

27 July 2010

Lyttelton Port Company  
Private Bag 501  
Norwich Quay  
Lyttelton

Attention: Mr Neil McLennan

Dear Mr McLennan

**Lyttelton Port of Christchurch Coal Stockyard Expansion Project Response to Further  
Information Request  
Gollans Bay Quarry, Haul Road and Te Awaparahi Bay Stormwater Construction Matters**

Lyttelton Port Company has applied for a suite of resource consents to expand the coal stockyard and the quarrying at Gollans Bay. The Canterbury Regional Council has requested further information under Section 92 of the Resource Management Act, 1991.

The purpose of this letter is to provide answers to those questions relating to construction stage stormwater and erosion and sediment control (ESC). These are Questions 56, 57, 73 - 92 of the further information request, dated 10 March 2010. The report answers the questions in the order contained in the Request.

***Coal Stockyard Stormwater***

***56. Stormwater is collected at pump stations. Please provide information about the storage and pump capacity of the five pump stations (we note that this information may be in the Opus Report which is referred to but not provided in the application).***

Of the total of 17 ha expanded coal stockyard, 1.2 ha will be available within roads and access between stockpiles for ponding of stormwater run-off. With a ponding depth of 0.5 m before overflow into the CMA, 6,000 m<sup>3</sup> of run-off can be safely accommodated.

The total capacity of the five pump stations will be configured to match the proposed treatment capacity of the lamella plant which will be sized at a nominal 100 L/s.

***57. Please provide a rainfall event based assessment of the stormwater system identifying when the system with a 100 L/s treatment capacity will be exceeded and result in untreated discharges to the coastal marine area (we note that this information may also be in the Opus Report referred to in the application).***

Discharge of 100 L/s has been selected as the nominal treatment capacity for stormwater run-off from the coal yard but this does **not** mean that whenever there is a rain event with peak discharges greater than 100 L/s there will be untreated stormwater discharging to the CMA. This is because of the stormwater attenuation that occurs as a result of ponding within the coal yard as explained in the MWH Report, Appendix 10 of the Application, which states:

*“the design of the proposed stormwater treatment system is based on the ability of the management within the coal stockyard to achieve stormwater attenuation to minimise peak flows through the treatment system.*

*The expanded coal stockyard will be designed to incorporate passageways between coal stockpiles to form areas that allow for stormwater storage to provide the attenuation required. The stormwater attenuation will allow the stockyard stormwater treatment system to be designed with a maximum capacity of 100 L/s.*

*In addition, the treatment capacity could be installed in stages, with the capacity increased when required by ensuring additional units can be readily incorporated into the treatment system, both in terms of installation of additional structures and additional control systems.*

*The design of the treatment process is based on modular design-build packages so if treatment of inflows greater than 100 L/s proves necessary additional modules could be installed.”*

In Appendix A attached, it can be shown that based on a simple analysis using the Rational Method, all duration rain events up to 2%AEP (50 yr ARI) and short or long duration (< 1 hour or greater than 12 hours) 1%AEP (100 yr ARI) could be accommodated within the coal yard without discharge of untreated coal yard runoff.

***73. It is proposed to divert surface water runoff from hillside areas above the coal stockyard via drains. Please provide details of catchment area for each of the discharge points for these drains, and the current design capacity of the drains. Please also outline what rainfall events exceed the existing drain capacity, and provide details of the proposed capacity of the new drains.***

Surface runoff from hillside areas above the coal stockyard currently drain to the coal stockyard perimeter drain which falls in two directions. It discharges to Te Awaparahi Bay via two existing outfalls – the western and the eastern outfalls. The eastern outfall also discharges the runoff from the coal stockyard after treatment via chemical dosing and a sediment retention pond. These outfalls are reported to be of a combination of 750 mm and 600 mm diameter pipes. The western pipe was originally 450 mm but was blanked off and replaced with the 600 mm pipe in order to reduce the risk of flooding of the coal stock from clean hillside stormwater. It has been reported that no flooding has since occurred. A third dedicated outfall may be constructed for the new coal stockyard runoff lamella plate treatment plant or else the existing eastern discharge outfall would be extended and used. The western outfall flows through a sump that buffers flows prior to the outfall pipe, as shown in Figure 1 below.

**Figure 1 Existing Sump Entry to Western Outfall**



### **Catchment Details**

Existing catchment details for the western and eastern outfalls are given in CPG Drawing No. 130C. The estimated total catchment areas draining to Te Awaparahi Bay via the two outfalls is approximately 46 ha (does not include Catchment A). Catchments B, C & D (total 42 ha) discharge via the western outfall with runoff being transmitted via a system of culverts, open drains and flumes, while Catchment E (4 ha) discharges directly over the slope to the coal stock yard perimeter drain before flowing into the existing settlement pond and discharges via the eastern outfall. Catchment A (9 ha) was identified as a catchment area which may, in larger storms, discharge into the sedimentation pond and the western outfall. The behaviour of these flows is dependent on the ability for these flows to flow down Sumner Road within existing water table drains and then cross Sumner Road when capacity is exceeded. There is no distinct flow path identified apart from down the Sumner Road to a CCC culvert under Sumner Road. Contribution of runoff from Catchment A to the LPC system is therefore negligible.

The existing coal stockyard (Catchment F) will be expanded from 7 ha to 17 ha on completion of the reclamation. The existing coal stockyard stormwater is currently discharged via the eastern outfall. It is proposed that the coal stockyard stormwater will be treated by a new lamella plate separator plant and discharged either via a new outfall dedicated to the new plant or directed to the existing outfall which will be extended.

It is not proposed to alter to any major extent the upgradient catchments above the coal stockyard. The existing Sumner Road provides the main clean water intercept and this water is mainly transported via corrugated flumes and discharged via the existing Western Outfall. The existing hill toe drain intercept picks up the remaining flow and this is also taken to the Western Outfall after a small sedimentation pond (see photo above).

The diversion in Catchments B & D is where the haul road and Hillside excavation will occur. This diversion is required to safely convey peak discharge from 10-minute 5% AEP storm (based on ECan's Erosion and Sediment Control Guidelines (ESCG)). This is considered conservative considering the size of the catchment and temporary nature of the diversion. A more appropriate design storm would be 30-minute 5% AEP storm. Based on the Rational Method and a 30-minute 5% AEP storm, with contribution from Catchments B, C & D (total 42 ha), a runoff coefficient of 0.75, and rainfall intensity of 37.08 mm/hr (HIRDS V2 output for Lyttelton with 46% adjustment to account for HIRDS V2 and climate change), the peak discharge is estimated to be 3.2 m<sup>3</sup>/s. This new drain (the diversion upstream of the sump) will have a capacity to convey 3.2 m<sup>3</sup>/s and is provided to drain all "clean" stormwater to the western outfall (see Photo above). Upon completion of the reclamation, a new perimeter drain next to the expanded coal stock yard will replace the existing one. Catchment E will continue to drain toward the eastern outfall after reclamation.

#### **74. Please provide details of the stormwater quality from the existing drains receiving stormwater from the hillside above the coal stockyard area.**

Stormwater from the hillside above the coal yard area can be coloured in a severe rainfall event such as that witnessed between 23 May - 29 May 2010. Site walkovers in both the morning and afternoon of Wednesday 26<sup>th</sup> May resulted in the following observations:

- i. Significant loess was being carried in the drains alongside the Old Sumner Road and areas of exposed loess (see attached Photos 1 – 3), Appendix B);
- ii. Areas with little loess were relatively clean flowing, as shown in Photos 4 and 5, **Appendix B**, where the water from the excavated road is significantly cleaner than that from upgradient loess areas;

- iii. Water from the Sumner Road was acting as a cut-off drain and remained relatively clean (see attached Photo 6, Appendix B); and
- iv. The western outfall discharge into the bay adjacent to the coal yard had a visible plume. A surface layer plume is expected due to the different density characteristics between the fresh water and seawater. This tended to hug the shoreline to the east of the discharge as the wind was from the Southwest (see attached Photo 7, Appendix B).

At this stage, the intensity, duration and exceedance probability of the event has not been determined by hydrologists but it is likely to be greater than a 20% AEP.

### ***Gollans Bay Quarry (GBQ)***

#### ***75. Please provide details of the maximum area of disturbance at any one time and the catchment area for the discharge points.***

The area disturbed in each of the proposed quarrying stages developed by Ashby Consultants Ltd is anticipated to be approximately 1.74 ha (Stage Q1), 3.92 ha (Stage Q2), 0.86ha (Stage Q3), 2.73 ha (Stage Q4 NE Ramp), 3.37 ha (Stage Q4 East Ridge) and 6.28 ha (Stage Q5). The maximum area of disturbance at any one stage is likely to be approximately 3.92 ha (shown on CPG Drawing No. 132E) for Stage Q1 to Stage Q4. Once quarrying within an area is finally completed, progressive restoration will be implemented. The total plan area for Stage Q5 is 6.28 ha but there is no plan to quarry the whole 6.28 ha in one operation. Quarrying operation will be progressive to limit active quarrying area to less than approximately 4 ha according to the size of the sediment retention pond provided. It is proposed to use the current benching above the quarried areas to divert as much upgradient “clean” runoff as possible.

Using one of the many possible scenarios to illustrate the proposed ESC concept, the following scenario is considered. The catchment area allowed for in the sizing of the sediment retention pond, including the disturbed area is approximately 4.0 ha (rounded up from 3.92 ha as shown on CPG Drawing No. 132E). For other details on GBQ, please refer to the response by Ashby Consultants Ltd.

The erosion and sediment control system, including the sediment retention pond, has been sized for a catchment area of approximately 4.0 ha. The maximum contributing catchment drain to a sediment retention pond (including area of disturbance) is therefore limited to approximately 4 ha as discussed in this scenario and in subsequent responses under ESCP. However, there is sufficient area for a basin to cater for a catchment area of up to 6 ha at any one time, or provide two ponds, if required. Details of the stormwater concept and the erosion and control design principles are provided in our responses to Questions 76 – 81 and 90 – 91.

**76. Please provide the likely treatability characteristics of stormwater runoff during construction.**

Treatability of stormwater is a function of particle size distribution of the sediments contained in the stormwater since sedimentation (via the use of sediment retention ponds) is one of the most common processes relied upon to settle out the sediments and particulates suspended in stormwater prior to discharge to the receiving environment.

