2.2.2 Stage 2

Stage 2 will include developing lots 9-12 as shown in Figure 1. Construction is likely to commence with earthworks for the access road to lots 7-9, including road swales, check dams and soakage if required and utilities along the new road.

Once access can be gained to the new lot's individual cut/fill, operations for the individual lots can commence. The upgrading of Curtis Road to Type E3 standard (QLDC LDSC) will also be required at this stage, which will include widening of the existing road from the junction with Pringles Creek Road to the main residential cluster. This can happen in parallel with the lot earthworks noting that Curtis Road is used for access to other properties. This will restrict the ability to have large open areas and require a sequence that allows the road to be trafficable in part during construction.

It is expected earthworks will be mostly localised to individual lots and road sections by cut to fill balancing to minimise the haulage of material. The construction duration is expected to be in the order of 3-5 months.

2.2.3 Stage 3

Stage 3 will include developing the final cluster of lots, 2-6, as shown in Figure 1. Construction is likely to commence with earthworks for the access road to lots 2-4, including road swales, check dams and soakage if required and utilities along the new road.

Once access can be gained to the new lot's individual cut/fill operations for the individual lots can commence. It is expected earthworks will be mostly localised to individual lots and road sections by cut to fill balancing to minimise the haulage of material. The construction duration is expected to be in the order of 3-5 months.

2.2.4 Disposal Fields

The disposal fields will consist of subsurface drains, laid along contour lines. It is assumed that the disposal field will be increased in size to suit the number of lots and follow the same staging. The following best practice guidelines from AC GD05 G3.2.2 should be considered for the installation of the drains:

- Plan the works to minimise the extent and duration of site disturbance.
- When trenching is completed independent of other activities on site, plan for progressive stabilisation and/or restoration of disturbed areas.
- Trenches should not be open for any longer than three days; complete the stabilisation of all disturbance in high-risk areas within two days of backfilling, and within five days in all other areas.
- Do not open trenches when there is a risk of high rainfall. (Note: An open trench becomes a diversion drain; consider where it will discharge.)
- Divert above-site water away from work areas with temporary diversion drains as shown on the ESCP drawing.
- Do not allow the trench excavation to concentrate or convey runoff.
- Topsoil and spoil should be stockpiled separately on the up-slope side of the trench.
- Do not put stockpiles of topsoil, spoil or bedding material in overland flow paths.
- Minimise soil loss by protecting all stockpiles with covers such as geotextile fabric.
- Remove excess spoil and/or bedding material from the site as soon as work is completed, or immediately incorporate into other works on site.

The proposed stage ESC plan is shown in Figure 2 below.

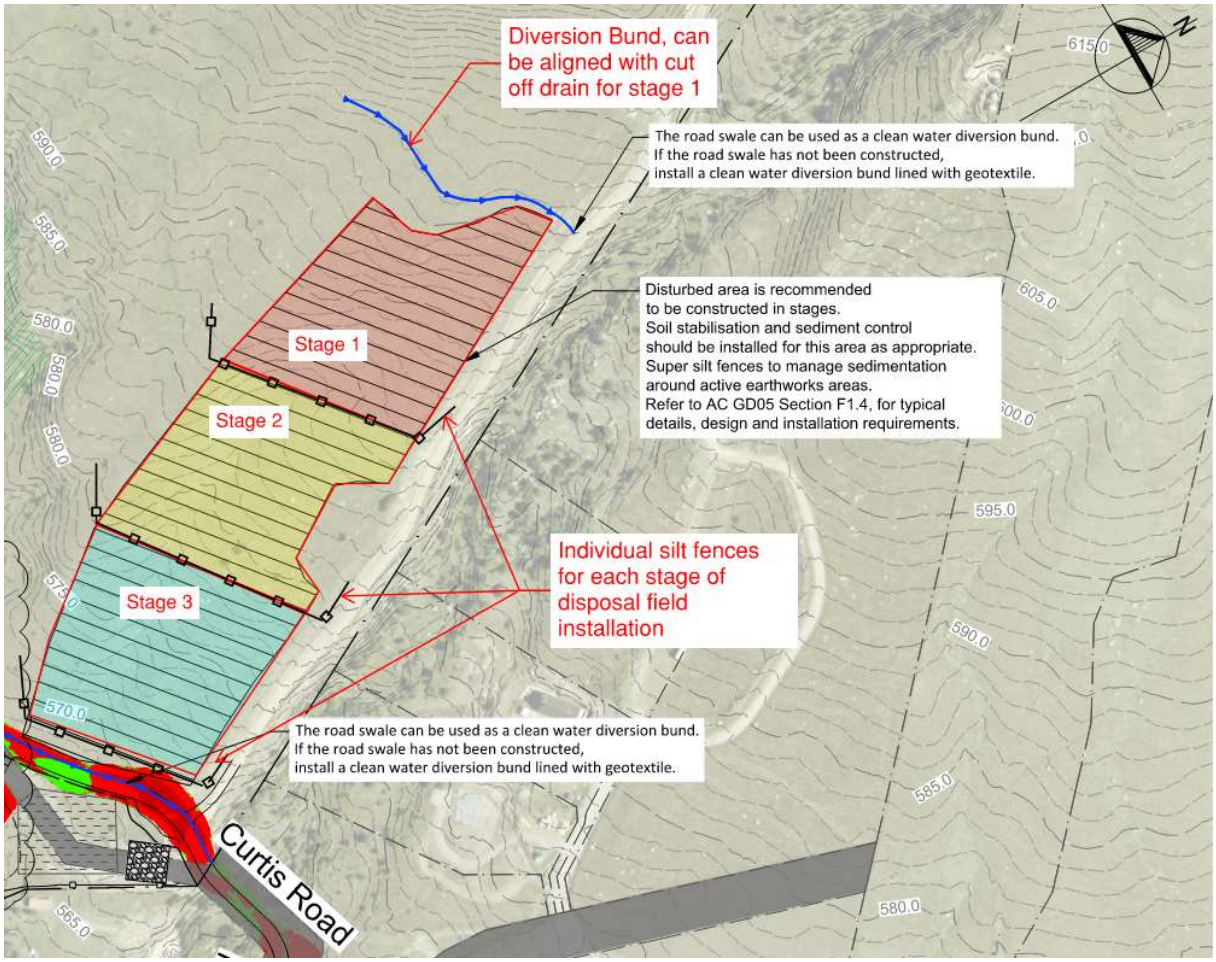


Figure 2: Disposal field stage ESC Plan

2.3 Earthworks

The proposed development will require earthworks to be completed to prepare the site for construction to include access roads and building platforms.

The development is embracing a low impact design philosophy to maintain its inherent rural and rustic character. The associated earthworks shall be sympathetic to the natural environment limiting visual impacts where possible.

Cut and fill volumes have been estimated comparing a conceptual bulk earthworks cut model with the existing site surface, see Table 1. All cut and fill volumes have been taken from the existing surface to proposed finished ground / surface levels, with no allowance being made for pavement or building platform build up at this stage. The batter slopes are based on the 1:3 grade advised by the geotechnical engineer. At the next design stage, the extent of the permanent works associated with this upgrade can be reviewed with options to reduce the extent by including retaining walls or steeper slopes, and potentially utilising ground reinforcement techniques.

The earthworks shown on drawing C23-01 show the potential disturbance areas associated with the possible wastewater application and fill areas.

The concept phase estimate of topsoil strip has been done by taking the total earthworks area (55,000m^2) less the existing road area (6,000m^2) = 49,000m^2 and multiplying this by a 200mm deep cut = 9,800m^3.

Table 1 Estimation of earthworks volumes from drawing C20-01, see Appendix 01

Earthwork	Volume
Cut	20,880 m^3
Fill	17,600 m^3
Total	+3,280 m^3

All earthworks will be undertaken under the supervision of a Geotechnical Engineer and in accordance with Geotechnical recommendations to ensure that the stability of the site and adjacent sites is maintained, and adequate compaction of fill is achieved during construction. All batter slopes will be constructed in accordance with the recommendations set out in Geosolve's Geotechnical Report, presented in Table 2 – the permanent cut slope values have been used as part of the conceptual earthworks modelling.

Table 2 Recommended maximum batter angles for cut slopes up to 3m high in site soils, taken from Table 2 of Geosolve Geotechnical Report

Material Type	Recommended Maximum Batter Angles for Temporary Cut Slopes Formed in Soil (horizontal to vertical)		Recommended Maximum Batter Angles for Permanent Cut Slopes Formed in Soil (horizontal to vertical)
	Dry Ground	Wet Ground	
Topsoil and Softened Fan Alluvium	2H : 1V	3H : 1V	3H : 1V
Fan Alluvium	1.5H : 1V	3H : 1V	2.5H : 1V

2.4 Treatment Requirements

The Contractor shall confirm treatment requirements with Otago Regional Council when submitting their final erosion and sediment control plan prior to earthworks commencing. As a minimum, 100 mm water clarity should be targeted for water treatment prior to discharging from site.

3 DUST CONTROL

3.1 Prevention Measures

- To minimise dust formation, the extent of exposed earth at one time shall be minimised where feasible.
- All exposed ground shall be sealed/re-vegetated as soon as practical.

3.2 Control Measures

Dust control is most critical during dry conditions. The potential for dust cloud formation will be monitored visually on a daily basis by the consent holder/construction supervisor, during periods of operation.

The following control measures are proposed:

- Water will be used to suppress dust if necessary.
- Construction should be completed in stages where possible, to minimise the area of exposed ground at one time.
- Sowing of grass or planting to reinstate batters and fill areas will be implemented as soon as possible, which will also help to mitigate dust from affected ground.
- Refer to AC GDO5 Section G9.2 for best practice for this activity.

4 EROSION AND SEDIMENTATION CONTROL

The existing site is dominated by grassed surfaces and generally slopes from the west to east at a gradient of 5°-20°. There are two races crossing through the site and overland flow routes through the property drain to either Pongs or Pringles Creek.

Left unchecked, stormwater runoff could erode exposed ground surfaces and deposit silt beyond the site onto private property or into the two water races. Measures to prevent this are described in the following sections.

4.1 Prevention Measures

The following preventative measures should be taken:

- Existing grass/vegetation will be retained where practical until construction works are ready to commence.
- Construction should take place in stages where possible to minimise the amount of exposed (i.e. un-vegetated/unsealed) ground at a time.
- It is recommended control measures be installed specifically for each lot rather than having an overall site control system for each stage of construction.
- Designated landscaped areas shall be vegetated as soon as practical.

4.2 Control Measures

The following measures could be used to help control sediment leaving the site in stormwater runoff.

4.2.1 General Control Measures

- To aid the effectiveness of the sedimentation control measures, work is recommended to not be undertaken during periods of heavy rain, and for the contractor to shore up and monitor the measures in place during any storm event.

- There have not been any springs encountered on-site. Perched ground water may need to be drained before work starts. The discharge of the perched ground water should not cause erosion or flooding to the adjacent land.
- Subsoil drains may need to be installed so that once ground water is struck, water has a place to drain to. The Contractor will need to develop their own strategy for managing ground water across this site.
- A freshwater assessment will be undertaken before the construction of the culvert by an ecologist. During their time on-site the ecologist should advise on the control measures that shall be put into place during the extension of the culverts.

4.2.2 Super Silt Fences

Super silt fencing will prevent sediment from leaving the individual lots and sections of road where earthworks are taking place in surface runoff. These are a standard boundary control measure, to be used downstream of any construction zone to control water leaving the area while preventing sediment loss.

The indicative layout of super silt fences is shown on the ESC drawing, and should be adjusted based on the detailed design and site conditions to adhere to the design criteria as shown in Table 3. Refer to AC GD05 Section F1.4, for typical details, design and installation requirements.

Table 3: Super silt fence design criteria - AC GD05 Section F1.4. Table 14

Slope steepness %	Slope length (m) (maximum)	Spacing of returns (m)	Super silt fence length (m) (maximum)
0 – 10%	Unlimited	60	Unlimited
10 – 20%	60	50	450
20 – 33%	30	40	300
33 – 50%	30	30	150
> 50%	15	20	75

Silt fences are not to be used as a means of reducing flow velocity or in areas where they will intercept concentrated flow.

4.2.3 Clean Water Diversion Channels and Bunds

Stabilised channels and bunds will be used to prevent clean surface water entering the construction areas. The stabilised channels will convey clean water away from the active earthworks areas. This will limit the volume of water that enters stormwater areas that needs treatment. Only rain that falls within the active earthworks area will need to be collected and treated prior to being discharged from site.

Refer to AC GD05 Section E2.1, for typical details, design, and installation requirements. The indicative layout of clean water diversion bunds is shown on the ESCP drawing C23-01. Alternative layouts can be considered where shorter individual clean water diversion bunds are used for individual lots, and should be adjusted based on the detailed design, contractor's construction methodology and site conditions, to adhere to the design criteria.

The largest catchment for the diversion is less than 5 ha (refer to Appendix A for calculations and sketches). Therefore, a standard clean water diversion arrangement is proposed as shown in the figure below.

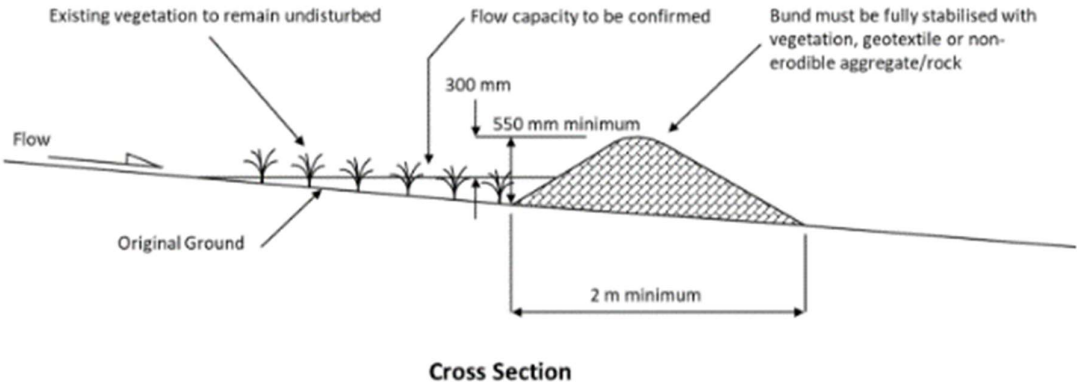


Figure 3: Cross-section of clean water diversion bund (AC GDO5 Figure 17)

The capacity of the diversion bund for various grades have been checked and is included in the calculations in Appendix A.

An alternative arrangement for a diversion channel is shown in Figure 4, below, and should be used where roadside swales have not yet been completed.

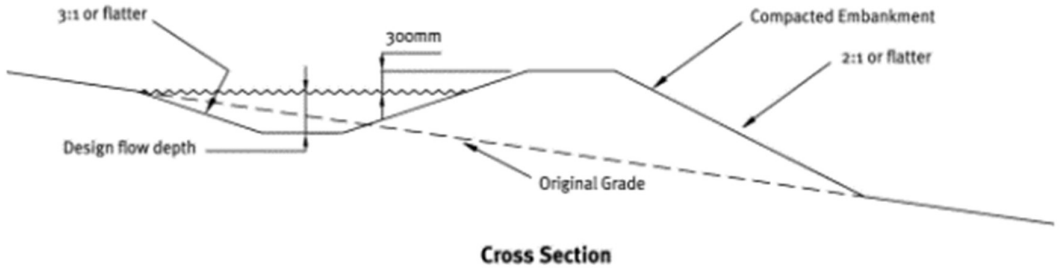


Figure 4: Alternative arrangement for diversion channels (AC GDO5 Figure 19)

It is important that the channels follow contour lines to keep the grades of the channels shallow. The contractor will need to incorporate stabilisation where velocities are greater than 1.0 m/s, as this will cause erosion in the channel bed.

The contractor will also need to provide an adequate and stabilised outlet for each diversion. In most cases the diversions will discharge to road swales or to stable watercourses. In all cases, the outlet must convey runoff to a point where outflow will not cause damage (erosion, flooding).

4.2.4 Stabilised Construction Entrance

A stabilised construction entrance is to consist of washed aggregate, average 50-150 mm diameter, placed 150 mm thick (minimum), 4.0 m wide (minimum) and 10 m long (minimum). The aggregate is to be placed on a woven geotextile mat, laid over the area where the stabilised entrance will be positioned. Ensure it is correctly pinned and overlapped. Ensure the stabilised entrance drains back into the construction site – a speed hump can be used for this purpose.

A stabilised construction entrance will reduce the amount of sediment leaving site. It also clearly identifies the authorised access points for construction vehicles. Combined with a formal wheel wash facility or shaker ramp, this will prevent sediment being tracked onto the adjacent roadways. Where a wheel wash is required, the surface of the stabilised entrance should be graded to the adjacent stabilised channel drain.

The Contractor shall check the vehicle entrance each day, to ensure no sediment is being tracked onto roads. Any sediment shall be cleaned up immediately. The washed aggregate is to be replaced when the amount of sediment build up is making the entrance ineffective.

Refer to AC GD05 Section E2.6, Figure 36 for typical details.

4.2.5 Geotextiles, Erosion Control Blankets, Revegetation and Mulching

Exposed areas should be stabilised as soon as practicable on completion of works, ensuring that any materials used for ground stabilisation are fully biodegradable to avoid plastic fragments remaining in the environment.

If any area of soil is to be left exposed for any long period of time; mulching, revegetation or geotextiles should be used, in consideration of the general site conditions. This will prevent dust during dry weather or erosion of the soil during periods of wet weather. When carrying out earthworks over a large area, use of geotextile to progressively stabilise the surface is recommended. Geotextiles or mulching will provide a quick-to-apply protective surface over exposed earth, allowing the Contractor to minimise the exposed area of earth. Once earthworks are complete, a more permanent stabilising surface can be constructed (e.g. compacted hardfill, coconut matting & grass seed).

Stockpiles shall be minimised by planning earthworks and cut to fill operations. If unavoidable they should be covered with plastic covers to prevent stormwater runoff from eroding the material and creating sedimentation.

Refer to AC GD05 Section E3.0 for soil and surface stabilisation practices.

4.3 Inspection Frequency

Table 4 sets out the minimum inspection requirements for the various sediment control devices on-site. The Contractor shall confirm any inspection schedules with Council prior to commencing construction.

Table 4: Minimum inspection requirements for devices on-site

Sediment and Erosion Control Device	Frequency of Inspection
Silt fences	Daily (minimum) + after every rainfall event
Stabilised construction entrance	Daily + after every rainfall event
Earth bunding	Weekly + after every rainfall event
Clean water diversion channels	Weekly + after every rainfall event
Stabilised areas (geotextiles etc.)	Daily + before/after every rainfall event

4.4 Contingency Measures

Weather forecasts will be regularly monitored by the Contractor for the duration of the works. Standard practise is to install a rain gauge on-site. Where practical, emergency measures will be installed at critical locations prior to the occurrence of heavy rainfall and storm events. For example; critical batters on site should be covered with pinned geotextile material and additional riprap placed at discharge points and in

diversion channels. This is to reduce the risk of sediment discharge from the site in the event of an extreme storm event. This is particularly crucial on this site, with the ecological sensitivity of the creeks.

4.5 Emergency Response

The Contractor shall prepare a site-specific Emergency Response Plan as part of their Construction Management Plan. However, any Emergency Response should aim to comply with the following procedures in the event of any failure of erosion and sediment device on-site:

1. The Contractor should visit the site to survey the extent of damage.
2. Contact Otago Regional Council and the Principal to report the failure of the device and what emergency measures are to be taken.
3. As soon as conditions allow safe work to progress, put temporary works in place to minimise further damage to the device or structure and the surrounding environment. Temporary control measures may include:
    a. Forming bunds and diversion drains to control runoff;
    b. Protect exposed surfaces by using geotextile or hay mulching;
    c. Temporary backfill of any voids created by erosion during device failure;
4. Cleaning out downstream channels.
5. As soon as conditions allow, carry out remedial work downstream of the failed device to repair any damage to infrastructure and property. Clean up deposited silt and debris. Reinstate surfaces and structures to their original condition.
6. Review to identify the cause of the device failure. Potential factors may include rainfall event intensity/duration, catchment size, catchment characteristics, the suitability of the device, construction issues (installation practices etc), lack of maintenance and monitoring.
7. Confirm any amendments to the design of the failed device prior to commencing project site works.
8. Re-construct the device or structure in accordance with approved plans and maintain for the remainder of the project work.

5 CONTRACTOR INPUT

5.1 Contractor's Construction Management Plan

Once a Contractor is appointed, and prior to start of the construction works, a Construction Management Plan (CMP) will be prepared which sets out the details of the proposed construction methodology and measures to be taken to minimise the potential erosion caused by construction.

5.2 Final Erosion & Sediment Control Plan

The Contractor will assume responsibility for overseeing erosion and sediment control maintenance and monitoring for the duration of the works.

A final version of the ESCP shall be produced by the Contractor and will form part of the CMP and be submitted to Otago Regional Council for approval. The Contractor's emergency shut-down procedure in the event of forecast heavy rainfall or spill shall be part of this documentation. Any conditions provided as part of the Resource Consent will be incorporated into the final ESCP.

6 REFERENCES

Auckland Council. (2016). *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region.* Guidelin Document 2016/005.

Geosolve Ltd. (2020). *Geotechnical Report for Resource Consent, Mcdougall's Block.*

Queenstown Lakes District Council. (2019). *QLDC Guidelines for Environmental Management Plans.* Queenstown: QLDC.

