GEO-LOGIC
LIMITED

Nelson Consulting Engineers Ltd
CIVIL - GEOTECHNICAL - STRUCTURAL

G7037

BC 080967

Specification
100, 000 m³ Irrigation Dam
Upton Downs Road, SEDDON

Client: Upton Downs Joint Venture
Contractor:

Content

1 Preliminary & General

1.1 Brief Description and Location of Works

A 100,000 m³ water storage facility is to be constructed to provide for irrigation. It will be filled with water pumped from the Awatere River together with any natural catchment flows. The reservoir site is on old river terraces above the deeply incised Upton Brook.

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1.2 Extent of Work

The work includes the stripping of topsoil from the footprint of the dam, spillway and borrow areas, bulk cut and fill with on site materials, supply and placement of selected gravel for a filter zone, construction of the spillway and outlet pipe, bank protection, topsoil and re-grassing.

1.3 Standard of Construction

The work shall comply with all relevant standards, such other Acts and Regulations in force and in all other respects the best trade practices shall prevail.

- NZS 4402 Methods of testing soils for civil engineering purposes
- NZS 4431 Code of practice for earth fill for residential development
- Marlborough District Council Engineering Standards & Policies

The above standards form part of this specification. In particular, NZS 4431 has specific requirements for construction and testing of fills.

The Inspection Engineer shall be engaged and undertake the duties of NZS 4431. For this project the Inspection Engineer shall be Nelson Consulting Engineers Ltd or a representative thereof.

1.4 Drawings

The drawings referenced in this specification are job number 07186 Sheets 00 to 09 dated 13 March 2008 Revision B.

1.5 Location and Setting Out

The location of the new embankment, drains and spillway is shown on the drawings in relation to property boundary pegs and existing features.

The exact positioning of the dam and spillway will be confirmed by the Engineer on site. Levels shown on the plans are in terms of Geodetic datum 1949, Marlborough circuit.

It shall be the responsibility of the Contractor to safeguard all pegs and markers, and any repetition of this work due to the Contractor's failure to safeguard them will be charged directly to the Contractor and deducted from the contract payments.

Levels shown on the plans are in terms of an assumed datum. The Contractor will be provided with at least two levels on survey marks adjacent to the working area. Any additional survey setout is the Contractor's responsibility.

1.6 Site Meetings

Regular site meetings will be held weekly at a mutually agreed time. The Engineer or their representative will take and distribute minutes. The Principal will be free to attend these meetings and contribute to the discussions.

1.7 Notification to the Engineer

Apart from regular site visits the Engineer must be notified at the following stages for inspection. Work is not to proceed until the Engineer has so authorized in writing, and to avoid delays the Contractor is advised to give adequate notice of times when work is ready for inspection.

Note that work is not to proceed to the next step without the specific written approval of the Engineer.

1. prior to Commencement of all work.
2. After stripping of the dam site and borrow areas.
3. After excavation for the clay core / cut-off trench but prior to placement of any earth fill.
4. At the beginning of placement of fill when compaction trials are being carried out and at the completion of every 1.0 metre of bank height.
5. At the start of chimney drain construction.
6. After laying and before backfilling of any underground service.
7. When the Contractor considers all contract work is completed. Before so advising, they must check all work including berms, pipework, etc.
8. At the end of the Defects Liability period after again checking all work and carrying out any necessary maintenance work.

At the end of the Defects Liability period, after being advised by the Contractor that all work is complete, the Engineer will inspect the work and list any work that is considered to require attention. If more than one subsequent inspection is required, then final costs of these further inspections will be deducted from the final payment.

In all cases the Contractor must plan his work and give reasonable notice to the Engineer. The Engineer will attend to these inspections as quickly as possible but may not always be available at short notice and will not be responsible for delays resulting from inadequate notice. Where detailed checking is required the Contractor shall allow time in their programme accordingly.

1.8 Responsibility

The Contractor is responsible for the set out and construction of earthworks cuts and fills, to the requirements herein to ensure compliance with NZS 4431, plans, specification and testing requirements.

The Principal shall engage a qualified independent third party Testing Agency for the purpose of undertaking material sampling, field and laboratory testing for the project. The Contractor shall liaise directly with the Agency when testing is required and assure copies of all test results are submitted to the Inspection Engineer promptly.

1.9 Methodology and Construction Programme

The Contractor shall provide a methodology statement with their tender, including a general description of previous experience and of work methods and equipment proposed to be used to complete the contract works to the required standard and time frame.

The Contractor shall also provide a programme for the works within one week of tender acceptance and update their programme as necessary during the contract period.

The contractor shall submit a testing programme to carry out sampling and testing of in situ material from which fill is to be obtained and for the control of compacted earth fill. This programme is subject to the approval of the Inspection Engineer.

1.10 Surplus Material

Excess strip material, unsuitable fill material and excess topsoil are to be disposed of on site as fill as directed by the Principal no further than 3km round trip from the dam site. It is intended that these fill areas be track rolled topsoiled and grassed on completion.

1.11 Local Body Acceptance of Works

The Contractor is to carry out all testing and work necessary to comply with Local Authority requirements.

1.12 Site

Disturbance to the general area is to be kept to a minimum. At the end of the contract the Contractor shall remove all their unused materials, rubbish, debris or other material resulting from the construction activities. Fill and excavations shall be tidied and left in a neat workmanlike manner all to the satisfaction of the Engineer.

Any damaged areas of public or private property shall be reinstated to at least their original condition.

Note that the Contractor is not responsible for any fence removal or re-fencing in the area of the works, and that the location of any dump sites or stockpile areas is/are to be agreed with the Principal.

1.13 Dust

The Contractor shall manage their operation to minimise the generation of dust. Where necessary a water cart shall be used to prevent dust blowing from the construction area.

1.14 Producer Statements

Upon completion of the works the Contractor shall provide a *Producer Statement – Construction.* A copy of the form of this is attached.

1.15 Consents

Resource Consent U080119 has been granted for the construction of the dam. The Contractor shall comply with all relevant conditions thereof, especially in relation to the avoidance of sediment movement into waterways.

Building consent has been applied for. Construction of the dam cannot commence on site before all Council approvals have been confirmed. The Contractor will be provided with the site copy of the Building Consent for their reference and compliance therewith.

Council require five working days notice of the commencement of construction and it is the responsibility of the Contractor to give this notice.

1.16 Establishment

Site establishment and ongoing contract work shall, as much as is practical, not interfere with vineyard/farm operations.

1.17 Services of Notices

The Engineer's minutes, site inspection notes and contract instructions will be distributed by electronic mail unless otherwise arranged.

1.18 Progress Claims

Monthly progress claims shall be in the form of the Schedule and be cumulative of work completed to date plus variations. Any work instructed as or considered by the Contractor to be variation shall be claimed at the end of the month in which the work was carried out.

