APPENDIX 13

STORMWATER MANAGEMENT REPORT [VC]

VISION CONSULTING
Engineers & Planners

STORMWATER AND WASTEWATER MANAGEMENT REPORT

1 Richardson Street, Opua

Prepared for

Doug Schmuck

7/06/2019

Report Information Summary

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1	08/04/2019	Issued to client as DRAFT.
2	26/04/2019	Revised due to existing culvert dimensions and to address Henderson Reeves comments
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Document Acceptance

Action	Name	Signed	Date
Author	Wil Pille	BEng (Civil)	07/06/2019

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Contents

1 Introduction

Vision Consulting Engineers Limited (VISION) was commissioned by Doug Schmuck to provide a stormwater and wastewater management report to accompany a Resource Consent application to both the Far North District Council (FNDC) and the Northland Regional Council (NRC) for a proposed development at 1 Richardson Street, Opua. It is proposed to construct a new slipway, stormwater treatment system and upgrade the existing wastewater disposal system. Site visits were undertaken on 23rd March and 19th April 2019 to assess the impacts of the proposed upgrades on the existing system and to carry out site measurements of the existing stormwater culverts.

2 Scope of Work

The scope of work for this report is to:

- Review site plans provided by client (refer Appendix A and Appendix B)
- Provide a response to the following questions:
  - Assessment of existing drainage, overland flow paths, impermeable areas and catchment areas.
  - Confirmation of the location of the proposed Humes "Stormwater 360" System and assessment of what can be achieved in respect to water quality from the proposed system to enable an assessment of the effects on the receiving environment.
  - Assessment of the sizing requirements for the Humes "Stormwater 360" system in regards to storm events and what would happen if this occurs.
  - Assessment of how the proposed system will alternate between discharge to sewer and discharge to the CMA in conjunction with the general site management plan.

3 Site Description & Details

The site is located at 1 Richardson Street, Opua being being Pt Lot 1 and Lot 2, Block XXXII, Town of Opua, and Section 3 Block XXXII Town of Opua, Record of Title (RT)21C/265 and on the adjoining esplanade reserve, legally described as Sections 1-4, SO 68634, RT 121C/187, together being "the site". The site is located below Richardson Street, some 550m to the west/northwest of the Opua to Russell ferry landing. The location of the Site is shown in Figure 1.

The site is located at the eastern extent of a gully feature and slopes gently to moderately to the east. The existing boatyard contains a concrete driveway and carparking area with access from Richardson Street, a shed and a gravel area to the east of the shed that is used to store boats. Further to the east, an existing slipway is present. A gabion wall was noted below the concrete driveway, retaining a slip which occurred when the culvert under Richardson Street was blocked and caused overland flows across Richardson Street resulting in considerable damage to the property.

Figure 1. Site Location Plan

Site boundary indicative only, north is up the page. Background image is courtesy of LINZ (modified).

4 Assessment of existing drainage, overland flow paths, impermeable areas and catchment areas.

Stormwater flows through the site are generated by catchment areas as shown on the Locality and Stormwater Plan included in Appendix C and described below.

- Catchment Area A; (19,341m²) located above Richardson Street and is mainly covered with bush and scrub, covering the area between English Bay Road, De Haven Street, Sir George Back Street and part of Richardson Street

- Catchment Area B; (975m²) is located in the western portion of the site and consists of the area located between Richardson Street and the existing shed and includes the access driveway and parking area.
- Catchment Area C, (218m²) is the proposed Containment Area and presently contains the existing slipway, turntable and hardstand area.
- Catchment Area D, (277m²) is located to the south of the existing shed and contains the existing hardstand and storage area.

In addition to the above, the roof area (108m²) of the workshop is discharging to land by downpipes on both sides of the building.

4.1 Existing Stormwater Management

The existing stormwater management at the site consists of following:

4.1.1 Catchment Area A:

Surface flows from Catchment Area A are conveyed by a Ø375mm culvert (culvert 1) from the area above Richardson Street towards the short open drain (open drain 1) next to the parking area below Richardson Street. The flow then continues via a Ø400mm culvert (culvert 2) for approximately 20 m towards an inspection chamber with wooden grate lid, and continues as a 300mm culvert (culvert 3) for another 20 m to an outlet in the CMA.

4.1.2 Catchment Area B:

Surface flows from the impermeable areas of Catchment Area B are directed towards open drain 1 from which water is then conveyed via culvert 2 and 3 towards the CMA. Surface water from the slopes above the car parking area flow as sheetflow onto the slipway.

4.1.3 Catchment Area C:

Surface flows from Catchment Area C are directed to an existing pump sump at the lower end of the slipway. From the sump, stormwater is pumped up to the reticulation wastewater connection via retention and settlement tanks.

4.1.4 Catchment Area D:

Surface flows from Catchment Area D are directed towards a sump at the south eastern corner of the workshop which discharges via a Ø250mm culvert towards the inspection chamber with wooden grate lid and then discharges via culvert 3 towards the CMA.

The location of the existing stormwater features are shown on the Thomson Survey plan included in Appendix B.

4.2 Proposed Stormwater Management

In order to manage stormwater at the site, in particular the runoff from the proposed containment area C, it is proposed to separate primary and secondary flows from Area B and D from the flows generated onsite by the proposed slipway (Area C).

By reducing the volume of runoff to be treated, treatment will be more effective in order to meet the water quality requirements imposed by the Resource Consent,

Areas A, B and D are considered to be natural runoff (clean water) and not affected by the activities within the contained area of the slipway. These flows will now discharge directly into the CMA via primary (culvert) and secondary (overland) flow paths. Stormwater runoff from Area C is to be directed to a new Stormwater 360 treatment system as discussed further below.

The proposed stormwater management consists of:

4.2.1 Catchment Area A:

Surface flows from Catchment Area A will continue to discharge via culvert 1), open drain 1 and culvert 2 to a new proposed manhole Ø1050mm with grated catch lid that replaces the existing inspection chamber.

Surface flows from between the workshop and the upper bank are to be directed towards the new catch lid by constructing a parapet wall to prevent clean water flows from entering the containment area.

Culvert 3 is to be upgraded from a Ø300mm culvert to a Ø450mm culvert to accommodate the flows from the upstream catchment areas, driveway and parking area.

The existing 250mm culvert from the corner of the workshop conveying surface water flows from Catchment area D will be blocked off and runoff will be redirected towards the second overland flowpath located near the dinghy racks.

4.2.2 Catchment Area B:

Surface flows from Catchment Area B are continued to be directed towards open drain 1 from which water is then conveyed via culvert 2 and upgraded culvert 3 to the CMA. Surface flows from the slopes above the the car parking area are to be directed to the new proposed manhole with grate and discharge via culvert 2 and upgraded culvert 3 into the CMA. The proposed modifications will prevent stormwater from catchment area B from entering the slipway.

4.2.3 Catchment Area C:

Surface flows from Catchment Area C (Containment Area) are to be directed to a new receiving cesspit as shown on Appendix D , SW and WW Disposal Concept Plan. From this cesspit flows are directed to a Fox FF600 demand valve and either directed to the existing pump sump at the lower end of the slipway, which pumps stormwater up to the reticulated wastewater connection via retention and settlement tanks or discharges to the Humes Stormwater 360 Peak Diversion Chamber which treats the flow before being discharged to the outfall in the CMA. Further details regarding the proposed new treatment system for the slipway are provided in Section 5.

4.2.4 Catchment Area D:

Surface flows from Catchment Area D are to be directed by a proposed new 1.2m parapet wall to the existing overland flowpath located at the southern end of the site) that discharges to the existing marine discharge point.

The sump at the south-eastern corner of the workshop and the Ø250mm culvert and inspection chamber is to be decommissioned and removed.

4.3 Stormwater Calculations

4.3.1 Catchment Area A:

Stormwater flows from the catchment have been calculated using run-off factors in accordance with Table 1 and 2, Verification Method E1/VM1 NZ Building Code as presented in Figure 2 below..

Table 1:	Run-off Coefficients Paragraphs 2.0.1, 2.1.1, 2.1.3
Description of surface	**C**
Natural surface types	
Bare impermeable clay with no interception channels or run-off control	0.70
Bare uncultivated soil of medium soakage	0.60
Heavy clay soil types:	
– pasture and grass cover	0.40
– bush and scrub cover	0.35
– cultivated	0.30
Medium soakage soil types:	
– pasture and grass cover	0.30
– bush and scrub cover	0.25
– cultivated	0.20
High soakage gravel, sandy and volcanic soil types:	
– pasture and grass cover	0.20
– bush and scrub cover	0.15
– cultivated	0.10
Parks, playgrounds and reserves:	
– mainly grassed	0.30
– predominantly bush	0.25
Gardens, lawns, etc.	0.25
Developed surface types	
Fully roofed and/or sealed developments	0.90
Steel and non-absorbent roof surfaces	0.90
Asphalt and concrete paved surfaces	0.85
Near flat and slightly absorbent roof surfaces	0.80
Stone, brick and precast concrete paving panels	
– with sealed joints	0.80
– with open joints	0.60
Unsealed roads	0.50
Railway and unsealed yards and similar surfaces	0.35
Land use types	
Industrial, commercial, shopping areas and town house developments	0.65
Residential areas in which the impervious area is less than 36% of gross area	0.45
Residential areas in which impervious area is 36% to 50% of gross area	0.55

Note:
Where the impervious area exceeds 50% of gross area, use method of Paragraph 2.1.2.

Table 2:	Slope Correction for Run-off Coefficients Paragraph 2.1.3	
Ground slope	**Adjust C by:**	
0-5%	subtracting	0.05
5-10%	no adjustment	
10-20%	adding	0.05
20% or steeper	adding	0.10

Figure 2. Runoff Coefficients
Extract from Verification Method E1/VM1 of the NZ Building Code

A time of concentration of 10 minutes, I_{10}: 115mm/hr and I_{100}: 180mm/hr have been adopted. Using a runoff factor (c) of 0.4, the predicted generated flow for a 10 year event (Q_{10}) is 0.247m^3/s, while the 100 year event would generate 0.387m^3/s.

No as built information was available from the FNDC in regards to sizing, location and invert levels of the existing culvert. Based on the FNDC maps and a review of the LiDAR data for the site, and on site measurements, it has been calculated that the existing culvert (culvert 1) is 36m in length, 375mm in diameter and has a change in height of 5m elevation over its length. Using this data the culvert is assessed to have a flow capacity of 0.55m^3/s using the Verification Method E1/VM1 of the NZ Building Code as presented in Figure 3.