Appendix A

Diversion Bund and Swale Flow Calcs

Project Name:	Roberts Development, Curtis Road, Cardrona
Project Number:	138332
Author:	GWF
Checked by:	
Date:	25/08/2021
Page:	1 of 5

Rainfall Intensity for Development

HIRDS V4 Intensity-Duration-Frequency Results

Sitename: curtis road

Coordinate system: WGS84

Longitude: 169.0056

Latitude: -44.8744

Temperature change results for site:

Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100													
ARI	**AEP**	**10m**	**20m**	**30m**	**1h**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**	**96h**	**120h**
1.58	**0.633**	20.9	15.6	13.3	10.2	7.67	4.7	3.31	2.26	1.45	1.09	0.875	0.735
2	**0.5**	23.7	17.6	15	11.4	8.6	5.23	3.68	2.48	1.59	1.19	0.959	0.802
5	**0.2**	33.9	24.9	21	15.8	11.8	7.07	4.92	3.27	2.07	1.55	1.24	1.03
10	**0.1**	42.4	31	26	19.4	14.4	8.5	5.87	3.87	2.44	1.81	1.44	1.2
20	**0.05**	52.1	37.7	31.5	23.4	17.2	10.1	6.88	4.5	2.82	2.08	1.65	1.37
30	**0.033**	58.3	42.1	35.1	25.9	19	11	7.5	4.88	3.05	2.24	1.78	1.47
40	**0.025**	63	45.3	37.7	27.8	20.3	11.7	7.97	5.17	3.21	2.36	1.87	1.55
50	**0.02**	66.9	48	39.9	29.3	21.3	12.3	8.33	5.39	3.34	2.46	1.94	1.6
60	**0.017**	70.2	50.2	41.7	30.6	22.2	12.8	8.64	5.59	3.45	2.54	2	1.65
80	**0.012**	75.6	54	44.7	32.7	23.7	13.6	9.13	5.88	3.63	2.66	2.1	1.73
100	**0.01**	79.9	56.9	47.1	34.4	24.8	14.2	9.53	6.13	3.77	2.75	2.17	1.79
250	**0.004**	99.5	70.2	57.8	41.7	29.9	16.8	11.2	7.12	4.33	3.15	2.48	2.03

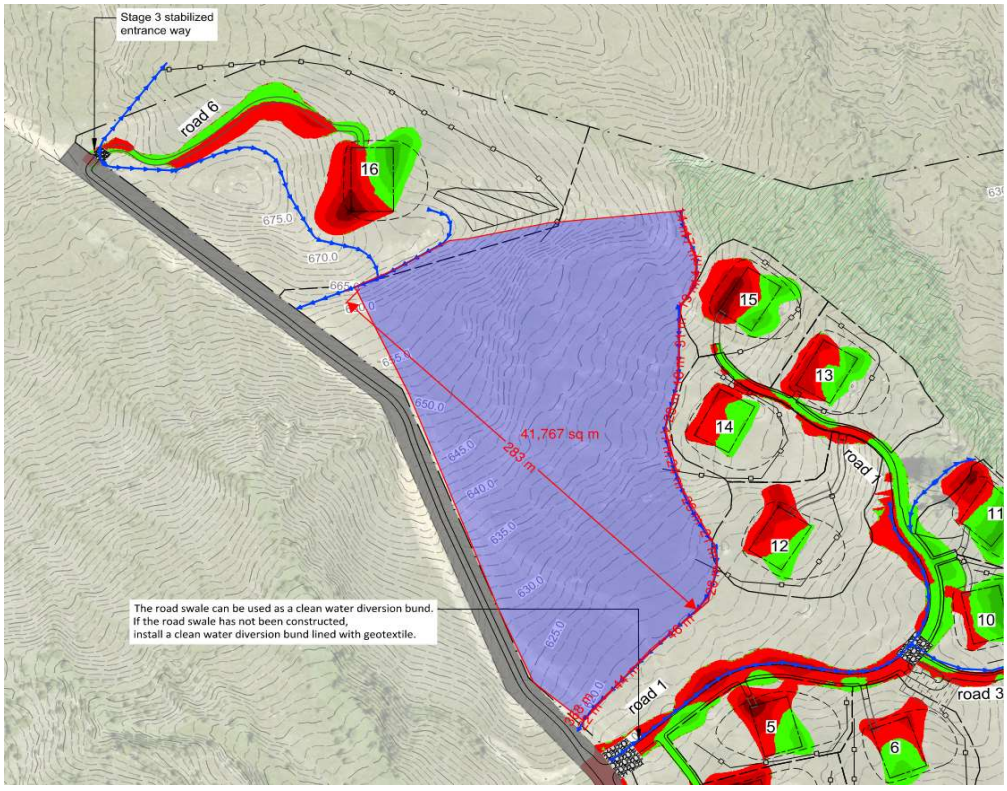
Notes:

1. Based on QLDC LDSC 2020 Section C4.3.5.1

Project Name:	Roberts Development, Curtis Road, Cardrona
Project Number:	138332
Author:	GWF
Checked by:	
Date:	25/08/2021
Page:	2 of 5

Time of Concentration (T_c) for largest diversion bund catchment			
L_o	283	m	Length of overland flow path
H	45	m	Elevation difference
S	16%		Average overland slope
n	0.045		Mannings n-value
t_c	42	mins	for overland flow
L_c	367	m	Length of Diversion Bund
t_c	5	mins	for channel flow at 1.2m/s flow velocity
Total t_c	47	mins	
Note: Calculations based on NZBC E1 - 2.3.2 (b)			

Calculations based on AEP of 5% as per AC GDO5 Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100							
Storm		**Total Area**	**Tc**	**C**	**I**	**Q**	**Comments**
ARI	AEP	m^2	mins	(avg)	mm/hr	m^3/s	
20	0.5	42000	20	0.350	37.7	0.154	
20	0.5	42000	30	0.350	31.5	0.129	
20	0.5	42000	47	0.350	26.9	0.110	Interpolated
20	0.5	42000	60	0.350	23.4	0.096	

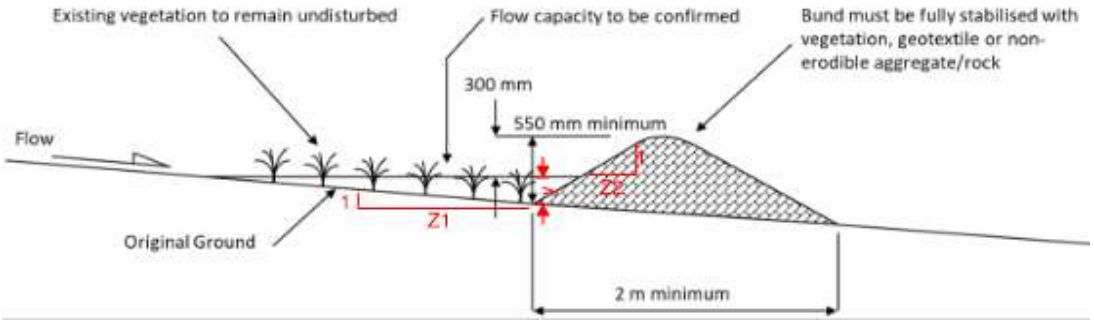


Project Name:	Roberts Development, Curtis Road, Cardrona
Project Number:	138332
Author:	GWF
Checked by:	
Date:	25/08/2021
Page:	3 of 5

MANNINGS EQUATION SOLUTION FOR UNIFORM FLOW IN A TRAPEZOIDAL CHANNEL - DIVERSION BUNDS

CALCULATE FLOW DEPTH (Y) FOR A GIVEN FLOW AND CHANNEL CONFIGURATION

Q_d = Design storm flow
Z = Side Slope
W = Channel floor width
A = Area of flow
P = Wetted Perimeter
R = Hydraulic Radius = A/P
S = Channel Slope
n = Mannings n-value
V_{mann} = Calculated velocity
Q_{mann} = Calculated flow
Accuracy test (%) = 2.50%



How to use this table:

1 Enter the channel characteristics - n, S, W, Z1, Z2, and flow (Q)
2 Guess (estimate) y and then adjust y to satisfy the "Check"column.
Adjust the "Accuracy test" if required to suit the situation and allow a healthy freeboard.
Suggestion: Test for the variation in "y" for a range of Mannings n values.

Calc. No	Mannings n	Q_{20} (m^3/s)	S	W (m)	Z1	Z2	A (m2)	P (m)	R (m)	Estimate y (m)	V_{Mann} (m/s)	Q_{Mann} (m^3/s)	Check
1	0.025	0.110	0.25%	0	6.3	3.0	0.24	2.14	0.11	0.225	0.46	0.108	OK
2	0.025	0.110	0.5%	0	6.3	3.0	0.19	1.91	0.10	0.200	0.60	0.111	OK
3	0.025	0.110	1%	0	6.3	3.0	0.14	1.67	0.09	0.175	0.77	0.110	OK
4	0.025	0.110	2%	0	6.3	3.0	0.11	1.46	0.07	0.153	1.00	0.109	OK
5	0.025	0.110	4%	0	6.3	3.0	0.08	1.29	0.07	0.135	1.30	0.110	OK

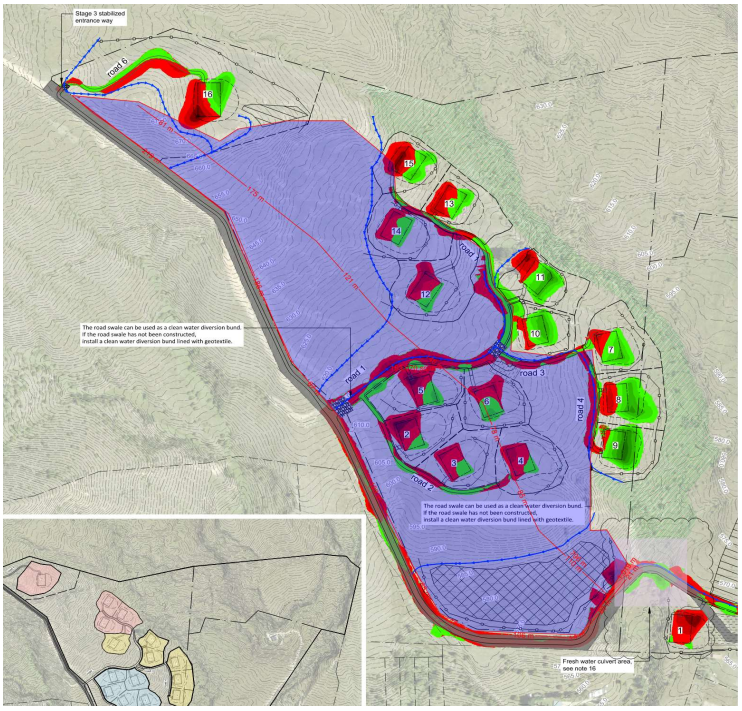
Notes:

1. Typical section based on AC GDO5 Figure 17, cross section for clean water diversion bunds
2. Assume maximum allowable water depth to be 0.25m
3. Calculated water depth below maximum depth for range of channel grades
4. Based on velocity, channels should be lined for slopes from 2% and steeper

Project Name:	Roberts Development, Curtis Road, Cardrona
Project Number:	138332
Author:	GWF
Checked by:	
Date:	25/08/2021
Page:	4 of 5

Time of Concentration (T_c) for largest possible swale catchment			
L_o	796	m	Length of overland flow path
H	105	m	Elevation difference
S	13%		Average overland slope
n	0.045		Mannings n-value
t_c	61	mins	for overland flow
L_c	1020	m	Length of Diversion Bund
t_c	14	mins	for channel flow at 1.2m/s flow velocity
Total t_c	75	mins	
Note: Calculations based on NZBC E1 - 2.3.2 (b)			

Calculations based on AEP of 5% as per AC GDO5 Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100							
Storm		**Total Area**	**Tc**	**C**	**I**	**Q**	**Comments**
ARI	AEP	m^2	mins	(avg)	mm/hr	m^3/s	
20	0.5	153000	20	0.350	37.7	0.561	
20	0.5	153000	30	0.350	31.5	0.469	
20	0.5	153000	60	0.350	23.4	0.348	
20	0.5	153000	75	0.350	21.8	0.325	Interpolated
20	0.5	153000	120	0.350	17.2	0.256	

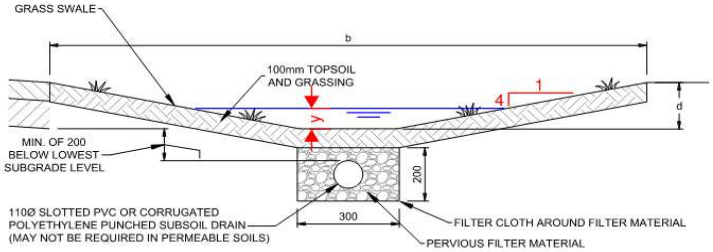


Project Name:	Roberts Development, Curtis Road, Cardrona
Project Number:	138332
Author:	GWF
Checked by:	
Date:	25/08/2021
Page:	5 of 5

MANNINGS EQUATION SOLUTION FOR UNIFORM FLOW IN A TRAPEZOIDAL CHANNEL - SWALES

CALCULATE FLOW DEPTH (Y) FOR A GIVEN FLOW AND CHANNEL CONFIGURATION

Q_d = Design storm flow
Z = Side Slope
W = Channel floor width
A = Area of flow
P = Wetted Perimeter
R = Hydraulic Radius = A/P
S = Channel Slope
n = Mannings n-value
V_{mann} = Calculated velocity
Q_{mann} = Calculated flow
Accuracy test (%) = 2.50%



SWALE CROSS SECTION

How to use this table:

1 Enter the channel characteristics - n, S, W, Z1, Z2, and flow (Q)
2 Guess (estimate) y and then adjust y to satisfy the "Check"column.
Adjust the "Accuracy test" if required to suit the situation and allow a healthy freeboard.
Suggestion: Test for the variation in "y" for a range of Mannings n values.

Calc. No	Mannings n	Q_{20} (m^3/s)	S	W (m)	Z1	Z2	A (m2)	P (m)	R (m)	Estimate y (m)	V_{Mann} (m/s)	Q_{Mann} (m^3/s)	Check
1	0.03	0.325	0.25%	0.3	4.0	4.0	0.60	3.19	0.19	0.350	0.54	0.324	OK
2	0.03	0.325	0.5%	0.3	4.0	4.0	0.46	2.82	0.16	0.305	0.71	0.328	OK
3	0.03	0.325	1%	0.3	4.0	4.0	0.36	2.49	0.15	0.265	0.92	0.332	OK
4	0.03	0.325	2%	0.3	4.0	4.0	0.27	2.16	0.13	0.225	1.18	0.319	OK
5	0.03	0.325	4%	0.3	4.0	4.0	0.21	1.91	0.11	0.195	1.53	0.323	OK

Notes:

1. Typical swale section based on QLDC LDSC standard drawing B5-5
2. Propose swale depth (d) of 0.5m to allow for sufficient freeboard
3. Detailed design of roads will determine swale grade and final swale design
4. Check dams will be required for grades steeper than 5%, and will be determined during detailed design

Curtis Road Cardrona
Ecological Assessment

Roberts Family Trust

February 2020

Arrow Lane Arrowtown 9302
www.e3Scientific.co.nz

Curtis Road Cardrona
Ecological Assessment

Document Status

Version	Purpose of Document	Prepared By	Reviewer	Review Date
0.1	Draft for internal review	MJ	GD	30/10/2019
1.0	FINAL for client review	MJ	GD	31/10/2019
1.1	FINAL REPORT	MJ	GD	9/05/2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 Introduction

1.1 Overview

Roberts Family Trust (RFT) is seeking resource consent to undertake a subdivision to form 16 residential lots off Curtis Road in Cardrona (see Figure 1). The development will require clearance of vegetation and earthworks for building platforms, associated curtilage and for access ways. To assess the potential impacts of the proposed vegetation clearance on the local ecological values, RFT commissioned e3Scientific Limited (e3s) to undertake an ecological assessment of the proposed areas to be developed. This ecological assessment describes the ecological values within the proposed house lots and reviews the ecological implications of the proposal.

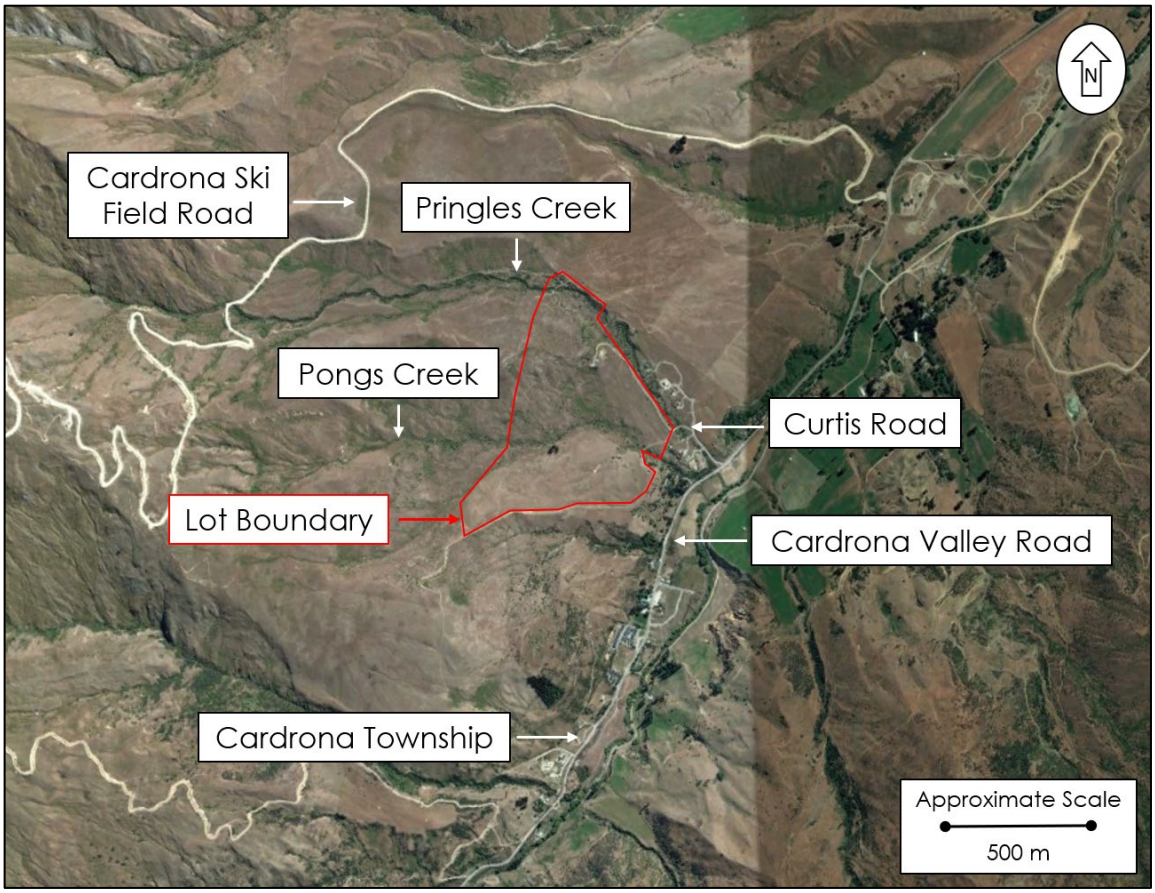


Figure 1: Site location plan.

Base map – Google Earth

1.2 Ecological Report Structure

The report is structured as follows:

- Section 2: Description of the environmental context and the proposed vegetation clearance and associated earthworks.
- Section 3: The methodology employed during the ecological assessment.
- Section 4: Description of the flora and faunal values present within the subject areas.
- Section 5: Assessment of the significance of the ecological values within the development footprint
- Section 6: Ecological Impact Assessment.
- Section 7: Conclusions and recommendations.

1.3 Limitations

e3s performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. The confidence in the findings is limited by the Scope of Work, and limited data due to the site visit being at one time of year. A full range of biota that are present at this site may not have been seen or recorded, however, desktop research was utilised to aid the assessment.

The results of this assessment are based upon site inspections conducted by e3s personnel, and information provided in scientific literature. All conclusions and recommendations regarding the properties are the professional opinions of e3s personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, e3s assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside e3s, or developments resulting from situations outside the scope of this project.

2 Description of the Activity and Existing Environment

2.1 Environmental Context

The proposed subdivision works are situated on an undulating terrace to the west of the Cardrona township. The house lots are predominately located to the south of Pongs Creek with the exception of the Lot 1 which is located on the eastern boundary to the north of Pongs Creek. All of the proposed lots are situated in the Shotover Ecological District within the Lakes Ecological Region (DOC, 2019). Under the operative Queenstown Lakes District Council District Plan the area is zoned Rural General (QLDC, 2017).

The area for the ecological review is presented in Figure 2 and henceforth referred to as 'the house lots', 'Pongs Creek', 'Pringles Creek' and collectively as the 'study area'. This Ecological Assessment only covers these identified areas, and not the whole area as shown by the property and lot boundary in Figure 1 and Figure 2. The study area occupies approximately 10 of the 54 hectares.

2.1.1 Physical Environment

The study areas are located on an undulating terrace, with gently sloping mounds between shallow overland flow paths that drain towards Pongs Creek (see Plate 1). The site is located at an elevation of approximately 570 m to 670 m above sea level. Based on the 1:250,000 Geological Map of New Zealand, the geology of the area is predominantly segregated psammitic schist with subordinate pelitic schist, rare greenschist and metachert. The site also contains undifferentiated Pleistocene - Holocene fan deposits of variably weathered, unsorted, locally derived, angular to rounded, sandy gravel in relatively older alluvial fans. Along Pringles Creek, Holocene river deposits of loose, commonly angular, boulders, gravel, sand, and silt forming alluvial fans are present. The NW Cardrona fault line is located within the study area (GNS Science, 2019).