1.19 Public Relations

The Contractor is to ensure that good public relations are maintained with adjacent landowners and residents and the general public, and ensure that their particular requirements are catered for.

1.20 Care of Works

The care of works shall be the responsibility of the Contractor. The Contractor shall be responsible for all damage including damage due to weather, careless or incomplete workmanship and handling, or defective materials from the date of commencement until the end of the period of maintenance.

Disturbance to private land is to be kept to a minimum and restored as soon as possible to the same conditions that it was prior to the works commencing. This includes but is not confined to fences, vegetation, etc.

The Contractor shall maintain the site and access in a neat and orderly condition throughout the construction period and shall not allow any area to become littered with rubbish and waste material. They shall remove temporary facilities as soon as they become redundant and remove rubbish of all kinds from any area which he has occupied and leave it in a neat, clean and tidy condition.

If the Engineer considers that the site is untidy a notice will be issued to the Contractor. If, after two days, the offending material is not tidied, removed or made safe, then the Engineer will arrange for this to be done. The cost of such work will be deducted from the following progress payment.

1.21 Artefacts, Historical, Cultural or Archaeological Sites

If any Artefact, Historical, Cultural or Archaeological sites are uncovered during operations, work shall cease immediately and the Contractor shall advise the relevant Iwi or Department of Conservation office and the Engineer.

1.22 Weather

If the Contractor must leave the site due to weather conditions they must advise the Engineer immediately. Any extension of time claims should state the time lost and the total accumulated claim.

1.23 Health and Safety

The Contractor is to meet all requirements of the Health and Safety in Employment Act and confirm the existence of a current Public Health and Safety Management Plan with their tender. The successful tenderer shall provide the Engineer and the Principal with a full copy of their Plan prior to work beginning on site.

1.24 Emergencies

The Contractor shall be contactable on a 24 hour a day, 7 day a week basis in case of any emergency at the construction site. The Contractor shall also maintain suitable equipment on site at all times to deal with emergencies.

2 Earthworks

2.1 Extent of Work

The earth fill dam is to be constructed to a maximum height of approximately 9.5 metres above existing ground level. This section covers the requirements for excavation, earth filling and drainage.

2.2 Drawings

Common to all sections of the work, the drawings shall be read in conjunction with the specification. Any contradictions shall be immediately brought to the attention of the Engineer.

While the test pit investigation carried out gives a good indication of the ground conditions likely to be encountered, the Contractor must satisfy themselves as to their knowledge of the site. The Engineer accepts no responsibility for the occurrence of differing soils where they have not been specifically investigated.

2.3 Control of Water, Drainage and Sediment

During construction, all areas of current filling operations shall be kept free from ponding water. Surface water shall be kept from flowing from the surrounding ground onto the excavations or areas of fill by drains, soakage areas or sediment ponds.

The Contractor shall ensure that there is adequate drainage at all times. Temporary side cross drains and/or soakage areas shall be provided as necessary and the excavation shall always be cambered and any loose material compacted to prevent absorption and to

facilitate surface drainage. Particular care shall be taken to ensure that surface water does not adversely affect fill material that has yet to be compacted as well as adjacent properties.

Sediment Control measures, meeting the guidelines of the ARC Erosion & Sediment Control – Guidelines for Land Disturbing Activities in the Auckland Region (TP90), shall be maintained in a functioning state and checked at the end of each working day as required.

2.4 Preparation of Site

Areas to be cut or filled shall be stripped of all unsuitable material to the satisfaction of the Inspecting Engineer. Unsuitable material includes vegetative matter including stumps and roots, debris, rubbish, topsoil and all other matter whose properties render them unsuitable for foundation materials.

Topsoil shall be stockpiled, for reuse after completion of excavation and filling.

Other unsuitable materials shall be disposed of off-site or to an approved stockpile area.

2.5 Materials

Construction of the dam requires careful selection and placement of materials to achieve an efficient and effective water retaining structure. The Contractor is encouraged and expected to keep in close contact with the Engineer.

2.6 Bulk Fill

Assumed properties of bulk fill material are based on limited testing, and natural variation is likely. Approved samples (2 m^3 minimum) of bulk fill material are to be kept covered adjacent to the borrow area to permit simple visual comparison with excavated soil. Any suspect material shall be rejected or referred to the Engineer for a decision as to its usefulness.

All gravels greater than 125mm shall be removed from fill material prior to transportation to the compaction site.

2.6.1 Alluvial Gravel (Fill Material 2)

The bulk fill material for the embankment shoulders is **silty clayey GRAVEL alluvium**, to be sourced from borrow areas located within the vicinity of the dam site.

An optimum moisture content of 10% and maximum dry density of 1,980kg/m^3 were obtained from samples tested with gravel clasts larger than 19mm removed.

2.6.2 Clay Colluvium (Fill Material 1)

The bulk fill material for the embankment core is **silty CLAY colluvium**, to be sourced from borrow areas located within the vicinity of the dam site.

Optimum moisture contents of approximately 14% and maximum dry densities of 1,830kg/m^3 were obtained from samples tested with gravel clasts larger than 19mm removed.

2.6.3 Other Materials

Papa siltstone materials will be excavated from the embankment site. These materials shall be referred to the Engineer as to whether they are suitable for placement in the outer areas of the dam or to be cut to waste.

2.7 Filter Material

The purpose of the filter zone, consisting of a chimney drain, to be constructed within the cut off trench and downstream (outer) shoulder of the dam is to protect the core material from piping and to assist the control of seepage and the overall stability of the structure.

The Contractor shall supply a sample of the proposed materials to the Engineer for approval prior to work beginning on site. An approved sample (2 m^3 minimum) of each filter material is to be kept covered adjacent to the dam site to permit simple visual comparison with supplied material as it comes to site.

2.7.1 Embankment Filter Material (Fill Material 3)

This 'higher specification' material is required where the risks associated with failure are higher, for example in the raised embankment, and adjacent to the Upton Creek ravine.

The design grading is as follows:

	Fine (minimum) values	Coarse (maximum) values
D_{100} =		50 mm
D_{90} =	6.0 mm	19 mm
D_{60} =	1.0 mm	4.75 mm
D_{15} =	0.2 mm	0.6 mm
D_5 =	0.063mm	

The individual gradation curve for filter material supplied shall have a uniformity co-efficient, D_{60}/D_{10} between 4 and 20.

If the filter material is to be manufactured by the mixing of screened fine gravel and sand then it becomes of utmost importance that consistency of the materials and mixing process be maintained throughout.

In general terms, the more parallel the grading curves are to that of the base soil the better. Pit run gravel would normally contain too high a proportion of fines; something similar to a concrete aggregate would be more suitable.

2.8 Riprap (Fill Material 4)

The riprap protection has been designed on the assumption that rounded stone is used. However, if the Contractor has a source of broken stone of similar grading and unit cost then they should present an alternative with their tender as the layer thickness may be reduced with the use of broken stone with potential cost savings.