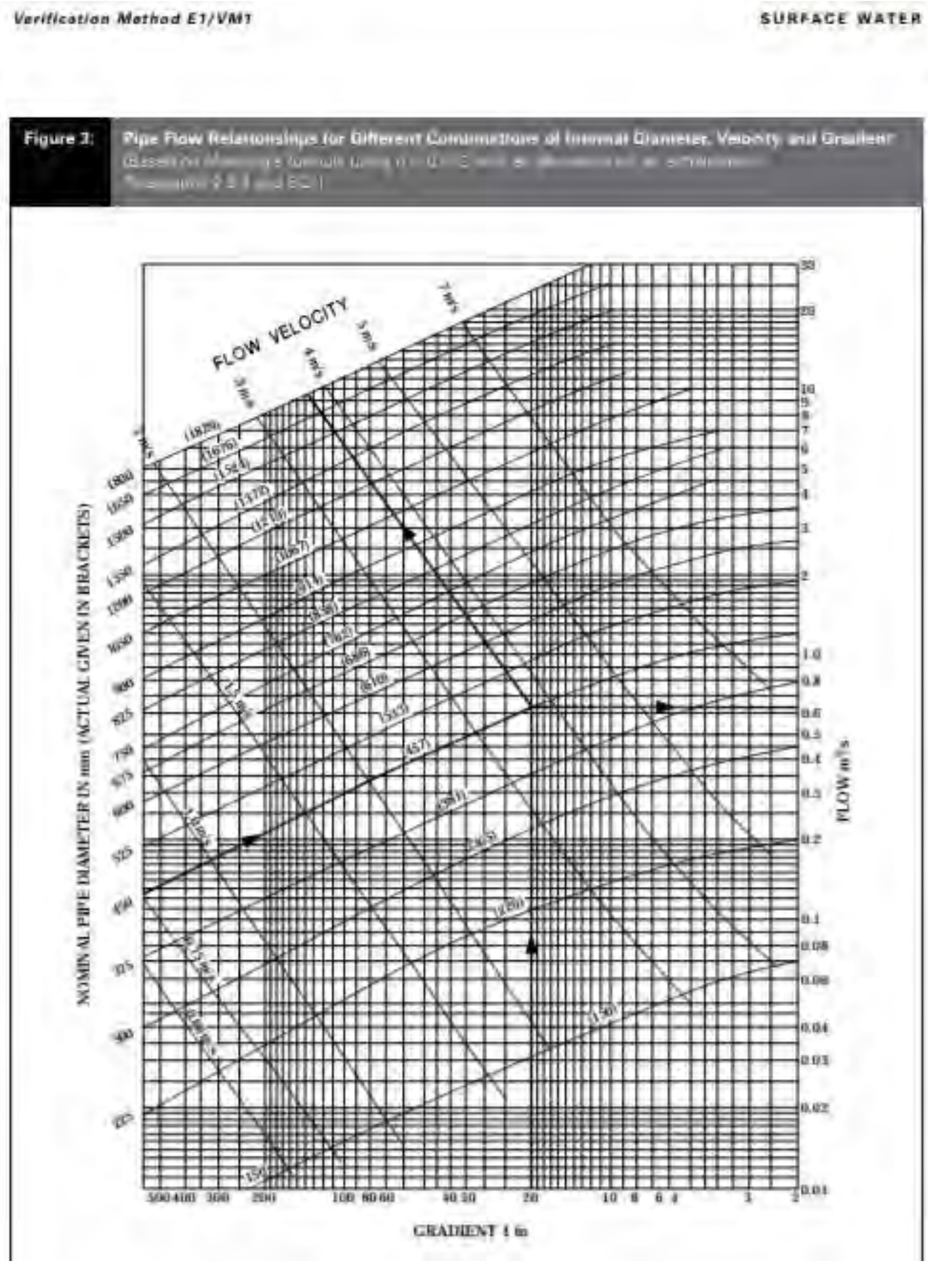

Figure 3. Pipe flow relationships

Extract from Verification Method E1/VM1 of the NZ Building Code

The capacity of culvert 1 under Richardson Street appears to be sufficient to convey surface water for the 10 year and 100 year rainfall events. In the case of the invert getting blocked, an overland flow-path will occur along and across Richardson Street. This may explain the presence of an approximately 200mm high nib-wall on the lower side of part of Richardson Street installed by the FNDC.

The proposal for the planned development of the boat yard includes the continuation of this nib-wall (or stormwater deflection wall) along the entire road frontage of the boat yard with Richardson Street. to prevent stormwater, not discharged through the existing Ø375 culvert (culvert1), from entering the development [1]. Please note that no calculations have been carried out to determine the required height of the nib wall. It is anticipated that the nibwall /stormwater deflection wall will be between 0.2 and 0.5 m in height.

[1] See Appendix A, Thomson Survey drawing titled "Dougs Opua Yard, Proposed containment & Stormwater Management

Calculations to determine the size of the required nib/reflection wall will be undertaken as part of the final design.

4.3.2 Catchment Area B:

Stormwater flows generated from the area below Richardson Street and from on site (Area B) have been calculated using run-off factors in accordance with Table 1, Verification Method E1/VM1 NZ Building Code as presented in Figure 2. A time of concentration of 10 minutes and a rain intensity I_{10}: 115mm/hr and I_{100}=180mm have been adopted and runoff coefficients (c) of 0.9 for impermeable surfaces and 0.4 for bush covered banks have been used. The following flows have been estimated:

- Concrete driveway and parking : A= 275m²; Q_{10}= 0.008m³/s; Q_{100}= 0.012m³/s
- Bank between Richardson Street and driveway/parking: A = 700m²; Q_{10}= 0.009m³/s; Q_{100}=0.014m³/s
- Catchment B Total Area: 975m²
- Total Q_{10}= 0.008 + 0.009 = 0.017m³/s
- Total Q_{100}=0.012 + 0.014 = 0.026m³/s

4.3.3 Catchment Area A and B combined discharge:

The total flow from Area A and Area B into the existing open drain 1 for a 10 year event is 0.247 + 0.017 = 0.264m³/s, while total flow for a 100 year event is 0.387 + 0.026 = 0.413m³/s.

The open drain 1 then discharges into culvert 2 and culvert 3 into the CMA, noted as an existing discharge point on the survey plan.

Culvert 2 is a Ø400mm PVC pipe with a length of 20m (from inlet to existing inspection sump).

From the inspection sump, Culvert 3 is a Ø300m concrete pipe for an unknown distance before changing to a Ø300mm PE (Poly Ethylene) pipe where it discharges to the CMA .

The capacity of culvert 3 is governed by the smallest diameter pipe, being Ø 300mm.

From the survey data it has been established that this culvert has a gradient of 8.7% (1V in 11.5H) which has a calculated capacity of 0.28m³/s using the Verification method E1/VM1 of the Building Code (see Figure 3).

4.3.3.1 Existing stormwater management system

With flows entering culvert 2 assessed as Q_{10}= 0.264m³/s and Q_{100}= 0.413m³/s it is therefore assessed that:

- The existing Ø400mm culvert (culvert 2) is capable of transferring both the 10 and 100 year event.
- The existing Ø300mm culvert (culvert 3) is capable of transferring the 10 year event but not the 100 year event.
- Stormwater above the 10 year event will flow as secondary flows through the containment area and into the CMA..

4.3.3.2 Proposed stormwater management system

As part of the proposed stormwater management plan, culvert 3 will be replaced with a Ø450 concrete culvert.

The capacity of the proposed Ø450mm culvert has been calculated as 0.82m³/s by using Figure 3, Verification Method E1/VM1 of the NZ Building Code.

- Proposed culvert 3 is capable of conveying both the 10 and 100 year event. (Q_{10}= 0.264m³/s and Q_{100}= 0.413m³/s)

A secondary overland flowpath (in case of a blockage) is proposed above the replaced Ø450 culvert. At this stage no calculcations have been carried out to size the secondary overland flow path and required nib/deflection wall.

4.3.4 Catchment Area C

Please refer to section 5.

4.3.5 Catchment Area D

A proposed nib/deflection wall is to be constructed along Richardson Street to create a secondary flowpath that conveys surface water beneath the existing concrete driveway access to a catchpit just south of the driveway on Richardson Street. The existing/ outfall from this catchpit consists of a Ø300mm concrete stub and PVC sleeve that conveys run-off down the bank towards a second overland flowpath (south) in the vicinity of the dinghy rack.

Run-off from catchment area D is to be redirected towards this existing overland flowpath by the construction of a proposed 1.2m parapetwall as shown on the Thomson Survey plan attached as Appendix A.

5 Confirmation of the location of the proposed Humes "Stormwater 360" System and assessment of what can be achieved in respect to water quality from the proposed system to enable an assessment of the effects on the receiving environment.

It is VISION's view that by constructing "clean water diversions" for both onsite surface flows and for the upper catchment flows (Richardsons Street and surrounds) flows generated from the contained slipway can be managed by a "Humes Stormwater 360 Chamber".

The location of the Humes Treatment Chamber is as shown on the survey plan by Thomson Survey included in Appendix A, and in more detail on the Stormwater (SW) and Wastewater (WW) Disposal Concept Plan included in Appendix D.

A receiving cesspit is to be located at the bottom end (northern side) of the slipway and will discharge into the "Humes Stormwater 360 Treatment Chamber". Dimensions of the Chamber are approximately 1.65 m deep and Ø1.50 m. Please refer to the attached concept plan (Appendix D) showing the cesspit collecting all runoff, the proposed location of the Humes Stormwater 360 Chamber, the sampling manhole and the outfall to the CMA.

By locating the receiving cesspit, the Fox Valve FF600, the Humes Stormwater 360 Treatment Chamber and the sampling manhole downstream from the containment area, the whole system will be "gravity fed" with the exemption of the waste discharge to FNDC trade waste connection. In case of a pump failure or a power outage the runoff will still be treated by the Humes Treatment Chamber before discharging into CMA.

5.1 Proposed System Layout

The proposed layout system is presented in Appendix D. The proposed layout includes a cess pit, Fox Valve FF600, Humes Stormwater 360 treatment system, sampling manhole and outfall to the CMA.

We recommend that the following activities are included within the operational management plan for the site:

1. After each activity involving waterblasting, scraping, sanding, painting etc the area will be thoroughly dry broomed to remove debris from the slipway and disposed of to an approved point of disposal.
2. Area to be thoroughly waterblasted.

5.1.1 Cesspit

The receiving cesspit (450x675mm) is capable of receiving flows up to 28 l/sec (AT code of practise). The following data is generated from the High Intensity Rainfall Design System (Hirds) generated by the National Institute of Water and Atmospheric Research (NIWA).

Rainfall intensities (mm/hr) : Historical Data for 1 Robertson Street, Opua

ARI	*AEP*	*10m*	*20m*	*30m*	*1h*	*2h*	*6h*	*12h*
1.58	*0.633*	*63.2*	*47.4*	*39.7*	*28.7*	*20.1*	*10.7*	*6.87*
2	*0.5*	*69.2*	*52*	*43.5*	*31.5*	*22.1*	*11.8*	*7.55*
5	*0.2*	*89.9*	*67.6*	*56.7*	*41*	*28.9*	*15.4*	*9.9*
10	*0.1*	*105*	*79.1*	*66.3*	*48.1*	*33.9*	*18.1*	*11.6*
20	*0.05*	*120*	*90.8*	*76.2*	*55.3*	*39*	*20.9*	*13.4*
30	*0.033*	*130*	*97.7*	*82*	*59.5*	*42*	*22.6*	*14.5*
40	*0.025*	*136*	*103*	*86.2*	*62.6*	*44.2*	*23.7*	*15.3*
50	*0.02*	*141*	*106*	*89.4*	*65*	*45.9*	*24.7*	*15.9*
60	*0.017*	*145*	*110*	*92.1*	*66.9*	*47.2*	*25.4*	*16.4*
80	*0.012*	*152*	*115*	*96.2*	*70*	*49.4*	*26.6*	*17.1*
100	*0.01*	*157*	*118*	*99.4*	*72.3*	*51.1*	*27.5*	*17.7*

Using the above data with Building Code formula for surface water run-off[2] set out below, the flowrate for a 1 in 100 year event is calculated as follows;

[2] NZ Building Code, E1 Surface water Run-off Rational Method

2.0 Estimation of Surface Water Run-Off

2.0.1 *Surface water* run-off for the catchment shall be calculated using the Rational Method. The formula to be used is:

Q_c = $CIA_c/360$

where

Q_c = catchment run-off (m^3/s).

C = run-off coefficient (see Table 1).

I = rainfall intensity (mm/hr).

A_c = area (hectares) of catchment above the point being considered.

- Q_{100}=(C.I.A)/360 = 3.94 l/s
- Q_2 = 1.69 l/s

Volumes as per proposed RC condition for a rain event 10mm/hr are:

- Flow for 1 hr duration: (C.I.A/360) = (0.9*10*0.0218)/360 = 0.545l/s
- Peakflow for 10 min duration: (0.9*23*0.0218)/360 = 1.25 l/s

Therefore the cesspit is assessed to have sufficient capacity (<<28l/s).

5.1.2 Fox Valve FF600

From the receiving cesspit, waterflows will be directed to a demand driven valve (Fox Valve FF600). This valve directs waterflow to either the trade waste connection or to the Humes Stormwater 360 system.

