PATERSONPITTSGROUP
Surveying • Planning • Engineering
Your Land Professionals
www.ppgroup.co.nz
0800 PPGROUP

RIVER TERRACE DEVELOPMENTS LIMITED REQUEST FOR A CHANGE TO THE OPERATIVE CENTRAL OTAGO DISTRICT PLAN INFRASTRUCTURE REPORT

PROJECT:	River Terrace, Sand Flat Road, Cromwell, Request for a Change to the Operative Central Otago District Plan
PRINCIPAL:	River Terrace Developments Ltd
OUR REF:	C2434
DATE:	December 2017

DUNEDIN: P.O. Box 5933, Dunedin 9058. **T** 03 477 3245
CHRISTCHURCH: P.O. Box 160094, Christchurch 8441. **T** 03 928 1533
ALEXANDRA: P.O. Box 103, Alexandra 9340. **T** 03 448 8775
CROMWELL: P.O. Box 84, Cromwell 9342. **T** 03 445 1826
QUEENSTOWN: P.O. Box 2645, Queenstown 9349. **T** 03 441 4715
WANAKA: P.O. Box 283, Wanaka 9305. **T** 03 443 0110

REVISION / APPROVAL PANEL

Rev:	Date:	Prepared By:	Reviewed By:	Comments:
0	11/11/17	PLD	AT	Issued for client review
1	28/11/17	PLD	MB	Reviewed by client and revised wastewater modelling report
2	4/12/17	PLD	MB	Revised Roading & Revised Water Supply Report

Prepared By:
Paterson Pitts Limited Partnership (Cromwell Office)
30 The Mall
P O Box 84
Cromwell 9342
Telephone: +64 3 445 1826
Email: cromwell@ppgroup.co.nz
Web: www.ppgroup.co.nz

Job No: C2434
Date: 4 December 2017
Report Prepared For: River Terrace Developments Ltd

CONTENTS

1. Scope

Paterson Pitts Limited Partnership (PPLP) has been engaged by River Terrace Developments Ltd (RTDL) to provide an infrastructure report to support a private plan change request for a master planned development at State Highway 6 at Sand Flat Road, Cromwell. The private plan change seeks to re-zone approximately 50 ha of land for a mixture of higher density living, conventional residential subdivision, a retirement village and a small neighbourhood centre.

A total of up to 900 dwelling units is planned. The masterplan also provides for the possibility of a new primary school within the site.

This report covers the availability of the following infrastructure elements.

- Wastewater
- Water Supply – Potable, Firefighting and Irrigation
- Network Utility Services (electricity and telecommunications)
- Road construction

This report is to be read in conjunction with the "Geotechnical Report for Plan Change" ref: 70574 September 2017 prepared by Geosolve Ltd in support of the plan change request.

2. Executive Summary

2.1 Stormwater

The site is underlain by a considerable depth of glacial out wash gravels, with depths to groundwater varying from 25-33 metres below ground level. Soakage tests have shown these gravels to be highly permeable. No issues are anticipated with the discharge of stormwater from roading, hand stand and roof-run off direct to ground via suitably designed soak pits, as is the norm for all land development within the Cromwell area.

2.2 Wastewater

Computer modelling of the Cromwell Wastewater reticulation by Mott MacDonald NZ Ltd shows that the River Terrace Development is likely to have a detrimental effect on the existing network. To service the development a new direct connection to the existing 750mm diameter pipe up stream of the Cromwell Treatment Station, located in Bannockburn Road, will be required.

2.3 Water Supply

Computer modelling of the Cromwell water reticulation by Mott MacDonald NZ Ltd shows that the River Terrace Development will have a detrimental effect on the existing network. To service the development will require a new trunk ring main from the existing Cromwell Town reticulation, and connecting to the Council main at the intersection of Sand Flat Road and Bannockburn Road.

It is feasible that any necessary public space irrigation requirements be met by on site groundwater sources (i.e. bore supplies).

2.4 Network Utility Services

Chorus New Zealand Ltd have confirmed that a suitable telecommunications (fibre) supply can be made available to the proposed development.

The options for a power supply to the development are:

- A direct supply from Aurora Energy Ltd's network. Aurora have advised that a suitable supply can be made available to serve the proposed development.
- An "embedded" network, connected to an Aurora supply, but owned by an alternative service provider.
- An independent network owned by an alternative service provider directly connected to Transpower's grid exit point at the Cromwell substation.

2.5 Road Construction

All roads will be constructed on sand and gravels. Bearing capacity tests on likely road subgrades were well in excess of the minimum requirements. No issues are expected with designing and constructing road pavements in compliance with the procedures of "Austroads" and the subdivisional pavement design standards of the Central Otago District Council. Road cross-section designs and geometry will be in accordance with "Austroads" and NZS 4404:2010, the updated version of Council's current subdivisional engineering standard NZS 4404:2004 and its 2008 amendments thereto.

3. Stormwater

There is no reticulated stormwater system in the Cromwell area.

Analysis of drill hole logs in the locality show that the site is underlain by a considerable depth of glacial outwash sand and gravel with depth to groundwater between 25-34 metres below the ground surface. Test pitting by Paterson Pitts and Geosolve show near surface topology to be 0.05-0.15m of topsoil (soft, organic silt) underlain by 0.1-0.45m of loess (loose silty sand and sand) over outwash sands and gravel, down to the 4.0m depth of all test pits.

A location plan and test pit logs are attached in Appendix (A)

Soakage tests were carried out on TP4 on the top terrace tread and TP11 on the lower terrace tread. Infiltration rates, of 1271mm/hr (0.35 litres/sec/m^2) at TP4 and 2800mm/hr (0.78 litres/sec/m^2) at TP11 were recorded. This equates to an average soakage capacity of a "Caudwell" type soak pit of 11 litres/sec. The NIWA HIRDS program was used to calculate a 2% Annual Exceeding Probability (AEP) short duration rainfall event of 56mm/hr using a 2 deg temperature risk factor to allow for climate change. This means that every 90m of a 20m wide road corridor will be able to be drained by a pair of sumps and "Caudwell" type soak pits, which is the maximum spacing between road sumps permitted by Council's subdivisional engineering standard.

This is a very conservative estimate as actual road pavement widths will be considerably less than 20m. Soakage tests, infiltration calculations and rainfall intensity calculations are attached in Appendix (B)

Direct discharge to ground for stormwater from roading, impermeable surfaces and roof run-off will therefore be possible. The standard solution acceptable to Council is a "Cauldwell type" soak pit, one per sump outlet. This method of stormwater disposal is universally used for land development over glacial outwash gravels in Cromwell, Alexandra and Clyde. See Fig 1.

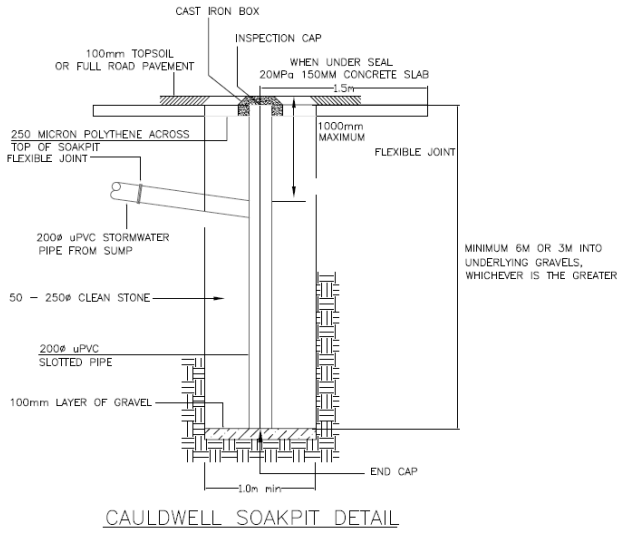


Fig 1

In order to comply with the Regional Water Plan rules, a silt and debris trap is required before discharge of stormwater to a soak pit. This will be provided by a "inverted syphon" type mud tank. See Fig 2.

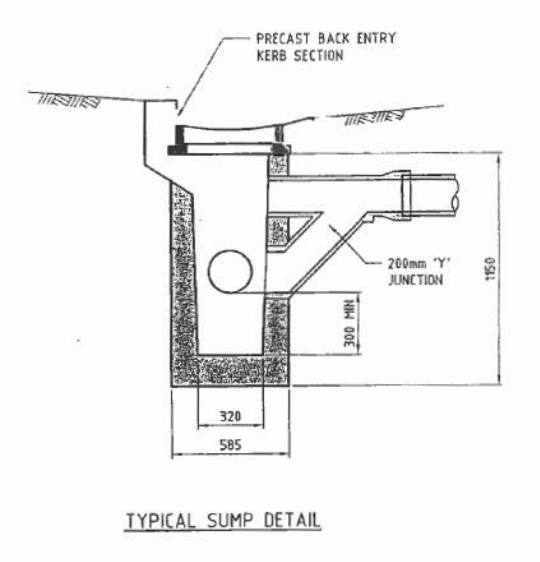


Fig 2

Where road swales are used, these provide a measure of pre-treatment of stormwater before discharge into mud tanks. There is a depth of 30m of gravel and sand below each soak pit, which will further filter stormwater before it is eventually discharged to groundwater. The inverted siphon mud tank/Caudwell soak pit system effectively provides for 3 stage treatment of stormwater. The mud tank (which is periodically sucked out by Council) removes silt, trash and gross pollutants, while the Caudwell soak pit (also periodically sucked out by Council) provides secondary treatment by removing finer silt and debris, with the 30m of sand and gravel below the soak pit providing tertiary filtration

For roof-run off, Council has a "rule of thumb" in the Cromwell area that 1m3 of soak pit is required for every 50m2 of roof area draining into the soak pit.

The site consists of two essentially flat terrace treads separated by a terrace riser. This means there will be a lack of secondary flow paths. From a stormwater/road design aspect this means that all roads will need to be cut into the surrounding terrain by a least 150-300 mm in order to provide longitudinal road drainage and for dwellings to be able to comply with Building Code requirements (E1/AS1) for minimum floor levels above the road crown. See Fig 3

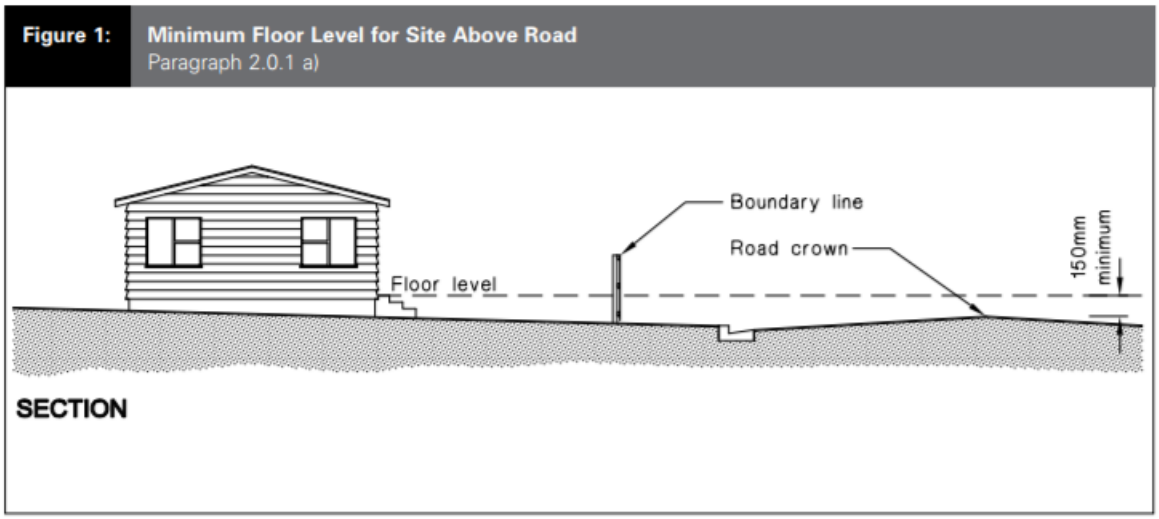


Figure 3

Essentially the roads act as temporary overflow ponding areas in the event of exceptional rain events and/or occasional blockage of mud tanks.

4. Wastewater

A Wastewater Assessment has been commissioned from Council's computer network modellers, Mott MacDonald. See Appendix C.

This concluded that the downstream pipework reticulation does not currently have sufficient capacity to cope with the wastewater flows from the development.

A further report from Mott MacDonald confirmed that a new direct connection to the existing 750mm diameter pipe upstream of the Cromwell Treatment Station, located in Bannockburn Road will be required. See yellow line in Fig 4. and Appendix C

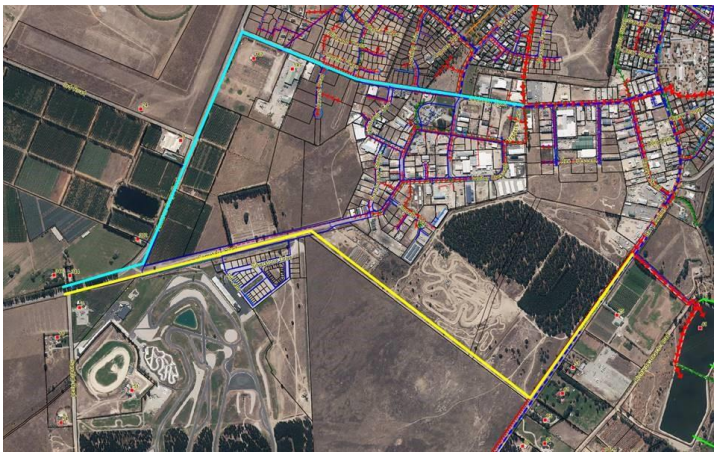


Fig 4

This route has the advantage of potentially servicing all the land to be south of the existing Cromwell Industrial Precinct (likely to eventually be re-zoned Industrial), and accordingly has a wider community benefit. At least two wastewater pump stations are likely to be required to service the River Terrace Development.

Further detailed modelling will be required to determine the final configuration of any pump station/gravity reticulation.

5. Water Supply

5.1 Irrigation

From the Otago Regional Council's "grow Otago" data base:

- "Dry summer rainfall" is 41-60mm for the Cromwell Basin
- "Median potential evapotranspiration" (Jan-Feb) is 216-220mm for the Cromwell Basin

Irrigation will therefore be essential to establish and maintain all landscaping within the development. This is particularly so given the very low Plant Available Water (PAW) of 45mm of the site, due to its light sandy/gravelly soils.

From the Otago Regional Council's "Aqualinc Report" LO5 128/2 October 2006 (Water Requirements for Irrigation Throughout the Otago Region), the requirements for public open space landscape irrigation over the site will be in the order of 6750m3/ha/season (Oct-March) and a peak monthly requirement (Jan-Feb) in the order of 1575m3/ha/month, equivalent to a peak application rate of 5mm/day (Jan-Feb). The planned "yield estimate" for public open space (field, greenway, alpine bank, boundary buffer) is 9.9ha. This will require 66, 825m^3/season and 15,590m^3/maximum month of water to irrigate. The Council's preferred option is that open public space irrigation be supplied from an independent bore, rather than the town reticulation.

