Terramark
Setting New Boundaries

Application for Resource Consent in accordance with Schedule 4 of the Resource Management Act 1991

1 November 2023

Prepared by Darryl Sycamore
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Please Reply To Dunedin Office
Our Ref: 230195

3 November 2023

Dunedin City Council
PO Box 5045
DUNEDIN 9054

ATTENTION: The Senior Planner

Dear Sir/Madam

Re: Subdivision Application – 195 & 245 Wakari Road, Dunedin

On behalf of JKS Paddock Limited, we submit for consideration by your Council an application for subdivision for Stage 1 of a staged development at 195 & 245 Wakari Road, Dunedin.

Please find enclosed the following documents:

1. Records of Title OT17C/596 and 795015
2. HAIL application for 195 Wakari Road
3. Terramark Stage 1 Scheme Plan dated 30 October 2023
4. Terramark Stage 1 Earthworks Plan dated 30 October 2023
5. Terramark Stage 1 Typical Road Cross-Section Plan dated 30 October 2023
6. Modal Consulting Transport Assessment dated October 2023
7. Fluent Solutions Limited Integrated Catchment Management Plan dated October 2023
8. Geosolve Geotechnical Report for 195 & 245 Wakari Road dated 7 July 2023
9. DCC Subdivision Consent SUB-2023-73

For reference, the applicant's details are:

JKS Paddock Limited
[redacted]

All resource consent associated correspondence is to be directed via the writer; the applicant's agents, and our contact details are as follows:

Terramark Limited	Attention:	Darryl Sycamore
Level 1 330 Moray Place	Phone:	03 477 4783
Dunedin 9016	Email:	darryl@terramark.co.nz

If you have any further queries, please do not hesitate to contact the undersigned.

Yours faithfully
Terramark Ltd

Darryl Sycamore
Resource Management Planner

Existing Title Structure

The property subject to subdivision is currently comprised in a two Records of Title.

For 195 Wakari Road (the 'Kidston Block') the property is legally described as Part Deposited Plan 6568, Lot 1 Deposited Plan 10300 and Part Lots 1 & 2 Deposited Plan 12686. It comprises 5.9116ha and is in the name of JKS Paddock Limited. There are a number of encumbrances associated with the Record including a Building Line Restriction 241814 and an Encumbrance 5114600.2 to the Dunedin City Council (the Council). Whilst the BLR has no relationship with the proposal the encumbrance materially affects the use of the land and is detailed further in this application. The site enjoys legal and physical access to Wakari Road.

With respect to 245 Wakari Road, the site is legally described as Lot 1 Deposited Plan 513716. It is comprised in RT 795015, has an area of 9.6451 hectares and is in the name of Jeffrey Irvin Holloway and Gregory Scott as to ½ shares each. There are two interests appended against the Record and neither have any interaction with the proposal. The site has legal and physical access to Wakari Road.

Site Description

Stage 1 will be comprised entirely within the Kidston Block as shown in Fig.1. It is an irregular parcel of land which is rural in nature. The site is gently sloping rising from 204m asl at Wakari Road up to 225m asl towards to rear of the site. The property rests between the ribbon of existing residential development along Wakari Road and the Flagstaff Hills to the north.

245 Wakari Road was recently the subject of subdivision SUB-2023-73 approved by Council on 16 August 2023. The subdivision created two lots, separating 3.71ha in proposed Lot 1 (the 'Scott Block South') from the remainder of the site in proposed Lot 2 (being the 'Scott Block North') as shown in Fig. 1 below. Access to both lots will continue to be from the existing vehicle crossing, which sits within proposed Lot 1. A proposed ROW will be created in proposed Lot 1, serving proposed Lot 2 which will potentially enable access to the Kidston Block in subsequent stages. This ROW will also provide the opportunity for construction access for Stage 1 of the Kidston Block.

Figure 1 : Layout of the Kidston and Scott Blocks

The site is currently offered a 12.1m wide access onto Wakari Road, which enjoys good sight lines. Wakari Road is a two-lane carriageway with kerb and channel.

Encumbrance 5114600.2 provides for a 20m wide strip within which "no building may be built or erected" against the existing ribbon of residential properties fronting Wakari Road. The extent of the encumbrance is shown in Fig.2 below. Other than the no-build requirement, there is no stipulation or restriction in the instrument as to ownership of the area or other use. For clarity, the encumbrance does not prohibit residential sites being located or partially located within the area.

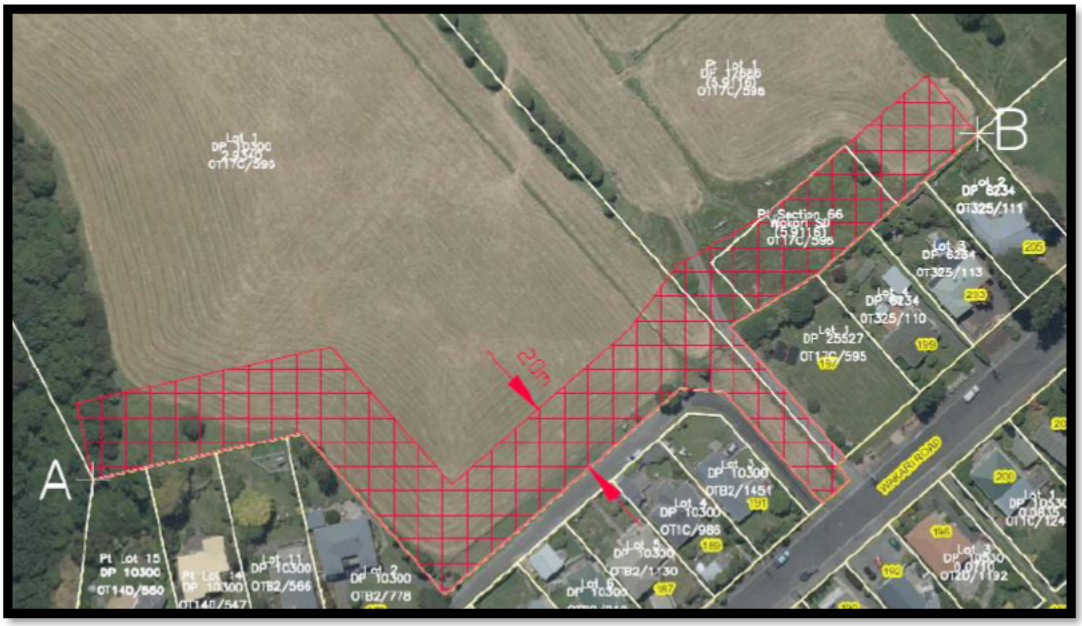

Figure 2 : Area Subject to Encumbrance 5114600.2

The site was recently rezoned General Residential 1 under the Variation 2 decisions of the 2GP. A New Development Mapped Area applies to the site and a Structure Plan Mapped Area overlay is applied to this area. A Residential Transition Zone formerly applied to a ribbon of the site fronting Wakari Road however this annotation was recently uplifted from the 2GP. High Class Soils partially extend into the property although these were assessed in the Variation 2 hearings prior to the land being rezoned as suitable for residential development. The NPS Highly Productive Land does not apply to this site.

There is no existing DCC Stormwater infrastructure located within the proposed development site. Any existing infrastructure is located under Wakari Road and to the southeast of Wakari Road. The nearby DCC stormwater networks consist of open channels and associated culverts which convey the overland flows to either the western stream or the channel running through the neighbouring site at 210 Wakari Road before discharging though an existing DCC owned culvert under Wakari Road. Both channels eventually end up discharging into Ross Creek.

Geosolve Limited carried out onsite investigations in July 2023 to assess the site-specific geology. Geosolve found that the site comprises colluvium and volcanic soils, and observed silty clays, with some gravel and traces of sand present in various test pits. Their report states that the site is naturally free-draining and there are no major areas of saturated ground within the wider site. There are no areas of saturated ground at all within Stage 1. Groundwater was not observed in any of the test pits within the development site. Test Pits AH1-AH8 are located within the Stage 1 area; test pit profiles are presented in the Geosolve report appended to this application.

Background to Application

As part of the 2GP Variation 2 process, the subject site was promoted as being suitable for additional development.

The principal purpose of Variation 2 was to enable Dunedin City Council to meet its residential capacity obligations under the National Policy Statement on Urban Development 2020 (NPS-UD). It was recognised that the existing housing capacity, as provided for by the 2GP, was insufficient and Variation 2 was designed to address the identified shortfall through mechanisms such as new residential zoned areas and adjustments to the density rules within existing residential zones. The site was rezoned to General Residential 1.

As part of that rezoning package, future development and access matters were considered to enable residential development to the north within the other adjacent rural zoned land parcels.

Following a favourable panel decision for the rezoning, the applicant initiated a discussion with the owners of the Scott block to develop both sites as one larger project. Lot 1 as approved by SUB-2023-73 was purchased by JKS Paddock Limited and once title issues within the next few weeks, ownership of Lot 1 will transfer to JKS Paddock Limited.

Accordingly JKS Paddock Limited retains ownership of the Kidston Block, and subject to the issue of title also to proposed Lot 1 being the Scott Block South.

Previous Consent History

Subdivision SUB-2023-73 approved the subdivision of the Scott Block to create Lot 1 which would be immediately carried into the overall development as a subsequent stage.

Figure 3 : Subdivision SUB-2023-73 on the Scott Blocks

Lot 1 comprised the 3.71ha of land adjoining the Kidston block and included a 16m wide access strip over the current formed driveway from Wakari Road. A Right of Way easement burdened against proposed Lot 1 for the benefit of proposed Lot 2 will provide both current access and allow for construction access as well as potential future residential access from Wakari Road.

Proposed Lot 2 comprises 5.94ha and include the existing residential unit, outbuildings and stand of mature macrocarpa. Access will continue over Right of Way 'A' as is the current situation.

Proposal

Terramark Plan 230195/12 shown below as Fig.4 sets out Stage 1 of the development comprising the land within the Kidston Block being the southern portion of the site proper.

Figure 4: Stage 1 Development Plan

Stage 1 will contain 36 new residential lots ranging from 404m^2 to 1,032m^2 in area. Lots on the upper slopes and southwestern boundary where the site falls toward the creek are proposed to contain two-level dwellings. The balance of the lots will be restricted by private covenant to single level dwellings with a maximum height of no more than 5.5m. Proposed Lots 10 and 13 are earmarked for duplex development – that is two dwellings sharing a common wall.

Consent will be sought for a breach of the front yard provisions for proposed Lots 25, 27, 32 and 36 which each enjoy frontage against two formed roads. It is proposed that a 3.0m front yard apply for these lots on one boundary and a 4.5m front yard setback remains on the other. Each new landowner can determine which boundary the setback reduction is to apply against at the time of seeking Building Consent.

The land to the west of the access road (Road 1) is proposed to vest as reserve. A 15m strip will be landscaped and planted, predominantly with native species, a walking / cycling path created and the proposed low impact design stormwater detention pond integrated into the landscaped area as a natural basin with high amenity values. Lots 1-7 and Lot 8 will have a frontage to this greenway. These lots will be subject to a private covenant enforcing the 5m strip with the lots subject to the no-build restriction.

A pedestrian accessway between Lots 12 and 13/14 from Road 1 will provide a further access point to the greenway and the adjacent creek. The location of this reserve provides a future opportunity for access to be provided to the recently rezoned land at Honeystone Street, and in effect creates a continuous green corridor between the different parts of the rezoned areas.

A further stormwater pond will be created in the land to the west of the access road (Road 1). It is envisaged that this area will in time be vested as reserve given the potential for it to be successfully integrated into the adjacent Council owned Bain Reserve.

Three access lots to service residential lots will be constructed. Access Lot 101 will be held in four undivided shares with proposed Lots 1-4. Access Lot 102 will be held in four undivided shared with proposed Lots 7-10 and Access Lot 103 will be held in four undivided shares with proposed Lots 13-16.