The flow direction is controlled by an automatic valve (Fox) which is pre-set to:

1. Dispose to trade waste when water supply to the water blaster is activated
2. Dispose to the Humes Stormwater System when a volume of 2.4m³ has been reached

The volume of 2.4m³ comprises:

- 1 hr waterblasting hull at 11.6l/s = 0.7 m³
- 1 hr waterblasting to clean slipway: = 0.7m³ (1st Flush)
- A further 1.0 m³ of 'clean water' from either rainfall or additional waterblasting of the spillway (2nd Flush)

5.1.3 Humes Stormwater 360 Treatment Tank

The proposed Humes Stormwater 360 Treatment Tank is designed to treat flows up to 1.42 l/s.

The required peak treatment flow in accordance with the proposed NRC Resource Consent conditions is 0.74l/s, which means that the system actually has a capacity of treating flows of approximately a 1 in 10 year event (based on HIRDS data)

When flows exceed that volume the proposed system automatically starts bypassing exceeded flows through its "Peak Diversion" bypass weir from where it is discharged via a sampling manhole into the CMA.

(Normal operating conditions (NRC) are up to 0.74 l/s)

As outlined in documentation provided by Humes included in Appendix D:

- Suspended solids can be removed to a level which exceeds the ARC TP10 standard of 75% removal of TSS (Total Suspended Solids).
- The proposed treatment system is also laid out to remove dissolved heavy metals such as Copper and Zinc by installing 2No of treatment cartridges (combined Zeolite and Perlite) inside the treatment chamber.
- Each cartridge is capable of treating 1.42 l/s of flow with dissolved metals as per manufacturer's recommendation, and removing > 75% of total suspended solids.

5.1.4 Sampling Manhole

The discharge consents relating to the boatyard's activities have recently been considered by the Environment Court. While a decision on that matter is awaited, a suite of proposed conditions has been agreed between the NRC and the applicant, Mr Schmuck. Of relevance, proposed condition 37 requires:

37. "To enable the collection of samples from the proprietary stormwater treatment system, easy and safe access shall be provided at all time to the discharge pipe"

To comply with this condition, it is proposed to direct the outflow from the proposed stormwater 360 system through a shallow sampling manhole prior to its discharge to the CMA.

The sampling manhole Ø600mm and 600mm deep, will allow easy access for the purpose of taking water quality samples prior to the point of discharge into the stormwater culvert 3 or the CMA

5.1.5 Capability of proposed 360 system to comply with RC conditions:

As there is currently no data available for the contaminants generated by activities on the slipway we have used the data from the sampling undertaken by NRC on 20 June 2018, attached as Appendix F, titled sampling site locations, and Appendix G, titled "Sample results."

However, the results of the sampling at POD site 319833 (being the pump sump), are not considered to be representative of what will be discharged into the proposed treatment system as the first 2.4m3 of runoff will be pumped to FNDC trade waste.

The sampling of POD site 319836 (existing combined slipway/stormwater outfall) is considered to be more representative for what is generated from the slipway, however this is mixed with the runoff from the upper catchment area. The concentrations measured are what is anticipated to be diverted to trade waste and not to the stormwater treatment system.

It has therefore been assessed that, after consultation with the manufacturer of Stormwater 360, 80% of combined dissolved and suspended particles will be removed. Based on the discussion with their design adviser, this figure is expected to be conservative a quoted efficiency rates achieved being 90 -95 % .

The table below presents the expected levels of Zn, Copper, Lead and TSS, the published efficiency rates of the treatment 360 system, expected flow-rates, treatment capacity, reduction, concentration after discharge to trade waste and conditions of resource consent.

Contaminant:	**Copper**	**Zinc**	**Lead**	**TSS**
POD 319836(g/m3)	0.24	0.11	0.018	78
POD 310389(g/m3)	0.017	0.022	0.0042	36
Likely concentration (g/m3) prior to discharge to trade waste	0.223	0.088	0.0138	42
Likely concentration (g/m3) after 1st and 2nd flush to trade waste (80%removal)	0.0446	0.0176	0.00276	8.4
Efficiency rates filters(%)	60	50		75
Estimated result(g/m3)	0.01784	0.0088		2.1
NRC RC Condition(mg/m3	<20	<50	<10	<20000
NRC RC Condition(g/m3	<0.02	<0.05	<0.02	<20
Compliance	√	√	√	√

Please note:

- The efficiency rates are derived from technical publications of performance of Humes using Zeolite and Perlite filter cartridges.
- The Zeolite component in the cartridge reduces dissolved heavy metals.
- The Perlite component in the cartridge reduces total suspended particles and solids.

If future water sampling shows a lower reduction in combined dissolved and suspended particles the following options are available:

- an option to carry out an additional round of waterblasting, with the runoff discharged towards the trade waste.
- an additional cartridge can be installed to meet the NRC RC conditions. To allow for this the manhole has been sized as being 1500mm in diameter so that a further cartridge can be installed.

6 Assessment of the sizing requirements for the Humes "Stormwater 360" system in regards to storm events and what would happen if this occurs.

The proposed Humes Stormwater 360 Chamber has a built in bypass channel when flows exceed 1.42 l/s. Therefore the proposed Humes Stormwater 360 system meets the minimum requirement of treating stormwater flows up to 0.8 l/s required by the proposed NRC RC condition.

Therefore flows exceeding 0.8 l/s up to 1.42 l/s will also be treated to the required standard. This is approximately equivalent to a 1 in 10 year rainfall event.

Flows exceeding 1.42 l/s will bypass the filters via the "Peak Diversion" bypass weir and flow into the CMA via the sampling manhole.

Referring to the advice note under proposed RC condition 36:

"Advice Note: For the purpose of this condition (36) 'Normal Operating Conditions' shall mean – The treatment of stormwater from rain intensities of up to a 10mm/hr rainfall event. Rainfall intensities over this are not normal operating conditions"

7 Conclusion

The stormwater and wastewater management system presented is expected to treat discharge from the site to the CMA to meet the minimum water quality requirements of the proposed NRC Resource Consent conditions.

Wil Pille

Senior Engineer

BEng, REA

Appendix A
2019Thomson Survey; Dougs Opua Boat Yard, Existing Stormwater Management Plan updated 29/03/2019

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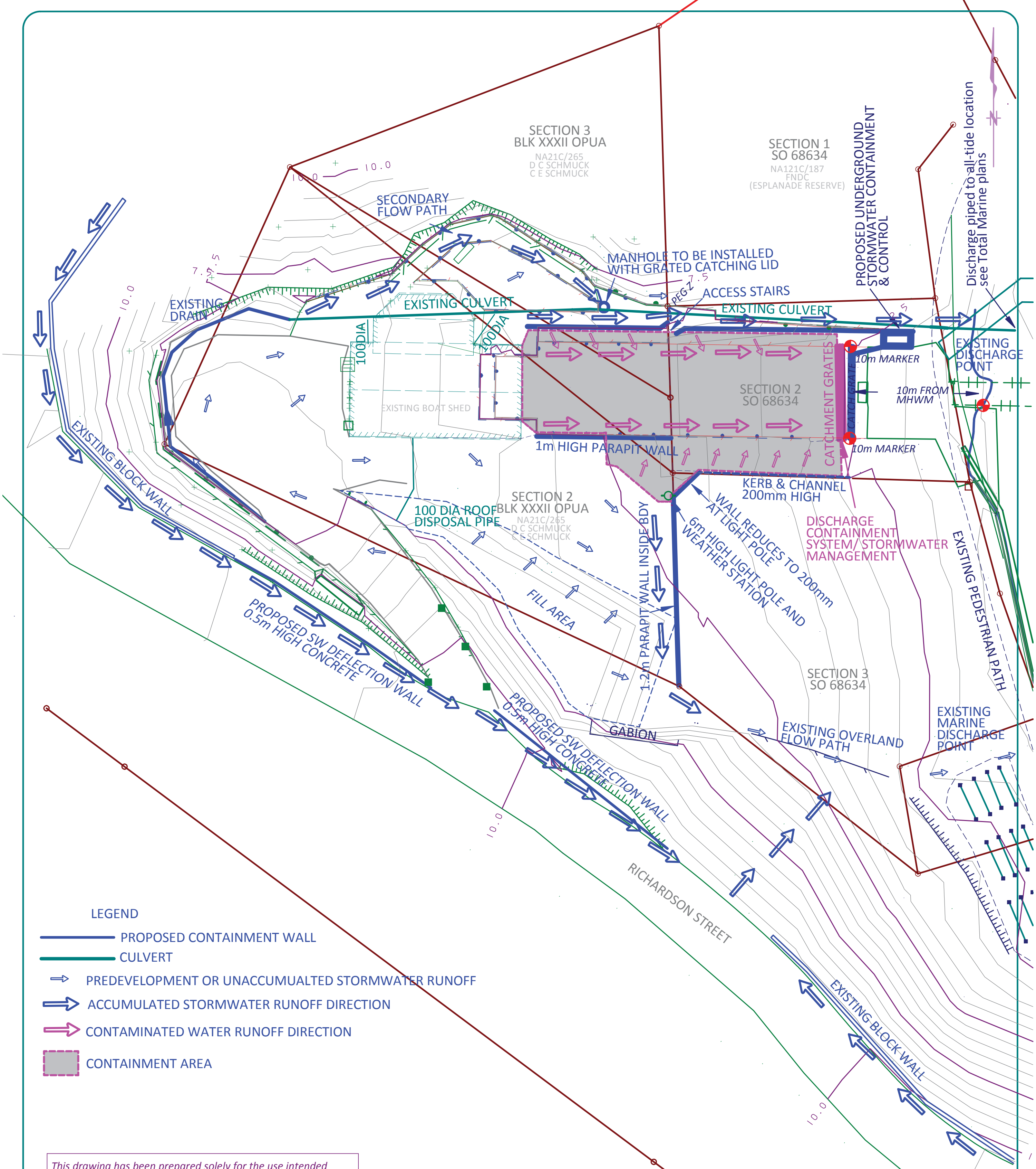


This drawing has been prepared solely for the use intended by the client stated on the plan, and must not be used for any other purpose. Thomson Survey Ltd accepts no responsibility for this plan, or any data contained on this plan, to be used for any other purpose.

LEVEL DATUM: MEAN SEA LEVEL (ONE TREE POINT)
LEVEL ORIGIN: BM DB 84 SO 49470 (A1E9) RL 3.41m
(ADD 1.4m TO EQUAL CHART DATUM)
OPUA RECORD MHWS LEVEL 1.1m (2.5m CHART DATUM)

PROPOSED SITE CONTOURS SHOWN
CONTOUR INTERVAL 0.5m MINOR, 2.5m MAJOR

DOUGS OPUA BOAT YARD, OPUA

0 5 10 20 25 m
Bar Scale

THOMSON SURVEY LIMITED
315 Kerikeri Rd
P.O. Box 372 Kerikeri
Email: kerikeri@tsurvey.co.nz
Ph: (09) 4077360 Fax (09) 4077322
Registered Land Surveyors, Planners & Land Development Consultants