The site is underlain by the Cromwell Terrace Aquifer, so groundwater is a potential source of an irrigation and construction water supply. Plan change 4C to the Regional Water Plan (now operative) sets a maximum allocation limit of 4Mm3/year for the Cromwell Terrace Aquifer. Current groundwater allocation for the aquifer is approximately 1.7Mm^3/year, according to the Otago Regional Council's "Cromwell Aquifer Draft Information Sheet 2014". This leaves 2.3Mm^3/year available for allocation. The irrigation requirement of the River Terrace Development is 0.07Mm^3/year or 3% of the available allocation from the aquifer. A groundwater supply for public open space landscape irrigation appears to be a very viable option, subject to obtaining a suitable water take permit from the Otago Regional Council.

Peak irrigation requirements for lawn and garden irrigation within private allotments will typically be in the order of 0.5-0.7m^3/day (Jan-Feb) with a metered supply. Experience elsewhere in Central Otago (Cromwell/Clyde/Alexandra) is that this can only practicably be met out of the town reticulation. The demand factors considered in the below analysis factor in a suitable domestic irrigation allowance. Storage and recycling of roof run-off is not a particularly viable option, because of the very low and irregular rainfall (350mm-440mm/year). An on-site storage reserve in the order of 30-40m^3 would be required to get through the Jan/Feb peak irrigation period. Given the small size of the proposed lots (200-450m^2), provision of this amount of storage within the lots is not practical.

5.2 Domestic and Firefighting

A Water Impact Assessment has been commissioned from Mott MacDonald NZ Ltd, see **Appendix D**. Computer modelling shows that the development cannot be adequately serviced without adversely affecting the existing Cromwell Town Network reticulation.

The report outlines four options to improve levels of service, security of supply and supplying ultimate demand for the future design horizon (2048) to cater for the projected growth of Cromwell, including not only RTDL's proposal, along with an indicative estimate of the cost of each proposal.

The preferred option (option 4) is for a 300mm diameter pipe duplication along Bannockburn Road from McNulty Road, then along the preferred wastewater upgrade alignment along Cemetery Road & SH6, then down Sand Flat & Pearson Road, connecting to the Cromwell – Bannockburn Main.

6. Network Utility Services

6.1 Telecommunications

Chorus New Zealand Ltd have confirmed that a suitable Air Blown Fibre (ABF) reticulation can be supplied to the proposed development. See **Appendix E**

Individual home owners will also have the alternative option of the cellular network (4.5G) and several long-distance wi-fi providers for their telecommunications and computer media service

6.2 Electricity

The attached report from Steve Tilleyshort Electrical Consulting outlines the options for the power supply to the proposed development. See **Appendix F**

7. Road Construction

No difficulty is expected in designing and constructing suitable road pavements within the site, in compliance with "Austroads" and the subdivision engineering design standards of the Central Otago District Council.

All roads will be formed on sand and gravel. Laboratory Soaked California Bearing Ratio (CBR) tests were taken at the likely road subgrade at all test pits. See **Appendix G**. Soaked CBR's varied from 25%-95%, well above the normal minimum requirement of 7% for road pavement design in terms of the "Austroads" standard.

Council's current subdivisional engineering design standard is NZ 4404:2004 and its July 2008 amendments thereto. The roading layouts and typical sections proposed for this development do not comply with this standard. It is instead proposed that road designs be in accordance with the updated version of this standard, being NZS 4404:2010. This updated version of the standard provides for a more innovative and flexible approach to road layout designs, in accordance with the contemporary urban design concepts proposed for this development. To quote from the forward to NZS 4404:2010:

- *Aims to encourage good urban design and remove road blocks to liveability and economic development in communities.*
- *Road design needs to allow 'context' or 'place' to be given significant emphasis, and to require roads to achieve safe (slower) operating speeds;*
- *Innovative subdivision has been discouraged to some extent under the 2004 version of NZS 4404.*
- *The review committee therefore challenged itself to produce a new Standard that:*
  - *Encourages sustainable and modern design;*
  - *Provides some certainty for designers and LAs; and*
  - *Prevents the outcomes that can arise when the sole focus is cost minimisation, and adherence to minimum standards.*

and from the outcome statement

- *This Standard provides local authorities, developers, and their professional advisors with standards for design and construction of land development and subdivision infrastructure. NZS 4404:2010 encourages sustainable development and modern design that emphasises liveability and environmental quality. It will also provide as much consistency as possible on land development and subdivision infrastructure while still allowing flexibility for local variations to suit local circumstances.*

Tables 3.1 & 3.2 of NZS4404:2010 set out the standard's road design criteria for the land use & area type proposed. Relevant extracts are included in Appendix H.

The applicable land use is 'live & play' and the area type 'suburban', rather than 'urban'. This is because private vehicles are expected to be the pre-dominant type of transport, with non-motorised trips primarily recreational and occurring on local roads.

Road Type 'A' fully complies with 'Primary Access to Housing' (up to 800 du) of table 3.2, apart from the maximum gradient increasing from 10% (1 in 10) to 12% (1 in 8) for a short distance where the terrace riser is crossed. The reason for this is to avoid excessive cut & fill batter earthworks. It is noted that table 3.2 allows grades up to 12.5% when 1-200du are served and that there will be no access to any lots from Road 'A' where it crosses the terrace riser.

Clause 3.3.1.7 of NZS4404:2010 also provides for steeper gradients for "shorter lengths of road in hilly country or low overall speed requirements, subject to TA approval".

Road Type 'B' fully complies with 'Primary Access to Housing' (1-200du) of table 3.2.

Road Type 'C' fully complies with 'Primary Access to Housing' (1-200du) of table 3.2, except that the legal width is 12m, instead of 15m. The localities served by Road Type 'C' are considerably less than 200du and fall between 'Access to Houses' (1-20du) of table 3.2 & 'Primary Access to Housing' (1-200du).

From a traffic engineering view point, the carriageway, footpaths etc comply with table 3.2, so the determinate of legal width is the ability to accommodate services & landscaping in the berms. For the localities served, 12m is a sufficient legal width to accommodate these requirements (9m is definitely too narrow).

Clause 3.3.1.8 of NZS4404:2010 allows a reduction in legal road reserve widths subject to specific design agreed with the territorial authority.

Joint Access Lots comply with 'Rear Service Access' (up to 100m in length between streets, 1-20 lots) of table 3.2 of NZS4404:2010

Slope stability, site preparation/earthworks, cut and fill batters and ground retention associated with roading works are addressed in section 3 of the Geosolve report.

8. Conclusion

Suitable provision can be made for roading, stormwater, wastewater, water supply and network utility services to the proposed development.

New trunk water main and wastewater main upgrades/connections to the Cromwell Town reticulations will be required to service the development, that will have benefits in terms of providing for the projected future growth of Cromwell, beyond the servicing of just the proposed development. There will need to be some negotiation with Council about the funding of these upgrades, including

the mix between existing development contributions, the possibility of a special development contribution area, direct funding by Council and/or River Terrace Developments Ltd and the possibility of staging the construction of these upgrades in line with the actual demand created by the staging of the proposed development.

Peter L Dymock
Principal, B.Sc, Dip Mgt, R.P. Surv, MNZIS, CSNZ
Paterson Pitts Limited Partnership (Cromwell)

APPENDIX A

Location Plan of Test Pits & Test Pit Logs

PATERSONPITTSGROUP

Your Land Professionals
www.ppgroup.co.nz
0800 PPGROUP

Client/Location: River Terrace

Purpose/Drawing Title: Test Pit Locations

Surveyed by:	MG	Original Size:	Scale: N.T.S
Designed by:			DO NOT SCALE
Drawn by:	KWG		
Checked by:	MG		
Approved by:	PD		
Job No: C2434		Sheet No:	Revision No: A / Date Created: 16/10/2017

J:\C_2434 RIVER TERRACE\CAD\TESTPITLOCATIONS.DWG

TEST PIT 1

Ground	0.00	
		Topsoil
	-0.30	
		Sabdy gravels. Compact. Brown
	-0.80	
		Sandy silts. mid plasticity
	-1.20	
		Calcification
	-1.40	
		coarse sandy gravels compact
	-2.20	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
764225	376016	5003606	1297885	TP 1

TEST PIT 2

Ground	0.00	
		Topsoil
	-0.30	
		Coarse gravels, small cobbles
	-1.00	
		calcification (compact)
	-1.30	
		Lime lenses Coarse gravels cobbles <300mm
	-2.20	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
764192	375837	5003565	1297707	TP 2

TEST PIT 3

Ground 0.00

Topsoil

-0.20

sandy gravel
(free flowing)

-1.20

calcification

-1.50

coarse gravels

cobbles
<300mm

-2.20

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
764022	375817	5003394	1297694	TP 3

TEST PIT 4

Ground	0.00	
		Topsoil
	-0.20	
		Coarse gravels
	-1.20	
		Sand & lime lenses
	-1.40	
		sand & gravel lenses
	-2.00	
		coarse gravels cobbles <400mm
	-3.20	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
764021	375906	5003397	1297784	TP 4

TEST PIT 5

Ground 0.00

Topsoil
-0.10

silty
gravels

-0.40

clean, mixed
gravels

loose

Cobbles <150mm

-2.30

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763860	375822	5003232	1297707	TP 5

TEST PIT 6

Ground	0.00	
		Topsoil
	-0.40	
		silty gravels
	-0.80	
		loose coarse gravels
	-1.50	
		compact gravels some calcification
	-2.40	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763746	375920	5003123	1297810	TP 6

SOAK PIT 7

Ground 0.00

Topsoil

-0.30

vaired
semi-compact
gravels

brown

-1.00

hard
calcified
gravels

-2.00

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763645	375760	5003015	1297654	TP 7

SOAK PIT 8

Ground 0.00

Topsoil

-0.15

fine
gravels

-1.20

fine gravels

occaisional
500mm rocks

lime lenses

-2.20

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763636	375477	5002994	1297371	TP 8

TEST PIT 9

Ground	0.00	
		Topsoil
	-0.30	
		coarse gravels non-cohesive brown
	-1.00	
		coarse gravels grey stabilised by caclification lenses
	-2.00	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763335	375487	5002693	1297395	TP 9

TEST PIT 10

Ground	0.00	
		Topsoil
	-0.40	
		fine gravels loose brown
	-0.70	
		fine gravels compact
	-1.00	
		clean sands (compact)
	-1.70	
		fine gravels
	-2.30	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763262	375729	5002631	1297640	TP 10

TEST PIT 11

Ground	0.00	
		Topsoil
	-0.15	
		coarse free flowing gravels
	-1.00	
		tight gravels & sand
		gravels
	-1.60	
		fine gravels compact
	-2.60	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763470	375704	5002838	1297606	TP 11

TEST PIT 12

Ground	0.00	
		Topsoil
	-0.30	
		river gravels mixed sizes round cobbles
	-1.00	
		mixed gravels well bound by calcification in lower reaches
	-2.30	

LOCATION:

LINDIS PEAK 2000		NZTM		
mN	mE	mN	mE	NAME
763421	375979	5002801	1297883	TP 12

APPENDIX B

Soakage Tests, Infiltration Calculations & Rainfall Intensity Calculations

Pit Dimensions			Area		Test Pit	4			C2434								
Length	1.8		2.34														
Width	1.3																
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²										
0	0	-0.0936	90		-1.0		-0.4										
90	0.04	-0.0468	60		-0.8		-0.3										
150	0.06	-0.0468	60		-0.8		-0.3										
210	0.08	-0.0468	60		-0.8		-0.3										
270	0.1	-0.0468	60		-0.8		-0.3										
330	0.12	-0.0468	60		-0.8		-0.3										
390	0.14	-0.0468	60		-0.8		-0.3										
450	0.16	-0.0468	60		-0.8		-0.3										
510	0.18			Average	-0.81		-0.35						Infiltration Rate		1271	mm/hr	
		0.4212	510		0.8		0.4	For time period									
Note:	3000l poured in over 3.5 minutes to get to water depth of 1.1m																
														total volume			
	1 in 20 (+2deg)										area m2	1000		7.2	m3		
	9.3	mm in 10 minutes		56mm/hr		Q=2.78CiA					runoff	0.8		rate per second			
						A = Q/2.78iC		0.091935	ha		depth	0.009		12	l/s		
								919.3538			seconds	600					
													runoff per m2 per s		0.012	l/s/m2	
Soakpit Base =			0.785398	m2							Soakage Capacity		577.4986	m2			
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence						metres of road		28.87493	57.749865	two sided		
			6.929984		Soakage Rate	l/s					(20m carriageway)						

Pit Dimensions			Area		Test Pit	11			C2434							
Length	1.7		2.55													
Width	1.5															
Time (s)	Depth	dVolume	dTime (s)		Soakage (l/s)		l/s/m²									
0	0	-0.204	90		-2.3		-0.9									
90	0.08	-0.1275	60		-2.1		-0.8									
150	0.13	-0.102	60		-1.7		-0.7									
210	0.17	-0.102	60		-1.7		-0.7									
270	0.21			Average	-1.95		-0.76					Infiltration Rate		2800	mm/hr	
		0.5355	270		2.0		0.8	For time period								
Note:	3500l poured in over 4.5 minutes to get to water depth of 0.8m															
														total volume		
	1 in 20 (+2deg)										area m2	1000		7.2	m3	
	9.3	mm in 10 minutes		56mm/hr		Q=2.78CiA					runoff	0.8		rate per second		
						A = Q/2.78iC		0.091935	ha		depth	0.009		12	l/s	
								919.3538			seconds	600				
													runoff per m2 per s		0.012	l/s/m2
Soakpit Base =			0.785398	m2							Soakage Capacity		1272.636	m2		
Effective soakage @ 2m deep			19.63495	m2	45 deg angle influence						metres of road		63.6318	127.2636	two sided	
			15.27163		Soakage Rate	l/s					(20m carriageway)					

High Intensity Rainfall System V3

Depth-Duration-Frequency results (produced on Friday 11th of August 2017)
Sitename: River Terrace
Coordinate system: NZTM2000
Easting: 1297730
Northing: 5003173

Rainfall depths (mm)

		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	3.4	4.7	5.7	7.9	10.8	17.8	24.4	33.4	37.4	39.9
2	0.5	3.8	5.3	6.4	8.8	11.9	19.4	26.5	36	40.3	43
5	0.2	5.3	7.3	8.8	12.1	16.1	25.5	34	45.3	50.7	54.1
10	0.1	6.5	9	10.9	15	19.7	30.5	40.1	52.7	59	63
20	0.05	8	11.1	13.3	18.4	23.9	36.2	47	61	68.2	72.9
30	0.033	9	12.4	15	20.7	26.7	39.9	51.5	66.3	74.2	79.2
40	0.025	9.8	13.5	16.3	22.5	28.9	42.8	54.9	70.4	78.7	84.1
50	0.02	10.4	14.4	17.4	24	30.7	45.2	57.7	73.7	82.4	88
60	0.017	11	15.2	18.3	25.3	32.2	47.2	60.1	76.4	85.5	91.3
80	0.012	11.9	16.5	19.9	27.5	34.8	50.6	64	81.1	90.7	96.9
100	0.01	12.7	17.6	21.2	29.3	37	53.4	67.3	84.8	94.9	101.4

