



Constellation Brands NZ Ltd

Hillersden Reservoir

**Technical Report in Support of Resource
Consent Application**



October 2016

MARLBOROUGH MANAGEMENT SERVICES LTD





Constellation Brands NZ Ltd

Hillersden Reservoir

Technical Report in Support of Resource Consent Application

October 2016

MARLBOROUGH MANAGEMENT SERVICES LTD

65 Cob Cottage Road
RD 4
Riverlands
BLLENHEIM 7274

Phone: (03) 577 5954
Fax: (03) 578 5481
Mobile: (021) 221 0003
E-mail: tim@smitventures.co.nz



TABLE OF CONTENTS

1.	<i>Terms of Reference</i>	1
2.	<i>Introduction/Background</i>	1
3.	<i>Proposed Reservoir Location</i>	1
4.	<i>Description of the Site and Geotechnical Conditions.</i>	1
5.	<i>Proposed Reservoir Layout / Configuration</i>	5
6.	<i>Reservoir Design</i>	6
6.1.	<i>Embankment</i>	6
6.2.	<i>Reservoir Spillway / Freeboard</i>	6
6.3.	<i>Reservoir Outlet and Inflow Pipelines</i>	7
6.4.	<i>Reservoir Drainage</i>	7
7.	<i>Dam Break Assessment and Effects</i>	7
8.	<i>Construction Methods</i>	10
9.	<i>Conclusion</i>	10
10.	<i>Applicability</i>	10
	<i>Appendix A – Concept Reservoir Plan and Cross Sections</i>	11
	<i>Appendix B – Test Pit Logs</i>	14

1. Terms of Reference

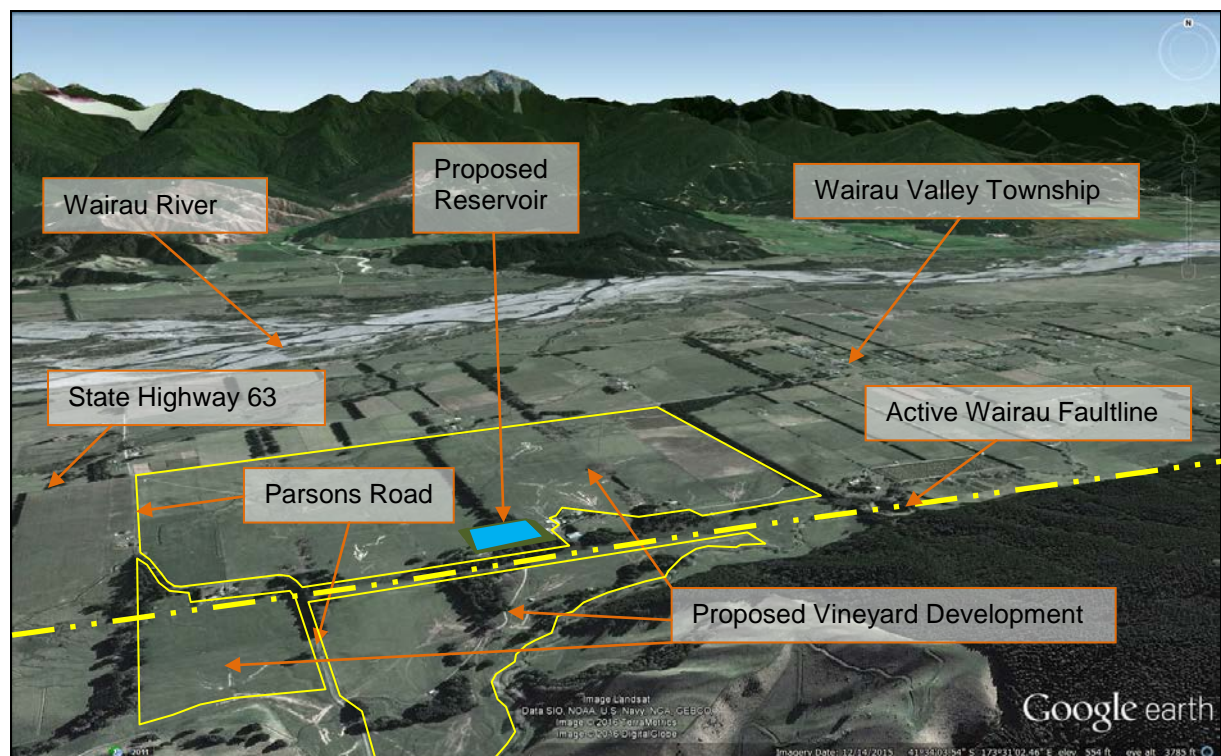
Marlborough Management Services Ltd has been engaged by Constellation Brands NZ Ltd to undertake the concept design and prepare a technical report for the proposed Hillersden storage reservoir. This report has been prepared for inclusion into the Resource Consent Application being prepared by RMCo Ltd.

2. Introduction/Background

Constellation Brands NZ Ltd requires this new storage reservoir to provide a secure supply of water for the irrigation of a proposed 164 hectare vineyard development on their property in the Wairau Valley. The property currently has a consent to take 5,011m³ of Wairau River Class A irrigation water (U150596). Back-up storage is therefore required in the event of the Wairau River water permit being restricted due to low river flows. Constellation Brands NZ Ltd are also applying for additional Class C water permits for filling of the reservoir.

3. Proposed Reservoir Location

The proposed reservoir is to be constructed some 1.9km south-west of the Wairau Valley township, on Section 4 Block IX Mt Olympus SD and Sec 5 and Pt 6 SO 1116 Hillersden Settlement Dist owned by Hillersden Vineyards Ltd and to be leased to Constellation Brands NZ Ltd. Refer to the locality plan below showing the location of the proposed reservoir relative to the proposed vineyard development, State Highway 63, the Wairau River and Wairau Valley township.