DOUGS OPUA BOAT YARD PROPOSED CONTAINMENT & STORMWATER MANAGEMENT

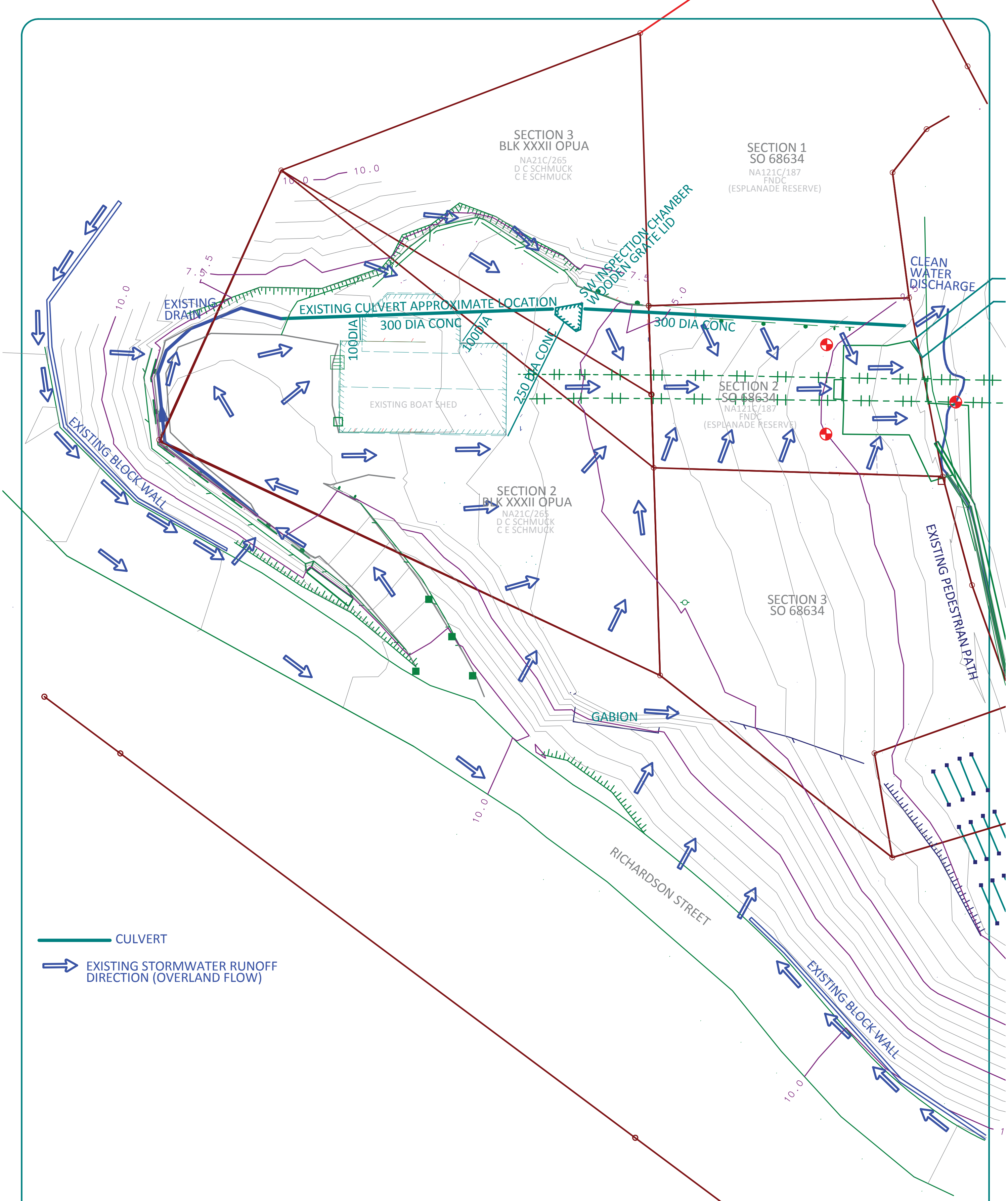
	Name	Date
Survey	SH	2017
Design		
Drawn	SL	17.12.18
Approved		
Rev	SL	29.03.19

8095 D8 SW PROPOSED.lcd

ORIGINAL
SCALE 1:250
SHEET SIZE A3

Surveyors Ref. No: 8095

Appendix B
Thomson Survey; Dougs Opua Boat Yard, Proposed Containment & Stormwater Management Plan dated March



CULVERT

EXISTING STORMWATER RUNOFF DIRECTION (OVERLAND FLOW)

LEVEL DATUM: MEAN SEA LEVEL (ONE TREE POINT)
LEVEL ORIGIN: BM DB 84 SO 49470 (A1E9) RL 3.41m
(ADD 1.4m TO EQUAL CHART DATUM)
OPUA RECORD MHWS LEVEL 1.1m (2.5m CHART DATUM)

EXISTING SITE CONTOURS SHOWN
CONTOUR INTERVAL 0.5m MINOR, 2.5m MAJOR

DOUGS OPUA BOAT YARD, OPUA

Bar Scale 0 5 10 20 25 m

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Registered Land Surveyors, Planners & Land Development Consultants

DOUGS OPUA BOAT YARD EXISTING STORMWATER MANAGEMENT

	Name	Date
Survey	SH	2017
Design		
Drawn	SL	17.12.18
Approved		
Rev		

ORIGINAL SCALE 1:250 SHEET SIZE A3

8095 DESIGN 7 CONTOURS PLANVIEW.lcd

Surveyors Ref. No: 8095

SHEET 2

Appendix C
VISION Locality and Stormwater Management Plan

LOCALITY MAP

SCALE A3 NTS

NOTE:
1. ALL STRUCTURES AND FEATURES ARE APPROXIMATE IN LOCATION AND SIZE AND HAVE BEEN BASED FROM LINZ AERIAL IMAGE AND SITE WALKOVER
2. LINZ 2014-16 AERIAL IMAGE
3. LIDAR CONTOURS

VISION CONSULTING
Engineers & Planners

CLIENT	PROJECT	DRAWING TITLE
DOUG SCHMUCK	1 RICHARDSON STREET OPUA	LOCALITY AND STORMWATER CATCHMENT PLAN

SURVEY		
DESIGN	WP	05/06/2019
DRAWN	LP	05/06/2019
CHECKED	WP	05/06/2019
APPROVED	WP	05/06/2019

No	REVISION	BY	DATE

SCALE	1:1000
SHEET	1 of 02
PROJECT	13958
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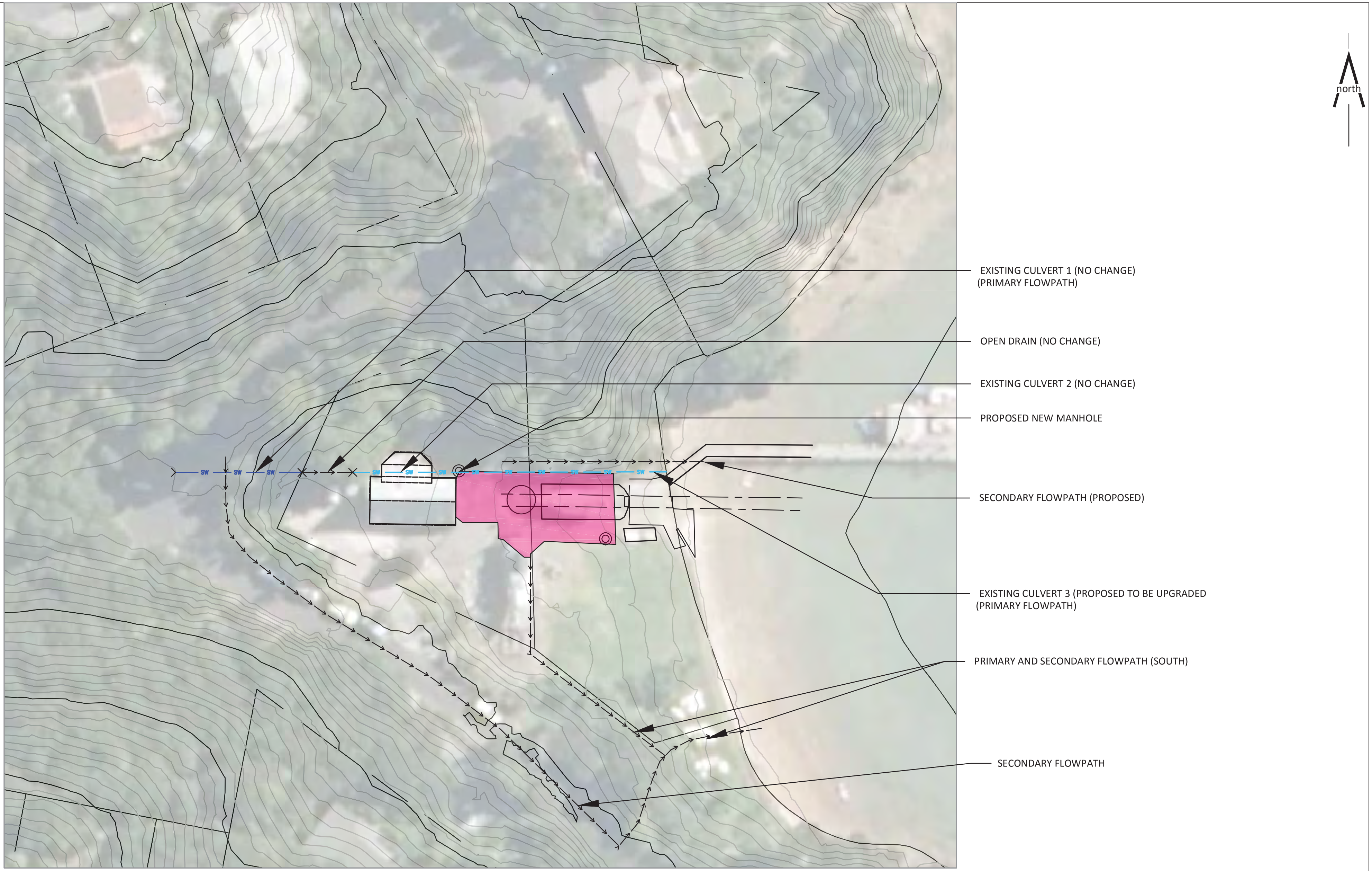

NOTE:
1. ALL STRUCTURES AND FEATURES ARE APPROXIMATE IN LOCATION AND SIZE AND HAVE BEEN BASED FROM LINZ AERIAL IMAGE AND SITE WALKOVER
2. LINZ 2014-16 AERIAL IMAGE
3. LIDAR CONTOURS

VISION CONSULTING Engineers & Planners

CLIENT	PROJECT	DRAWING TITLE
DOUG SCHMUCK	1 RICHARDSON STREET OPUA	STORMWATER MANAGEMENT PLAN

SURVEY		
DESIGN	WP	05/06/2019
DRAWN	LP	05/06/2019
CHECKED	WP	05/06/2019
APPROVED	WP	05/06/2019

No	REVISION	BY	DATE

SCALE	1:500
SHEET	2 of 02
PROJECT	13958
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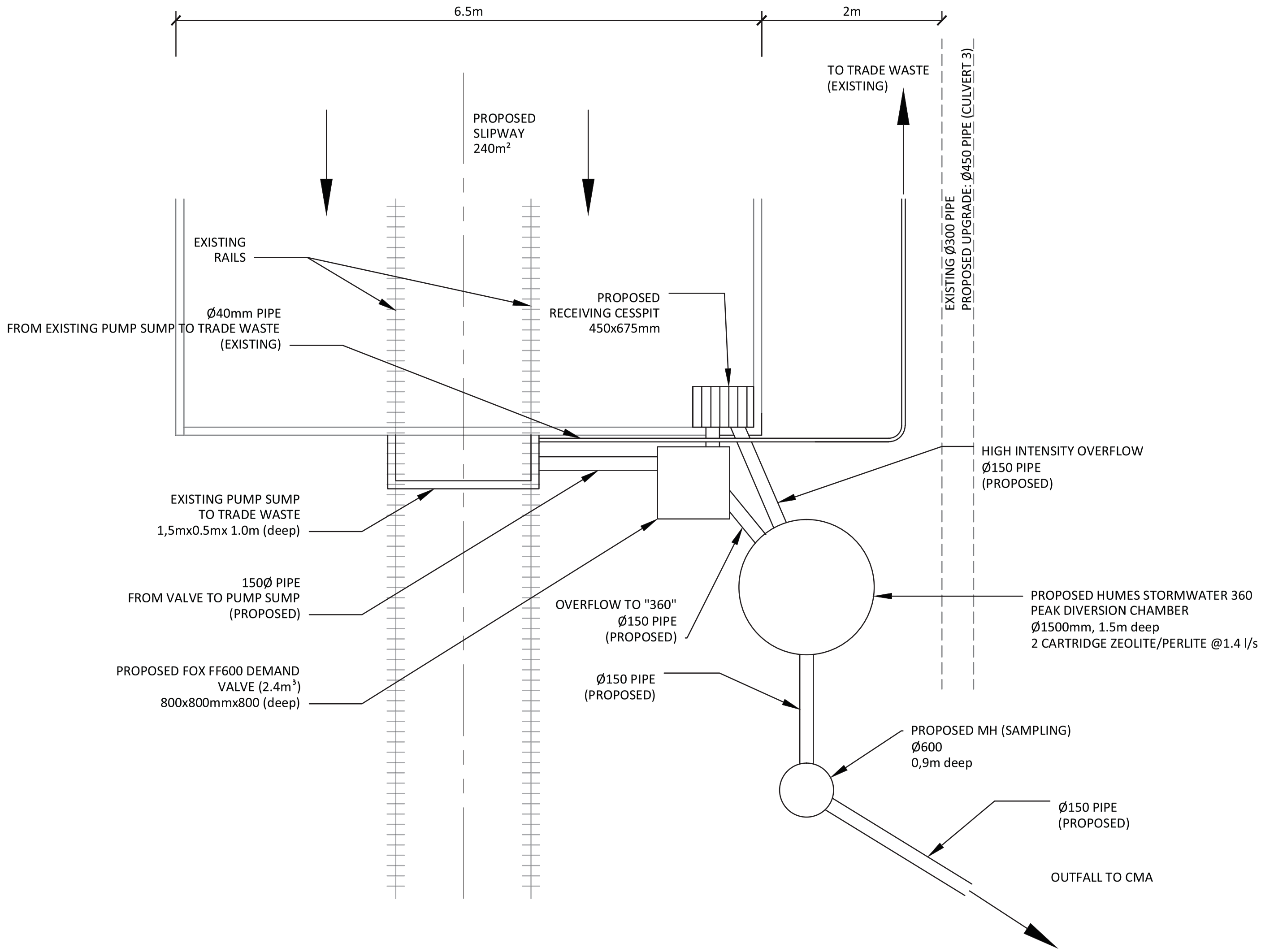
Appendix D
VISION SW and WW Disposal Concept Plan