Coefficients

c1	c2	c3	d1	d2	d3	e	f
0.0008	-0.0261	0	0.4619	0.4542	0.1619	0.2852	2.0662

Standard errors (mm)

		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7
2	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.7	0.7
5	0.2	0.4	0.4	0.5	0.5	0.6	0.8	0.9	0.9	1	1.1
10	0.1	0.5	0.5	0.6	0.7	0.8	1.2	1.4	1.3	1.5	1.5
20	0.05	0.6	0.7	0.9	1.2	1.2	1.8	2.2	1.9	2.1	2.2
30	0.033	0.7	0.9	1.2	1.5	1.5	2.3	2.8	2.3	2.6	2.7
40	0.025	0.9	1.1	1.4	1.8	1.7	2.7	3.3	2.7	3.1	3.2
50	0.02	1	1.2	1.6	2	2	3.1	3.8	3	3.4	3.6
60	0.017	1.1	1.4	1.8	2.3	2.2	3.4	4.2	3.3	3.7	3.9
80	0.012	1.2	1.6	2.1	2.7	2.6	4	4.9	3.8	4.3	4.5
100	0.01	1.4	1.8	2.3	3.1	2.9	4.5	5.5	4.2	4.8	4.9

Extreme rainfall assessment with climate change

Projected temperature change: 2.0 degree Celsius
Rainfall depths (mm)

		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	3.9	5.4	6.5	9	12.1	19.7	26.7	36.3	40.2	42.7
2	0.5	4.4	6.1	7.3	10	13.4	21.5	29	39.1	43.4	46
5	0.2	6.1	8.4	10.1	13.8	18.3	28.6	37.9	50.2	55.8	59.3
10	0.1	7.5	10.4	12.6	17.2	22.5	34.6	45.3	59.3	66.2	70.4

20	0.05	9.3	12.9	15.4	21.2	27.5	41.6	53.9	69.8	77.9	83.1
30	0.033	10.4	14.4	17.4	24	31	46.3	59.7	76.9	85.8	91.4
40	0.025	11.4	15.7	18.9	26.1	33.5	49.6	63.7	81.7	91.1	97.3
50	0.02	12.1	16.7	20.2	27.8	35.6	52.4	66.9	85.5	95.6	102.1
60	0.017	12.8	17.6	21.2	29.3	37.4	54.8	69.7	88.6	99.2	105.9
80	0.012	13.8	19.1	23.1	31.9	40.4	58.7	74.2	94.1	105.2	112.4
100	0.01	14.7	20.4	24.6	34	42.9	61.9	78.1	98.4	110.1	117.6

Projected temperature change: 4.0 degree Celsius

Rainfall depths (mm)

		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	4.5	6.1	7.3	10	13.5	21.6	29.1	39.1	43.1	45.5
2	0.5	5	6.9	8.2	11.2	14.9	23.5	31.6	42.2	46.4	49
5	0.2	7	9.5	11.4	15.5	20.4	31.7	41.9	55.1	60.8	64.5
10	0.1	8.6	11.8	14.2	19.4	25.4	38.8	50.5	66	73.4	77.9
20	0.05	10.6	14.7	17.4	24.1	31.2	46.9	60.7	78.6	87.6	93.3
30	0.033	11.9	16.4	19.8	27.3	35.2	52.7	68	87.5	97.4	103.6
40	0.025	12.9	17.8	21.5	29.7	38.1	56.5	72.5	92.9	103.6	110.5
50	0.02	13.7	19	23	31.7	40.5	59.7	76.2	97.3	108.8	116.2
60	0.017	14.5	20.1	24.2	33.4	42.5	62.3	79.3	100.8	112.9	120.5
80	0.012	15.7	21.8	26.3	36.3	45.9	66.8	84.5	107.1	119.7	127.9
100	0.01	16.8	23.2	28	38.7	48.8	70.5	88.8	111.9	125.3	133.8

Projected temperature change: 6.0 degree Celsius

Rainfall depths (mm)

		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	5	6.9	8.2	11.1	14.8	23.5	31.4	42	45.9	48.3
2	0.5	5.6	7.7	9.2	12.3	16.3	25.6	34.1	45.3	49.5	52
5	0.2	7.8	10.7	12.7	17.3	22.6	34.8	45.8	60	65.9	69.7
10	0.1	9.6	13.2	15.9	21.7	28.2	42.9	55.7	72.6	80.6	85.3
20	0.05	11.8	16.4	19.5	26.9	34.8	52.3	67.6	87.4	97.3	103.5

30	0.033	13.3	18.4	22.2	30.6	39.5	59.1	76.2	98.1	108.9	115.8
40	0.025	14.5	20	24.1	33.3	42.8	63.3	81.3	104.2	116	123.7
50	0.02	15.4	21.3	25.8	35.5	45.4	66.9	85.4	109.1	122	130.2
60	0.017	16.3	22.5	27.1	37.4	47.7	69.9	88.9	113.1	126.5	135.1
80	0.012	17.6	24.4	29.5	40.7	51.5	74.9	94.7	120	134.2	143.4
100	0.01	18.8	26	31.4	43.4	54.8	79	99.6	125.5	140.5	150.1

In

APPENDIX C

Wastewater Impact Assessment

MOTT MACDONALD

Quentin Adams,
Central Otago District Council
1 Dunorling Street
PO Box 122, Alexandra 9340
New Zealand

Cromwell Wastewater Assessment – River Terrace Development

Our Reference
385321

Mason Bros. Building
Level 2, 139 Pakenham Street West
Wynyard Quarter
Auckland 1010

T +64 (0)9 375 2400
mottmac.com

22th November 2017

1 Introduction

Mott MacDonald was commissioned by Central Otago District Council (CODC) to undertake a hydraulic modelling analysis to assess the impact of the proposed River Terrace development at Cromwell, Central Otago which is part of the existing Cromwell wastewater system. A short form agreement covering the work was signed on 28th of August 2017.

This memo is an addendum to the first part of this study (see MM report dated 7th November 2017) and covers an option analysis with respect to the new proposed connection point as shown in Figure 1.

The scope of work included the following:

- Update the existing Cromwell wastewater model to reflect the River Terrace development. Insert an additional sub-catchment covering the extent of the proposed residential area as shown in Figure 1.

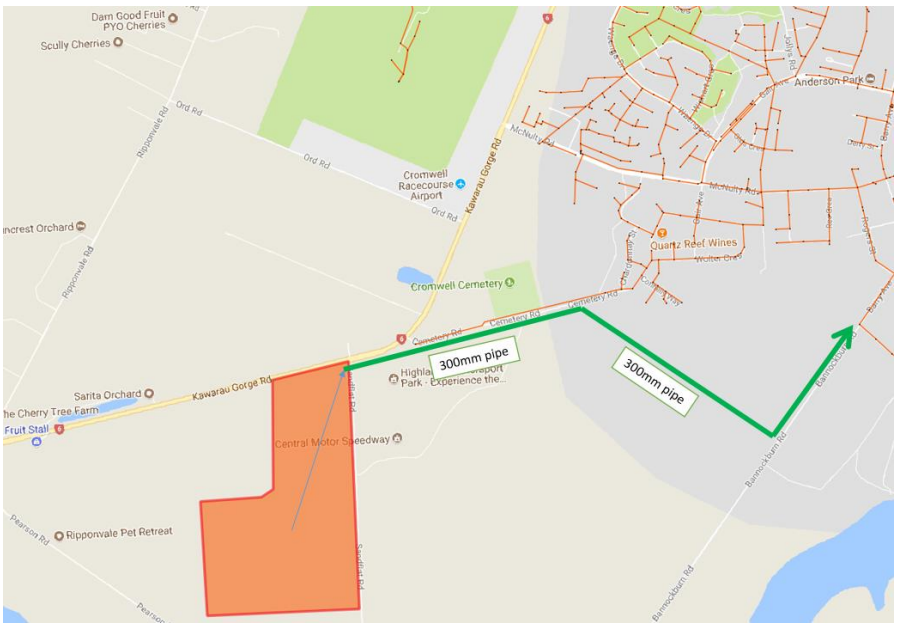


Figure 1. River Terrace Development Location

- Estimate the additional wastewater discharge resulting from the development. There are approximately 779 residential lots and/or dwelling units, a retirement village, and a small commercial development.

Mott MacDonald New Zealand
Limited Registered in New Zealand
no. 3338812

- Simulate the current dry weather and wet weather (10-year ARI storm) scenarios with and without the new development.
- Perform system performance analysis in terms of capacity of the wastewater system to accommodate the proposed development. Assess the impact of the new development against the existing network to examine if there are any detrimental effects.
- Report on investigation and results.

2 Flow Calculation and Routing

The number of units and population equivalent were estimated based on the proposed Master Plan (Document: River Terrace Yield Estimate) as shown in Table 2-1 below. As per email dated 05/10/17 no demand was added for a potential Care Facility.

Table 2-1. Lots Estimate

No.	Land Use	Surface Area (ha)	Units	Assumption
1	Commercial	0.5	1	Based on proposed River Terrace Yield Estimate: Neighbourhood Centre.
2	Residential	24.5	779	Based on proposed River Terrace Yield Estimate: Residential Conventional, Cluster Single and Cluster Double
3	Retirement Village	4.9	122	Based on proposed River Terrace Yield Estimate: Retirement

Calculation of the wastewater loads were based on the New Zealand Standard for Land Development and Subdivision Infrastructure NZS 4404:2010:

- Daily consumption = 250 L/person/day
- Peaking factor (residential) = 2.5
- Commercial flow = 0.4 L/s/ha (assumed 'light' water usage)
- Density (residential) = 3 persons per dwelling in residential areas
- Density (retirement village) = 1.45 persons per unit (assumption based on data from another retirement village in Queenstown Lakes District)
- Infiltration & inflow scaling factor = 2

The design commercial flow of 0.4 L/s/ha includes both sanitary wastewater and trade wastes as well as dry/wet weather peaking factors. Therefore, no additional loads were applied for infiltration allowance and surface water ingress in the commercial area since these have already been accounted for in the design flow.

A standard 24-hour diurnal profile was applied to residential flow as shown in Figure 2. The commercial flow takes a commercial diurnal profile having a peak factor of 1.4 as shown in Figure 3. This was adopted from the same diurnal profile that has been used for all other commercial areas in the existing Cromwell model. Using a peak factor of 1.4 and a design flow of 0.4 L/s/ha, the average dry/wet weather flow was estimated to be 0.286 L/s/ha. The resulting design peak dry and wet weather flows are summarised in Table 2-2.

Table 2-2. Flow calculation

Land Use	Total Area (ha)	Lots	Instant Peak Wet Weather Flow (L/s)	Average Daily Volume (m3/day)
Residential	24.5	779	33.81	584.25
Commercial	0.5	n/a	0.20	12.34
Retirement Village	4.9	122	2.56	44.23
Total			36.57	640.82

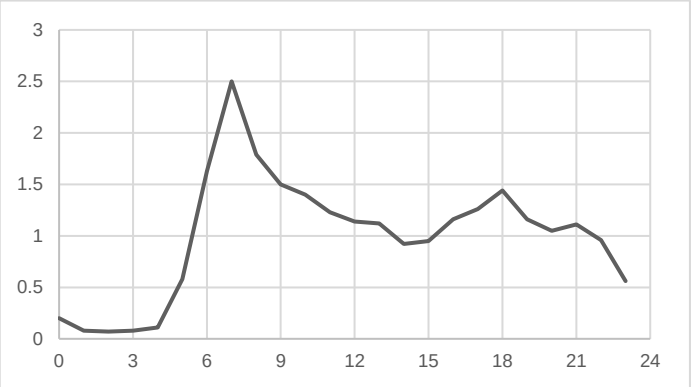


Figure 2. Residential diurnal profile

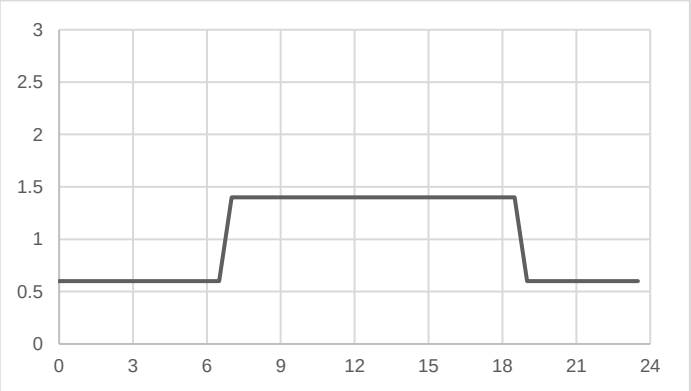


Figure 3. Commercial diurnal profile

3 Connection Points and Reticulation

In the first part of this investigation (see MM memo dated 7th November 2017), the total wastewater load from the area was directly routed to the existing network through manhole 20060315160243 located upstream on Cemetery Rd as suggested by Paterson Pitts Group (email dated 20/08/2017). However, results indicated that the existing pipe along Cemetery Road does not have enough capacity to convey the flows during dry and wet weather events.

A new connection point has been proposed by Paterson Pitts Group (email dated 09/11/2017) which involves constructing a pipe (approximately 2.8km long) that conveys flows to manhole 20030820191356 at the intersection of Bannockburn Rd and Richards Beach Rd as shown in Figure 1. The topography in the area suggests that no pump is required and a gravity main would be sufficient to transport the wastewater load from River Terrace.

The diameter of the connection pipe was determined by an iterative process. Initially, a 200mm pipe was used in the model, however this proved to be insufficient with surcharge evident within the pipe. Further investigation suggested that a 300mm pipe should be used.

In addition, it should be noted that the long section/profile of the pipe has a significant effect on the hydraulics and could cause possible surcharge if not designed appropriately. A preliminary simulation has been performed assuming a uniform depth of manhole inverts from the ground level. Nevertheless, this resulted in surcharge at some parts along the new pipe due to shallow slopes. Figure 5 shows an indicative optimum long section of the pipe solution from River Terrace to manhole.

4 Scenarios Modelled

The primary objective of the system performance is to assess the wastewater network capacity and overflow occurrences under different scenarios as follows:

1. Existing model (Cromwell base scenario)
2. Existing model + River Terrace development

The base scenario also includes consented development in the area (i.e. McNulty Rd development).

Table 4-1. System performance scenarios

Scenario ID	Network Load	Flow Scenarios
Existing	2017 network	DWF
		10-year storm
Existing + River Terrace	2017 network	DWF
		10-year storm

5 Pipe Capacity in Dry and Wet Weather

Pipe capacities were evaluated in two ways: firstly, by comparing the modelled peak flow with the theoretical pipe full capacity (Qmax/Qf) and secondly, by comparing the modelled peak depth with the pipe diameter (Hmax/Diameter). Peak flows above the theoretical pipe capacity indicate that the pipe is undersized and cannot convey the peak flows that are required through the network.

An analysis of the results indicated that the River Terrace development caused very little detriment to the overall network capacity under dry and wet weather events. The number of pipes in the network that are surcharged in the existing model scenario is presented in Table 5-1 and in Figure 4. As illustrated, the differences between the pre-development and post-development scenarios are minimal to none, with the increase in surcharged pipes during the dry weather and the 10-year ARI storm event being just less than 1%.