Stormwater

Fluent Solutions Limited have undertaken significant investigative works to design a low impact stormwater design for the site. An Integrated Catchment Management Plan (ICMP) was developed to ensure post-development flows will be held in the two proposed ponds to ensure that any discharges from the site is at no more than pre-development levels. It is Fluent's opinion the ICMP complies with the requirements of DCC 2GP Policy 9.2.1.Y.

There is no existing DCC stormwater infrastructure located within the proposed development site. Any existing infrastructure is located under Wakari Road and to the southeast of Wakari Road. The DCC stormwater networks which consist of open channels and associated culverts which convey the overland flows to either the western stream or the channel running through 210 Wakari Road. Both channels eventually end up discharging into Ross Creek.

Residential lots greater than 600m^2 in area will be required to have onsite detention tanks to mitigate increased post-development runoff. These detention tanks hold back peak stormwater flows and enable controlled discharge into the wider stormwater network following the storm peaks. This concept assists in keeping post development flows below predevelopment flows. Sizing will be confirmed during detailed engineering design but will be approximately in the order of a 3,000 litre tank on each lot. The outlet orifice on the tanks will be sized such that the runoff from the lots is no greater than the runoff during pre-development from the same lot area. The tank outlets will drain to the piped stormwater network located within the roads. It is proposed that lots smaller than 600m^2 will discharge stormwater directly to the piped stormwater network located in the roads.

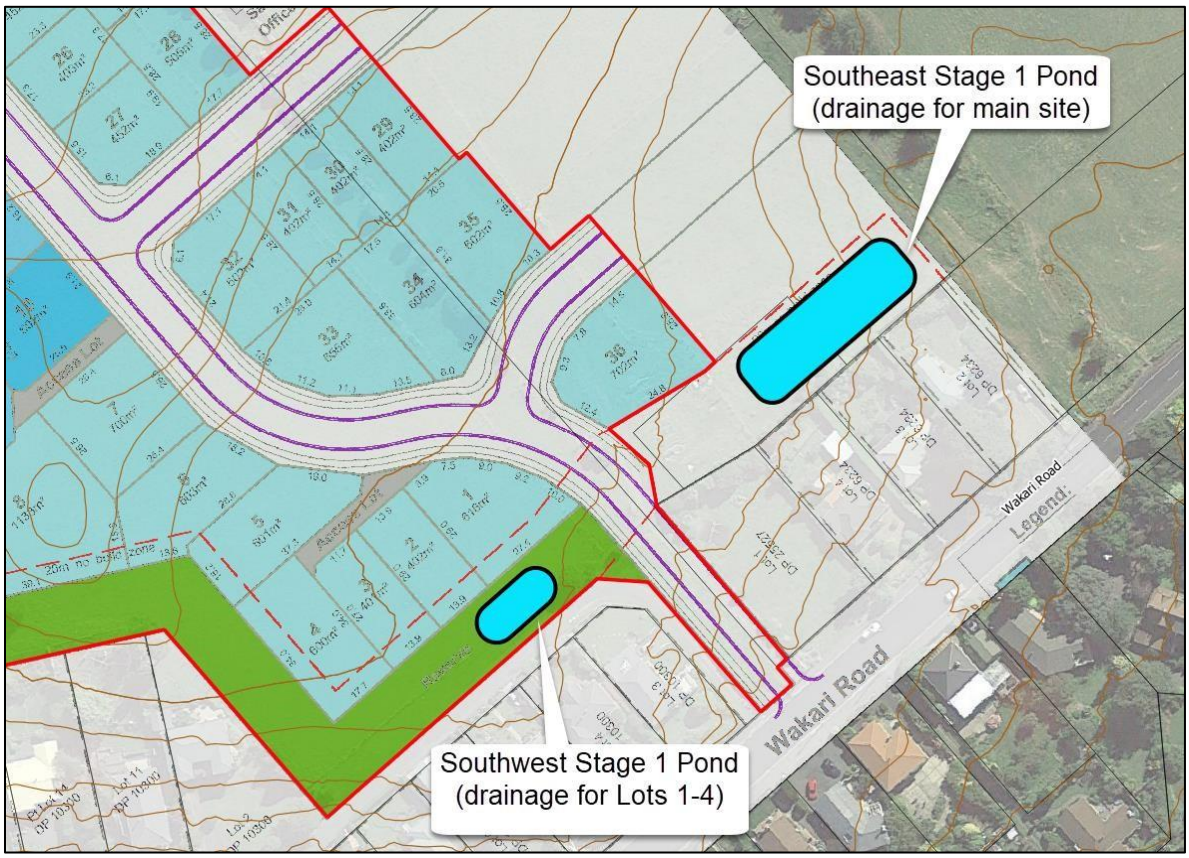

Figure 5 : Stage 1 Detention Pond Locations

The roads and footpaths will also discharge stormwater into the piped stormwater network via kerb and channels feeding into standard mudtanks. The piped stormwater network in the roads will be designed for 10yr ARI flows using climate change rainfall (RCP8.5 2081-2100) in accordance with the DCC COP. Pipe sizes will be confirmed during detailed design. The piped stormwater network will drain down towards the detention pond (sized for 100yr ARI storms) described below.

Roads will also be used as secondary overland flow paths within the development. Flow rates will be calculated for 100yr ARI flows in accordance with the DCC COP. The runoff will be collected by large mudtanks on Road 1 near Lot 36 of the Stage 1 development and will drain to the into the larger detention pond via larger pipes that have been sized for the 100yr ARI flows. Runoff from Lots 1-4 will drain to a smaller detention pond (sized for 100yr ARI storms) located adjacent to the lots which will in turn discharge toward the larger pond on the opposite side of Road 1.

The flows exiting the detention ponds and draining towards the existing low point of the development (adjacent to Lot 2 DP513716) will be controlled by the use of flow control devices such that post development flows do not exceed predevelopment flows leaving the site in accordance with the DCC COP. Along the upper extent of the site, a cut-off drain running along the northwest boundary will intercept hillside runoff flow from the upper Flagstaff catchment area and convey the water to the western stream. Most of this upper catchment is already draining there naturally in the pre-development case with an existing cut-off drain near the upper boundary.

Based on the Fluent report and ICMP it is my opinion the effects on the receiving environment and existing infrastructure will be less than minor.

Transportation Matters

With respect to transportation matters, Wakari Road is classified as a Local Road at the site, but further to the southwest it is classified as a Collector Road. A new road intersection with Wakari Road will be constructed to serve as the primary entrance to Stage 1. It is anticipated that access to future stages could be provided via the further access to Wakari Road over the Scott Block South although this is subject to design and is not applied for here. The proposed access will provide primary access to the subdivision, with the proposed internal roading network including access lots providing access to properties. The road design has been carried out with expert guidance from Modal Consulting Limited. Modal concluded the new layout and design will:

- Encourage a low-speed environment through a combination of physical dimension and alignment;
- Include footpaths and grass berms;
- In response to the under width access from Wakari Road, a single footpath will be located on the southwestern side of initial portion of proposed Road 1, reverting to footpaths on both sides of the internal road network;
- Include good levels of pedestrian connectivity throughout the site to ensure the walkability within the development; and
- Provision for road connections to future stages of the development to the northeast of the subdivision site.

Traffic generation and safety assessments were also prepared by Modal. For the proposed 38 units (accounting for two duplex sites), up to 34 vehicle movements per hour at peak periods are anticipated with 312 movements per day. An assessment for up to 100 residential units using this access was also provided in terms of contemplating the effects at the completion of all development stages.

Access

Access to the site is via a 12.1m access strip owned by the Applicant.

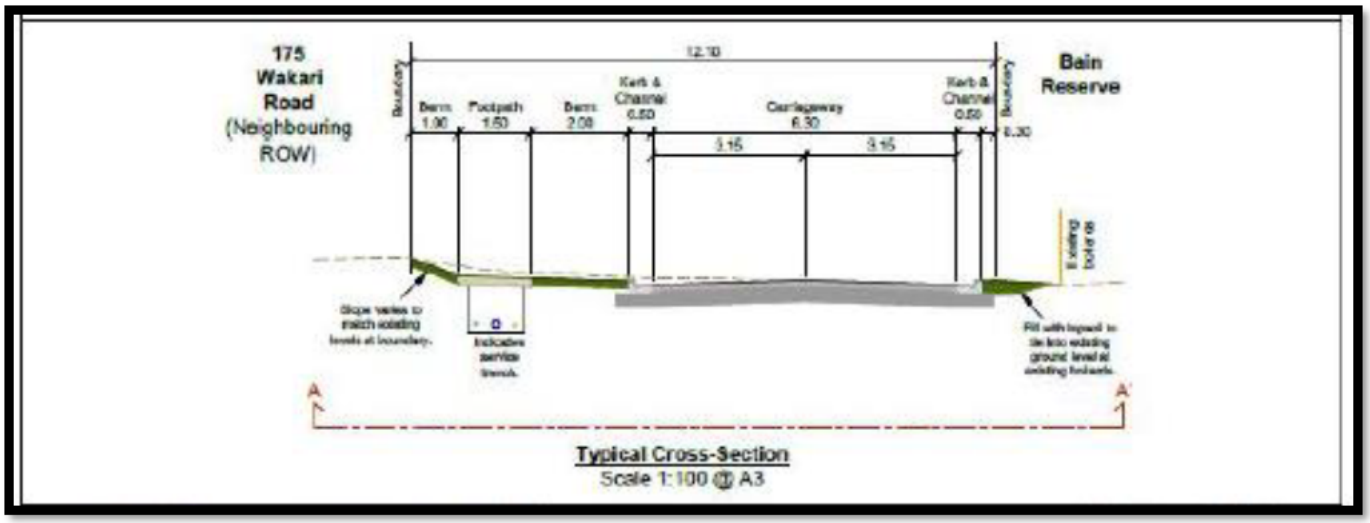

Figure 6: Typical Road Cross-Section for Access Between #175 Wakari Road and Bain Reserve

Design of Road 1 adjacent to the Bain Reserve is shown in the cross-section above. To the south is the Right of Way owed by 175 Wakari Road, which serves a number of residential properties. To the north sits Bain Reserve. Whilst it is accepted that the boundary to boundary legal width of this portion of Road 1 is technically under width, the carriageway is the same width as the remainder of the roads within the subdivision. The expert assessment by Modal considers the overall formation design and limitations are acceptable given the context of those breaches and is supportive of the design from an operational and safety perspective.

The proposed new road intersection will be formed as a T-intersection with Wakari Road, as shown in Figure 7 below. Modal notes that whilst the intersection does not require priority intersection control, it may be desirable to install controls to enhance conspicuity of the intersection.

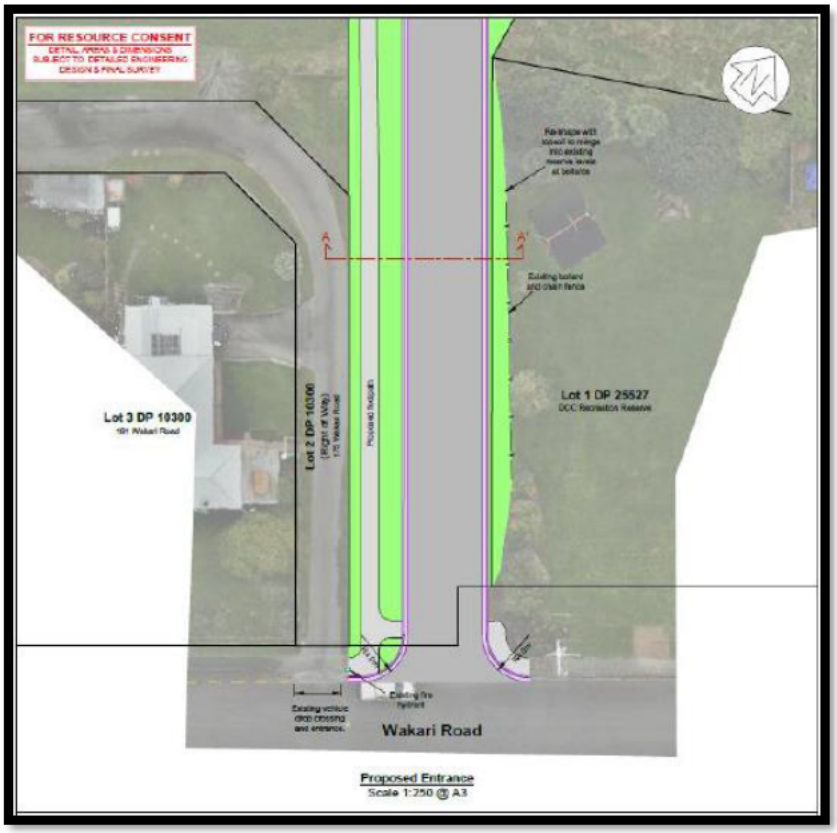

Figure 7 : Access Formation Design Between #175 Wakari Road and Bain Park

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Appropriate sight distance requirements at an intersection are indicated in the Austroads publication "Guide to Road Design" Part 4A "Unsignalised and Signalised Intersections". The two key sight distance parameters most relevant to the proposed intersection location are:

- Safe Intersection Sight Distance (SISD), which provides a sufficient distance for a driver of vehicle on the major road to observe a vehicle from a minor road approach moving into a collision situation and to decelerate to a stop before reaching the collision point.; and
- Minimum Gap Sight Distance (MGSD), which provides a sufficient distance for a driver of a vehicle entering onto a major road to see a vehicle in the conflicting traffic stream in order to safely commence the desired manoeuvre.