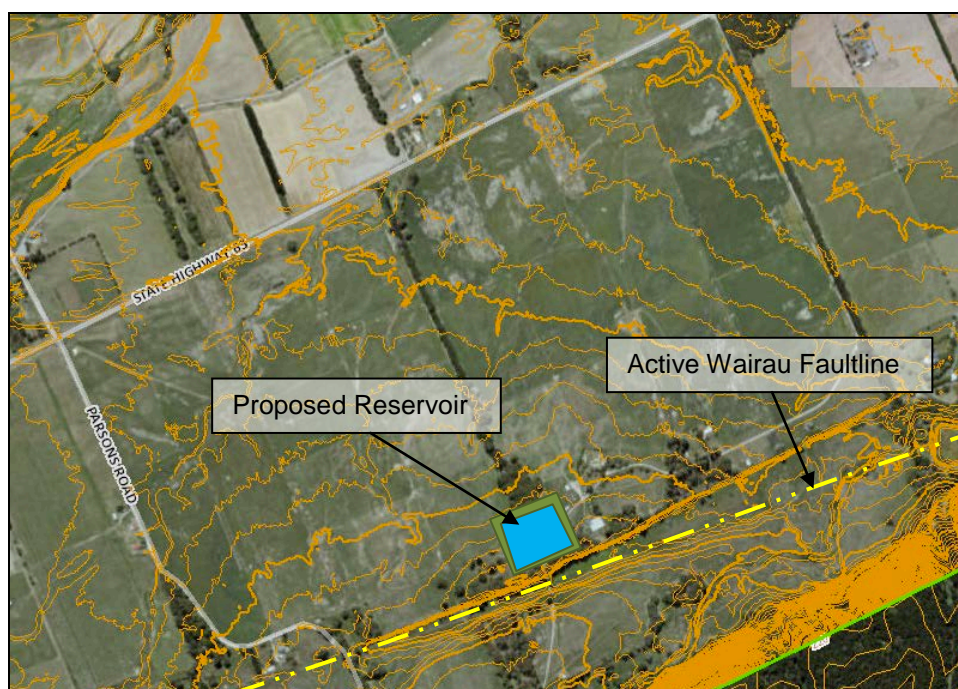
Locality Plan Looking North

4. Description of the Site and Geotechnical Conditions.

The new reservoir is proposed to be constructed close to the middle of the proposed vineyard, some 50m to the north of the active Wairau Faultline.

The landform in the location of the proposed reservoir is dominated by this faultline which exists in the form of an 8m high terrace bank falling away to the south of the reservoir.

The balance of the land to the north of the faultline fans out from a high point in the location of the reservoir north-westwards to SH63 as can be seen from the contours across the site shown in the next page.



Aerial photo with 1 m LIDAR contours showing general landshape and Wairau Faultline

The flat land to be occupied by the proposed reservoir was covered in grass pasture with large trees, which have recently been removed, with the exception of the trees on the fault line terrace bank.



Panorama photo looking south towards the proposed reservoir (note test pit locations).

Field investigations were carried out on 7 September 2016 with the help of a 20 tonne excavator and five test pits were dug around the site, with depths ranging from 4.8 to 5.6m. Refer to the concept reservoir plan, attached in Appendix A, which shows the location of the test pits (Test Pit A to Test Pit E).

Test pits A, C and E all show similar soil profiles, being:

- a 0.25m thick layer of dry, dark brown, silty topsoil with roots, over;
- a 0.35 to 2.15m thick layer of dry, yellow/brown, silty clay with minor fine gravel intrusions, over;
- a 1.1 to 2.3m thick layer of dry, yellow/grey sandy gravels ranging from 0 – 100mm with lenses of finer, open gravels ranging from 0-100mm. In Test Pit A the moisture in this sandy gravel increased with depth and a minor amount of water seeped out of the bottom of this layer. In Test Pits C and E this layer was dry.

- a 1.1 to 1.8m thick layer of moist, yellow/brown, silty clay, over;
- yellow/grey sandy gravels ranging from 0 – 100mm with lenses of finer, open gravels ranging from 0-100mm. In Test Pit A minor free water seeped out of this layer. In Test Pits C and E this layer was dry.



Photo of Test Pit A showing typical soil layers.



Photo showing material excavated from Test Pit A.

Test pits B and D also showed similar soil profiles, being:

- a 0.25 to 0.3m thick layer of dry, dark brown, silty topsoil with roots, over;
- a 3.65 to 4.0m thick layer of dry, yellow/grey sandy gravels ranging from 0 – 100mm with lenses of finer, open gravels ranging from 0-100mm.
- a 1.0m thick layer of moist, yellow/brown, silty clay, over;
- dry, yellow/grey sandy gravels ranging from 0 – 100mm with lenses of finer, open gravels ranging from 0-100mm. In Test Pit A free water seeped out of the bottom of this layer.

Although the test pits were excavated at the end of winter, of the five test pits excavated to around 5m depth, only Test Pit A revealed any subsurface water. The other four pits were all very dry.

Even Test Pit A did not intercept much groundwater and after 1.5 hours only some 100mm of water had collected in the bottom of Test Pit A, as can be seen from the photo below.



Photo showing water collected in Test Pit A after 1.5 hours.

Refer to Appendix B for detailed test pit logs.

The proposed reservoir site is close to the active Wairau Fault which runs some 50m to the south of the proposed reservoir site and has resulted in a 8m high terrace bank. Test Pit E was excavated as close to this bank as possible (without damaging the trees that were retained along the bank) to see whether any trace of the faultline could be found which would have a direct effect on the reservoir.



