ANNEXURE F (I):

STORMWATER MANAGEMENT CONCEPT

ocdl
O'Callaghan Design Ltd
3 Lochiel Rd
Khandallah
Wellington, 6035
Phone: 04 479 0000
Email: ray@ocallaghandesign.nz

12th June 2017

Kim McCracken & Associates
PO Box 2551
CHRISTCHURCH

Attention: Kim McCracken

JOHNS ROAD CAR STORAGE PROJECT – SECTION 92 RESPONSE – ENGINEERING MATTERS

Further to CCC's letter dated 5th May, we set out our response to the various engineering questions below.

3 Truck Wash Issues

Council has requested additional information on the frequency of use of the truck wash and the expected volume of water (and waste) used for the truck wash.

The truck wash is primarily for washing the delivery trucks and is not used very often for washing cars stored on the site. It is expected that the truck wash will be used approximately 20 times per week. The truck wash uses approximately $0.2m^3$ of water for each wash, resulting in a weekly use of $4m^3$. This water will be supplied from the on-site water storage tank.

The waste water from the truck wash will be directed to a settlement tank to settle out sediment. The settlement tank will have a capacity of 2 days detention to achieve good solids settlement. The outlet from the settlement tank will be to a suitable sized soakage trench.

4 – 6 Stormwater Disposal

We attach a copy of the report, prepared by E2 Environmental Consulting Engineers, that deals with the results from their on-site soakage testing and an amended basin design. As can be seen from the E2 report, the onsite soakage was found to vary between 1,200mm/hr to 2,000mm/hr. They have adopted a shallower first flush basin (0.5m) to minimize the time that it will take to empty the first flush basin and they have adopted a combined detention/infiltration basin solution for the flows greater than the first flush flow to reduce the size of the detention basins, and thus reduce the duration of any ponded water in the retention basins. Their proposed amendments have been adopted and drawing C304 Rev 8 shows the general position of each first flush and detention basin for each of the six catchments. The E2 report includes preliminary basin sizing and details of the graded filtration metal in the basins, which will be to CCC approval.

7 Fire Fighting Provisions

As there is no firefighting reticulation in the vicinity of the site, it is proposed to install a storage capacity of $90m^3$ (3 * 30,000l tanks) on the site. This will meet the FW2 fire-fighting requirement plus provide water storage for the truck wash.

The proposed building will be fitted with sprinklers and is not going to be used for the storage of any notable quantity of flammable materials/liquids. The building is a mixture of office space and car grooming/maintenance and, with a sprinkler system, is expected to meet the FW2 standard at time of detailed design, when a specific fire hazard assessment will be carried out.

The storage tanks will be feed from roof water collection if it is not possible to re-activate one of the existing small water bores on the site.
Yours faithfully

Ray O'Callaghan
CPEng
O'Callaghan Design Ltd

CAR DISTRIBUTION GROUP LTD

12 June 2017

711 JOHNS ROAD

Review of Stormwater Management Concept

e2 environmental CONSULTING ENGINEERS

12 June 2017

CAR DISTRIBUTION GROUP LTD
711 JOHNS ROAD

Review of Stormwater Management Concept

Quality Control			
Author	*Lindsay Blakie*	Client	*Car Distribution Group Ltd*
Reviewed by	*Bevan Pratt*	Date Issued	*12 June 2017*
Approved by	*Lindsay Blakie*	Revision No.	*3*
Doc Name/Location	*rpt 170607 711 Johns Rd SW Review Rev3.docx*		

Disclaimer
This report has been prepared solely for the benefit of Car Distribution Group Ltd. No liability is accepted by e2Environmental or Car Distribution Group Ltd if information contained in this report is used by any third party.

© Copyright e2Environmental Ltd
All rights are reserved. This publication may not be copied or reproduced in any form without the permission of Car Distribution Group Ltd. Permission will only be given within the terms and conditions of the contract with e2Environmental and Car Distribution Group Ltd. This copyright extends to all forms of storage including any sort of storage retrieval system.

© e2Environmental Ltd 2017

Table of Contents

1 Summary

The soakage testing, completed by e2environmental in May 2017, achieved significantly higher soakage rates that previously assumed for this site, with soakage likely to be between 1,200 mm/hr and 2,000 mm/hr near the site boundaries.

We have reviewed the previous conceptual designs. As part of our review we considered longer duration ponding in the first flush basins (to minimise the extent required) and using rapid soakage chambers to do away with attenuation basins.

Our design solution is similar to what has been previously proposed with all runoff is pre-treated in swales before discharging to first flush basins that soak via filter media to land. However, the runoff in excess of the first flush will be diverted, by splitter box, into a partial attenuation basin which in turn discharges runoff directly to the underlying free draining gravels (via a gravelled covered invert or by an overflow structure with subsoil discharge drains in the invert of the basin).

Our design results in a slightly longer first flush basin extent and partial attenuation basins with significantly reduced extent.

Our calculations show that the revised designs do not surcharging of the stormwater basins in 2% Annual Exceedance Probability (AEP) storms. So there is no ponding or flooding on the surrounding pavement.

As the six catchments are of similar size our assessment is based on analysis of just the largest catchment (of 1.9ha). Our recommendations are to inform the conceptual design phase. There will be further analysis and refinement for each catchment during the detailed design phases to achieve the final arrangement of the stormwater management areas.

2 Background

The Car Distribution group are proposing to develop this 10 ha site into a large carpark with multiple catchments discharging to land via pre-treatment swales to first flush infiltration basins and to land in attenuation basins.

The site is situated on an old quarry that has been filled with uncontrolled fill to a depth of less than or equal to 8m below surface[1]. The pavement proposal will have a long ridge along the centre of the site and drain runoff to the outside boundaries for stormwater treatment and disposal (see Appendix A). This will potentially allow the stormwater rapid soakage systems to be located in undisturbed gravels at the boundary of the site and will prevent any soakage of stormwater into the uncontrolled fill in the centre of the site.

A draft engineering servicing report was prepared by Orogen Ltd for the resource consent application (RMA 2017 765) and assumed:

- Full first flush treatment (25mm) from individual catchments by swales then via an engineered soil filter media in infiltration basins.
- Stormwater runoff volumes in excess of the first flush would be attenuated in basins and soaked to land.

[1] Ref. Geophysical Ground Condition Report, RDCL, June 2016

- In long duration events greater than the 12 hour 2% AEP event, runoff would be allowed to surcharge out of basins and pond on the adjacent pavement. Peak storage volume, and flooding, was assumed to occur at the 36 hour duration 2% AEP event.
- Calculations are based on an average soakage rate of 25mm/hr in the underlying soils.

The engineering servicing report is silent on possible potential of the stormwater basins to attract birds and it may have been excluded from Orogen's scope. However, given the proximity to the Christchurch International Airport, the stormwater system at this site is likely to assessed under the city plan for bird strike potential. The following standards apply in business zones (and are likely to be given regard in CCC assessment at this site):

- The design, operation and management of the stormwater system shall avoid attracting bird species which constitute a hazard to aircraft;
- Stormwater infiltration basins are designed to fully drain within 48 hours of the cessation of a 2% AEP storm event;
- Rapid soakage overflow chambers in sufficient numbers and with sufficient capacity to minimise any ponding of stormwater outside the infiltration basin areas;
- The use of plant species within the basin (including its margins) that are suitable for inundation by stormwater and are not attractive to birds;
- Basin size and side slope dimensions that are suitable for stormwater management and are not attractive to birds;

Soakage testing completed by us earlier this month suggests that the soakage rate assumed by Orogen is very conservative for the attenuation basin designs. On the southern boundary in sandy gravels 2m below the surface, the soakage rate was 400-600 mm/hr; and, on the northern boundary in more the open graded gravels, the soakage rate exceeded 2,000 mm/hr.

Additional excavation to 2.5m in one of the southern soakage pits resulted in a soakage rate of 1,200 mm/hr. This indicatest on the southern boundary that higher soakage rates are possible (≥1,200 mm/hr) but that it maybe necessary to dig slightly deeper (into freer-draining gravels) to achieve this. For our analysis we assume a minimum of 1200 mm/hr is achievable in the underlying gravels at all locations around the site.