The sight distance requirements for each were assessed and are considered further in the Modal Transport Assessment. These are based on an operating speed of 50km/h being the set speed limit for the carriageway. While no grade correction has been applied, the proposed intersection location is effectively located on a crest meaning that these values are conservative, as vehicles on Wakari Road will be travelling uphill toward the intersection. Both the measures were assessed as acceptable in Modal's expert opinion.

With respect to the proximity to the Right of Way, it is acknowledged that the vehicle crossing to the right of way within 175 Wakari Road will be located in close proximity to the proposed intersection. It is noted that, Rule 6.6.3.4.a of the 2GP requires a separation of 10m between a vehicle crossing and a "Local Road-Local Road" intersection, whereas only 5m can realistically be achieved due to existing boundary positions and the proposed carriageway location.

In assessment of the proximity of the new intersection to the right of way, it is the expert view of Modal Consultant that as the road network near the site primarily serves residential areas, it is expected that most drivers (particularly at peak times) will be familiar with any potential conflict arising due to the proximity of the vehicle crossing and the new road intersection, reducing the likelihood of such conflict occurring. Furthermore Modal consider vehicle turning movements into and out of the right of way, and new road intersection, are expected to be undertaken at low speeds, and therefore be well below the safe systems-recognised threshold speeds for "Head-on" and "Intersection" type crashes.

Overall, Modal considers the proposed separation distance between the new road intersection and the right of way can be supported in this instance given that existing boundary positions do not allow for compliance with the relevant 2GP rule, and both the likelihood of conflict and the severity of crashes are assessed as being minimal. I have read and concur with this assessment.

Earthworks

Earthworks will be required as part of the wider site development, which is shown in the figure below.

Approximately 8,600m^3 of cut will be required for the construction of the lots, the roading network and the stormwater detention ponds. Approximately 5,300m^3 of fill will be required. Maximum depth of cut is 3.4m and maximum depth of fill is 1.7m. Bulk earthworks figures will be fine-tuned during detailed engineering design. Any excess material will be stockpiled in a controlled area elsewhere on the site.

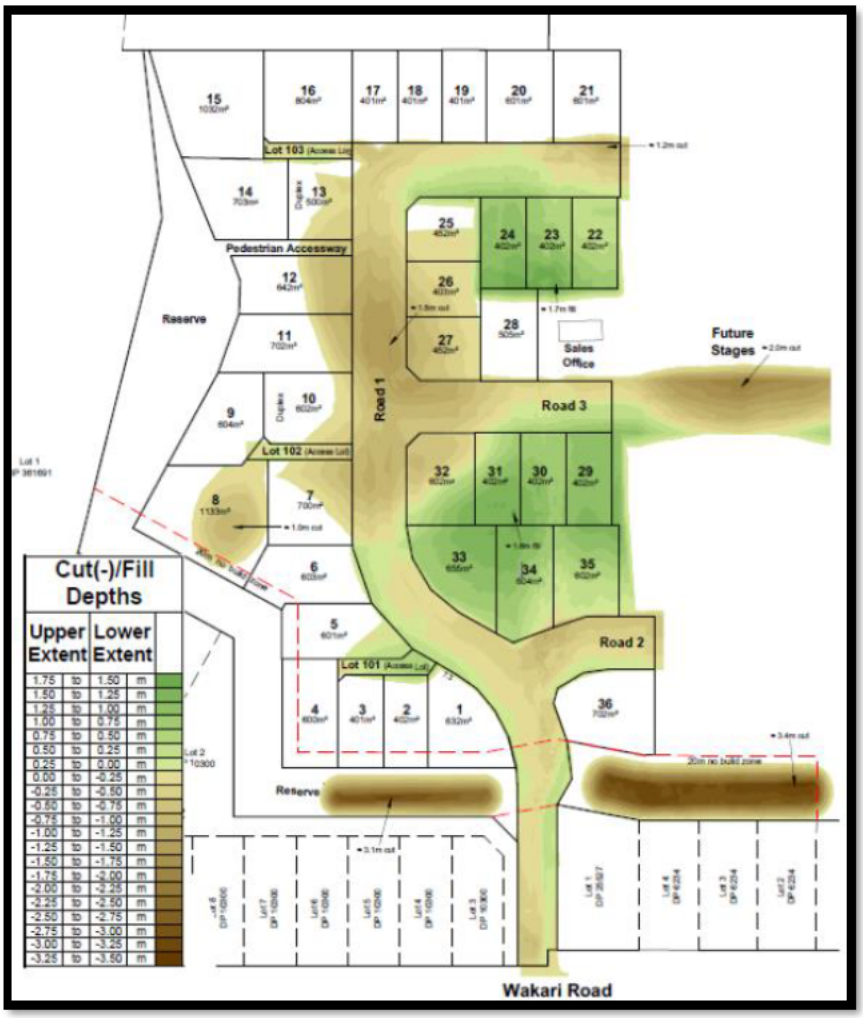

Figure 8 : Stage 1 Earthworks Plan

Earthworks has been designed with input from Fluent Solutions and design by Geosolve Limited. Works will be overseen by suitably qualified and experienced persons to ensure sediment loss beyond the site is appropriately controlled.

Public Mains

A 300mm distribution main is located within Wakari Road. Water will be provided to Stage 1 via a take-off the distribution main. This matter has been the subject of discussions with the DCC and given the scale of the wider development, agreement has been reached to allow direct connection

A foul sewer line is found within the Wakari Road carriageway at the entrance to the site comprising a 150mm main. Stormwater can be managed via on-site detention for smaller sites with larger sites being directed to the two public stormwater detention ponds.

Fire Fighting Water Supply

A number of existing fire hydrants are located along Wakari Road however given the scale of the development, these will not comply with the SNZ/PAS:4509:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice. WFH00980 is located near the proposed access with Wakari Road and WFH00979 is sited further to the north-east. They are approximately 280m and 375m respectively from the upper extent of the Stage 1 development.

New fire hydrants will be installed as required to service the wider development as part of the road construction associated with Stage 1 on the Kidston block.

Easements

A number of new easements will be required for Stage 1. These relate to the ownership of Access Lots 101, 102 and 103. This is shown in the schedule of easements on the scheme plan. Additional easements may be required for the detention ponds in the reserve area.

No other easements or encumbrances are required for the stage of the proposal. It is however appropriate to incorporate the following notice into the consent decision to address any unforeseen easement matters.

> *"If a requirement for any easements for services, including private water supply pipes or private drainage, is incurred during the survey then those easements must be granted or reserved and included in a Memorandum of Easements on the cadastral dataset."*

Reasons for Application

Dunedin currently has two district plans: the Operative Dunedin City District Plan 2006 (the "Operative District Plan", and the Proposed Second-Generation Dunedin City District Plan (the "Proposed 2GP"). Until the Proposed 2GP is made fully operative, both district plans need to be considered in determining the activity status and deciding what aspects of the activity require resource consent. Variation 2 of the Proposed Plan was notified on 4 February 2021.

The site was recently rezoned General Residential 1 under the Variation 2 decisions of the 2GP. A New Development Mapped Area applies to the site proper and Structure Mapped Plan overlay is applied to this area. Until recently, a Residential Transition Zone applies to a ribbon of the site fronting Wakari Road. DCC has recently formally uplifted the RTZ annotation in the Plan. High Class Soils partially extend into the property although these were not considered a barrier to rezoning the site for residential use in the Variation 2 hearings. The NPS Highly Productive Land does not apply to this site.

The revised rules are not in effect and have no implications for the determination of the activity status of the proposal.

Proposed 2GP

The activity status tables in rules 15.3.3 to 15.3.5 specify the activity status of land use activities, development activities and subdivision activities in the residential zones and relevant overlay zones. The site is also subject to the Helensburgh Structure Plan Mapped Area Rules set out in 15.8.14 of the 2GP.

Development Activity

The Performance Standards in 15.6 apply to all development activities. No new buildings or structures are proposed as part of the proposal. It is considered that any future development will be assessed against the development activity rules at the time of seeking Building Consent.

Land Use Activities

Rule 15.3.3 set outs the activity status of all land use activities and the performance standards associated therewith. The proposed land use activities on both lots is defined as "standard residential activity". Rule 15.3.3.3 provides for these as a permitted activity subject to compliance with performance standards 15.3.3.1, and 15.3.3.3.3a-e.

Consent will be sought for a breach of the front yard provisions for proposed Lots 25, 27, 32 and 36 which each enjoy frontage against two formed roads. It is proposed that a 3.0m front yard apply for these lots on one boundary and a 4.5m front yard setback remains on the other.

Rule 15.8.14 for the Helensburgh Structure Mapped Plan Area Rules sets out a minimum site size of 1,000m^2 and a maximum development potential of one habitable room per 150m^2 of site for that land identified in Area 'A'. Stage 1 sits to the immediate south of this area and therefore the Rule does not apply.

Each new lot within Stage 1 has been designed such that a residential unit can comfortably be constructed on the lot and meet all the relevant performance standard. This will be assessed at the time of seeking Building

Consent and any design breach will then need to be assessed on its merits as a subsequent resource consent application.

Subdivision Activities

Rule 15.3.5.2 sets out performance standards that apply to subdivision in the General Residential 1 zone.

a	Access	Compliance with Rule 6.8.1. Vehicle access is for each resultant site via a formed road to vest with Council, or one of three Access Lots. The proposal complies with this standard. In addition to compliance with Rule 6.8.1, Rule 15.8.14.2 of the Helensburgh Structure Mapped Plan Area Rules also applies. This stipulates that each resultant site must have direct or indirect (e.g. leg-in) access to an internal roading network that serves the whole structure plan mapped area. It further requires that all sites have access through the structure plan mapped area to a minimum of two road connection points from the structure plan mapped area directly or indirectly to Wakari Road (or a suitable alternative i.e Honeystone Street). The applicant has secured a second potential access to Wakari Road via SUB-2023-73, however understandably, it will not be constructed as part of the Stage 1 works. Until the second access is constructed this standard is technically not met.
b	Esplanade reserves	Compliance with Rule 10.3.1. N/A
c	Fire Fighting	Compliance with Rule 9.3.3. Resultant sites must have access to sufficient water supplied for firefighting consistent with the SNZ/PAS:4509:2008 New Zealand Fire Service Firefighting Water Supplies Code of Practice. Fire hydrants within the required servicing distance will be installed as part of Stage 1, and therefore this standard is met.
d	Minimum Site Size	Rule 15.7.4.1(a) requires a minimum site size of 400m^2 for each resultant lot. In this instance, the lots for residential purposes range from 402m^2 to 1,032m^2.
e	Service Connections	Compliance with Rule 15.7.5. Subdivision activities must provide for infrastructure connections in accordance with Rule 9.3.7. Rule 9.3.7 requires subdivision activities must provide all resultant sites connections to public water supply, waste water and stormwater networks, which must be laid at least 600mm into each site. Each unit will be served by separate service connections consistent with Rule 9.3.7 and therefore this performance standard will be met.
f	Shape	Compliance with Rule 15.7.6. Subdivision activities requires that each resultant site intended to be developed must be of a size and shape that is large enough to contain a building platform of at least 7m by 10m that meets the performance standards of the Plan.