Photo looking west showing Test Pit E being excavated close to the Wairau Fault terrace bank (note fault follows the grassed hollow to the right of the photo)



Photo of Test Pit E showing uninterrupted horizontal deposition of soil layers

The soil profile in Test Pit E was found to consist of dry, uninterrupted horizontally deposited soil layers similar to the other four test pits excavated around the reservoir.

We are therefore reasonably confident that the actual fault trace does run along the bottom of the bank to the south of the reservoir and will be some 50m away from the toe of the proposed reservoir embankment.

However if, during construction of the reservoir, signs of a fault trace are found through the proposed reservoir footprint, then the reservoir will be moved northwards to avoid it.

Even with the fault line being outside the reservoir footprint, it could affect the reservoir by means of seismic instability or liquefaction, although the latter is unlikely due to the nature of the gravels which exist in this area. Liquefaction generally only occurs in areas with thick, uniformly graded, saturated sand and silt layers. All subsoil materials (with the exception of the deeper layers in Test Pit A) were found to be dry.

The impact of these seismic forces will be taken into account in the final reservoir design.

5. Proposed Reservoir Layout / Configuration

The new 60,000m³ reservoir is proposed to be constructed on the relatively flat land some 50m to the north of the Wairau Faultline.

For efficiency the reservoir is designed as a square.

To assist with draining the reservoir, the floor of the reservoir has been graded at 1% to a 0.5m deep sump in the north-eastern corner.

The reservoir has been designed with an average water depth of 6.8m and a maximum water depth of 7.8m due to the slope in the reservoir floor and the a 0.5m deep sump in the lowest corner.

The average embankment height is 2.6m. However, due to the slope of the underlying land, the maximum embankment height in the north-eastern corner is 4.4m and the minimum embankment height in the south-western corner is 0.7m. The invert of the reservoir sump is level with the toe of the faultline embankment, which allows the reservoir subliner drainage system to freely drain into the watercourse that follows the faultline, from pipework daylighting out of this lower terrace.

The completed reservoir occupies an area of some 2.14ha.

Please refer to the Preliminary Reservoir Plan and Typical Cross Sections, attached as Appendix A.

6. Reservoir Design

6.1. Embankment

The reservoir will be designed in accordance with the New Zealand Society of Large Dams (NZSOLD) Guidelines and will comply with all relevant legislation, including the Building Act.

As a lined reservoir, the reservoir embankment will be designed to meet stability requirements only, as the synthetic liner will replace the low permeability core commonly found in other earthfill dams. Without having completed this stability analysis, based on many other similar lined reservoirs successfully completed in the district, the embankment will likely have side slopes of 1m Vertical to 3m Horizontal inside and outside.

The crest is proposed to be 4m wide to facilitate access around the reservoir.

The maximum height of the wall, above natural ground level, will be 4.4m.

The earth embankments will consist of reworked, well compacted sandy gravels and gravelly sands, which will all be obtained from excavation within the proposed reservoir. Based on local experience on similar structures, the design allows for a 10% to 15% reduction of these materials from their natural state to a compacted state and should result in a near balance of cut to fill.

The total earth fill required for the reservoir has been estimated at 24,459m³ compared to a total combined cut volume of topsoil and material to be used as fill from within the reservoir of 33,079m³, allowing for topsoil removal and a bulking/compaction factor.

The sandy gravel and gravelly sand fill materials, mixed with the silty clay are good for building structural embankments, although the sandy gravel is clearly not good for retaining water. Hence it is proposed to line the reservoir with a continuously welded, 1.5mm thick, HDPE liner.

To protect the HDPE liner from possible punctures from the underlying sandy gravel fill the finished internal slope of the reservoir will be covered with a minimum 25mm layer of blinding material, prior to the placement of the liner. This blinding material will ideally be won from the sands and silts found on site, or alternatively may have to be imported.

The blinding layer on the inside faces of the reservoir needs to be a clean, easily worked material to provide a smooth layer, without any sharp stones that may puncture the HDPE liner, which will be placed directly onto it.

The liner will be anchored into a 0.6m deep, 0.6m wide anchor trench along the crest of the embankment.

All stripped topsoil will be placed on the outside face of the reservoir and grassed on completion.

6.2. Reservoir Spillway / Freeboard

Other than any precipitation which falls directly on the lined surface itself, the reservoir has no catchment area, as one would find with a dam on a river, stream or creek.

The reservoir will therefore have only a relatively small spillway, just to cope with this minimal rainfall capture, and to discharge any pumped water, if for some reason the pumps filling the reservoir were kept going after it was full.

The size of the spillway is therefore largely dictated by construction practicalities as the 1.5mm HDPE liner is relatively rigid. For these reasons, a 7.4m wide spillway is proposed with a 2m wide bottom and 1 in 3 sloped sides approximately at the eastern end of the southern embankment of the reservoir, where the spillway level will be 200mm below the natural ground. The water from this spillway will be channelled in a HDPE lined open channel across the ground in a southerly direction, before taking it all the way down the adjacent natural terrace embankment from where it will flow into the watercourse that exists here.

Freeboard is similarly not required for flooding reasons and is purely to cope with wave action. As the water surface when the reservoir is full is only 160m long, in the prevailing north-west/south-east wind diagonal directions, the fetch for wave formation is quite limited. A total freeboard of 0.9 metres is therefore deemed appropriate.

6.3. Reservoir Outlet and Inflow Pipelines

As mentioned earlier, the reservoir floor will be designed with a fall towards a 0.5 metre deep sump, in the north-eastern corner of the proposed reservoir. This sump will allow the majority of the water stored to be drawn for irrigation, without a suction vortex occurring at the pipe end.

The final outlet pipe underneath the embankment will be determined as part of the vineyard irrigation design, but is likely to be in the order of 200 to 250mm diameter.

The pipe will consist of continuously welded HDPE which will be installed in a reinforced concrete surround, to prevent deformation of the pipe due to the weight of 7.6m high trench backfill and embankment fill constructed over it.