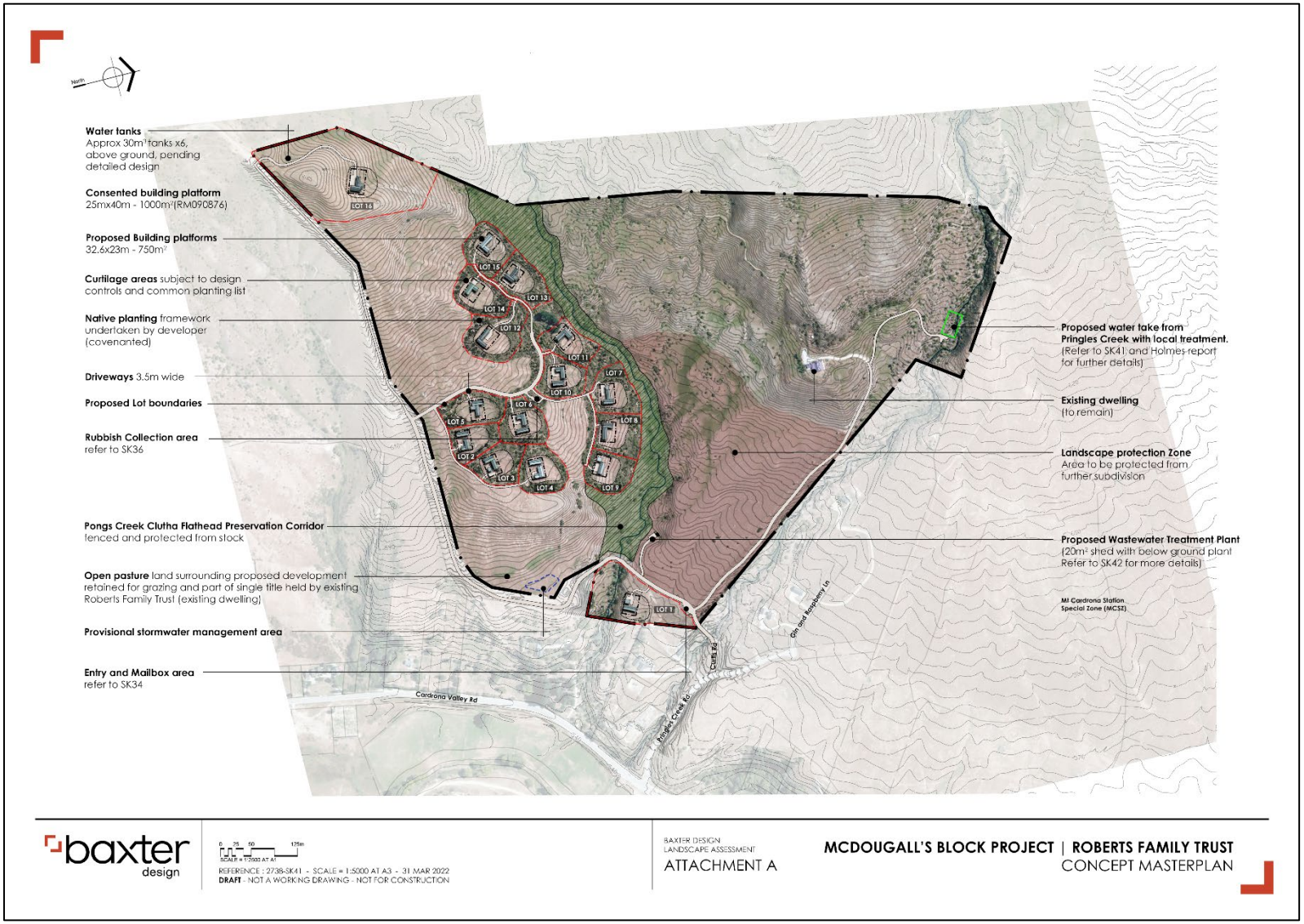


Figure 2: Study area showing the proposed house lots.

Plate 1: Photos showing the topography and gently sloping nature of the site.

2.1.2 Biological Environment

Flora

The vegetation and habitats present within the study area consist predominantly of exotic pasture grasslands and scattered grey shrubland species, which are similar to those surrounding the study area and found throughout the Cardrona Valley. The pre-European vegetation cover on the lower slopes would have consisted of fescue tussock grassland, with speargrass and groves of matagouri and *Carex* swamps. In the gully's woodland of kanuka, matagouri, small-leaved coprosmas and olearias, native broom and kowhai, with abundant lianes including *Rubus* and *Muehlenbeckia* would have been present, and at the higher elevations mountain beech and silver beech forest with species such as mountain totara and mountain toatoa likely present (Leathwick, *et al.,* 2003). The present-day vegetation has been highly modified and no longer represents the pre-European vegetation cover.

Fauna

The Conservation Resources Report for Branch Creek (DOC, 2006), which is located approximately 3 km to the north of the study area, found a range of

invertebrates including ground beetles, cicada, moths, butterflies, grasshoppers and crickets which are commonly found within the Otago grasslands. This study also found a number of species which have a restricted distribution, however, these appear to be at higher elevations in the more alpine areas, than what is present within the study area.

The Branch Creek Conservation Resources Report found no lizards in the highly modified areas of lowland pasture or within 3 km of the Cardrona Valley Road (DOC, 2006).

Native avifauna species that were observed within the Branch Creek Station included grey warbler, harrier hawk, NZ falcon, pipit, Southern black-backed gull, silvereye, spur-winged plover and tomtit (DOC, 2006). These species are known to utilise habitat that is present within the study area.

2.2 Description of Activity

The proposed activity involves subdividing the property to create 16 residential lots with associated building platforms. The proposal will include 19,500 m^3 of cut and 21,000 m^3 of fill earthworks to create and upgrade accessways and recontour the land for building platforms. It is also proposed to upgrade and widen the access way over Pongs Creek and Pringle Creek to form a chip sealed road.

On site wastewater is proposed as no public system is available. A tertiary wastewater treatment plant with a communal disposal field is proposed to treat and dispose of wastewater generated by the 16 lots. No discharge from either of these dispersal fields will enter Pongs Creek above the perched culvert. Cut off drains will be used to ensure that any discharge from the communal waste field enters Pongs Creek below the culvert. A 50 m buffer between the dispersal fields and both Pongs Creek and Pringles Creek will be maintained.

On site stormwater is also proposed as no public system or connection is available. A combination of soakage pits, swales and dispersal fields will be used. These systems will be designed to mimic the natural hydrology of the site and overland flow paths will be maintained. In addition, a stormwater management area has also been included on the eastern site boundary. This area will primarily capture

runoff from the adjacent road and will provide storage volume to match pre and post development flows without solely relying on tanks and soakage.

Mass native plantings are proposed within each of the house lots. These plantings total approximately 4.6 hectares. Indigenous vegetation communities proposed to be cleared in the study area include grey shrubland and *Raoulia* cushion field. These communities are described in section 4.1

3 Methodology

The ecological assessment of effects for the proposed subdivision at Curtis Road in Cardrona is based on a desktop study, and a site visit completed on 31 May 2019.

3.1 Desktop Research and Site Visit

The desktop and site visit included:

- Review of existing ecological information to determine ecological habitats and species likely present on the site; and,
- A site visit to survey the vegetation communities and faunal habitats. The site survey involved walking through the study area that is proposed to be disturbed to record the species observed. Representative photographs of the proposed area were taken and are provided within this report.

3.2 Assessment of Information

An assessment of the species and ecological habitats present was conducted by undertaking the following steps:

- Establishing the representativeness of the ecological habitats present and significance through a site visit and a review of the expected pre-disturbance vegetation and Land Environments of New Zealand (LENZ) classification (Leathwick, *et al.,* 2003).
- Establishing the presence and significance of plant species through a site visit and the Department of Conservation's threat classification for New Zealand vascular plants (de Lange, *et al.,* 2018).
- Establishing the likely presence and significance of native avifauna species through a site visit, existing scientific knowledge and the Department of Conservation's threat classification for New Zealand birds (Robertson*, et al.,* 2017).
- Establishing the possible presence and significance of invertebrate and lizard species through a review of existing scientific knowledge.

4 Ecological Values

4.1 Vegetation

The main vegetation habitat present within the house lots and fill areas is highly modified exotic pasture grassland (see Plate 2). The main species present within these grasslands are brown top (*Agrostis capillaris*) and chewing's fescue (*Festuca rubra*), which form a thick cover over most of the study area. Other exotic species present where the grasses thin out include white clover (*Trifolium repens*), woolly mullein (*Verbascum thapsus*), thistles (*Cirsium* sp.), moth mullein (*Verbascum virgatum*), sheeps sorrel (*Rumex acetosella*), Yorkshire fog (*Holcus lanatus*), yarrow (*Achillea millefolium*), St John's wort (*Hypericum perforatum*) and mouse-ear hawkweed (*Pilosella officinarum*). Exotic shrubs that are present throughout the study area include hawthorn, English broom (*Cytisus scoparius*), sweet briar (*Rosa rubiginosa*), with scattered elderflower (*Sambucus nigra*). Native species include the At Risk – Declining matagouri (Discaria toumatou), which is located throughout the study areas, along with the occasional porcupine shrub (*Melicytus alpinus*) and hard tussock *(Festuca novae-zelandiae*).

In the damper areas, where there is overland flow occurring (see Plate 2), species such as *Juncus effusus* var. *compactus*, *Juncus tenuis*, *Carex leporina* and the native *Juncus edgariae* are present, as well as the species listed above.

A small patch of cushion field (see Plate 2) is located on proposed Lot 15. Species present amongst the heavily grazed grasses include *Raoulia subsericea*, *Raoulia tenuicaulis*, the At Risk – Declining *Raoulia australis* and the At Risk – Declining *Raoulia parkii*. This area is present due to rabbits keeping the pasture grass low.

The vegetation along Pongs Creek is similar to that on the house lots. The dominant vegetation is exotic pasture grasses, with numerous hawthorn, briar, broom and matagouri bushes (see Plate 2). Other species noted along the creek include *Carex coriacea*, prickly shield fern (*Polystichum vestitum*), golden spaniard (*Aciphylla aurea*) and one *Olearia odorata*. Additional species to those mentioned that are found along Pringles Creek include *Veronica salicifolia* and more *Olearia odorata* plants. Native species such as lancewood, kowhai, cabbage trees, mountain beech and *Olearia odorata* have been planted along

Pongs Creek and Pringles Creek. Exotic willow trees are present at the crossing of Pongs Creek.

Mature pine trees are present, along with seedlings of Douglas fir (*Pseudotsuga menziesii*) and contorta pine (*Pinus contorta*). Larch trees *(Larix decidua*) are present within the property boundary, but not within the study areas.

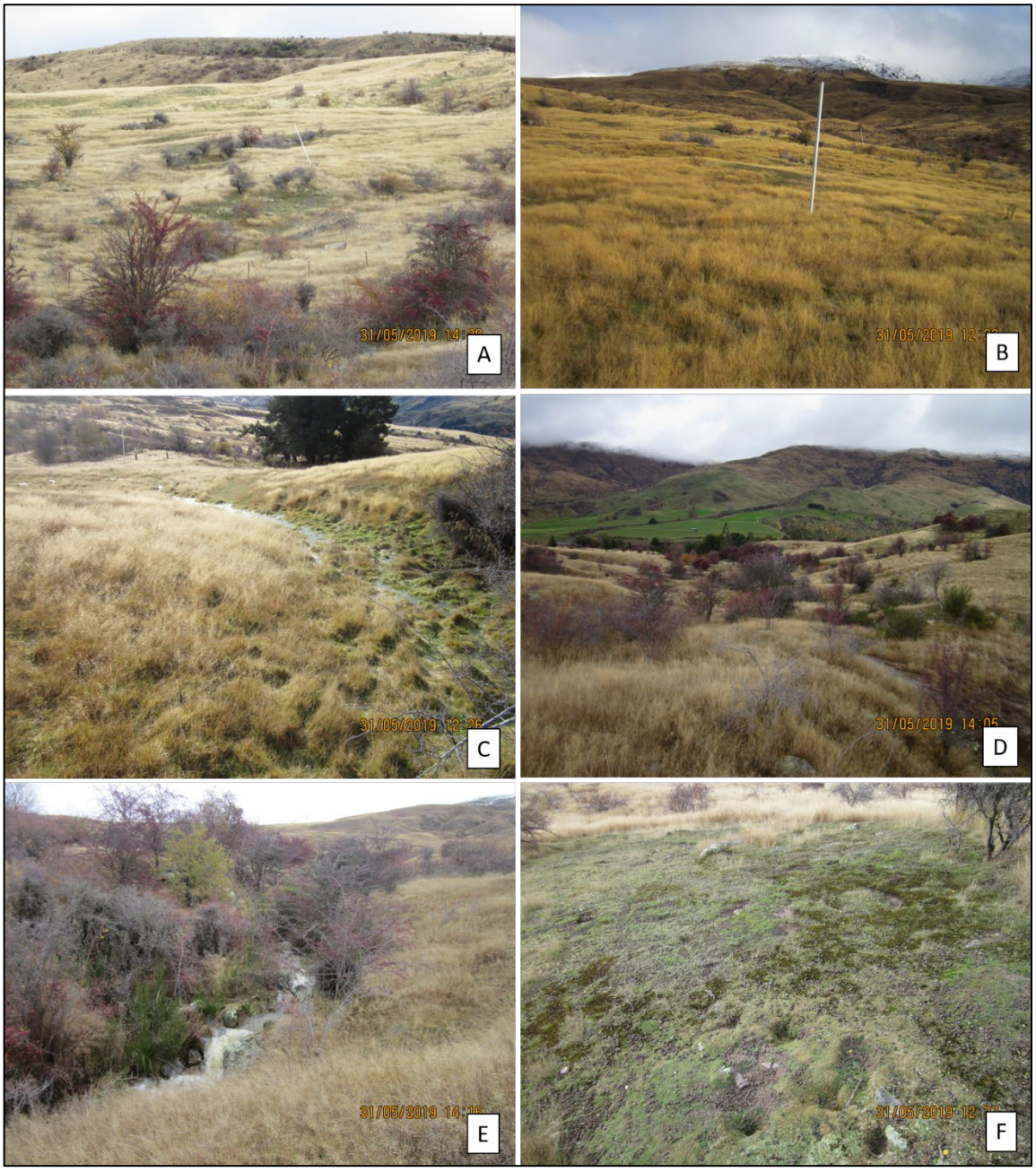


Plate 2: Examples of vegetation within the site. A & B – Exotic grasslands with scattered shrubs. C – Overland flow area. D & E – Pongs Creek. F – Area of cushion field.

4.2 Fauna

4.2.1 Avifauna

Native bird species that were observed during the site visit included harrier hawks (*Circus approximans*), silvereyes (*Zosterops lateralis lateralis*), grey warbler (*Gerygone igata*) and paradise shelduck (*Tadorna variegata*). These species have a conservation status of Not Threatened (Robertson *et al.,* 2017). Introduced and naturalised species that were recorded included Australian magpies (*Gymnorhina tibicen*), chaffinch (*Fringilla coelebs*), blackbirds (*Turdus merula*), greenfinch (*Carduelis chloris*) and yellow hammer (*Emberiza citrinella*).

4.2.2 Fish

Pongs Creek is a known, secure population of the Clutha flathead galaxias (Galaxias "species D") which has a conservation status of Threatened – Nationally Critical (Dunn et al., 2018). Clutha flathead galaxias have a very limited distribution in waterways in Otago.

In April 2016 the Department of Conservation undertook an electric fishing survey of Pongs Creek in order to investigate the population of Clutha flathead galaxias. The survey methods and findings were documented in a Department of Conservation file note (see Appendix A). The investigation included 29 survey locations along the creek with a total of 68 galaxias captured.

The DOC investigation found a perched culvert downstream of the recorded galaxias population is a significant barrier to the movement of koaro and brown trout and this barrier has securely protected nearly 1 km of flathead galaxias habitat.

The New Zealand Freshwater Fish Database shows that the only species recorded in Pringles Creek is Brown Trout (*Salmo trutta*). The culvert present in Pringles Creek allows for fish passage.

4.2.3 Lizards

Based on previous lizard surveys within the surrounding Cardrona area (DOC, 2006) on habitat and in vegetation that is similar to that present within the study area, there is a low likelihood of lizards being present. The Branch Creek Conservation Resources Report found no lizard species in the highly modified

areas of lowland pasture or within 3 km of the Cardrona Valley Road. Lizards were found along ridgelines, tussock grassland or in rocky valley gorges (DOC, 2006). In order to confirm that lizards will not be disturbed during the construction phase of the development, a condition of consent is proposed for a lizard survey to be undertaken prior to the commencement of works.

4.3 Summary of Ecological Values

The existing ecological values within the proposed Curtis Road subdivision are predominantly associated with the matagouri, cushion fields and Pongs Creek. A summary of the ecological values on site are provided in Table 1 below.

Table 1: Summary of Ecological Values.

Ecological Value	Description
Matagouri and cushion fields	The study area contains scattered At Risk – Declining matagouri and one small area of the At Risk – Declining *Raoulia australis* and At Risk – Declining *Raoulia parkii*.
Presence of threatened fauna	Pongs Creek contains a population of the Threatened – Nationally Critical Clutha flathead galaxias.
Habitat for native bird species	The habitat present on site provides hunting, nesting and forging habitat for native bird species.

5 Ecological Significance and Value

The assessment of the significance of the ecological values associated with the study area are based on the following:

- The Operative QLDC District Plan Criteria for assessing ecological significance (QLDC, 2009);
- The Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems, 2nd edition (EIANZ, 2018); and,
- New Zealand's Department of Conservation threatened flora and fauna lists.

5.1 Queenstown Lakes District Plan Ecological Significance Criteria

5.1.1 Habitat Ecological Values

An assessment of the vegetation and habitat has been completed using both the EIANZ guidelines and the QLDC District Plan.

Table 2: Assessment of the indigenous vegetation and habitat using the ecological criteria in the EIANZ Guidelines and the QLDC District Plan.

Matter	Reasoning	Score (EIANZ, 2018)	QLDC Criteria Satisfied
Representativeness	The exotic pasture grasslands and riparian margin are no longer representative of the vegetation that would have been present in the Wanaka and Shotover Ecological Districts. The site has been highly modified and the indigenous vegetation that is present is patchy. The grey shrubland species are remnants of a low altitude shrubland community that has regenerated after historic disturbance.	Moderate - Low	No
Rarity/ distinctiveness	The study area contains the At Risk – Declining matagouri, *Raoulia australis* and *Raoulia parkii*. Pongs Creek supports a population of the Threatened – Nationally Critical Clutha flathead galaxias, which has a very limited distribution within Otago. This stretch of habitat is protected from predatory fish species by a perched culvert. Habitat which contains acutely and chronically threatened species is a National Priority 4 habitat.	High	Yes
Diversity and pattern	The native vegetation present within the study area has a low diversity, which is a result of the	Low	No

	habitat modification that has already occurred.		
Ecological context/Special ecological character	The highly modified open pasture habitat does not provide preferable habitat for native bird species. However, the perched culvert in Pongs Creek has provided a secure habitat for the Clutha flathead galaxias. This culvert has created a barrier to other fish species, creating a stretch of habitat where this fish is able to survive.	High	Yes
Size and Shape	The length of Pongs Creek on the site that is protected by the culvert is approximately 800 m, with more creek and tributaries further upstream of the property boundary. The highly modified nature of the catchment has resulted in this being a sensitive habitat that will have little buffer to change. However, this catchment without further modification, has the potential to continue to support this species. The native vegetation that is proposed to be cleared is scattered throughout the site.	N/A	Yes
Connectivity	The shrubland within the study area although scattered, provides a connection to the wider shrubland remnants that are found throughout the Cardrona Valley. Pongs Creek has high ecological value due to the lack of connectivity with the Cardrona	N/A	Yes

	River as a result of the perched culvert.		
Long Term Sustainability	The vegetation within the study area is predominantly thick, exotic grassland, which will restrict the ability of native species to establish within the site. The riparian margin of Pongs Creek is highly modified. Changes in factors such as water flow paths and sediment levels are likely to affect the Clutha flathead galaxias. However, without modification in the study areas, this species is likely to continue to exist in stasis in this stretch of the creek.	N/A	Yes

5.1.2 Fish Ecological Values

The Clutha flathead galaxias is present within Pongs Creek (DOC, 2016). This species has a conservation status of Threatened – Nationally Critical. This species has a restricted distribution in the Otago area, therefore the stretch of creek that this species inhabits has Very High ecological value.

5.1.3 Bird Ecological Values

The scattered native and exotic shrubs present amongst the pasture grassland habitat, generally provides poor quality habitat for native bird species. The bird species observed during the site visit have a conservation status of Not Threatened or Introduced and Naturalised (Robertson, *et al.,* 2017). Other species which are known to utilise habitat that is present within the study area and not observed during the site visit include NZ falcon, pipit, Southern black-backed gull, silvereye, spur-winged plover and tomtit (DOC, 2006). The pipit has a conservation status of At Risk – Declining and the falcon is At Risk – Recovering (Robertson, *et al.,* 2017). The assigned ecological value under the EIANZ (2018) guidelines for species that are At Risk – Declining is High and At Risk – Recovering is Moderate. All other bird species have a Low conservation status. The habitats that these species utilise are scattered throughout the wider Cardrona Valley.