		This performance standard will be met.
g	Structure Plan Mapped Area	Helensburgh Structure Plan Mapped Area Rules Rule 15.8.14 sets out the requirements for minimum site size, maximum development potential and access to the new development approved under Variation 2. In this case, Stage 1 cannot comply until the second access to Wakari Road is constructed as part of a future stage.

With respect to earthworks, the DCC datamap shows the site has a slope of less than 12 degrees which informs the earthworks assumptions for compliance against the standards. The activity status table in Rule 8A.3.2 shows the activity status of earthworks activities across all zones, provided any performance standards are met. The activities in the earthworks category are listed in the Nested Table in Section 1.3.

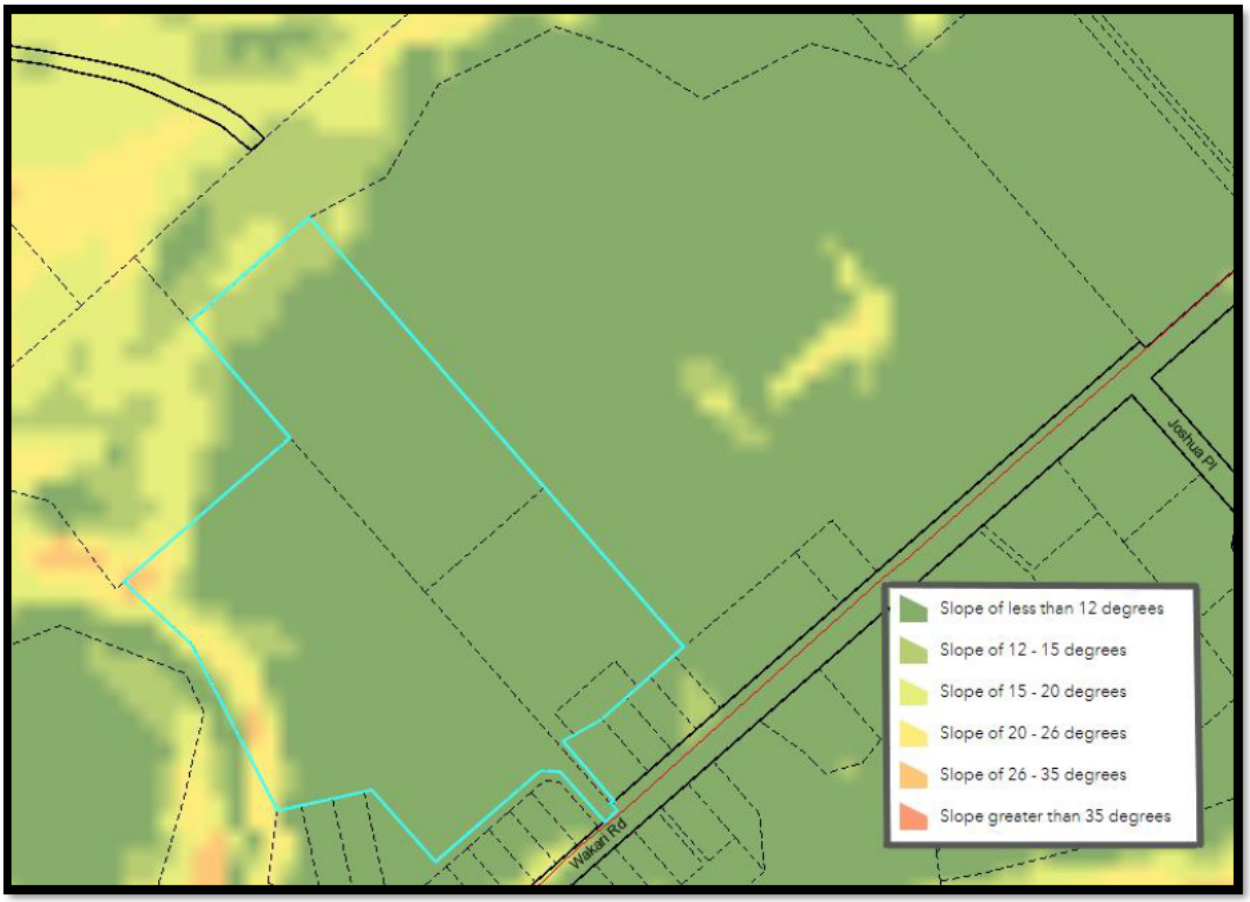

Figure 9 : Slope Assessment of Site

The table below summarises the small-scale threshold and the proposed scale of works. The site is assessed as <12 degrees slope as shown in Fig. 9. The proposed earthworks do not comply with Rule 8A.5.1.2.a, and therefore are considered a large-scale earthworks activity, which is a restricted discretionary activity.

Rule 8a.5.1.2 To remain small scale earthworks	Small scale threshold values	Proposal scale of works	Compliance
Rule 8a.5.1.3.i – Maximum change in ground level	1.5m	The maximum cut will be 3.4m and the maximum fill will be 1.7m	No

Rule 8a.5.1.4 – Maximum Area	N/A	N/A	Yes
Rule 8a.5.1.5 – Maximum Volume of combined cut and fill	$30m^3/100m^2$ is permitted over the 59,116m² site area = 17,734m³	13,900m³ combined cut and fill.	Yes

All earthworks activities are also required to comply with general performance standard of Rule 8A.3.2.1

a	Archaeological Sites (Rule 8A.5.2)	Compliance with Rule 13.3.3. N/A
b	Batter Gradient (Rule 8A.5.3)	Compliance with Rule 8A.5.3. Compliant
c	Setback from property boundary, buildings, structures and cliffs (Rule 8A.5.4)	Compliance with Rule 8A.5.4. Not compliant as consent is sought for to reduce the front yard on Lots 25, 27, 32 and 36 being sites with two frontages. Not compliant.
d	Setback from National Grid (Rule 8A.5.5)	Compliance with Rule 5.6.1.2. N/A
e	Setback from network utilities (Rule 8A.5.6)	Compliance with Rule 5.6.2. There will be earthworks somewhere that breaches the new Council interpretation in terms of earthworks near utilities and will therefore require approval to avoid the potential for a consent in the future when the applicant carried out works to connect to the existing network.
f	Sediment Control (Rule 8A.5.7)	Compliance with Rule 8A.5.7. Compliant
g	Removal of High Class Soils (Rule 8A.5.8)	Compliance with Rule 8A.5.8. This standard is technically not met, however is superseded by the Variation 2 decisions.
h	NZ Environmental Code of practise for plantation forestry	Compliance with Rule 8A.5.9. N/A
i	Setback from Scheduled Tree	Compliance with Rule 7.5.2. Compliant
J	Dust Control	Compliance with Rule 8A.5.12. Compliant

Overall, the proposed activity is for large scale earthworks and remains a restricted discretionary activity.

Overall Activity Status

Overall, the proposal shall be assessed as a **restricted discretionary** activity and will be assessed in accordance with section 104 and 104C of the RMA. Only those matters to which Council has restricted its discretion will be considered, and Council may grant or refuse the application, and, if granted, may impose conditions with respect to matters over which it has restricted its discretion.

National Environmental Standards

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect on 1 January 2012. The National Environmental Standard applies to any piece of land on which an activity or industry described in the current edition of the Hazardous Activities and Industries List (HAIL) is being undertaken, has been undertaken or is more likely than not to have been undertaken.

A HAIL assessment will be sought as part of this proposal. A search of the ORC database has been undertaken and there is no evidence of HAIL activity on the site or in the immediate vicinity of the site.

There are no other National Environmental Standards triggered by this application.

Statutory Considerations

This application must be considered in terms of Section 104 of the RMA. Subject to Part 2 of the RMA, Section 104(1) sets out those matters to be considered by the consent authority when considering a resource consent application. Considerations of relevance to this application are:

(a) any actual and potential effects on the environment of allowing the activity; and
(ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity; and
(b) any relevant provisions of:
  (i) A national environmental standard;
  (ii) Other regulations;
  (iii) a national policy statement
  (iv) a New Zealand coastal policy statement
  (v) a regional policy statement or proposed regional policy statement
  (vi) a plan or proposed plan; and
(c) any other matters the consent authority considers relevant and reasonably necessary to determine the application.

Effects on the Environment

Affected Persons

No persons are considered to be adversely affected by this proposal for the reasons outlined below.

Assessment of Environmental Effects

Section 104(1)(a) requires consideration of the actual and potential effects on the environment of the activity.

Permitted Baseline and Receiving Environment

Under sections 95D(b) and 104(2) of the Resource Management Act 1991, the Council may disregard an adverse effect of the activity on the environment if the district plan or a national environmental standard permits an activity with that effect. In this instance, there is no subdivision permitted as of right and no permitted baseline to be applied to this application with respect to subdivision.

Whilst there is no permitted baseline for subdivision as complying subdivisions are restricted discretionary activities, it is likely that a restricted discretionary subdivision that meet the relevant performance standards would normally be granted consent on a non-notified basis.

The existing and reasonably foreseeable receiving environment is made up of:

- The existing environment and associated effects from lawfully established activities;
- Effects from any consents on the subject site (not impacted by proposal) that are likely to be implemented;
- The existing environment as modified by any resource consents granted and likely to be implemented; and
- The environment as likely to be modified by activities permitted in the district plan.

The site has been assessed for residential activity and was approved as part of the Variation 2 decisions. The concept plan is consistent with the decision. For the subject site, the adjacent and nearby receiving environment comprises established low density residential development, and rural land. For surrounding land, the existing and reasonably foreseeable receiving environment comprises low density residential development, Rural Hill Slopes land and extending into the Flagstaff-Mt Cargill Significant Natural Landscape.

It is the effects arising from the proposal, beyond the permitted baseline and existing and lawfully established receiving environment that are the crucial elements for consideration, and which form the basis of this assessment of effects.

Assessment Matters

Effects on Residential Character and Amenity

Amenity values are commonly controlled via the District Plan density provisions of the various zones. In this case, the proposal reflects the concept plan promoted at the Variation 2 hearings, and the density standards will be respected.

The under-width access and the effects on amenity are, in my view less than minor and consistent with the intention of the Variation 2 decision (noting that the operational and safety aspects of the design have been assessed as no more than minor). Those limitations are a constraint imposed by land ownership. They existed at the time of the Variation 2 decision and they remain now.

Overall, the character and amenity remain consistent with that anticipated within the zone Plan Change, and characteristics of the surrounding environment.

Risk from Natural Hazard

An engineering geological site appraisal was undertaken by Geosolve with confirmatory subsurface investigations. GeoSolve Ltd visited the subject property on 22 June 2023, undertaking geotechnical investigations comprising:

- 24 hand auger and/or Scala penetrometer investigation holes which were generally advanced to refusal to a maximum depth of 1.8 m.
- Reconnaissance observation of the adjacent mapped landslide, fill, surface saturation and site geomorphology.

Auger and Scala penetrometer locations and logs are contained in Appendices A and B of the Geosolve report respectively.

Testing by Geosolve indicates that (following stripping of topsoil), good ground as defined by NZS3604 is likely to be at depths of less than 1 m over most of the site which implies very good subgrade conditions to enable standard foundation design and construction.

Geosolve make the following observations and recommendations:

- That upon removal of topsoil and localised fill all foundations on in-situ soils are expected to be mostly on firm to very stiff overburden soils or weathered rock. These materials will provide good bearing for conventional spread footings or shallow pile foundations;
- It is recommended by Geosolve that all foundation excavations be inspected by a suitably qualified and experienced geotechnical specialist to confirm the conditions are in accordance with the assumptions and recommendations provided in this report (and future site-specific reports for individual lots) and that all design assumptions have been met;
- Robust site drainage is recommended as above to minimise the potential for softening of the soils during seasonally variable weather conditions, storms. During the earthworks operations all topsoil, organic matter, fill and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:1989;
- Geosolve noted that some of the soils present across the site are mildly erodible and therefore sediment control measures should be instigated during earthworks construction. Water should not be allowed to pond or collect near or on any pavement or foundation slab subgrades. Positive grading of the subgrades should be undertaken to prevent water ingress or ponding.