3 Assessment of Existing Stormwater Concept

We provide the following comments regarding the proposed stormwater design:

3.1 First Flush Basin

Ecan will accept infiltration rates of 12-75 mm/hr in first flush infiltration basins. The assumed rate of 25 mm/hr for design purposes to allow for a gradual reduction in infiltration rate due to sedimentation that is likely to occur over the duration of the consent.

We agree with the recommendation made in point 6 of the CCC s92 letter for engineering the soakage soil and underlying filtration layer in the invert of the first flush basins. It is feasible to modify the design of the first flush basins in the way suggested.

The first flush basins have been designed to be 0.5m deep. However our calculations based on a typical 1.9ha catchment suggests that the first flush basins may be slightly undersized.

We estimate that approximately 40% of additional land will be required over and above what has been shown on the previous concept. This excludes additional area required for free board or if the basin inverts need to be lowered to match into grades required to achieve drainage from pavement catchment.

A first flush basin, on the 1.9ha catchment, with invert dimensions of 14m x 54m would discharge the first flush volume in just under 24 hours (at a design soakage rate of 25 mm/hr). Calculations and sketches are included in Appendix A.

3.2 Attenuation and Stormwater Disposal

Stormwater runoff, in excess of the first flush volume, for all events up to and including the 2% AEP event needs to be collected for discharge to land. The current design assumes the attenuation basin has volume for runoff up to and including 2% AEP 12 hour event. Any additional runoff discharged to the basin will pond on the pavement nearby.

Rapid soakage chambers (i.e. soak holes) could also be used for the same purpose of disposing runoff in excess of the first flush runoff volume. However, these devices are significantly more expensive to construct[2] than a similar soakage basin and would require a larger extent than a basin.

Our recommendation is that the attenuation basins are modified to utilise the soakage potential of the in-situ soils. This may involve lining the invert with coarse gravels at a depth where free draining gravels are intercepted or installing under-drains under the basin invert (to discharge into the underlying gravels). If the invert was lined with gravel it may minimise the attraction to birds by removing vegetation that can be grazed. However, if under-drains were installed, a grassed invert might create a habitat for grazing birds but would probably be easier to maintain than gravel inverts.

For the largest 1.9ha catchment a minimum of 105m² of attenuation basin invert would be requiredand assuming an average soakage rate of 1,200 mm/hr a basin with invert with would be required. A sketch of this solution and calculations are included in Appendix A.

3.3 Review Summary

Our calculations show that:

- The first flush basin lined with an engineered filter soil will discharge it's design volume in 19-24 hours,
- The captured runoff from a 1.9ha catchment will treat and attenuate runoff for all events up to and including the 2% AEP event and both the first flush and (rapid soakage) attenuation basins will discharge to land within 48 hours after a storm event.
- The runoff held in the basins storm will surcharge out of the basins for events ≤ the 2% AEP design event.
- Some modifications to the basin dimensions are necessary as a result of the recent soakage testing results.

[2] In our experience the cost of constructing a basin is roughly a third to a half of the cost of constructing a comparative soak hole of a similar capacity

4 Consolidation of the Stormwater Management System

Orogen's Engineering Servicing Report makes mention of consolidating the stormwater infrastructure during detailed design process once actual soakage information is available.

We don't recommend consolidating the stormwater areas because there is potential for the large body of water in the basins to attract birds. A first flush basin serving half the site would require up to 2,500-3,000m² of land and would be frequently inundated with stormwater runoff.

The proposal to of splitting the carpark into six individual catchments will result in smaller bodies of water each with smaller footprints that are likely to be less attractive to birds.

5 Assessment of CIAL requirements

We are not suitably qualified to comment on the bird species that are attracted to waterbodies or the habitats that attract them. However, we can confirm that the proposed stormwater amendments would:

- Allow the basins batters to be mowed with reduced batter slopes (reducing the habitat for grazing birds);
- Ensure all runoff captured in the basins would soak to land in less than 48 hours after a storm event.
- Ensure that no runoff captured would pond on land outside of the stormwater management areas and create a large bodies of water that would be attractive to birds

Appendix A

Revised Stormwater Concept and Calculations

Car Haulaways Ltd

711 Johns Road

Roading Runoff

Existing SW Design							
Catchment	**1**	**2**	**3**	**4**	**5**	**6**	**Totals**
Area ha	1.91	1.9	1.72	1.57	1.56	1.59	**10.25**
V_{ff} m³	450	450	390	360	360	360	**2370**
Attn basin m³	1000	1000	880	800	800	800	**5280**
Ex Area FF (m²)	705	705	411	583	575	573	
Ex Area Attn Basin (m²)	1170	1170	904	973	945	956	
Revised Design FF (m²)		970					
Revised Design Attn (m²)		280					

Catchment Area			**Impervious Area**		
Road Area	1.90	ha	Road	0.00	ha
Lots	0.00	ha	Footpath	0.00	ha
Roofs	0.00	ha	Driveways	0.00	ha
	1.900	**ha**		**1.900**	**ha**
			Impervious Area:	100.0%	

Runoff Coefficients (refer Section 21.3.4.3 and Table 21-8, CCC Drainage Design Guide)

10 yr Event: 0.77 C values WWDG Chapt 6 and 21 (tbl 21-5)

50 yr Event: 0.82

Time of Concentration: 10 min

Climate Change Factor: 2% increase (included WWDG 2011 rainfall data)

Rainfall Intensities - Capacity Design

Primary System: 49.4 mm/hr (10 yr 10min event)

Secondary System: 70.3 mm/hr (50 yr 10min event)

Treatment Design Rainfall Event

(First Flush) 25.0 mm

Composite First Flush Coefficient (C_{ff}) 0.90 WWDG Table 6-10 and Eqn 6-3 where %im = 100%

Subsoil Soakage Rate: 1200 mm/hr (refer to Section 9.0.2, NZBC Approved Document E1/VM1)

Hydraulic (Capacity) Design (Rational Method)

Primary Peak Flow: 201 l/s

Secondary Peak Flow: 304 l/s

Initial First Flush Basin Sizing (refer Section 6.5.5, CCC Drainage Design Guide)

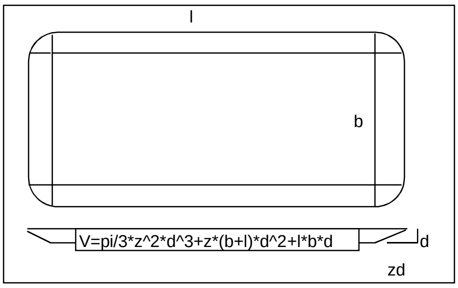
Effective Runoff Area, A_{eff} 1.90 ha

First Flush Volume, V_{ff} **428** m³

Basin First Flush Depth, y_{ff} 0.500 m

Basin FF Water Surface Area, A_{ff} 972 m²

(assumes 1:4 side batters)



FF Soakage Basin Design

Bottom Length, l 54 m

Bottom Width, b 14 m

Side Slopes, z 3 (H:V)

Depth, d 0.500 m

Floor Infiltration Rate, f 25 mm/hr

Basin First Flush Depth, y_{ff} 0.49 m

Basin Full Volume, V_B **430 m³**

Basin FF Infiltration Area, A_{if} 892 m²

Floor Infiltration Flow Rate, Q_{if} 6.2 l/s

Check:

22 m³/hour through FF basin floor @ Q_{if}

19 hrs to discharge to land

50 yr Design overflowing FF basin

Storm Duration, min	50 yr Rainfall Intensity (mm/hr)	Mean Runoff Flow Rate, Q_{avg} (l/s)	Total Storm Volume, V_S (m^3)	Basin Infiltration Capacity, V_{if} (m^3)	Basin Storage Volume, V_{LS} (m^3)	Basin Overflow Volume (m^3)
10	70.3	304.5	183	4	179	0
20	49.6	214.8	258	7	250	0
30	40.5	175.4	316	11	305	0
60	28.6	123.9	446	22	424	0
120	20.2	87.5	630	45	430	155
360	11.6	50.2	1085	134	430	521
720	8.2	35.5	1532	268	430	835
1440	5.8	25.0	2163	535	430	1197
2160	4.4	18.8	2442	803	430	1209