5.2 Summary of Ecological Significance and Values

The ecological values within the proposed residential lots and Pongs Creek has been determined using the criteria outlined in the 2018 EIANZ Guidelines and the significance criteria in the QLDC District Plan. The overall ecological value of the terrestrial vegetation and habitat that is proposed to be disturbed is Moderate and the ecological value of Pongs Creek is Very High. The habitats within the study areas satisfies most of the QLDC significance criteria. The ecological value of the At Risk – Declining matagouri, pipit, *Raoulia australis* and *Raoulia parkii* species is High, the At Risk – Declining falcon is Moderate and the ecological value of the Threatened – Nationally Critical Clutha flathead galaxias is Very High. All other Not Threatened plant and fauna species are considered to have Low ecological value.

6 Ecological Impact Assessment

6.1 Ecological Impact Assessment Methodology

The ecological impact assessment follows the 2018 EIANZ Ecological Impact Assessment Guidelines for New Zealand. This assessment is based on the ecological values determined within the study area in Section 5, and the magnitude of effect of the proposed activity, which is then used to determine the ecological impact within the zone of influence, the wider context of individual species populations and the extent of remaining vegetation and habitat within the wider area. Ecological effects represent an effect on ecological or conservation values that may warrant avoidance, mitigation and potentially offsetting measures.

6.2 Direct Effects

The development of the proposed building platforms and associated curtilage areas will result in the removal of individual indigenous plants and very small area of indigenous vegetation that is estimated at less than 1000 square metres. The site contains scattered matagouri and porcupine shrubs and one patch of cushion field. The loss of these habitats and plants will be permanent. The magnitude of the effect of the proposed disturbance to this vegetation is low as the removal of scattered vegetation is minor in scale compared to the presence of these species and communities both onsite and within the wider environment. The vegetation removal proposed will there have a minor effect on the ecological values of the site.

The proposed development will provide considerable positive ecological effects to the terrestrial ecology through the planting of ecological restoration plantings proposed through the development. These plantings will provide shelter and a food resource for invertebrates and birds and will reintroduce plant species that are no longer present on the site or the wider area. The plantings may also encourage the movement of lizards into the area.

The proposed earthworks and recontouring of the topography of the study areas, will result in disruption to overland flow paths. However, the development is designed to maintain natural overland flow paths downgradient of the

development, and stormwater attenuation and retention features are designed to mimic the natural hydrology of the site.

The access to the proposed lots will be via the existing road alignment. Curtis Road crosses both Pringles Creek and Pongs Creek which flow through culverts under the road. This road will be required to be upgraded and widened to a chip sealed road, which may involve stream works. The detailed design of these works has not been finalised however e3s considers the existing culvert should be excluded from upgrade works, if possible, as it currently forms an effective barrier to trout migration into the upper reaches of Pongs Creek. Removing the risk of trout migration will be fundamental in the design of upgrade work.

6.3 Indirect Effects

In addition to the direct effect of the earthworks on the vegetation and habitat it is possible that the earthworks for the proposed building platforms, curtilage areas, fill areas, mounds and roading could result in the mobilisation of sediment into Pongs Creek and Pringles Creek. This effect is most prevalent during and immediately following the construction phase. The habitat that is the most sensitive to this potential effect is Pongs Creek and Pringles Creek as sediments have the potential to affect water quality and deposit onto the bed of the creek. The potential ecological impact of the sedimentation without management is Very High. This potential effect can be managed by requiring a specific sediment and erosion control management plan to mitigate the risk of runoff into overland flow paths and watercourses.

6.3.1 Stormwater and Wastewater Effects

Stormwater and wastewater from the residential dwellings have the potential to impact water quality, through increased pollutants and nutrients. This effect could be delayed, as it will take time for the pollutants to reach the creeks. The introduction of pollutants into the waterways could have a Very High magnitude of effect as there is the potential for a degradation of water quality. The ecological impact of wastewater and stormwater entering the creeks would be Very High. This effect can be managed through vigilant design and placement of the stormwater and wastewater treatment systems.

Tertiary treatment of wastewater is proposed, along with a communal disposal field. Cut off drains will be installed to ensure no discharge from the wastewater communal field will occur to Pongs Creek above the perched culvert. Therefore, the discharge of wastewater will not increase nutrient loads into the core flathead galaxias habitat.

Stormwater will be discharged to soakage pits, swales and above ground dispersal fields into vegetation. Stormwater discharge will not occur directly into Pongs Creek and is to mimic the natural hydrology of the site. Particular care of the stormwater placement on lot 11 is required due to the proximity of Pongs Creek (less than 50 m). Other lots in close proximity where stormwater dispersal field locations will require consideration to ensure no impact on Pongs Creek include lots 7, 8, 9, 13 and 15.

6.3.2 Effects on Hydrology

The subdivision requires the installation of cut of drains up hydraulic gradient from the building platforms in order to depress groundwater levels. The cutoff drains will collect water and discharge into the individual lot stormwater system.

The stormwater systems discharge to ground or soakage fields. All stormwater from the house sites will discharge into the Pongs Creek catchment. Therefore, the groundwater throughflow diversion will not result in a loss of water from the Pongs Creek catchment and there will be no reduction in groundwater recharge into Pongs Creek.

Based on the above commentary, the subdivision will not result in a reduction of stream flow in Pongs Creek.

6.3.3 Weeds

The introduction and spread of exotic weed species, in particular along the creek banks and in the riparian margin of Pongs Creek has the potential to impact the ecology of the area. The ecological impact of this, without management measures is Very High. The further introduction and spread of exotic weed species will result in competition for space and resources, resulting in a fundamental change in the ecology of the creek. This effect can be managed by ensuring that any machinery or equipment that is used during the proposed works is free of soil that could contain seeds or plants that could contaminate the area. Only clean

soil from outside the study area is to be brought onto the site, and no movement of machinery within the riparian margin of Pongs Creek is to occur. Restricting the movement of soil and machinery within the site will help to reduce the spread of exotic weed species, in particular the introduction of new weed species into Pongs and Pringles Creek.

6.4 Impact Management Measures

Very High and High ecological effects represent an effect on ecological or conservation values that warrants avoidance and/or extremely high intensity mitigation and remediation actions. Roberts Family Trust have proposed to take potable water from Pringles Creek rather than Pongs Creek to avoid further fluctuations in the flowrate of Pongs Creek, especially during the drier months. It is also proposed to undertake 4.6 hectares of native plantings in residential Lots 2 to 15 (see Appendix B).

To manage the effects of the proposal, e3s recommends the following consent conditions.

1. No works are to occur within Pongs Creek or within the riparian margin without an assessment of the proposed effects occurring by a suitably qualified ecologist.
2. Upgrading the road over Pongs and Pringles Creek shall be overseen by a suitably qualified freshwater ecologist to ensure no disturbance to the perched culvert.
3. The culvert design and installation in Pongs Creek is to be overseen by a suitably qualified and experienced freshwater ecologist, with expertise in fish passage and construction.
4. The alignment and associated installation methodology of the potable water supply line and wastewater main across Pongs Creek is to be assessed by a freshwater ecologist.
5. A sediment and erosion control management plan is to be prepared prior to works commencing to mitigate the risk of runoff and sedimentation into Pongs Creek, Pringles Creek and any overland flow paths.
6. To confirm the presence or absence of lizards within the site, a survey is to be carried out by a suitably qualified herpetologist prior to works commencing. Any recommendations provided, including an

application for a Wildlife Permit to the Department of Conservation are to be adhered to by the consent holder.

7. Prior to any machinery or equipment entering the study area, it must be cleaned and checked for soil that could potentially contain seeds or exotic plants that could further contaminate the site.
8. To reduce the spread of exotic weed species, in particular the introduction of new weed species into Pongs Creek only clean, screened soil, is to be brought onto site.
9. No stormwater discharge is to occur directly into Pongs Creek and all stormwater discharge is to mimic the natural hydrology of the site.
10. Detailed stormwater designed and placement on proposed Lot 7, 8, 9, 11, 13 and 15 is required due to the proximately of the Lots to Pongs Creek to ensure no impact on Pongs Creek occurs.
11. No wastewater is to be discharged to Pongs Creek above the perched culvert.
12. Ecological restoration plantings are to be installed in residential Lots 2 to 15 as set out in the development masterplan.

6.5 Summary

The proposed subdivision and creation of 16 residential lots has the potential to impact the surrounding environment. The proposed activities have the potential to impact Pongs Creek, which has a population of Clutha flathead galaxias. The proposed development will only remove a relatively small amount of native vegetation including At Risk – Declining matagouri and one patch of cushion plants, however substantial native replanting, which will improve habitat for the native fauna is proposed on the site.

7 Conclusions and Recommendations

Based on the ecological assessment the following conclusions are made:

1. Roberts Family Trust are seeking resource consent to undertake a subdivision to form 16 residential lots off Curtis Road in Cardrona.
2. The proposal will include 19,500 m3 of cut and 21,000 m3 of fill earthworks. It is also proposed to upgrade and widen the access way over Pongs Creek and Pringle Creek to form a chip sealed road.
3. The main vegetation habitat present within the house lots is highly modified exotic pasture grassland. The At Risk – Declining matagouri is scattered as individual plants through the site. A small patch of cushionfield which includes the At Risk – Declining *Raoulia australis* and *Raoulia parkii* is located on proposed Lot 15.
4. The development will require minor clearance of indigenous vegetation for building platforms, associated curtilage and for access ways. The indigenous vegetation clearance is estimated to be less than 1000 square metres and is permitted under the Operative District Plan.
5. A secure population of the Threatened – Nationally Critical Clutha flathead galaxias is present within Pongs Creek.
6. The overall ecological value of the vegetation that is proposed to be disturbed is Moderate and the overall ecological value of Pongs Creek is Very High.
7. Stormwater and wastewater disposal has been identified as a key risk to the Clutha flathead galaxias population in Pongs Creek. Design of these systems will ensure impact to the creek is avoided.
8. The development proposes extensive ecological restoration planting that can provide a positive ecological benefit through providing a food source and cover for native fauna and reintroducing indigenous species that are no long present on the site or within the wider environment.

In summary, the ecological investigation has identified a range of ecological values within the development site. e3s considers the development would result in a positive benefit to the terrestrial ecology of the site given the scale of the ecological restoration proposed. e3s also concludes that careful site design such as placement of the wastewater disposal field and construction management

can ensure the development can proceed without impacting the habitat of the Clutha flathead galaxias.

8 References

de Lange, P.J., Rolfe, J.R., Barkla, J.W., Courtney, S.P., Champion, P.D., Perrie, L.R., Beadel, S.M., Ford, K.A., Breitwieser,I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P.B., & Ladley, K. (2018). *Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22.* Wellington: Department of Conservation.

DOC. (2006). *DOC Conservation Resources Report on Tenure Review of Branch Creek Pastoral Lease. Department of Conservation.*

DOC. (2016). *Freshwater Survey Pongs Creek, Cardrona Valley, 19 April 2016.* Dunedin, Department of Conservation.

DOC. (2019). Department of Conservation Maps – General map viewer. Retrieved from http://maps.doc.govt.nz/mapviewer/index.html?viewer=docmaps

Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B,O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M., & Rolfe, J.M. (2018). *Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24.* Wellington: Department of Conservation 11 p.

EIANZ. (2018). *Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems, 2nd edition.* Melbourne, Australia: Environment Institute of Australia and New Zealand Inc.

GNS Science. (2019). *New Zealand Geology Web Map*. Retrieved from http://data.gns.cri.nz/geology/

Leathwick, J., Wilson, G., Rutledge, D., Wardle, P., Morgan, F., Johnston, K., McLeod. M., & Kirkpartrick, R. (2003). *Land Environments of New Zealand.* Auckland: David Bateman Ltd.

QLDC. (2009). *Operative Queenstown Lakes District Plan.* Queenstown Lakes District Council.

QLDC. (2017). *Proposed Queenstown Lakes District Plan*. Queenstown Lakes District Council.

Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G. P., Hitchmough, R. A., Miskelly, C. M., McArthur, N., O'Donnell, C. F.J., Sagar, P. M., Scofield, R. P., & Taylor, G. A. (2017). *Conservation status of New Zealand birds, 2016. New Zealand Threat Classification Series 19.* Wellington: Department of Conservation.

Appendices

Appendix A:
Freshwater Survey Pongs Creek, Cardrona Valley, 19 April 2016

Department of Conservation
Te Papa Atawhai

File Note

Freshwater Survey Pongs Creek, Cardrona Valley, 19 April 2016.

Report prepared by Daniel Jack, Dunedin Office, field assistance by Florence Gaud, Wanaka Office.

Introduction

Clutha flathead galaxias were first identified in the lower reaches of Pongs Creeks following survey work completed by the Department of Conservation in December 2015. The survey was instigated by the landowner, Martin Curtis, who had observed small fish residing in pools where the creek flows through his property. Brown trout and koaro appeared to be displacing Clutha flathead galaxias and they were only holding on in environmentally severe areas of habitat within the lower reaches of the creek (Jack 2015). Martin Curtis has had a walk through the upper reaches of Pongs Creek and observed fish occupying pools on the neighbouring property. Martin approached the owner of the neighbouring property and secured access for the Department of Conservation to survey the upper reaches of Pongs Creek. This file note presents the findings of that survey.

Map 1. An aerial view of the 29 surveyed sites (red circles), and perched culvert, Pongs Creek, Cardrona Valley, 19 April 2016.

Methods/Results

A total of 29 sites (Map 1) were electro-fished using Kainga backpack electric fishing machine (NIWA Instrument Systems). Each site fished covered approximately 10 m^2 of wetted stream area. Surveyors moved in an upstream direction. The instream habitat was predominantly a mixture of meandering riffle and long slow moving pool with the occasional steep rapid. Overhanging vegetation and large boulders and cobbles provided abundant fish refugia. Sedge and rush species comprised the riparian vegetation as well as rough pasture grasses (Fig 1). Clutha flathead galaxias were found throughout the upper reaches of Pongs Creek (Map 1) and occurred in a variety of size ranges from 42 – 126 mm (Fig.2, Table 1). No brown trout or koaro were observed in this area and some sites appeared to have no fish species. The presence of a large perched culvert appears to be acting as a barrier to brown trout and koaro (Fig. 3, Map 1). The culvert (NZTM 1284323 / 5023115) was approximately 1 m high, falling onto boulders. A single brown trout was present in the pool directly below the culvert.

Figure 1. Stream habitat above culvert, Pongs Creek, Cardrona Valley.

Figure 2. Martin Curtis measuring three Clutha flathead galaxias, Pongs Creek, Cardrona Valley.

Figure 3. Perched culvert in Pongs Creeks, Cardrona Valley (NZTM 1284323 / 5023115).

Discussion

The perched culvert prevents the upstream colonization of both koaro and brown trout into the upper reaches of Pongs Creek. This is a significant barrier, securely protecting nearly 1 km of Clutha flathead galaxias habitat. An additional advantage for this barrier is the absence of a plunge pool below the culvert which substantially reduces the chance that brown trout would be able to jump up during high surface flows.

Only one brown trout was observed just downstream of the culvert in a deep pool and a single Clutha flathead galaxias was observed in the section of creek flowing through Martin Curtis's property. High temperatures in addition to low water flows are lethal to brown trout (Elliot 2000) however galaxiid fishes may survive short periods of exposure to higher water temperatures provided refugia is available amongst the substratum (Dunn 2003). It appears the severe low surface flows during the 2015-16 summer have drastically reduced all fish species numbers within Martin's section of Pongs Creek. Sites surveyed in the upper catchment of Pongs Creek that had no fish species presence may also have been affected during this period. Despite the drought conditions in the Cardrona Valley the Clutha flathead galaxias in Pongs Creek above the culvert have survived the low surface flows.

This is the second documentation of a secure population of Clutha flathead galaxias in the Cardrona Valley. The use of perched culverts as a barrier in other tributaries containing Clutha flathead galaxias may be a viable tool of protection. This reinforces the necessity of site visits during the RMA consenting processes where threatened fish species occur to identify potential opportunities.

Table 1. Summary of sites surveyed, grid reference (NZTM), fish species, number captured and size range, Pongs Creek, 19 April 2016.

Easting	Northing	Species (n)	Size range (mm)
1284232	5023176	Clutha flathead galaxias (7)	65 - 81
1284212	5023208	No species	
1284191	5023210	Clutha flathead galaxias (1)	97
1284084	5023231	Clutha flathead galaxias (2)	88, 111
1284055	5023231	Clutha flathead galaxias (2)	84, 88
1284031	5023216	Clutha flathead galaxias (3)	74 - 90
1284009	5023210	Clutha flathead galaxias (3)	57 - 101
1283973	5023186	Clutha flathead galaxias (2)	78, 87
1283945	5023164	Clutha flathead galaxias (2)	85, 110
1283900	5023140	No species	
1283885	5023144	Clutha flathead galaxias (1)	53
1283868	5023136	Clutha flathead galaxias (1)	76
1283818	5023134	No species	
1283798	5023137	Clutha flathead galaxias (8)	53 - 93
1283752	5023119	Clutha flathead galaxias (1)	86
1283708	5023121	Clutha flathead galaxias (4)	60 - 91
1283671	5023126	Clutha flathead galaxias (1)	68
1283635	5023129	Clutha flathead galaxias (5)	55 - 73
1283587	5023129	Clutha flathead galaxias (1)	54
1283499	5023115	Clutha flathead galaxias (2)	42, 50
1283467	5023106	Clutha flathead galaxias (4)	42 - 86
1283442	5023107	Clutha flathead galaxias (2)	67, 80
1283339	5023116	Clutha flathead galaxias (3)	96 - 109
1283281	5023133	Clutha flathead galaxias (2)	78, 104
1283257	5023127	Clutha flathead galaxias (5)	50 - 104
1283230	5023117	Clutha flathead galaxias (3)	45 - 107
1283197	5023101	Clutha flathead galaxias (3)	91 - 126
1283176	5023095	No species	
1284323	5023115	Brown trout (1)	180

References

Dunn, N.R. 2003: *The effects of extremes in flow on alpine (*G. paucispondylus*) and Canterbury (*G. vulgaris*) Galaxias*. Unpublished MSc Thesis. University of Canterbury, Christchurch, New Zealand.

Elliott, J.M. 2000: Pools as refugia for brown trout during two summer droughts: trout responses to thermal and oxygen stress. *Journal of Fish Biology*, 56, 938–948.

Jack, D.C 2015. Freshwater survey Pongs Creek, Cardrona Valley – 1 December 2015. Unpublished Internal File Note. Department of Conservation, Dunedin Office, Dunedin. https://doccm.doc.govt.nz/wcc/faces/wccdoc?dDocName=DOC-2651481

Appendix B:
Landscape Plans

North

Water tanks
Approx 30m³ tanks x6, above ground, pending detailed design

Consented building platform
25mx40m - 1000m²(RM090876)

Proposed Building platforms
32.6x23m - 750m²

Curtilage areas subject to design controls and common planting list

Native planting framework undertaken by developer (covenanted)

Driveways 3.5m wide

Proposed Lot boundaries

Rubbish Collection area
refer to SK36

Pongs Creek Clutha Flathead Preservation Corridor
fenced and protected from stock

Open pasture land surrounding proposed development retained for grazing and part of single title held by existing Roberts Family Trust (existing dwelling)

Provisional stormwater management area

Entry and Mailbox area
refer to SK34

LOT 16
LOT 15
LOT 13
LOT 14
LOT 12
LOT 11
LOT 7
LOT 10
LOT 6
LOT 5
LOT 8
LOT 2
LOT 3
LOT 4
LOT 9
LOT 1

Cardrona Valley Rd
Pringles Creek Rd
Curtis Rd
Gin and Raspberry Ln

Proposed water take from Pringles Creek with local treatment.
(Refer to SK41 and Holmes report for further details)

Existing dwelling
(to remain)

Landscape protection Zone
Area to be protected from further subdivision

Proposed Wastewater Treatment Plant
(20m² shed with below ground plant
Refer to SK42 for more details)

Mt Cardrona Station Special Zone (MCSZ)

Tracked changes in red

baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK41 - SCALE = 1:5000 AT A3 - 31 MAR 2022
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT A

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
CONCEPT MASTERPLAN

North

Water tanks
Approx 30m³ tanks x6, above ground, pending detailed design

Consented building platform
25mx40m - 1000m²(RM090876)

Proposed Building platforms
32.6x23m - 750m²

Curtilage areas subject to design controls and common planting list

Native planting framework undertaken by developer (covenanted)

Driveways 3.5m wide

Proposed Lot boundaries

Rubbish Collection area
refer to SK36

Pongs Creek Clutha Flathead Preservation Corridor
fenced and protected from stock

Open pasture land surrounding proposed development retained for grazing and part of single title held by existing Roberts Family Trust (existing dwelling)

Provisional stormwater management area

Entry and Mailbox area
refer to SK34

LOT 16
LOT 15
LOT 13
LOT 14
LOT 12
LOT 11
LOT 7
LOT 10
LOT 6
LOT 5
LOT 8
LOT 2
LOT 3
LOT 4
LOT 9
LOT 1

Proposed water take from Pringles Creek with local treatment.
(Refer to SK41 and Holmes report for further details)

Existing dwelling
(to remain)

Landscape protection Zone
Area to be protected from further subdivision

Proposed Wastewater Treatment Plant
(20m² shed with below ground plant
Refer to SK42 for more details)

Mt Cardrona Station Special Zone (MCSZ)

Gin and Raspberry Ln
Curtis Rd
Pringles Creek Rd
Cardrona Valley Rd

baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK41 - SCALE = 1:5000 AT A3 - 31 MAR 2022
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT A

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
CONCEPT MASTERPLAN

North

Pongs Creek Clutha Flathead Preservation Corridor
fenced and protected from stock

Mixed native mass planting within residential lots 2-15.