CONCEPT PLAN

VISION CONSULTING Engineers & Planners	CLIENT DOUG SCHMUCK	PROJECT DOUGS OPUA BOAT YARD PROPOSED SLIPWAY 2019	DRAWING TITLE SW AND WW DISPOSAL CONCEPT PLAN

SURVEY		
DESIGN	WP	05/06/2019
DRAWN	LP	05/06/2019
CHECKED	WP	05/06/2019
APPROVED	WP	05/06/2019

No	REVISION	BY	DATE

SCALE	1:50
SHEET	1 of 01
PROJECT	13958
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Appendix E
HUMES Technical Data

First Flush Diversion System
FOX FF600

Demand driven diversion unit providing additional environmental protection

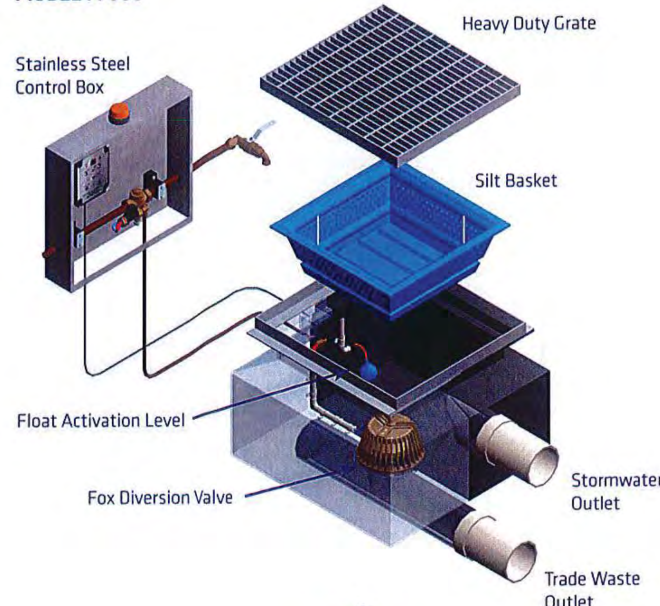
The Fox FF600 is a Demand Driven Diversion System for an unroofed wash bay that provides additional stormwater protection by capturing the "First Flush" of rain from the wash area when it starts to rain.

The Fox First Flush Diversion System is hydraulically actuated from the wash point in the wash bay, opening automatically and diverting all dirty wash water to the underground holding tank for treatment by an Oil Separator.

HOW DOES IT WORK?

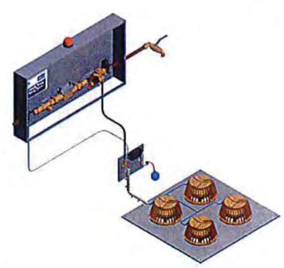
At the commencement of rain the FF600 automatically diverts the contaminated "first flush" of rain to the underground dirty water holding tank. After diverting the First Flush of rain to treatment the FF600 automatically locks the diversion valve closed sending all rain water to the stormwater course.

MODEL FF600



Fox Demand Valve DMV25

Fox Diversion Valve DV150



APPLICATIONS

- Aviation/Airports
- Earthmoving
- Armed Forces
- Ports
- Marinas
- Fuel/Gas Stations
- Mining
- Slipways
- Trucking/Transport
- Vehicle Dealerships

CONTACT DETAILS

Stormwater360

FREEPHONE:
0800 STORMWATER
(0800 786769)

www.stormwater360.co.nz

Stormwater360 BETWEEN SKY AND SEA

SCHEMATIC DETAIL OF FF600 SYSTEM

Stormwater360 BETWEEN SKY AND SEA

SPECIFICATIONS

Material	6mm MDPE
Silt Basket Capacity	50 Litres 9mm holes
Diversion Valve	1200l/min
Flow Rate	@.5m head
Grate	Class B Heavy Duty Galvanised

Available Options

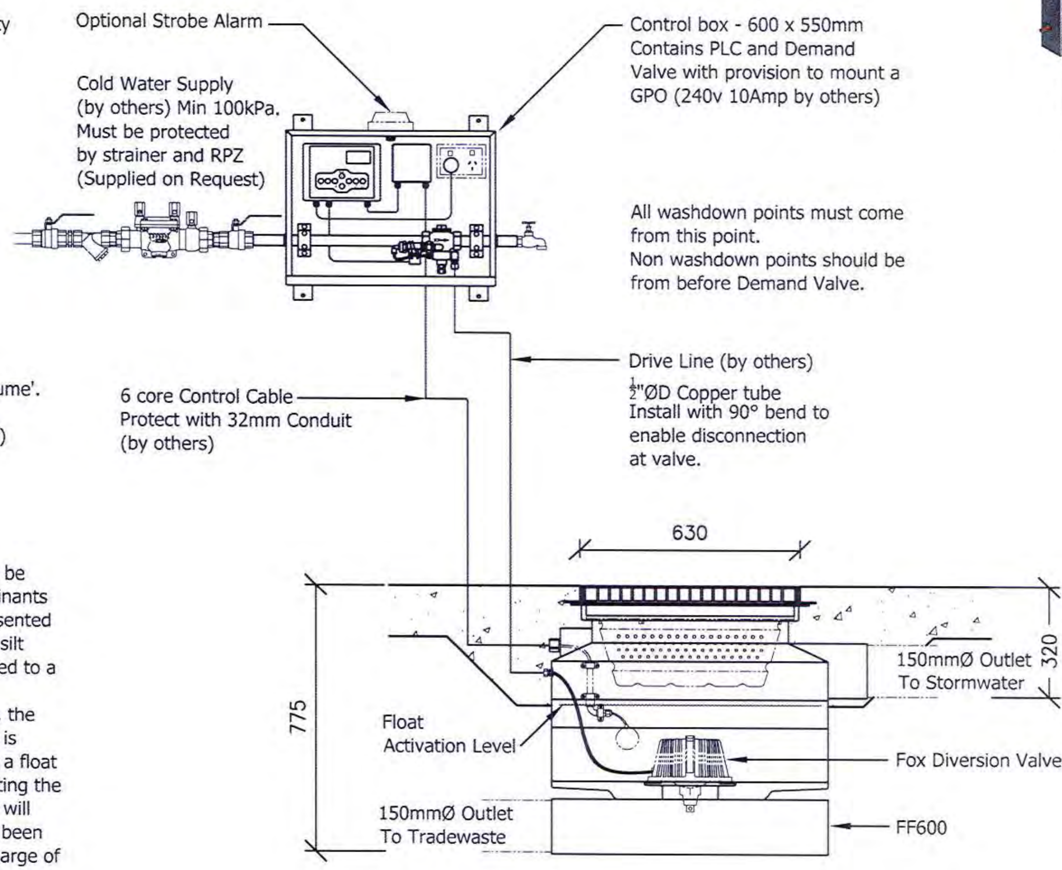
Class 'C' Grate
Class 'D' Grate
Note: Inverts will change.
Request details if required.
Control Panel available in
Stainless Steel.

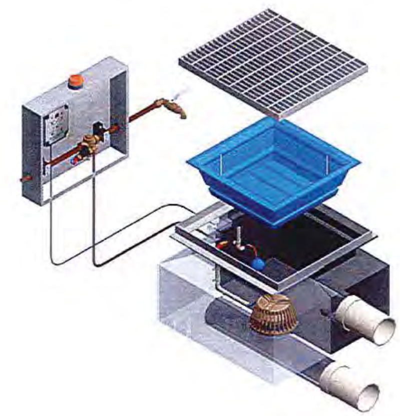
Calculation Note:
The working volume is the 'First Flush Capture Volume'.

= Area of Wash Slab (m²) x First Flush Depth (mm)
i.e. 250m² area x 10mm depth = 2500 Litres.

PROCESS DESCRIPTION

The Fox FF600 is suitable for use where it can not be guaranteed that an area will be left free of contaminants at the end of a washdown operation. Runoff is presented to the Fox FF600 chamber via the grated inlet and silt basket. During a wash operation all runoff is diverted to a holding tank for treatment or proper disposal.
During a rain event if no washdown is taking place, the level in the chamber will rise as the diversion valve is closed. At a point just below the stormwater outlet a float will activate, opening the diversion valve and diverting the pit contents to the Treatment tank. This procedure will continue until the required 'First Flush' volume has been diverted. After the First Flush has been taken discharge of the runoff will be through the stormwater outlet pipe.
This arrangement eliminates the larger volumes of runoff that are normally collected with a conventional First Flush capture system.





FOX ENVIRONMENTAL SYSTEMS

This is a schematic representation only. Slab size and gradient to engineers details as arranged by customer. All plumbing and electrical connections to be installed by certified tradesmen in accordance with relative authorities requirements. Tradesmen to be engaged by the purchaser. System to be approved by relative Local Authorities before Installation.

This Drawing and design is the Property of Fox Environmental Systems Pty Ltd. It must not be used for any other purpose than that for which it was issued.

Project
System Specifications

Drawing Title
FF600 System

Drawn by:	J.F.S
Date:	15/01/2010
Scale:	As Specified
Drawing No:	A4-SPEC-1007/2

STORMFILTER™

High efficiency / low maintenance stormwater filter.

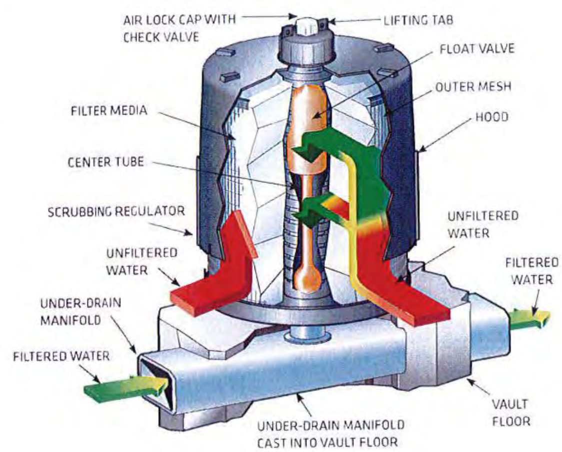
SIPHON-ACTUATED FILTRATION The Stormwater Management StormFilter® cleans stormwater through a patented passive filtration system, effectively removing pollutants to meet the most stringent regulatory requirements. Highly reliable, easy to install and maintain, and proven performance over time, StormFilter products are recognised as a versatile BMP for removing a variety of pollutants, such as sediments, oil and grease, metals, organics, and nutrients. These systems come in variable configurations to match local conditions and come with prolonged maintenance periods to ensure long-term performance and reduce operating costs.