Soakage Attenuation Design (refer to Section 9, NZBC Approved Document E1/VM1)

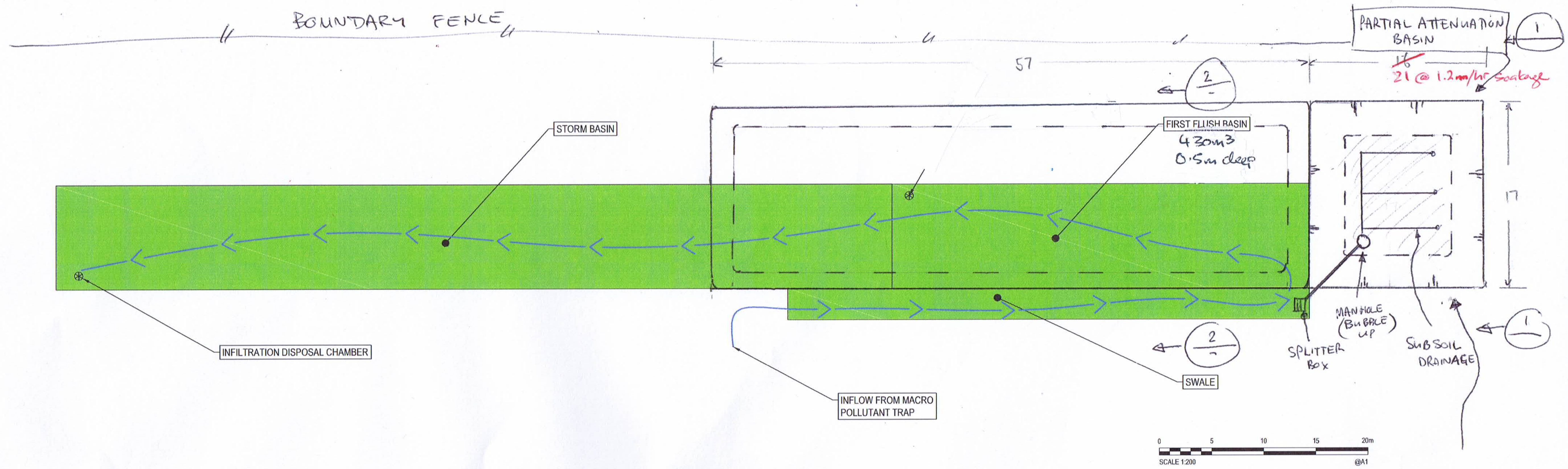
Width	10	m	
Length	15	m	
Depth	1	m	
Number of Soakage Chambers:	1		
Porosity	1		(stone-filled 0.38 or 1 if chamber or basin)
Capacity Reduction Factor	0.333		(refer Section 6.5.5, CCC Drainage Design Guide reduce by factor of 3, compared to NZBC E1 AS1= 1.0)
Storage Volume	150.0	m^3	
Infiltration Flow Rate	16.650	l/s	59.9 m^3/hr

area	**150 m^2**
volume	**150 m^3**

@2m/hr soak	@1.2m/hr
invert 9.5x11	invert10x15
crest 16x17	crest 16x21

50yr Design runoff exceeding FF basin and discharged to soakage structure

Storm Duration, min	50 yr Rainfall Intensity (mm/hr)	Mean Runoff Flow Rate, Q_{avg} (l/s)	Total Storm Volume, V_S (m^3)	FF Basin Infiltration Capacity, V_{if} (m^3)	FF Basin Storage Volume, V_{LS} (m^3)	FF Basin Overflow Volume (m^3)	Soakage BASIN & Storage Capacity, (m^3)	Secondary Flow Volume, (m^3)
10	70.3	304.5	183	4	179	0	160	0
20	49.6	214.8	258	7	250	0	170	0
30	40.5	175.4	316	11	305	0	180	0
60	28.6	123.9	446	22	424	0	210	0
120	20.2	87.5	630	45	430	155	270	0
360	11.6	50.2	1085	134	430	521	510	12
720	8.2	35.5	1532	268	430	835	869	0
1440	5.8	25.0	2163	535	430	1197	1589	0
2160	4.4	18.8	2442	803	430	1209	2308	0

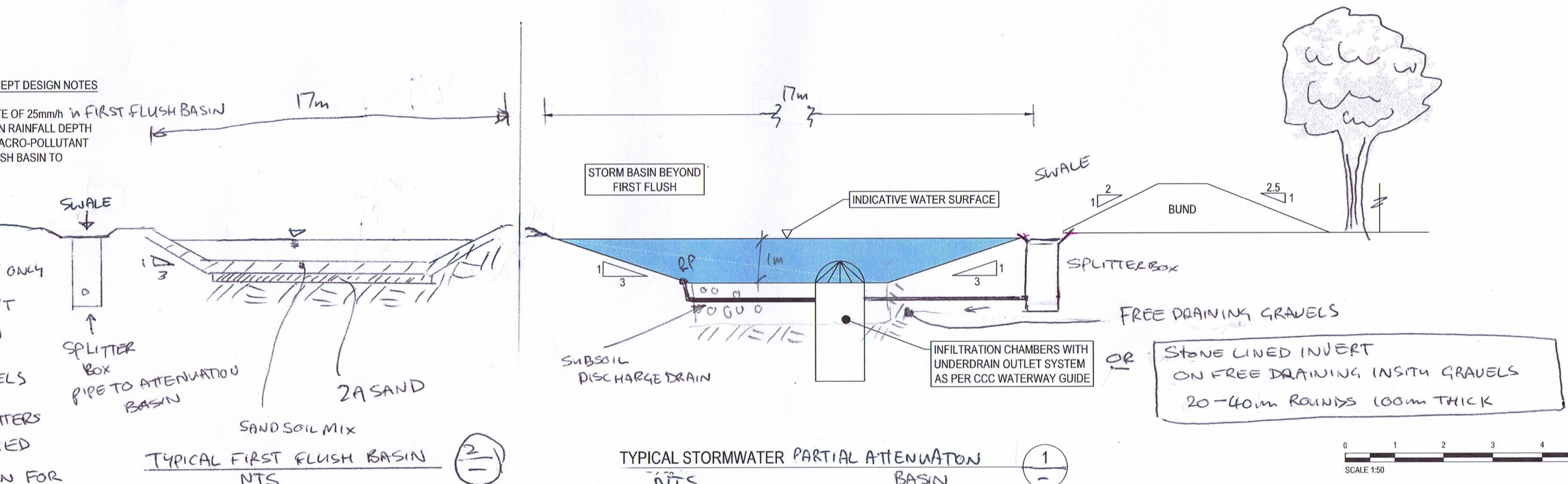


PARTIAL ATTENUATION BASIN VOLUME
150 ~~105~~ m3
1.0m DEEP

GENERAL ARRANGEMENT OF TYPICAL STORMWATER SOLUTION
SCALE 1:200

STORMWATER DISPOSAL CONCEPT DESIGN NOTES

1. INFILTRATION DESIGN RATE OF 25mm/h in FIRST FLUSH BASIN
2. FIRST FLUSH 25mm DESIGN RAINFALL DEPTH
3. TREATMENT INCLUDES; MACRO-POLLUTANT TRAP, SWALE & FIRST FLUSH BASIN TO INFILTRATION DISPERSAL
4. CONCEPTUAL ARRANGEMENT ONLY
5. BASIN EXTENT DOESN'T ALLOW FOR PAVEMENT DRAINAGE LEVELS
6. ALL BASIN BATTERS TO BE PLANTED
7. TYPICAL DESIGN FOR 1.9Ha CATCHMENT ONLY
8. Insitu Stone soakage of 1200mm/hr