Geosolve did not identify any natural hazard issues that cannot be resolved during design and construction. It is my opinion that should the Geosolve recommendations be adopted, it is my opinion the risk to natural hazards is less than minor.

Stormwater

As the existing site is considered entirely pervious and sits on sloping land it was imperative to demonstrate how stormwater would be managed on site to ensure post-development flows are no greater than pre-development flows off the site. Further, as the development site is located within a New Development Mapped Area (NDMA) additional modelling was required. Rule 9.9X of the 2GP requires that integrated stormwater management plans must address the whole NDMA area.

Stormwater has been assessed by Fluent in the ICMP appended to this application. Having considered the Fluent report I consider the stormwater effects associated with the development will be less than minor on the existing Council infrastructure and to the adjoining existing residential properties.

Effects on the Safety and Efficiency of the Transport Network Rule and Effects on Accessibility

Wakari Road is classified as a Local Road in the vicinity of the subject site and is considered a Collector Road to the south-west of Helensburgh Road. It enjoys a 9.2m wide kerb-to-kerb sealed carriageway and has a posted speed limit of 50km/hr.

An Integrated Traffic Assessment was prepared by Grant Fisher of Modal Consulting which is appended to the application to assess Stage 1. To summarise, his report finds;

- The proposed development will generate in the range of 312 traffic movements per day, and peak hour traffic movements of about 34 traffic movements per hour;
- It is estimated that the peak hour traffic volume of Wakari Road is in the order of 8% to 10% of daily traffic volumes, equating to 69 to 86 traffic movements per hour;
- There has been a single recorded accident on Wakari Road between 2018 and 2023 within the vicinity of the subject site. The description of the crash involves a nose-to-tail crash at the intersection with Helensburgh Road, which did not result in any injuries. Modal concludes, the crash data suggests there are no current underlying safety concerns for the road;
- That the Safe Intersection Sight Distance and Minimum Gap Sight Distance in relation to the proposed access to the development are compliant with Austroads standards;
- A simple 'T-intersection' into the site is considered appropriate;
- The proposed separation distance between the new road intersection and the right of way is supported by Modal given that existing boundary positions do not allow for compliance with the relevant 2GP rule, and both the likelihood of conflict and the severity of crashes are assessed as being minimal.
- The provision of a single footpath for that area of access where it narrows between 175 Wakari and the DCC owned Bain Reserve affects a relatively short section of the proposed new road and is considered acceptable. Mr Fisher suggests a footpath through the margin of Bain Park linking the subdivision directly to Wakari Road and the reserve.
- The traffic generated by the proposal can be accommodated on the road network with little or no adverse effects on safety or functionality.
- The subdivision is designed to an appropriate standard and has good connections (pedestrian and vehicle) to the existing public road network.

As part of the Variation 2 discussions, Council indicated a second access formation to Wakari Road will be required to ensure efficient transportation links throughout the development and in a manner which limits effects on the existing roading network. SUB-2023-73 has secured the second access point which is slightly askew to the intersection between Wakari Road and Caleb Place. Whilst not forming part of this application, it is anticipated this access point can be used for secondary access as part of a further development stage.

Having considered the traffic assessment by Modal, it is my opinion the effects of Stage 1 are less than minor on the receiving environment, the road users and the adjoining landowners. With respect to the aspects that are not aligned with the 2GP transport provisions, I accept Modal's expert view that the effects of those breaches are acceptable from a network efficiency, operational and safety perspective.

Development Contributions

Stage 1 will be subject to development contributions.

Offsetting or Compensation Measures

In accordance with Section 104(1)(ab) of the Resource Management Act 1991, there are no offsetting or compensation measures offered nor are any deemed necessary.

Relevant Provisions

2GP Objective and Policy Analysis

Objectives	Supporting Policies	Assessment
Objective 2.4.1: Form and Structure of the environment The elements of the environment that contribute to residents' and visitors' aesthetic appreciation for the enjoyment of the city are protected and enhanced.	Policy 2.4.1.5 To maintain or enhance the attractiveness of streetscapes, public open spaces and residential amenity by using rules the manage building bulk and location, site development and overall development density.	The subdivision will not introduce any material change to the existing neighbourhood beyond that contemplated in the Variation 2 decisions. The proposal is considered **consistent** with this objective and policy.
Objective 2.7.1 Efficient public infrastructure Public infrastructure networks operate efficiently and effectively and have the least possible long-term cost burden on the public.	Policy 2.7.1.1 Manage the location of new housing to ensure efficient use and provision of public infrastructure	The subdivision will not introduce any material change to the existing neighbourhood beyond that contemplated in the Variation 2 decisions. Any future application will be assessed on its merits however the expectation remains any future development will be sufficiently accommodated by the infrastructure to be installed as part of the Stage 1 development. The proposal is therefore assessed as **consistent** with this objective and policy.
Objective 6.2.3 Land use, development and subdivision activities maintain the safety and efficiency of the transport network for all travel modes and its affordability to the public.	Policy 6.2.3.9 Only allow land use and development activities or subdivision activities that may lead to land use or development activities, where: adverse effects on the safety and efficiency of the transport network will be avoided or, if avoidance is not practicable, adequately mitigated; and any associated changes to the transportation network will be affordable to the public in the long term.	All sites will enjoy legal and physical access at the time of subdivision and any future developments will be assessed at the time of seeking consent. It is acknowledged the legal width of Road 1 is under-width. The carriageway is a consistent width here and throughout the subdivision. This boundary to boundary breach has been assessed by Modal Consulting who concluded the effects were acceptable. Should DCC Parks & Reserves allow for a pedestrian footpath through the reserve, the effects will lessen even further. The applicant is open to discussing this with the DCC. With respect to the secondary access, this will not be provided as part of Stage 1. Modal considers the location of the secondary access to be acceptable and the secondary access can be will be formally put to DCC in a future application for subdivision.

		The proposal is therefore considered **generally consistent** with this objective and the relevant policies.
Objective 9.2.1 Land use, development and subdivision activities maintain or enhance the efficiency and affordability of public water supply, wastewater and stormwater infrastructure.	Policy 9.2.1.1 Only allow land use or subdivision activities that may result in land use or development activities where: a. in an area with public water supply and/or wastewater infrastructure, it will not exceed the current or planned capacity of that infrastructure or compromise its ability to service any activities permitted within the zone.	No additional demand is proposed as part of this subdivision beyond that approved in the Variation 2 decisions. For future development new sites can served by all critical services from Wakari Road. No additional servicing is required beyond that contemplated by the underlying zone and therefore the proposal poses no threat to the infrastructure capacity. The proposal is assessed as **consistent** with this objective and policy.
Objective 15.2.2 Residential activities, development and subdivision activities provide high quality on-site amenity for residents.	Policy 15.2.2.1 Require residential development to achieve a high quality of on-site amenity by: a. providing functional, sunny, and accessible outdoor living spaces that allow enough space for on-site food production, leisure, green space or recreation; b. having adequate separation distances between residential buildings; and c. retaining adequate open space uncluttered by buildings; and d. having adequate space available for service areas.	This subdivision simply seeks to address create individual lots for residential development. No development of individual houses is proposed in this application, however it is expected residential units can be established on each new lot which complies with the 2GP performance standards. Overall, the proposal is found to be **consistent** with this objective and policy
Objective 15.2.4 Activities maintain or enhance the amenity of the streetscape and reflect the current or intended future character of the neighbourhood.	Policy 15.2.4.2 Require residential activity to be at a density that reflects the existing residential character or intended future character of the zone. Policy 15.2.4.6 Only allow subdivision activities where the subdivision is designed to ensure any future land use and development will: a. maintain the amenity of the streetscape b. reflect the current or future intended character of the neighbourhood; c. provide for development to occur without unreasonable earthworks or engineering requirements; and d. provide for quality housing.	Future residential activity will be managed to ensure that no adverse amenity effects on surrounding residential properties and public spaces will be introduced as a result of this proposal The proposal is considered **consistent** with this objective and the relevant policies.

Having regard to the relevant objectives and policies individually, and considering these holistically, the above assessment indicates that the application is consistent with those provisions set out in the Proposed 2GP.

Assessment of Regional Policy Statements

Section 104(1)(b)(v) of the Act requires that any relevant regional policy statements be considered. The Partially Operative 2019 Regional Policy Statement for Otago (RPS) was reviewed in respect of this proposal and must be given effect to. The Proposed Otago Regional Policy Statement 2021 was also reviewed and whilst

not operative must be given regard to. No policies specifically relevant to this proposal were identified. Overall, the proposal is considered consistent with the two relevant Otago RPS plans.

Other Planning Instruments

Section 104(1)(b) requires consideration of other relevant planning instruments. There are no other planning instruments considered relevant to this proposal.

Draft Conditions

In previous years, Dunedin City Council has circulated draft consent conditions for comment prior to the formal consent decision being issued. We wholeheartedly support this initiative as it provides an early opportunity for any contentious consent issues or unworkable conditions to be resolved at a departmental level. This clearly is of mutual benefit as a potential s127 variation, s128 review or s357 objection could be avoided. While there are unlikely to be any significant issues in respect of this application, it is considered appropriate that such draft conditions be circulated in this same manner. We look forward to receiving those in due course.

Notification and Affected Parties

With regard to notification:

- The applicant does not request notification.
- The proposal does not relate to the exchange of reserves land, does not involve a statutory acknowledgement area and does not involve an affected protected customary rights group.
- There are no rules in the District Plans or NES which require notification.
- It is considered that there are no special circumstances relating to the application.
- It is assessed above that the effects of the proposal on the wider environment are less than minor.

No parties are considered affected by this proposal because-

- The development has been considered by the Variation 2 hearings panel and Council staff and assessed as being an acceptable site to establish further housing stock for the city,
- The design is consistent with the concept plan,
- The 20m no-build encumbrance area has been respected providing a buffer and opportunity for landscaping and amenity improvements,
- The development includes careful attention to addressing post-development stormwater flows,
- The road network proposed does not impact on any adjacent or existing use nor introduce risk of vehicle or pedestrian conflict.
- The proposal is consistent or generally consistent with the 2GP objectives and policies.

Conclusion

The proposal is to subdivide the subject site to create Stage 1 of a development concept approved by the 2GP Variation 2 decisions. The works are assessed as a restricted discretionary activity, consistent with the District Plan performance standards. Any potential adverse effects on the environment are assessed as being less than more than minor and remains consistent with the overall policies and objectives of Second-Generation District Plan. Accordingly, we would ask for Council's favourable consideration to the approval of this application.