Total area to be planted by developer approximately 4.6ha

All species are to be planted at 1m centres with coverage being shared equally

Curtilage areas to be planted with same species list and specifications to fit within the native planting framework

Refer to Baxter Design Design Controls Document for further details

LOT 16
LOT 15
LOT 13
LOT 14
LOT 12
LOT 11
LOT 7
LOT 10
LOT 6
LOT 5
LOT 8
LOT 2
LOT 3
LOT 4
LOT 9
LOT 1

Open Pasture
Open Pasture
Open Pasture
Open Pasture


A


B

Tree species

A - South Island Kowhai:
Sophora microphylla, 5.5% coverage, planted @ 1m centres

B - Ribbonwood:
Plagianthus regius, 5.5% coverage, planted @ 1m centres


D


C


E

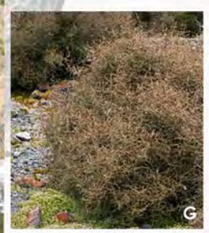
Tussock and Flax species

C - Snow Tussock:
Chionochloa rigida, 5.5% coverage, planted @ 1m centres

D - South Island Toe Toe:
Cortaderia Richardii, 5.5% coverage, planted @ 1m centres

E - Whaririki/Mountain Flax:
Phormium cookianum, 5.5% coverage, planted @ 1m centres


F


G


H


I


J


K


L


M


N


O


P


Q

Grey Shrubland species

F - Mingimingi:
Coprosma propinqua, 5.5% coverage, planted @ 1m centres

G - Needle-leaved Mountain Coprosma:
Coprosma rugosa, 5.5% coverage, planted @ 1m centres

H - NZ Coprosma:
Coprosma virescens, 5.5% coverage, planted @ 1m centres

I - Korokio:
Corokia Cotoneaster, 5.5% coverage, planted @ 1m centres

J - Matagouri:
Discaria toumatou, 5.5% coverage, planted @ 1m centres

K - Cypress Leafed Hebe:
Hebe cupressoides, 5.5% coverage, planted @ 1m centres

L - Koromiko:
Hebe salicifolia, 5.5% coverage, planted @ 1m centres

M - Tree Daisy:
Olearia odorata, 5.5% coverage, planted @ 1m centres

N - Small-leaved Tree Daisy:
Olearia lineata, 5.5% coverage, planted @ 1m centres

O - Tree Daisy:
Olearia bullata, 5.5% coverage, planted @ 1m centres

P - Hectors Tree Daisy:
Olearia hectorii, 5.5% coverage, planted @ 1m centres

Q - Mountain Cottonwood:
Ozothamnus vauvilliersii, 5.5% coverage, planted @ 1m centres

baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK25 - SCALE = 1:5000 AT A3 - 18 FEB 2020
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT B

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
PLANTING PALETTE

North

LOT 16
LOT 15
LOT 13
LOT 14
LOT 12
LOT 11
LOT 10
LOT 7
LOT 6
LOT 5
LOT 8
LOT 2
LOT 3
LOT 4
LOT 9
LOT 1

Gin and Raspberry Ln
Curtis Rd
Cardrona Valley Rd
Pringles Creek Rd

Lot Schedule	
Lot 1	10500 m²
Lot 2	3870 m²
Lot 3	4550 m²
Lot 4	5120 m²
Lot 5	4940 m²
Lot 6	4830 m²
Lot 7	5000 m²
Lot 8	4870 m²
Lot 9	4500 m²
Lot10	4420 m²
Lot 11	4290 m²
Lot 12	6750 m²
Lot 13	4790 m²
Lot 14	4850 m²
Lot 15	4870 m²
Lot 16*	29200 m²

*Building platform approved as per RM090876
Note: Areas rounded to the nearest 10-100m²
(Refer Scheme Plans for details)

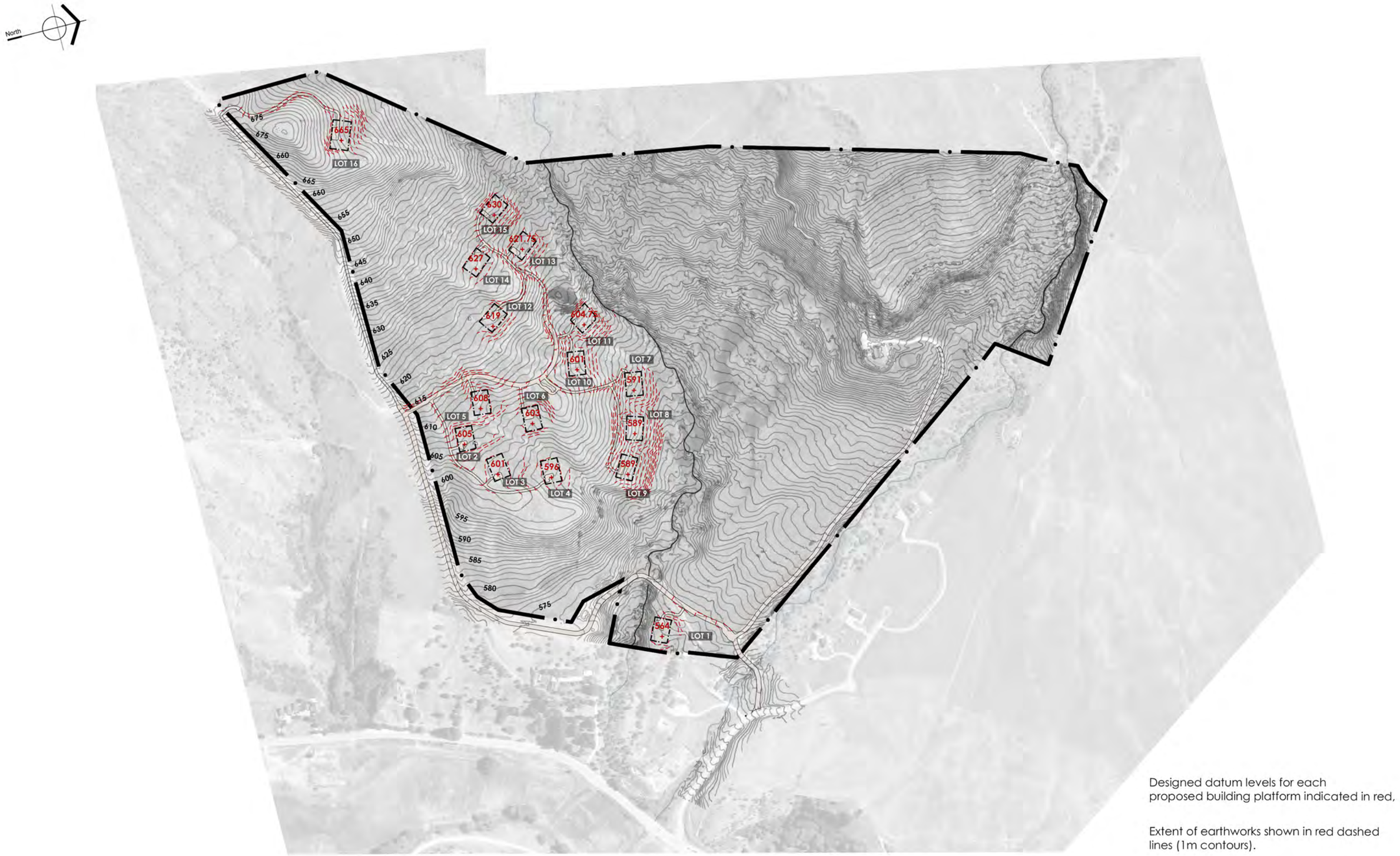
baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK26 - SCALE = 1:5000 AT A3 - 18 FEB 2020
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT C

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
LOT SCHEDULE



Designed datum levels for each proposed building platform indicated in red,

Extent of earthworks shown in red dashed lines (1m contours).

baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK27 - SCALE = 1:5000 AT A3 - 08 JAN 2020
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT D

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
CONTOUR PLAN

North

LOT 16
LOT 15
LOT 13
LOT 14
LOT 12
LOT 11
LOT 10
LOT 7
LOT 6
LOT 5
LOT 8
LOT 2
LOT 3
LOT 4
LOT 9
LOT 1

Cardrona Valley Rd
Pringles Creek Rd
Curtis Rd
Gin and Raspberry Ln

Pongs Creek Clutha Flathead Preservation Corridor
Protection of Pongs Creek and the endangered Clutha Flathead Galaxias

Landscape Protection Zone
Area is protected from further subdivision

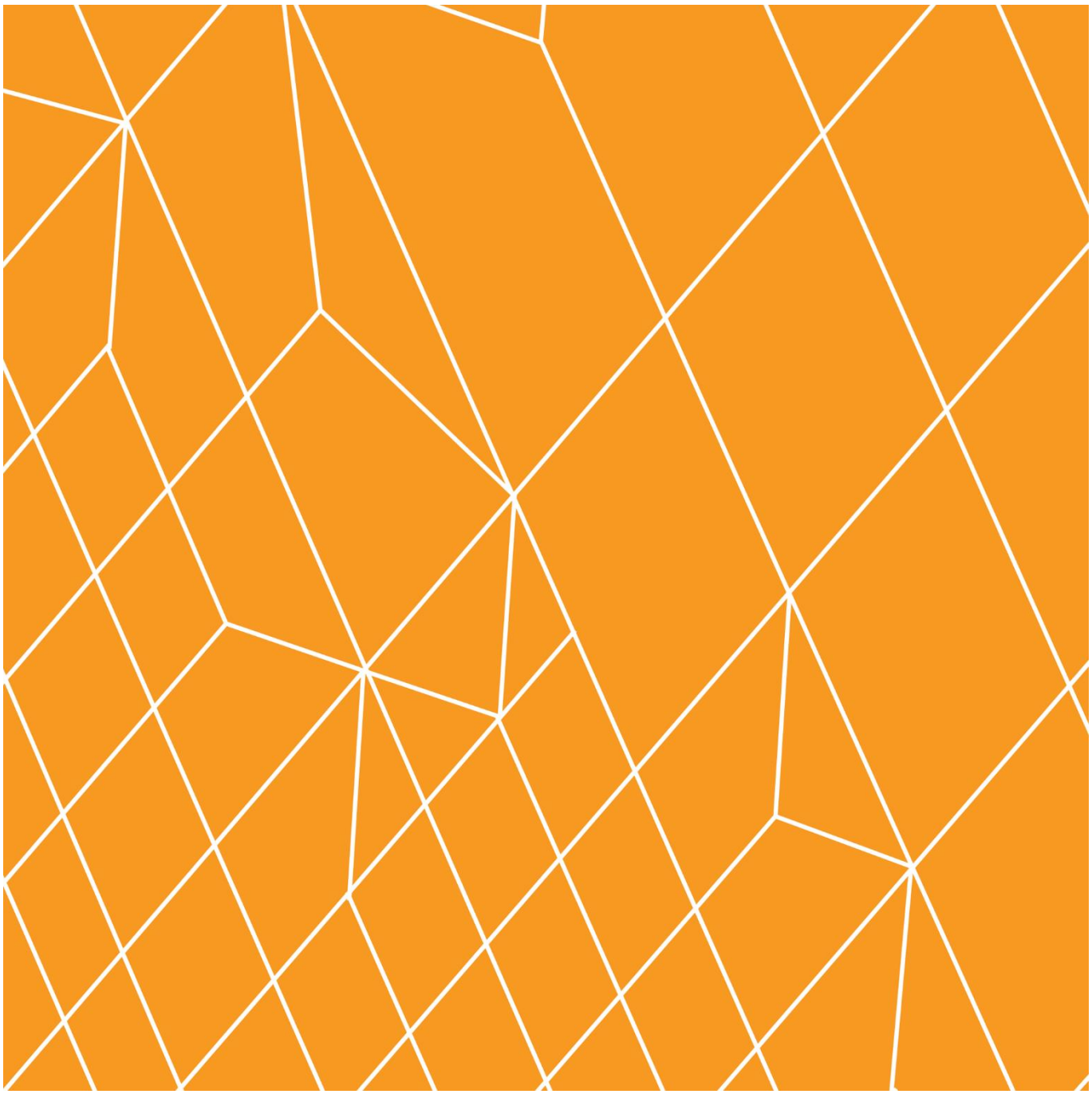
baxter design

0 25 50 125m
SCALE = 1:2500 AT A1

REFERENCE : 2738-SK28 - SCALE = 1:5000 AT A3 - 18 FEB 2020
DRAFT - NOT A WORKING DRAWING - NOT FOR CONSTRUCTION

BAXTER DESIGN
LANDSCAPE ASSESSMENT
ATTACHMENT E

MCDOUGALL'S BLOCK PROJECT | ROBERTS FAMILY TRUST
PROTECTION ZONES



Infrastructure Report
McDougall's Block

10 Curtis Road
Cardrona
New Zealand

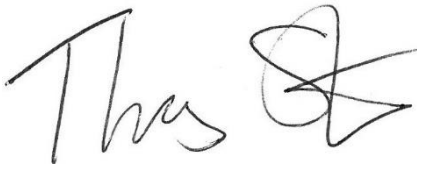
V7

Report

McDougall's Block

Prepared For:
Roberts Family Trust

Date: 19 July 2022
Project No: 138332.00
Version No: 7

Prepared By:	Updated By:	Reviewed By:
		
Thomas Shenton PROJECT ENGINEER Holmes NZ LP	Gerhard Fourie SENIOR PROJECT ENGINEER Holmes NZ LP	Ben Henry SENIOR PROJECT ENGINEER Holmes NZ LP

DATE	VER. NO.	REASON FOR ISSUE
02/09/19	1	Draft report for project team review
16/10/19	2	Updated report following project team review
10/12/19	3	Removed option for trenchless crossing of Creek as per PMI from Leon West
23/01/20	4	Omit Lot 17 as per PMI from Leon West
04/03/20	5	Revise Pongs Creek Clutha Flathead preservation corridor as per PMI from Leon West
16/05/22	6	Consent
19/07/22	7	Consent

Limitations

Findings presented as a part of this project are for the sole use of Roberts Family Trust and Queenstown Lakes District Council in their evaluation of the subject properties. The findings are not intended for use by other parties and may not contain sufficient information for the purposes of other parties or other uses. Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

Contents

Table of Figures

Table of Tables

Table of Appendices

Appendix No.	Appendix name	Appendix version
01	Holmes Resource Consent drawing set	5
02	Aurora Energy Provisioning Letter	1
03	Chorus Network Services Provisioning Letter	1
04	Holmes Sketches	7
05	Erosion and Sediment Control Plan	4
06	Concept Road Longsections	1
07	Preliminary earthworks calculations at creeks	1

Table of Acronyms and Abbreviations

Item	Expanded acronym or abbreviation
AEP	Annual Exceedance Probability
CAD	Computer Aided Design
CoP	Code of Practice
DWF	Dry Weather Flow
HIRDS	High Intensity Rainfall Design System
LDSC	Land Development and Subdivision Code of Practice (QLDC)
LiDAR	Light Detection and Ranging
ORC	Otago Regional Council
QLDC	Queenstown Lakes District Council
STEP	Septic Tank Effluent Pump

1 EXECUTIVE SUMMARY

1.1 Overview

Holmes has prepared this infrastructure feasibility report on behalf of Roberts Family Trust to support the proposed formation of 16 lots (one of which will contain a previously consented building platform under RM090876), including the establishment of 15 additional residential building platforms. The proposed development is located west of Cardrona Valley Road off Pringles Creek Road, east of the Cardrona Ski Field and south of the Pringles Creek subdivision.

The development envisioned will follow a low impact design philosophy to maintain its inherent rural and rustic character. The associated infrastructure shall be sympathetic to the natural environment limiting visual and environmental impacts.

1.2 Wastewater

Options for wastewater treatment that are either on-site or communal have been considered as well as connecting to the recently completed 'The Cardrona Valley' wastewater scheme.

Due to the proposed lot layout and a perched water table across much of the site, it is not possible for each lot to have its own on-site wastewater application area to dispose treated effluent to land, so a communal one is needed.

The on-site treatment option would involve an on-site wastewater system providing primary, secondary and potentially tertiary treatment before the effluent is pumped into a small-bore low-pressure community main that conveys flows to the communal wastewater application area. The effluent would be applied to the land via subsoil drip irrigation.

The communal treatment option would involve wastewater or primary treated effluent for each household that is collected via a septic tank effluent pump (STEP) system. Each STEP system pumps to a small-bore low-pressure main that conveys flows to a communal wastewater treatment plant where flows would be treated to the required standard before effluent is discharged to the application area via subsoil drip irrigation.

QLDC recently completed the Cardrona Valley wastewater upgrade, including wastewater reticulation and treatment. Consideration during detailed design should be made for a connection point from the new development to this scheme in lieu of the on-site and communal treatment. QLDC has indicated that there is capacity available on this new scheme for the Roberts development. Their preference for the public connection is along Curtis Road, and Down Pringles Creek Road to the pumpstation located at the intersection with the Cardrona Valley Road.

1.3 Stormwater

There is no available public stormwater system to connect the development to, so options for stormwater disposal include soakage and above ground dispersal. On-site rainwater harvesting tanks will also offer retention of flow.

The proposed development will create a relatively small increase in impervious area, resulting in a small increase in stormwater runoff. The increased impermeable area is from the roofs of the new buildings, associated paved areas within the lots and upgrade of Curtis Road. Increase in peak stormwater discharge resulting from the development will be mitigated through attenuation and retention features that mimic the natural hydrology of the site. Natural overland flow paths will be maintained throughout the development that will also deal with exceedance flows from the stormwater disposal devices.

Stormwater runoff from the new roads will be collected in roadside swales which will offer attenuation of flow before being discharged to the ground via soakage.

1.4 Water

There currently is no available public water supply system to connect the development to, so a new water take from Pringles Creek is proposed to provide the required domestic, irrigation and firefighting water requirements for the development.

There are onsite and communal storage options for provision of a potable water supply to meet the peak domestic demand and static reserve firefighting requirements of the development. The preferred, and most flexible option is to have on-site storage of domestic and firefighting water topped up by a communal trickle feed main, distributing treated water from the new Pringles Creek surface water take.

QLDC is also finalising the Cardrona Valley Water Supply Scheme, which is a collaboration project with Mount Cardrona Station. The infrastructure has not been commissioned, but a connection to this scheme is viable option once commissioned. There may be an opportunity to recognise some synergies with this development. A future point of connection should be considered during detailed design and incorporated.

1.5 Access

Access to the proposed development will continue to be via Cardrona Valley Road and Pringles Creek Road.

The proposed road layout is shown on the masterplan. The specific design of the roads will be undertaken during the detailed design phase of the project. All road geometry and construction will conform to the requirements of the Queenstown Lakes District Council (QLDC) Land Development and Subdivision Code of Practice (LDSC).

The unsealed section of Curtis Road, just past its junction with Pringles Creek Road to the main residential cluster, will be upgraded to a LDSC Type E3 road.

The initial section of roading within the main residential cluster will be road type LDSC E2 road.

The other internal roads which serve less than 6 dwellings would be a type LDSC E1 road.

1.6 Bulk Enabling Earthworks

Bulk earthwork calculations have been completed to illustrate the volumes and grading required for the proposed development. The total cut/fill on the site requires a net approx. 5,460m^3 of cut.

1.7 Other services

Gas infrastructure does not extend to the development boundary and any gas use on site will require individual gas bottle supply.

Aurora Energy's grid is near the development and confirmation has been received that their network can accommodate the project demands.

Chorus telecommunication grid is near the development and confirmation has been received that their network can accommodate the project demands.

2 INTRODUCTION

Holmes has been engaged by Roberts Family Trust to prepare an infrastructure report to support a resource application for the proposed 16 lot Development at 10 Curtis Road in the Cardrona Valley.

Throughout this report the following terms are used:

- **Property** – 10 Curtis Road, a 55.4 ha property consisting of the following existing lots: Lot 1 Deposited Plan 433836, Lot 6 Deposited Plan 34432 and Lot 1 Deposited Plan 425263. Refer to Figure 1 below. The property is within the jurisdiction of QLDC and Otago Regional Council.
- **Lots** – The property will be subdivided into 16 sections. The 16 subdivided sections affect a total area of 1.6 ha of the property. Through the report the individual sections will be referred to as Lots.
- **Site** – the proposed lot; for example on-site would be within the individual lot.
- **Communal** – outside of a lot, but inside the property, a centralised system.