Table 5-1. Number of surcharged pipes in dry and wet weather

Scenario	No of Pipes Qmax/Qf > 1	%Total	No of Pipes Hmax/Dia > 1	%Total
Dry Weather Flow				
Existing	8	0.64	176	14.05
Existing + River Terrace	8	0.64	176	14.05
Wet Weather Flow				
Existing	12	0.96	200	15.96
Existing + River Terrace	12	0.96	200	15.96

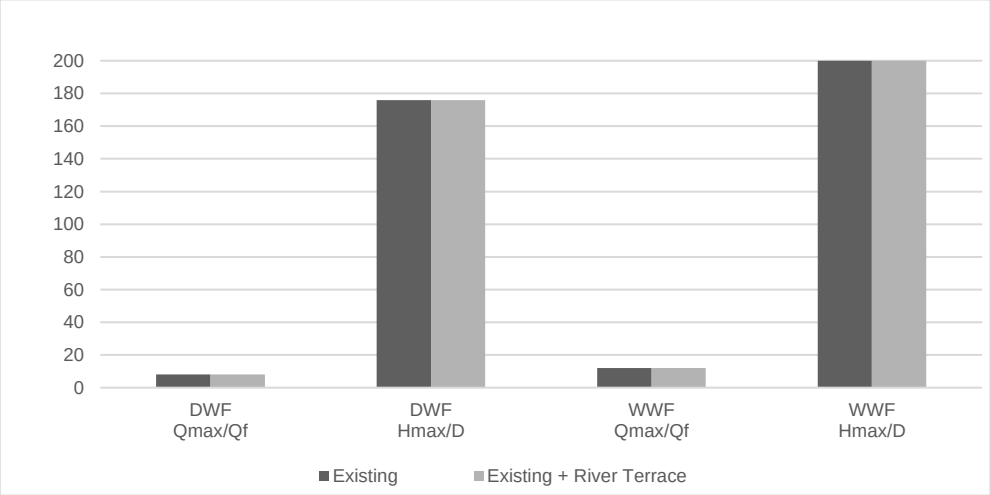


Figure 4. Surcharged pipes in dry and wet weather

The long section in Figure 5 below shows the maximum water level in the pipe where the loads enter the network (illustrated by the dashed red line). It can be seen that the proposed development is unlikely to cause detrimental effect on the capacity of the local wastewater network.

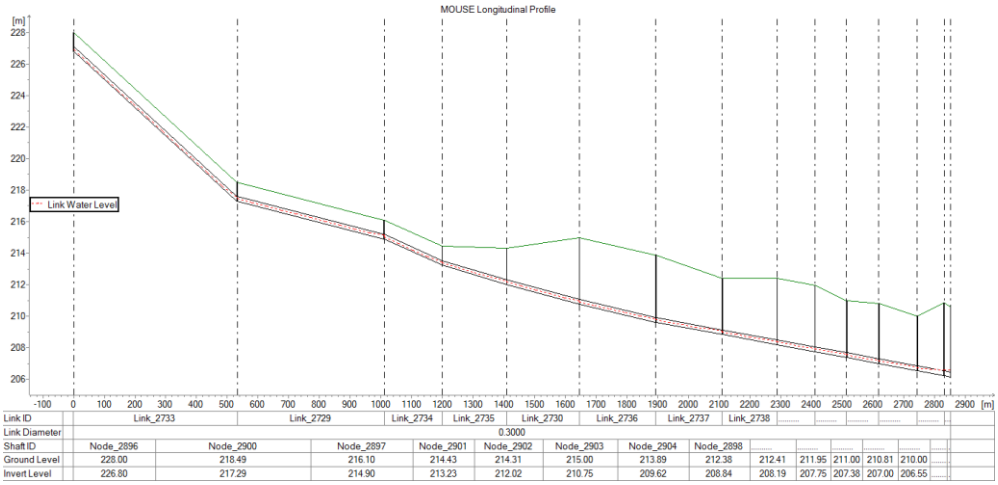


Figure 5. Impact of development (10-year ARI)

6 Overflows

There is one uncontrolled dry weather overflow in the network, however this is located in the south-west part of Cromwell, and not in the vicinity of the River Terrace development. Hence, this overflow is not attributed to the additional loads from the proposed development.

The total number of spill locations for the dry weather and the 10-year ARI storm events are presented in Table 4. As shown in the table, the number of overflows predicted during the existing plus development model does not increase.

The hydraulic model indicates that the proposed River Terrace development is not expected to contribute to or exacerbate the occurrence of actual overflows within the Cromwell network.

Table 6-1. Number of overflows (10-year ARI)

Scenario	Number of Overflows	Overflow Volume (m^3)
Dry Weather		
Existing	1	15.5
Existing + River Terrace	1	15.5

	Wet Weather	
Existing	3	239.0
Existing + River Terrace	3	239.0

7 Conclusions

The Cromwell wastewater model was recently updated by Mott MacDonald in September 2017 using the latest GIS to represent the current network. In this study, the model was updated to incorporate the proposed River Terrace development. Additional wastewater load from the development was estimated using the New Zealand Standard for Land Development and Subdivision Infrastructure (NZS 4404:2010) Specifications. The flow included sanitary wastewater as well as dry/wet weather peaking factors.

A high-level system performance assessment was undertaken to analyse the effect of the new development on the network capacity. Using the new proposed connection point, the analysis yielded very similar results between the pre-development and post-development scenarios for both dry weather and wet weather events.

Based on this high-level study, it is therefore concluded that the River Terrace development is unlikely to have a detrimental effect to the existing network provided that the design of the new pipe and its layout follow the NZS4404:2010 engineering standard and the recommendations set forth in this report.

Jennyl Estil
Network Hydraulics Engineer
D +64 (0)9 973 7450
jennyl.estil@mottmac.com

APPENDIX D

Water Impact Assessment

MOTT
MACDONALD

Central Otago District Council
1 Dunorling Street,
Alexandra,
Alexandra 9340,
New Zealand

Cromwell Future Growth – High Level Option Investigation

Our Reference
348664

Mason Bros. Building
Level 2, 139 Pakenham Street West
Wynyard Quarter
Auckland 1010
PO Box 37525, Parnell, 1151
New Zealand

T +64 (0)9 375 2400
mottmac.com

24 November 2017

This letter summarises the results of a high-level option assessment undertaken for Cromwell's water network. Options were compared to improve current and future levels of service along Cemetery Rd and Bannockburn Rd. The preferred option was selected and then verified for the proposed River Terrace residential development consisting of 779 lots and 122 retirement units planned on the southeast side of Cemetery Rd and Sandflat Rd. The proportion of work required for this development was identified and quantified.

1 Background

Mott MacDonald had previously been commissioned by Central Otago District Council (CODC) to assess the system performance in terms of Levels of Service (LOS) and firefighting capacity for the proposed River Terraces development. The impact of this development on the remaining network had also been investigated.

Demand from the proposed residential development had been added to the network for current peak day conditions including proposed network upgrades (300mm pipeline along Sandflat Rd) to determine if suitable levels of service could be obtained.

The minimum pressure expected at the development was 49m, which is well above the recommended level of service, and FW3 fire flow requirements could be met in the proposed development. However, head losses were forecasted to exceed 10m/km along Cemetery Rd, Kawarau Gorge Rd and Chardonnay Rd as a result of the proposed development, showing insufficient pipe capacity along those sections. It was recommended to improve the network conveyance in the Cromwell supply zone area to mitigate the proposed development impact on the existing network.

The population is predicted to increase in Cromwell. It was recommended to undertake options investigation for ultimate predicted growth, and to estimate the portion of the proposed work required to mitigate the River Terraces development only.

This letter summarises the high level options investigation and estimation of the portion of work required by the River Terraces development.

2 Population Growth

A future scenario was created, considering predicted population growth (including visitors) in Cromwell between 2013 and 2048. The River Terraces and the Golf proposed developments were not included in the CODC predicted growth, therefore both development populations were added in addition to the original forecast growth.

The daily consumption was calculated based on the Code of Practice NZS4404-2004 addendum, considering the following:

- Daily consumption of 500L/person/day
- Peak hour factor of 5
- Density: 3 persons per dwelling in residential areas.

3 System Performance Assessment

Figure 1 to Figure 3 below show the maximum head losses predicted in Cromwell, for the current peak day, the current peak day with River Terraces and the 2048 peak day. Pressure in Cromwell are well above the recommended 30m threshold for all three scenarios so they are not shown on the figures.

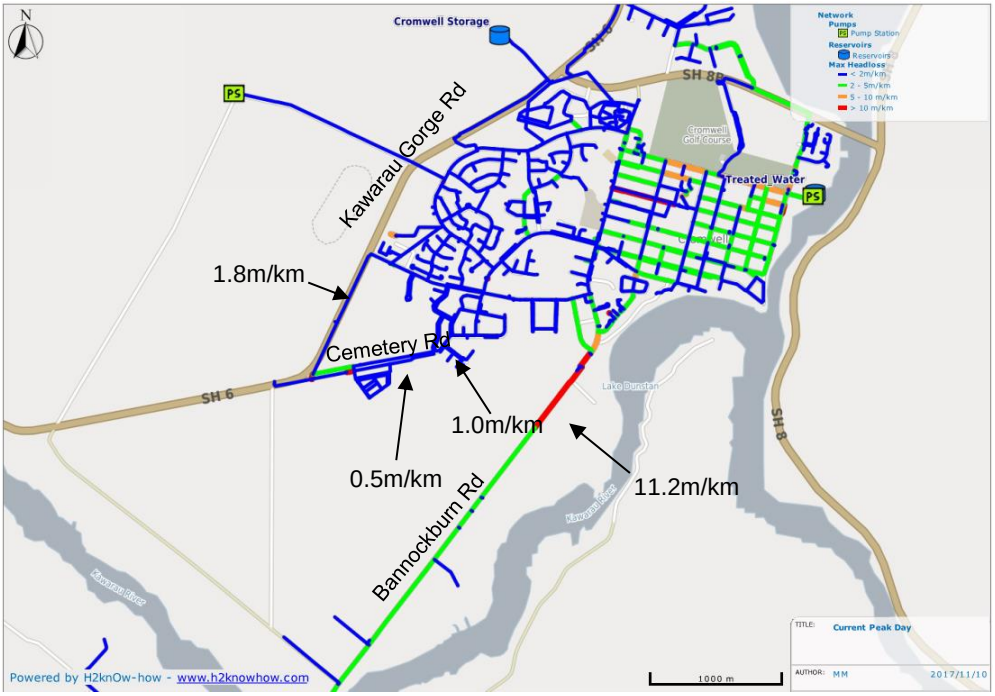


Figure 1 - Maximum Head Losses - Current Peak Day

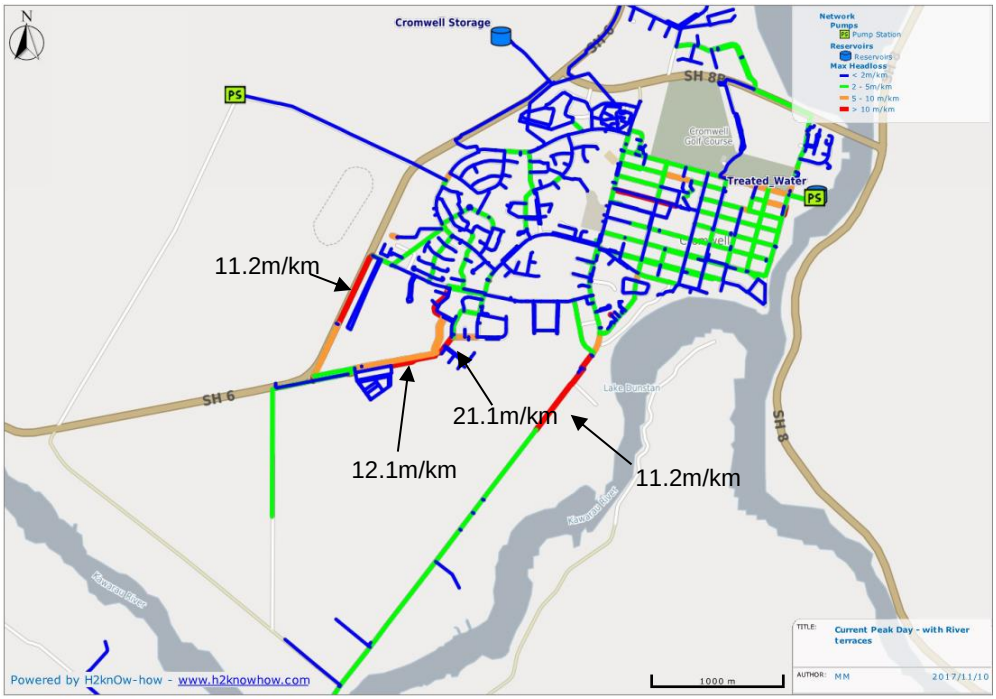


Figure 2 - Maximum Head Losses - Current Peak Day with River Terraces

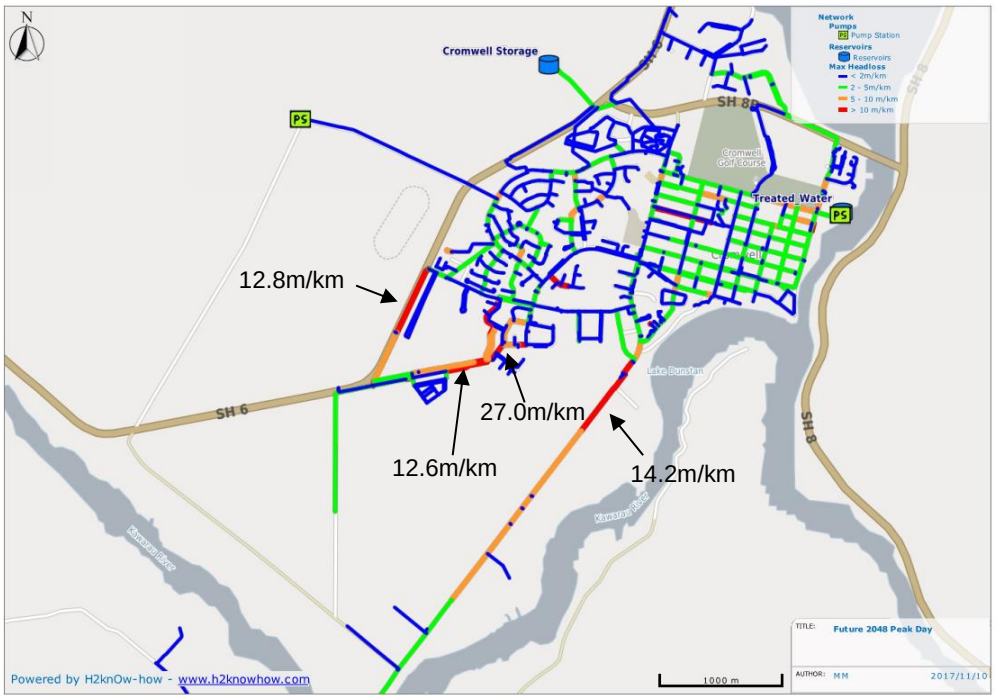


Figure 3 - Maximum Head Losses - 2048 Peak Day

As shown on the figures above, most of the system performance deterioration is caused by River Terraces: head losses increase significantly with the addition of the proposed development on the current peak day. The head loss increase is smaller between the current peak day including River Terraces and the 2048 peak day. Even though the population increase is significant between those two scenarios, the future residential development density is low (3 dwellings per hectare as opposed to 16 dwellings per hectare in River Terraces), resulting in a demand evenly spread across the existing network.