Yours faithfully,
Terramark Ltd

Darryl Sycamore
Resource Management Planner

GEOSOLVE

GEOTECHNICAL

WATER RESOURCES

PAVEMENTS

Geotechnical Report

195 & 245 Wakari Road

Dunedin

Report prepared for:

JKS Paddock Limited

Report prepared by:

GeoSolve Limited

Distribution:

JKS Paddock Limited

Terramark Ltd

GeoSolve Limited (File)

July 2023

GeoSolve Ref: 230385

Revision	Issue Date	Purpose	Author	Reviewed
1	7/07/2023	Client issue	RC/MTW	MTW

GEOTECHNICAL WATER RESOURCES PAVEMENTS

Table of Contents

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1 Executive Summary

- We understand that the site has recently been rezoned to General Residential 1 under the DCC 2GP District Plan Review and subdivision is now proposed. At this early stage it appears likely that approximately 180 new residential lots may eventually be accommodated on site, however a staged approach is likely to be used.
- An engineering geological site appraisal has been undertaken with confirmatory subsurface investigations, comprising 24 hand auger and/or Scala penetrometer investigation holes, which were generally advanced to refusal at a maximum depth of 1.8 m.
- The nearest mapped potentially active faults lie within 1-2 km of the site (Kaikorai Fault and Titri Anticline). Inactive faults are also mapped on and near to the site. However, the presence of these faults does not require any specific development measures on site.
- The proposed subdivision lies adjacent to an area mapped in a 2017 GNS Science report as being a landslide with 'likely certainty, 'unknown' historic activity, and 'medium' sensitivity to destabilising influences. We note that Stantec NZ Ltd has reviewed this feature to assist Council and concluded that it is not considered a hazard to the site.
- No evidence of recent slope instability was identified during the time of our site investigations within the area of the proposed subdivision.
- Apart from the surface layer of topsoil, the site is underlain by thin colluvium or residual volcanic soil with weathered volcanic rock at relatively shallow depth. Some very localised alluvial soils were encountered (e.g., AH17) and uncontrolled fill was observed locally at AH 19 as expected based on the historical site activity.
- The primary risk factor for potential slope instability relates to potential saturation of the soils. All sources of slope saturation should be eliminated by measures such as effective swales and permanent cut-off drains upslope of the subdivision extents where required. No stormwater or wastewater should be discharged onto the slopes, and we note that infrastructure will be provided to manage this.
- We provisionally recommend designs of 2:1 (horizontal: vertical) for all cut and fill batters in areas of less than 3 m of cut/fill. Shear surfaces are likely to dictate batter angles (if encountered) and hence specific geotechnical inspection of all cuts is required during construction. Cut batters may potentially be formed steeper, subject to geotechnical inspection.
- The subsurface materials in the upper 1-2 m will be likely be relatively easy to excavate by conventional methods, however strong rock could be encountered, and this could be a significant design and constructability consideration if deep cuts are proposed.

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- We recommended that all fill (particularly under building areas and roadways) should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect.
- We recommend that all excavations, pavement subgrades and future foundation subgrades should be inspected by a geotechnical practitioner during earthworks construction to enable any further advice.
- Site-specific investigations should ideally be carried out at least in accordance with NZS 3604 for all individual lots developments when specific building plans are available, however the testing carried out to date indicates that (following stripping of topsoil), good ground as defined by NZS3604 is likely to be at depths of less than 1 m over most of the site which implies very good subgrade conditions to enable standard foundation design and construction.
- It is possible that some subsoil drainage to capture and divert spring flows may be required, but this is generally a consideration for construction when any spring flows are much easier to observe.
- We recommend that a surveyor should be engaged to determine the most appropriate alignment for the accessways. Cross-sections at critical locations should be provided by the surveyor showing cut and fill profiles. These cross-sections should be checked by a geotechnical practitioner (particularly for cuts greater than 2 m) to enable further advice on any physical support requirements or advice for fill methodologies as required.
- The testing to date indicates that pavement design and construction is likely to be straightforward, with competent subgrade available at relatively shallow depths generally below the organic topsoils. GeoSolve can provide further information on pavement design when the final alignments and cut/fill depths have been defined by the surveyor.
- We conclude that the proposed development is entirely feasible and will not create or exacerbate natural hazards on the site, or neighbouring sites, provided that the recommendations of this report are followed.

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2 Introduction

2.1 General

This report presents the results of geotechnical investigations carried out by GeoSolve Ltd in order to determine subsoil conditions and provide geotechnical advice for a proposed subdivision at 195 and 245 Wakari Road, Dunedin.

The geotechnical report discusses natural hazards, subdivision suitability, slope stability and the geotechnical ground model. Advice is provided on hazards, earthworks considerations, accessways, general geotechnical considerations and preliminary foundation recommendations for future dwellings.

The investigations were carried out for JKS Paddock Limited in accordance with GeoSolve Ltd's proposal and agreement dated 12 June 2023, which outlines the scope of work and conditions of engagement.

2.2 Development

We understand that the site has recently been rezoned to General Residential 1 under the 2GP District Plan Review.

No subdivision scheme plan is available at this stage, but we note that preliminary concepts envisage residential lot areas ranging from 400 m^2 – 1000 m^2. At this early stage it appears likely that approximately 180 new residential lots may eventually be accommodated on site, however a staged approach is likely to be used.

A preliminary sketch layout (Figure 2.1) shows a likely future reserve of approximately 1 ha along the southern and eastern margins (partly adjoining the creek).

Preliminary road alignments are shown on Figure 2.1, but detailed design is yet to be completed.

We understand that a wider integrated stormwater catchment system will be designed by others, including a likely detention pond.

At this stage, there are no specific details of the earthworks, however we note that some cut to fill methods may be considered and earthworks will be required to establish roads.

We have reviewed the supplied assessment report prepared by Stantec NZ Ltd for Council and we note that no major constraints to residential development have been identified based on their desktop review. Some reference to previous earthworks and potential contamination is mentioned, as well as a localised mapped landslide feature. Overall, a low hazard level was assigned by Stantec, with no hazards associated with slope instability and no other listed hazards which would affect development.

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Figure 2.1 – Development area bounded by yellow, with potential roads (blue) and reserve (green)

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3 Site Description

3.1 General

The subject property is located at Wakari, which is situated approximately 3 km northwest of central Dunedin. The property is accessed from Wakari Road and lies on the volcanic hillslopes of Dunedin.

The site is currently undeveloped and being used as farmland. Vegetation comprises pasture with localised mature trees, mostly within shelterbelts.

Structures include minor sheds on 195 Wakari Rd. A dwelling and associated sheds occupy part of 245 Wakari Rd where a large platform has been formed and is bounded by mature trees. That site was reportedly used historically for aged residential care. The platform appears to be largely a fill platform and we note that available contours at this stage indicate that the localised fill may be up to about 2-3 m thick. Examination of historical aerials shows that this historical development was on site as early as 1947.

The subdivision site occupies gently dissected hillslopes and slopes moderately to the east and south-east at approximately 10°. The difference in elevation between the highest and lowest surveyed parts of the site is approximately 40 m. Therefore, the overall slopes are gentle, generally between 5-10 degrees but with some locally steeper land, especially at the margins of the gully adjacent to the SW boundary.

There are some watercourses locally and these may be partly supplied by spring flow sources. There is a relatively deeply incised watercourse along the SW boundary, but the steeper land here is likely to coincide with the proposed reserve land. Another similar gully lies immediately to the NW of the site, however only minor or ephemeral streams are noted within the proposed area of development, with flow increase within these likely during heavy rainfall. We understand that these will be subject to drainage design consideration by others. The site is naturally free-draining and there are no major areas of saturated ground apart from the lower reaches of the ephemeral watercourse near the southern corner of #245 and an area near the north boundary, where spring flows are evident.

4 Geotechnical Investigations

An engineering geological site appraisal has been undertaken with confirmatory subsurface investigations. GeoSolve Ltd visited the subject property on 22 June 2023, undertaking geotechnical investigations comprising:

- 24 hand auger and/or Scala penetrometer investigation holes which were generally advanced to refusal to a maximum depth of 1.8 m.
- Reconnaissance observation of the adjacent mapped landslide, fill, surface saturation and site geomorphology.

Auger and Scala penetrometer locations and logs are contained in Appendices A and B respectively.

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5 Subsurface Conditions

5.1 Geological Setting

5.1.1 Regional Geology

The geology of the Dunedin area is dominated by volcanic rock types of basaltic to andesitic composition that were intruded through pre-existing marine sediments during Miocene times. Extensive volcanism at that time produced lava flows and bedded volcanoclastic materials were widely distributed by eruptions. The generalised stratigraphic profile comprises schist at depth, overlain by a Cretaceous to Tertiary-age sequence; initially by thin non-marine sediments and then a thick accumulation of marine sediments including sandstones and mudstones. The volcanic rock types cross-cut these sediments where vents were present and extensively mantle them where lava flows or volcanic ejecta were deposited.

More recently (Pleistocene times), the hills of Dunedin have been extensively mantled by windblown loess to depths of up to several metres. Watercourses and tidal embayments such as Otago Harbour have locally deposited alluvial, estuarine and marine deposits and generally modified the volcanic landscape by deep incision and sedimentation. Fill and refuse has been placed locally during post-settlement times. Landslips have occurred on steeper hillsides particularly where springs emerge or where fills have been placed.

5.1.2 Seismicity

Dunedin has traditionally been considered to have lower than average seismic activity when compared to other areas in New Zealand, however nearby active faults are known and strong shaking is certain to occur periodically.

Cook et al[1] states that the earthquake hazard in Dunedin is dominated by relatively infrequent moderate to large earthquakes (magnitude up to M_w 7.5) in eastern Otago, and large to very large earthquakes in the much more seismically active Fiordland and Westland regions.

The nearest active faults with demonstrated Late Quaternary movement history are the Green Island Fault and the Akatore Fault. The Green Island Fault is currently considered to be the cause of the 1974 earthquake that caused damage in Dunedin. It is mapped approximately 8 km to the southwest of the subject site, but its projection is believed to continue through South Dunedin and may run northeast up the harbour in which case it would pass within about 4 km of the site.

The nearest mapped trace of the Akatore Fault passes within about 5 km of the site. The Akatore Fault is expected to have a recurrence interval of 2-3,000 years[2]; however a recent

[1] Cook, DRL, McCahon, IF and Yetton, MD (1993). The Earthquake Hazard in Dunedin. Study funded by EQC, Research Project 91/56.

[2] Otago Regional Council (2005). Seismic Risk in the Otago Region. Report No SPT: 2004 / 23. Wellington, NZ: Opus International Consultants.

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paleoseismic study of the Akatore fault[3] found that three recent ruptures of this fault which occurred in the past 15,000 years (two of which occurred in the past 1,300 years) were preceded by a minimum 110,000 year period of quiescence, suggesting this fault exhibits strong aperiodicity of earthquake occurrence. The authors suggest it is prudent to assume that the relatively high rates of recent fault activity will continue, with an estimated recurrence interval of 450-5110 years.

Both of these faults are likely to be capable of generating magnitude 7.5 earthquakes in Dunedin.

The nearest mapped potentially active faults are shown in Figure 5.1 and these lie within 1-2 km of the site (Kaikorai Fault and Titri Anticline).

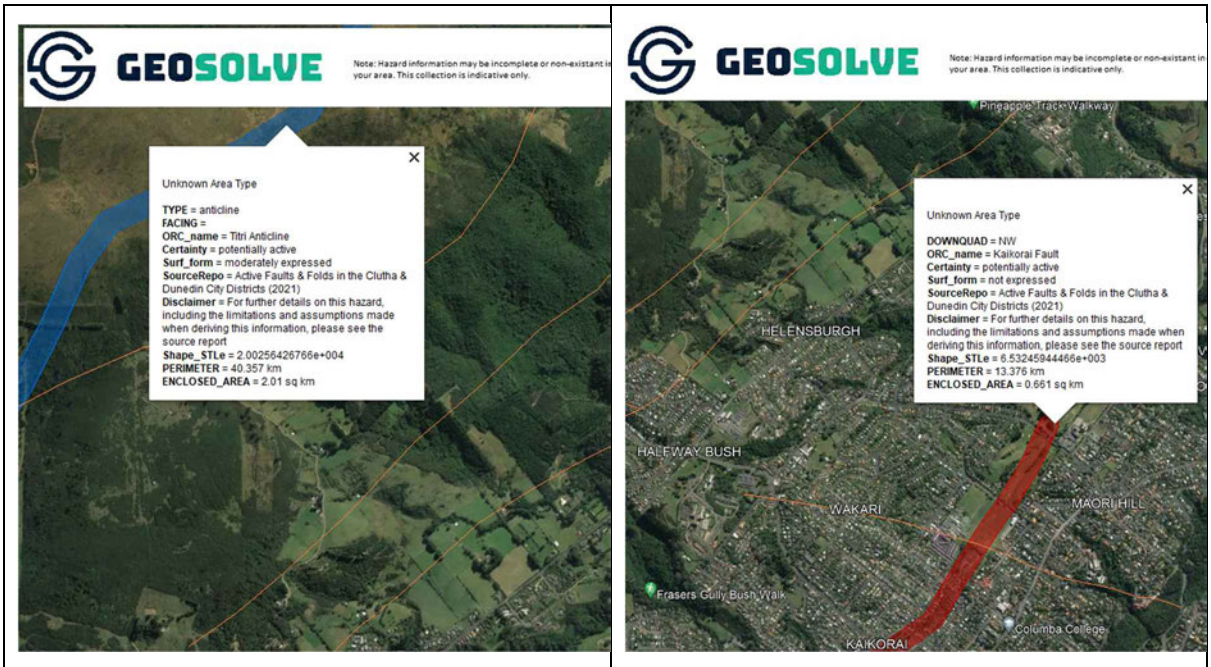

Figure 5.1 – Potentially active faults within 1-2 km of the subject site (GNS Science Ltd)

Inactive faults are also mapped on and near to the site as shown in Figure 5.2 according to GNS Science Ltd. This could mean that differing rock types are possible under the site if fault offsets are significant. The recent Canterbury earthquakes have highlighted the issue that previously unidentified faults or presumed activity status may be very significant factors in the actual future risk applying to any particular site.