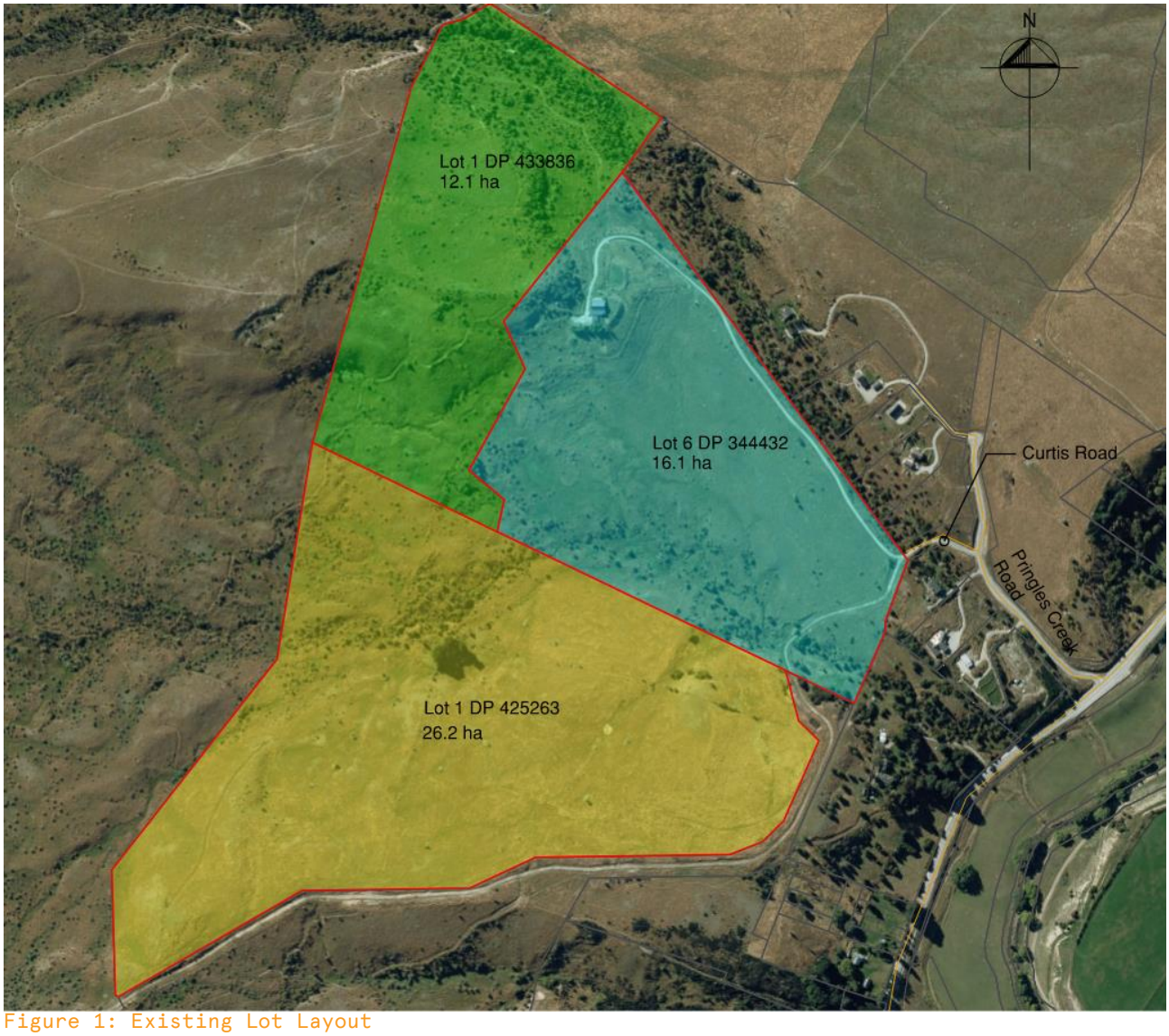


Figure 1: Existing Lot Layout

3 PROJECT INPUTS

This study relies on the proposed development masterplan dated 31st of March 2022 by Baxter Design, shown in Figure 2 and other information presented in Table 1.

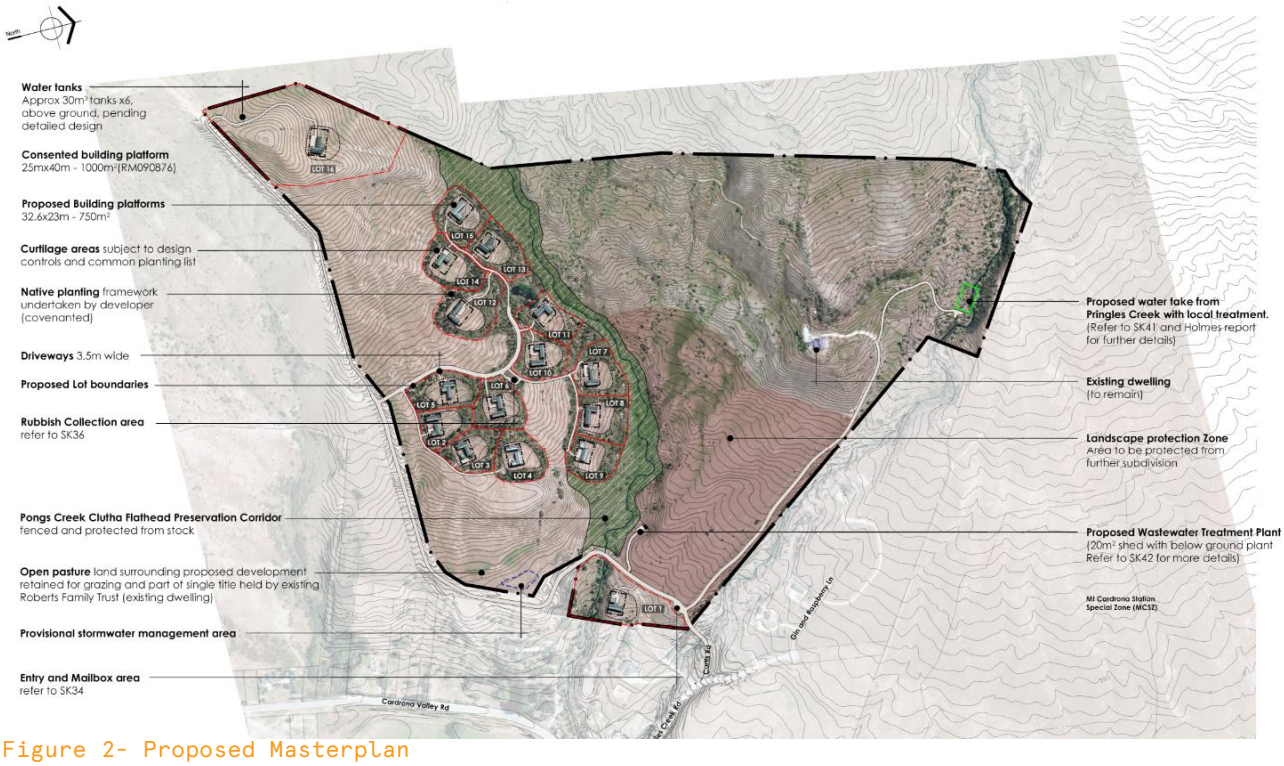


Figure 2- Proposed Masterplan

Each of the proposed building platforms are approx. 750m^2. Four-bedroom dwellings have been assumed for each building platform. In accordance with AS/NZS 1547:2012 this would equate to a population of six to seven people.

Table 1 Summary of relevant site investigation

Type	Specified by	Provided by	Latest date / version	Notes
Light Detection and Ranging (LiDAR) data	NA	LINZ	2019	1m contours
Computer Aided Design (CAD) masterplan for property boundary, lot boundaries, planting areas, riparian protection corridor, building platforms, road layout, and contour levels	Maestro Projects	Baxter Design	31/03/2022	See Master Plan
Road alignment and geometry	Maestro Projects	Bartlett Consulting	11/07/22	
Geotechnical Report	Maestro Projects	Geosolve Ltd	Geotechnical Report for Resource Consent (GeoSolve ref: 190098-Rev3)	
Ecological Assessment	Maestro Projects	E3 Scientific	Ecological Assessment v1.1 February 2020	Pongs Creek is a known, secure population of the Clutha flathead galaxias (Galaxias "species D") (DOC, 2016), which has a conservation status of Threatened. This species is currently protected from other fish species by the presence of a perched culvert.
Onsite Wastewater Management Site Assessment Report	Maestro Projects	E3 Scientific	Version C, 23/09/2019	• Wastewater application areas based on site permeameter testing • Primary, secondary and tertiary wastewater treatment requirement
Permitted and Consented water off-take volumes	Maestro Projects	Environmental Associates Ltd	Certificate of Compliance Application 16 August	See Table 1 permitted and Consented Water Takes: • 0.5 L/s & 25,000 L/day (domestic + animal) • 10 L/s & 100,000 L/day (not for irrigation) • 0.5 L/s & 25,000 L/day (any use) • 1 L/s & 3,000 L/day (any use)

4 DESIGN PERFORMANCE, STANDARDS AND CRITERIA

The Section outlines the standards and requirements of particularly relevant to this design.

4.1 Wastewater

The wastewater system should be designed to convey the peak wet weather flow without surcharge and an asset life of at least 100 years. Some components such as pumps, metering, control valves, and control equipment may require earlier renovation or replacement but should have a minimum 20yr design life.

The following relevant standards and performance requirements apply:

- QLDC Land Development Code of Practice 2020 (Dated 23/09/20)
- AS-NZS 1547-2012 On-site domestic wastewater management
- IS-OSW-Onsite-Wastewater-Disposal-Guidance-Rev-2
- NZ Building Code Clause G13 Foul Water Amendment 9
- Guideline Document 2021/006: On-Site Wastewater Management in the Auckland Region Jan 2021

4.2 Stormwater

The primary piped SW system should be designed to convey flow from the critical 5% AEP storm event, with climate change allowance, without surcharge and an asset life of at least 100 years. Some components such as pumps, metering, control valves, and control equipment may require earlier renovation or replacement but should have a minimum 20yr design life.

The secondary over land stormwater system should be designed to convey flow from the 1% AEP storm event without increasing the risk of flooding to downstream properties and maintaining relevant freeboard.

The following relevant standards and performance requirements apply:

- NZ Building Code Clause E1 Surface Water Amendment 11 (latest at time of this report)
- QLDC Land Development Code of Practice 2020 (Dated 23/09/20) – 'QLDC LDSC'

4.3 Water Supply

The water supply system should be designed to provide sufficient capacity to meet peak demand while maintaining minimum pressure and ensuring the appropriate firefighting flows and pressure can be achieved. Backflow prevention must be suitable for the hazard rating of the system.

The following relevant standards and performance requirements apply:

- QLDC Land Development Code of Practice 2020 (Dated 23/09/20)
- NZ Building Code Clause G12 Water Supplies Amendment 12
- SNZ PAS 4509-2008 NZ Firefighting Water Supplies Code of Practice (CoP)

The proposed design meets the design requirements bar the following deviations:

- It is common practice for consents in the Queenstown area to specify a 20,000 L static firefighting reserve within a 30,000 L tank for on-site water storage. This 20,000 L firefighting supply is not consistent with Table 2 of SNZ PAS 4509:2008 which specifies 45,000 L for a fire classification of FW2. This is discussed in a recent hearing: https://www.qldc.govt.nz/assets/Uploads/Planning/District-Plan/Hearings-Page/Memorandums/S0438-NZFS-Commission-T02-memorandum-of-counsel.pdf

4.4 Other Services

The assessment and provision of other services is by others, but the following relevant standards and performance requirements apply to their coordination:

- National Code of Practice for Utility Operators' Access to Transport Corridors

4.5 Pavements

Pavements, roads and footpaths shall be designed to resist the expected design loads and achieve an asset life.

The following relevant standards and performance requirements apply:

- QLDC Land Development Code of Practice 2020 (Dated 23/09/20)

4.6 Sustainable design

- QLDC Land Development Code of Practice 2020 (Dated 23/09/20)

5 WASTEWATER

5.1 Existing Infrastructure

The Cardrona Valley wastewater upgrade was recently completed by QLDC, and includes:

- 250mm gravity drainage along Cardrona Valley Road up to the intersection with Pringles Creek Road;
- Pumpstation at the above intersection and 200mm rising main along Pringles Creek Road to Mt Cardrona Station;
- 315mm – 400mm gravity drainage to the new Cardrona Valley wastewater treatment plant.

QLDC has indicated that there is capacity available on this new scheme for the Roberts development.

It is assumed that the existing dwelling within the project boundary and the adjacent Pringles Creek Subdivision utilise traditional on-site wastewater treatment and disposal systems.

5.2 Proposed Development Flows

It is assumed that the future dwellings will have four bedrooms each. In accordance with AS/NZS 1547:2012 this equates to a design population equivalent of 6-7 people, producing a wastewater demand that required the waste tank size presented in Table 2. If the final owners of the property choose to have additional or fewer bedrooms, then a refinement of this initial wastewater sizing can be carried out during the Building Consent phase.

Table 2 Wastewater demand estimation per dwelling (from Table J1 of AS/NZS 1547:2012)

No. of bedrooms	Population equivalent (people)	Design flow (L/day)	All waste tank capacity requirement per dwelling (L)
4	6 - 7	1,000 - 1,400	3,500

Equating the design flow in Table 2 with the population equivalent gives a wastewater design flow of approx. 200 L/person/day (1,400 L/day / 7 people). Section 5.3.5 of QLDC LDSC states that, based on three people per dwelling, the average Dry Weather Flow (DWF) is 250 L/person/day with a diurnal peaking factor of 2.5 and a dilution / infiltration factor of 2, see Table 3. Table 3 shows a single property would have a daily DWF of 0.75m^3/day (750 L/day) which is significantly less than the proposed 1,400 L/day. The 1.5m^3/day (1,500 L/dwelling/day) in Table 3 is similar to the proposed 1,400 L/dwelling/day flow and includes an allowance for groundwater infiltration and stormwater flows. Groundwater infiltration and incorrect stormwater connections should be minimal on the proposed network involving a small number of private wastewater connections from lots with dedicated stormwater management discharging to a sealed low pressure main.

Table 3 Wastewater demand estimation based on Section 5.3.5 of QLDC LDSC

Number of dwellings	Dry Weather Flow (DWF) (m^3/day)	Daily peak DWF (L/s)	Wet Weather Flow (WWF) (m3/day)	Daily peak WWF (L/s)
1	0.75	0.022	1.5	0.043
16	12	0.347	24	0.694

Combined with the use of water efficient appliances, the design values presented in Table 2 are considered appropriate. Further details are provided in E3's documentation.

5.3 Wastewater Management

Various options were considered for wastewater management of the development. The first four options are for the wastewater to be treated and the treated effluent discharged to land on the development site. The alternative is connecting to the new QLDC Cardrona Valley wastewater scheme.

Wastewater treatment and effluent discharge to land on development site

Considering the variable topography of the site, this could be achieved by subsoil drip irrigation utilising a UniRam, or similar, pressure compensating emitter system that can be laid at a variable grade. In accordance with QLDC's Onsite Wastewater Disposal Application Form, drip lines would be installed at a minimum depth of 300mm below the surface to minimise the risk of damage resulting from freezing. Further frost protection is achieved through specification and design of the drip lines to be free of effluent between application doses.

The wastewater application area is located and sized in accordance with Section M7 of AS/NZS 1547:2012. Desk study identifies the predominant soil type to consist of moderately structured light clays which is a category 5 soil to Table M1 of AS/NZS 1547:2012 with an indicative permeability rate of 0.06-0.12 m/day; the recommended design irrigation rate of secondary treated effluent in this soil is 0.003 m/day (3mm/day).

This desk study was confirmed following site investigations. E3 Scientific has undertaken constant head permeameter field tests on possible application areas to assess the design irrigation rate, see Section 3.1.2 of E3's Onsite Wastewater Management Site Assessment Report. Testing showed much of the property to be unsuitable for disposal via shallow irrigation due to a perched water table, but the ground that was suitable had measured permeability rates consistent with the 3mm/day from the desk study. The property is also constrained because of the desire to maintain a 50m offset to surface water which is a resource consent trigger for Otago Regional Council (ORC); this requirement is considered to be best practice rather than a site constraint as resource consent will be required in any event for this development due to the volume of effluent being discharged to land (>2000 L/day). Suitable application areas have been identified by E3 on the western side of Pringles Creek, largely between the 50m offsets of Pringles and Pongs Creeks.

The possible wastewater application areas are shown in Figure 3, Section 5.4 of the report. The required size of the application areas is shown in Table 4 which assumes a 100% reserve area is required in accordance with Section 5.5.3.4 of AS/NZS 1547:2012. However, with the provision of secondary and tertiary treatment the need for 100% reserve can be challenged. Section B5.5 of Auckland Council Guideline Document 2021/006 provides guidance about how a reduced reserve area can be justified where secondary effluent is being discharged and where conservative estimates for wastewater flow generation can be demonstrated.

Table 4 Total wastewater drip irrigation estimation

Application area	Design drip irrigation rate[1] (mm/day)	Number of dwellings [1]	Design flow (L/day)	Base application area (ha)	Total application area including reserve (ha)
Communal	2.0	16	22,400	1.12	2.24

[1] *From E3 Onsite Wastewater Management Site Assessment Report including 20% reduction due to 10-20% sloping site as advised in Table M2 of AS/NZS 1547:2012*

Options for domestic wastewater management on the development site are presented in Table 5 – each would be sized to meet the design flows presented in Table 4, or adjusted to suit the actual dwelling size. Option 1 is not viable, whilst Options 2 to 5 are viable subject to a cost assessment. The required level of wastewater treatment is to be assessed at detailed design to meet the required discharge consent conditions.

E3's 'Onsite Wastewater Management Site Assessment Report' states tertiary treatment is required due to the sensitive nature of the receiving environment. Options 2 to 4 require a low pressure main to collect flows from the lots and convey to the treatment plant and communal application area shown on the master plan. The communal treatment facility is proposed be located on the south-eastern side of the disposal field.

Table 5 Domestic wastewater management options

Option	Description	Assessment	Decision
1	On-site full treatment + on-site disposal	Except for lot 16 (existing consent) on-site disposal not possible due to limited lot size and a perched water table across much of the site	Unviable
2	On-site full treatment + communal disposal	Dependent on individual lot owners maintaining their treatment units or paying into body corps with rights of access. Allows staged development of lots with construction of communal treatment facility	Viable, subject to cost assessment
3	Communal full treatment + communal disposal	Likely to be most cost-effective option but requires treatment for entire development to be operational prior to any lots being occupied.	Viable, subject to cost assessment
4	On-site partial (primary) treatment, communal partial (secondary, tertiary) treatment + communal disposal	Possibility to stage development with some additional on-site treatment costs required until communal treatment online. May provide good balance of costs with majority of solids retained at source	Viable, subject to cost assessment

The on-site treatment (options 2 and 4) arrangement would involve a septic tank effluent pump (STEP) system involving primary, secondary and potentially tertiary treatment within the lot before the treated effluent is pumped into a low-pressure community main that conveys flows to the communal wastewater application area. The effluent would be applied to the land via subsoil drip irrigation.

The communal treatment (options 3 and 4) arrangement would involve flows to be collected via a low-pressure community main that conveys flows to the communal wastewater treatment plant providing the required level of treatment before the effluent is pumped to application area and discharged via subsoil drip irrigation.

On-site wastewater treatment options are presented in QLDC Onsite Wastewater Disposal Guidance. Options for communal wastewater treatment are presented in Table 6.

Table 6 Communal (centralised) wastewater treatment options from MFE (Table 8.4 of https://www.mfe.govt.nz/publications/waste/sustainable-wastewater-management-handbook-smaller-communities-part-3-options-2)

Wastewater conditioning	Primary treatment	Secondary treatment	Tertiary treatment
Screening and grit removal	Imhoff tank Clarigester	Activated sludge: • standard aeration • extended aeration	Sand filters (following activated sludge, biofilter or pond systems)

Wastewater conditioning	Primary treatment	Secondary treatment	Tertiary treatment
		• oxidation ditches • sequencing batch reactors	
	Sedimentation (large capacity septic tank) Sedimentation with chemical addition	Biofilters: • trickling filter (biological filter) • rotating biological contactor • recirculating Packed bed Reactor	Disinfection (pathogen removal): • chlorination • UV • ozone
	Oxidation ponds (primary treatment)	Sand filters: • intermittent sand filter • recirculating sand filter	Oxidation ponds (maturation treatment)
		Oxidation ponds (secondary treatment)	Overland flow / land application

The wastewater application areas would have limited above ground impact in the form of fences, marker posts and potentially some bunding to control stormwater runoff or fluvial flooding. Cut-off drains and a buffer zone will be included on the downslope side of the application area as shown on the E3 drawings to mitigate wastewater breakout. Cut and carry or controlled grazing could take place in the form of sheep (cattle / horses will be too heavy).

There is likely to be a desire by lot owners to install spas or swimming pools. If swimming pools / spas are to be installed there would need to be dedicated on-lot treatment for the backwash wastewater which cannot be treated using conventional domestic wastewater treatment devices. Considering the sensitivity of the receiving environment, this treatment could also be applied to pool overflow water or the entire body of water if it is being drained. A de-chlorination device may form part of the treatment required for draining the pool, although leaving the pool for a week would allow chlorine to dissipate. The treated swimming pool water would then discharge to soakage / land application which could be the same discharge used for the stormwater (see Section 6.3), although there would be some design and operational requirements to limit capital cost such as draining the pool only in dry weather and via a restriction.

Public wastewater connection

QLDC have completed the Cardrona Valley wastewater upgrade, which includes conveyance and treatment as described in section 5.1. QLDC have also indicated that there is sufficient capacity on the scheme to accommodate the Roberts Development. A direct connection to the QLDC network should be considered during the detailed design. This will likely require a combination of pumped and gravity systems, depending on where the connection to the public network is made.

QLDC has indicated their preference for the public connection to be made along Curtis Road, and Down Pringles Creek Road to the pumpstation located at the intersection with the Cardrona Valley Road.

An alternative connection would be across the Cardrona Domain to the wastewater pipeline in Cardrona Valley Road.