Gollans Bay Quarry is a steep hard rock quarry and any overlying loess or loess/colluvium is thin. Where it is sufficiently thick, it will be stripped, stockpiled, and used for quarry rehabilitation at a later date or alternatively trucked off site. Nevertheless, stormwater runoff from the quarry area will contain some fines associated with any residual loess and also from the blasting, screening and crushing or from trafficking.

The proposed treatment system is detailed in responses to Questions 77 – 81 and 90 – 92. In summary:

- There will be a sediment retention pond at the base of the quarry area as shown in Drawing 132E. The sediment retention pond will only be used to deal with “dirty” stormwater runoff from the disturbed area. Depending on the location of the extraction, the sediment retention pond may need to be shifted to suit gravity flow.
- The diverted “clean” water from the undisturbed areas will not pass through the settlement pond and will instead be conveyed by a cut-off drain around the pond.

Table 1 below shows that sediment retention ponds typically remove 60 – 80% of suspended solids (TSS) provided it is correctly operated and maintained. The ESCG design is based on 75% effectiveness of sediment removal.

**Table 1: Stormwater Treatment Technology Performance Removal Effectiveness**

Treatment Device	TSS	TPH/Oil	Metals	BOD	Nutrients	Litter
Swale	20 – 60%	55%	20 - 60%	20 - 40%	20 - 40%	High
Extended Detention Wet Pond	60 - 80%	NA	40 - 80%	20 - 60%	40 - 80%	NA

Source: Table 6-6 CCC (2003): *Waterways, Wetlands and Drainage Guide*. Christchurch City Council.

Loess however is known to be more difficult to treat due to its poor settlement characteristics and chemical dosing systems are sometimes required. At the quarry, as described earlier, it is expected that the concentration of suspended loess in the stormwater is likely to be small and therefore we predict chemical dosing will not be needed. Nevertheless, this option remains in the event that treatment is proving more difficult than anticipated. See further discussion of chemical dosing under Question 93.

As discussed earlier, the existing benches at the quarry will divert “clean” stormwater to the adjoining gullies (CPG Drawing 132E). This water from the gullies will then be diverted via cut-off drains and discharged into the l gully below the quarry footprint.

The “dirty” water will discharge into the basin and the treated water will then discharge into the gully leading into the bay. The gullies below the quarry floor are currently vegetated (CPG Drawing 132E). Further polishing will occur in the vegetated gully that the pond will discharge into. Auckland Regional Council’s Technical Publication TP10 (ARC TP10) summarises results of a literature review on the efficacy of vegetated conveyance treatment systems for suspended sediments. The following is an extract from ARC TP10:

- Khan et al (1992) showed that a 60 m long swale used to treat runoff from a 6 hectare suburban catchment achieved an average suspended solids concentration reduction of 83% for six storms.
- Barrett et al (1998) reported a TSS load removal of 86% in field monitoring of storm events in Texas USA.
- Yu et al (2001) recorded mass removal of TSS averaging 94%.
- Wong, (undated) states that reported removal efficiencies of suspended solids range from 25% to 80% depending on the grading of the suspended solids in the stormwater.
- Fletcher (2002) reported TSS concentration reduction of 73-94% (mean 83%) and mass reduction of 57- 88% (mean 69%) for a synthetic stormwater with TSS concentration of 150 mg/L. Fletcher (2002) showed that the reduction in TSS concentration during passage through the swale was lower at higher hydraulic loadings. Larger TSS particles were found to settle out rapidly, while smaller particles remained in suspension.
- Fletcher (2002) concluded that swale length (as a measure of hydraulic loading or detention time) has a significant impact on TSS removal performance, particularly if fine particles are present. In cases where fine material is of specific concern and available swale length is limited, other measures such as bioretention systems or wetlands may be required.

Thus, a further reduction of TSS will occur in the vegetated conveyance systems. We would expect the level of treatment provided by the vegetated gullies to be at least 25% as reported in the ARC TP 10 above.

As discussed above, TPH/oils are usually adsorbed to sediments. This means that as sediments settle out in the sediment retention pond TPH/oils are also removed from the stormwater prior to discharge from the pond.

Although the initial receiving environment is the gully below the quarry footprint, we consider that the appropriate location to monitor the discharge is the harbour. This is because the coastal water in this instance is the sensitive receiving environment in question. We note the gully runs into the harbour for which its waters are classified Coastal CR (contact recreation) by the Regional Coastal Environment Plan (RCEP). Rule 7.1 (b) of the RCEP permits the discharge of stormwater subject to a number of conditions. Relevantly, the conditions on colour and visual clarity state that the colour of the receiving water should not be changed by greater than ten points, as measured using the Munsell Scale, and the visual clarity of the receiving water shall not be reduced by greater than 50%. These conditions are to be achieved within 100 m from the stormwater discharge point. We recommend that the discharge be monitored for these parameters for a specified storm event and if they cannot be complied with, then a chemical dosing system in our view would need to be installed.

It is also worth noting that sediment that is trapped by the sediment retention pond will be actively managed. On a regular basis, it will be excavated from the ponds and taken to off-site permitted disposal areas if suitable on-site disposal is not available.

**77. Please clarify 'where' this significant volume of loess material may be excavated from and how this affects the likely quality of the stormwater discharge from the quarry?**

This has been discussed in Question 76 above. If loess is used in the reclamation it will be excavated from the Te Awaparahi Bay hillside slope immediately next to the coal yard (p13 AEE). Further details are provided in response to Question 87 below.

**78. ECan's Erosion and Sediment Control Guidelines recommend using a runoff coefficient (Cv) 0.55 for slopes of 20% (Table 7.5 in the guidelines). Please assess the appropriateness of using this coefficient for predicted stormwater from the quarry given that the slope is greater than the 20%.**

We have assessed the runoff coefficient that was presented in the consent application. We agree that a coefficient of 0.55 is only appropriate for slopes less than 20%. Given the slope at the quarry is much steeper, an adjustment upward is appropriate.

The Christchurch City Council's Waterways, Wetlands Drainage Guide (2003) recommends an adjustment factor of +0.2 to the 0.55 coefficient for terrain steeper than 1 in 5. We therefore recommend that a runoff coefficient of 0.75 be used for stormwater calculations at the quarry.

The sediment retention pond, the cut-off drain and all the other stormwater infrastructure calculations at Gollans Bay Quarry have been based on C<sub>v</sub> value of 0.75.

**79. Please provide details of vegetation type, density, cross section area and channel profile measures for the vegetated waterways relied on for sediment control.**

As discussed earlier, the primary treatment device for the quarry is the sediment retention pond. Although the vegetated gully below the quarry floor would provide further polishing, it is not being relied on for primary sediment control.

**80. Please provide details on the expected discharge quality and an assessment of effects relating to suspended solids and turbidity as a result of the discharge to the ephemeral waterways and coastal marine area.**

The expected stormwater characteristics and the treatment train has been explained in Question 76 above and Questions 90 and 91 below provide further details.

The sediment retention pond at the quarry will treat stormwater runoff prior to discharge. Table 1 above shows that some literature estimates that sediment removal in basins can be up to 80% depending on sediment characteristics, basin design and operation and maintenance regimes. Typical sediment removal rate of a pond designed and constructed to ECan Guidelines is up to 75%. Stormwater discharge post treatment will in general flow down the existing ephemeral vegetated waterways into the coastal marine area.

If the sedimentation pond is operating as designed, all sediment will be retained within the pond. Any minute fines that do escape will be minor and will not result in visible deposition on the existing ephemeral waterway. Further reduction will occur within the ephemeral waterways but as stated above in our response to Question 79, this is not relied on as the primary removal mechanism. However, we consider removal rates within these ephemeral waterways could be at least 25% based on the literature quoted in the ARC TP10.

Removal rates of the other likely contaminants have been discussed in detail in response to Question 76 above.

*Assessment of Effects as a Result of Discharge to Ephemeral Waterways and the Marine Area*

Dirty water from disturbed areas will be directed to the sediment retention pond. The pond will be designed for a 10-hour 20% AEP in accordance with the ESCG. The treatment efficacy of the pond has been discussed in detail above. Further treatment will occur in the swale between the pond and the lower gully and the gully prior to discharge into the marine area. It is expected that the effect of the discharge will be no more than minor as long as the treatment train is installed, operated and maintained using best management practices. As discussed under Question 76, we anticipate the treated stormwater would meet the clarity and turbidity conditions set out in Rule 7.1 (b) of the RCEP.

**81. Please assess the potential effects of the proposed stormwater treatment and sediment control devices on leachate from the old landfill site below the quarry.**

The lower gully i.e. the gully below the sediment retention pond into which the cut-off drain and the outfall from the sediment retention pond discharge is at least 25 m (as the crow flies) away from the landfill. The Gollans Bay Quarry stormwater treatment and sediment control devices will be sited away from the existing landfill site and any runoff draining within the ephemeral waterways will be following the existing natural flow path along this existing gully that tracks below the toe of the landfill. The location of the landfill relative to the proposed treatment train and conveyance systems is shown in CPG Drawing No.132E.

The proposed quarrying and provision of a treatment system will not alter the natural flow paths that currently exist, thus the ephemeral gully that currently conveys runoff near the landfill will not have flows increased as a result. Flows will be slightly reduced due to buffering in the pond. Thus, there will no effect on landfill leachate.

### **Quarry Access Road**

**82. Please provide the likely quantity of earthworks for the construction of the access road including re-alignment and widening works and the likely area of disturbance at any point in time.**

The haul road is an existing gravel road between Gollans Bay Quarry and Te Awaparahi Bay and is approximately 2.34 km long. Two sections of the haul road can be distinguished; the relatively flat portion extending from the GBQ to Battery Point along the Old Sumner Road (upper section); and the steeper portion from Battery Point to the hairpin and down to Te Awaparahi Bay (Figure 2 and CPG Drawing No. 131C). The Old Sumner Road will be widened and extended where feasible. At locations where it is not feasible to reach the full nominal carriageway width of approx 15 m (overall width of approximately 17.6 m which includes a berm) then it will only be widened to approximately 8 m width and a passing-bay type of arrangement will be provided.

The amount of bulk earthworks that will result from widening of the existing Old Sumner Road section of the haul road and from the construction and realignment of the access road down to the Te Awaparahi Bay reclamation area is now reported in detail in the Ashby Consultants Ltd response to Question 23. In summary, the volume of earthworks in the Old Sumner Road section is estimated at 12,750 m<sup>3</sup> (ch1000-1570), however, from observations; the percentage of loess in this section appears minimal. The majority of earthworks (approximately 76,520 m<sup>3</sup>) occurs in the section from Te Awaparahi Bay up the incline, however, only the hairpin section of this contains significant loess.