Where the pipes enters the reservoir, the concrete surround will be finished to match the internal dam profile and a HDPE E-lock Channel will be cast into the concrete, to allow the liner to be “welded” to the concrete and its integrity to be continuous. In addition a “boot” made from the liner will be welded to the liner and strapped to the pipe with stainless steel straps.

The inflow pipeline is proposed to come over the reservoir wall and discharge into the reservoir above full water level. Hence, no liner penetration details will be required and this pipe will be added after the construction of the reservoir has been completed.

6.4. Reservoir Drainage

As can be seen from the typical cross sections on the concept dam drawings and the test pit logs, the dam floor has been designed to be above the anticipated winter groundwater table surface. However, as these pits were excavated at the end of a relatively dry winter, it is recognised that the estimated level of this surface may be higher. However, as it is likely that the reservoir will be constructed in late winter/early spring, the actual water level should become apparent during excavation of the reservoir.

It is therefore possible that minor water seepage into the lower part of the excavated reservoir may still occur when the water level rises above what was observed in September 2016. This water seepage could be above the final floor level and may therefore create problems during construction and may also result in water pressures lifting the liner when the completed reservoir is empty.

A sub liner drainage network will therefore be installed to avoid these problems, with the drainage outlet discharging out of the lower terrace bank north-east of the sump location.

This network will consist of perforated PVC pipes laid in drainage metal, wrapped in geotextile in the reservoir. Where the drainage pipes crosses under the reservoir embankment it will consist of a solid pipe with no perforations.

The water from the underfloor drainage network will be connected to and discharged into the watercourse that follows the faultline. In summer and at time of a low groundwater table, it is unlikely that any groundwater will be collected and drained into the stream. In winter, and at time of a high groundwater table some flow will be collected and discharged to the stream, but this will be limited to the top of the groundwater table and will not affect its level, or availability of this water for other users.

7. Dam Break Assessment and Effects

Most historic reservoir failures have resulted from either seismic events causing embankment rupture, or piping where a small “leak” progressively scours out till a partial or total failure occurs.

Due to their construction methods, synthetically lined, earthfill embankments have a much lower risk profile than normal earth fill dams. This is due to the fact that the HDPE liner is both flexible and strong, and even when ruptured, will not easily tear.

In addition, in the unlikely event of a small hole in the liner occurring, the gravel embankment fill and gravel subgrade under the proposed embankments have a relatively high permeability, allowing some seepage of the water from a hypothetical liner rupture to occur within the fill structure, without structural failure of the embankment.

Such seepage will be picked up by the sub liner drainage and a sudden increase in flows from this system would provide an early warning that a small liner failure may have occurred, allowing the reservoir to be drained and repairs to be undertaken. It is therefore important that following construction, monitoring of the sub liner drainage outlet is undertaken on a programmed regular basis.

Well compacted silty gravel embankments also have a high internal structural strength, even when relatively saturated, and hence the chances of slumping of the fill during seismic events, will be less than in finer earth fills.

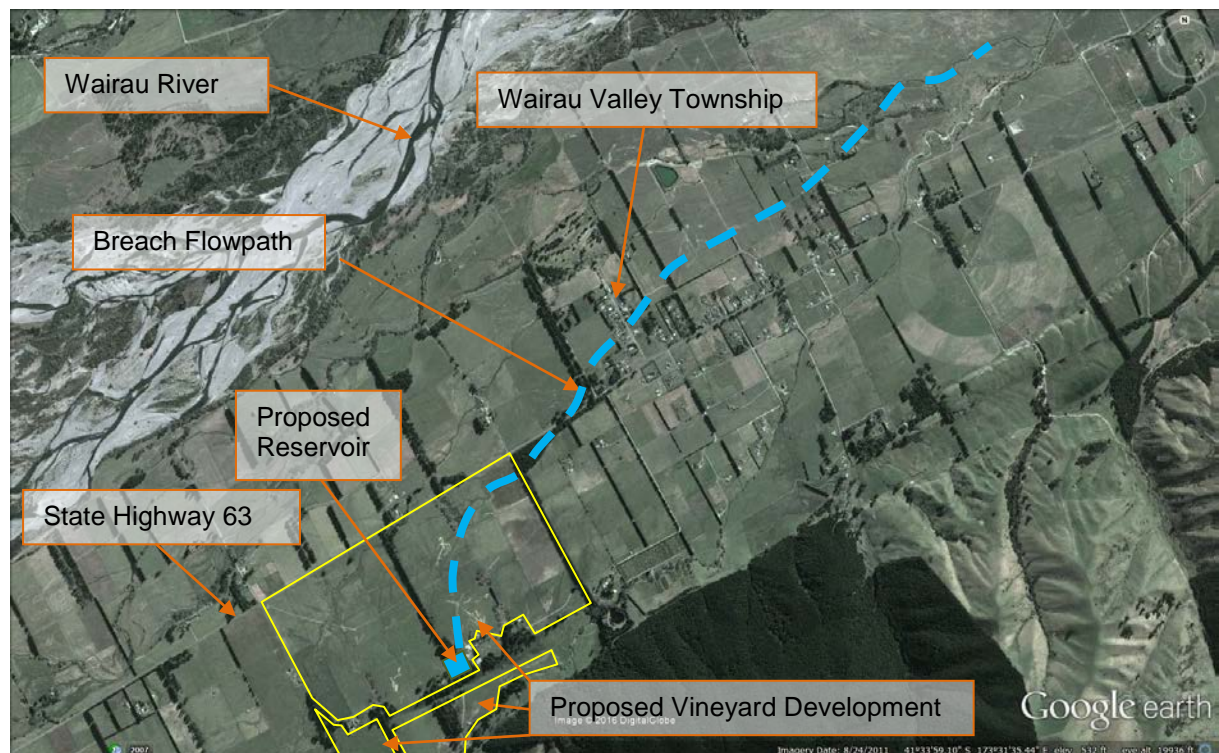
It should however be noted that the reservoir sits close to the active Wairau Fault line.