There is some flexibility in the permissible grading for the riprap. In general, the acceptable gradation is a well graded durable gravel with stone size ranging from 75 to 200 mm and a median size of 150 mm.

The Contractor shall supply a sample of the proposed material to the Engineer for approval prior to work beginning on site. An approved sample (2 m^3 minimum) is to be kept covered adjacent to the dam site to permit simple visual comparison with supplied material as it comes to site.

2.9 Construction

2.9.1 Excavation and Foundation Preparation

The stripped footprint shall be shaped to eliminate sharp changes in grade i.e. to provide smooth contoured shapes for filling, to the satisfaction of the Engineer. The Contractor shall take care to avoid over stripping beyond that necessary for dam construction.

Any area over stripped or likewise damaged shall be reinstated by the Contractor at their cost.

The preservation of natural soil cover over the sides of the old terraces is important and no cutting of banks for haul roads or other reasons outside of the nominated borrow area may occur.

The cut off trench is to be excavated into the underlying siltstone as shown on the drawings. Prior to first placement of fill, the excavated profile shall be cleaned to remove loose soil and ponded water to the satisfaction of the Engineer, followed by scarification and dampening down.

Prior to filling the subgrade shall be proof-rolled with a smooth drum roller to the approval of the Inspection Engineer and witnessed on site. It is expected to take 4 to 8 passes depending on the equipment used. Soft spots with an area greater than 1.0m^2 shall be undercut further as required by the Inspection Engineer.

2.9.2 Borrow Areas

The Contractor is encouraged to keep in contact with the Engineer with regard to the suitability of borrow materials.

Permenant cut batters shall be no steeper than 1V:2.5H and blend in with surrounding slopes. Care shall also be taken not to undermine any existing features in the proximity of the borrow areas.

2.9.3 Bulk Fill

(a) Placement

Prior to placing fill, surfaces that are too dry or wet of optimum shall be scarified and conditioned by wetting or drying before placing the next layer.

The fill shall be placed in complete uniform layers of 150 mm maximum compacted thickness, laid parallel to the centreline of the embankment wherever possible.

The working surface and finished crest shall have 5% cross fall to permit the drainage of stormwater. It is expected that the Contractor will slightly overbuild the embankments and trim to the finished profiles to ensure adequate compaction throughout.

Particular care and attention to the placement of the clay colluvium fill is required. The colluvium is considered to be moderately-dispersive. This material shall be placed with a moisture content within -2% (dry) to +2% (wet) of the optimum moisture content.

It is anticipated that the in-situ moisture contents will be slightly below the lower end of this range and the Contractor will need to be aware that wetting and mixing will be required.

The watering and mixing operation should occur at the borrow area away from the confined spaces of the dam construction. The achievement of a uniform mixture within the stated moisture content range is very important and the Contractor's strict compliance with this is expected.

(b) Compaction

The fill operation shall be strictly in accordance with NZS 4431:1989. The bulk fill shall be compacted to achieve a density of at least 98% of New Zealand Standard Compaction (as defined by NZS 4402:1986) and a maximum of 5% air voids. Each area laid as a single operation shall be reasonably uniform in density and moisture content.

Transition slopes between fill layers compacted at different times shall be no greater than 1V:4H.

The Engineer will exercise strict controls to ensure compliance with the fill specification and the Contractor is expected to keep in close contact with the Engineer during construction.

Compaction of bulk fill shall be carried out by a sheep foot roller of minimum weight of 3 tonnes per metre length of drum with feet projecting at least 150 mm from the surface of each drum. Spaces between feet shall be kept clear of material build-up. Details of the roller proposed to be used shall be supplied to the Engineer for approval prior to the start of construction.

The spread material shall be trimmed with a bulldozer or grader prior to rolling so the roller does not bridge over low areas. Light scarification of the surface of the compacted layers shall be carried out prior to the placement of the next layer if

deemed necessary by the Engineer. Areas which have dried out shall be scarified and watered prior to the next placement of fill.

The Engineer shall be present at the start of the bulk fill operation to supervise the carrying out of a test layer to confirm the layer thickness and number of passes required to achieve suitable compaction. This trial may be best carried out at the borrow area.

Signs that the fill material is being placed too dry are incomplete penetration of the roller pads into the fill and obvious layering of the fill when it is trimmed back for compaction testing.

If excessive heaving or weaving of the fill is observed, it shall be removed and replaced or ripped to allow drying to the specified moisture content prior to re-compaction.

2.9.4 Filter Zone

The filter material shall be laid in 250 mm compacted thickness uniform layers and firmly compacted with a smooth surface vibrating compaction equipment. It is of utmost importance that this material remains uncontaminated by adjacent materials.

The Contractor shall minimise the dumping of gravel in piles at the dam site to reduce the chance of segregation during spreading out for compaction. Segregation is defined as occurring in areas of the fill where fines do not fill the gaps between particles gravel sized and larger. Segregation of the gravel is unacceptable and where it occurs, all segregated material shall be removed and replaced.

2.9.5 Riprap

The riprap material shall be placed by mechanical excavator as batter filling or excavation, as appropriate, proceeds. Riprap shall not be dumped from the top of the crest.

2.10 Tolerances

Materials shall be placed to the following tolerances.

(a) The overall slopes, i.e. a line from the top of the base of the fill, shall be no steeper than the grades shown on the drawings.

(b) The finished crest levels shall not be less than those shown on the drawings.

(c) Humps and hollows should not exceed 100 mm deviation from the average slopes.

2.11 Quality Control Testing

Quality Control will be generally based on the Contractor's approved testing programme, but subject to additional testing which may be required by the Engineer.

Compaction control will be carried out using a nuclear densometer. In-situ density, and air voids tests will be performed as a means of acceptance of the fill.

Any areas of material that test unsuccessful shall, on the Engineer's direction be excavated (if required) and re-compacted and or wetted or dried. Any surfaces passed by

the Engineer which then incur damage from weather or any other cause may be subsequently rejected and require reworking at the Contractor's expense.

While not an absolute requirement, it would be seen as an advantage for the Contractor to have their own testing equipment and qualified staff to monitor the fill operation between the Engineer's inspections. The Contractor will also be expected to provide the Engineer with copies of the results of testing.

2.12 Revegetation

As soon as possible following completion, borrow areas, the crest and downstream face of the dam and the base of the inlet and outlet channels shall be topsoiled (150 mm thick).

Topsoil shall not be handled or worked when plastic (mouldable), unless directed by the Engineer. Where it is necessary to place the topsoil when plastic, the soil shall be loosely deposited across the site, and then allowed to dry before being worked. All traffic shall be kept off the topsoil when plastic.