High head losses along Bannockburn Rd are mainly due to the presence of a large user and the operation of the Bannockburn Reservoir, causing high head losses

when the reservoir is filling at peak demand period. The proposed Golf Course development causes the system performance to deteriorate further.

Independently of the growth, security of supply is an existing issue in the south of the zone, with only one pipe supplying Bannockburn.

4 Options Assessment

Four options aiming to improve levels of service, security of supply and supplying ultimate demand were assessed for the future design horizon (2048). The core achievements targeted by the developed options are discussed below:

- **Improving level of service**: due to the significant predicted growth, high head losses are forecasted in the water network. To supply the ultimate growth while minimising pipe fatigue, significant pipe upgrade needs to be undertaken to provide a strong core network that will improve conveyance in the network.
- **Improving security of supply**: security of supply is an existing issue, with the 200mm pipeline along Bannockburn Road identified as a critical pipe. To improve security of supply in the zone, the proposed options include pipe upgrades which will improve network conveyance and provide more redundancy.

4.1 Options Description

The figures below show the proposed options for Cromwell water supply zone. Each option's system performance (maximum head losses) is shown in appendix.

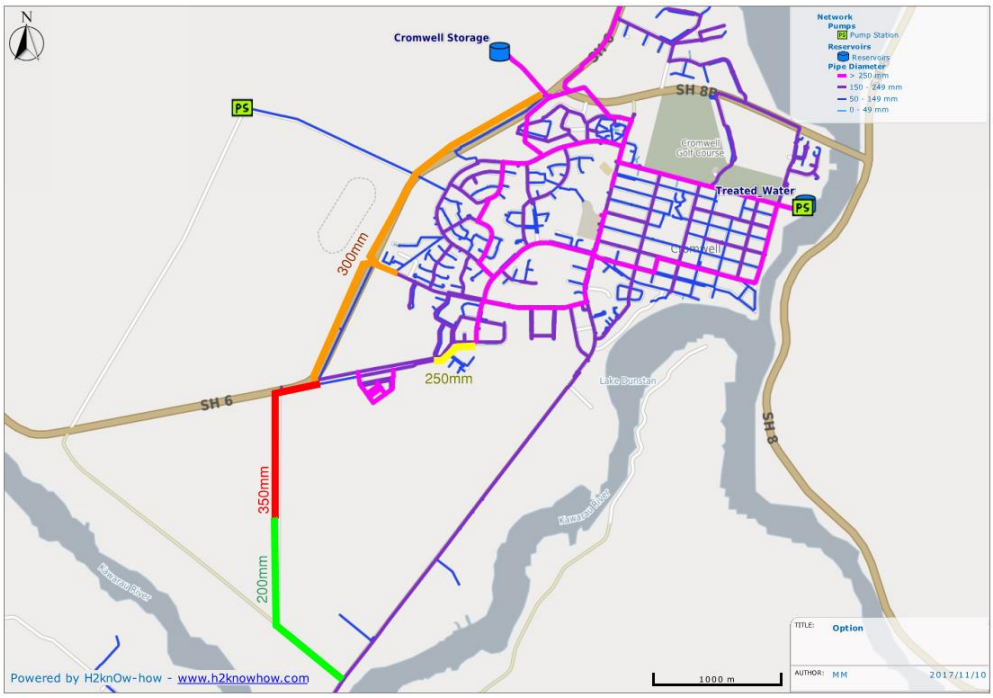


Figure 4 - Option 1 – 300mm Extension along Kawarau Gorge Rd

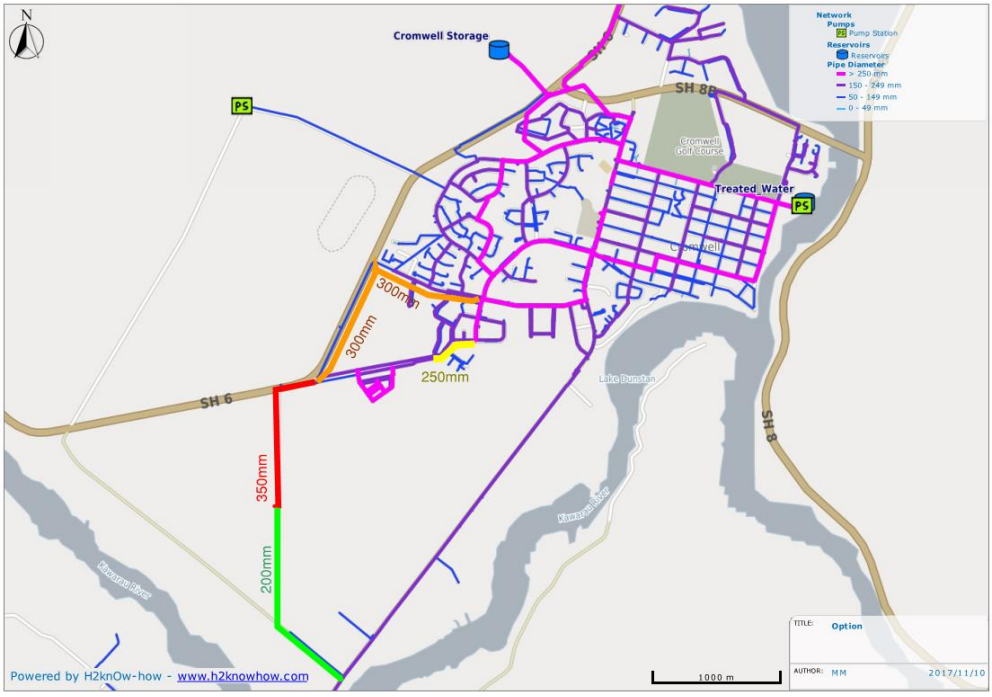


Figure 5 - Option 2 – 300mm Duplication along McNulty Rd and Kawarau Gorge Rd

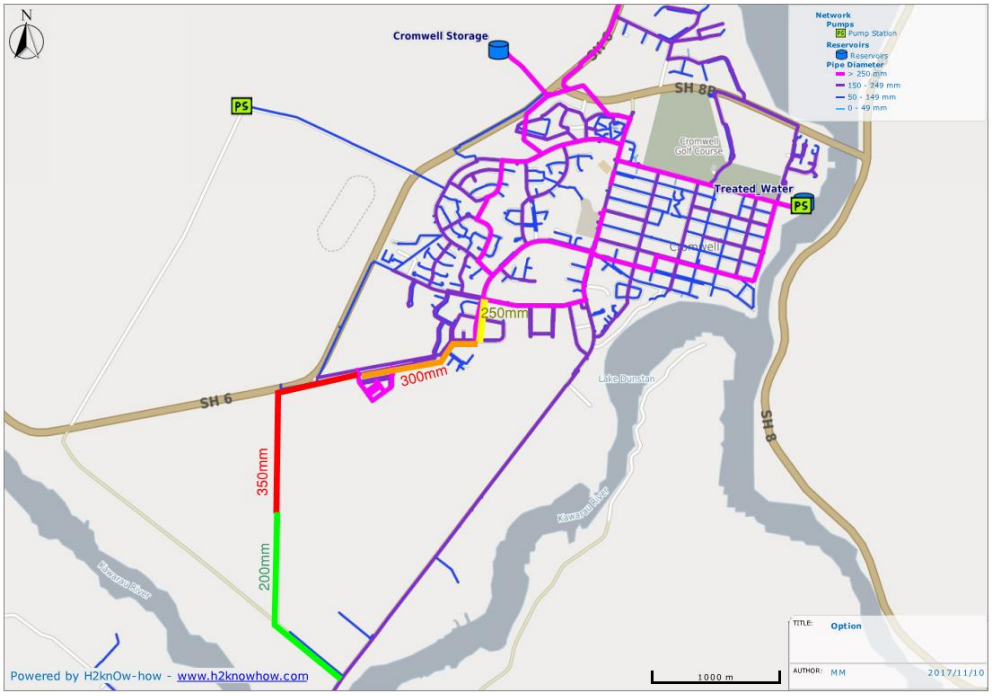


Figure 6 - Option 3 – 300mm Duplication along Cemetery Rd

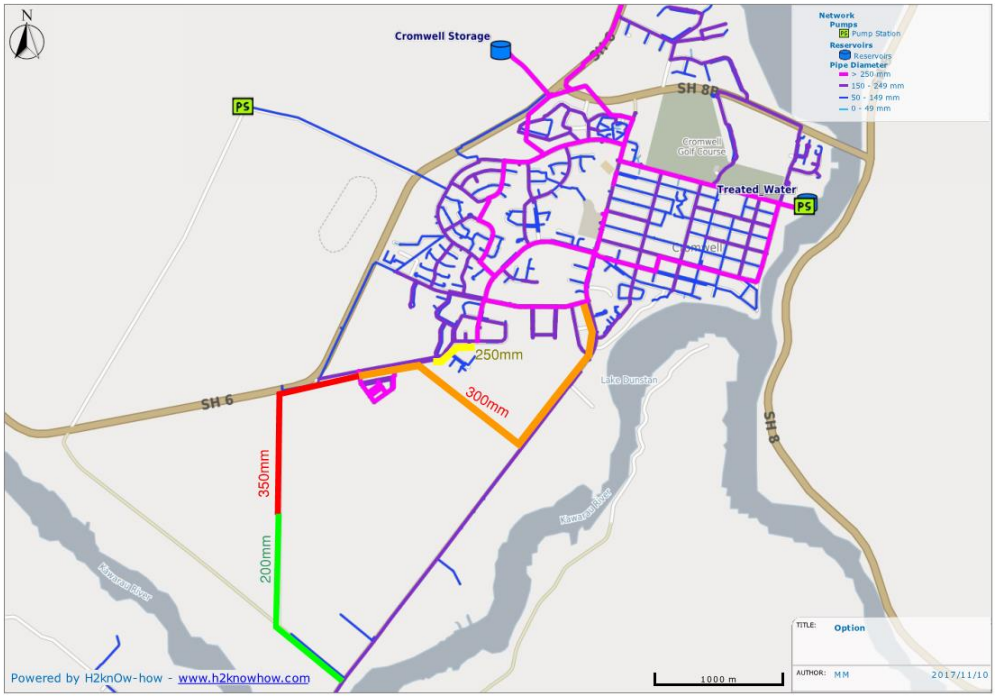


Figure 7 - Option 4 – 300mm Connection to Bannockburn Rd

All options include the following:

- **A connection between Cemetery Rd and Bannockburn Rd**, off Pearson Rd is required to improve the network resilience. At the moment, a prolonged pipe closure along the 200mm pipeline leading to Bannockburn would result in a loss of service in Bannockburn, as the existing storage is limited (0.5MLD). Additionally, a large user located along this road, together with the current operation of the Bannockburn reservoir, result in high head losses along this pipe. The proposed connection will help reduce head losses along Bannockburn Rd. The proposed connection will improve conveyance as well as resilience. Due to the increased flow to Bannockburn Rd, the pipeline servicing River Terrace needs to be upgraded to a 350mm ID and a 200mm connection is required between River Terrace and Bannockburn Rd to maintain head losses under 3m/km as typically recommended for new pipes.
- **A 250mm pipe duplication along Cemetery Rd** is required to improve the network conveyance (Option 3 is slightly different – see description below). Head losses up to 27m/km are predicted in the 150mm pipeline (between Gair Avenue and Chardonnay St) due to the additional demand. This pipe is a network constriction: it is connected to a 250mm pipe at one end (Gair Ave) and a 150 and 200mm pipe at the other end (intersection with Chardonnay St). Duplicating this section with a 250mm main will maintain head losses under 5m/km in the area, as recommended for existing pipes.

The table below summarises each option's specificities:

Option	Proposed Network
Option 1	• 300mm pipe connecting to the 525mm pipe from Cromwell Reservoir, to the 200mm main along McNulty Rd and to the 200mm pipe along Cemetery Rd.
Option 2	• 300mm pipe connecting to 300mm pipes at the intersection between McNulty Rd and Gair Avenue, and to the 200mm pipe along Cemetery Rd, following McNulty Rd and Kawarau Gorge Rd.
Option 3	• 250mm pipe duplication along Gair Avenue between McNulty Rd and Cemetery Rd, • 300mm pipe duplication between Gair Avenue and the end of the 200mm pipe along Cemetery Rd.
Option 4	• 300mm pipe duplication along Bannockburn Rd from McNulty Rd to 75 Bannockburn Rd, • 300mm connection between Bannockburn Rd and Cemetery Rd till the end of the 200mm along Cemetery Rd.

MOTT MACDONALD

4.2 Options Cost estimate

The table below shows the estimated cost for each option. These are indicative estimates and should only be used for planning purpose and option comparison (costs do not include land purchase). A breakdown of the cost and upgrade attribution is attached in appendix. It should be noted that the diversity of upgrades location (brownfield/greenfield, installation along the motorway) makes the comparison between options difficult. If cost is a major factor when selecting the preferred option, it is recommended to undertake a more detailed cost estimate.

Option	Total Cost Estimate (NZD)
Option 1	$4,262,800
Option 2	$3,260,500
Option 3	$2,365,600
Option 4	$3,505,000

4.3 Options Comparison

Different factors should be considered when selecting the preferred option:

- **Maintenance and operation**: Options 1 and 2 include sections of pipe along the SH6, which increase risks in terms of health and safety of workers, both during the pipe installation and the network maintenance and operation. Level 2 road traffic management will be required to mitigate the risks.
- **Ease/Feasibility**: Upgrades within the city will be more difficult to implement due to the existing services (water, gas, power, telecom, …) already in the ground. Option 3 in particular includes 1km of work along Gair Avenue and Cemetery Rd which is already significantly developed. In general, greenfield upgrades are easier to implement.
- **Other upgrades:** a wastewater potential upgrade includes the installation of a pipe between Cemetery Rd and Bannockburn, following Option 4 layout. Cost saving will result from installing both pipes at the same time.
- **Cost:** As mentioned above, estimated cost are indicative estimates and should only be used for planning purpose and option comparison. However, the diversity of upgrades location (brownfield/greenfield, installation along the motorway) makes the comparison between options difficult. If cost is a major factor when selecting the preferred option, it is recommended to undertake a more detailed cost estimate.