**Figure 2 – Old Sumner Road Section of Haul Road**



Having walked the entire length of the haul road, there is only one spot identified as having significant loess (Figures 3 & 4). It is intended to isolate this area with a compacted earth bund and treat the runoff, or alternatively remove the loess as a priority and stabilise the exposed face. The majority of the haul road is relatively flat with exposed rock surfaces (Figure 5).

**Figure 3 - Loess along Old Sumner Road Section of Haul Road**



**Figure 4 - Loess along Old Sumner Road Section of Haul Road**



**Figure 5 – Typical section of Haul Road along Old Sumner Road Section**



In the response to Question 23, road width, cut height and unit area at different chainages are provided by Ashby Consultants Ltd. Within each of the two identified loess work areas, the carriageway will be stabilised with metal in a timely manner before moving on to the next section of road. From the site walkover, only the lower section hairpin and the area near the junction with the Old Sumner Road have volumes of loess requiring treatment and the remainder of the road could be constructed without staging. CPG Drawings 138 & 140 shows the concept for erosion and sediment control for haul road widening.

**83. Please provide information about how existing stormwater discharges will be kept separate to stormwater from construction areas.**

The present Sumner Road provides an upper cut-off system, with approximately four discharge points. Some of these are via corrugated pipes that discharge under the existing haul road system. The others are into small gullies that are also directed under the existing haul road.

The existing stormwater system along the flat upper Old Sumner Road section of the haul road will not be modified. The existing discharges will not be kept separate to construction stage stormwater as it is not expected that this will result in sediment laden runoff. In the one location identified as

having a potential for loess in the runoff, the construction phase will be separated and treated as described.

The stormwater discharge arrangement for the steep incline and hairpin section of the haul road is given in CPG Drawing No.134D. Dirty stormwater from the re-alignment of the haul road is proposed to be captured by the sediment pond downstream and treated prior to discharge (as set out in the Hillside Excavation section of our answer to Q90).

**84. Please provide details of the catchment area for each of the discharge points for the access road, the likely quantity of the loess soils to be excavated and how will they be managed or stockpiled.**

The details of catchment area for each of the discharge points for the haul road will be provided during detailed design, as these are not considered critical at this stage of investigation. It is likely that the existing catchments will not be altered significantly by the road as widening and realignment are minimal. The current culvert locations and gullies are likely to be used. The photo below shows a typical table drain alongside the haul road and Detail L of CPG Drawing No. 140 shows a typical drainage outlet.

**Figure 6 – Photograph of the Drain alongside the Haul Road**



At the location where an outlet is specified or where an existing culvert is located, the catchment area contributing to the outlet will comprise the haul road, the adjacent cliff face and any contributing catchment above and from the present Sumner Road. For the purpose of ESC during construction, stormwater runoff is retained by roadside safety berm which acts as a barrier for runoff discharging to the bay and prevents washouts and erosion of the slope below. As discussed above, there is only one location in each section that loess is anticipated and treatment will be required. Discharge points will run under the road and discharge on the hillside high above the marine area as at present. Rocks will be placed below each discharge pipe to dissipate the energy thus protecting the hillside from potential erosion.

As discussed in response to Question 77 above, the material above the haul road is predominantly hard rock and widening of the haul road is not expected to yield a large volume of loess based on visual inspection along the road. Any excavated loess will be trucked off site if it cannot be suitably disposed off on site. The topsoil may be used for rehabilitation purposes. All stockpiles will have perimeter bunds downgradient to prevent runoff originating from the stockpile from escaping. Possible areas for stockpiling are given in CPG Drawing No. 134D.

## **Construction Phase Te Awaparahi Bay**

**85. Please confirm whether the proposed new hillside drains will divert all of the catchment above the earthworks area during construction.**

Yes.

Stormwater in this area from the present Sumner Road currently flows down the hillside in corrugated drains and discharges into the coal yard cut-off drains and sumps then into Te Awaparahi Bay via the Western or Eastern outfalls.

Part of this existing network, below the Old Sumner Road, will be disrupted by the construction of the new access road and the excavation at Te Awaparahi Bay. Therefore, the drainage system below the Old Sumner Road up to the existing sump will be re-configured to capture all “clean” runoff from the upper catchment to discharge to the sea via the western outfall while maintaining the other half of the perimeter drain to capture “dirty” runoff for treatment prior to discharge.

Clean water diversion will generally be achieved by installing a diversion drain upgradient of and around the hillside excavation (or on the upper most bench) to direct this runoff for discharge via the existing western outfall (refer CPG Drawing No.134D). In line with what is proposed at the quarry in locations where the perimeter drain at the top of the slope is impractical, the drain will be constructed within the first bench.

Hillside excavation can commence after the clean water diversion is in place and the downstream diversion is ready to capture and direct ‘dirty’ runoff to the sediment retention pond for treatment prior to discharge (refer Drawing No. 134D).

**86. Please provide details of the maximum area of disturbance at any one time during construction and the likely loess soil content of the exposed surfaces.**

If this excavation is undertaken, then the area made available through hillside excavation would be approximately 2.0 ha. Taking into consideration cut batters and area set aside for stockpiles and the ESC pond, the maximum area of disturbance for hill side excavation could be up to approximately 3.0 ha.

The likely loess content of the material excavated is estimated at 20% (p13 AEE). Once the excavation is at the finished level, any exposed loess will be stabilised with erosion control products or alternatively the contractors will provide and maintain downstream ESC measures until the exposed loess faces are considered stabilised.

It is predicted that approximately 100,000 m<sup>3</sup> of loess could be excavated and used in the reclamation paddock.

**87. Details in the application suggest that significant volumes of loess will be used for the reclamation (as per Opus DRWG 95R2). Please clarify where this significant volume of loess material will be excavated from, and how this affects the likely quality of the stormwater discharge from construction area.**

Significant quantities of loess would only be used in the reclamation if hillside excavation at Te Awaparahi Bay is carried out. The photograph in Figure 7 below shows the area that would be excavated for loess at Te Awaparahi Bay. Exposed surfaces containing loess can result in

stormwater runoff that discolours the receiving water if no treatment is provided prior to discharge. As detailed in our response to Question 90, a temporary sediment retention pond with chemical dosing is proposed. We consider this would provide the necessary treatment to meet the colour and visual clarity conditions set out under Rule 7.1 (b) of the RCEP described earlier.

Our experience in dealing with significant quantities of Port Hills loess is that settlement without chemical aids is very difficult to achieve, thus a chemical dosing system will most likely be required for the excavation work on the hillside at Te Awaparahi Bay. Some excavation may be necessary to create space for the temporary pond, thus it may not be possible to install the pond and dosing system before any excavation occurs but these will be installed as soon as practicably possible. An option to address this issue would be to temporarily direct the discharges prior to the pond installation to the coal stockyard stormwater treatment system.

**Figure 7 - Te Awaparahi Bay – showing loess hillside**



#### *Road Construction*

The access road will be constructed from the coal yard up towards Te Awaparahi Bay at a slope of approximately 10%, with a hairpin turn at the top of Te Awaparahi Bay to run parallel to the Old Sumner Road and joining the Old Sumner Road just above Battery Point.

The stormwater run-off during this construction stage will be collected by cut-off drains below the new road and conveyed to a sediment retention pond. The treatment capabilities of sediment retention pond have been discussed in detail in response to Question 76 above. The treated runoff will then discharged into the bay via one of the existing discharge pipe networks. The temporary basin can be constructed anywhere within the Te Awaparahi excavation area.

Stormwater quality during the construction of the road and the excavation at Te Awaparahi Bay should, after treatment, meet the conditions defined in the RCEP. Details of the stormwater treatment and the erosion and sediment control measures during construction are detailed in response to Questions 90 – 92 below.

#### *Reclamation Area*

As detailed on drawing Opus DRWG 95R2, the reclamation may contain a layer of loess fill after the completion of the rock seawall (if Te Awaparahi Bay is excavated). In this event, prior to

depositing the loess fill within the reclamation areas, a layer of filtration geofabric is specified on the inner face of the bund wall. This is to contain 'dirty' seawater within the reclamation paddock during construction and provide a barrier to prevent fines from escaping during the service life of the reclamation.

**88. Please assess the appropriateness of using a coefficient of Cv of 0.55 for the predicted stormwater from the hillside excavation given that the slope is greater than 20%.**

As discussed in our response to Question 78, we consider a coefficient of 0.75 to be appropriate for predicting stormwater from the hillside excavation. Therefore, all hillside stormwater calculations have been based on a runoff coefficient of 0.75.

**89. Please clarify the difference between HIRDS Version 1.5b and Version 1.5 in terms of rainfall depths.**

The reference to HIRDS is given on page 4 of Opus ESCP submitted with the consent application. The origin of this reference can be attributed to the ECan ESC Guideline which states that HIRDS v2 underestimates rainfall depth. Opus adopted the ECan Guideline recommendation to use HIRDS v1.5 for estimating appropriate rainfall depth in the Banks Peninsula area. The rainfall depth for Lyttelton adopted by Opus was 70 mm compared to 50 mm adopted for Christchurch.

For sediment retention pond sizing within Christchurch, Table A3 (same as Table 7.5, ECan Guidelines) is relied upon after soil type and slope of the site is determined. For areas outside of Christchurch, pond sizes can be extrapolated using Table A3 x [site 10-hour 20% AEP rainfall depth/50]. Rainfall depth for Lyttelton, as determined by Opus, is 70 mm which will result in a larger pond due to the higher rainfall depth. This is considered appropriate.

### ***Erosion and Sediment Control Plan (ESCP)***

**90. Please identify the erosion and sediment control measures that are proposed, including conceptual designs of measures and a site plan for each of the sites (hillside excavation and reclamation, haul road and Gollans Bay Quarry)**

The approach to be taken in the preparation of ESCP for this project needs to be a two-stage process: a conceptual primary ESCP and then the more detailed progressive ESCP as the detailed design of the works progresses, as it is not appropriate to undertake all phases until full detail design is undertaken.