Reservoirs will generally fail during a significant seismic event where the embankment is at its highest, due to increasing water pressure on the embankment with increasing head.

In the case of the proposed reservoir, the highest embankment is in the north-eastern corner, where the embankment 4.4m high.

Hence, in the unlikely event of a failure, it is most likely to occur in this north-eastern corner and water escaping will discharge onto the Constellation Brands NZ Ltd vineyards and from there flow in a north-westerly direction to the Highway and an unnamed watercourse and follow this watercourse to Keith Coleman Lane and the lower areas of the Wairau Valley township, and ultimately through other vineyards to the Wairau River, as shown on the marked-up aerial photo below.

Dam break assessments are carried out to assess a proposed dam's downstream hazard potential so as to set the standard of design and construction required. It must be stressed that they are hypothetical assessments only, which do not reflect the chances of the failure ever occurring.

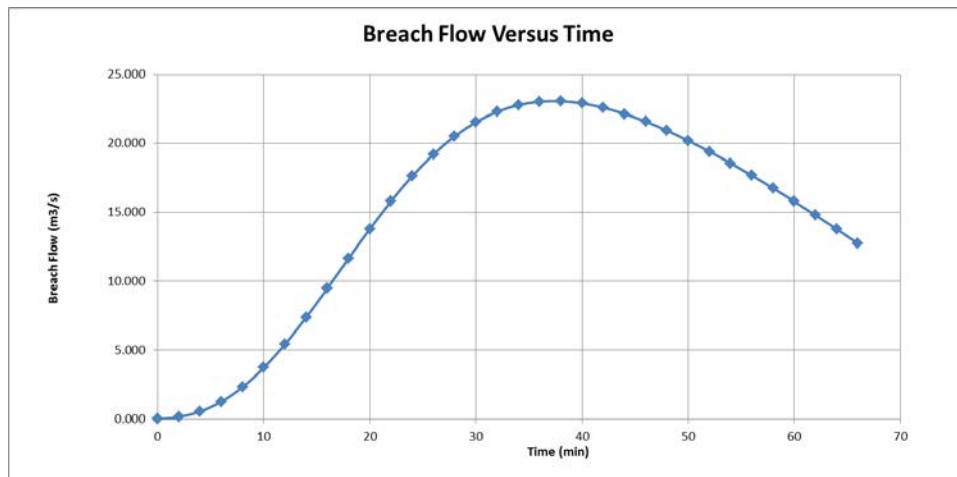


Plan Showing Breach Flowpath

In this case the dam break assessment has been assumed for a worst case scenario, 30 minute full breach development, which is a reasonable time for a well constructed zoned earth embankment lined with synthetic liner. This is because the liner will still provide some resistance to scour of the fill behind it.

The reservoir was also assumed to be full at the time of the breach and that the breach will only cut down to the level of the lower terrace, which is still 4.3m above the floor of the reservoir sump.

The dam break assessment has resulted in a peak outflow of 23m³/s as shown in the graph on below.



Breach Flow Versus Time Curve

This flow steadily increases from nothing to the estimated peak of 23m³/s over some 38 minutes, after which it reduces back down over a slightly longer period.

The breach flows will discharge to the Wairau River some 7.2km to the north-east. To reach the river the breach flows will likely follow the slope of the land and an unnamed ephemeral watercourse. Looking at the relatively shallow watercourse and flat land on either side, it is anticipated that the majority of breach flow will consist of shallow sheet flow over the land.

Assuming a flow width of 40m with sloping sides at 10 to 1 a flow depth of some 0.44m would carry this flood flow at the valley gradient of 1 in 175 and a velocity of 1.1m/s immediately downstream of the breach, but this will reduce, due to retention behind the highway and other obstructions, as the breach flow progresses downstream.

Reviewing the effect of a breach against Tables 1 and 2 of the Building (Dam Safety) Regulations 2008 we note the following:

- The breach flow will enter the Wairau River and natural river flood flows far exceed the breach flows. For comparison, the 1 in 2 year flood flow in the Wairau River is in the order of 2,000m³/s and a 1 in 100 year flood is 5,500m³/s (data from MDC's Floodwatch System). In the vicinity of the reservoir the river bed is in the order of 400m wide and hence the 23m³/s breach flow would only raise the water depth by some 58mm. Hence, there is likely to be little or no damage to the natural Wairau River environment from such a breach.
- The unnamed ephemeral watercourse, into which this breach water will flow, runs through pastoral and vineyard land until it reaches the Wairau Valley township, where there are residential houses, a school and a golf course in the proposed breach flow path and hence there could be some minor damage to these.
- There are no large infrastructure assets in the proposed breach flow path and hence there will be no damage to any.
- There is a risk associated with people which could be within the watercourse, vineyard or the Wairau Valley township areas downstream of the breach, however, the low depth of flood flow and duration from start to peak would rapidly reduce, as the flow progresses downstream. The population at risk is deemed between zero and 1 to 10 in the unlikely event that someone would be caught downstream of the breach in an area where the flow depth and velocity would make it difficult to get out safely.

It is our opinion that the relative resistance to scour of the drained compacted reworked sandy gravel embankment fill as well as the scour protection of the HDPE liner to the fill during a breach would make it less likely that a full breach would occur in a period as short as 30 minutes. We have been involved with lined reservoirs which have had concentrated leaks in the past. These had developed as tears in the liner and in all cases these had not developed/increased quickly and have been picked up through increases in discharge in the underliner drainage network and were repaired before they became a serious problem.