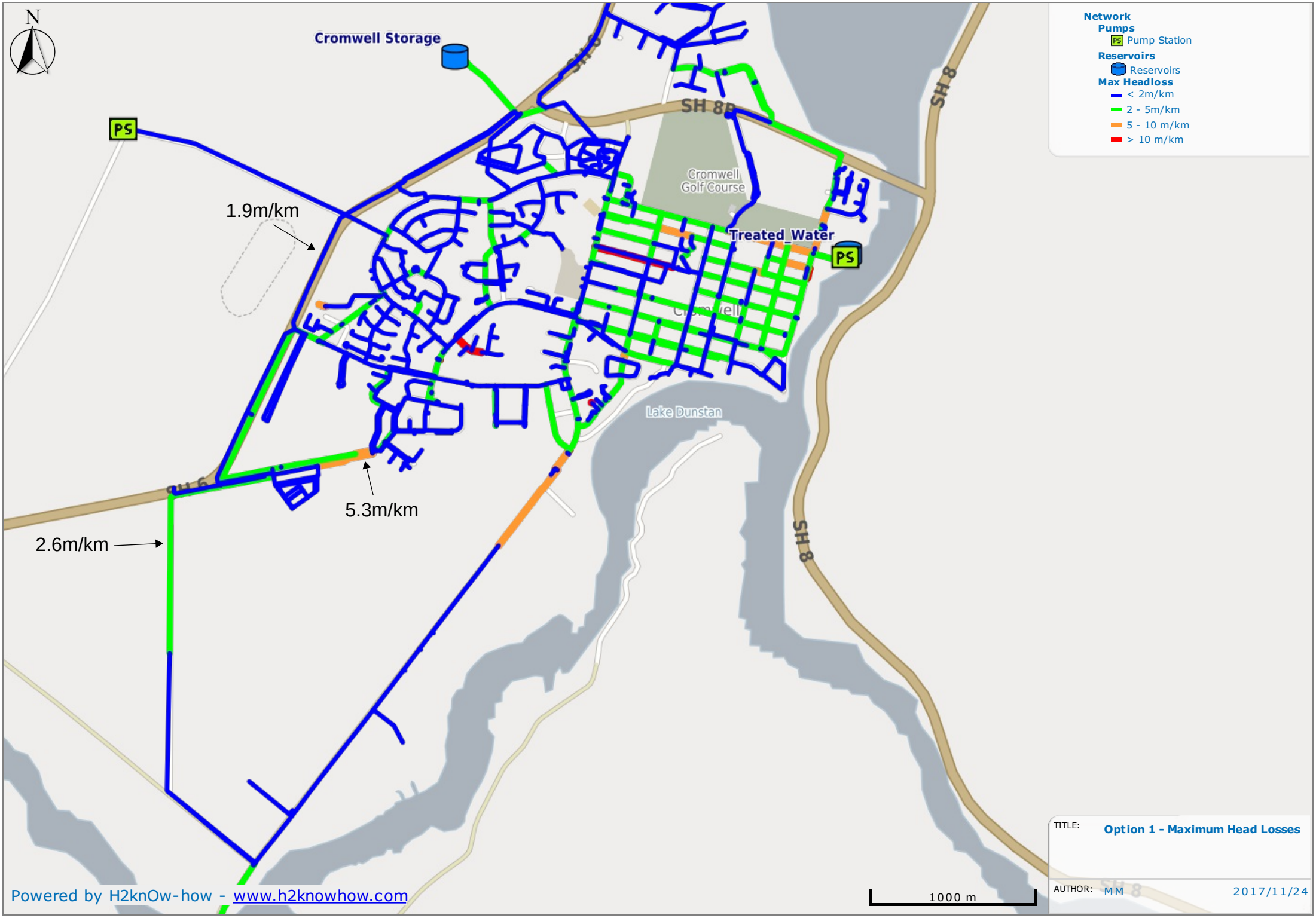
The table below shows the advantages and inconvenient of each option. Each factor has the same weight in this simple multi-criteria analysis. Based on this assumption Option 4 seems to be the preferred option.

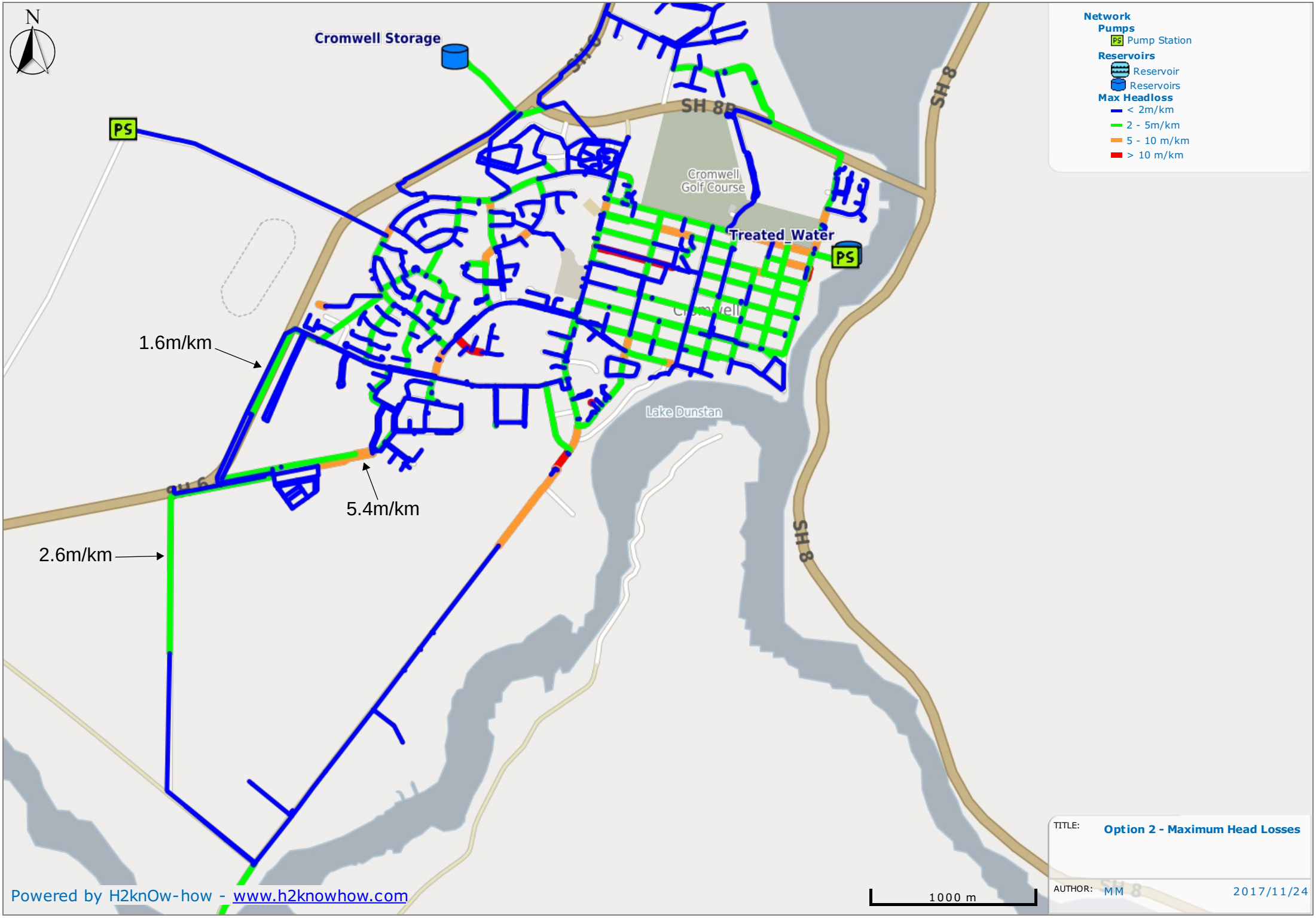
Option	Health and Safety	Feasibility	Other upgrades	Costs	Total
Option 1	- -	+	-	- -	- - - -
Option 2	-	+	-	+	0
Option 3	+	- -	-	++	0
Option 4	+	+	+	-	++

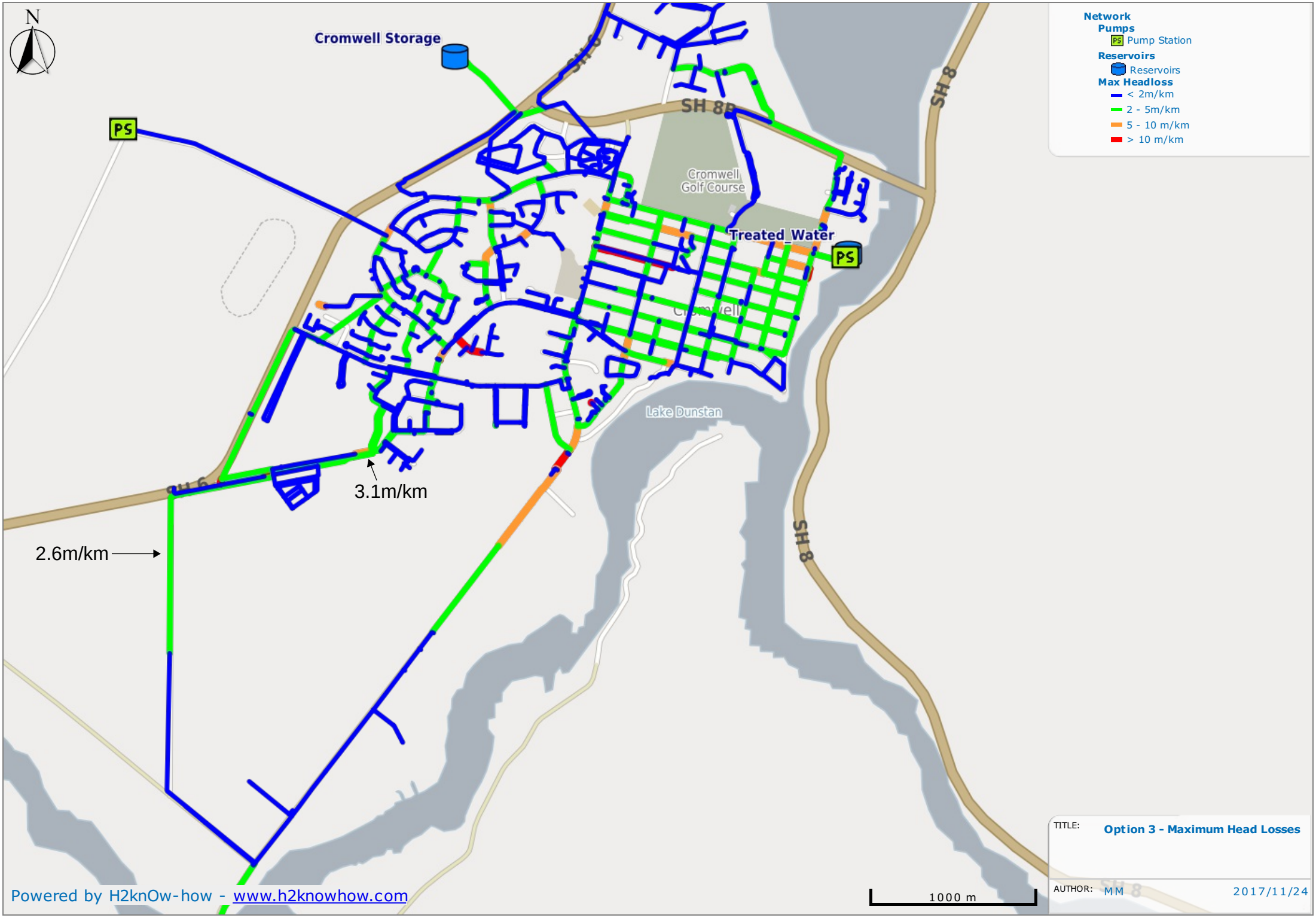
5 Proportion of Selected Option Required for River Terraces

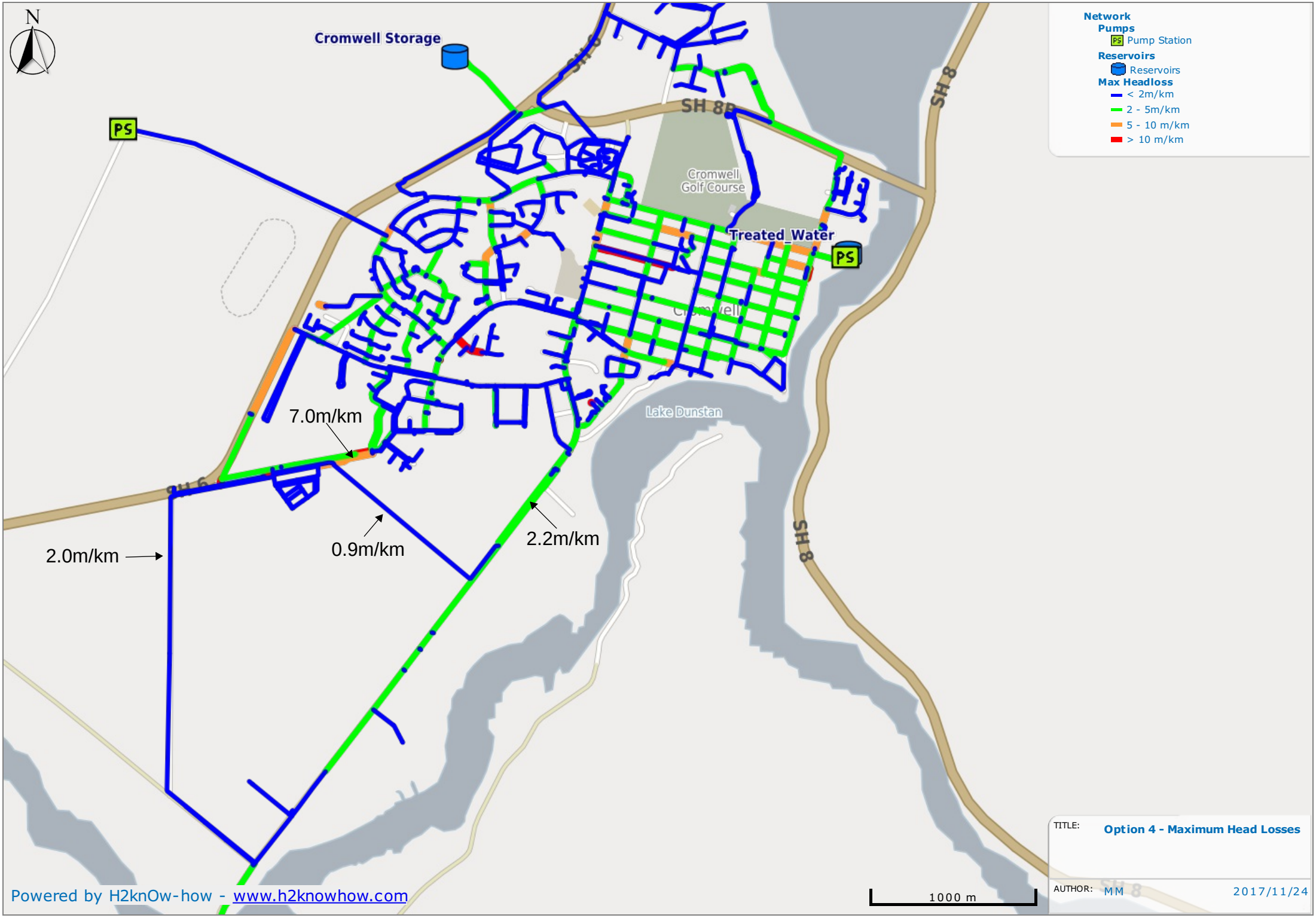
TBC once preferred option selected by CODC