The primary ESCP is a broad-based framework that outlines the intentions and fundamental principles that will be followed in planning and implementing control measures for an entire project. The primary ESCP usually includes standard drawings of control measures to be used in the project. It is often supplemented with a series of subordinate 'progressive' ESCPs to be prepared and submitted after detailed design. The primary ESCP was provided with the application (Appendix 11 of the AEE submitted), titled Draft Erosion and Sediment Control Plan.

The responses to Questions 90 – 93 of the RFI below also provide further detail for the primary ESCP.

Progressive ESCPs detail the specific location and type of individual erosion and sediment control measures specified for the project. These should be consistent with the approach outlined in the primary ESCP, referencing standard drawings in the primary ESCP as appropriate.

Progressive ESCPs are prepared with construction personnel to formulate practical documents for field reference. They are prepared on relevant copies of the drawings, particularly for:

- stockpiling with provision for bulk earthworks;
- areas of high erosion hazard (e.g. culvert construction, and areas with significant limitations, such as steep slopes); and
- specific areas that may occur outside the road alignment (e.g. compounds, stockpile sites and access roads).

Progressive plans should be reviewed and updated as construction activities change, for example, from the clearing and grubbing stage to bulk earthworks and drainage works. Accordingly, it is important to maintain a register of these progressive ESCPs on site, to ensure that:

- there is no confusion regarding which ESCP is current; and
- appropriate processes are followed in the planning, implementation and decommissioning of erosion and sediment controls during the life of the project.

The construction works can be broken into a number of activities and stages, as follows:

- the incline (ramp) section of the haul road from the Old Sumner Road down to Te Awaparahi Bay would take a period of approximately 3 to 6 months to upgrade and construct;
- the Old Sumner Road (Haul Road) section to the Quarry would be widened and upgraded over a period of approximately 3 months;
- quarrying, to supply rock for the reclamation, would occur over a period of approximately between 1½ and 3 years, depending on whether the reclamation is staged. As described in the report from Ashby Consulting Ltd and CPG Drawing 132E, this is likely to be excavated in five discrete stages; and
- the hillside excavation at Te Awaparahi Bay, if it proceeds, would take approximately a year to construct.

If the hillside excavation at Te Awaparahi Bay proceeds then the volume of rock required from the Gollans Bay Quarry would be reduced.

CPG Drawing No. 131C gives an overview of the ESC for the proposed Lyttelton coal stockyard expansion and the following sections describe the ESC for each of the sites:

### ***Hillside Excavation***

LPC may excavate the hill directly to the north of the existing coal stockyard to gain an area of approximately 2 ha and to construct an access connecting the reclamation site to the Gollans Bay Quarry.

The proposed excavation, if it is to occur, would do so on the hillside to the north of the existing coal stockyard. Currently there is an existing drain along the northern perimeter of the coal stockyard. This perimeter drain receives runoff from catchments external to the LPC site as well as from LPC land above the coal yard and discharges the runoff to the sea via the two outfalls (see CPG Drawing No. 131C).

The clean water that originates from the hillside catchment above the coal yard will have to be diverted from the proposed excavation as much as practicable. Dirty runoff from the excavation site will be retained and treated prior to discharge. The proposed measures to treat construction stage runoff are a sediment retention pond and a rain-induced Polyaluminium Chloride (PAC) dosing system. As an alternative, consideration may be given to utilising the lamella plant for treatment of run-off from this area.

Based on the estimated maximum disturbed area at any one time of 3.0 ha (inclusive of batters), the sediment retention pond required is approximately 1,575 m<sup>3</sup>. This is based on pond storage of 525 m<sup>3</sup>/ha of catchment.

The concept layout plan for this component of the project is given in CPG Drawing No. 134D.

### **Gollans Bay Quarry**

The quarry would be developed in stages, with only sufficient area disturbed at any one time to allow efficient operations. See CPG Drawing No. 132E for ESC concept.

The ESC measures to be installed will be commensurate with the scale and extent of the disturbed area.

Activities will vary throughout the life of a quarry, and it is accepted that erosion and sediment control measures and activities will evolve over time. Erosion control strategies for quarries comprise the following:

- minimisation of extent and duration of disturbed areas draining to waterways, and prompt revegetation of disturbed areas once the resource is exhausted (using temporary revegetation if required and practicable);
- ensuring both temporary earthworks and any permanent land-shaping provide a landform which minimises erosion hazard;
- prompt stabilisation of land following land-shaping (both temporary and permanent); and
- design of temporary surface-water collection, conveyance and disposal systems in a manner which minimises erosion.

It is intended that stormwater will be diverted around any active quarry area by relying on existing benching as far as possible. This will minimise both the flow rate and volume of runoff to be handled by on-site ESC facilities and enable them to perform more effectively. Runoff from stable rehabilitated areas will also be diverted away from operational areas.

Erosion and sediment control measures will be inspected regularly while construction activities and active quarrying are being carried out, with maintenance and modification as necessary, together with more intense inspection and maintenance regimes during periods of wet weather and wet-weather clean-up. Arrangements will also be made for inspection and maintenance during industry shutdowns for weekends and holidays, particularly if rainfall is forecast.

Quarries usually incorporate excavated sumps in their operational areas to collect runoff which can be reused and/or evaporated. This is the case at Gollans Bay Quarry, where a sediment retention pond of approximately 2,100 m<sup>3</sup> is required based on maximum disturbed area of approximately 4.0 ha and 525 m<sup>3</sup>/ha storage. The pond could be used in conjunction with a chemical dosing system if monitoring indicated this was necessary.

CPG Drawing No. 132E shows the anticipated staging of the quarry excavation work. Please note that the proposed staging is for illustrative purposes and the site specific information will determine which area starts and the progressive quarrying.

### **Haul Road**

The existing haul road is planned to be widened to a nominal carriageway width of 15 m (approximately 17.6 m overall including room for a berm) along much of its length. Trucks may need to wait in some sections where the full width cannot easily be constructed. The haul road after the hair-pin is to be limited to 8 m (one lane). Typically, widening would involve maximising excavation of the uphill slope and minimising any "side casting".

Taking into consideration the site constraints, methodology for erosion and sediment control for the widening of the existing haul road that are considered practical include:

- Construction of safety berm on the outside which also acts as stormwater runoff control, preventing washouts and erosion of slope below (please also see Ashby Consultants Ltd response to Question 23);
- Timely restoration of disturbed surfaces after road widening;
- Timing construction to avoid wet weather as far as practicable;
- Programming construction to minimise erosion;
- Conveying clean water through or around the site with early installation of culverts and other permanent drainage works (or back to the quarry treatment pond); and
- Practice good house keeping.

The following temporary erosion and sediment control measures will be introduced:

- The installation of check dams every 20 m for slopes between 2 and 10%, in-line with road excavation progression;
- The installation of temporary sedimentation ponds in locations where practical and there is sufficient space available;
- The installation of sediment traps at culvert outlets, in-line with road excavation progression;
- The construction of a compacted earth bund or sediment fences on the outer side of the road;
- Timely resurfacing of road with rock/gravel after excavation completion;
- The lining of table drains with metal at steep gradients; and
- The progressive stabilisation of batters where applicable.

CPG Drawing Nos. 133, 138 and 140 give the specific and generic ESC concept for the haul road.

### **Reclamation**

Detailed description of the steps involved in the construction of the proposed reclamation are given in Section 2.1 and are illustrated in a drawing provided in Appendix 8 of the AEE. These include:

1. Laying of high strength geotextile fabric on the seabed under the seawall from a barge;
2. Laying of a gravel layer;
3. Construction of a rock platform;
4. Construction of the sea wall;
5. Armouring of the sea wall;

6. Laying of a layer of geotextile fabric (to minimise silt escaping during infilling);
7. Infilling;
8. Capping of expanded area with approximately 3.5 m thick rock fill; and
9. Providing rock surcharge.

Based on the steps taken in Actions 1 and 6 above, and the fact that all material placed on the bund wall would consist of rock/gravel then it is considered that effects of such activities on water quality should be minor. We understand that the bund wall is to be completed before material would be placed in the paddock or alternatively a silt curtain would be installed to fence off the paddock.

In the event “dirty” water needs to be contained in the reclamation paddock, a floating silt curtain, designed and fabricated to the site conditions will be deployed. However, it is very unlikely that this will be needed due to the sediment restricting characteristics of the geotextile.

***91. Please provide an assessment and design details of any sediment control ponds proposed, including pond size, decant and spillway design and any proposal for chemical dosing.***

According to the ECan ESCP Guidelines, sediment retention ponds are sized using the runoff from the 10-hour 20 percent AEP rainfall event, which for Banks Peninsula equates to a 70 mm storm. For any given storm, site runoff will vary with soil type and topographic features of the catchment. Guideline values for various soil type and slope within Christchurch area are given in Table 7.5 of the Guidelines. These need adjustments (to higher values) for Bank Peninsula and LPC site conditions. A typical pond design applicable in the Bank Peninsula area is given in CPG Drawing No. 139 based on approximately 525 m<sup>3</sup>/ha storage. This takes into account the higher rainfall depth for the Bank Peninsula area and the revised  $C_v$  of 0.75.

The discharge from the sediment retention pond is controlled by the floating decant system provided. Table 7.6 of ESCG requires 72 holes to be provided for each hectare of contributing catchment based on steep clay with 20% slope. Detail F of CPG Drawing No. 139 Sheet 2 gives the proposed arrangement for a sediment retention pond. The ESCG also provides guidance on the sizing of emergency spillways. The adopted design value is 1.25 m of spillway width per hectare (Table 7.6 ESCG).

Chemical dosing is likely to be implemented for the excavation at Te Awaparahi Bay (if it is undertaken). The system will be based on an arrangement as shown in Detail H of CPG Drawing No. 139 Sheet 2.

***92. Please provide the likely treatability characteristics of stormwater runoff during construction from each area.***

***Gollans Bay Quarry***

The treatability characteristics of stormwater runoff from Gollans Bay Quarry have been discussed in detail in response to Question 76.

### **Haul Road**

The characteristics of the stormwater runoff from the construction of the haul road will be similar to that of the stormwater from Gollans Bay Quarry, i.e. low concentrations of loess.

The haul road faces constraints due to its location and there is no large flat area available for stormwater treatment or retention. The strategy is to limit the area of disturbance. For further details on ESC, please see Drawing No's. 138, 139 and 140 and response to Question 90.

