CONCEPT DESIGN STATEMENT

NGAKAWAU RESTORATION PROJECT – OCEAN OUTFALL COMPONENT

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In response to your letter dated 30 May 2008 we have reviewed the proposed outfall concept for this proposal in conjunction with a visit to site on Thursday 26 June, and comment as follows in relation to the specifications and methodology you have provided. These comments are generally as requested in your letter, to summarise views on the HDL proposal, and to make suggestions for improvement.

We note firstly that design flow rates have yet to be determined with the result that final pipe sizes will be optimised and established during detailed design. The indicative flows and velocities being considered suggest inside diameters in the range 1.6 to 2.0 m. We note also that a range of potential discharge options is presently under consideration in relation to water quality assessment, including discharge to sea via an outfall, shoreline discharge at the back of the beach, and discharge to Granity Stream adjacent to the powerstation site.

Ocean Outfall Options

Pipes in the size range required are substantial in terms of handling securing and installing, and present a significant challenge for outfall construction. Two current outfall projects installing 1.4 and 1.66 m ID pipelines are presently under construction at St Kilda in Dunedin, and South Brighton Christchurch respectively. Both projects have used microtunnelling technology (resulting in a concrete lined tunnel 1.5 and 1.8 m ID respectively) to traverse the exposed surf zone section where the greatest construction risk exists and where the outfall pipeline prudently needs to be buried to protect it from constant battering of wave loading and potential seabed profile changes due to bar movement that may expose the pipeline or impose undue loadings.

Beyond the surf zone on these projects, and the practical extent of microtunnelling, the pipes are polyethylene (PE) with concrete weight blocks, one installed in a trench and backfilled, the other designed with adequate added weight to self bury. Installation methods being used avoid even delivery of the pipestrings through the surf zone by either using a temporary steel trestle structure from which the PE pipe is launched to seaward of it at Dunedin, or assembling pipe strings in sheltered water and towing them to site for sinking in place at Christchurch.

The methodology provided for discussion by HDL for an outfall at Granity suggests launching an unweighted continuous floating PE pipeline into an open trench through the surf zone, where a concrete sleeve will be added by incrementally pumping concrete into fabric forms around the pipeline. The pipeline to be gradually sunk into the trench and backfilled.

We have significant reservations with this proposal and would not recommend its adoption for the following reasons:

- to take advantage of the continuous nature of the PE pipe the full length would need to be extended out through the surf zone and restrained in place before sinking, a slow and difficult process

- concrete weight to be added to provide on bottom stability for a pipe of this size requires concrete in the order of 1 m^3/m of pipe, a huge task to be done in situ and in the surf zone

- the use of a barge in the surf zone for trench excavation is unsafe and impractical, and calm conditions are very unlikely to prevail for any extended period. Further, the relative isolation of the site by sea from safe harbour is a matter requiring some consideration of the amount and nature of marine input to the project.

- surf zone trenches (and those further out) are very unstable in any sort of swell conditions and generally require continuous sheet piling (in turn requiring trestle access for installation, removal and excavation) and some kind of facility for re-excavating as infilling invariably occurs during the construction process

- the concept indicates that the pipe is only buried (covered?) to low water. Beyond this point it is thus exposed to waves and coastal processes and would be expected to be exposed to changing support conditions through the bar system.

- the site visit, when breaking surf was observed to about 1 km offshore, confirms our opinion that a means of construction that avoids the surf zone and nearshore is prudent at this site which comprises a high energy open ocean exposure, and gradual sloping bathymetry resulting in a very wide surf zone under moderate swell.

These issues were considered as part of our input to the URS report to Solid Energy on Stockton Mine Water to Ocean where we concluded that a practical solution to outfall construction in this area required microtunnelling of the nearshore section. For your project the same conditions apply. Microtunnelling (which would need to be affirmed as feasible in terms of detailed geology/soil conditions but applicable in sands as suggested to exist) has been shown to be successful for single drives of 800 to 1000 m providing the option to traverse the surf zone. A discharge location a minimum of 800 m offshore is recommended to reduce storm exposure and ensure reasonable access for inspection and maintenance of the terminal structure.