TYPICAL FIRST FLUSH BASIN
NTS

TYPICAL STORMWATER PARTIAL ATTENUATION BASIN
NTS

Issue	Date	Description	Des.	Veri.	App.
1	12/5/2016	FOR CLIENT REVIEW	DVB	ROC	ROC

Drawn	CBR	Date 12/5/2016
Checked	DVB	Date 12/5/2016
Designed	DVB	Date 12/5/2016
Verified	ROC	Date 12/5/2016
Approved	ROC	12/5/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP REVISED
Project: HAREWOOD CAR STORAGE YARD, HAREWOOD, CHRISTCHURCH
Title: STORMWATER CONCEPT TYPICAL SECTION & TYPICAL PLAN 12/6/2017
Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
DATUM MTPL2000 | Council Ref: | Scale AS SHOWN | Original Size A1
Drawing Number ~~W16008-C351~~ | Issue 1

DO NOT SCALE DRAWING

DATE: 12 May 2016 2:30 PM
Reference Files: X-W16008-AERIAL; X-W16008-BDY; X-W16008-EWORKS-FSL
Drawing File: P:\W16008\cad\W16008-C300-EWORKS.dwg

ANNEXURE F:

ENGINEERING AND SERVICING REPORT

OROGEN LIMITED
PO BOX 56051, TAWA 5249, WELLINGTON

Engineering servicing report

December 2016

THE CAR DISTRIBUTION GROUP

HAREWOOD CHRISTCHURCH

> CONTENTS

1 EXISTING SERVICES

The application site is located on Waimakariri Road in Harewood adjoining Johns Road as shown on the site location plan C301 in Appendix 1.

To provide full servicing to the proposal solutions need to be described to manage stormwater, water supply, sewage, earthworks, and provide for utilities. A summary of the current level of service at the application site for these services is provided below as background to any future services solutions:

A. Stormwater

No dedicated Council maintained service for stormwater exists on the application site or within the surrounding public roads. The nature of the current land use and soil geology at this location indicate that any runoff on the site is likely only to occur during extreme storm events and in those instances, locally pond, and disperse via soakage.

It is noted that Resource Consent CRC150989 for stormwater discharge to land exists with an expiry date of 30 September 2019. This consent permits discharge from a construction activity followed by discharge of runoff from a development at the northern portion of the site.

Any stormwater service concept that supports the proposal needs to consider this information and be an onsite solution.

B. Water Supply

No water mains are recorded on the Canterbury Maps GIS record adjoining to the site. At the southern end of Waimakariri Road a 63mm diameter water main provides a local supply to that locality with no other water mains in Waimakariri or Johns Road adjoining the application site.

A number of Environment Canterbury water permits exist in this locality and it is assumed that current residents utilize ground water and/or roof water as their source of water.

C. Sewage

A 150mm sewer main is recorded on the Canterbury Maps GIS record adjoining to the site on Waimakariri Road. This sewer main indicates that it drains to Sawyers Arms Road and then to the east along that road.

D. Utilities

Power and telecommunication exist on the surrounding roads to the application site. These utility authorities would be contact to assist with specification of any service connections to support development on the application site.

E. Access

Access to the application site will be from Waimakariri Road. The existing access into the site at the northern end will be used. A second access into the site, from Waimakariri Road may be formed, depending on the outcome of the transport route from Johns Road.

2 EARTHWORKS

The topography of the application site is shown in Plan C305 which is generally flat with a slightly lower area on the north-western boundary. Earthworks are required to shape the topography to support the proposed paved area and provide manageable stormwater sub catchments on this site.

A. Cut to fill

A cut and fill concept design for the site is provided on Plan C303. The concept promotes for cut and fill across the site to form the carpark, stormwater basins, and perimeter bund.

The proposed car park shape promotes a high crest at approximately RL 34.7 metres along the centre of the site. This crest is important as it provides for segregating the pavement for the purpose of stormwater runoff mitigation at a reasonable pavement gradient of no greater than 1%. An allowance for cutting to a pavement subbase of 250mm is anticipated to then allow formation of the pavement and carpark surface.

To achieve the base formation for this carpark a cut of approximately 36,000m^3 is required. Of this volume, approximately 20,000m^3 will be placed as fill on the yard site. This fill allows for a 10% compaction of the cut which is reasonable for the soils anticipated on this land.

B. Bund and stormwater basins

A bund is proposed on the perimeter of the site as shown on C304. The bund is proposed to be formed from the cut material generated from forming the stormwater basins described in Section 5 and shown on Plan C304 and from excess cut exceeding the required filling. The volume of cut from the stormwater basins is approximately 9,000m^3 with a required fill to form the bund of approximately 25,000m^3 for these features. The shortfall of 16,000m^3 will be sourced from the excess cut from forming the car storage yard surface.

During site works material volumes may change either as a result of detailed design, engineering site management of any unsuitable fill material, of site improvements to finished surface or landscaping.

As described in the geotechnical report, there are some areas within the site that have soft spots. It is proposed to expose these areas during the earthworks and remediate them with re-compaction. Some unsuitable material is expected to be required to be removed from the structural areas. This material is likely to be respreads in the southern area of the site, beyond the paved area. The final surface level will be adjusted to incorporate the removed material to avoid the need to import replacement material.

C. Construction management and erosion and sediment control

In accordance with industry guidelines a Construction Management Plan would be prepared for the final engineering design to stipulate the methodology, mitigation features, and construction programme to build the proposal. In broad terms the key content will include the following points:

a. GENERALISED METHODOLOGY

Site establishment will involve formation of erosion and sediment control features on the site to enable earthworks. Formation of key sediment retention ponds in the location of the future stormwater ponds in addition with silt fencing will enable sufficient site protection.

Earthworks areas will be restricted to the phasing of activities on the site to ensure that they are finished and stablised in a timely fashion that aligns to a reasonable construction sequence and programme.

As the site is cut the material will be placed as fill across the proposed pavement areas in general accordance with the earthworks plan. As the stormwater basins are cut this material will be placed in the perimeter bunds. No subsoil drains will be placed in the stormwater basins until the site is stablised post earthworks.

Following earthworks drainage, civil works, and roading activities can commence.

b. KEY EROSION AND SEDIMENT CONTROL DEVICES

Key erosion and sediment control devices likely on this site will be:

- Sediment retention ponds – to suit open earthworks catchment
- Cut of drain – supported by bunds to direct runoff
- Silt fence – protection of smaller open catchments, or to reduce onsite runoff velocity
- Bidim lining – liner for drains, inlet basins, or ponds
- Dust suppressant – Mechanism to provide dust suppression

D. Earthworks recommendation

The concept design proposed achieves a suitable carpark surface to support prudent stormwater management and carpark grading. This concept is achieved by an onsite cut and fill material balance that allows for a small material surplus which provides scope for site improvements during construction.

Management of construction activities can occur with a competent construction management plan which is current industry practice and therefore the proposal's earthwork solution is appropriate for this activity on this site.

3 SEWER

A. Background

A 150mm sewer main is recorded on the Canterbury Maps GIS record adjoining to the site on Waimakariri Road. This sewer main indicates that it drains to Sawyers Arms Road and then to the east along that road. It is likely that this main can be connected to from the development site and this would be confirmed during any detailed design for a proposal. If technical difficulties prevent the use of this sewer, an on-site system would be installed to service the ablutions and kitchen facilities in the proposed building.

B. Potential development demand

The proposed activity anticipates a site management office with supporting water facilities which typically include toilets, kitchenette, shower, and a truck wash. The waste water demand for the site is likely to be low and managed by a small onsite (private) sewage pump station via a small bore rising main to the sewer main in Waimakariri Road, or, as discussed above, an on-site disposal system if the public sewer is not available.

Discussions will commence on the detail around the proposal and its waste water flowrates to then work through a sustainable solution for the site that may involve a small private pump station.

4 WATER SUPPLY

C. Background

No water mains are recorded on the Canterbury Maps GIS record adjoining to the site. At the southern end of Waimakariri Road a 63mm diameter water main provides a local supply to that locality with no other water mains in Waimakariri or Johns Road adjoining the application site.