It should be noted the fault terminations shown on fault trace maps are often approximations (owing to lack of data) and the presence of other active faults may be unknown because they may be obscured by overburden soils.

[3] Taylor-Silva, B.I., Stirling, M.W., Litchfield, N.J., Griffin, J.D., van den Berg, N.J., Wang, N. (2019). Paleoseismology of the Akatore Fault, Otago, New Zealand. New Zealand Journal of Geology and Geophysics, 63(2): 151-167; doi: 10.1080/00288306.2019.1645706

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Figure 5.2 – Inactive faults on or near the subject site (GNS Science Ltd)

Other known faults that have some potential to cause strong shaking in Dunedin are the Titri Fault and the North Taieri Fault, located roughly 7 km and 25 km southwest of the site, respectively.

The above faults are not included in Table 3.6 of NZS 1170.5:2004 as major faults requiring near fault factors when assessing structural design actions.

Strong ground shaking throughout the South Island is likely to be associated with a rupture of the Alpine Fault, located along the West Coast of South Island. Recent research[4] suggests there is a 75% probability of an Alpine Fault earthquake occurring within the next 50 years and an 82% probability that the next earthquake on the Alpine Fault will be of magnitude 8 or greater.

Average return periods for shaking intensity are: MM 7 = 100 years, MM 8 = 450 years and MM 9 = >2,500 years. The most recent major earthquake to affect Dunedin occurred in 1974 and produced damage consistent with MM 7 intensity.

[4] Howarth, J.D., *et al.* (2021). Spatiotemporal clustering of great earthquakes on a transform fault controlled by geometry. Nature Geoscience; doi: 10.1038/s41561-021-00721-4

5.2 Stratigraphy

The engineering geological model for the site is straightforward as described below. More detailed geotechnical description of soils is provided in the hand auger logs contained in Appendix B.

Apart from the surface layer of topsoil, the site is underlain by thin colluvium or residual volcanic soil with weathered volcanic rock at relatively shallow depth. Some very localised alluvial soils were encountered (e.g. AH17) and uncontrolled fill was observed locally at AH19 as expected based on the historical activity discussed above.

Topsoil comprises soft to firm organic SILT with traces of rootlets etc. The organic layer is between 200-400 mm thick.

The topsoil is underlain mostly by colluvium or weathered residual volcanic soils which comprise variable soils (as logged below) but generally silty CLAY or SILT with minor-trace gravel and trace sand in firm to very stiff condition.

Uncontrolled fill occurs locally near the previous area of historical development as shown on Figure 1 (appended). This was found to be 1 m thick where tested but may be up to 3 m locally (to be confirmed). The fill was underlain by an organic buried topsoil layer and thereafter by residual volcanic soils.

Weathered bedrock was frequently encountered at relatively shallow depth and is also locally visible in road cuttings (e.g. adjacent to 225 Wakari Rd). Rock is expected to lie at shallow to moderate depth below the site as indicated by the shallow penetrometer refusal depths (less than 1.8 m). Based on observation of outcrop and published geological mapping, the rock type likely comprises basaltic flow rocks of the third eruptive phase of the Dunedin Volcano, which is expected to extend to great depth.

5.3 Groundwater

No significant groundwater seepage was observed during investigations. Groundwater seepage was noted only in AH 17, which was located in an area of wet soils, and may relate to underlying spring flows.

The soils observed over the remainder of the site were predominantly moist in condition with little evidence of elevated groundwater.

Perched groundwater may develop on the contact between various soil layers with permeability contrasts.

The ephemeral watercourses would be expected to carry flow and saturate adjacent soils and runoff areas during rainfall events, but we understand that control of runoff will be addressed in a separate stormwater management plan.

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5.4 Slope Stability

The area has been mapped by Benson[5] as being underlain by Dunedin Volcanic Group basalt, a strong rock type in its unweathered form. This rock type is locally underlain by terrestrial sedimentary rock types known as the younger floodplain conglomerate, but this was not observed on site.

The proposed subdivision lies adjacent to an area mapped in a 2017 GNS Science report[6] as being a landslide with 'likely certainty, 'unknown' historic activity, and 'medium' sensitivity to destabilising influences.

We note that Stantec NZ Ltd has reviewed this feature to assist Council and concluded the following:

> The land stability hazard only affects a minute corner of the proposed area and is not considered a hazard for the site. There are no other hazards on adjacent land that may affect this site.

Figure 5.1: Landslide feature mapped within the proposed subdivision site.

Engineering geological mapping of the site (and in particular the area of the site within the above landslide feature) revealed no indicative scarps or hummocky terrain characteristic of recent land movement.

Our nearest investigation site (AH6) adjacent to this feature indicated very similar conditions to the remainder of the site, with no softening to indicate previous deposition of

[5] Benson, W.N. (1968). Dunedin District, 1:50,000. NZGS Miscellaneous Series Map 1. Department of Scientific and Industrial Research.

[6] Barrell D.J.A., Smith Lyttle B., Glassey P.J. (2017). Revised landslide database for the coastal sector of the Dunedin City district. Lower Hutt (NZ): GNS Science. 29 p. (GNS Science consultancy report; 2017/41).

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soft debris, i.e. “good ground” was encountered at 1 m with refusal at 1.5 m , most likely on weathered rock.

Review of stereoscopic photography (1947 SN399) indicates that the mapped landslide shown above is a subdued and ancient feature on the hillside above the site which may potentially be the lower reaches of an ancient, eroded debris tongue. The outline of this feature matches with that identified by the 2017 GNS Science report[7]. No obvious scarp features or hummocky terrain were identified, and no signs of recent movement were apparent on site or on aerial imagery. We also note that there is an existing dwelling within the landslide extents, and we are unaware of any damage.

Geological mapping suggests that the landslide may be associated with the contact between basalt and underlying conglomerates which have been mapped on the neighbouring hillsides but not on the subject site.

Very minor shallow landslips are also apparent on the hills above the site, but these appear shallow and would not be expected to result in a significant risk of inundation damage to the subject site.

The risk of localised slope instability over the site in general is currently interpreted to be low based on the relatively gentle undulating slopes, the presence of firm to stiff overburden soils across the site and lack of any evidence of widespread groundwater flows at shallow depths.

[7] Barrell D.J.A., Smith Lyttle B., Glassey P.J. (2017). Revised landslide database for the coastal sector of the Dunedin City district. Lower Hutt (NZ): GNS Science. 29 p. (GNS Science consultancy report; 2017/41).

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6 Engineering Considerations

6.1 General

The recommendations and opinions contained in this report are based upon ground investigation data obtained at discrete locations and historical information held on the GeoSolve database. The nature and continuity of subsoil conditions away from the investigation locations is inferred and cannot be guaranteed.

6.2 Slope Stability

Most of the site is no steeper than 15 degrees (which is generally the benchmark to trigger greater geotechnical scrutiny by Council if exceeded).

Council's geotechnical advisors (Stantec NZ Ltd) will still require assurance that potential slope suitability is adequately addressed. In particular, assurance is required that the site is suitably stable, and that the development proposal will not create or exacerbate instability on this or adjacent properties. However, we note that an assessment of "low hazards level" has already been provided by Stantec.

As discussed above, no evidence of recent slope instability was identified during the time of the site investigations within the area of the proposed subdivision.

The primary risk factor for potential slope instability relates to potential saturation of the soils. In addition, softening and general nuisance could occur where water is able to collect and infiltrate, particularly as there are natural swales located on the site. Consequently, robust site drainage is recommended. All sources of slope saturation should be eliminated by measures such as effective swales and permanent cut-off drains upslope of the subdivision extents where required, particularly above any cuts proposed and upslope of the proposed building platforms. No stormwater or wastewater should be discharged onto the slopes, and we note that infrastructure will be provided to manage this.

All drains should be designed to discharge to suitable Council-approved stormwater disposal points.

Placement of uncontrolled fill should be avoided.

Any spring flows encountered should be assessed further by a geotechnical specialist.

In the event that voids are encountered during excavations (i.e. under-runners) or any soft/wet soils, a geotechnical specialist should advise further on appropriate remediation and drainage measures.

If any lots are steeper than 15 degrees, additional recommendations apply as follows:

- All building platforms on lots where slopes exceed 15 degrees should have a site-specific cut-off drain installed upslope of the building platforms.
- All building platforms on lots where slopes exceed 15 degrees should have their building platforms specifically supervised by a geotechnical specialist with review of intended earthworks and possible additional test pitting investigations. Specific

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recommendations for development may be required and this may include minimising cuts and installation of additional subsoil drainage.

Provided the recommendations of this report are followed, particularly relating to site drainage, the risk of global slope instability across the site is interpreted to be low, based on the relatively gentle slopes, an absence of slope instability indicators, the precedent performance of the site, the general lack of shallow groundwater, the generally stiff or better conditions of the soils observed beyond about 0.5 m depth, and observation of refusal with the penetrometer at depths less than 1-2 m.

6.3 Excavations

At the time of the investigations, no earthworks plans were available, however some cut/fill earthworks are likely to be proposed, particularly for roading. General excavation recommendations are outlined below, and a geotechnical practitioner should review any earthworks plans prior to commencement to confirm that design is appropriate for the soil types encountered or whether any physical support measures are required.

No seepage was encountered during investigations and hence groundwater is unlikely to be encountered during excavations, particularly following management of site drainage. However, a geotechnical practitioner should inspect any seepage, spring flow, voids or under-runners that may be encountered during construction.

Recommendations for permanent batters are as follows. Higher cuts may require specific design.

Table 6.1 – Recommended batters for permanent cuts up to 3 m in height

Material type	Recommended maximum batter for permanent cuts less than 3 m high (horizontal to vertical)	
	Dry ground	Wet ground
Topsoil (0.2-0.4 m thick)	2 : 1	3 : 1
Colluvium and alluvium	2 : 1	3 : 1
Stiff to very stiff residual volcanic soils*	2 : 1 to 1.5:1	3 : 1

**i.e. may be formed steeper subject to inspection but provisionally we recommend designs of 2:1 for all cut batters. Shear surfaces are likely to dictate batter angles (if encountered) and hence specific geotechnical inspection of all cuts is required during construction.*

Temporary cuts may be formed at steeper angles (see below) subject to geotechnical advice.

It is possible an earthworks consent will be required, and this should be checked with Council.

We recommend that all excavations should be inspected by a geotechnical practitioner during earthworks construction, particularly as any adversely oriented shear surfaces may promote local instability.

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The subsurface materials in the upper 1-2 m will be likely be relatively easy to excavate by conventional methods, however strong rock could be encountered, and this could be a significant design and constructability consideration if deep cuts are proposed.

6.4 Fill Earthworks

We understand that earthworks including cut/fill works may be proposed for accessways and potentially to create more sub-horizontal sites for development. Once formal cut to fill plans become available, they should be reviewed by a geotechnical practitioner for further specific advice.

We recommended that all fill (particularly under building areas and roadways) should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect. Therefore, a fill specification and geotechnical supervision (including laboratory verification) should be sought at an early stage to enable a statement of suitability to be supplied. Adequate compaction is necessary to minimise future differential settlement on the proposed lots and roadways which will occupy the areas of fill.