While it is suggested in the HDL preliminary proposal that the tailwater from the power station would be conveyed parallel and adjacent to Granity Stream, before being piped to sea, microtunnelling lends itself to direct (and indeed only straight line) conveyance from below the power station site to sea. The outfall construction site viewed at the time of the site visit, an area seaward of the highway and immediately north of the Granity Stream bridge, is not well suited to microtunnel construction as it is of limited size and not convenient for the delivery and storage of tunnelling materials. A more suitable area for a temporary construction site below the power house on Solid Energy owned land and the vacant side of the rail corridor would allow the crossing of the rail, the highway, and tunnelling to an offshore discharge location in a single operation. While land ownership above the alignment seaward of the highway is an issue, it is suggested that in the scale of the project this could be easily overcome with several options of alignment location available. This option would ensure that adequate construction area is available with more opportunity to keep construction access, noise etc further from numerous dwellings. Possible sites are roughly sketched on a cadastral plan attached (Sketch 1), and a photo showing a typical microtunnel construction site with the sheet piled access pit in the foreground is appended (Photograph 1).

At the seaward end of the microtunnel some 800 m offshore a substantial riser would be required to convey the discharge from the tunnel which would require about 4.5 m cover to the seabed above it. This could comprise a concrete caisson structure with rock scour protection to ensure stability in storm conditions. One option would be to install and backfill such a caisson, and drive the tunnel into it allowing the tunnelling machine to be recovered without having to expose the end of the segmental tunnel structure in a large excavation (Sketch 2). The need for particular dilution performance at this location has not been defined with a point discharge considered adequate in the meantime.

In terms of durability of the concrete micro tunnel pipes exposed to acid discharge flows, it is suggested that PE lined pipes be considered. This material has been used in the microtunnel section of the Tahuna Outfall in Dunedin with a 2.5 mm ribbed PE liner cast into the pipe wall (see Sketch 3). Similar treatment could be applied to the discharge structure if required. Greater thicknesses of PE are available and provide a good option if low pH is an issue.

Beach Discharge Option

One of the options discussed was that of discharging the tailwater at the top of the beach adjacent to Granity Stream mouth. This would require significantly less driving head than the outfall option and thus provide the opportunity to lower the power station and obtain more generating head. Conveyance by PE pipe as proposed is feasible, and requiring an energy dissipation and discharge structure at the outlet position. Establishment of an appropriate position will require careful assessment of the coastal processes and establishment of the rate of retreat to ensure that the structure does not become exposed to potential damage or undermining as the coast retreats as suggested is likely in other reports. An initial suggestion is that the structure should be sited at least 10 m back from the present vegetation line.

An impact type stilling basin structure appears appropriate at the discharge position with accompanying protection from downstream and sea induced scour to prevent undermining. A sketch outline of such a structure is attached (Sketch 4), with typical dimensions shown for the flows and velocities envisaged.

While the HDL preliminary design indicates that the tailwater under this option would be conveyed adjacent to Granity Stream and discharged at its outlet to the top of the beach, it is noted that Granity Stream tends to be diverted to the north by the coastal and beach processes, running behind the gravel beach crest before discharging some distance from the actual stream emergence in line with the highway bridge. On this basis piping the flow from the power station directly across to the coast as suggested for the tunnel alignment could be considered.

We trust these preliminary comments provide the input you require. Clearly they should be treated as preliminary at this stage, and for further discussion. Significant further investigation and development is required to advance the suggested options if required. Unfortunately time constraints have prevented presentation of the step by step procedures, and likely adverse effects of the proposals, but that may not be a bad thing given that review of the suggestions is required and may limit the information needed. Please advise if you wish these issues, and which ones to be advanced.

CONSTRUCTION ACCESS REQUIREMENTS AND EFFECTS

1 Temporary Access Across Railway for Site Establishment

With regard to programming, we would allow 4 weeks each for establishment/demobilisation. However, thoughts with regard to the temporary bridge were that it would link the tunnel pit site and the construction site area you indicated would be made available by SE to the south of the stream. That site would be used for storage etc with deliveries and access via there with road access further south. The bridge access crossing Granity Stream would allow construction access to the bottom of the indicated powerstation site independent of the roading system or any other public access area. ie the temporary bridge (see below) would be an alternative to the temporary rail crossing you are suggesting. Note that some form of rail crossing will be needed for materials delivery as construction proceeds.