HOW DOES IT WORK?

During a storm, runoff passes through the filtration media and starts filling the cartridge center tube. Air below the hood is purged through a one-way check valve as the water rises. When water reaches the top of the float, buoyant forces pull the float free and allow filtered water to drain.

After the storm, the water level in the structure starts falling. A hanging water column remains under the cartridge hood until the water level reaches the scrubbing regulators. Air then rushes through the regulators releasing water and creating air bubbles that agitate the surface of the filter media, causing accumulated sediment to drop to the vault floor. This patented surface-cleaning mechanism helps restore the filter's permeability between storm events.

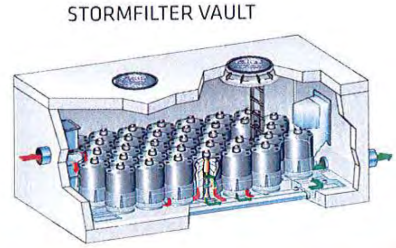
STORMFILTER CARTRIDGE



PROVEN PERFORMANCE

- New Zealand's only independently verified filter by Washington Department of Ecology, New Jersey Department of Environmental Protection and USEPA's Environmental Technology Verification program).
- Approved Auckland Council >75% TSS removal and approved on high trafficked roads (>20,000 V.P.D)
- Over 550 x StormFilter's installed throughout New Zealand-treating over 3.7 million m² of catchment area
- 8th generation of the product. Design refined and perfected over two decades of research and experience

STORMFILTER VAULT



STORMFILTER BENEFITS

UNDERGROUND SYSTEMS MAXIMISE PROFITABILITY

- Save land space allowing denser developments reducing sprawl
- Add parking spaces and increase building size, increasing profitability
- Compact design reduces construction and installation costs by limiting excavation

RELIABLE LONGEVITY & LOWER MAINTENANCE COSTS

- Self cleaning hood prevents surface blinding, ensures use of all media and prolongs cartridge life
- 1-3 year maintenance cycles
- 8 years maintenance experience – 1-5 year contracts with cost guarantees
- Minimal or no standing water. Lower disposal costs

CONTACT DETAILS

Stormwater360

FREEPHONE:
0800 STORMWATER
(0800 786769)

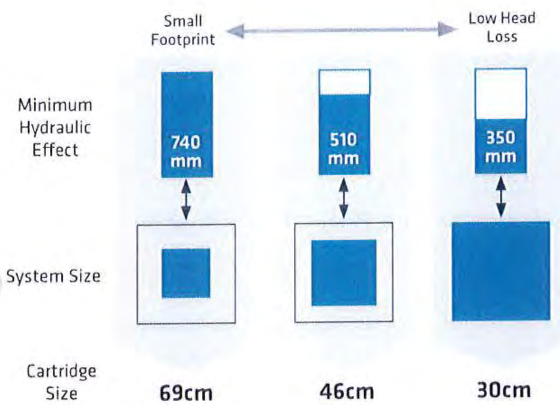
www.stormwater360.co.nz

Stormwater360®
BETWEEN SKY AND SEA

BETWEEN SKY AND SEA

SUPERIOR HYDRAULICS

Multiple cartridge heights gives design solutions for site restraints.



Other hydraulic benefits

- Low hydraulic effect as low as 350 mm head loss
- Zero surcharge of inlet pipe unlike upward flowing filters
- Can be operated with tail water e.g tidal conditions
- Online and offline configurations can limit hydraulic effects

MEDIA CHOICES

Our filtration products can be customised using different filter media to target site-specific pollutants. A combination of media is often recommended to maximise pollutant removal effectiveness.

Perlite is naturally occurring puffed volcanic ash. Effective for removing TSS, oil and grease.

ZPG™ is a multi-purpose media option approved for highly trafficked sites or sites with high metal loadings. ZPG is a mixture of Zeolite, Perlite and GAC (granular activated carbon). ZPG is ideal for removing soluble metals, TSS, oils and grease, organics and ammonium.

Zeolite is a naturally occurring mineral used to remove soluble metals, ammonium and some organics.

GAC (Granular Activated Carbon) has a micro-porous structure with an extensive surface area to provide high levels of adsorption. It is primarily used to remove oil and grease and organics such as PAHs and phthalates.

CONFIGURATION

Stormfilter's can be configured in any drainage structure. Please contact SW360 for a customised design.

PRECAST VAULT

- Treats medium sized sites
- Simple installation – arrives on-site fully assembled

DRYWELL/SOAKAGE

- Provides treatment and infiltration in one structure
- Available for new construction and retrofit applications
- Easy installation
- Shallow and Rock soakage models available

HIGH FLOW

- Treats flows from large sites
- Consists of large, precast components designed for easy assembly on-site
- Several configurations available, including: Panel Vault, Box Culvert, or Cast-In-Place

DETENTION

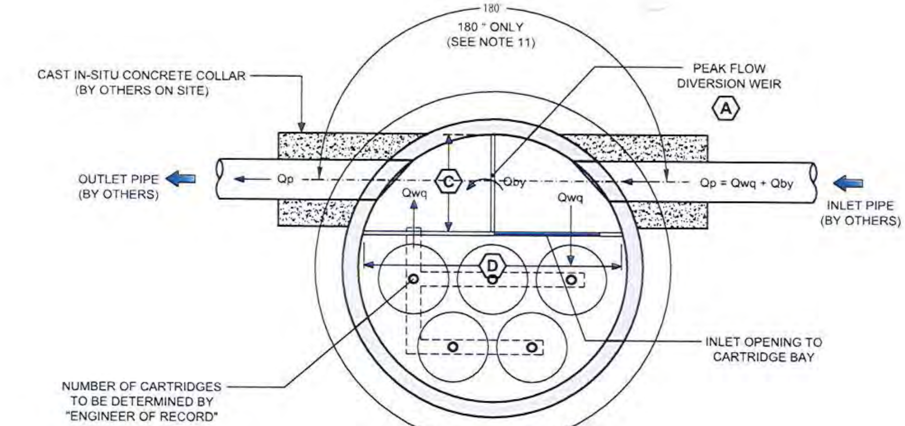
- Meets volume-based stormwater treatment regulations
- Captures and treats site specific Water Quality and Quantity Volume
- StormFilter cartridges provide treatment and control the discharge rate
- Can be designed to capture all, or a portion, of the WQv
- Detention vault configured to provide pre-treatment

CATCHPIT/ CURB-INLET

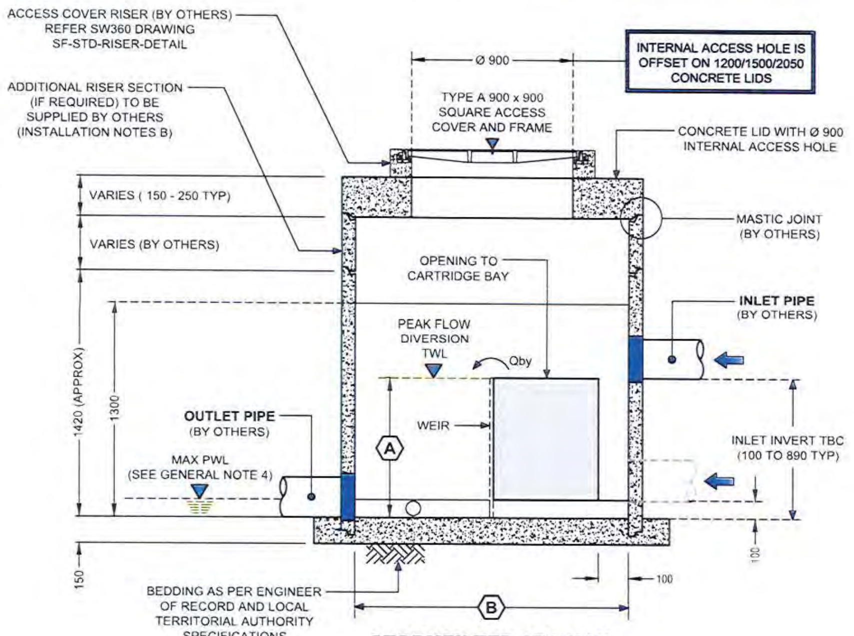
- Provides a low cost, low drop, point-of-entry configuration
- Treats sheet flow from small sites
- Accommodates curb inlet openings from 1 to 3 metres long

PRECAST MANHOLE

- Provides a low drop, point-of-entry configuration
- Uses drop from the curb inlet to the conveyance pipe to drive the passive filtration cartridges
- No crane required (Hi-AB lifting for most sizes)
- 1050-2400mm diameter sizes available



STORMFILTER PLAN VIEW



STORMFILTER SECTION

STORMFILTER DESIGN NOTES

STORMFILTER TREATMENT CAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE PEAK DIVERSION MODEL INTEGRATES AN "OFFLINE" BYPASS WEIR WITHIN THE STORMFILTER MANHOLE. THE STORMFILTER RATED MAXIMUM TREATMENT CAPACITY PER CARTRIDGE IS SHOWN IN THE TABLE BELOW. MAXIMUM HYDRAULIC INTERNAL BYPASS @ 200 mm HYDRAULIC HEAD IS SHOWN IN THE TABLE BELOW. SITE SPECIFIC PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD. CONTACT YOUR STORMWATER CONSULTANT FOR ADDITIONAL INFORMATION

CARTRIDGE HEIGHT (cm)	69		46		30 (LOW DROP)	
RECOMMENDED HYDRAULIC DROP (mm) (A)	890		660		500	
SPECIFIC FLOW RATE (L/s/m2)	1.40	0.70	1.40	0.70	1.40	0.70
CARTRIDGE FLOW RATE (L/s)	1.42	0.71	0.95	0.475	0.63	0.315

STORMFILTER STRUCTURE MODEL	SFMHPD1015	SFMHPD1215	SFMHPD1515	SFMHPD1815	SFMHPD2015	SFMHPD2315
MAXIMUM No. OF CARTRIDGES	1	2	3	5	6	9
MAX. TREATMENT FLOW RATE Qwq (L/s)	1.42	2.84	4.26	7.10	8.56	12.78
(B) CHAMBER DIAMETER	Ø 1050	Ø 1200	Ø 1500	Ø 1800	Ø 2050	Ø 2300
(C) BYPASS WEIR LENGTH*	400	430	560	650	700	750
(D) BYPASS BAFFLE LENGTH*	1035	1165	1420	1750	1930	2150
BYPASS FLOW, Qby @ 200mm ABOVE WL*	65 L/S	70 L/S	90 L/S	105 L/S	110 L/S	120 L/S
WEIGHT OF MANHOLE	1.5 T (MH)	1.9 T (MH)	2.6 T (MH)	4.17 T (MH)	5.07 T (MH)	6.8 T (MH)
WEIGHT OF LID	0.5 T (LID)	0.9 T (LID)	1.0 T (LID)	1.6 T (LID)	2.0 T (LID)	2.8 T (LID)

*CUSTOM PEAK DIVERSION CONFIGURATIONS ARE AVAILABLE WHERE GREATER BYPASS FLOWS ARE REQUIRED. CONTACT A SW360 STORMWATER CONSULTANT FOR MORE INFORMATION.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
CATCHMENT AREA			
WATER QUALITY FLOW RATE - Qwq (L/s)			
PEAK FLOW RATE - Qp (L/s)			
RETURN PERIOD OF PEAK FLOW (yrs)			
# OF CARTRIDGES REQUIRED x CARTRIDGE HEIGHT (ie 1 x 69 cm)			
CARTRIDGE FLOW RATE			
MEDIA TYPE (ZEO, PER, ZPG, PHS)			
ACCESS COVER TYPE (ALL CLASS D)	TYPE A SOLID 900 x 900	TYPE H (NZTA) GRATE 900 x 900	
PIPE DATA:	R.L.	MATERIAL	DIAMETER
INLET PIPE			
OUTLET PIPE			
LID LEVEL		N/A	N/A
AS PER ENGINEER OF RECORD			

GENERAL NOTES :