Stormwater treatment during construction will occur in the gullies below the haul road and in the roadside swales/drain next to the haul road. The treatment levels achievable will be similar to those in Table 1 and from the literature values derived from the ARC TP10 as discussed in response to Question 76. The one area identified to have significant loess in the flat Old Sumner Road section will be treated separately by minimising the area of disturbance down to a bare minimum, the use of silt fences and a larger sump for sedimentation. The area identified on the hairpin will have its runoff directed to the sedimentation pond at the base of the incline (or alternatively treated through the lamella plant) prior to discharge.

Further polishing will occur as the treated stormwater flows down the vegetated slopes into the coastal marine area.

### *Te Awaparahi – Hillside Excavation*

As part of the excavation, room would be created at the toe of the hillside to enable a temporary pond for a construction stage stormwater retention and treatment to be constructed, after provision to divert all clean run-on water has been made. CPG Drawing No. 134D gives the concept for the ESC for hillside excavation. For further details on ESC, please also see our response to Question 90.

Reclamation: For detailed response, please see our response to Question 90.

### **93. Please clarify whether chemical dosing is proposed for the construction phase stormwater discharges, and if so, please provide an assessment of potential effects from the discharge of residual chemicals.**

As discussed previously, in all cases, the treated stormwater runoff is anticipated to meet the colour and visual clarity conditions set under Rule 7.1 (b) for the those coastal waters classified as Coastal AE (aquatic ecosystems) or Coastal CR (contact recreation).

Out of the four work areas described in the AEE, chemical dosing is initially proposed only for the hillside excavation to deal with the presence of loess within the excavation. The other work areas will be monitored and dosing implemented if required.

Loess can produce suspended sediment in earthworks stormwater that has very poor settlement behaviour in a normal sediment retention pond. Dosing of chemicals has been found to be effective with such soil types<sup>1</sup>. Chemical flocculants will improve performance.

Examples of common chemicals used in sediment control are Aluminium coagulants e.g. poly aluminium chloride (PAC), aluminium sulphate (Alum), and polyacrylamide (floc block). PAC will most likely be the chemical dosed in this application.

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<sup>1</sup> Erosion and Sediment Control Chemical Use Workshop conducted by ECan on April 2009.

The proposed chemical dosing system will be of the type described in TP227<sup>2</sup> (ARC, 2004) and the chemical PAC is likely to be used for sediment control. Aluminium coagulants are commonly used in potable water treatment. Even though the aluminium coagulants contain high concentrations of toxic ionic form of aluminium, the toxic aluminium derived from the coagulant dose is very rapidly reduced by the precipitation and coagulation reactions to a low concentration with no serious toxicity implications (ARC, 2004).

After the addition of aluminium coagulants to water containing dissolved and/or suspended matter, dissolved aluminium ions are rapidly incorporated into microscopic aluminium hydroxide and aluminium phosphate precipitates. These precipitates combine with phosphorus, suspended solids, metals, and other dissolved and suspended matter. The insoluble precipitates that are formed from this process are stable. As the particle size increases, the density also increases, and they tend to sink towards the bottom.

Insoluble precipitates formed by the addition of Alum to water containing dissolved and/or suspended matter are stable. Most pollutants are tightly bound to the aluminium matrix with little or no affinity for release from either dried or wet sludge. The aluminium appears to be tightly bound in Alum treated sediment under both reduced and oxidised conditions, and at pH ranges between 5 and 7. The release of aluminium from Alum treated sediment appears to be relatively unaffected by changes in the redox potential within the sediment.

Based on the sediment retention pond design with decanting outlet arrangement, only the water near to the surface of the pond is discharged and the settled sediment collected at the bottom of the pond is required to be removed periodically and either disposed off-site or mixed with gravels and reused to rehabilitate the quarry benches.

If there is a discharge to the receiving environment, it is expected to happen only during significant rain storm events when there are significant other discharges occurring. The effect of the discharge of residual chemicals, if any, will therefore be very minor.

Yours sincerely  
**CPG NZ Ltd**

A handwritten signature in black ink, appearing to read 'Francis Ho', is positioned below the typed name.

Francis Ho  
Senior Engineer

**Enclosure**

- » Drawing 130 C
- Drawing 131 C
- Drawing 132 E
- Drawing 134 D
- Drawing 138 C
- Drawing 139 C
- Drawing 140 C

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<sup>2</sup> Technical Publication 227 – The Use of Flocculants & Coagulants to Aid the Settlement of Suspended Sediment in Earthworks Runoff: Trial, Methodology & Design, Auckland Regional Council, 2004

## Appendix A

The occurrence of untreated coal yard stormwater runoff discharging to the coastal marine area (CMA) is influenced by the following factors: (1) severity of rainfall events, (2) capacity of the outfall, (3) treatment capacity of the Lamella plant, (4) storage available within the coal yard, and (5) design features of the reclamation (height of bund wall).

A simplified analysis taking into account the above factors is presented to give an indication of rainfall event that could overtop the bund wall bordering Te Awaparahi Bay resulting in the discharge of untreated coal yard runoff to the CMA.

Rainfall input is based on HIRDS v2 with an adjustment for climate change (16%) and under estimation by HIRDS within the Port Hills(30%).

Capacity of the outfall is dependent on numerous factors. For this simplified analysis, the capacity of the western outfall is calculated at 0.5 m<sup>3</sup>/s based on 2.0 m head available at the sump, length of pipe at 350 m (based on the extended length with the reclamation) and pipe diameter of 600 mm. The 2.0 m head adopted is the approximate height of water allowed to pond above the sump when the tide is high. The long length of outfall means that friction losses are dominant and minor losses can be ignored.

The treatment capacity of the Lamella plant is set at 100 L/s.

Storage required within the coal yard is approximated by the differences between  $Q_{in}$  and  $Q_{out}$ .

This analysis was carried out based on the Rational Method and using the following assumptions:

Rainfall intensity (for 5%, 2% & 1% event) from HIRDS v2 applicable for Lyttelton Port with adjustment for climate change and 30% increase to allow for HIRDS v2 underestimation.

Hillside catchment = 42 ha (Catchment B,C,D)

Eastern outfall catchment = 17 ha (expanded coal yard) + 4 ha Hill catchment (Catchment E)

Runoff coefficient (hill catchment) = 0.75

Runoff coefficient (coal yard) = 0.3 (coal absorbs much of rain)

Ponding area available within coal yard = 1.2 ha

Bund wall height available= 0.5 m

$Q_{out}$  = 0.5 (western outfall) m<sup>3</sup>/s

$Q_{out}$  = 0.1 (eastern outfall) (lamella plant treatment capacity) m<sup>3</sup>/s

$Q_{out}$  assume constant throughout the rain event

Based on this analysis, it can be shown that **with 0.5 m** bund wall and **1.2 ha** storage area, **100 L/s** Lamella plant capacity and **0.5 m<sup>3</sup>/s** outfall capacity, runoff from all duration rain events up to 2%AEP can be contained and small and long duration 1%AEP storms within the coal yard with no discharge of untreated runoff to the CMA (see attached spreadsheet).

Appendix A		HIRD v2 intensity (mm/hr)									
AEP(%)	ARI(year)	10m	20m	30m	1 hr	2 hr	6 hr	12 hr	24 hr	48 hr	72 hr
50%	2	22.8	17.1	14.4	10.8	7.9	4.85	3.56	2.61	1.60	1.21
10%	10	34.8	25.5	21.2	15.7	11.5	7.03	5.15	3.78	2.33	1.76
5%	<b>20</b>	<b>42</b>	<b>30.6</b>	<b>25.4</b>	<b>18.6</b>	<b>13.6</b>	<b>8.30</b>	<b>6.08</b>	<b>4.46</b>	<b>2.76</b>	<b>2.08</b>
3.33%	30	46.8	34.2	28.4	20.6	15.1	8.30	6.08	4.46	3.06	2.31
2.50%	40	51	36.9	30.6	22.2	16.3	9.93	7.28	5.33	3.29	2.50
2%	<b>50</b>	<b>54.6</b>	<b>39.6</b>	<b>32.8</b>	<b>23.6</b>	<b>17.3</b>	<b>10.57</b>	<b>7.74</b>	<b>5.96</b>	<b>3.70</b>	<b>2.80</b>
1%	<b>100</b>	<b>69</b>	<b>49.2</b>	<b>40.4</b>	<b>28.9</b>	<b>21.15</b>	<b>12.92</b>	<b>9.45</b>	<b>6.92</b>	<b>4.30</b>	<b>3.26</b>
<b>Ponding area available</b>		<b>1.20E+04 m2</b>									
<b>1 in 20 years</b>											
West outfall Qout(m3/s)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
East outfall Qout(m3/s)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Catchment Area (ha)		42	17	4							
runoff coefficient,C=		0.75	0.3	0.75							
Factor(adjustment for climate change and HIRDv2)		1.46									
Hillside Qpeak(m3/s)		5.37	3.91	3.24	2.38	1.74	1.06	0.78	0.57	0.35	0.27
Coalyard Qpeak(m3/s)		1.38	1.01	0.83	0.61	0.45	0.27	0.20	0.15	0.09	0.07
Hillside Runoff Vol(m3)		1609.65	2345.49	2920.37	4277.07	6254.64	11451.51	16786.35	24627.65	30468.38	34492.50
Coalyard Runoff Vol(m3)		413.91	603.13	750.95	1099.82	1608.34	2944.67	4316.49	6332.82	7834.73	8869.50
Hillside Net Volume(m3)		1309.65	1745.49	2020.37	2477.07	2654.64	651.51	-4813.65	-18572.36	-55931.63	-95107.50
Coalyard Net Volume(m3)		353.91	483.13	570.95	739.82	888.34	784.67	-3.51	-2307.18	-9445.28	-17050.50
Total Net Volume(m3)		1663.56	2228.62	2591.32	3216.89	3542.98	1436.18	-4817.16	-20879.53	-65376.90	-112158.00
m (ponding depth)		<b>0.139</b>	<b>0.186</b>	<b>0.216</b>	<b>0.268</b>	<b>0.295</b>	<b>0.120</b>	<b>-0.401</b>	<b>-1.740</b>	<b>-5.448</b>	<b>-9.347</b>
<b>1 in 50 years</b>											
Catchment Area (ha)		42	17	4							
runoff coefficient,C=		0.75	0.3	0.75							
Hillside Qpeak(m3/s)		6.98	5.06	4.19	3.01	2.21	1.35	0.99	0.76	0.47	0.36
Coalyard Qpeak(m3/s)		1.79	1.30	1.08	0.78	0.57	0.35	0.25	0.20	0.12	0.09
Hillside Runoff Vol(m3)		2092.545	3035.34	3771.18	5426.82	7956.27	14578.83	21362.355	32905.845	40885.11	46403.91
Coalyard Runoff Vol(m3)		538.08	780.52	969.73	1395.47	2045.90	3748.84	5493.18	8461.50	10513.31	11932.43
Hillside Net Volume(m3)		1792.55	2435.34	2871.18	3626.82	4356.27	3778.83	-237.64	-10294.16	-45514.89	-83196.09
Coalyard Net Volume(m3)		478.08	660.52	789.73	1035.47	1325.90	1588.84	1173.18	-178.50	-6766.69	-13987.57
Total Net Volume(m3)		2270.63	3095.86	3660.91	4662.29	5682.17	5367.67	935.53	-10472.65	-52281.58	-97183.66
m (ponding depth)		<b>0.189</b>	<b>0.258</b>	<b>0.305</b>	<b>0.389</b>	<b>0.474</b>	<b>0.447</b>	<b>0.078</b>	<b>-0.873</b>	<b>-4.357</b>	<b>-8.099</b>
<b>1 in 100 years</b>											
Catchment Area (ha)		42	17	4							
runoff coefficient,C=		0.75	0.3	0.75							
Hillside Qpeak(m3/s)		8.81	6.29	5.16	3.69	2.70	1.65	1.21	0.88	0.55	0.42
Coalyard Qpeak(m3/s)		2.27	1.62	1.33	0.95	0.69	0.42	0.31	0.23	0.14	0.11
Hillside Runoff Vol(m3)		2644.43	3771.18	4644.99	6645.56	9726.89	17821.13	26076.33	38171.70	47507.67	53992.26
Coalyard Runoff Vol(m3)		680.00	969.73	1194.43	1708.86	2501.20	4582.58	6705.34	9815.58	12216.26	13883.72
Hillside Net Volume(m3)		2344.43	3171.18	3744.99	4845.56	6126.89	7021.13	4476.33	-5028.30	-38892.33	-75607.74
Coalyard Net Volume(m3)		620.00	849.73	1014.43	1348.86	1781.20	2422.58	2385.34	1175.58	-5063.74	-12036.28
Total Net Volume(m3)		2964.42	4020.91	4759.42	6194.41	7908.08	9443.70	6861.67	-3852.72	-43956.07	-87644.02
m (ponding depth)		<b>0.247</b>	<b>0.335</b>	<b>0.397</b>	<b>0.516</b>	<b>0.659</b>	<b>0.787</b>	<b>0.572</b>	<b>-0.321</b>	<b>-3.663</b>	<b>-7.304</b>