Based on the size of the reservoir, and the review above, the reservoir has been assessed as having a Medium Potential Impact Category (PIC), albeit it at the low end of the of Medium.

8. Construction Methods

The reservoir will be constructed in accordance with the New Zealand Society of Large Dam Guidelines by a contractor experienced with this type of work. The reservoir construction will also be under a standard civil engineering construction contract with adequate supervision by a representative of the design firm, allowing a Construction Producer Statement to be provided.

Construction will largely be undertaken with excavators, trucks and vibrating roller compactors to ensure the earth fill meets recognized compaction criteria.

On completion of earth filling, the inside surface of the reservoir will be "dressed" with a minimum of 25mm of sand or silt blinding layer to provide a smooth profile, prior to the placing of the liner.

The HDPE liner will be placed and the edges of adjacent sheets welded by a recognized/certified installer using double track fusion welds, and all welds will be air tested prior to the initial filling of the reservoir, to ensure the total integrity of the liner.

Quality Control records will be kept of all earth fill compaction and liner placement and welding.

To minimise the impact of the work on surrounding properties, adequate dust and silt erosion/run-off control will be required to be put in place through the Contract Conditions.

9. Conclusion

Synthetically lined gravel and earth fill reservoirs have been successfully constructed and operated in Marlborough, other parts of New Zealand and the world for many years.

They are recognized as safe structures, which also provide a high water quality at reasonable costs.

The proposed reservoir is in close vicinity to the active Wairau Fault line and it is deemed a medium hazard structure as defined in New Zealand Society of Large Dam Guidelines, due to its design, and downstream development affected by the hypothetical breach flows.

In our opinion, there are no technical reasons for Council not to grant resource consent for this proposed reservoir.

We trust this provides the information you require, but if there are any questions relating to this report, do not hesitate to contact the undersigned.

10. Applicability

This report has been prepared for the benefit of Constellation Brands NZ Ltd with respect to the particular brief given to us and it may not be relied upon by any other party, other than the Marlborough District Council, in other contexts or for any other purpose without our prior review and arrangement.

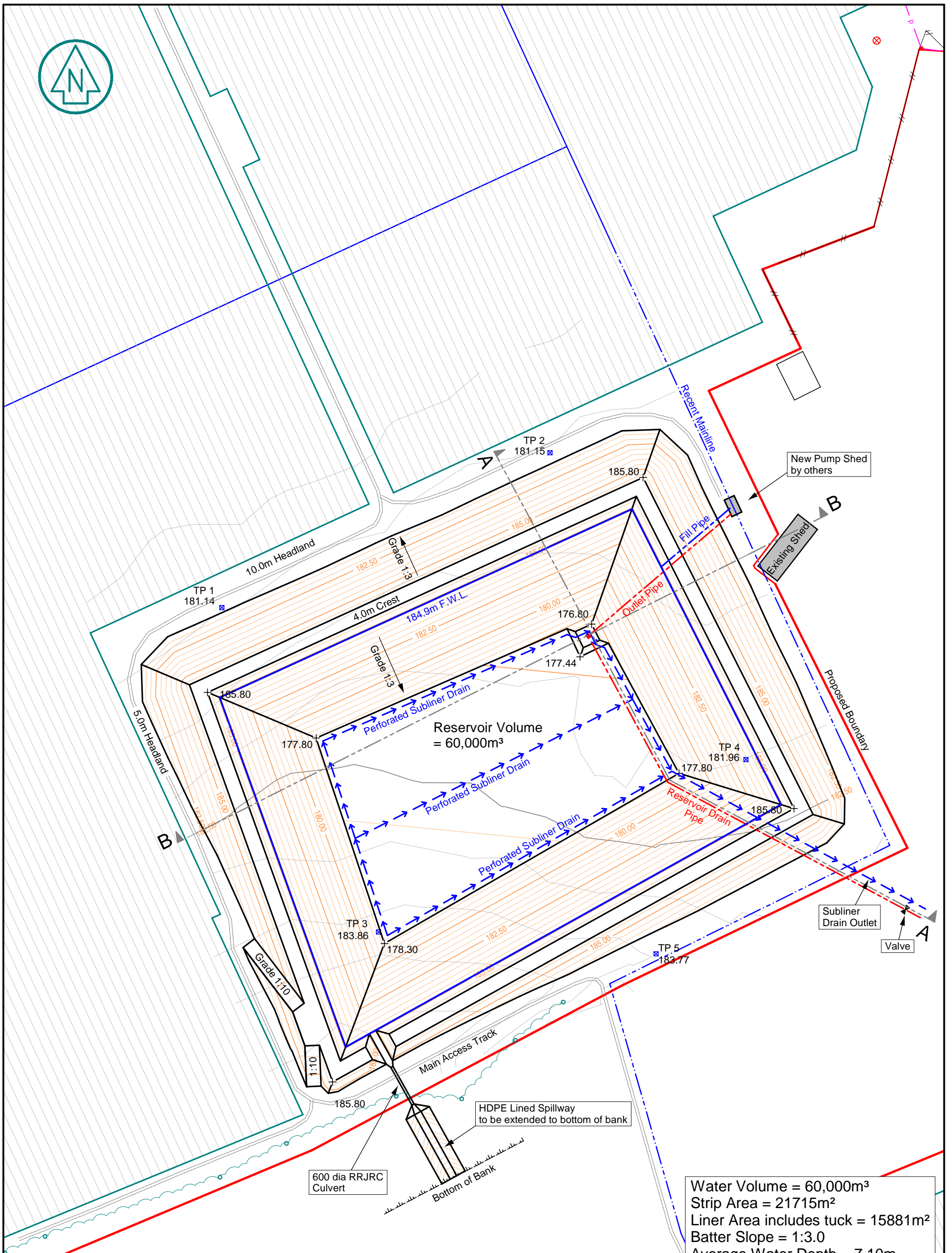
MARLBOROUGH MANAGEMENT SERVICES LTD

Report prepared by:



T H Smit

Appendix A – Concept Reservoir Plan and Cross Sections



Reservoir Volume = 60,000m³

Water Volume = 60,000m³
 Strip Area = 21715m²
 Liner Area includes tuck = 15881m²
 Batter Slope = 1:3.0
 Average Water Depth = 7.10m
 Free Board 0.90m
 Crest = 4.0m
 Cut = 33092m³
 Fill = 24704m³

MARLBOROUGH MANAGEMENT SERVICES
 2 Cob Cottage Rd
 RD 4, Riverlands
 Blenheim, 7274
 Phone (03) 5775954
 Fax (03) 5785481
 Mobile (021) 221 0003
 E-mail tim@smitventures.co.nz



Note: Levels are in Terms of BM R33 (AD5A) being 175.209m in terms of the NVD 1955

SCALE 1:1000 - A3

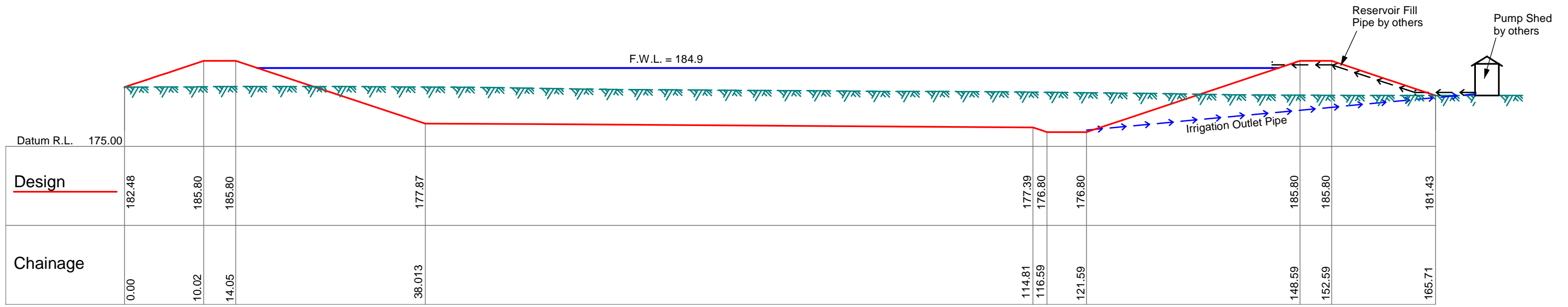
DATE 17/10/2016 DRAWN Chris Williams

JOB REF 9735

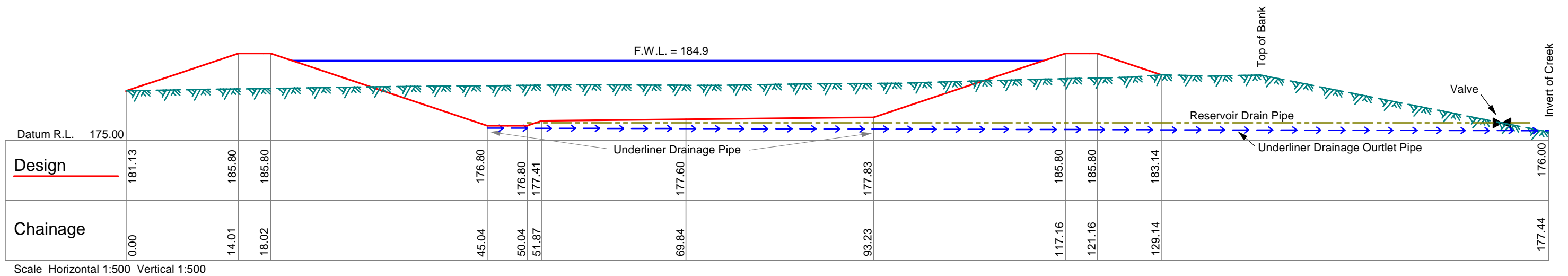
CAD FILE HILLERSDEN - RESERVOIR

PREPARED BY:
GILBERT, HAYMES & ASSOCIATES LTD
 REGISTERED SURVEYORS
 P.O.BOX 380 - 14 QUEEN STREET - BLENHEIM
 PHONE (03)5787984 - FAX (03)5787709
 E-MAIL office@gilberthaymes.co.nz

Constellation Brands NZ
Hillersden Block
Proposed Reservoir



X-Section B - B



X-Section A - A

PREPARED BY:
[GILBERT, HAYMES & ASSOCIATES LTD](http://www.gilberthaymes.co.nz)
 REGISTERED SURVEYORS
 P.O.BOX 380 - 14 QUEEN STREET - BLENHEIM
 PHONE (03)5787984 - FAX (03)5787709
 E-MAIL office@gilberthaymes.co.nz

MARLBOROUGH MANAGEMENT SERVICES
 2 Cob Cottage Rd
 RD 4, Riverlands
 Blenheim, 7274
 Phone (03) 5785481
 Fax (103) 5785481
 Mobile (021) 221 0003
 E-mail tim@smitventure.co.nz



Constellation Brands NZ
Hillersden Block
X-Sections

SCALE: As Above	- A3	DATE 17/10/2016
DRAWN Chris Williams	JOB REF 9735	
CAD FILE HILLERSDEN - X-SECTIONS		