2 Temporary Bridge

This would need to allow heavy vehicle access between the sites either side of Granity Stream including heavy trucks for pipe delivery/transfer, perhaps a 150 t crawler crane and general construction plant (as well as anything for the powerstation construction.) A steel structure with a timber or concrete deck will do this in 9 to 10m spans. (I'm not sure how wide the stream was).

3 Construction Effects

Note that URS have all the consent info for the CCC outfall microtunnel section which would save a lot of effort.

Once tunnelling has commenced it needs to be a 24 hour operation to ensure continuity of movement is available. Otherwise sheet piling etc in preparation of the site can be restricted to nominated hours. The ongoing tunnel operation will create noise through the separation plant, gantry (or crawler) crane operation and power supply. These need to be managed by the contractor to acceptable levels, and appear to have been at South Brighton where the jacking pit was over the road from dwellings.

Lighting of the site will be required to allow 24 hour operation.

Settlement over the tunnel alignment is a possibility and will require pre construction dwelling surveys to identify cracking etc. This and subsequent monitoring was managed by the contractor at CCC.

Dust is more likely to be an issue from construction traffic than spoil which is transported and separated from a slurry system. Disposal of the spoil needs to be considered.

Other contaminants include fuel for which standard procedures would be imposed, and possibly drilling mud which could be an issue if not properly controlled (for reuse).

4 Marine Environment Effects

These (construction related effects) are really limited to disturbance of the seabed at the riser location which is expected to be excavation and backfill in sand. The environment will be high energy with little physical change overall. Compared to the chemical/biological effects the construction effects are not significant.

5 Geotech Investigations for Microtunnel

The feasibility of the process depends upon an appropriate and consistent tunnelling medium. Sand is acceptable (and likely, we are advised, although clearly any outcrops like the Torea Rocks on the alignment would be an issue), rock may not be depending on characteristics, and it would be necessary to identify this in advance of confirming method. The following are advised investigations:

- onshore test bores with SPT and sampling including on beach
- detailed profile by survey and bathymetric survey
- side scan sonar of offshore alignment to identify seabed surface constituents
- sub bottom profiling (sparker/boomer/seismic?) and detailed interpretation to identify rock and changes in material in the tunnel zone
- jet probing (diver and small boat operation) to 6m depth along the alignment to confirm rock absence
- offshore drilling (diver operated as per Ngakawau jetty investigation) with SPT at terminal site, and as far inshore as practicable

6 Rough Order of Costs

Based on the estimates provided for the 2007 URS report ($12.188 M) for say 1200 m total length (ie less 290 m @ $4200= $1218k),
less one jacking pit $350k,
Add - Caisson construct $460k

