimum possible at any one time.
- Repatriating stripped areas with topsoil and vegetation as soon as construction activity is completed.
- Fostering vegetation around the perimeter of stripped areas to filter runoff
- Utilising silt fences where appropriate.
- Encouraging a vegetation berm around the perimeter of the construction to filter run off if any.

Erosion and Sediment control will be managed by:

- Following the management and design parameters set out in the ECAN guidelines applicable to local site conditions.
- Installing the new storm water culverts in dry no flow conditions prior to earthworks in the vicinity commencing.
- Using topsoil bunds to control and divert storm water away from the works and to sediment detention ponds, or into completed ponding areas or into grassed run off area.
- Restricting diversion channel grades to less that 2% unless armoured.
- Erecting silt fences where runoff cannot be filtered by natural vegetation before entering waterways.
- Containing and detaining sediment laden run off water within the work sites such as borrow areas and canal cuts as far as is practical.
- Construct ponding areas starting from the down stream end so that completed ponds can be utilized as sediment retention ponds for areas constructed above.
- Designing and constructing sediment retention ponds for the treatment of run off water from disturbed areas.

- Designing and constructing sediment detention ponds with floating decants and emergency spillway.
- Sizing the detention pond surface area (m^2) to approximately 1.5 x peak inflow rate (l/s).
- Carrying out regular inspection and maintenance and cleaning the ponds when the sediment volume exceeds 20% of the storage capacity.

3.13. Dewatering and Groundwater Control

3.13.1 General

Some of the structures and pond are expected to be excavated and constructed below the existing groundwater level. Control of groundwater and dewatering is necessary to:

- Allow earthworks to proceed economically and expeditiously (saturated or submerged soils slow production and require more mass per cubic metre to be carted)
- Allow concrete at the base of structures to be poured in the dry and/or in still water conditions.
- Prevent piping or foundation instability in the event fine sands or silts are encountered in the base of the excavation.

Where natural groundwater inflows into excavations are predicted or turn out to be prohibitive, such that pumping needs are excessive or work in the area becomes infeasible, cut off or control measures will be implemented to reduce the water entering the excavations.

Some of the excavations will require dewatering by pumping. The water will be directed to the temporary storm water/sediment control facilities. These facilities will be constructed prior to commencement of that specific excavation.

The canals and ponds are not expected to have significant groundwater inflows during construction. If necessary, temporary sumps will be established within the canal during construction for intercepting any groundwater and storm water that accumulates within the canal. The water would be pumped out into the stormwater/sediment control system.

Bunds would be left in place for most of the construction period to stop any seepage water flowing through the works.

3.14. Lighting

3.14.1 Lighting Requirements for Construction

Lighting on the construction site will be provided at two "levels" as follows.

Background Lighting

Background lighting for the work site provides illumination to enable people and traffic to move safely around the site.

Background lighting is normally sufficient for security purposes however, there may be situations where additional lighting will be required to meet security needs. Security lighting if required will operate continuously at night time.

Local Lighting

Localised lighting provides higher illumination over the actual area where the work is taking place, eg, lighting of an excavation, fill placement on the canal or adjacent to the civil structures, concrete placement

The higher level of illumination required for localized lighting at the work sites can be provided from lights fixed to crane booms and/or towers (of varying heights) and lights attached to completed sections of structures or formwork.

It is expected that there will only be very limited need for night work. If it is required, it is most likely to relate to the civil structures and the need to complete a large concrete pour.

Some lighting may be required on the site in the winter months at the start and end of each day.

4.0 POND OPERATION

The Pond will be linked to river via the fish barrier and the piped reticulation will be pumped with an automated pumping system based at the northern edge of the pond.
There are basically operation modes for the pond.

- Pond filling
- Operation while river inflows are available
- Operation from storage.

The scheme will only take water as determined by the resource consent condition.

The telemetry which controls the river intake can be linked to the ECAN Waitaki site so that the abstraction starts and stops in compliance with the consent.

5.0 AUTOMATION

The discharge gate if the MGIIS option is used will be telemetered and automated so that the gates and pumps will deliver the selected flow as river level or demand changes.

This can be done with a PLC (programmable logic controller) linked to down-stream water recorders and a rated site or a PLC linked to in-pipe flow meters.

With the alternative supply option at the Waitaki River below Pub Road the pumps will be automated to meet irrigation demand, consent conditions and telemetered to allow remote monitoring and control.

6.0 OPERATION

While much of the system will be automated it is expected that one race men will be employed.

Amongst their functions will be:-

- Operation of pressurised pipeline system
- Inspection and maintenance.

The racemen will regularly inspect the fish barrier and all structures. They will particularly ensure that the fish barrier is rigorously maintained. The race men will ensure the rock protection is sound and does not act as a barrier or obstruction in the channel. The flow must also be maintained along and past the fish barrier to ensure the sweep velocities are maintained. River works will comply with consent conditions. Furthermore; excess river borne gravel must not be left as barriers in the river channel.

Appendix – Specification for Irrigation Race Construction and Pipelines