Julie Plessis
Hydraulic Engineer
Julie.plessis@mottmac.com


N
Cromwell Storage
PS
SH 8B
SH 8
Cromwell Golf Course
Treated_Water
PS
1.9m/km
5.3m/km
2.6m/km
Lake Dunstan
SH 8
Network
Pumps
PS Pump Station
Reservoirs
Reservoirs
Max Headloss
< 2m/km
2 - 5m/km
5 - 10 m/km
> 10 m/km
TITLE: Option 1 - Maximum Head Losses
AUTHOR: MM
2017/11/24
1000 m
Powered by H2knOw-how - www.h2knowhow.com


N
Cromwell Storage
PS
SH 8B
SH 8
Cromwell Golf Course
Treated_Water
PS
Lake Dunstan
1.6m/km
5.4m/km
2.6m/km
SH 8
Network
Pumps
PS Pump Station
Reservoirs
Reservoir
Reservoirs
Max Headloss
< 2m/km
2 - 5m/km
5 - 10 m/km
> 10 m/km
TITLE: Option 2 - Maximum Head Losses
AUTHOR: MM
2017/11/24
1000 m
Powered by H2knOw-how - www.h2knowhow.com


N
Cromwell Storage
PS
SH 8B
SH 8
Cromwell Golf Course
Treated_Water
PS
Lake Dunstan
3.1m/km
2.6m/km
SH 8
Network
Pumps
PS Pump Station
Reservoirs
Reservoirs
Max Headloss
< 2m/km
2 - 5m/km
5 - 10 m/km
> 10 m/km
TITLE: Option 3 - Maximum Head Losses
AUTHOR: MM
2017/11/24
1000 m
Powered by H2knOw-how - www.h2knowhow.com


N
Cromwell Storage
PS
SH 8B
SH 8
Cromwell Golf Course
Treated_Water
PS
Lake Dunstan
SH 6
SH 8
7.0m/km
2.0m/km
0.9m/km
2.2m/km
Network
Pumps
PS Pump Station
Reservoirs
Reservoirs
Max Headloss
< 2m/km
2 - 5m/km
5 - 10 m/km
> 10 m/km
TITLE: Option 4 - Maximum Head Losses
AUTHOR: MM
2017/11/24
1000 m
Powered by H2knOw-how - www.h2knowhow.com

Option	Pipe size	Development Service line	Reducing head losses	Improving network resilience	Approximate Quantity (m)	Greenfield/ Brownfiled	WSL Rate ($/m)	Cost Estimate	Total Option Cost
Option 1	350	x			1000	Greenfield	652	$ 652,000	
	300		x		3200	Brownfield	894	$ 2,860,800	
	250		x		400	Brownfield	679	$ 271,600	
	200			x	1600	Greenfield	299	$ 478,400	$4,262,800
Option 2	350	x			1000	Greenfield	652	$ 652,000	
	300		x		2100	Brownfield	885	$ 1,858,500	
	250		x		400	Brownfield	679	$ 271,600	
	200			x	1600	Greenfield	299	$ 478,400	$3,260,500
Option 3	350	x			1000	Greenfield	652	$ 652,000	
	300		x		1100	Brownfield	876	$ 963,600	
	250		x		400	Brownfield	679	$ 271,600	
	200			x	1600	Greenfield	299	$ 478,400	$2,365,600
Option 4	350	x			1000	Greenfield	652	$ 652,000	
	300		x	x	3000	Greenfield/Brownfield	701	$ 2,103,000	
	250		x		400	Brownfield	679	$ 271,600	
	200			x	1600	Greenfield	299	$ 478,400	$3,505,000

Rates are based on the unit replacement cost models developed by Aecom in 2011 for Watercare.
A 60% factor was applied to greenfield upgrades.
A traffic management fee of 1800$/day assuming a pipe installation rate of 100m/day was assumed for section along the SH6.

APPENDIX E

Confirmation of Telecom Supply

Chorus Network Services
PO Box 9405
Waikato Mail Centre
Hamilton 3200
Telephone: 0800 782 386
Email: tsg@chorus.co.nz

Sub Div Ref: CMW42988
Your Ref:

11 October 2017

River Terrace Developments Ltd

Attention: Peter Dymock
Dear Sir / Madam

SUBDIVISION RETICULATION – CMW: Kawarau Gorge road, Cromwell: Retirement village, 901 lots Estimate

Thank you for your enquiry regarding the above subdivision.

Chorus is pleased to advise that, as at the date of this letter, we would be able to provide ABF telephone reticulation for this subdivision. In order to complete this reticulation, we require a contribution from you to Chorus' total costs of reticulating the subdivision. Chorus' costs include the cost of network design, supply of telecommunications specific materials and supervising installation. At the date of this letter, our estimate of the contribution we would require from you is $1,656,000.00 (including GST).

We note that (i) the contribution required from you towards reticulation of the subdivision, and (ii) our ability to connect the subdivision to the Chorus network, may (in each case) change over time depending on the availability of Chorus network in the relevant area and other matters.

If you decide that you wish to undertake reticulation of this subdivision, you will need to contact Chorus (see the contact details for Chorus Network Services above). We would recommend that you contact us at least 3 months prior to the commencement of construction at the subdivision. At that stage, we will provide you with the following:

- confirmation of the amount of the contribution required from you, which may change from the estimate as set out above;

- a copy of the Contract for the Supply and Installation of Telecommunications Infrastructure, which will govern our relationship with you in relation to reticulation of this subdivision; and

- a number of other documents which have important information regarding reticulation of the subdivision, including - for example - Chorus' standard subdivision lay specification.

Yours faithfully

S I Hoult

Shaun Hoult
Network Services Coordinator

APPENDIX F

Electrical Supply Report

RIVER TERRACE DEVELOPMENT

SAND FLAT ROAD, CROMWELL

POWER SUPPLY

1. There are three possible options for a power supply to the development:

   - An Aurora Energy Ltd supply with Aurora owning the subdivision infrastructure.
   - "An embedded" supply from an alternative provider connected to a dedicated feeder off Aurora's Zone substation or a feed off Aurora's distribution network, with the alternative provider owning the subdivision infrastructure.
   - An independent supply from an alternative provider from a Grid Exit Point (GXP) off the Transpower Cromwell substation, with the alternative provider owning the subdivision infrastructure.

2. Aurora Energy Ltd have confirmed that a supply can be made available from its distribution network with Aurora owning the subdivision infrastructure. Please refer to the attached supply availability letter.

3. Aurora's capital funding contribution will either fully or partially fund the strengthening of the network to supply the subdivision and build costs of the subdivision infrastructure depending on parameters such as costs, connected capacity and the timing of staging of the subdivision. If the subdivision is completed in stages, funding will be calculated by Aurora based on the parameters for each stage. Decisions on funding will be decided by Aurora after a Network Development Application for all stages of the subdivision has been received by Aurora.

4. Preliminary discussions have been held with alternative providers as to the possibility of an embedded network or direct feed from Transpower's GXP. It appears that a direct feed from a Transpower's GXP is unlikely to be economically viable.

5. At this point, the option of an embedded network is still under review and is dependent on projections for future electrical load growth in the wider Cromwell basin.

Steve Tilleyshort
PMEngNZ (Electrical)
S.Tilleyshort Electrical Consulting
s.tilleyshort@gmail.com
Ph 027 773 5481

Encl

AURORA ENERGY LIMITED
PO Box 5140, Dunedin 9058
PH 0800 22 00 05
WEB www.auroraenergy.co.nz

10 November 2017

Your ref:
Our ref:

Peter Dymock
Paterson Pitts Group
30 The Mall
Cromwell 9310

By email only: peter.dymock@ppgroup.co.nz

Dear Peter

ELECTRICITY SUPPLY FOR DEVELOPMENT RIVER TERRACE, CROMWELL
PROPOSED DEVELOPMENT OF PART SECTION 24 BLOCK I CROMWELL SURVEY DISTRICT AND SECTION 28 BLOCK I CROMWELL SURVEY DISTRICT

Thank you for your letter and accompanying plans dated 24 July 2017, outlining the above proposed development.

Aurora Energy can make an electricity supply available for this development, subject to the following conditions:

- Supply confirmation is limited to a three phase 3,500kVA supply;
- Easements in gross, in favour of Aurora Energy, must be granted over the placement of all new and existing Aurora Energy plant associated with this development, unless installed in road reserve;
- Where the development involves further subdivision of a land parcel containing an existing serviced installation, the mains cables (overhead or underground) intended to supply each lot must be completely contained within the lot that it serves. In some cases this will require relocation of the cable serving the existing installation;
- All electrical installations must comply with Aurora Energy's Network Connection Standard and related standards & policies;
- The developer must comply with the Electricity Act, subordinate Regulations and associated Codes of Practice. Particular attention must be paid to the minimum distances between power lines and other structures defined in NZECP34:2001 "NZ Electrical Code of Practice for Electrical Safe Distances";
- No building shall be erected over any electricity easement without specific written authority from Aurora's General Manager – Network Commercial;
- The developer is responsible for all resource consents and local authority approvals;
- The developer will be required to make capital contributions toward the costs of providing the power supply, in accordance with Aurora Energy's Capital Contributions policy prevailing at the time the development, or each stage of development, proceeds;
- This approval will lapse within 12 months of the date of this letter, unless the developer enters into a formal supply agreement with Aurora Energy for this development;

Please note that this letter is to confirm that a power supply can be made available and does not imply that a power supply is available now, or that Aurora Energy will make power available at its cost.

Aurora Energy's Network Connection Standard and Capital Contributions policy provide more specific information on matters identified in this letter. These documents are available on Aurora Energy's website.

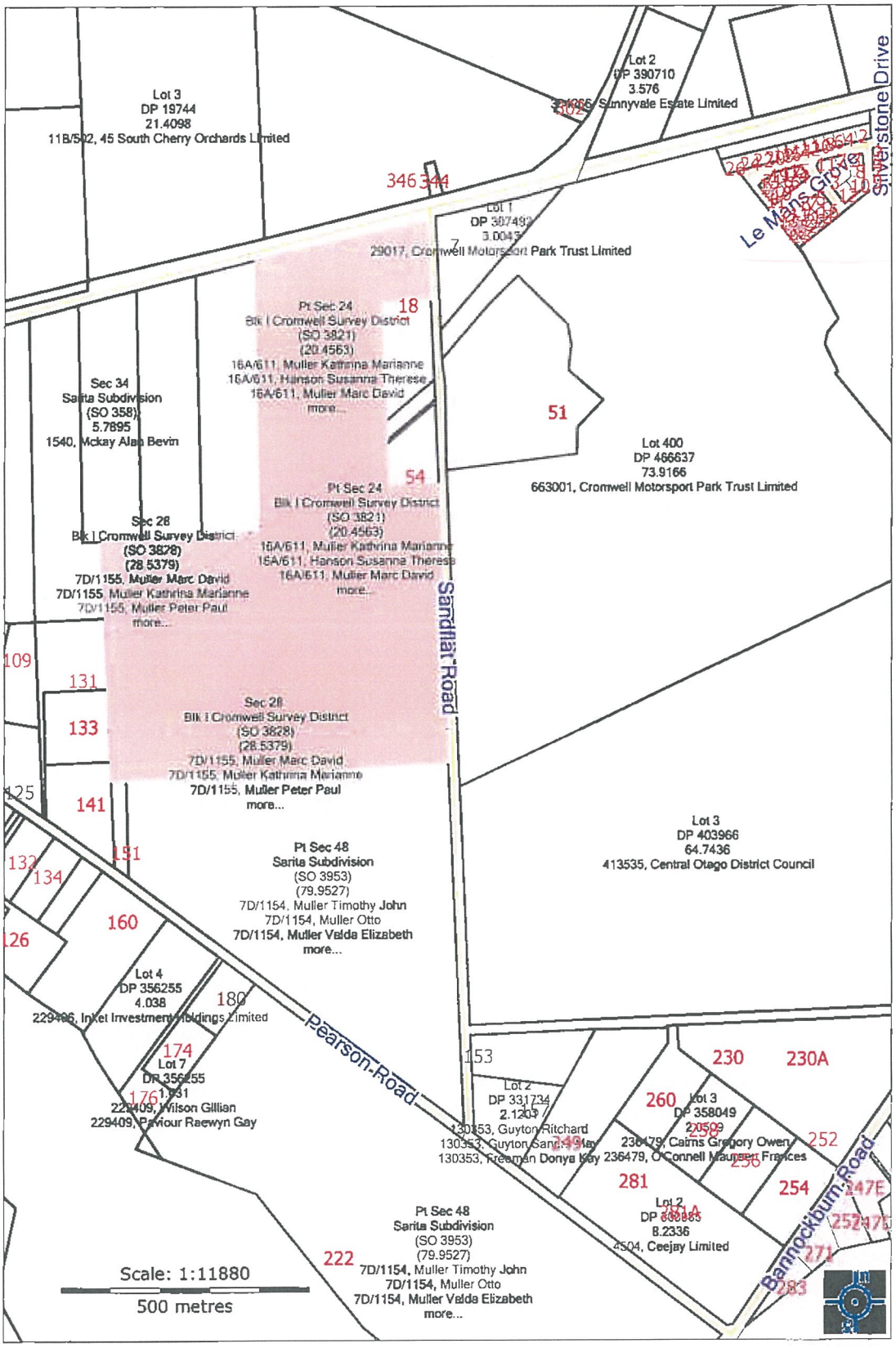
Should you require further information or clarification please contact the undersigned.