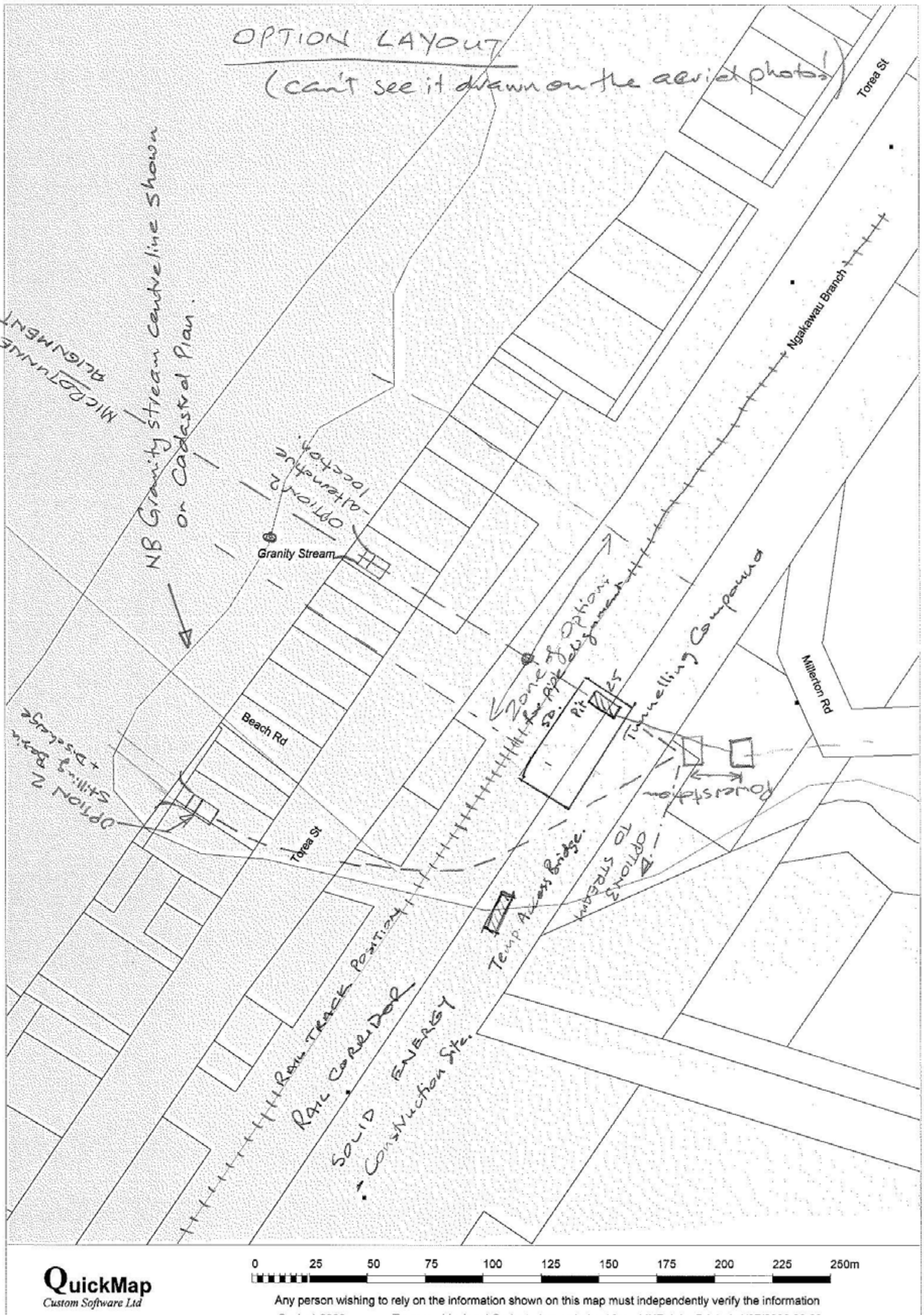
- Dredge - $250k to excavate and backfill (Kawatiri from Westport could be cheaper and could possibly grab dredge)
- Tow and sink - $350
- Scour protection - $150k

ie total basic cost still in same order at $12.2 M plus (to match their estimate) 40% contingency, plus 13% investigation, engineering and construction management = $19.3 M.