Unless otherwise instructed, the Contractor shall use the stockpiled material removed during site preparation. Should there be a shortage of stockpiled materials the Contractor shall obtain the approval of the Engineer for the importation of topsoil from sources external to the Site. Such imported topsoil shall be clean friable soil, free from excessive amounts of sand, gravel and stones, and shall be capable of supporting the vegetation specified.

For the placement of topsoil, the Contractor shall use low ground pressure equipment such as tracked vehicles, in preference to wheeled vehicles. Prior to commencing this, the Contractor shall disc-cultivate the prepared subgrade to a minimum depth of 100 mm, and shall be harrowed and/or screed to form surfaces to line and level. These surfaces shall be left in a loose condition until ready to accept the re-spread topsoil.

Spreading shall not be done when the ground or the topsoil is excessively wet or otherwise in a condition detrimental to the work.

All topsoil shall be smoothed with a chain harrow towed by a light tractor or similar to eliminate all minor depressions and wheel marks and to produce a smooth evenly graded open textured surface.

Grass Seed Mix: The Contractor shall submit to the Engineer for approval his proposed seed mixture and fertiliser type and respective application rates prior to the commencement of the grassing.

2.13 Traffic on Earthworks

Traffic on the earthworks shall be controlled to prevent contamination of and damage to critical zones. As much as possible, construction traffic on the different zones shall be limited to operations necessary to place and compact the particular materials. Any material contaminated or disturbed by construction activities shall be removed and replaced prior to placing the next lift.

Particular care shall be taken not to contaminate the filter material while it is being laid.

The movement of all construction vehicles and other traffic shall be evenly distributed over the full width of the filling area, so as not to damage or overstress the construction.

2.14 Weather

The construction surface shall be sloped to drain storm water and prevent ponding.

Fill shall not be placed on frozen ground or when conditions are near freezing.

Any compacted material made unsatisfactory due to climatic conditions, shall be replaced and re-compacted.

Project costs vary depending on the following:

1. Complexity of the project
2. Project quantity
3. How many changes
4. Animation / walkthroughs (costing depends heavily on the duration of the animation and content.)

For a simple house:-

- Final rendering or montage. From $800-$1100 (*for the first A3 format hard copy)*
  For second view from alternative angle +$50.00

For complicate house or very nice rendering:-

- Final rendering or montage. From $1100-$1700 (*for the first A3 format hard copy)*
  For second view from alternative angle +$50.00

For apartment rendering:-

- Final rendering or montage. From $1200-$2000 (*for the first A3 format hard copy)*
  For second view from alternative angle +$50.00

For commercial rendering:-

- Final rendering or montage. From $1300-$2500 (for the first A3 format hard copy)
  For second view from alternative angle +$50.00
- *For a wire frame model:-35-50% of final rendered price*
- For a simple rendered image 50-70% of final rendered price

For Animations / Walk throughs:-

A great marketing tool for developers and architects.again there are many factors that need to taken into consideration and therefore very difficult to quotes for. We would need a design brief and possibly setup a meeting to discuss exactly what you need.

MARLBOROUGH
DISTRICT COUNCIL

ISO 9001:2000
Form Ref CI 711

RESOURCE MANAGEMENT ACT 1991

Decision on Application for Resource Consent

RESOURCE CONSENT No: U080119

APPLICANT: Upton Downs Joint Venture

This document contains a record of decision(s) on the following application for resource consent(s):

LAND USE (DAM)
WATER PERMIT (DAM WATER)
LAND USE (LAND DISTURBANCE)

DECISION DATE:

2 April 2008

MARLBOROUGH DISTRICT COUNCIL
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RESOURCE CONSENT DECISION

Decision No: U080119

Applicant: Upton Downs Joint Venture

Location of Activity: Upton Downs Road, Awatere Valley

Legal Description: Lot 1 DP 11023

Grid Reference:

Easting	2585863
Northing	5940037

Land Use (Dam)

Pursuant to the Resource Management Act 1991 a resource consent has been GRANTED:

- To construct a 8 metre high dam and to dam up to 100,000m³ of water on Lot 1 DP 11023.

This resource consent is subject to compliance with the following conditions:

01 The activity shall be in general accordance with resource consent application prepared by Abel Properties Limited and scheme plans (Ref: Job No. 07186, Dated 07 February 2008, prepared by Nelson Consulting Engineers Limited, Sheets 1-3) received by Council on 12 February 2008, and held on Council file U080119.

02 If any historical, cultural or archaeological material (including any artefact) of Maori origin or likely to have significance to Maori, or of heritage or scientific value is found or uncovered during the performance of work authorised by this consent, the following will be complied with:

Works shall cease immediately.

Advice of the discovery shall be given, as soon as possible to the New Zealand Historic Places Trust, Te Runanga O Kaikoura and the Marlborough District Council.

No work shall commence within 100 metres of the discovery, until 72 hours after advice has been given to the above parties or agreement reached between the parties, regarding appropriate protection measures, whichever sooner.

03 Inspection and monitoring by Council in respect of the conditions of this consent may take place as set out below:

At the commencement of the operation.
At intervals following the commencement.
At the completion of the operation.

The consent holder will be required to pay the administrative charges incurred in respect of such inspections, monitoring and travel. The charges will be in accordance with the schedule of sees as approved by Council from time to time in terms of section 36 of the Resource Management Act 1991.

04 The consent holder shall ensure that erosion control measures are in place throughout the exercise of this consent and that all practical measures are taken to prevent contamination of natural runoff by suspended solids during construction. This shall include the appropriate use of sediment traps, silt nets and settling ponds.

05 All disturbed slopes, not to be inundated with water, shall be re-vegetated within 6 months of completion of the dam and shall be maintained to minimise dust and prevent erosion.

06 The dam shall be maintained so as not to cause any erosion or inundation on any other persons, company or organisation's property (i.e. property not owned by the applicant).

07 The dam and associated structures shall be designed, constructed, operated and maintained for the life of the dam in accordance with NZSOLD Dam Safety Guidelines November 2000 for low potential impact dams. The works shall be designed by a registered engineer/chartered professional engineer who shall lodge a professional opinion with Council prior to the commencement of the construction stating that the designer has experience in the design of low potential impact dams (as defined in the NZSOLD Guidelines) and that the design is consistent with accepted professional practice. Following completion of the dam and prior to filling the Designer shall confirm in writing that the construction has been in accordance with the design.

08 The consent holder shall comply with the quality assurance requirements applying to low potential impact dams set out in section C.3 of the NZSOLD Dam Safety Guidelines November 2000, during construction of the dam.

09 Dam safety inspections (Routine, Intermediate, Comprehensive, Special and Emergency) shall be carried out in accordance with the method and frequencies specified in the NZSOLD Dam Safety Guidelines November 2000 for low potential impact dams and also in accordance with the NZSOLD Guidelines on Inspecting Large Dams. The results of an annual Intermediate or any Special or Emergency inspections shall be submitted to the Council as soon as practical following completion of the inspection.