**APPENDIX B: PHOTOS OF MAY 2010 EVENT**

**Photo 1: Old Sumner Road Loess Hillside Area**



**Photo 2: Drain above Coal Yard adjacent to Rill Erosion Loess Area**



**Photo 3: Upgradient Western Drain in Coal Yard Showing Loess Colouring**



**Photo 4: Upgradient Road showing Clean Runoff adjacent to drain from Loess Area**



**Photo 5: Old Sumner Road showing Clean Runoff from Road and Dirty from Hillside**



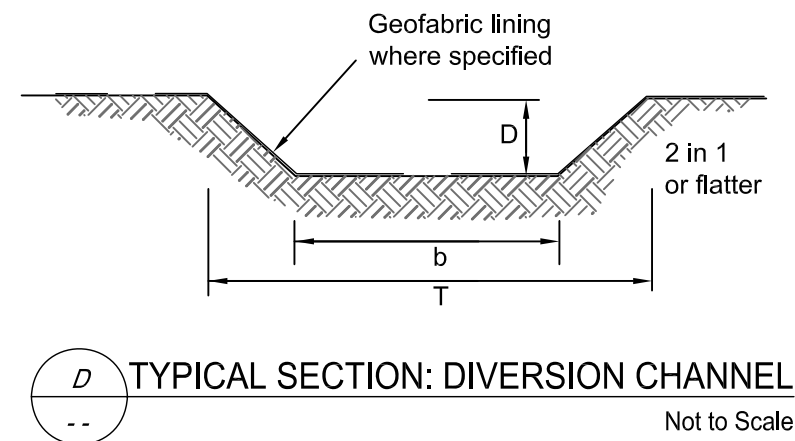
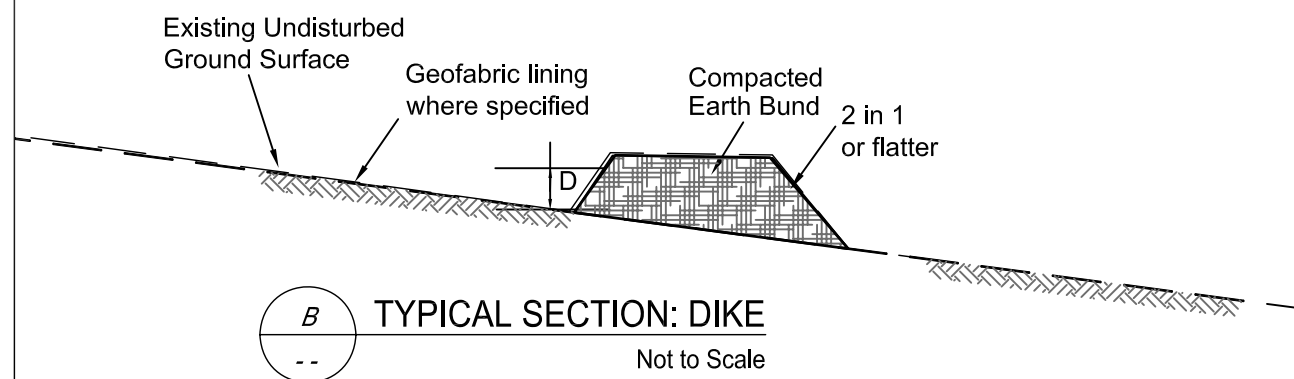
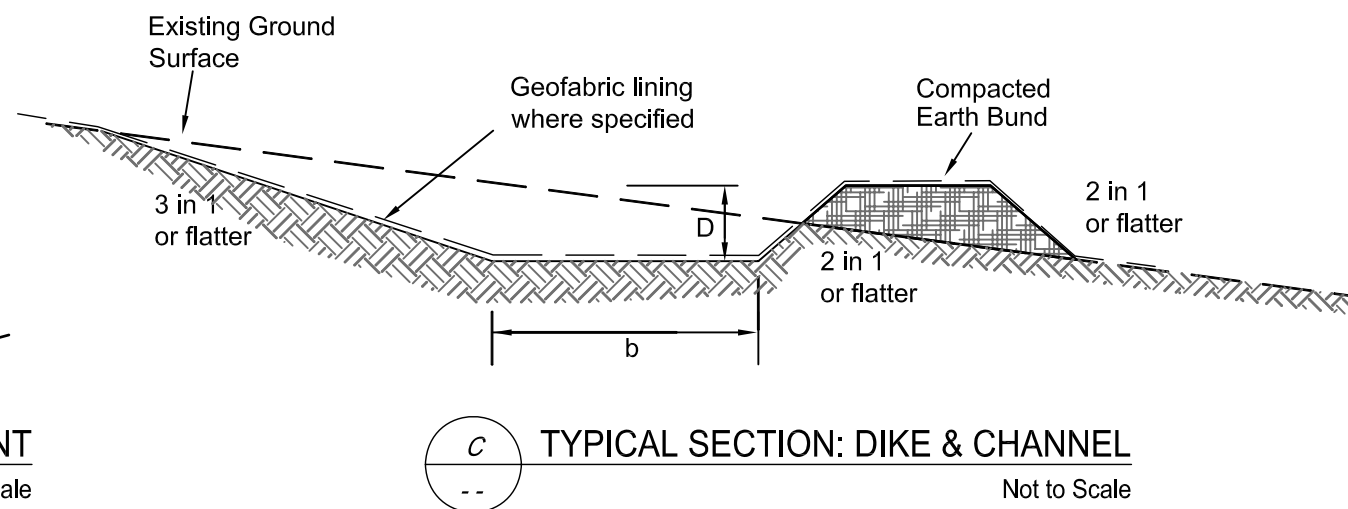
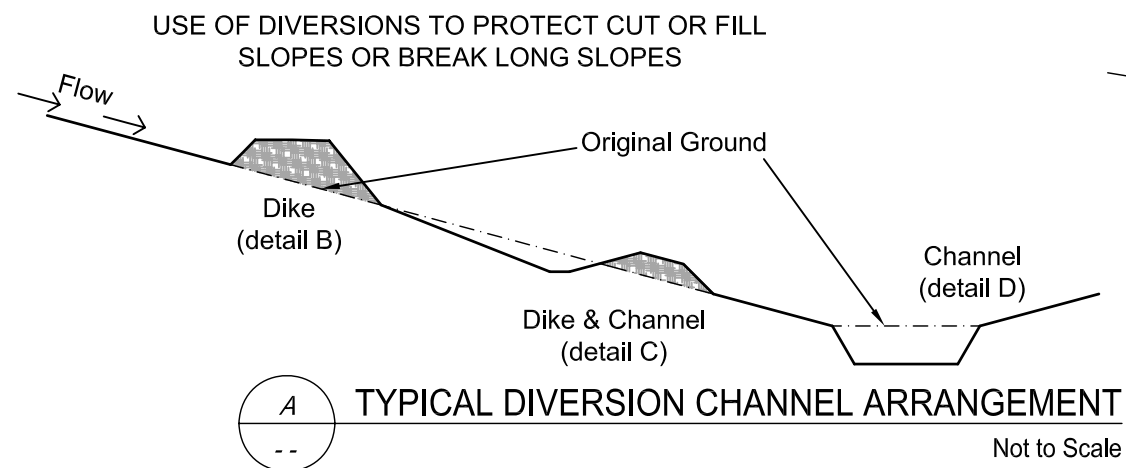
**Photo 6: Clean Runoff from Sumer Road**



**Photo 7: Western Outfall Discharge into Bay**



- Notes
1. All diversions where the gradient exceeds 2% are to be lined with Geofabric or other approved rolled erosion control products, or in accordance with Engineer's specifications.
  2. All lining will be installed in accordance with manufacturers' instructions.
  3. Clean water diversion unless specified otherwise will be lined.
  4. Clean water diversion installed initially can be converted to dirty water diversion at later stage of construction.