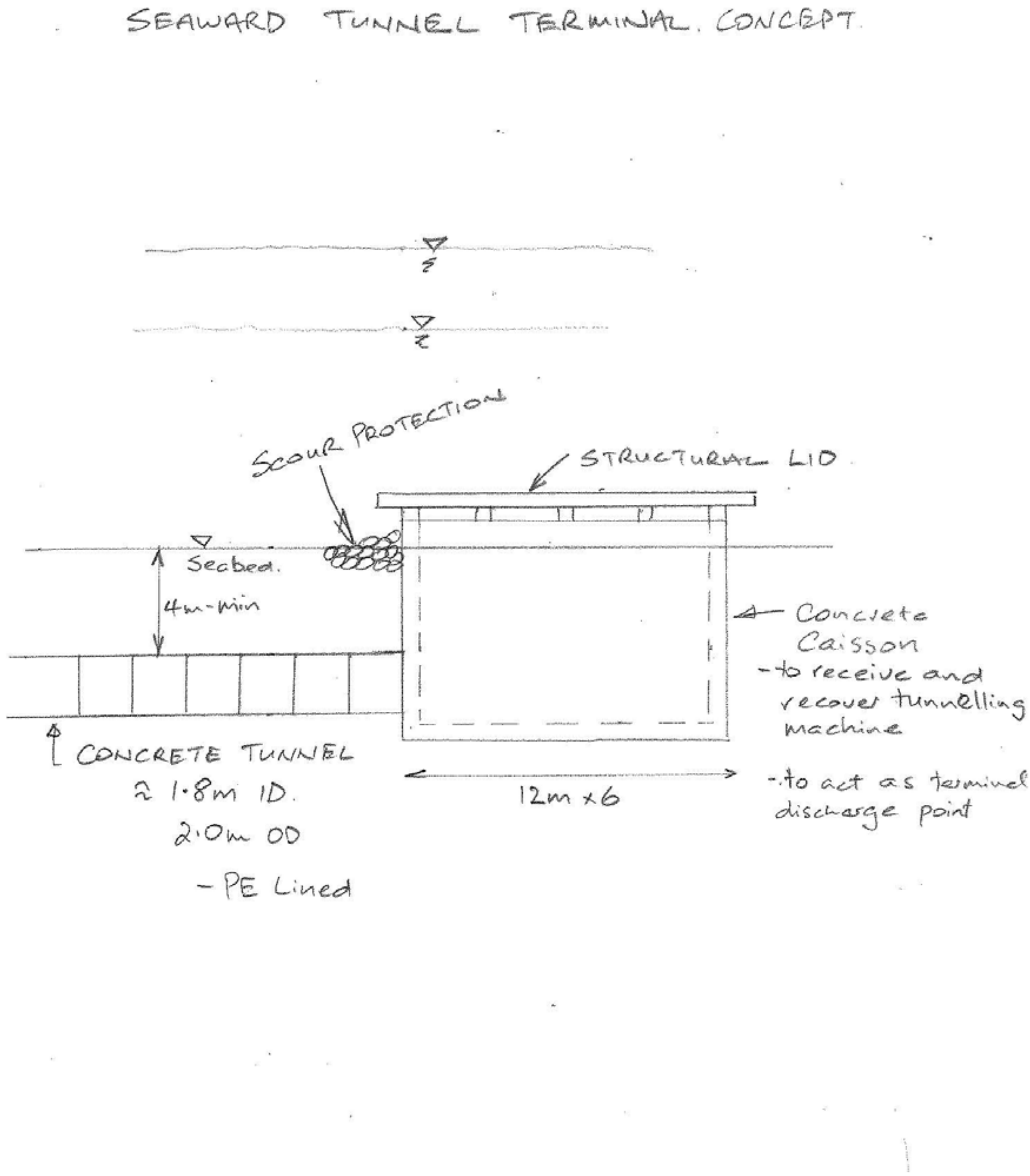
7 Option for Improved Discharge Dilution

It would be possible to construct a diffuser and/or extension of the pipeline from the seaward end of the riser structure if the discharge quality requires it. I have assumed that the riser location is a worst case, and presume you are still considering discharging at the beach or to Granity Stream as a preference.