A number of Environment Canterbury water permits exist in this locality and it is assumed that current residents utilize ground water and/or roof water as their source of water.

Water supply for the staff facilities and for the truck/car wash will be from either an existing on-site bore or from roof water collection from the building. If the supply is from the proposed 1,000m^2 building, a suitable water storage tank will be installed.

D. Potential development demand

The proposed activity anticipates a site management office with supporting water facilities which typically include toilets, kitchenette, shower, and a truck wash. The demand for the site is therefore not extensive and can be accommodated in either a roof collection system with supplementary water bore supply.

Discussions will commence on the detail around the proposal and its water demand to then work through a sustainable water supply solution for the site.

5 STORMWATER MANAGEMENT CONCEPT

The location of the application site provides for the opportunity to utilize the attributes of the site's topography and underlying geology to collect, manage, and dispose of stormwater runoff from the proposed development.

The Christchurch City Council's *Waterways, Wetlands and Drainage Guide* (WWDG) provides guidelines for stormwater management that are appropriate for this development that are in included and promoted in the stormwater management concept for the site. In addition to that guideline key engineering decisions are made to ensure that a practical concept is promoted that minimizes any risk with stormwater inundation as a result of the development.

The key features of the concept are:

1. Site shaping by earthworks to discrete stormwater management areas using open basins. Locating these basins in the site to enable ponding during extreme events that minimises any offsite overland runoff;
2. Site shaping to enable discrete stormwater subcatchments that are approximately 1.5 hectare to enable manageable runoff flow rates via surface flows within the site and the proposed treatment and disposal devices.
3. Collection of surface runoff in macropollutant traps to capture gross or floating pollutants, followed by conveyance into a grass lined swale that is around 50 metres in length.
4. A first flush runoff depth of 25mm is applied in the concept design and this runoff is collected in the first flush basin following conveyance through the macro pollutant trap and swale drain.
5. Beneath the first flush basin a novadrain subsoil drainage system is proposed to collect infiltrated runoff and convey this to a high volume infiltration chamber as per the Waterways Guideline. Noting that in this location the Waimakariri geology will provide infiltration value in these basins.
6. The infiltration rate is assumed at 25mm/hour which is appropriate for the nature of geology anticipated on the land. Specific infiltration testing at the locations of the stormwater infiltration chambers would confirmed the design rate for the basins which would then confirm their final size.
7. An overflow weir from the first flush basin to a larger storage basin with supporting infiltration disposal system to collect and manage larger storm events. The proposed volume for this basin is set by considering appropriate land use and risk. A volume of 800m3 is proposed for this basin that provides for storage for up to a 20 year and 50 year 12 hour event before ponding will commence in the lower areas of the proposed carpark.
8. The peak storage event for the 1.5 hectare catchment is the 36 hour storm event that will include ponding on the proposed carparks during the 20 year and above design storms. For a 50 year event the extend of ponding is insignificant on the carpark and is shown on the concept plans as it is located around the stormwater management areas and transitions around the perimeter of the paved areas.

6 STORMWATER DESIGN DETAILS

A. Site drainage characteristic

The topography of the application site is shown on Plan C305 and this can be described as generally flat with elevations around the Reduced Level 33-34m contour.

There is no notable drainage system on the site, on Johns Road, or Waimakariri Road that could service the land. Due to its current landuse and topography during any storm event runoff would essentially pond on the land and disperse via soakage.

Due to the location we anticipate that the underlying geology will be river gravels with silty sands and therefore be favorable to soakage.

B. Catchments and site shaping

The proposal is to form a paved surface of 8.5 hectares which would then generate direct runoff during a storm event. Due to the size of the proposed paved surface it is important that a detailed surface level design is completed in order to segregate the paved surface into multiple smaller stormwater sub catchments. Creating smaller subcatchments enables manageable runoff rates through the application site versus larger concentrated flows, and therefore smaller and manageable collection and disposal areas.

Therefore the proposal promotes 6 subcatchments across the proposed 8.5 hectare paved surface area as shown on Plan C304. These catchments are formed by creating a ridgeline through the site split by valleys in the pavement to direct surface water runoff around the site. The details on earthworks to create this formation is described in Section 3 and we summarise the proposed subcatchments in Table 1.

Catchment	Area (hectare)	Design Area (hectare)	Description
1	1.96	2	Proposed pavement
2	1.78	2	Proposed pavement
3	1.58	1.6	Proposed pavement
4	1.57	1.6	Proposed pavement
5	1.51	1.6	Proposed pavement
6	1.49	1.6	Proposed pavement and access road
Total	9.9 hectares	10.4	Area to be managed by proposed stormwater system

Table 1 Catchment summary

In order to size an appropriate management solution for these subcatchments we are proposing a solution for a 1.6 hectare catchment (or less), and a 2 hectare catchment (or less). These generalised solutions are then analysed for the proposal that enables allocation of appropriate land area to support a stormwater management concept for that design area. The resulting analysis therefore includes contingency for a developed 0.5 hectare (10.4ha Vs. 9.9ha) that allows flexibility in detailed development design.

C. Design storm assessments

To evaluate design storms for peak volume and peak flow we have followed the WWDG using the rational method. The pavement surface has been considered to have a 90% effective impervious coefficient for a "Business Zone" as defined in Table 6-10 of the WWDG.

Rainfall intensities applied are from Appendix 10 of the WWDG with a Climate Change factor of 116% to then calculate resulting peak flow and runoff volumes. Peak flow rate is assumed to occur with a time of concentration in the order of 10-15 minutes.

Full calculations are provided in Appendix 2 with a catchment summary shown in Table 2.

Catchment	Design concept area (hectare)	10 year Peak flow (L/s)	20 year Peak flow (L/s)	50 year Peak flow (L/s)
1	2	23	28	33
2	2	23	28	33
3	1.6	19	22	27
4	1.6	19	22	27
5	1.6	19	22	27
6	1.6	19	22	27

Table 2 Catchment peak flow rate summary

Based on these preliminary runoff rates the concept of surface conveyance in a pavement valley at a typical slope of no less than 0.2% is deemed to be an acceptable management concept.

Similarly, the peak flow rates would be acceptable for management in standard commonly available macro pollutant traps.

D. Treatment and disposal

In accordance with the concepts provided in Table 6-5 the treatment concept proposed on this site is for a macro pollutant trap, followed by a grass lined swale drain, to a first flush basin. The first flush basin is sized for a 25mm rainfall depth event that equates to a 360m^3 basin for the 1.6 hectare design catchment and a 450m^3 basin for the 2 hectare design catchment. An underdrain and infiltration outlet is proposed from the first flush basin.

For larger duration events overflow from this basin is likely and a storm basin is proposed to manage this additional runoff to the first flush runoff. Inflow for this basin can occur from the first flush basin or swale drain which can be confirmed through detailed design.

To utilize the geology and flat topography of the site the proposed disposal concept is via infiltration. Infiltration will occur via the base of the swale, first flush basin, and storm basin. The concept promotes the detailed design and installation of an infiltration chamber and underdrain system in the basins. For the purposes of concept design we have applied an rate of 25mm/hour for a sandy loam soil type. Site testing at the locations of these infiltration chambers will enable detailed design of the disposal and basin system but applying this infiltration rate is deemed appropriate in order to allocated sufficient area for management of stormwater.

The size of the storm basins has been determined at an 800m^3 basin for the 1.6 hectare design catchment and a 1000m^3 basin for the 2 hectare design catchment. The judgement applied to sizing these basins is a function of appropriate landuse for the application and the peak runoff generated from the design catchments.