Appendix B – Test Pit Logs

Constellation Brands NZ Ltd		
Hillersden		
Trial Pit Log No.	A	
Date	Thursday, September 8, 2016	
Equipment	20t Excavator	
Depth	Graphic Log	Description
0		
0.1		Dark brown, silty topsoil with roots, dry
0.2		
0.3		
0.4		
0.5		
0.6		Yellow/brown silty clay, firm, dry
0.7		
0.8		
0.9		
1		
1.1		Yellow/grey sandy gravel (0-100mm) with increasing dampness with depth
1.2		
1.3		
1.4		
1.5		
1.6		
1.7		
1.8		
1.9		
2		
2.1		
2.2		
2.3		
2.4		
2.5		
2.6		
2.7		
2.8		
2.9		
3		Yellow/brown silty clay, firm, moist
3.1		
3.2		
3.3		
3.4		
3.5		
3.6		
3.7		
3.8		
3.9		
4		Brown silt bound gravel (0-100mm), wet
4.1		
4.2		
4.3		
4.4		
4.5		
4.6		
4.7		
4.8		
4.9		
5	Bottom of Pit	100mm water collected after 1.5 hours
5.1		
5.2		
5.3		
5.4		
5.5		
5.6		
5.7		
5.8		
5.9		
6		

Constellation Brands NZ Ltd		
Hillersden		
Trial Pit Log No.	B	
Date	Thursday, September 8, 2016	
Equipment	20t Excavator	
Depth	Graphic Log	Description
0		
0.1		Dark brown, silty topsoil with roots, dry
0.2		
0.3		
0.4		
0.5		
0.6		
0.7		
0.8		
0.9		
1		
1.1		
1.2		
1.3		
1.4		
1.5		
1.6		Yellow/grey sandy gravel (0-100mm) with increasing dampness with depth
1.7		
1.8		
1.9		
2		
2.1		
2.2		
2.3		
2.4		
2.5		
2.6		
2.7		
2.8		
2.9		
3		
3.1		Yellow/brown silty clay, firm, moist
3.2		
3.3		
3.4		
3.5		
3.6		
3.7		
3.8		
3.9		
4		
4.1		
4.2		
4.3		
4.4		
4.5		
4.6		
4.7		
4.8		
4.9		
5		Brown silt bound gravel (0-100mm), wet
5.1		
5.2	Bottom of Pit	Dry - No free water
5.3		
5.4		
5.5		
5.6		
5.7		
5.8		
5.9		
6		

Constellation Brands NZ Ltd			
Hillersden			
Trial Pit Log No.	C		
Date	Thursday, September 8, 2016		
Equipment	20t Excavator		
Depth	Graphic Log	Description	
0			
0.1		Dark brown, silty topsoil with roots, dry	
0.2			
0.3			
0.4			
0.5			
0.6			
0.7			
0.8			
0.9			
1			
1.1			
1.2			
1.3			
1.4			
1.5			Yellow/brown silty clay, firm, dry
1.6			
1.7			
1.8			
1.9			
2			
2.1			
2.2			
2.3			
2.4			
2.5		Yellow/grey sandy gravel (0-100mm) with increasing dampness with depth	
2.6			
2.7			
2.8			
2.9			
3			
3.1			
3.2			
3.3			
3.4			
3.5			Yellow/brown silty clay, firm, moist
3.6			
3.7			
3.8			
3.9			
4			
4.1			
4.2			
4.3			
4.4			
4.5		Yellow/brown silty clay, firm, moist	
4.6			
4.7			
4.8			
4.9			
5			
5.1			
5.2			
5.3			
5.4			
5.5			Bottom of Pit Dry - No free water
5.6			
5.7			
5.8			
5.9			
6			

Constellation Brands NZ Ltd			
Hillersden			
Trial Pit Log No.	D		
Date	Thursday, September 8, 2016		
Equipment	20t Excavator		
Depth	Graphic Log	Description	
0			
0.1		Dark brown, silty topsoil with roots, dry	
0.2			
0.3			
0.4			
0.5			
0.6			
0.7			
0.8			
0.9			
1			
1.1			
1.2			
1.3			
1.4			
1.5			Yellow/grey sandy gravel (0-100mm) with increasing dampness with depth
1.6			
1.7			
1.8			
1.9			
2			
2.1			
2.2			
2.3			
2.4			
2.5			
2.6			
2.7			
2.8			
2.9			
3		Yellow/brown silty clay, firm, moist	
3.1			
3.2			
3.3			
3.4			
3.5			
3.6			
3.7			
3.8			
3.9			
4			
4.1			
4.2			
4.3			
4.4			
4.5		Brown silt bound gravel (0-100mm), wet	
4.6			
4.7			
4.8			
4.9			
5			
5.1			
5.2			
5.3			
5.4			
5.5			
5.6			
5.7	Bottom of Pit		Dry - No free water
5.8			
5.9			
6			

Constellation Brands NZ Ltd		
Hillersden		
Trial Pit Log No.	E	
Date	Thursday, September 8, 2016	
Equipment	20t Excavator	
Depth	Graphic Log	Description
0		
0.1		Dark brown, silty topsoil with roots, dry
0.2		
0.3		
0.4		
0.5		
0.6		Yellow/brown silty clay, firm, dry
0.7		
0.8		
0.9		
1		
1.1		
1.2		
1.3		
1.4		
1.5		
1.6		Yellow/grey sandy gravel (0-100mm) with increasing dampness with depth
1.7		
1.8		
1.9		
2		
2.1		
2.2		
2.3		
2.4		
2.5		
2.6		Yellow/brown silty clay, firm, moist
2.7		
2.8		
2.9		
3		
3.1		
3.2		
3.3		
3.4		
3.5		
3.6		Brown silt bound gravel (0-100mm), wet
3.7		
3.8		
3.9		
4		
4.1		
4.2		
4.3		
4.4		
4.5		
4.6		Yellow/brown silty clay, firm, moist
4.7		
4.8		
4.9		
5		
5.1	Bottom of Pit	100mm water collected after 1.5 hours
5.2		
5.3		
5.4		
5.5		
5.6		
5.7		
5.8		
5.9		
6		