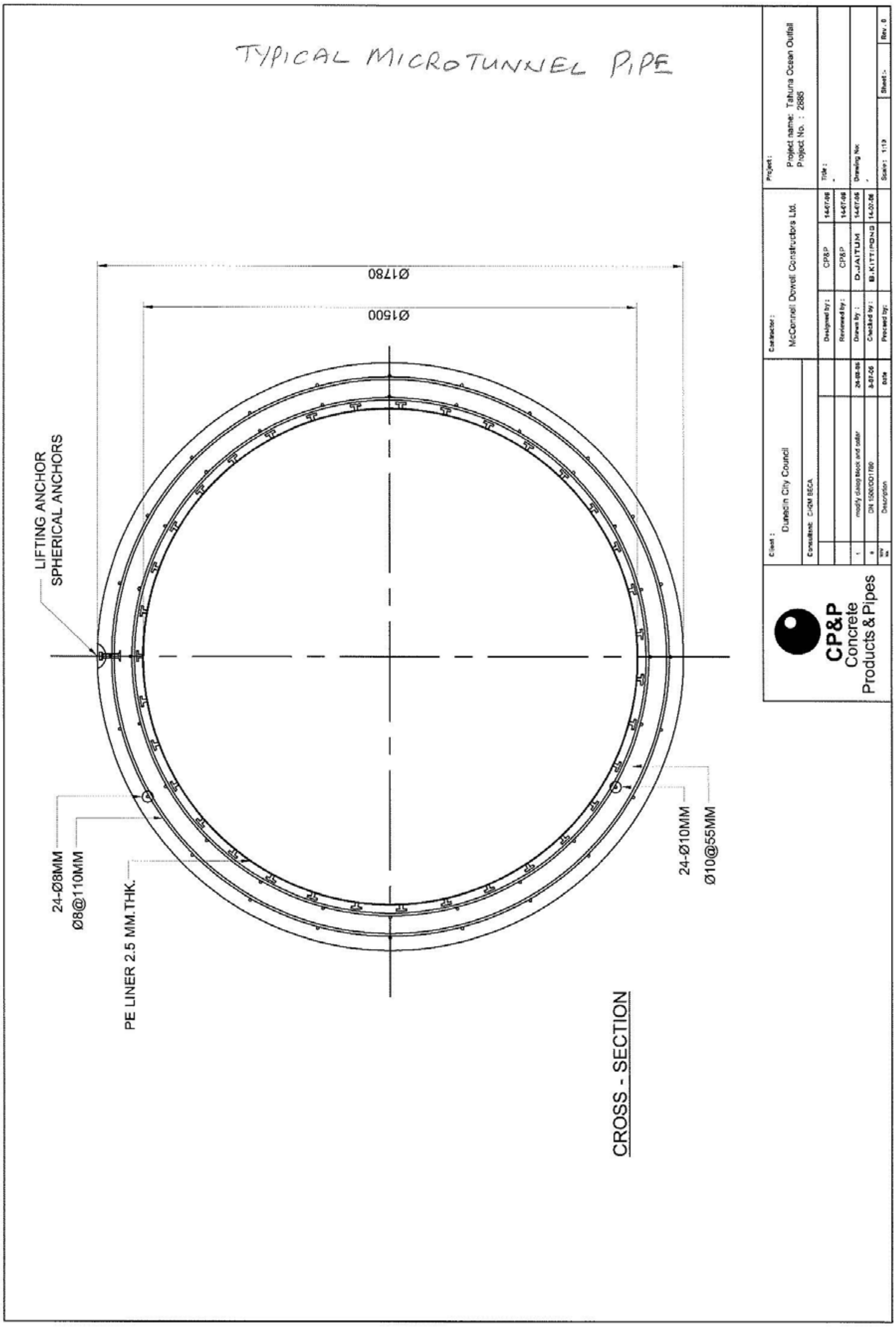
Photograph 1
Microtunnel site South Brighton dunes. Access pit in foreground, slurry handling system to right of crane, boring machine components to left of crane. Note earth bunding and the proximity of nearby dwellings.



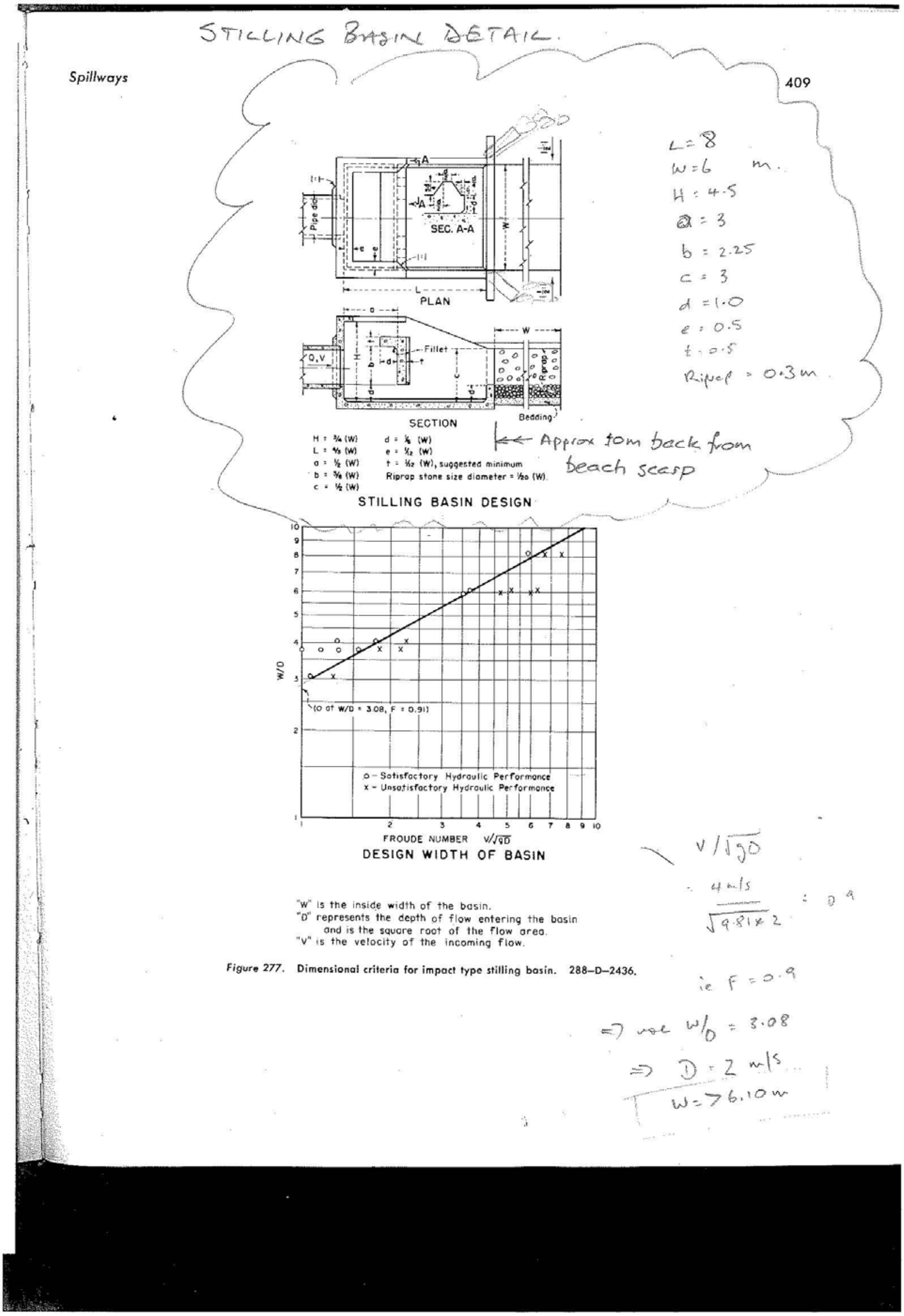
Sketch 1 – Possible Site Location and Layout