5.4 Assessment of Infrastructure Effects

Based on site investigation the development has sufficient capacity to facilitate the communal disposal of effluent to land via a STEP system, a small community wastewater treatment plant using sub-soil drip irrigation or a public wastewater connection. The permanent effects of the proposed systems on the environment are considered to be minor.

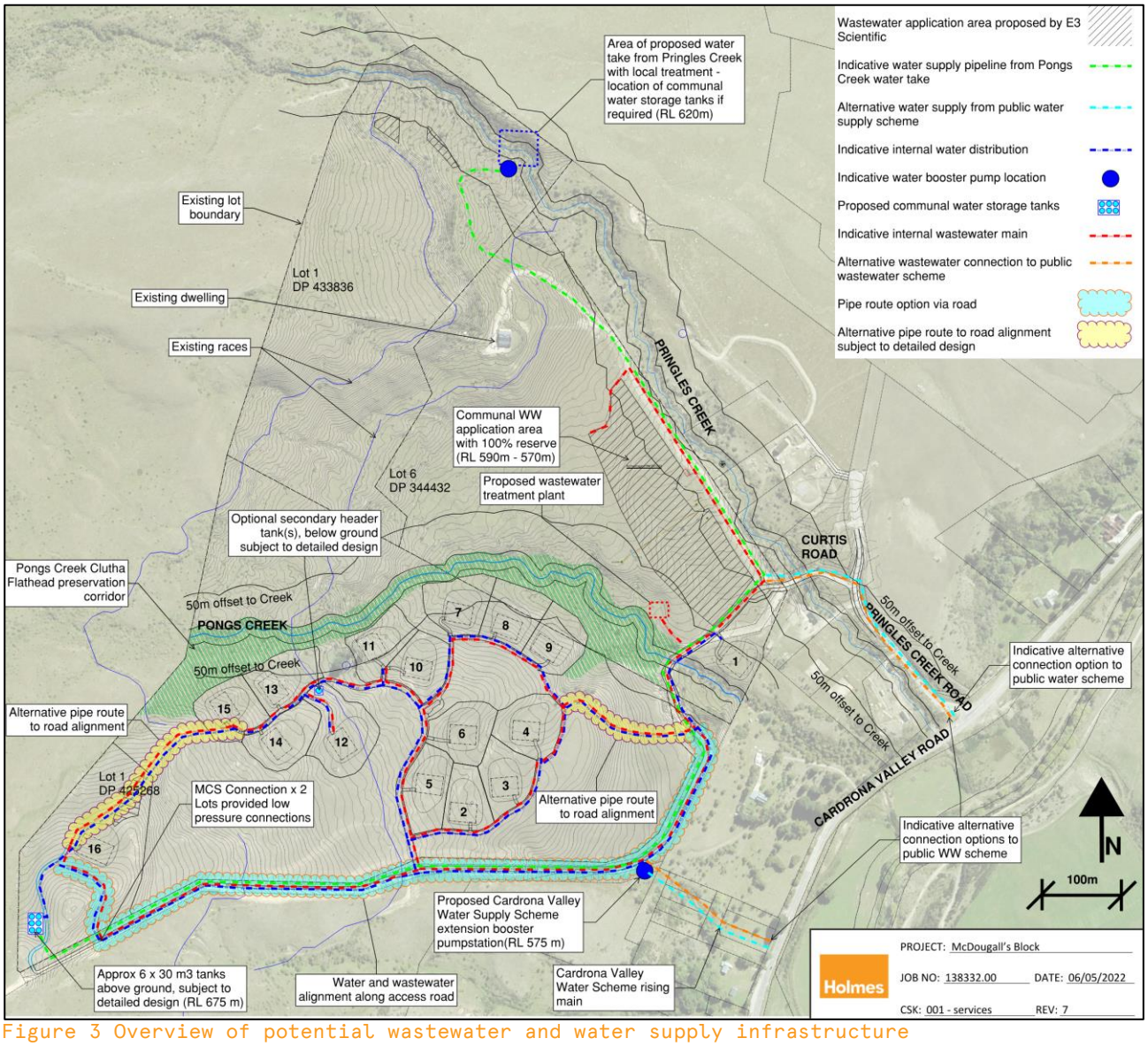


Figure 3 Overview of potential wastewater and water supply infrastructure

6 STORMWATER

6.1 Existing Infrastructure

The existing site is dominated by grassed surfaces and generally slopes from the south to the north, with some existing swales, hills, gullies, and creeks within the site boundary. There are two races crossing through the site and overland flow routes through the property drain to either Pongs or Pringles Creek.

The site is located outside of the QLDC stormwater drainage scheme boundary. There is no integrated stormwater infrastructure or management plan for the Cardrona area. The existing dwelling within the site disposes of stormwater via soakage to ground.

Stormwater drainage is generally conveyed via roadside swales, ephemeral gullies and culverts towards Pongs and Pringles Creek, under the Cardrona Valley Highway and ultimately draining to the Cardrona River.

There are a few existing culverts which currently convey stormwater beneath the local roads bordering the development.

6.2 Proposed Stormwater Flows

The Landscape Architect's design of the proposed development has aimed to maintain as much of the existing rural character and hydrology as possible. Maintaining the existing hydrology involves mimicking natural stormwater runoff and infiltration regimes and not creating new dedicated discharge points to watercourses. E3's Environmental Assessment Report establishes the sensitivity of Pongs Creek and so the design approach to stormwater management is to allow water to move through and across the land as it currently does. The development primarily consists of natural grass lands. Thus, the only increase in impervious area will be from the building roofs, new roadways, driveways and on-lot hard landscaping.

6.3 Stormwater Management

Because the nature of the new dwellings is unknown it is difficult to quantify the additional runoff associated with the development. Rainwater harvesting will reduce the demand on the proposed reticulated water supply system for irrigation whilst also offsetting any potential increase in impermeable area resulting from the buildings. The aim of the stormwater management for the development is to replicate the pre-development hydrological regime. Rainwater falling on new impermeable surfaces will partly:

- Be retained via rainwater harvesting, mimicking the retention of stormwater on the surface
- Discharge to ground via soakage, mimicking natural infiltration
- Discharge to surface via above ground dispersal, mimicking run off following saturation

When discharging to a primary stormwater drainage system it is a requirement under Section 4.3.5.1 of QLDC LDSC to limit post-developed peak discharge to pre-development rates for a given AEP storm event. For this development, there will be no discharge to a piped stormwater system and so there is no requirement to restrict peak discharge. Rather, the proposed approach will naturally mitigate any potential local increase in peak flow through the low impact design measures outlined. Calculating pre and post-development peak runoff in this instance will do nothing to achieve the primary aim of replicating the pre-development hydrological regime, instead a pragmatic and intuitive approach is taken.

In accordance with Section 4.3.7.9 of QLDC LDSC, soakage devices are to be sized to accommodate the 5% AEP storm event with a 50% reduction factor applied to the soakage rate determined on site. Section 7.3 of Geosolve's Geotechnical Report presents test data from across the development suggesting a long-term infiltration rate of 0.1 L/m^2/min at a minimum of 1m depth. All soakage is required to be at 1m below ground

level due to the perched water table across much of the site. Applying the 50% reduction factor gives a design infiltration rate of 0.05 L/m^2/min (mm/hr). This is not a viable infiltration rate for soakage alone meaning storage is required to contain stormwater until it has time, post storm event, to infiltrate into the ground. For buildings, it is advised that any rainwater tank harvesting system be linked to the soakage system via an overflow such that water is retained before overflowing to soakage. Table 7 presents required soakage pit sizes for 100m^2 impermeable areas based on the 5% AEP storm (HIRDS v4 data including 2.1degree climate change in accordance with C4.3.5.1 of QLDC LDSC).

Table 7 Soakage pit sizes for 100m^2 impermeable areas based on the 5% AEP storm

Impermeable area type	Runoff coefficient[1]	Required soakage pit storage volume (m^3) / 100m^2 of impermeable area
Roof	0.9	8.0
Asphalt and paving	0.85	7.4

1 From NZ Building Code Clause E1

Based on Table 7:

- A 250m^2 building roof would require a soakage pit of 20.0m^3
- A 25m length of LDSC Type E3 Road (6m seal width) would require a soakage pit of 11.1m^3

Road runoff could be managed by an adjacent swale on the downslope side with soakage pits or above ground dispersal installed intermittently along its length. Alternatively, new discharge connections to Pongs Creek could be made, although this is not advised upstream of an existing culvert due to the sensitivity of the receiving environment, particularly with respect to the protected Galaxias fish; see E3's Environmental Assessment report for details. Depending on the topography, swales could include check dams to retain flow, potentially reducing the size of the required soakage device. A dry pond on the northern side of the access road is also proposed as a stormwater management feature for storing stormwater from the northern roadside swale of the access road. The provisional location for this pond is shown on the masterplan drawings as well as the sketches included in Appendix 4.

Overflows from soakage devices, particularly from buildings, could be managed using above ground dispersal pipes installed around landscaped areas. This would mimic the natural hydrology of the site whereby stormwater infiltrates into the ground until saturated, at which time it runs off overland to the watercourse. Overland flow paths will be re-routed and modified where required to establish building platforms and will be detailed as part of Engineering Acceptance.

There is a myriad of green infrastructure, low impact, options to manage stormwater flows across the development, to complement the approach of retention, soakage and above ground disposal, listed in Section 4.3.7.3 of QLDC LDSC. Selection and placement of these devices, if appropriate, will be undertaken at detailed design. So as not to destabilise building platforms, soakage devices should be located at least 10m away from new permanent slopes.

Existing races running through the site will largely be maintained although some slight alteration / re-routing around lots 11 and 12 may be required depending on how the design develops. The proposed wastewater application areas will also require cut off drains (as shown in E3's Onsite Wastewater Management Site Assessment Report). Where possible, intercepted or diverted flow paths will be reconnected to their current

downstream path to maintain the current flow regime of the area. Detailed design of these aspects will require a detailed site topographical survey, for example via a drone.

The majority of the proposed infrastructure works will be outside of the Pongs Creek Clutha Flathead preservation corridor although there is a risk of flooding to Lots 11 and 13 from the Creek. As proposed in Geosolve's Geotechnical Report, the risk of flooding to property could be mitigated through nominally 1m high bunding and ensuring Finished Floor Levels (FFLs) provide adequate freeboard.

We recommend a consent condition or consent notice that requires a hydraulic and flood assessment at the time a building consent is applied for that will detail the FFL depending on the location within the allocated areas. This will consider the dwelling design and finished ground in the areas adjacent to Pongs Creek.

Downstream culvert extensions are required to facilitate an upgrade of the existing access road to QLDC LDSC Figure E3 where it crosses Pongs and Cringles Creeks. These culvert extensions will take place on the downstream side so as not to impact on sensitive upstream environments. Barriers could be installed to limit the road width at these crossings, but earthworks negating the need for barriers has been provided for in the earthworks drawings.

6.4 Assessment of Infrastructure Effects

Water sensitive design principles will be applied to mimic the existing hydrology of the area, namely soakage and runoff to the creeks. This will be achieved through a combination of on-site rainwater harvesting for reuse, soakage to ground and above ground dispersal.

Stormwater discharge to land and water is authorised by ORC's 'Water for Otago Regional Plan' which was prepared to manage the water resources of Otago in accordance with the Resource Management Act of 1991. Stormwater discharge from roads and overland flow not connected to a reticulated system to land or water is a permitted activity, subject to the rules set out in Section 12.B.1.9.

The discharge of stormwater from any road not connected to a reticulated stormwater system to water, or onto or into land, is a permitted activity, providing the discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage.

The permanent effects of the proposed systems on the environment are considered to be minor.

7 WATER SUPPLY

7.1 Existing Infrastructure

The closest water supply infrastructure to the development is owned by a private water company, Cardrona Water Supply Ltd., but due to spatial separation and lack of adequate supply this is not a suitable connection option for this development.

Existing dwellings within and around the site currently utilise an existing surface water take from Pringles Creek, see Environmental Associates Ltd's Permitted and Consented water off-take volumes letter 16 August 2019.

QLDC is also finalising the Cardrona Valley Water Supply Scheme, which is a collaboration project with Mount Cardrona Station. The infrastructure has not been commissioned, but a connection to this scheme is viable option once commissioned.

7.2 Proposed Development Flows

The proposed development will create a new demand for both domestic and fire-fighting water supply which will principally be catered for via a new surface water take from Pringles Creek in conjunction with suitably sized storage tanks. Alternatively, a new water connection to the QLDC Cardrona Valley Water Supply Scheme can be considered subject to capacity and final completion of this project.

Water derived from a surface water source will require a high level of treatment before it can be considered suitable for human consumption. Bacteriological content, nutrient levels, colour, pH and mineral content must be tested to determine the treatment required to comply with the Drinking Water New Zealand Standards. Above ground infrastructure would be required to treat the water with above ground pump enclosures across the distribution network to ensure the treated water reaches all parts of the development. The sizing and specification of the above ground infrastructure will be undertaken at detailed design to suit the development requirements.

E3 Scientific has advised that the proposed on-site planting will not require irrigation, so no specific allowance for irrigation flow is being made. Furthermore, non-potable demand could be partly met by the provision of on-site rainwater harvesting – this has not been specifically considered in the demand estimates.

Section 6.3.5.6 of QLDC's LDSC states that a minimum residential water demand of 700 litres/person/day should be provided. This volume allows for both indoor and outdoor use include landscape watering, external cleaning, and all internal uses. This development is proposing to use rainwater collection for irrigation use, thus reducing the volume of water required. Section 6.3.5.6 of NZS 4404:2010 advises there should be provision for 250 L/person/day which could still be considered conservative considering modern water saving appliances – approval of this 250 L/person/day figure is at the discretion of the Council.

Proposed water demand should be seen in the context of the 200 L/person/day wastewater demand presented in Section 5.2. In the absence of irrigation and with an allowance for leakage in the water distribution network, the majority of the water supplied will go to waste. Provision of a domestic water supply based on 250 L/person/day is therefore considered proportionate. Leakage from this small private scheme is likely to be lower than would occur in a much larger network such as in Queenstown.

A suitable static firefighting water volume will be required to meet QLDC requirements.

Estimates for the required water supply can be assessed in the following ways with respect to Table 8:

1. Based on on-site storage

2. Based on communal storage

3. Based on a combination of onsite and offsite storage

Table 8 Peak water supply demand comparing 250 and 700 L/person/day demand for single and 16 lots

Population equivalent (people)	Domestic water demand / person (L/person/day)	No. of dwellings	Average Daily Demand (L/day)[1]	Mean Day Max Month (L/day)[2]	Peak day (L/day)[3]	Peak hour (l/s)[4]	Firefighting demand (L/s)	Total required flow (L/s)
7	250	1	1,750	2,625	3,500	0.08	22	22.08
7	250	16	28,000	42,000	56,000	1.30	23	24.30
7	700	1	4,900	7,350	9,800	0.23	24	24.23
7	700	16	78,400	117,600	156,800	3.63	25	28.63

1. *The operational storage requirement are based on assumptions within WSA 03-2002:*
2. *Average Daily (AD) demand is people x L/person/day x No. of dwellings*
3. *Mean Day Max Month is 1.5 times AD*
4. *Peak Day (PD) is 2 times AD*
5. *Peak hour is 1/12th of PD*

Option 1 considers each dwelling having its own on-site storage tank for domestic and firefighting water supply. Experience within QLDC shows that a static firefighting water supply of 20,000 L within a 30,000 L tank is normally acceptable although a smaller domestic demand volume than 10,000 L could be admissible based on 250 L/person/day average demand; Table 8 Shows that peak day volume for a single property is 3,500 L based on 250 L/person/day compared to 9,800 L based on 700 L/person/day. On-site booster pumps would provide the required minimum 250kPa pressure for domestic use. On-site tanks could be above or below ground and would negate the need for a communal storage facility. The 20,000 L firefighting volume negates the need for hydrants with the on-site tanks being drip-fed by a small-bore line distributing potable water from the communal treatment facility. On-site tanks also provide a degree of resilience and flexibility because water can be tankered into individual lots which may assist with the staged development of the site. Combined on-site domestic and firefighting water storage would need to be carefully designed to ensure water quality is not compromised considering average daily turnover would likely be less than 2,000 L/day.

Option 2 considers communal storage southwest of Lot 16 with a water main supplying each lot for both domestic and firefighting. There may be opportunities to have parallel mains, one with untreated raw water for firefighting and a second with treated potable water for domestic use. Separate storage tanks would increase the turnover of the domestic water that would be beneficial from a water quality perspective. This arrangement would incur the extra capital cost of the second pipe in a slightly wider trench whilst potentially saving operational cost on the amount of water to be treated – this saving would only be realised in the event the fire supply was used. Such an arrangement would require fire hydrants to be located in accordance with SNZ PAS 4509:2008 (Table 2): two fire hydrants will be required at a maximum distance of 135m and 270m from each lot, with each of the two hydrants providing a minimum of 12.5 L/s, a total of 25 L/s. Booster pumps would be required to convey water from the water take along a supply pipeline next to the access road to the storage tanks. The elevation of the storage tanks in relation to the rest of the site is likely to provide a minimum 100kPa of pressure at hydrants and 250kPa at buildings, and will be confirmed during detailed design.

The required storage for domestic water could be based on the 10,000 L / dwelling capacity implied by the typically consented on-site storage option presented in Option 1, or the 3,500 L peak day flow based on 250 L/person/day, 160,000 L or 56,000 L respectively.

Based on a water supply classification of FW2 to SNZ PAS 4509:2008 (Table 2), 45m^3 of storage is deemed to be an appropriate amount of static firefighting reserve water considering the need to supply two hydrants, although it could be argued the 20m^3 based on what is typically consented for on-site firefighting storage is sufficient. For the purposes of the communal firefighting water storage, only one building is assumed to be on fire at any time – this is appropriate considering the size of the lots and the separation distances between buildings. A conservative estimate of leakage from the new water reticulation main is 5% of the domestic + firefighting storage. Based on 250 L/person/day, this would give a total communal storage volume of approx. 110,000 L (56,000 + 45,000 + 5,050).

Option 3 would involve some hybrid of Options 1 and 2.

A new water take from Pringles Creek is proposed in the northern side of the development. This would take water in accordance with the permitted and consented water take from Environmental Associates Ltd's Permitted and Consented water off-take volumes letter 16 August 2019, shown in Table 9.

Water would be collected from Pringles Creek at the average daily demand which is, based on 250 L/person/day and 100% site occupancy, 0.32 L/s. The permitted and consented water take is presented in Table 9 with the maximum 30 day month take equating to 0.41 L/s (based on max 106,5000 L/month presented in 'Permitted and Consented water off-take volumes letter 16 August 2019') which means there is adequate permitted and consented water supply to service the development. In the event of drought and surface water take restrictions implemented by ORC, potable water will need to be tankered to site and community restrictions implemented to minimise water usage.

Table 9 Permitted and Consented Water Takes for the Roberts Family Trust Landholding (from Environmental Associates Ltd's Permitted and Consented water off-take volumes letter 16 August 2019)

Rule and Consent rate, volume and use	12.1.2.1[1] 0.5 L/s and 25,000 L/day	12.1.2.4[1] 10 L/s and 100,000 L/day Not for irrigation	12.1.2.5 0.5 L/s and 25,000 L/day For any use	RM17.212.01 1 L/s[2] and 3,000 L/day For any use
Maximum daily volume	25,000	100,000	25,000	3,000
Maximum monthly volume (30 day month)	750,000	300,000	750,000	90,000
Maximum potential daily water use	750,000	300,000	750,000	90,000
Maximum potential irrigation water use	0	0	750,000	90,000
Subject to suspension	0	300,000	750,000	90,000[3]

[1] *Permitted activity not subject to per-landholding requirement*
[2] *Cumulative instantaneous rate of take*
[3] *Subject to suspension if utilised for irrigation purposes*

The alternative would be to have a new water connection to the Cardrona Valley Water Supply Scheme.

7.3 Water Supply Management

If water is sourced from Pringles Creek and treated locally to Drinking Water New Zealand Standards there are two principal options for the storage and distribution of this water. Storage of some kind is required

because the peak instantaneous demands presented in Table 8 cannot be met based on the permitted and consented water take. The three Options for water supply management, introduced in Section 7.2, are summarised in Table 10. All three options require communal treatment at the water take with storage volumes being verified during detailed design based on a calculated water balance taking account of seasonal flow variations in Pringles Creek and a cost / risk assessment of more storage versus tankering supply in times of water scarcity.

Table 10 Example water storage and distribution options (excluding storage associated with the communal water treatment plant)

Option	Description with min storage volumes	Assessment	Decision
1	Based on on-site storage: • 20,000 L firefighting • 3,500 L domestic	A single onsite tank for each lot, potentially compartmentalised to retain firefighting flow and provide good turnover of domestic supply. Low pressure drip feed from communal main would keep tanks topped up.	Preferred option, results in most resilient and flexible supply.
2	Based on communal storage: • 45,000 L firefighting • 110,000 L domestic	A series of tanks to be provided local to the water take treatment facility supplying a pressure main (or possibly two if raw / treated water is segregated) that supplies each lot, including hydrants across the development.	Viable, although larger main with hydrants required.
3	Based on a combination of onsite and offsite storage • 45,000 L firefighting • 3,500 L onsite domestic	Option to retain onsite storage tank for resilience / flexibility of supply with communal raw water firefighting storage.	Possible advantages separating raw firefighting water from treated domestic, although largely incurring the disadvantages of both Options 1 and 2.