REASONS FOR DECISION

The effects of constructing a 8.0 metre high dam will be no more than minor given the dam will be designed and constructed in accordance with the New Zealand Society of Large Dams Dam Safety Guidelines.

Sediment control measures will ensure that little or no sediment gets into any waterway.

OTHER MATTERS

1. Unless otherwise specified, this is the full text of the decision.

Lapse Date

2. If no lapse date is specified in the conditions of this consent, the consent will lapse 5 years after the decision date, unless the consent has been actioned (given effect to).

The lapse date is subject to the provisions of section 125 of the Resource Management Act 1991.

Initial

Appeal Information

3. If intending to appeal this decision, the appeal must be lodged with the Environment Court within 15 working days of the receipt of this decision.

Authorised under the Marlborough District Council's Instrument of Delegation by:

.....

Marlborough District Council Commissioner/Delegated Officer

Dated this 2nd **day of** APRIL **2008**

RESOURCE CONSENT DECISION

Decision No:	U080119
Applicant:	Upton Downs Joint Venture
Location of Activity:	Upton Downs Road, Awatere Valley
Legal Description:	Lot 1 DP 11023
Grid Reference:	
Easting	2585894
Northing	5939988

Water Permit (Dam Water)

Pursuant to the Resource Management Act 1991 a resource consent has been GRANTED:

- To dam up to 100,000m³ of water on Lot 1 DP 11023.

This resource consent is subject to compliance with the following conditions:

01 This consent shall expire on 31 March 2043.

02 The activity shall be in general accordance with resource consent application prepared by Abel Properties Limited and scheme plans (Ref: Job No. 07186, Dated 07 February 2008, prepared by Nelson Consulting Engineers Limited, Sheets 1-3) received by Council on 12 February 2008, and held on Council file U080119.

03 The dam shall be maintained so as not to cause any erosion or inundation on any other persons, company or organisation's property (i.e. property not owned by the applicant).

04 The dam and associated structures shall be designed, constructed, operated and maintained for the life of the dam in accordance with NZSOLD Dam Safety Guidelines November 2000 for low potential impact dams. The works shall be designed by a registered engineer/chartered professional engineer who shall lodge a professional opinion with Council prior to the commencement of the construction stating that the designer has experience in the design of low potential impact dams (as defined in the NZSOLD Guidelines) and that the design is consistent with accepted professional practice. Following completion of the dam and prior to filling the designer shall confirm in writing that the construction has been in accordance with the design.

05 The consent holder shall comply with the quality assurance requirements applying to low potential impact dams set out in section C.3 of the NZSOLD Dam Safety Guidelines November 2000, during construction of the dam.

Initial

06 Dam safety inspections (Routine, Intermediate, Comprehensive, Special and Emergency) shall be carried out in accordance with the method and frequencies specified in the NZSOLD Dam Safety Guidelines November 2000 for low potential impact dams and also in accordance with the NZSOLD Guidelines on Inspecting Large Dams. The results of an annual Intermediate or any Special or Emergency inspections shall be submitted to the Council as soon as practical following completion of the inspection.

07 During filling of the reservoir and thereafter for the duration of this consent, the consent holder shall monitor the shoreline for ground subsidence or erosion, and should any subsidence or erosion occur, implement such measures to remedy or prevent further subsidence and erosion.

REASONS FOR DECISION

The effects of filling an 8.0 metre high dam will be no more than minor given the dam will be designed and constructed in accordance with the New Zealand Society of Large Dams Dam Safety Guidelines.

Sediment control measures will ensure that little or no sediment gets into any waterway and maintenance and monitoring regimes will ensure that the dam water will not have adverse effects on the environment.

OTHER MATTERS

1. Unless otherwise specified, this is the full text of the decision.

Lapse Date

2. If no lapse date is specified in the conditions of this consent, the consent will lapse 5 years after the decision date, unless the consent has been actioned (given effect to).

   The lapse date is subject to the provisions of section 125 of the Resource Management Act 1991.

Appeal Information

3. If intending to appeal this decision, the appeal must be lodged with the Environment Court within 15 working days of the receipt of this decision.

Authorised under the Marlborough District Council's Instrument of Delegation by:

.....

Marlborough District Council Commissioner/Delegated Officer

Dated this 2ND **day of** APRIL **2008**

RESOURCE CONSENT DECISION

Decision No: U080119

Applicant: Upton Downs Joint Venture

Location of Activity: Upton Downs Road, Awatere Valley

Legal Description: Lot 1 DP 11023

Grid Reference:

Easting	2585860
Northing	5940037

Land Use (Land Disturbance)

Pursuant to the Resource Management Act 1991 a resource consent has been GRANTED:

- To construct a 8 metre high dam on Lot 1 DP 11023.

This resource consent is subject to compliance with the following conditions:

01 The activity shall be in general accordance with resource consent application prepared by Abel Properties Limited and scheme plans (Ref: Job No. 07186, Dated 07 February 2008, prepared by Nelson Consulting Engineers Limited, Sheets 1-3) received by Council on 12 February 2008, and held on Council file U080119.

02 If any historical, cultural or archaeological material (including any artefact) of Maori origin or likely to have significance to Maori, or of heritage or scientific value is found or uncovered during the performance of work authorised by this consent, the following will be complied with:

Works shall cease immediately.

Advice of the discovery shall be given, as soon as possible to the New Zealand Historic Places Trust, Te Runanga O Kaikoura and the Marlborough District Council.

No work shall commence within 100 metres of the discovery, until 72 hours after advice has been given to the above parties or agreement reached between the parties, regarding appropriate protection measures, whichever sooner.

REASONS FOR DECISION

The effects of constructing a 8.0 metre high dam will be no more than minor given the dam will be designed and constructed in accordance with the New Zealand Society of Large Dams Dam Safety Guidelines.

Sediment control measures will ensure that little or no sediment gets into any waterway.

Initial

OTHER MATTERS

1. Unless otherwise specified, this is the full text of the decision.

Lapse Date

2. If no lapse date is specified in the conditions of this consent, the consent will lapse 5 years after the decision date, unless the consent has been actioned (given effect to).

   The lapse date is subject to the provisions of section 125 of the Resource Management Act 1991.

Appeal Information

3. If intending to appeal this decision, the appeal must be lodged with the Environment Court within 15 working days of the receipt of this decision.

Authorised under the Marlborough District Council's Instrument of Delegation by:

.....