1. STORMWATER360 TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR SW360 STORMWATER CONSULTANT VIA www.stormwater360.co.nz, OR 0800 STORMWATER, OR sales@stormwater360.co.nz.
3. T.W.L. = TREATMENT WATER LEVEL.
4. THE MAXIMUM DOWNSTREAM PERMANENT WATER LEVEL (PWL) IS TO BE SET AT OR BELOW THE BASE OF THE CARTRIDGES. TYPICALLY 100 mm ABOVE OUTLET INVERT.
5. PEAK DIVERSION WEIR CORRESPONDS TO RECOMMENDED HYDRAULIC DROP (A) ON TABLE ABOVE.
6. STRUCTURE SHALL MEET NZTA'S HN-HO-72 OR PER APPROVING JURISDICTION TRAFFICKED LOAD REQUIREMENTS, WHICHEVER IS MORE STRINGENT. COVER AND FRAME ARE TO BE RATED TO EITHER CLASS B (FOR PEDESTRIAN AREAS) OR CLASS D (TRAFFICKED ROADS) IN ACCORDANCE WITH AS 3996 : 2006.
7. STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO NZS 3109 : 1997, NZS 3114 : 1987 AND AS/NZS 4058 : 2007.
8. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 178 mm. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 39 SECONDS.
9. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (L/s) DIVIDED BY THE FILTER CONTACT SURFACE AREA (m2).
10. MINIMUM INVERT DIFFERENCE BETWEEN INLET PIPE AND OUTLET PIPE IS 100 mm.
11. DEVICE SUITABLE FOR INSTALLATION ON STRAIGHT (180 °) PIPE RUNS. ALTERNATIVE PIPE ANGLES ARE ARE NOT SUITABLE. CONTACT SW360 FOR ALTERNATE OPTIONS.
12. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

INSTALLATION NOTES :

A. SIZE AND CLASS OF PIPE OR SQUARE KNOCKOUT SIZE TO BE SPECIFIED ON DRAWING BY CLIENT / CONTRACTOR.
B. ADDITIONAL RISERS TO BE FORMED ON SITE BY CONTRACTOR (IF REQUIRED).
C. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
D. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
E. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
F. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPES. STRAIGHT PIPES TO BE INSTALLED WITH 180° ANGLES ONLY. A CAST IN-SITU CONCRETE COLLAR IS TO BE POURED ON SITE BY CONTRACTOR AS SHOWN ON DRAWINGS.
G. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

Stormwater360
BETWEEN SKY AND SEA

0800 STORMWATER
sales@stormwater360.co.nz
www.stormwater360.co.nz

CONDITION OF USE

STORMFILTER
PEAK DIVERSION
MANHOLE CONFIGURATION
GENERAL ARRANGEMENT

SCALE : XXX | DRG No : SF-STD-MHPD-ALL

DRAWING				ISSUE	REVISION DETAIL	DATE
1	JOB NO :					
	PROJECT :			C	GENERAL REV	30.04.18
D	DEVICE # :			D	GENERAL REV	31.07.18
	DRN :	R.P.	30.04.18			
	CKD :	T.B.	30.04.18			

DEVELOPMENT AND TESTING OF FILTER MEDIA FOR REMOVAL OF DISSOLVED METALS

Nick Vigar, Mike Hannah. Stormwater360.*

ABSTRACT (200 WORDS MAXIMUM)

Stormwater is a complex mixture of dissolved, colloidal and particulate species. When developing and testing filter media to treat dissolved metals we must bear in mind the role of colloid and particulate retained in the filter. These latter species have the capacity to bind dissolved metal ions in much the same way as the filter media itself. It is for this reason that performance testing must ultimately involve full scale field trials with real runoff. Conversely, it is the variable nature of runoff that makes media development particularly difficult. Laboratory simulations allow accurate benchmarking under well controlled, reproducible conditions. An outline of Stormwater360's current development and testing programme is presented, along with performance comparisons for dissolved metals removal by various media.

KEYWORDS

filtration media dissolved metals zeolite slag

PRESENTER PROFILE

Nick Vigar is Research Manager for Stormwater360. He has a BSc (Hons) in chemistry and is currently finishing his PhD in Physical Chemistry at The University of Auckland.

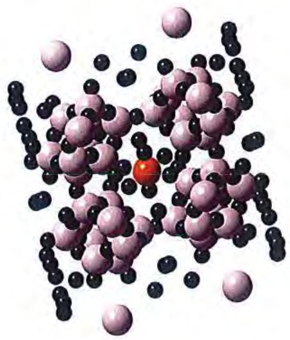
1 INTRODUCTION

Runoff from roads and urban pavement carries contains environmentally significant loadings of zinc, copper, lead, cadmium, and other heavy metals. These metals may exist as dissolved species, or bound to particulate within the runoff. Generally, dissolved metals are found to be more bioavailable, and therefore pose more of a toxicity risk to aquatic life in receiving waters. Copper and zinc are generally of most concern in stormwater, since they are common, and have a significant dissolved fraction.

The speciation of metals in stormwater run-off is complex. They may exist as dissolved species, but often sorb to particulate and colloidal components of the run-off. The partitioning between these species is a consequence of multiple factors and is potentially very dynamic. Whilst the demonstration of any stormwater best management practice (BMP) must necessarily involve field testing, it is a time-consuming and expensive practice. Laboratory testing is viewed as an accessory to field testing. By isolating specific variables it provides the opportunity to investigate simpler systems. The results of laboratory testing, however, may not be directly extrapolated to BMP performance in the field.

Removal of a dissolved metal ion from solution requires either that the ion be 'precipitated' from solution, 'adsorbed' to the surface of a solid substrate, or that it 'exchanges' with another ion from an ion-exchange medium. Currently, the most practicable, and well researched filtration medium in this regard is zeolite. Zeolites are a family of aluminosilicate minerals. They possess a crystalline structure which may be described as a lattice of cavities or cages, and are typically found with sodium, potassium or other (non-heavy) metal ions bound within the cages. Figure 1 shows the crystal structure of the naturally occurring zeolite, clinoptilolite. The orange sphere represents the metal ion bound within the aluminosilicate cage. It is free to exchange with a metal ion in solution, and this is the mechanism by which zeolites may remove dissolved heavy metals from solution.

Figure 1 Crystal structure of exchanged clinoptilolite, a naturally occurring zeolite.



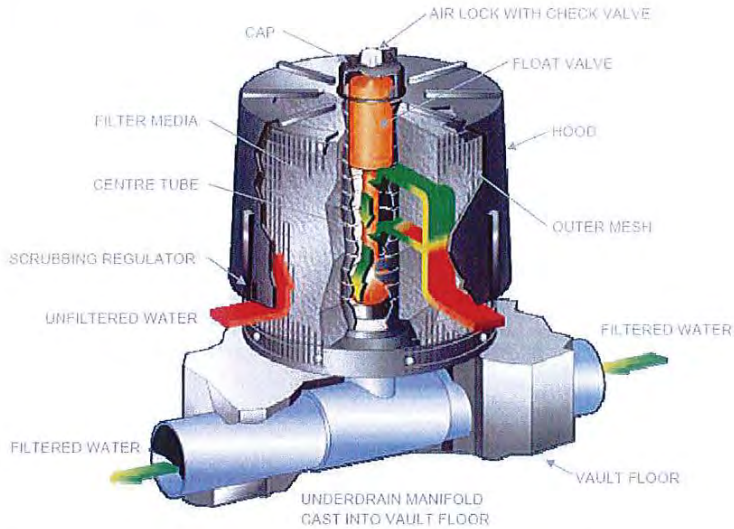
Iron and steel making slags have also shown some potential to remove dissolved heavy metals. These byproducts of the iron and steel making industry are mixtures of metal oxides. They typically have a high surface area, and the surface is capable of adsorbing dissolved metal ions from solution. We have performed initial investigations using melter slag and electric arc furnace slag from the Glenbrook Steel Mill. The former is an iron-making slag, the latter a steel-making slag.

An important step in using materials such as zeolites or iron and steel slags in working filtration devices is establishing how their performance changes as a function of flow rate through the filtration device. In other words we are not concerned with the filtration media's ultimate capacity for heavy metal ions, but instead the removal efficiency that can be expected, given a particular contact time. The concept of contact time incorporates both the surface area presented to the solution and the time the surface and solution spend in close association. Given sufficient contact time we could essentially achieve total removal.

2 MEDIA TESTING

2.1 LABORATORY SETUP AND PROCEDURES

Figure 2 Schematic of the StormFilter



The Stormwater Management StormFilter® (StormFilter), as shown in Figure 2, is a siphon-actuated filtration unit with the capacity to treat a full range of pollutants in urban runoff, including total suspended solids (TSS), soluble heavy metals, oil and grease, and total nutrients. Various filter media may be used to target these pollutants, including perlite for TSS, oil and grease; granulated carbon for organic compounds; and zeolites for soluble heavy metals. Flow through the filtration unit is controlled by a flow-restrictor disc at the filter outlet.

In order to develop media for use in the Stormwater Management StormFilter® (StormFilter) we utilize 1/24th scale versions of the full size device. These horizontal flow columns (HFCs)are capable of being operated at a controlled flow rate, as are the full size StormFilters. They filter radially, from the outside to the inside of the device, as do the full-size units, and have the same bed-depth and geometry as the StormFilter.

Figure 3 Horizontal Flow Column test units

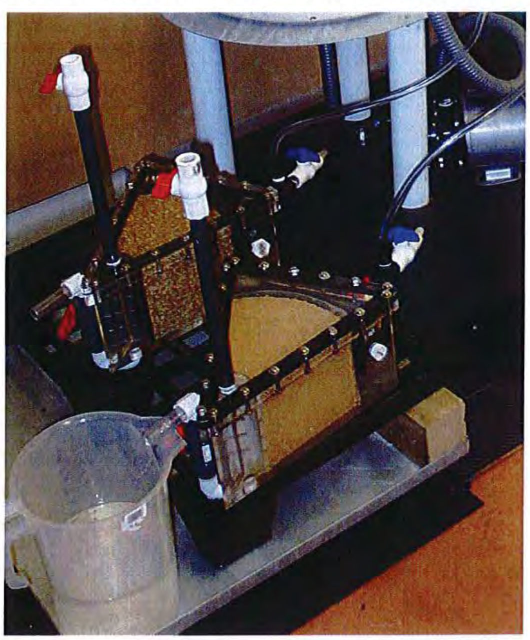
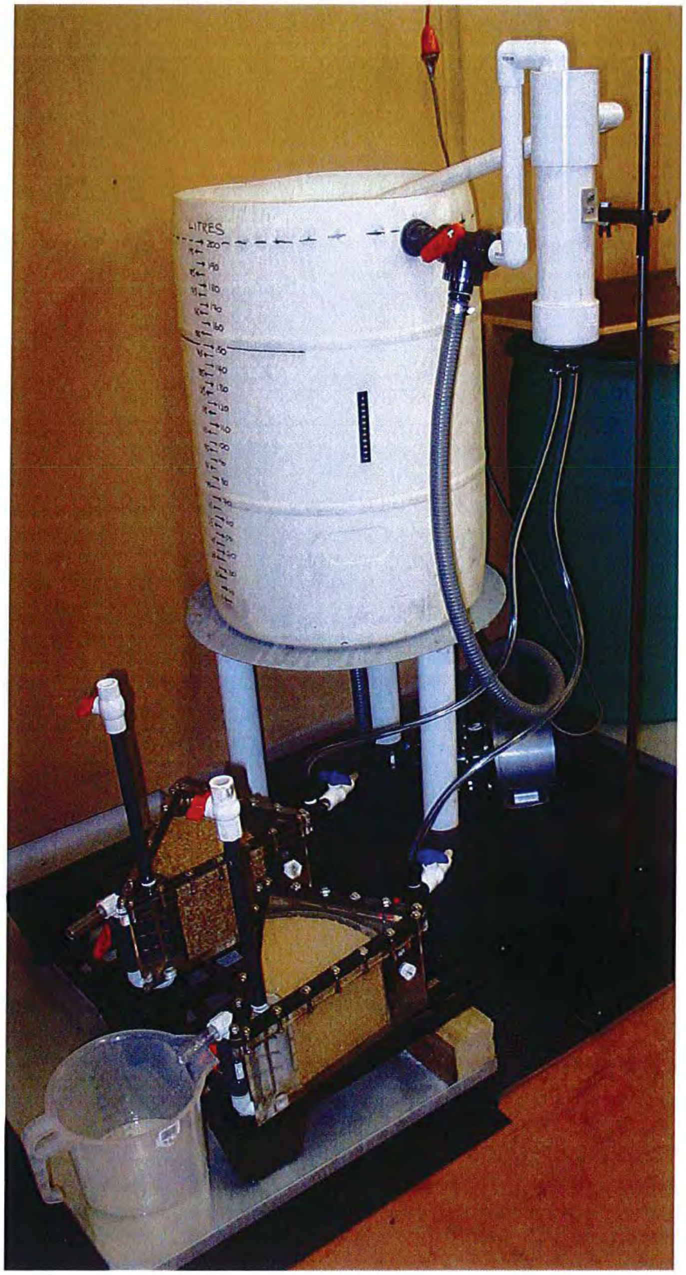