A variant of Option 1 could involve lots sharing a local water tank. The reality is that a single tank within 90m of two properties would need to be approx. 40,000 L to accommodate the firefighting demand and 10,000 L domestic demand / property. Providing storage this way may means standard size tanks aren't available and costs shift from the property owner to the developer. The sharing of water tanks is not deemed to provide any significant benefits over individual lot storage.

Raw and treated water storage would be required at the communal water treatment plant to buffer demand and to allow for pump operating volumes; these volumes would be additional to those shown in Table 10 and would be determined at detailed design to ensure adequate storage for the operation of the water supply system.

The proposed water take is near the high point of the development and all options will require a suitably sized distribution main and booster pumps as needed. Detailed design shall ensure that the required residual pressures are met in accordance with QLDC LDSC and other relevant standards in order to provide reliability and quality of supply.

As mentioned in Section 7.1, QLDC is also finalising the Cardrona Valley Water Supply Scheme. There may be an opportunity to recognise some synergies with this development. A future point of connection should be considered during detailed design and incorporated.

7.4 Assessment of Infrastructure Effects

The proposed surface water take can meet the required water demand of the development with storage providing the required buffer to accommodate peak domestic and firefighting demands. Potable water treatment methodology will be implemented to ensure the water supply meets NZ Drinking Water Standards. The permanent effects of the proposed systems on the environment are considered to be minor.

8 ACCESS

8.1 Existing Infrastructure

Curtis Road is a private road that takes access from the public Cardrona Valley Road via approx. 200m of private Pringles Creek Road. Only the first approx. 50m of Curtis Road, from its junction with Pringles Creek Road, is chip sealed with the rest of the road being gravel.

Existing culverts convey Pringles and Pongs Creeks respectively beneath Curtis Road. General stormwater drainage is accomplished via crossfalls and roadside swales.

8.2 Proposed Access

Access to the proposed development will continue to be via the sealed section of Curtis Road, as proposed in the subdivision masterplan. All roads within the development will remain private but will be upgraded to suit the number of lots served in accordance with Table 3.2 of QLDC LDSC. The proposed upgrades have been specified by Bartlett Consulting.

The road upgrades are summarised in Figure 4, as follows, see Bartlett Consulting documentation for details:

- The unsealed section of Curtis Road, just past its junction with Pringles Creek Road to the main residential cluster, will be upgraded to an increased carriageway width of 7.5m. This is made up of a 5.5m movement lane width, a sealed shoulder width of 0.5m each side plus 0.5m of unsealed shoulder, akin to LDSC Figure E3 road type. Refer Figure 4 below. The max. gradient of this road will be designed not exceed 16.0%.
- The upgrade of Curtis Road will also require minor changes to the layout of the intersection with Pringles Creek Road. To meet design guidance the intersection would include the installation of appropriate signs and markings as well as creating an intersection layout to meet the minimum requirements of Austroads guidance and QLDC requirements.
- The initial section of Road 1, providing access to Lots 2-15 shall be LDSC type E2 road.
- The other internal roads which serve less than 6 dwellings would be a LDSC type E1 road.
- Stormwater drainage of roads will generally be managed using swales with stormwater disposal in accordance with Section 6.3.
- All road pavement details and geometry will be developed at detailed design and shall conform to the requirements of LDSC. Typical sections for the different classes of road are shown in Figure 5.

Where Curtis Road crosses Pringles and Pongs Creeks the roadway will be widened to accommodate recoverable slopes and eliminate safety barriers. Reduced speed curves will be required in an effort to minimise changes to the road alignment. This will require earthworks within these creeks and the extension of the existing culvert. Care will need to be taken to ensure the ecological quality of the creeks is maintained as well as the vertical separation of the downstream culvert on Pongs Creek; to mitigate possible effects on the sensitive upstream sections of watercourse, culvert extensions will be made on the downstream side, with safety barriers being installed as required.

In order to accommodate the proposed road upgrades, the road reserve may exceed the current right of way easement, as shown on the earthworks drawings. This impact could be mitigated through the installation of new retaining walls and refinements made following a detailed survey at the next design stage.

Concept longsections for the roads have been developed to indicate the approximate grades that can be expected on the longsections. The longsections are included as Appendix 6 for reference and will be developed further during the detailed design process to ensure compliance with the QLDC LDSC requirements.

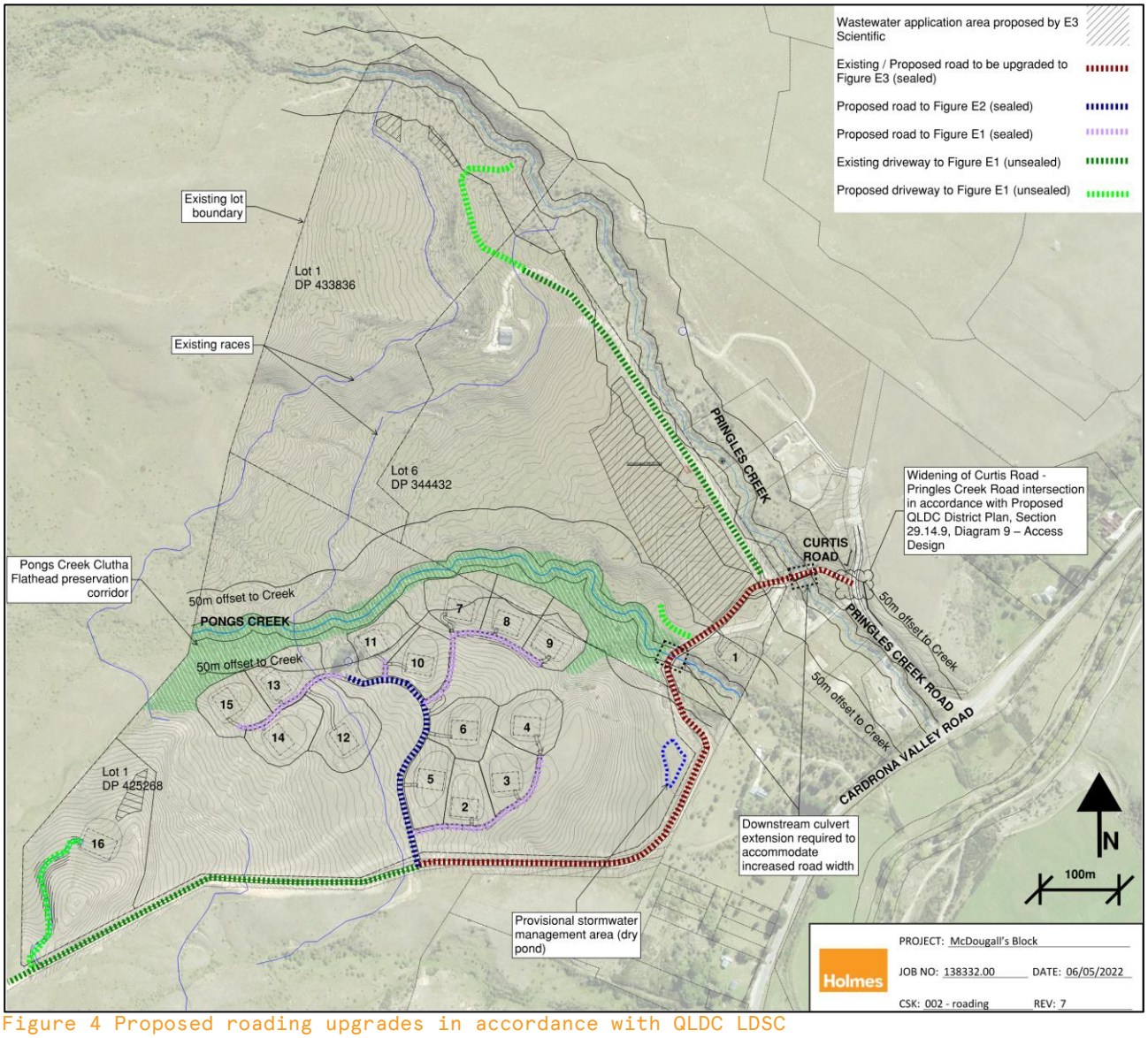


Figure 4 Proposed roading upgrades in accordance with QLDC LDSC

8.3 Assessment of Infrastructure Effects

The proposed development access will be formed to generally fit the existing site constraints, meet QLDC LDSC and achieve compliance with the QLDC District Plan Transport Rules.

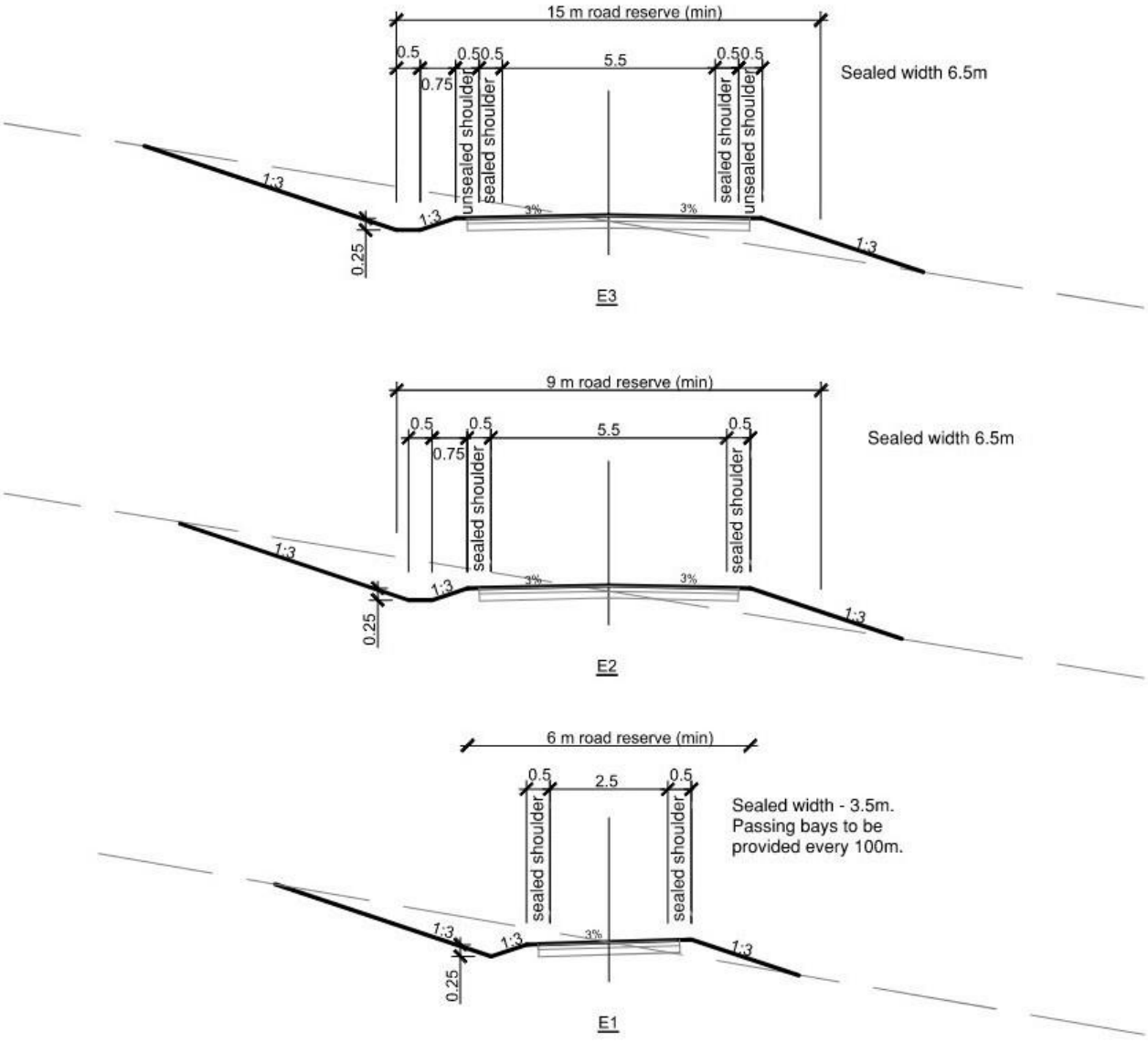


Figure 5 Typical sections for type E1, E2 and E3 roads complying with QLDC LDSC

9 BULK ENABLING EARTHWORKS

Site investigations into soil conditions have been undertaken in the vicinity of the proposed building platforms with the findings summarised in the Geotechnical Report. These investigations indicate that soils in the area are typified by topsoil, overlying softened fan alluvium overlying fan alluvium.

The proposed development will require earthworks to be completed to prepare the site for construction to include access roads and building platforms.

The development is embracing a low impact design philosophy to maintain its inherent rural and rustic character. The associated earthworks shall be sympathetic to the natural environment limiting visual impacts where possible

Cut and fill volumes have been estimated comparing a conceptual bulk earthwork cut model with the existing site surface, see Table 11 and Appendix 01. All cut and fill volumes have been taken from the current to proposed finished ground / surface levels with no allowance being made for pavement or building platform build up at this stage.

A crude assessment of topsoil strip can be done by taking the total earthworks area (55,000m^2) less the existing road area (6,000m^2) = 49,000m^2 and multiplying this by a 200mm deep cut = 9,800m^3. This would need to be verified at the next design stage to be used with any degree of confidence, as topsoil depths can vary.

Table 11 Estimation of earthworks volumes from drawing C20-01, see Appendix 01

Earthwork	Volume
Cut	22,520 m^3
Fill	17,060 m^3
Total	+5,460m^3

The earthworks drawings show the potential disturbance areas associated with the possible wastewater application and fill areas.

Preliminary calculations on the earthworks within 10m of the bed of both Pongs and Pringles Creek have also been completed. The calculations indicate that the volume of earthworks will exceed 5m^3 for the culvert and road upgrades at both creeks. Refer to Appendix 7 for these calculations.

The existing right of way easement is also shown. It should be noted that the E3 upgrade to Curtis Road extends outside of the current easement, based on the 1:3 batter slopes advised by the geotechnical engineer. At the next design stage the extent of the permanent works associated with this upgrade can be reviewed with options to reduce the extent including retaining walls or steeper slopes, potentially utilising ground reinforcement.

All earthworks will be undertaken under the supervision of a Geotechnical Engineer and in accordance with Geotechnical recommendations to ensure that stability of the site and adjacent sites is maintained, and adequate compaction of fills is achieved during construction. All batters will be constructed in accordance with the recommendations set out in Geosolve's Geotechnical Report, presented in Table 12 – the permanent cut slope values have been used as part of the conceptual earthworks modelling.

Table 12 Recommended maximum batter angles for cut slopes up to 3m high in site soils, taken from Table 2 of Geosolve Geotechnical Report

Material Type	Recommended Maximum Batter Angles for Temporary Cut Slopes Formed in Soil (horizontal to vertical)		Recommended Maximum Batter Angles for Permanent Cut Slopes Formed in Soil (horizontal to vertical)
	Dry Ground	Wet Ground	
Topsoil and Softened Fan Alluvium	2H : 1V	3H : 1V	3H : 1V
Fan Alluvium	1.5H : 1V	3H : 1V	2.5H : 1V

An erosion and sediment control plan (ESCP) prepared in accordance with 'Queenstown Lakes District Council's Standard for Environmental Management Plans' will be prepared by the contractor. This will detail specifically how erosion and sediment control will be managed with the construction layout and be submitted to QLDC for approval prior to the commencement of works. This will prevent dust and contaminated soil running into the creeks.

A preliminary ESCP has been compiled prepared as part of the consent application to the Otago Regional Council, and is included as Appendix 5. This demonstrates how erosion and sediment control can be managed during the construction process to avoid and/or mitigate potential adverse effects arising from sedimentation, dust, discharge etc.

The permanent effects of the proposed earthworks on the environment are considered to be minor.

10 OTHER SERVICES

Gas infrastructure does not extend to the development boundary and any gas use on site will require individual gas bottle supply.

The existing site is currently supplied with power from Aurora Energy. Aurora Energy have confirmed via email, enclosed in Appendix 02, that a point of supply is available for this development.

The existing site is currently supplied with a telecommunication connection from Chorus Network Services. Chorus has provided a provisioning letter via email, enclosed in Appendix 03, stating the development can be supplied with the required infrastructure.

Appendix 1

Holmes Resource Consent drawing set

Version 7
19 July 2022
138332.00

McDOUGALL'S BLOCK PROJECT
ROBERTS FAMILY TRUST
QUEENSTOWN

Holmes Consulting

Project 138332.00

Drawing Index

Project Notes

1 The contractor shall obtain all applicable codes, licenses, standards, specifications, etc. which are necessary to perform the proposed work at no additional cost to the owner.
2 Construction specifications issued with this project must be used in conjunction with these drawings. Specifications take precedence over drawings if there is a discrepancy between them.
3 The contractor shall maintain one copy of the current and approved construction plans, specifications, resource consent and building consent at the job site at all times.
4 The contractor shall notify the Design Engineer immediately upon discovering any conflicts or other problems in conforming to the approved construction drawings, specifications or details for any element of the proposed improvements prior to proceeding with its construction.
5 Offsite and adjacent site data is for information purpose only.
6 Otago LiDAR 1m DEM (2016) elevations were obtained from Land Information New Zealand (https://data.linz.govt.nz)
7 Proposed site plan (including accessibility requirements and car park configuration) designed and provided to Holmes Consulting, Ltd by: Baxter Design, drawing referance number 2738 dated 18 February 2020
8 Contractor shall reference "Geotechnical Report by Geosolve Ltd, dated July 2019.
9 Access to all adjacent properties and facilities shall be maintained at all times.
10 If hazardous material or suspect material is encountered the contractor shall notify the Client, Project Manager, and Design Engineer before continuing work.
11 All existing underground utility information (public and private) is indicative only and shown according to the best information available to the Design Engineer. The contractor shall contact all utility owners prior to beginning excavation or site grading. It shall be the contractor's responsibility for locating and protecting all utilities during construction and for coordinating with the appropriate utility company for any utility crossings required.
12 The contractor shall be responsible for the coordination of the installation or relocation of all utilities above and below grade (water, wastewater, stormwater, street lights, gas, electric, telecommunications, etc.).
13 Permission for any contractor or client proposed use, disturbance or access of offsite property, permanent or temporary, shall be obtained by the contractor in advance of the work.
14 The contractor shall provide written copy of any agreement or permit to use offsite property to the client prior to any use. The contractor shall not obligate the client to any stipulations unless the client becomes a party to the agreement.
15 Property boundaries shall be clearly indicated in order to delineate allowable limits of construction. No offsite disturbance allowed without adjacent property owner approval.
16 Boundary lines and easements indicated hereon reflect information proved by Baxter Design as part of their Masterplan. This plan may not include all information of record.
17 All work located within the road reserve shall be in accordance with the latest edition of the QLDC LDSC.
18 All site work to be in accordance with the New Zealand Building Code and all other relevant standards.
19 All abandoned water, wastewater, and stormwater mains, manholes, stubs and accessories shall be abandoned per Council specifications.
20 The contractor shall provide all required temporary traffic control in accordance with Council and NZTA standards.
21 Contractor shall be responsible for temporary erosion and sediment control during construction.
22 Contractor to check all set out dimensions and coordinate with the appropriate discipline.
23 All landscaping and revegetation requirements by others.
24 All areas disturbed by construction and not paved at the completion of construction shall be reinstated to original conditions.

All dimensions to be verified on site before making any shop drawings or commencing any work

Rev	Date	Appd	Reason
4	2020-03-04	GWF	Consent

Consultants

Baxter Design Group Ltd
Landscape Architect

Geosolve Ltd
Geotech

Origin Consultants Ltd
Archaeological

Environmental Associates Ltd
Water Suply

Bartlett Consulting
Traffic

E3 Scientific
Contamination and Ecology

Maestro
Project Delivery
maestroprojects.co.nz

Holmes Consulting
39 Market Place
Auckland 1010
New Zealand
HolmesConsulting.co.nz
T: +64 9 965 4789

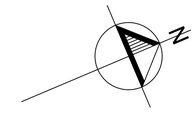
McDOUGALL'S BLOCK PROJECT
ROBERTS FAMILY TRUST
QUEENSTOWN

Sheet Title: drawing index and project notes

Drawn JAV- Scale nts (at A1)

Filename 138332.00 P - C00 Cover sheet and drawing index.d

Job No 138332.00 Sheet No C00-01 Rev 4



notes:

1. contours at 1m intervals

legend:

- Contours major (existing)
- Contours minor (existing)
- Lot boundary (existing)
- Adjacent lot boundary (existing)
- Subdivision lot boundaries (proposed)
- Building platforms (proposed)
- Curtilage Areas (proposed)

All dimensions to be verified on site before making any shop drawings or commencing any work

This drawing set contains colour.
All reproduction to be in colour.

Rev	Date	Appd	Reason
3	2020-01-22	TS	consent (Omit Lot 17)

Consultants

Baxter Design Group Ltd Landscape Architect	Environmental Associates Ltd Water Suply
Geosolve Ltd Geotech	Bartlett Consulting Traffic
Origin Consultants Ltd Archaeological	E3 Scientific Contamination and Ecology

Maestro
Project Delivery
maestroprojects.co.nz

Holmes
Holmes Consulting
39 Market Place
Auckland 1010
New Zealand
HolmesConsulting.co.nz
T: +64 9 965 4789

McDOUGALL'S BLOCK PROJECT
ROBERTS FAMILY TRUST
QUEENSTOWN

Sheet Title: existing site and contour plan

Drawn JAV | Scale 1:2000 (at A1)
Filename 138332.00 P - C10 Existing conditions.dwg
Job No 138332.00 | Sheet No C10-01 | Rev 3