Marlborough District Council Commissioner/Delegated Officer

Dated this 2ND **day of** APRIL **2008**

IMPORTANT NOTES

Transfer of Ownership

01 A reminder to the applicant, that in the event of relinquishing the water permit to a new owner, notification of the transfer must be lodged with the Council on the appropriate forms, containing signatures of both parties and with payment of the appropriate fee. Further, all conditions of consent must have been complied with, in particular any requirement for water flow meter installation

02 The Ministry for the Environment (MfE) proposes to introduce a National Environment Standard (NES) for water measuring devices by the end of 2008. The proposed standard would require all water permit holders to install a meter that is capable of continuous measurement and data storage. This effectively means pulse emitting meters and data loggers would be required on all new and existing water permits. Should the proposed standard become regulation the Marlborough District Council would be required to ensure that all water permit holders comply with the NES. Any consent holder installing a new water meter, or replacing an existing water meter should give consideration to the proposed standard when deciding on the type of meter to be installed. Further details of the proposed NES are available from MfE, and can be viewed on their web site http://www.mfe.govt.nz/laws/standards/water-measuring-devices.html

ANNOTATION HISTORY

Date	Reason for Amendment/Alteration

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2.13 Traffic on Earthworks

Traffic on the earthworks shall be controlled to prevent contamination of and damage to critical zones. As much as possible, construction traffic on the different zones shall be limited to operations necessary to place and compact the particular materials. Any material contaminated or disturbed by construction activities shall be removed and replaced prior to placing the next lift.

Particular care shall be taken not to contaminate the filter material while it is being laid.

The movement of all construction vehicles and other traffic shall be evenly distributed over the full width of the filling area, so as not to damage or overstress the construction.

2.14 Weather

The construction surface shall be sloped to drain storm water and prevent ponding.

Fill shall not be placed on frozen ground or when conditions are near freezing.

Any compacted material made unsatisfactory due to climatic conditions, shall be replaced and re-compacted.

SIXTH SCHEDULE

FORM OF PRODUCER STATEMENT – CONSTRUCTION

ISSUED BY: .....
(Contractor)

TO: .....
(Principal)

IN RESPECT OF: .....
(Description of Contract Works)

AT: .....
(Address)
.....

..... has contracted to .....
(Contractor) *(Principal)*

to carry out and complete certain building works in accordance with a contract, titled .....

..... (" the contract")
(Project)

I ....., a duly authorized representative of .....
(Duly Authorized Agent) *(Contractor)*

believe on reasonable grounds that ..... has carried out and completed
(Contractor)

☐ All ☐ Part only as specified in the attached particulars of the building works in accordance with the contract.

..... Date.....
(Signature of Authorized Agent on behalf of)

.....
(Contractor)

.....

.....
(Address)

GEO-LOGIC
LIMITED

G7037

28 May 2008

Dam Design Statement
100,000 m^3 Irrigation Dam for Upton Downs Joint Venture
Upton Downs, Awatere Valley, Marlborough District

Geo-Logic Ltd in association with Nelson Consulting Engineers Ltd (NCE) has been engaged to investigate and design a proposed 100,000 m^3 irrigation dam at Upton Downs in the Awatere Valley, near Seddon. The background, setting and details have been described in previous reporting and documents referenced below.

This report summarizes the key criteria and design parameters adopted and to support a Building Consent Application.

Project Related Documents

Drawings:	Job number 07186 Sheets 00 to 09 dated 13 May 2008 Revision B.
Specification:	Specification 100, 000 m^3 Irrigation Dam, Upton Downs Road, SEDDON
Investigation and Reporting:	*"Geotechnical Assessment for the Proposed Irrigation Dam Lot 1 DP11023 Upton Downs, Marlborough District"* prepared for Upton Downs Stage 2 Joint Venture dated 7 February 2008 by Nelson Consulting Engineers Ltd (ref 07186) containing field data and laboratory test results. *"Preliminary Dam Design Report – 100,000 m^3 Irrigation Dam for Upton Downs Joint Venture"* dated 8 February 2008 by Geo-Logic Ltd (ref G7037)

Design Considerations

Potential Impact Classification

Population at risk:	Loss of itinerant or identifiable lives is unlikely, population at risk less than 5.
Severity of property damage:	Minimal, beyond property boundary.
Potential Impact Classification:	LOW

Key Variables Influencing Design

Site geology and characteristics

- Permeable granular overburden overlying impermeable siltstone and mudstone ("papa") bedrock (site subsoil class B – rock)

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- In the immediate proximity of the reservoir, the confirmed/inferred contour of bedrock follows the form of the surface contour, so that subsurface groundwater is expected to flow consistent with the ground contour.
- Proximity to deeply incised, actively down cutting Upton Brook ravine to the north-east;
  - Instability risk due to seismically or rainfall induced event assessed as low to very low.
  - Risk of increased erosion with possibility that additional seepage from reservoir may occur with subsequent potential increase in rate of erosion assessed as low to moderate.
- 'Moderately dispersive' nature of available colluvium material for clay core (interpreted as 'moderately erodible' in the context of design of filter for prevention of piping failure)
- Informal dispersion assessment using the Emerson Aggregate Test indicates;
  - Grey brown SILTSTONE bedrock is 'highly dispersive' (slakes rapidly)
  - Grey MUDSTONE bedrock is 'non-dispersive' (no slaking, no clouding)

Seismicity

- High seismic accelerations expected, with 'near-fault' effects. The site is 4km from the historically active Awatere Fault

Hydrology

- No permanent natural surface inflow or outflow. Ephemeral flows are concentrated in an existing channel and pond.

Reservoir Operation

- Avoid penetrations through clay core.

Design Criteria, Methods and Review

The design procedures and criteria adopted follow those in reference 1 (NZSOLD, 2000), for LOW impact dams, specifically;

- Table III-2 "Summary of Minimum Procedures for Development of New Dams related to Potential Impact Classification", and
- Appendix B - Design

A design working life of 100 years has been adopted for elements that are not readily accessible for inspection and maintenance.

Structural Design

- Empirical design based on precedence, including adoption of conservative upstream and downstream shoulder batters, which provide support for the clay core and seepage control measures.
- Employing defensive seismic design details such as;
  - well designed filter with ample drainage capacity,
  - transitioned embankment to abutment contacts.

Seepage and Groundwater Control Design

A graded granular filter chimney drain is placed on the downstream side of the clay core to;

- Prevent/control migration of fines from the clay core under the influence of seepage flows,
- Provide a primary conduit to direct seepage outflow from the reservoir to the low point of the permeable natural overburden intercepted.
- Intercept groundwater inflow from upslope (the south-west generally) and direct it to the low point of permeable natural overburden intercepted.

Pairs of subsurface drains with sealed inverts provide a secondary conduit for seepage and groundwater flows, should the hydraulic grade line intersect the ground surface, due, perhaps to inadequate capacity in the chimney drain or permeable natural overburden.