C	MINOR AMENDMENTS	RP	31.05.10
B	MINOR AMENDMENTS	RP	07.05.10
A	INITIAL ISSUE	RP	28.04.10
Revision		App	Date
Surveyed	--		--
Designed	FH		26.04.10
Drawn	NC		07.05.10
Reviewed	FH		07.05.10
Approved	ROB POTTS		07.05.10

Verify all dimensions on site before commencing work. Prioritise figured dimensions over scaling. Refer all discrepancies to the drawing office.

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CPG New Zealand Ltd  
236 Armagh Street  
Christchurch 8141  
Phone 03 374 6515  
Fax 03 374 6516  
christchurch@nz.cpg-global.com

Client



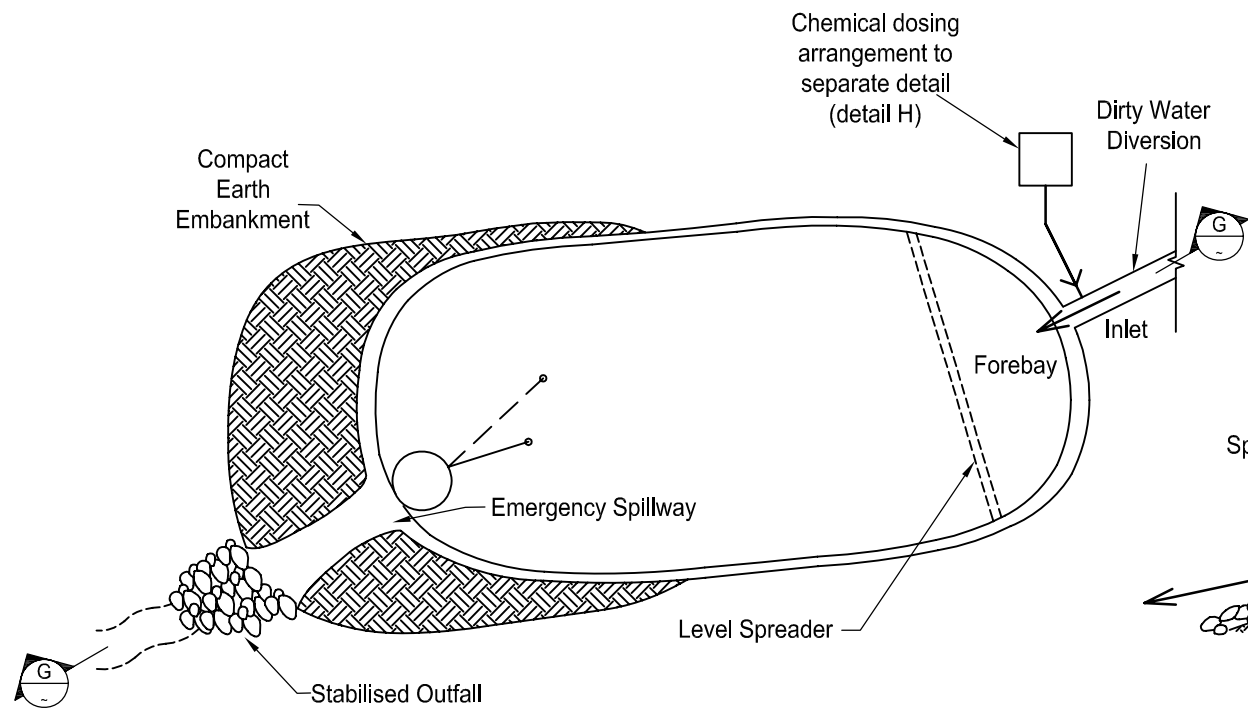
Lytelton Port of Christchurch

Project Title  
**L.P.C. RECLAMATION  
STORMWATER**

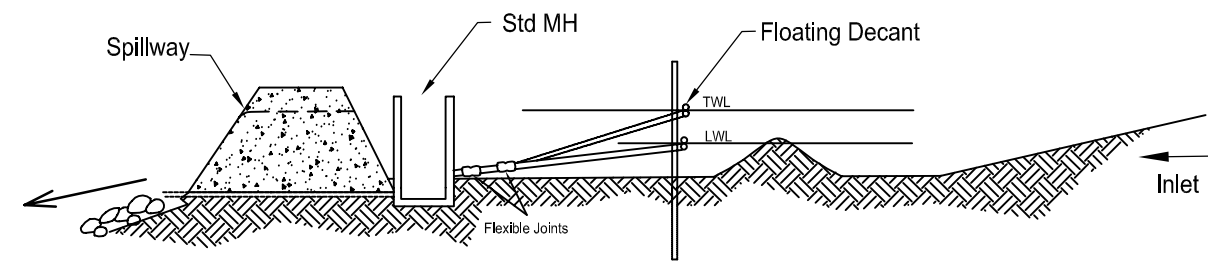
Sheet Title  
**CONCEPTUAL ESCP  
DETAILS  
(SHEET 1 OF 3)**

Scale ( A3 Original )  
**SCALE AS NOTED**

Project No	Sheet	Revision
701770	138	C

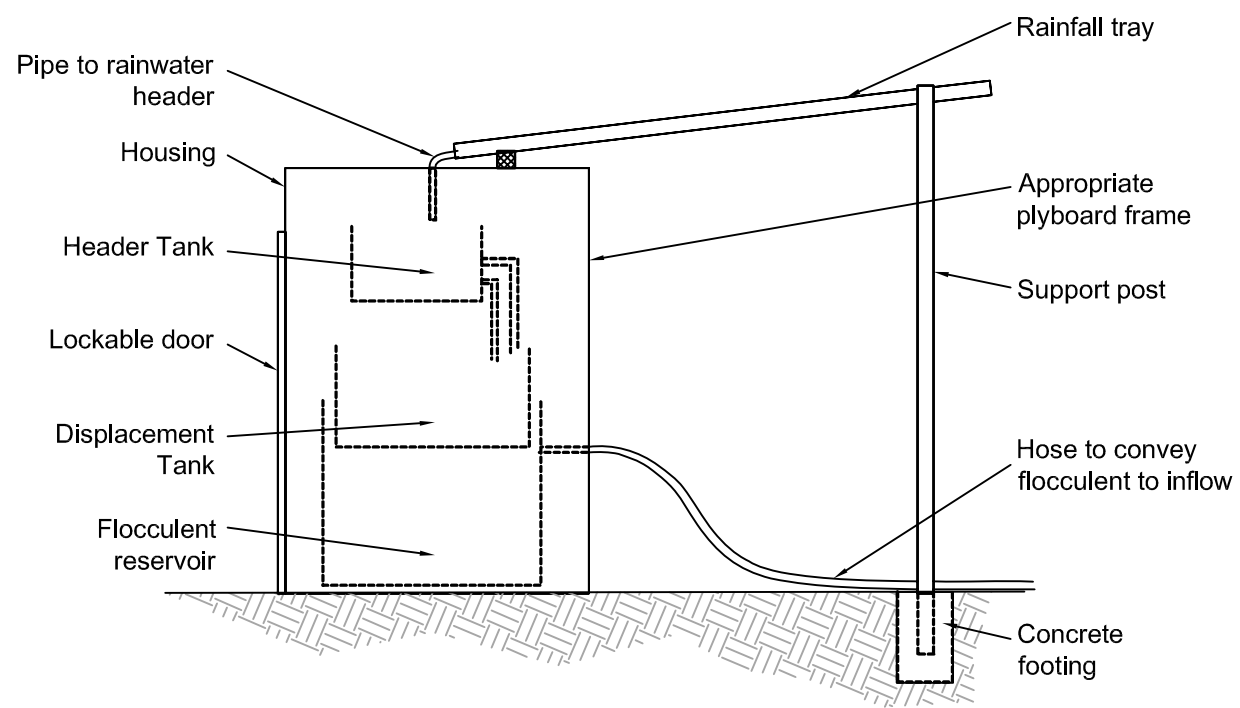


**F** PLAN: SEDIMENT RETENTION BASIN  
Not to Scale

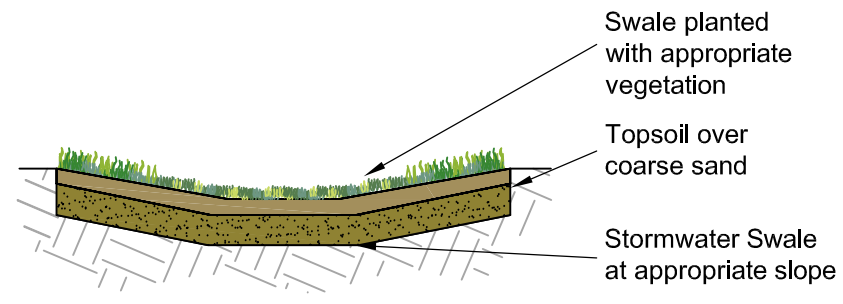


**G** SECTION: SEDIMENT RETENTION BASIN  
Not to Scale

- Note:
1. A forebay with a total volume of 10 to 20 percent of the design volume should be placed at the inlet to the sediment retention basin to allow coarse sediment to settle.
  2. No of decant and No of perforated tiles as per Table 7.8 of the ECAN Erosion & Sediment Control Guideline.