Detailed calculations of these storm events is provided in Appendix 2 with a summary of the peak volume event with the proposed stormwater system provided in the following tables:

Catchment	Design concept area (hectare)	Runoff generated (m^3)	Volume remaining in first flush basin (m^3)	Volume remaining in storm basin (m^3) 10 Year	Volume remaining across paving 10 Year
1	2	2035	180	985	-
2	2	2035	180	985	-
3	1.6	1628	144	788	-
4	1.6	1628	144	788	-
5	1.6	1628	144	788	-
6	1.6	1628	144	788	-

Table 3 Peak 10 year 24 hour event. Volume results remaining in basins

Catchment	Design concept area (hectare)	Runoff generated (m^3)	Volume remaining in first flush basin (m^3)	Volume remaining in storm basin (m^3) 20 Year	Volume remaining across paving 20 Year
1	2	2700	45	1000	350
2	2	2700	45	1000	350
3	1.6	2160	36	1000	80
4	1.6	2160	36	1000	80
5	1.6	2160	36	1000	80
6	1.6	2160	36	1000	80

Table 4 Peak 20 year 36 hour event. Volume results remaining in basins

Catchment	Design concept area (hectare)	Runoff generated (m^3)	Volume remaining in first flush basin (m^3)	Volume remaining in storm basin (m^3) 50 Year	Volume remaining across paving 50 Year
1	2	3270	45	1000	920
2	2	3270	45	1000	920
3	1.6	2616	36	1000	536
4	1.6	2616	36	1000	536
5	1.6	2616	36	1000	536
6	1.6	2616	36	1000	536

Table 5 Peak 50 year 36 hour event. Volume results remaining in basins

E. 36 hour duration design storm ponding

Through our concept design analysis all storm events up to generally a 12 hour event are managed within the proposed basins. Storm events with a longer duration greater than 12 hours are anticipated to pond out onto the pavement areas.

We propose that the ponding is controlled and it can be described as an increase of water depth to fill the stormwater areas to increase the water depth above the top of bank of the basins. The increase in water depth will then extend out across the lower areas of the site and be contained by the site's perimeter bunding and fill back into the paved areas. The preliminary maximum ponding depth is expected to RL 33.8m during the worst case peak volume design event (50 year 36 hour storm) which is shown in concept on Plan C351.

The extent of ponding will more than likely reduce following site investigation to confirm infiltration rates and detailed design of the actual subcatchment pond sizes and storage volumes. However, based on the scale of water remaining during these longer duration events, ponding depths, and the fact that recovery is expected over the following day the proposed system concept is deemed acceptable in that it manages all runoff from the proposal within its own title.

Refinement of the concept is also achievable through detailed design to potentially integrate storm basins across subcatchments into single larger basins based upon actual subcatchments areas, rather than the design concept areas used in our assessment. The scale of swales and first flush basins can also be refined following confirmation of site specific infiltration rates.

F. Section 106 Inundation evaluation

Based on the proposed stormwater management concept we can provide an evaluation of proposal in accordance with Section 106 of the Resource Management Act in engineering terms.

(1)(a) We can confirm from Tables 3 – 5 that there is no risk of inundation, erosion or material damage to any structure on the land.

(1)(b) Any future use of the land will not increase inundation, erosion or material damage to the land or surrounding land. At that time such developments would be assessed for their own applications.

7 CONCLUSION

The application site requires earthworks and shaping to provide a pavement formation that facilitates good stormwater management practice in accordance with Council's expectations for development. A sewer, water, and utilities can be provided to support eh proposal and upgrades are required in order to provide an appropriate level of site servicing.

In summation the current landform can be developed in a manner that meets technical guidelines and expectation of construction management that will have no adverse effect from an engineering servicing perspective.

> APPENDIX A – CONCEPT DESIGN PLANS

Issue	Date	Description	Des.	Veri.	App.
3	29/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
2	13/05/2016	CLIENT AMENDMENTS	DVB	DVB	ROC
1	29/04/2016	FOR CLIENT REVIEW	MOD		DVB

Drawn MOD Date 28/04/2016

DVB 29/04/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: LOCALITY PLAN

Status: PRELIMINARY

DATUM: MTPL2000 | Council Ref: | Scale: 1:2000

Drawing Number: W16008-C301 | Issue: 3

DO NOT SCALE DRAWING

NOTES

1. CONTOUR INTERVAL = 0.20m
2. LEVELS ARE IN TERMS OF THE CHRISTCHURCH DRAINAGE DATUM (CDD)

Issue	Date	Description	Des.	Veri.	App.
3	29/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
2	13/05/2016	CLIENT AMENDMENTS	DVB	DVB	ROC
1	29/04/2016	FOR CLIENT REVIEW	ROC	DVB	DVB

Drawn	MOD	Date 28/04/2016
	DVB	Date 28/04/2016
	ROC	Date 28/04/2016
	DVB	Date 28/04/2016
	DVB	29/04/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: SURFACE CONTOUR PLAN

Status: PRELIMINARY

DATUM MTPL2000 | Council Ref: | Scale 1:1000

Drawing Number W16008-C302 | Issue 3

DO NOT SCALE DRAWING

ANTICIPATED EARTHWORKS VOLUMES	
ITEM	VOLUME
CUT	19,600m³
FILL	18,000m³
POND CUT	8,000m³
BUND FILL	12,000m³
SOURCED FROM BALANCE LAND	4000m³

NOTES

1. CONTOUR INTERVAL = 0.25m
2. LEVELS ARE IN TERMS OF THE CHRISTCHURCH DRAINAGE DATUM (CDD)

Issue	Date	Description	Des.	Veri.	App.
4	29/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
3	19/05/2016	CUT/FILL VOLUMES AMENDED	MOD		ROC
2	13/05/2016	CLIENT AMENDMENTS	DVB	DVB	ROC
1	29/04/2016	FOR CLIENT REVIEW	ROC	DVB	DVB

		Date
Drawn	MOD	28/04/2016
	DVB	28/04/2016
	ROC	28/04/2016
	DVB	28/04/2016
	DVB	29/04/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: CUT/FILL PLAN

Status: PRELIMINARY

DATUM: MTPL2000

Council Ref:

Scale: 1:1000

Drawing Number: W16008-C303

Issue: 4

DO NOT SCALE DRAWING

Issue	Date	Description	Des.	Veri.	App.
6	18/01/2017	BUILDING LAYOUT UPDATED	ROC		ROC
5	30/11/2016	CATCHMENT 3 POND AMENDMENTS	KWC	ROC	ROC
4	25/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
3	19/05/2016	BUND EXTENDED - POND AMENDMENT	MOD		ROC
2	13/05/2016	CLIENT AMENDMENTS	DVB	DVB	ROC
1	29/04/2016	FOR CLIENT REVIEW	DVB	DVB	DVB

Drawn	MOD	Date 28/04/2016
	DVB	Date 28/04/2016
	DVB	Date 28/04/2016
	DVB	Date 28/04/2016
	DVB	29/04/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: CATCHMENT PLAN

Status: PRELIMINARY

DATUM MTPL2000 | Council Ref: | Scale 1:1000

Drawing Number W16008-C304 | Issue 6

DO NOT SCALE DRAWING

NOTES

1. CONTOUR INTERVAL = 0.20m
2. LEVELS ARE IN TERMS OF THE CHRISTCHURCH DRAINAGE DATUM (CDD)
3. TOPOGRAPHIC SURVEY BY CARDNO - APRIL 2016

Issue	Date	Description	Des.	Veri.	App.
1	13/05/2016	FOR CLIENT REVIEW	MOD	ROC	ROC

Drawn	MOD	Date 13/05/2016
[illegible]	DVB	Date 13/05/2016
[illegible]	DVB	Date 13/05/2016
[illegible]	ROC	Date 13/05/2016
[illegible]	ROC	13/05/2016

© O'Callaghan Design Limited - All Rights Reserved.