Yours sincerely

Richard Starkey

Commercial Development Manager

River Terrace Development Ltd



APPENDIX G

CBR TESTS

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 17/1972

Date: 30 August 2017

TEST REPORT - LABORATORY SOAKED CBR'S

Client Details:	**River Terrace Developments Ltd, c/o Paterson Pitts Group, P.O. Box 84, Cromwell**	**Attn:**	**M. Bretherton**
Job Description:	**Sandflat Road Investigations**	**Client Order No:**	**N/A**
Sample Description:	**Subgrade**	**Sample Source:**	**Test Pits**
Sampled By:	**L.T. Smith**	**Date & Time Sampled:**	**8-Aug-17**
Sample Method:	**NZS 4407:2015, Test 2.4.2 (Test Pit)**	**Sample Label No:**	**Various**
Test Method:	**NZS 4407:2015, Test 3.15**	**Date Received:**	**8-Aug-17**

LABORATORY SOAKED CBR RESULTS			
Sample Source:	**TP:1**	**TP:2**	**TP:3**
Sample Depth: (mm)	**300 - 550**	**350 - 650**	**500 - 750**
Sample Description:	**GRAVEL with some sand and trace of silt**	**Sandy GRAVEL with trace of / minor silt**	**Sandy GRAVEL with trace of silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**
Time Soaked:	**5 days**	**5 days**	**4 days**
Swell: (%)	**0.0**	**0.0**	**0.0**
Water Content as Compacted: (%)	**4.9**	**5.7**	**3.5**
Water Content From Under Plunger: (%)	**7.0**	**6.6**	**8.1**
Dry Density As Compacted: (t/m^3)	**1.94**	**2.14**	**2.05**
CBR Value @ 2.5 mm Penetration:	**15**	**70**	**25**
CBR Value @ 5.0 mm Penetration:	**30**	**90**	**40**
Reported CBR Value:	**30**	**90**	**40**

Notes:

- ***The material was received in a natural state.***
- ***The material tested was the fraction passing the 19.0mm test sieve.***
- ***The sample was compacted to NZ Standard Compaction at the water content as received.***
- ***The rate of penetration was 1.14 mm / min.***
- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith & L. Reiher** **Date:** **9 to 30-Aug-17**

Checked By: 

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 17/1972

Date: 30 August 2017

TEST REPORT - LABORATORY SOAKED CBR'S

Client Details:	**River Terrace Developments Ltd, c/o Paterson Pitts Group, P.O. Box 84, Cromwell**	**Attn:**	**M. Bretherton**
Job Description:	**Sandflat Road Investigations**	**Client Order No:**	**N/A**
Sample Description:	**Subgrade**	**Sample Source:**	**Test Pits**
Sampled By:	**L.T. Smith**	**Date & Time Sampled:**	**8-Aug-17**
Sample Method:	**NZS 4407:2015, Test 2.4.2 (Test Pit)**	**Sample Label No:**	**Various**
Test Method:	**NZS 4407:2015, Test 3.15**	**Date Received:**	**8-Aug-17**

LABORATORY SOAKED CBR RESULTS			
Sample Source:	**TP:4**	**TP:5**	**TP:6**
Sample Depth: (mm)	**400 - 700**	**400 - 700**	**500 - 800**
Sample Description:	**Sandy GRAVEL with trace of / minor silt**	**Sandy GRAVEL with trace of silt**	**Sandy GRAVEL with trace of / minor silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**
Time Soaked:	**4 days**	**4 days**	**4 days**
Swell: (%)	**0.0**	**0.0**	**0.0**
Water Content as Compacted: (%)	**4.7**	**3.5**	**4.9**
Water Content From Under Plunger: (%)	**7.9**	**8.1**	**7.2**
Dry Density As Compacted: (t/m^3)	**2.01**	**1.93**	**2.13**
CBR Value @ 2.5 mm Penetration:	**35**	**20**	**80**
CBR Value @ 5.0 mm Penetration:	**45**	**25**	**90**
Reported CBR Value:	**45**	**25**	**90**

Notes:

- ***The material was received in a natural state.***
- ***The material tested was the fraction passing the 19.0mm test sieve.***
- ***The sample was compacted to NZ Standard Compaction at the water content as received.***
- ***The rate of penetration was 1.14 mm / min.***
- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith & L. Reiher** **Date:** **9 to 30-Aug-17**

Checked By:

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 17/1972

Date: 30 August 2017

TEST REPORT - LABORATORY SOAKED CBR'S

Client Details:	**River Terrace Developments Ltd, c/o Paterson Pitts Group, P.O. Box 84, Cromwell**	**Attn:**	**M. Bretherton**
Job Description:	**Sandflat Road Investigations**	**Client Order No:**	**N/A**
Sample Description:	**Subgrade**	**Sample Source:**	**Test Pits**
Sampled By:	**L.T. Smith**	**Date & Time Sampled:**	**8-Aug-17**
Sample Method:	**NZS 4407:2015, Test 2.4.2 (Test Pit)**	**Sample Label No:**	**Various**
Test Method:	**NZS 4407:2015, Test 3.15**	**Date Received:**	**8-Aug-17**

LABORATORY SOAKED CBR RESULTS			
Sample Source:	**TP:7**	**TP:8**	**TP:9**
Sample Depth: (mm)	**300 - 600**	**350 - 650**	**700 - 1000**
Sample Description:	**Sandy GRAVEL with trace of / minor silt**	**Sandy GRAVEL with trace of silt**	**GRAVEL with some sand and trace of silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**
Time Soaked:	**4 days**	**4 days**	**4 days**
Swell: (%)	**0.0**	**-0.2**	**0.0**
Water Content as Compacted: (%)	**5.4**	**4.7**	**4.1**
Water Content From Under Plunger: (%)	**8.2**	**7.7**	**4.8**
Dry Density As Compacted: (t/m^3)	**2.08**	**1.91**	**1.99**
CBR Value @ 2.5 mm Penetration:	**55**	**15**	**40**
CBR Value @ 5.0 mm Penetration:	**60**	**25**	**50**
Reported CBR Value:	**60**	**25**	**50**

Notes:

- ***The material was received in a natural state.***
- ***The material tested was the fraction passing the 19.0mm test sieve.***
- ***The sample was compacted to NZ Standard Compaction at the water content as received.***
- ***The rate of penetration was 1.14 mm / min.***
- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith & L. Reiher** **Date:** **9 to 30-Aug-17**

Checked By: 

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 17/1972

Date: 30 August 2017

TEST REPORT - LABORATORY SOAKED CBR'S

Client Details:	**River Terrace Developments Ltd, c/o Paterson Pitts Group, P.O. Box 84, Cromwell**	**Attn:**	**M. Bretherton**
Job Description:	**Sandflat Road Investigations**	**Client Order No:**	**N/A**
Sample Description:	**Subgrade**	**Sample Source:**	**Test Pits**
Sampled By:	**L.T. Smith**	**Date & Time Sampled:**	**8-Aug-17**
Sample Method:	**NZS 4407:2015, Test 2.4.2 (Test Pit)**	**Sample Label No:**	**Various**
Test Method:	**NZS 4407:2015, Test 3.15**	**Date Received:**	**8-Aug-17**

LABORATORY SOAKED CBR RESULTS			
Sample Source:	**TP:10**	**TP:11**	**TP:12**
Sample Depth: (mm)	**600 - 900**	**400 - 650**	**300 - 700**
Sample Description:	**Sandy GRAVEL with trace of silt**	**Sandy GRAVEL with trace of / minor silt**	**Sandy GRAVEL with minor cobbles and trace of / minor silt**
Condition of Sample:	**Soaked**	**Soaked**	**Soaked**
Surcharge Mass: (kg)	**4.0**	**4.0**	**4.0**
Time Soaked:	**4 days**	**4 days**	**4 days**
Swell: (%)	**0.0**	**0.0**	**0.0**
Water Content as Compacted: (%)	**7.5**	**6.1**	**7.5**
Water Content From Under Plunger: (%)	**8.7**	**6.9**	**7.9**
Dry Density As Compacted: (t/m^3)	**2.04**	**2.03**	**2.10**
CBR Value @ 2.5 mm Penetration:	**45**	**45**	**50**
CBR Value @ 5.0 mm Penetration:	**60**	**50**	**75**
Reported CBR Value:	**60**	**50**	**75**

Notes:

- ***The material was received in a natural state.***
- ***The material tested was the fraction passing the 19.0mm test sieve.***
- ***The sample was compacted to NZ Standard Compaction at the water content as received.***
- ***The rate of penetration was 1.14 mm / min.***
- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith & L. Reiher** **Date:** **9 to 30-Aug-17**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

Tests indicated as Not Accredited are outside the laboratory's scope of accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

APPENDIX H

EXTRACTS FROM TABLES 3.1 & 3.2 NZS4404:2010

Table 3.1 – Land use and area type matrix describing typical place and transport context

LAND USE	AREA TYPE			
	RURAL	**SUBURBAN**	**URBAN**	**CENTRE**
LIVE AND PLAY (Residential and parks) Homes, home-based businesses, and mixed use developments with residential uses, as well as parks and low impact recreation. *Transport: These land uses primarily generate home-based and internal circulation trips (recreation, social, school, and retail). Home-based work trips are concentrated at peak periods, while other types of trips are dispersed across time periods. Streets to these land uses prioritise recreation walking and cycling over vehicle movement.*	Low density, generally no more than 4 units per hectare located outside the urban limits. *Transport: Private motor vehicles are the predominant form of transport with low trip volumes throughout the day.*	Low and moderate density housing generally up to 15 units per hectare in an area where housing is the exclusive or dominant use. *Transport: Private vehicles are the predominant form of transport but public transport should provide peak period service on arterials and connector/collectors. Non-motorised trips are primarily recreational and occur on local roads.*	Moderate and high density housing often in combination with other uses such that combined population of residents, employees, and students is typically 50 per hectare or greater. *Transport: A higher portion of trips are made on public transport and by walking and cycling. There is lower priority for the provision of residential parking in urban areas.*	Moderate and high density housing often in combination with other uses such that combined population of residents, employees, and students is typically 200 per hectare or greater. *Transport: Residents typically walk or cycle to nearby destinations and rely on public transport for longer trips, and they may choose not to own a vehicle. Provision for residential and commuter parking is a low priority in centres.*
SHOP AND TRADE (Retail and services) Retail or other service where most trips to the business are by customers and clients, rather than employees. *Transport: A large volume of destination trips occur across time periods, especially weekends and peak shopping times to these land uses. A low-to-moderate volume of freight truck traffic is served. Streetscapes may serve as connections for destination users to reach several or numerous businesses in the area.*	Isolated or small clusters of stores or service-based businesses located outside the urban limits. *Transport: Most trips are made in private motor vehicles with low trip volumes throughout the day.*	Includes both traditional town centres and newer shopping centres of generally 1-2 storeys where the dominant use is retail and services businesses and the combined retail and commercial floor-to-area ratio (FAR) is typically under 0.3 (gross). *Transport: Most trips are made in private motor vehicles with moderate and high trip volumes, especially on weekends, requiring these land uses to have large amounts of parking allocated to each site.*	Retail and services focused in a town centre or concentrated along an urban corridor in combination with other uses. The combined population of residents, employees, and students is typically 50 per hectare or greater. *Transport: Trips are made on a variety of modes at all times with limited amounts of shared and paid parking.*	Moderate to high density land uses include retail mixed with other uses in an urban or town centre. Centres typically have, or are planned to have, a combined population of residents, employees, and students of 200 per hectare or greater. *Transport: Public transport services are typically focused on centres, and centres are among the most highly connected and walkable environments. Provision for parking is the lowest land use priority in centres.*

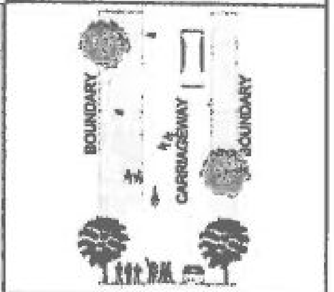
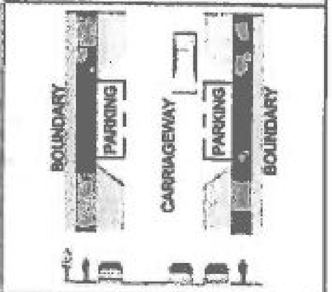
PLACE CONTEXT			DESIGN ENVIRONMENT				LINK CONTEXT					TYPICAL PLAN AND CROSS SECTION
Area	Land use	Local attributes	Locality served	Target operating speed (km/h)	Min. road width (m)	Max. grade	Pedestrians	Passing, parking, loading and shoulder	Cyclists	Movement lane (including cyclists)	Classification	
Notes:	See 3.2.4, table 3.1 & 3.3.1.6	See table 3.1	See table 3.1	See 3.3.5	See 1.2.2, 3.3.1.3, & 3.4.16		See 3.3.11	See 3.3.6 & 3.3.1.4	See 3.3.1.5, 3.3.7, & 3.3.11.2	See 1.2.2, 3.3.1.1, 3.3.1.2, 3.3.1.3, 3.3.1.10, 3.3.11.2	See 3.2.4.2 & 3.3.16 (Typical max volumes)	
Suburban	Live and play	Side or rear service access	Up to 100 m in length between streets, 1 to 20 lots	10	6	16%	Shared (in movement lane)	Allow for passing up to every 50 m	Shared (in movement lane)	2.75 – 3.00	Lane (<200 vpd)	
	Live and play	Access to houses/ townhouses	1 to 20 du	20	9	16%	Shared (in movement lane)	Shared (in movement lane)	Shared (in movement lane)	5.5 – 5.7	Lane (~200 vpd)	
	Live and play	Primary access to housing	1 to 200 du	40	15	12.5%	1.5 m one side or 1.5 m each side where more than 20 du or more than 100 m in length	Shared parking in the movement lane up to 100 du, separate parking required over 100 du	Shared (in movement lane)	5.5 – 5.7	Local road (<2000 vpd)	

Table 3.2 (continued)

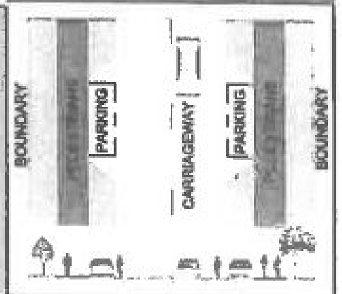
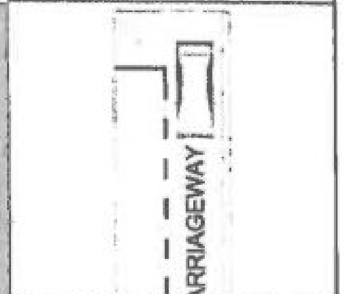
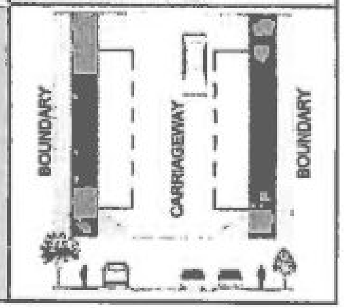
PLACE CONTEXT			DESIGN ENVIRONMENT				LINK CONTEXT					TYPICAL PLAN AND CROSS SECTION
Area	Land use	Local attributes	Locality served	Target operating speed (km/h)	Min. road width (m)	Max. grade	Pedestrians	Passing, parking, loading and shoulder	Cyclists	Movement lane (excluding shoulder)	Classification	
Notes	See 3.2.4, table 3.1 & 3.3.1.6	See table 3.1	See table 3.1	See 3.3.5	See 4.2.2, [illegible]		See 3.3.11	See 3.3.6 & 3.3.14	See 3.3.1.5, 3.3.7, & 3.3.13.2	See [illegible], 3.3.1.1, [illegible]	See 3.2.4.2 & 3.3.15 (Typical max. volumes)	[illegible]
Suburban	Live and play	Primary access to housing	Up to 800 du	50	20	10%	2.0 m each side	Parking is separate and recessed. See 3.3.6. Public transport is likely (see clause 3.3.14, 3.3.1.5)	Separate provision where local authority defined cycle route.	2 x 4.2	Connector/ collector (~ 8,000 vpd)	
	Shop and trade, work and learn	Side or rear service access	Suburban village, access to office and education, 1 - 20 lots	10	6	10%	Shared (in movement lane)	Recessed loading bays in accordance with 3.3.6	Shared (in movement lane)	3.5	Lane (~ 200 vpd)	
	Shop and trade, work and learn	Access to trade, office and education	Suburban village 1 - 200 lots	40	18	10%	3.0 m each side	Parking and loading bays both sides may be in the movement lane or recessed. See 3.3.6.	Shared (in movement lane)	5.5 - 5.7	Local road (~ 2,000 vpd)	

Table 3.2 (continued)