Sketch 2 – Schematic section of Outfall Terminal Discharge



Sketch 3 – Typical PE lined microtunnel pipe section



Sketch 4 – Generic requirements for impact type stilling basin for shoreline discharge option

Additional information in response to Section 92 Request

17 March 2009

Responses on an informal basis are as follow. Note that we are not tunnelling specialists, and that the best advice in that area, especially in relation to state of the art processes and equipment is likely to be from established contractors (eg Harkers, McConnell Dowell).

The consent findings and conditions for the Christchurch City outfall can be found at:
http://www.ecan.govt.nz/NR/rdonlyres/FCF7D92E-8E92-4644-A19F-A6CA2CD65080/0/finaldecisioncccoceanoutfall.pdf

They are not particularly detailed in terms of the tunnelling constraints.

Section C: Engineering information request

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

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

What monitoring during excavation is proposed? What criteria is proposed for acceptable levels of settlement?
What contingency measures would be implemented if settlement levels are exceeded?

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

Response

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

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

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

Section E: Noise and Vibration information Request

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Micro tunnelling is to take place in close proximity to the historic Granity Library and historic war memorial. Vibrations are always produced during ground modification or excavation.

How will the tunnelling vibrations affect the stability/structural integrity of heritage sites and what mitigation measures are proposed?

What standards will be complied with concerning vibrations caused by micro tunnelling and associated construction machinery?

Is trial micro tunnelling proposed to give an idea of likely vibration levels?

Response

Tunnelling vibrations are considered very unlikely to affect the stability or structural integrity of these structures. Cosmetic damage (eg cracking of plaster) is the first level of vibration damage. This can be difficult to identify or attribute to any particular occurrence, as such minor cracking is often present due to other causes. It is common to carry out detailed survey to identify before and after differences. Recent micro tunnelling for Christchurch City outfall passed along a street alignment for 3 blocks with no cosmetic damage to dwellings (they were inspected in detail before and afterwards), and barely perceptible centreline street settlement.

There are several standards which provide structural damage limits for peak particle velocities resulting from vibration. These are generally related to explosive use, and include NZS 4403:1976, and the more conservative AS 2187.2:1993.

It is generally not practical to trial the micro tunnelling process given the setup and access pit requirements, and the need for a dedicated machine matched to appropriate tunnel diameter and ground conditions.