This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

The Car Distribution Group

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: EXISTING SITE CONTOURS

Status: PRELIMINARY

DATUM: MTPL2000 | Council Ref: | Scale: 1:1000

Drawing Number: W16008-C305 | Issue: 1

DO NOT SCALE DRAWING

Issue	Date	Description	Des.	Veri.	App.
5	18/01/2017	BUILDING LAYOUT UPDATED	ROC		ROC
4	30/11/2016	CATCHMENT 3 POND AMENDMENTS	KWC	ROC	ROC
3	29/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
2	19/05/2016	BUND EXTENSION - POND AMENDMENT	MOD		ROC
1	13/05/2016	FOR CLIENT REVIEW	DVB	ROC	ROC

Drawn	MOD	Date 13/05/2016
[illegible]	DVB	Date 13/05/2016
[illegible]	DVB	Date 13/05/2016
[illegible]	ROC	Date 13/05/2016
[illegible]	ROC	13/05/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: LAYOUT PLAN

Status: PRELIMINARY

DATUM: MTPL2000
Council Ref:
Scale: 1:1000

Drawing Number: W16008-C306
Issue: 5

DO NOT SCALE DRAWING

Issue	Date	Description	Des.	Veri.	App.
2	18/01/2017	BUILDING LAYOUT UPDATED	ROC		ROC
1	30/11/2016	FOR INFORMATION	KWC	ROC	ROC

Drawn KWC Date 22/11/2016
ROC Date 22/11/2016
ROC Date 22/11/2016
ROC Date 22/11/2016
ROC 22/11/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

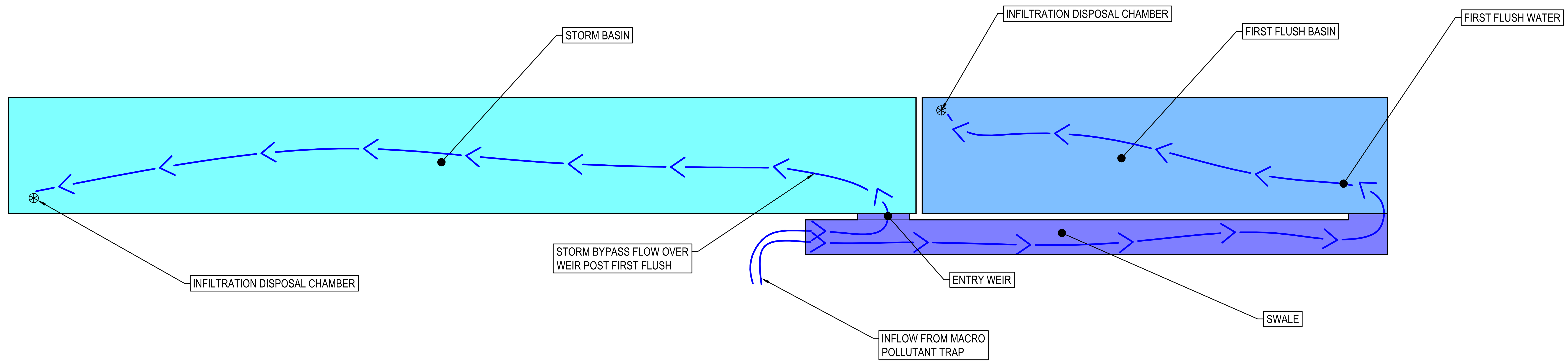
Title: SITE ACCESS OPTIONS

Status: PRELIMINARY

DATUM: MTPL2000
Council Ref:
Scale: 1:2000

Drawing Number: W16008-C307
Issue: 2

DO NOT SCALE DRAWING



GENERAL ARRANGEMENT OF TYPICAL STORMWATER SOLUTION
SCALE 1:200

STORMWATER DISPOSAL CONCEPT DESIGN NOTES

1. INFILTRATION DESIGN RATE OF 25mm/h
2. FIRST FLUSH 25mm DESIGN RAINFALL DEPTH
3. TREATMENT INCLUDES; MACRO-POLLUTANT TRAP, SWALE & FIRST FLUSH BASIN TO INFILTRATION DISPERSAL.
4. STORM BASINS DESIGNED FOR CATCHMENT SPECIFIC RETENTION OF PEAK DURATION EVENT (GENERALLY 1% AEP 36 HOUR STORM)

TYPICAL STORMWATER TREATMENT & DISPERSAL AREA
SCALE 1:50
1
C304

Issue	Date	Description	Des.	Veri.	App.
3	29/08/2016	LANDSCAPING BUNDS AND POND AMENDMENTS	MOD		ROC
2	19/05/2016	BUND DEPICTION CORRECTED	MOD		ROC
1	13/05/2016	FOR CLIENT REVIEW	DVB	ROC	ROC

Drawn MOD Date 12/5/2016
DVB Date 12/5/2016
DVB Date 12/5/2016
ROC Date 12/5/2016
ROC 12/5/2016

© O'Callaghan Design Limited - All Rights Reserved.
This document is produced by O'Callaghan Design Limited for the sole use and benefit of the original recipient. O'Callaghan Design Limited Limited does not and shall not assume any responsibility or liability whatsoever for any use of this document by a third party

O'Callaghan Design Limited
3 Lochiel Road, Khandallah, Wellington

Client: THE CAR DISTRIBUTION GROUP

Project: HAREWOOD CAR STORAGE YARD
HAREWOOD
CHRISTCHURCH

Title: STORMWATER CONCEPT
TYPICAL SECTION & TYPICAL PLAN

Status: PRELIMINARY

DATUM: MTPL2000
Council Ref:
Scale: AS SHOWN

Drawing Number: W16008-C351
Issue: 3

DO NOT SCALE DRAWING

> APPENDIX B – CALCULATIONS

Job name: **The Car Distribution Group**
Job #: **W16008**

Stormwater concept design calculations
Guide: CCC WWDG

Catchment details:

Area (Ha)	1.6	
Area impervious (Ha)	1.6	
Area pervious (Ha)	0	
% impervious (%)	90%	T6-10 WWDG
A_{eff} (Ha)	1.44	

First Flush rainfall calculation: *All basin side slopes are 1v : 4H as per WWDG*

d_{ff} (mm)	25	
First flush basin capacity V_{ff} (m^3)	360	First flush capacity
Set depth y_{ff} (m)	1	
A_{ff} (m^2)	512	First Flush basin water surface area
A_{if} (m^2)	360	First Flush basin infiltration area (set at 100% base area)
Storm basin capacity (m^3)	800	Storm basin capacity
Set depth y_{ff} (m)	1	
A_{ff} (m^2)	1026	Storm basin water surface area
A_{if} (m^2)	800	Storm basin infiltration area (set at 100% base area)
Ultimate infiltration rate (mm/hr)	25	Sandy loam - WWDG to be confirmed by site testing
Floor infiltration rate (m/s)	6.9E-06	
Basin infiltration rate (m^3/s)	0.0025	= Underdrain flow rate Q_{ud}
Basin infiltration rate (L/s)	2.5	= Underdrain flow rate Q_{ud}

Area required (m2)