Figure 4 HFC test apparatus



The experimental set-up is shown in Figure 4. Up to 150 L of test solution is prepared in a large polyethylene reservoir. It drains from a centrally located exit in the base of the reservoir to a pump. This pump is a screw design in order to retain the suspension of any sediment. It pumps at 25 L min^{-1}, thus pumping the entire volume of the reservoir every 6 minutes. The test solution is pumped to a 3-way splitter valve. Initially, the splitter valve is set to direct all of the pumped flow back into the reservoir, effectively mixing the solution. Once thorough mixing has been achieved, the splitter valve is set to direct a portion of the flow (typically between 25% and 50% of total) to the constant head reservoir. With provision of adequate flow, this reservoir remains full to the level of the downward sloping pipe which returns excess solution to the main reservoir. As such a constant head of 1 m is maintained that drives the test solution through each

HFC. Up to 3 HFCs may be used at any one time, permitting a parallel testing arrangement. The blue-handled valves in the photo permit influent samples to be taken prior to the test solution passing through each HFC. Test solution that enters the HFC passes through the media from the broad end to the narrow end of the wedge. Here it exits the HFC via a flow-control valve. Effluent samples are taken at this point.

Flow through the HFC is calibrated via a 5 L graduated measuring cylinder and a stopwatch. Flow through the cartridge is controlled, up to a maximum of 2.5 L min^{-1}; being the equivalent of the maximum of 60 L min^{-1} of a full scale StormFilter filtration unit. 25 L of solution were passed through each HFC at the appropriate flow rate before influent and effluent samples were collected. This is approximately 12 times the fluid volume within a packed HFC; sufficient to effectively flush the device of prior, retained solution.

3 COMPARISON OF NEW ZEALAND ZEOLITE WITH MELTER SLAG AND ELECTRIC ARC FURNACE SLAG FOR REMOVING DISSOLVED ZINC AND COPPER

Figure 5 displays the treatment efficiencies for removal of dissolved copper and zinc as a function of flow rate. A treatment efficiency of 100% corresponds to total removal from solutions.

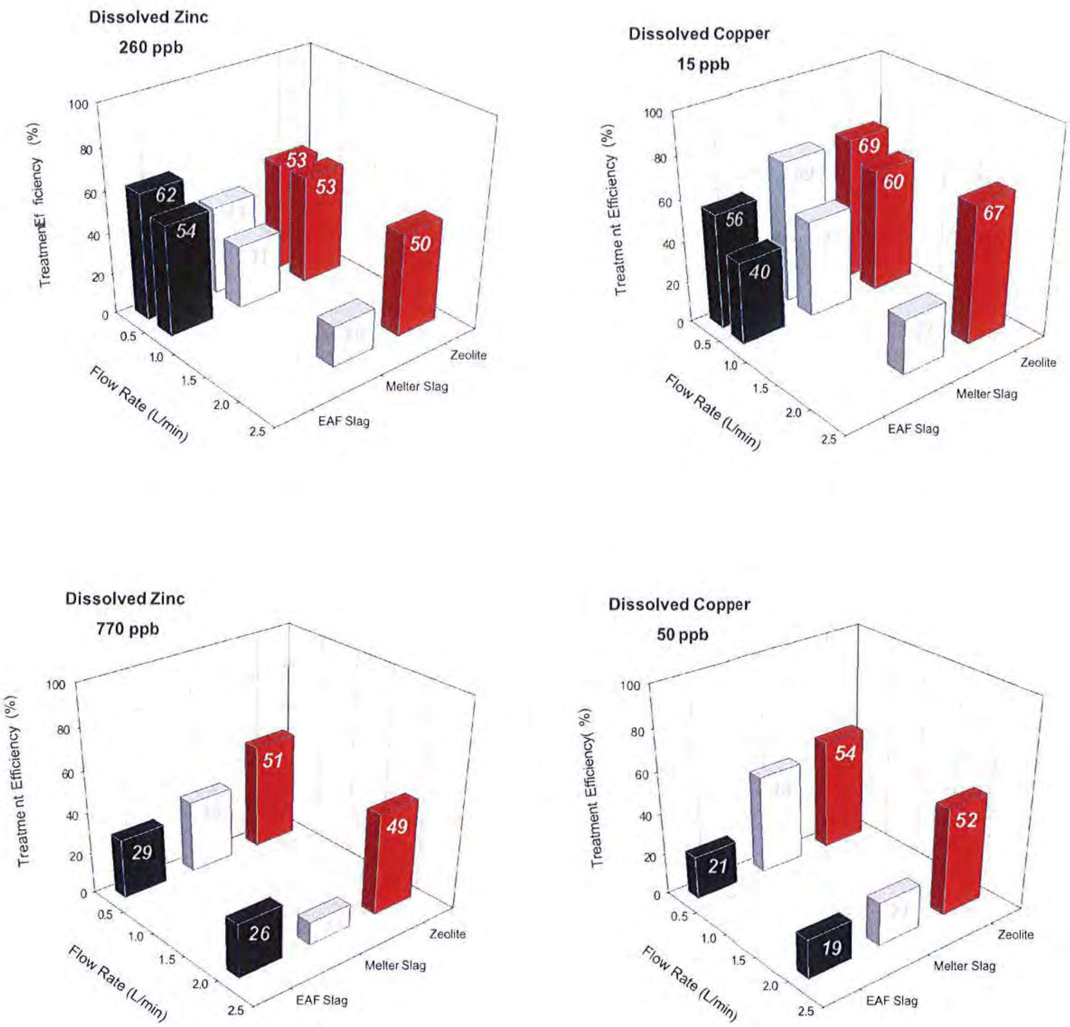
Dissolved concentrations of 260 ppb zinc and 15 ppb copper represent levels of these contaminants that might be considered at the high end of the normal range. Concentrations of 770 ppb zinc and 50 ppb copper represent very high, acutely toxic concentrations.

Flow rates of 2, 0.6 and 0.2 L min^{-1} were used. These correspond to 48, 14 and 5 L min^{-1} flowing through full scale StormFilters.

It can be seen that at low flow rates all media give very similar performance. With 260 ppb zinc and 15 ppb copper solutions, treatment efficiencies for zeolite and both slags are all in the range 43 to 69%. As the flow rates are increased the treatment efficiencies for zeolite change very little, whereas those of melter slag and electric arc furnace slag are significantly reduced.

When we move to more concentrated solutions of zinc (770 ppb) and copper (50 ppb) we see once again that the zeolites give a very consistent treatment efficiency, whereas the performance of both slags has been diminished.

Figure 5 Treatment Efficiencies for Dissolved Zinc and Copper Removal



4 CONCLUSIONS

New Zealand zeolites perform very well across a range of concentrations and flow rates for the removal of dissolved copper and zinc. When used with similar media particle sizes NZ iron and steelmaking slags give comparable results to zeolite at low flow rates. However in highly elevated metals concentrations and at high flow rates the New Zealand zeolite's performance is currently superior.

Present investigations are focused on improving the performance of both slags by utilizing a finer media, and thus increasing their contact time. In particular, if their treatment efficiency can be improved at higher flow rates they become good candidates to replace zeolites, the most currently used technology.

ACKNOWLEDGEMENTS

Bill Bourke, SteelServ for provision of slag samples.

New Zealand Steel for ICP analysis.

Appendix F
Sample Locations


LOC.310389
Doug's Opua Boatyard at
Upstream of discharge
LOC.319836
Bay of Islands at
POD of unnamed
stream adjacent
Dougs Boatyard
LOC.319833
Untreated discharge at
sump at Dougs Boatyard
LOC.107735
Stormwater disch
from boatya
at a point 10 m from
the point of
discharge to the CMA
LOC.319834
Bay of Islands at Southern
end of English Bay
Sampling Sites
Type
Coastal - water
Discharge - industrial and trade
Discharge - stormwater
Rivers, streams, drains, wetland
Sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 3.0 New

Appendix G
Sample Results

Please Quote File: REG.007914.10, ACT.126982
REYR:SQUA

12 July 2018

Douglas Craig Schmuck
1 Richardson Street
Opua 0200

Dear Doug

DISCHARGE OF TREATED BOAT WASHDOWN WATER
- RICHARDSON ST, OPUA. DISCHARGE OF STORMWATER TO THE CMA

Council officers sampled the stormwater discharges from the boatyard on 20 June 2018, during a heavy rain event.

Samples were analysed for heavy metals, turbidity and total suspended sediments, and physical parameters were collected onsite.

The results are shown below and are compared to the consent limits for the existing consent and limits for your current application APP.039650.01.01 (on hold).

Whilst the compliance limit for copper was exceeded at the 10m mixing zone boundary, the results are inconclusive in terms of assessing compliance. The upstream site (310389) and the receiving environment control (319834) exceed the compliance value.

These results indicate the discharge was not having any noticeable effect on the receiving environment at the 10m mixing zone boundary.

The sampling did however indicate there were high levels of Copper and Zinc running off the site through the stormwater system, with levels of 2.2 g/m^3 and 1.2 g/m^3 respectively.

The sampling did not include a sample from the discharge of the treatment system, and therefore a direct assessment of the efficiency of the treatment system cannot be undertaken. That said, the results indicate there is a noticeable increase from the upstream site and the result exceeds the proposed compliance values for Copper, Lead, and Zinc. These results indicate the high levels of heavy metals from the site should be addressed through better site management, sealing of the workspace (to reduce input to stormwater system) or upgrading of the treatment system.

It is worth noting the upstream site also exceeds the proposed compliance limits and the appropriateness of this limit may wish to be reviewed.

Further sampling will be undertaken in the coming financial year to assess the effectiveness of the system during stormwater discharge events.

Yours faithfully

Ricky Eyre
Coastal Monitoring Manager

A1085376

Sample results

	Site 310389	Site 319833	Site 319836	Site 107735	Site 319834		
	Doug's Opua Boatyard at Upstream of discharge	Slipway Sump - Dougs Boatyard, Opua	Stream POD - Dougs Boatyard, Opua	Stormwater discharge from boatyard to CMA at a point 10 m from the point of discharge to the CMA	BOI - Southern end of English Bay.	Compliance - existing consent - 10m mixing	Compliance - current application - POD
Dissolved Oxygen (g/m3)	9.7	10.14	8.34	8.44	8.03		
Dissolved Oxygen Percent Saturation (% Sat)	94.7	96.8	92.3	94.8	93		
Salinity (ppt)	0	0	18.9	21.3	25.8		
Temperature (degC)	14.3	13.3	14.7	14.7	14.8		
Copper Total (g/m3)	0.017	2.1	0.24	0.015	0.031	0.0013	0.01
Lead Total (g/m3)	0.0042	0.067	0.018	0.0013	0.0057	0.0044	0.01
Zinc Total (g/m3)	0.022	1.2	0.11	<0.01	0.025	0.015	0.1
Turbidity (NTU)	120	33	60	20	50		
Total Suspended Solids (g/m3)	36	38	78	39	83		100