- A simplified flow net analysis was carried out to estimate seepage flows from the reservoir through the clay core, in general accordance with reference 2 (USACE 1986)
- Graded granular filter envelope design in general accordance with reference 3 (GEOTECHNICAL ENGINEERING OFFICE, 1993) Table 17 "Design Criteria for Granular Filters"

Spillway and Overflow Channel Design

- Outlet design flows are based on the dam being full and suffering a Q_{100} storm event.
- The spillway and overflow channel design relies on a rock lined channel seated on heavy weight geotextile fabric, founded on natural competent ground. The rock lining design is based the Ministry of Works *Culvert Manual Vol 2*.
- The channel exits into the existing pond and present stream channel.

Surface Water Control

- Surface water upslope of the reservoir is collected by a toe drain, and this discharges either to the inlet channel or to the existing pond.

Design Review

Our proposal has been peer reviewed (GEOTECH CONSULTING LTD, 2008), and appropriate modifications/ enhancements were made as a result of this review.

Design Assumptions

- Competent, stable foundations, not susceptible to liquefaction.
- Normal operation will typically result in the reservoir being well below it's design capacity.
- Bulk fill will be compacted to achieve a density of at least 98% of New Zealand Standard Compaction (as defined by NZS 4402:1986) and a maximum of 5% air voids.
- Material property values assumed in design are based on limited testing and are subject to review of amendment as construction proceeds. Design permeabilities have been assumed half to one order of magnitude more than those measured in the laboratory.

Design Parameter	Clay core	Gravel shoulders	Bedrock siltstone
Maximum Dry Density	1830 kg/m^3	1980 kg/m^3	-
Optimum Moisture Content	14 %	10 %	-
Permeability at 95 % MDD	1x10^{-7} m/s	1x10^{-6} m/s	Impermeable

Construction Review and Monitoring

The following items need to be addressed during construction, commissioning and operation of the reservoir.

- Review of proposed piped supply and outlet reticulation and locations to ensure these do not compromise integrity.
- Monitor groundwater outflow on steep slopes to the north-west to north-east of the site;
  - baseline prior to construction,
  - reservoir half full, and
  - reservoir full.

- Groundwater and seepage collected is expected to emerge at the contact of the overburden with bedrock in the gully to the north-west of the site. This may warrant construction of an access track and collection chamber to allow for pumped recovery of water. Maintenance of the downstream channel (to pass spillway flows) past this location may be required.
- Inspect clay core foundation excavation into bedrock to verify removal of all weathered material including all grey brown SILTSTONE and ensure no joints or faults are present below this level. If possible water conduits are present, then remediation is required.
- Other key stages for construction inspection are listed in the specification, Section 1.7
- Regular ongoing inspection and review is recommended in accordance with reference 1 (NZSOLD, 2000) Table III-3 and Table III-4 and reference 4 (NZSOLD, 1997).

References

1. NZSOLD, 2000; "New Zealand Dam Safety Guidelines", issued Nov 2000
2. USACE, 1986; "Seepage Analysis and Control for Dams EM 1110-2-1901"
3. GEOTECHNICAL ENGINEERING OFFICE, 1993; "Review of Granular and Geotextile Filters – Geo Publication 1/93", Geotechnical Engineering Office, Hong Kong
4. GEOTECH CONSULTING LTD, 2008; Review provided by Ian MaCahon, 3 March 2008 (reference 3410)
5. NZSOLD, 1997; "Guidelines on Inspecting Small Dams", issued Nov 1997

Engineering Data Summary

Reservoir

Map Reference:	NZMS 260 Sheet P29 859 940
Surface Area:	19250 m^2
Storage volume to spillway crest invert:	100,000 m^3
Maximum depth:	7.1 m
Elevation at spillway crest invert:	285.0 m
Perimeter:	550 m approx
Cut batter margin length:	190 m approx
Lining:	Continuous perimeter compacted clay core with graded granular chimney filter. Riprap wave protection to internal surface, except where durable bedrock exposed.
Estimated seepage loss:	10 m^3/day (reservoir full)
Estimated evaporation loss:	Not estimated

Embankment

Earth embankment with compacted clay core and granular shoulders

Dam crest elevation:	285.6m
Freeboard:	0.6m
Maximum embankment height:	5.7 m
Maximum fill depth:	12.0 m
Minimum cut elevation:	274 m approx
Crest length (filled embankment):	360 m approx
Crest width:	3.0 m

Upstream slope:	1V:3H
Downstream slope:	1V:3H

Conduits

There are no conduits penetrating the embankment.

Primary outlet:	Floating pump moored to weighted anchor.
Low level outlet:	Not applicable
Primary inlet:	Floating pipe outlet moored to weighted anchor. 1160 m^3/day
Secondary seepage conduits:	7.8 m^3/day for each pair of drains. (Three pairs in total)

Spillway

Emergency spillway (and Overflow Channel):	Rock lined channel cut through crest, where crest is cut entirely into natural ground. Energy dissipation in existing pond below base of embankment, to be rock lined.
Design spillway capacity:	15.4 m^3/s (0.6 m flow depth at crest) 4.2 m^3/s (0.28 m flow depth at crest)
Design rock-lined channel capacity beyond embankment:	4.2 m^3/s (0.5 m flow depth)
Downstream channel:	Existing steep ephemeral channel into Upton Brook

Catchment

Area:	47 Ha
Normal flow:	Ephemeral storm event flows only.
Design flood inflow: Estimated Q_{100} inflow:	3.8 m^3/s

If you have any queries or require clarification please contact us by phone, fax or email.

Yours faithfully
GEO-LOGIC LIMITED

Bruce Mutton
Geotechnical Engineer

Reviewed by

Paul Denton
Engineering Geologist

GEO-LOGIC
LIMITED

G7037

8 February 2008

Preliminary Dam Design Report - 100,000 m^3 Irrigation Dam for Upton Downs Joint Venture
Upton Downs, Awatere Valley, Marlborough District

Geo-Logic Ltd in association with Nelson Consulting Engineers Ltd (NCE) was engaged to investigate and design a proposed 100,000 m^3 irrigation dam at Upton Downs in the Awatere Valley, near Seddon. The property on which the proposed dam is located is legally described as Lot 1 DP 11023 and is situated adjacent to Upton Brook as shown on the attached concept design drawings.

The purpose of this report is to provide the design parameters and criteria supporting the preliminary design at the chosen site and is suitable for submission as part of a Resource Consent Application.

The preliminary design follows the recommendations of the New Zealand Society of Large Dams (NZSOLD). The detailed design and construction drawings will also meet these recommendations and follow best accepted practice and design methods. A supplemental design report supporting the detailed design will be submitted along with the required Building Consent application to Marlborough District Council (MDC) for specialist review.

Please reference the attached NCE concept design drawings and geotechnical assessment report which support and are associated with this report

1. Reservoir Safety

Based on the NZSOLD Guidelines, the proposed dam is classified as a low potential impact dam. The procedures for investigation, design, construction and commissioning are to follow those in the Dam Safety Guidelines (Reference[1], Table III-2, Appendix B) appropriate to the potential impact classification. A Design working life of 100 years is to be adopted. The dam is also required by Marlborough District Council to have both Resource Consent and Building Consent, and meet the provisions of the New Zealand Building Code.