**H** RAINFALL ACTIVATED FLOCCULATION SYSTEM & HOUSING  
Not to Scale



**I** GRASSED SWALE  
Not to Scale

Revision	App	Date
C MINOR AMENDMENTS	RP	17.05.10
B MINOR AMENDMENTS	RP	07.05.10
A INITIAL ISSUE	RP	28.04.10

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236 Armagh Street  
Christchurch 8141  
Phone 03 374 6515  
Fax 03 374 6516  
christchurch@nz.cpg-global.com

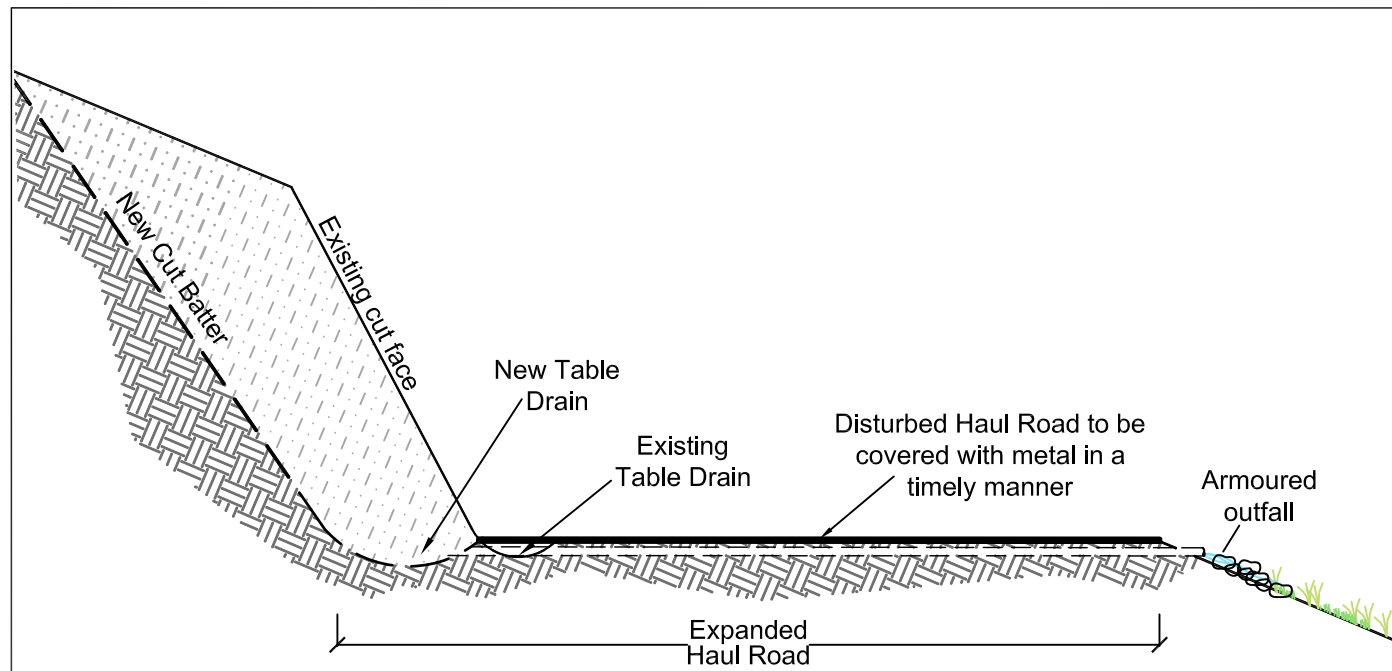
Client  
**Lpc** Lyttelton Port of Christchurch

Project Title  
**L.P.C. RECLAMATION STORMWATER**

Sheet Title  
**CONCEPTUAL ESCP DETAILS (SHEET 2 OF 3)**

Scale ( A3 Original )  
**SCALE AS NOTED**

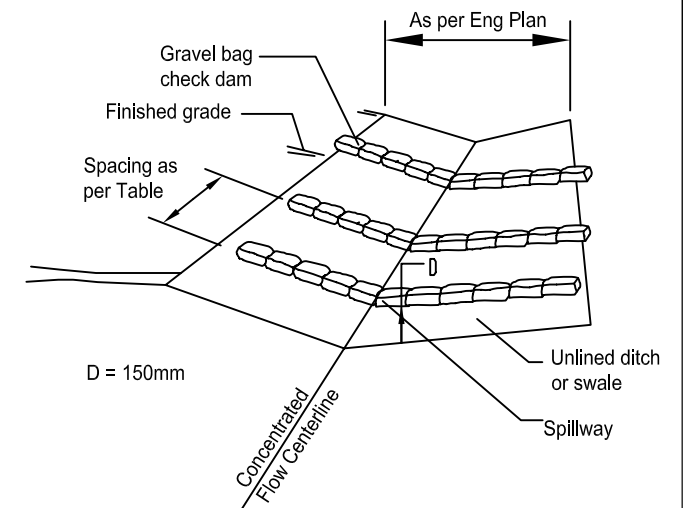
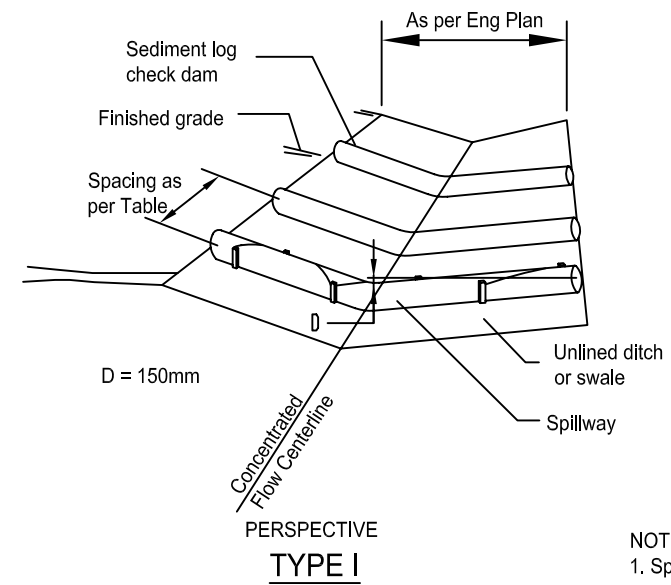
Project No	Sheet	Revision
701770	139	C



J  
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**SECTION: ROADING STORMWATER TREATMENT & DISPOSAL**

Not to Scale

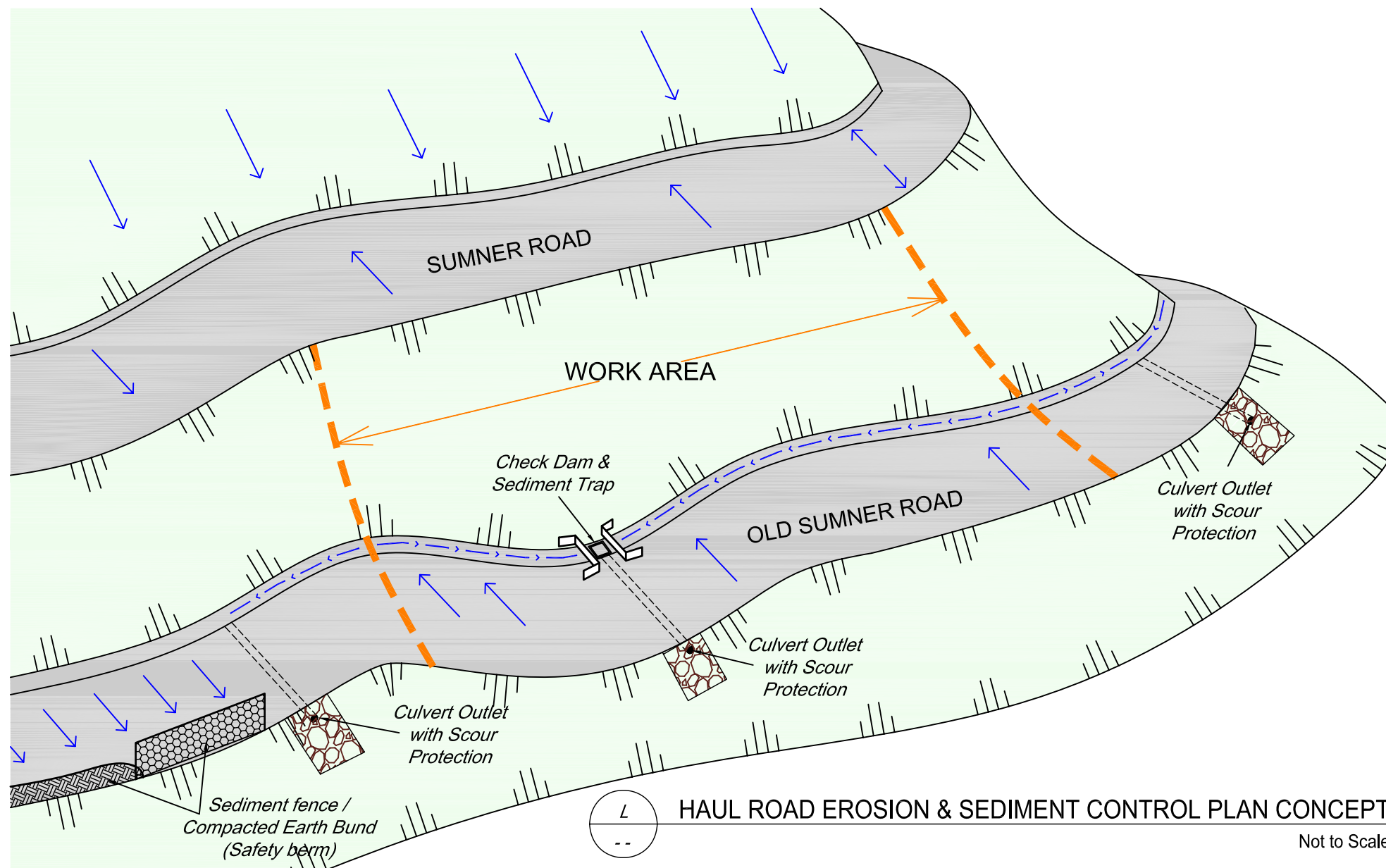


NOTES:  
 1. Spillway depth "D" shall be maintained to prevent flanking of concentrated flow around the ends of the check dam.  
 2. For check dam spacings refer to Ecan ESC guideline, Table 6.3.

K  
--

**TEMPORARY CHECK DAM**

Not to Scale



L  
--

**HAUL ROAD EROSION & SEDIMENT CONTROL PLAN CONCEPT**

Not to Scale

C	MINOR AMENDMENTS	RP	31.05.10
B	MINOR AMENDMENTS	RP	07.05.10
A	INITIAL ISSUE	RP	28.04.10
Revision		App	Date
Surveyed	~		~
Designed	FH		23.04.10
Drawn	NC		28.04.10
Reviewed	FH		29.04.10
Approved	ROB POTTS		29.04.10

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 236 Armagh Street  
 Christchurch 8141  
 Phone 03 374 6515  
 Fax 03 374 6516  
 christchurch@nz.cpg-global.com

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Project Title  
**L.P.C. RECLAMATION STORMWATER**

Sheet Title  
**CONCEPTUAL ESCP DETAILS (SHEET 3 OF 3)**

Scale ( A3 Original )  
**SCALE AS NOTED**

Project No	Sheet	Revision
701770	140	C