First flush	512
Storm basin	1026
	1538

Assessment across various storm events

Event		Duration (mins)	Intensity (A10 *WWDG*)	CC factor (116%) [mm/hr]	Volume of runoff (m3)	First Flush capacity	Volume to first flush (m3)	Soakage ability from FF basin (m3)	Volume in FF Basin at end of storm	Volume to storm basin (m3)	Soakage ability storm basin (m3)	Volume in storm basin at end of storm		Peak flowrate for each storm event based (L/s)
10 year storm		15	40.3	46.7	168	360	168.3	2.3	166.0	0.0	0.0	Empty		18.7
		30	28.4	32.9	237	360	237.2	4.5	232.7	0.0	0.0	Empty		
		60	20.1	23.3	336	360	335.8	9.0	326.8	0.0	0.0	Empty		
		120	14.2	16.5	474	360	360.0	18.0	342.0	114.4	40.0	74		
		180	11.5	13.3	576	360	360.0	27.0	333.0	216.3	60.0	156		
		240	10	11.6	668	360	360.0	36.0	324.0	308.2	80.0	228		
		300	8.93	10.4	746	360	360.0	45.0	315.0	385.8	100.0	286		
		360	8.15	9.5	817	360	360.0	54.0	306.0	456.8	120.0	337		
		720	5.75	6.7	1153	360	360.0	108.0	252.0	792.6	240.0	553		
	24	1440	4.06	4.7	1628	360	360.0	216.0	144.0	1267.6	480.0	788	**Peak volume**	
		2160	3.06	3.5	1840	360	360.0	324.0	36.0	1480.1	720.0	760		
		2880	2.5	2.9	2004	360	360.0	432.0	0.0	1644.5	960.0	684		
20 year storm		15	47.4	55.0	198	360	197.9	2.3	195.7	0.0	0.0	Empty		22.0
		30	33.4	38.7	279	360	279.0	4.5	274.5	0.0	0.0	Empty		
		60	23.6	27.4	394	360	360.0	9.0	351.0	34.2	20.0	14		
		120	16.6	19.3	555	360	360.0	18.0	342.0	194.6	40.0	155		
		180	13.6	15.8	682	360	360.0	27.0	333.0	321.5	60.0	262		
		240	11.7	13.6	782	360	360.0	36.0	324.0	421.7	80.0	342		
		300	10.5	12.2	877	360	360.0	45.0	315.0	517.0	100.0	417		
		360	9.58	11.1	960	360	360.0	54.0	306.0	600.1	120.0	480		
		720	6.76	7.8	1355	360	360.0	108.0	252.0	995.0	240.0	755		
		1440	4.77	5.5	1912	360	360.0	216.0	144.0	1552.3	480.0	1072		
	36	2160	3.59	4.2	2159	360	360.0	324.0	36.0	1798.8	720.0	1079	**Peak volume**	
		2880	2.94	3.4	2357	360	360.0	432.0	0.0	1997.3	960.0	1037		
50 year storm		15	57.4	66.6	240	360	239.7	2.3	237.5	0.0	0.0	Empty		26.6
		30	40.5	47.0	338	360	338.3	4.5	333.8	0.0	0.0	Empty		
		60	28.6	33.2	478	360	360.0	9.0	351.0	117.7	20.0	98		
		120	20.2	23.4	675	360	360.0	18.0	342.0	314.8	40.0	275		
		180	16.4	19.0	822	360	360.0	27.0	333.0	461.8	60.0	402		
		240	14.2	16.5	949	360	360.0	36.0	324.0	588.8	80.0	509		
		300	12.7	14.7	1061	360	360.0	45.0	315.0	700.7	100.0	601		
		360	11.6	13.5	1163	360	360.0	54.0	306.0	802.6	120.0	683		
	12	720	8.19	9.5	1642	360	360.0	108.0	252.0	1281.7	240.0	1042		
		1440	5.78	6.7	2317	360	360.0	216.0	144.0	1957.2	480.0	1477		
	36	2160	4.35	5.0	2616	360	360.0	324.0	36.0	2255.8	720.0	1536	**Peak volume**	
	48	2880	3.56	4.1	2854	360	360.0	432.0	0.0	2494.4	960.0	1534		

Job name: **The Car Distribution Group**
Job #: **W16008**

Stormwater concept design calculations
Guide: CCC WWDG

Catchment details:

Area (Ha)	2	
Area impervious (Ha)	2	
Area pervious (Ha)	0	
% impervious (%)	90%	T6-10 WWDG
A_{eff} (Ha)	1.8	

First Flush rainfall calculation: *All basin side slopes are 1v : 4H as per WWDG*

d_{ff} (mm)	25	
First flush basin capacity V_{ff} (m^3)	450	First flush capacity
Set depth y_{ff} (m)	1	
A_{ff} (m^2)	620	First Flush basin water surface area
A_{if} (m^2)	450	First Flush basin infiltration area (set at 100% base area)
Storm basin capacity (m^3)	1000	Storm basin capacity
Set depth y_{ff} (m)	1	
A_{ff} (m^2)	1253	Storm basin water surface area
A_{if} (m^2)	1000	Storm basin infiltration area (set at 100% base area)
Ultimate inflitration rate (mm/hr)	25	Sandy loam - WWDG to be confirmed by site testing
Floor infiltration rate (m/s)	6.9E-06	
Basin infiltration rate (m^3/s)	0.003125	= Underdrain flow rate Q_{ud}
Basin infiltration rate (L/s)	3.1	= Underdrain flow rate Q_{ud}

Area required (m2)

First flush	620
Storm basin	1253
	1873

Assessment across various storm events

Event		Duration (mins)	Intensity (A10 *WWDG*)	CC factor (116%) [mm/hr]	Volume of runoff (m3)	First Flush capacity	Volume to first flush (m3)	Soakage ability from FF basin (m3)	Volume in FF Basin at end of storm	Volume to storm basin (m3)	Soakage ability storm basin (m3)	Volume in storm basin at end of storm		Peak flowrate for each storm event based (L/s)
10 year storm		15	40.3	46.7	210	450	210.4	2.8	207.6	0.0	0.0	Empty		23.4
		30	28.4	32.9	296	450	296.5	5.6	290.9	0.0	0.0	Empty		
		60	20.1	23.3	420	450	419.7	11.3	408.4	0.0	0.0	Empty		
		120	14.2	16.5	593	450	450.0	22.5	427.5	143.0	50.0	93		
		180	11.5	13.3	720	450	450.0	33.8	416.3	270.4	75.0	195		
		240	10	11.6	835	450	450.0	45.0	405.0	385.2	100.0	285		
		300	8.93	10.4	932	450	450.0	56.3	393.8	482.3	125.0	357		
		360	8.15	9.5	1021	450	450.0	67.5	382.5	571.0	150.0	421		
		720	5.75	6.7	1441	450	450.0	135.0	315.0	990.7	300.0	691		
	24	1440	4.06	4.7	2035	450	450.0	270.0	180.0	1584.5	600.0	985	**Peak volume**	
		2160	3.06	3.5	2300	450	450.0	405.0	45.0	1850.1	900.0	950		
		2880	2.5	2.9	2506	450	450.0	540.0	0.0	2055.6	1200.0	856		
20 year storm		15	47.4	55.0	247	450	247.4	2.8	244.6	0.0	0.0	Empty		27.5
		30	33.4	38.7	349	450	348.7	5.6	343.1	0.0	0.0	Empty		
		60	23.6	27.4	493	450	450.0	11.3	438.8	42.8	25.0	18		
		120	16.6	19.3	693	450	450.0	22.5	427.5	243.2	50.0	193		
		180	13.6	15.8	852	450	450.0	33.8	416.3	401.9	75.0	327		
		240	11.7	13.6	977	450	450.0	45.0	405.0	527.2	100.0	427		
		300	10.5	12.2	1096	450	450.0	56.3	393.8	646.2	125.0	521		
		360	9.58	11.1	1200	450	450.0	67.5	382.5	750.2	150.0	600		
		720	6.76	7.8	1694	450	450.0	135.0	315.0	1243.8	300.0	944		
		1440	4.77	5.5	2390	450	450.0	270.0	180.0	1940.3	600.0	1340		
	36	2160	3.59	4.2	2699	450	450.0	405.0	45.0	2248.5	900.0	1349	**Peak volume**	
		2880	2.94	3.4	2947	450	450.0	540.0	0.0	2496.6	1200.0	1297		
50 year storm		15	57.4	66.6	300	450	299.6	2.8	296.8	0.0	0.0	Empty		33.3
		30	40.5	47.0	423	450	422.8	5.6	417.2	0.0	0.0	Empty		
		60	28.6	33.2	597	450	450.0	11.3	438.8	147.2	25.0	122		
		120	20.2	23.4	844	450	450.0	22.5	427.5	393.6	50.0	344		
		180	16.4	19.0	1027	450	450.0	33.8	416.3	577.3	75.0	502		
		240	14.2	16.5	1186	450	450.0	45.0	405.0	736.0	100.0	636		
		300	12.7	14.7	1326	450	450.0	56.3	393.8	875.9	125.0	751		
		360	11.6	13.5	1453	450	450.0	67.5	382.5	1003.2	150.0	853		
		720	8.19	9.5	2052	450	450.0	135.0	315.0	1602.1	300.0	1302		
		1440	5.78	6.7	2896	450	450.0	270.0	180.0	2446.5	600.0	1846		
	36	2160	4.35	5.0	3270	450	450.0	405.0	45.0	2819.8	900.0	1920	**Peak volume**	
		2880	3.56	4.1	3568	450	450.0	540.0	0.0	3118.0	1200.0	1918		