Potential Impact Classification

The potential impact category (PIC) [1,2] is a measure of dam failure incremental consequences (loss of life, economic, environmental) due to the failure of a dam or reservoir, and can be assessed as low, medium or high.

Should a rapid breach of the reservoir occur, water will spill/flow directly into the deeply entrenched Upton Brook stream channel. The Upton Downs Road bridge crosses almost 2km downstream and is well above the stream channel being more than 30 metres above. The confluence with the braided Awatere river is 2.5km downstream of the site. Annual peak flood

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flows in the Awatere at Awapiri Station, some distance upstream, are of the order of 160 cumecs, and while we have not assessed peak dam breach flow, we don't expect it to exceed this figure.

We have made an initial assessment of the potential flood path using aerial photographs. Based on our limited investigation we are not aware of any buildings or structures likely to be at risk. The area is sparsely populated. People using the river channel and flood plain at the time of the breach may be at risk due to rapid rising of water levels. We assess the population at risk (PAR) to be less than 5 persons, and that the loss of identifiable or itinerant lives is unlikely.

As a consequence, no fatalities are expected, and only minimal damage (Reference [2], Figs 5 to 7) is expected beyond the reservoir owners' property.

We assess the PIC of the proposed reservoir as LOW.

Design Risk Management

Potential hazards considered include;

- Site geology and slope stability in the vicinity, both existing natural and proposed cut and fill batters.
- Seismic accelerations and effects (seiche included).
- Storm and flood characteristics, control and overflow.
- Seepage and erosion related issues.

A detailed geotechnical investigation and assessment was undertaken by our associate consultant Nelson Consulting Engineers Ltd in November and is covered in their report dated 8 February 2008. The reservoir site is in a region of significant seismicity, and it can be expected to be subject to significant horizontal accelerations during its life.

We recommend a pragmatic approach in that rather than focus on analytical seismic and stability analyses and implement expensive mitigation measures (flatter batters resulting in significantly larger earthworks volumes). We propose an appropriate response to be that some risk be accepted by the reservoir owner, and to base the dam design on conservative precedent and implement recognised good practice with respect to defensive seismic design. (Reference[1], B.6 b)

Selective laboratory testing has been carried out and a preliminary assessment of soil test result data has been made. The preliminary assessment is that there may be a moderate to low risk of susceptibility of potential source materials, proposed to be used for the dam structure and foundation, due to piping erosion, dispersion and slaking. Appropriate measures to reduce the risk will be evaluated and implemented.

For example, defensive design features will include;

1. pe netrations in embankment are to be avoided,
2. provide adequate freeboard,
3. m ain overflow outlet to be generously dimensioned and be cut into original ground, avoiding filled ground.
4. fla ring transitions between embankment and *in-situ* abutments to be provided,
5. ca rry out seepage analyses, and provide foundation cut-off barriers, filter drainage blankets and drains as appropriate.
6. use of technical specialists in our design team for specialised aspects of design and review of overall proposal by appropriately experienced peers and contractors.

2. Reservoir Construction

As shown on the preliminary concept design drawings the reservoir will be formed by excavating to the nominal depth of the papa bedrock, and forming naturally lined earth fill embankments where necessary, primarily on the down slope, north-western and north-eastern edges.

The upslope, south-western and south eastern edges will be primarily unlined cut batters in *in-situ* alluvium and colluvium.

Embankment

No penetrations of the embankment are envisaged. Piped services will be routed over the crest of the dam. Inflow and outflow spillways will be located in positions where the reservoir is cut from natural ground, and rock protection will be provided accordingly.

Lining and Cut Off Trench

The embankment lining will be colluvium material won from near the site, provisionally compacted in thin horizontal layers to a nominal thickness of 1.0m. Where the embankment abuts the cut batters, the lining will continue into permeable ground, in the form of a 4m wide trench backfilled with low permeability compacted colluvium, sealed against the bedrock and extending south for a distance sufficient to minimise losses by seepage.

Freeboard

A provisional freeboard of 600mm has been adopted, subject to verification of wave height during detailed design. Rip-rap wave protection materials will be provided near the crest of the embankment.

3. Reservoir Fluid Balance

Pumped Flow

We understand that the primary source of stored water will be that pumped from the Awatere River in accordance with Resource consent U030350. The pumped water will discharge to a floating outlet moored to the reservoir floor. Taking water at a rate of 1160m^3/day it would take a minimum of 86 days to fill.

The primary outflow delivery will also be by floating pump moored to the reservoir floor. The maximum outflow is unknown at this time. The specifics of the irrigation needs are currently being assessed by the irrigation consultant WaterForce.

Emergency / Stormwater Flow

Emergency flow scenarios include rain storm events, and human or operational error, for example pumps failing to switch off.

Overland flow upslope of the site will be collected into the existing grass lined ephemeral channel to discharge into the reservoir. Rock lining will be provided on the reservoir batter where velocities are higher.

As assessed in the NCE report the ephemeral inlet stream drains a catchment of 47 Ha.
The adopted design storm inflow is $Q_{100} = 3.8$ m^3/sec

An emergency spillway will be provided founded in in-situ material, and channelled clear of the embankment and into the gully just north of the existing pond. Rock lining will be provided at the crest and in areas deemed to be at risk from erosion.
The adopted design spillway outflow is $Q_{100} = 4.2\ m^3/sec$.

Evaporation

Evaporation has not been assessed in this report but we understand it has been considered in the overall scheme by WaterForce and the Upton Downs JV.

Seepage

Water loss via seepage is expected primarily via horizontal flow through the embankment. Seepage rates and volumes have not yet been assessed, but will be calculated based on measured and empirically derived soil properties.

Drainage blankets will be considered at the detailed design phase beneath the downstream toe of embankments where embankment or foundation materials may not be sufficiently free draining.

Seepage inflow is possible on the south-western and south-eastern batters, due to groundwater flow. These batters are to be unlined for this reason.

4. Closure

The design parameters and criteria supporting preliminary design at the chosen site follow the recommendations of the New Zealand Society on Large Dams (NZSOLD). The detailed design and construction drawings will also meet these recommendations and follow best accepted practice and design methods.

5. References

1.NZ SOLD, 2000; New Zealand Dam Safety Guidelines, November 2000 published by NZ Society on Large Dams.
2.DB H, 2006; Regulations for the Dam Safety Scheme: Discussion Document, May 2006 published by the Department of Building and Housing, Wellington.

If you have any queries or require clarification please contact us by phone, fax or email.

Yours faithfully
GEO-LOGIC LIMITED

Bruce Mutton
Geotechnical Engineer

Reviewed by:

Paul Denton
Engineering Geologist