The overburden soils could be used as engineered fill on site (during good weather and in accordance with an earthfill specification). Laboratory testing and verification will be required and boulders/cobbles/broken rock over 75 mm in size will need to be screened from engineered fill sources.

For engineered fills, the contractor will need to submit a sample of the proposed fill materials (possibly more than one) to obtain laboratory compaction curves, and in-situ Nuclear Density Meter (NDM) testing of the fill will need to be arranged. An engineer will need to specify the fill methodology and review the lab results to ensure that a statement of suitability for the fills can be issued; this will likely be required for compliance.

The subgrade of any proposed fills will need to be sub-horizontal (with benching of slopes as required) to ensure stability. A geotechnical specialist should inspect all subgrades prior to fill placement.

Maintaining the moisture content of any cohesive fill soils to achieve the required compaction will need to be addressed by the contractor. It is recommended that cut to fill soils be placed and compacted immediately as they are excavated, as stockpiling and reworking is highly likely to degrade the compaction properties of the soils.

Earthworks should only be carried out in the summer or during a period of forecast, prolonged dry weather as the soils proposed for filling are susceptible to becoming excessively moist and could rapidly become unsuitable for placement if they get wet.

Engineered fill specification and certification to NZS 4431:1989 can be provided on request.

The depth of any fill and designation of whether it is certified or uncontrolled should be available to potential purchasers of lots that coincide with fill. An as-built fill contour map should be prepared if this is the case.

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Any fill placement will require additional undercut of unsuitable soils. All topsoil, organic material, fill and any other soft and unsuitable soils should be removed prior to placement of new fill.

All certified fill batters should be formed no steeper than 2:1 (horizontal: vertical). We recommend that plans for all fill slopes should be reviewed prior to construction by a geotechnical specialist to determine whether any specific engineering assessment and design is required (e.g. steeper fills should be specifically reinforced with geogrids or physically retained). To minimise erosion, effective vegetation cover should be established on fill batters and no water flows should be directed to these slopes.

Underdrainage may be required locally within the fill subgrade (if seepage is encountered). Drainage requirements should be confirmed by a geotechnical specialist prior to any fill placement. If localised seepages are encountered, these will need to be tapped at source and conveyed via appropriately designed fabric wrapped subsoil drainage (e.g. TNZ F/6) to prevent migration of slit and to ensure long term control of groundwater conditions. Provision for future maintenance of any such drains should be in place where required (e.g. cleaning eyes at the upper extents).

6.5 Ground Retention

We understand that no retention of cuts is currently proposed however retaining walls would be suitable modes of retention for parts of any cuts or fills proposed if there are any geometrical constraints to battering at angle discussed above.

Any retaining wall proposed should be designed by a chartered professional engineer using specific geotechnical parameters to be advised upon review (and possibly requiring further investigations).

Pole walls may be difficult owing to embedment limitations where rock is shallow as expected. Gravity walls would be suitable.

Temporary slopes for retaining wall construction should be feasible battered at 1:1 provided these are within stiff soils and less than 3 m high and subject to geotechnical checks.

Groundwater was not widely identified but has the potential to develop following completion of the earthworks, in particular as a result of heavy or prolonged rainfall. To ensure potential groundwater seeps and flows are properly controlled behind any retaining walls, the following recommendations are provided:

- A minimum 0.3 m width of durable free draining granular material should be placed behind all retaining structures;
- A heavy duty non-woven geotextile cloth, such as Bidim A14, should be installed between the natural ground surface and the free draining granular material to prevent siltation and blockage of the drainage media; and
- A heavy-duty (TNZ F/2 Class 500) perforated pipe should be installed within the drainage material at the base of all retaining structures to minimise the risk of

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excessive groundwater pressures developing. This drainage pipe should be connected to the permanent piped storm water system.

The safety implications of working under temporary cuts will need to be adequately addressed.

Further comment on retention can be provided once earthworks plans have been finalised and reviewed by a geotechnical practitioner.

6.6 Settlement and Foundations

As part of the future building consent stage, site-specific investigations should be carried out by the future owners, at least in accordance with NZS 3604 for all individual lots when specific building plans are available. However, the testing carried out to date indicates that (following stripping of topsoil), good ground as defined by NZS3604 is likely to be at depths of less than 1 m over most of the site which implies very good subgrade conditions to enable standard foundation design and construction.

Upon removal of topsoil and localised fill etc, all foundations on in-situ soils are expected to be mostly on firm to very stiff overburden soils or weathered rock. These materials will provide good bearing for conventional spread footings or shallow pile foundations. It will likely be straightforward to design footing for lower bearing capacity if required.

There is some very localised older uncontrolled fill on site as shown provisionally on the appended site plan. This should be defined in greater detail as part of subdivision works and practical options for development over the filled area includes removal of the fill or utilising specific foundation design of foundations.

Any new fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS4431:1989. If engineered fill is proposed for building sites, as discussed above, then standard foundations in accordance with NZS 3604 on those lots are likely to be appropriate once certified, however we recommend confirmatory site-specific investigations should still be carried out in accordance with NZS 3604 to confirm this on a site-specific basis.

All unsuitable materials identified in foundation excavations and soils with evidence of voids or those softened by exposure to water should be undercut and replaced with engineered fill during construction or otherwise piled foundations would be required (including under floor slabs unless designed for spanning by a structural engineer). Any foundation areas affected by seepage will require specific assessment.

It is recommended all foundation excavations be inspected by a suitably qualified and experienced geotechnical specialist to confirm the conditions are in accordance with the assumptions and recommendations provided in this report (and future site-specific reports for individual lots) and that all design assumptions have been met.

If any remnant fill is uncertified then this should be for reserve or yard areas only unless specific foundation design is carried out for any structures. If buried services are required in uncertified fill, then specific detailing will be required to address settlement issues.

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6.7 General Site Preparation Advice

Robust site drainage is recommended as above to minimise the potential for softening of the soils during seasonally variable weather conditions, storms etc.

During the earthworks operations all topsoil, organic matter, fill and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:1989.

Owing to the moderately erodible nature of some of the soils present across the site, sediment control measures should be instigated during earthworks construction.

Water should not be allowed to pond or collect near or on any pavement or foundation slab subgrades. Positive grading of the subgrades should be undertaken to prevent water ingress or ponding.

All fill that is utilised as bearing for foundations should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect. An earthfill specification can be provided on request.

We recommend topsoil stripping and subsequent earthworks be undertaken only when a suitable interval of fair weather is expected, or during the earthworks construction season.

6.8 Groundwater Issues

The watertable is expected to lie well below the likely excavation levels and floor levels of future dwellings. Dewatering or other groundwater-related construction issues are therefore unlikely to be required. The potential for groundwater issues can be minimised by implementing the surface drainage, as discussed above. It is important that GeoSolve be contacted should there be any seepage, spring flow or under-runners encountered during construction.

It is possible that some subsoil drainage to capture and divert spring flows may be required but this is generally a consideration for construction when any spring flows are much easier to observe.

6.9 Surface Runoff and Drainage

During earthworks construction a cut-off drain should be installed at the crest of the main cut slopes to avoid upslope surface runoff eroding the slopes. This drain should be carefully detailed to ensure that flows into the drains do not lead to saturation of the subsoil (e.g. by ensuring sufficient gradients in drains and/or lining the base of the drain). Additionally, depending on the design adopted a second drain may need to be installed at the base of the main cuts to intercept any slope surface runoff.

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6.10 Accessway and Pavements

We understand that a series of new access roads will be constructed off Wakari Road to serve the subdivision. Conceptual roads are indicated in Figure 2.1.

We recommend that a surveyor should be engaged to determine the most appropriate alignment for the accessways. Cross-sections at critical locations should be provided by the surveyor showing cut and fill profiles. These cross-sections should be checked by a geotechnical practitioner (particularly for cuts greater than 2 m) to enable further advice on any physical support requirements or advice for fill methodologies as required, however the batter advice above is likely to enable design at most locations.

The roads should be contoured appropriately to allow surface runoff to fall to a contour drain or equivalent in order to intercept any surface runoff.

Topsoil stripping should be carried out over the road alignments and all remaining soft and/or unsuitable materials (e.g. fill, root systems etc) which are exposed during preparation of pavement subgrade should be excavated and replaced with engineered fill.

The testing to date indicates that pavement design and construction is likely to be straightforward, with competent subgrade available at relatively shallow depths below the organic topsoils. GeoSolve can provide further information on pavement design when the final alignments and cut/fill depths have been defined by the surveyor.

Construction of the accessway should be carried out under the supervision of a geotechnical practitioner. Any seepage encountered will require appropriate drainage measures during the earthworks.

It may be that engineered fill is required locally for stream crossings etc and in this case the advice in Section 6.4 should be followed.

6.11 Site Subsoil Category

The following geotechnical information has been used to characterise the site subsoil class in respect of NZS 1170.5:2004 Structural Design Actions:

Based on the best available information, we consider the site subsoil class in terms of NZS 1170.5:2004 Clause 3.1.3 to be Class C (Shallow soil).

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7 Neighbouring Structures/Hazards

Seismic: A risk of seismic activity has been identified for the region as a whole, as discussed in Section 5.1.2 and appropriate allowance should be made for seismic loading during detailed design of the proposed development, but there are no site-specific constraints.

Liquefaction: Owing to the density and type of soil encountered and no occurrences of groundwater on site, the risk of liquefaction is expected to be very low. The site is mapped as Domain A with respect to liquefaction "ground predominately underlain by rock or firm sediments'.

Landslide and slope stability hazard: This has been discussed above in Sections 5.4 and 6.2.

Expansive Soil: As the soils examined during our investigations were non-plastic or exhibited a low plasticity, have minimal clay content (as determined by our visual inspection only), the soils are unlikely to exhibit shrink/swell behaviour, but this should be confirmed for all future building platforms in accordance with the relevant standard (NZS 3604).

Flood hazard has not been assessed in this study but is unlikely in this hillslope setting, provided that upslope flow paths and swales are well controlled. We understand that inputs including a full stormwater management plan will be prepared to address potential flood hazards.

Distances to adjoining structures: No adverse geotechnical implications apply for neighbouring properties during construction of the subdivision provided the above excavation considerations are noted.

Aquifers: No aquifer resource will be adversely affected by the development.

Erosion and Sediment Control: The site presents some potential to generate silt runoff and this would naturally drain downslope, potentially to watercourses. Only the least amount of subsoil should be exposed at any stage and surfacing established as soon as practical. Silt runoff should not be permitted to enter any watercourse. We recommend advice be sought from a qualified specialist where compliance with local and regional erosion and sediment control regulations is uncertain.

Noise: Rock-breaking and/or blasting is unlikely to be required.

Dust: Regular dampening of soil materials with sprinklers should be effective if required.

Vibration: No vibration induced settlement is expected in these soil types; however, any works that create vibrations should be subject to geotechnical advice. Neighbouring structures should be considered by the contractor with respect to vibration effects and further advice sought if there is any uncertainty.

Soil Contamination: This is beyond our scope and a specialist may be required to check fills or if any other evidence of contaminated soils is found.

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8 Applicability

This report has been prepared for the sole use of our client, JKS Paddock Ltd, with respect to the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior review and written agreement.

Investigations have been undertaken at discrete locations in accordance with the brief provided. It must be appreciated that the nature and continuity of subsoil conditions away from the investigation locations cannot be guaranteed.

During construction, foundation excavations should be examined by an inspector or engineer competent to confirm that subsurface conditions encountered throughout are compatible with the findings of this report. It is important that we be contacted if there is any variation in subsoil conditions from those described in this report.

Report prepared by:

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Mark Walrond
Senior Engineering Geologist

Appendices: Appendix A – Site Plan - Figure 1
Appendix B – Investigation Data – AH 1-24 [24p]

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Appendix A: Site Plan

Key

- Hand Auger and/or Scala penetrometer test locations
- Area of wet and pugged ground (approx extents)
- buried power cable (approx location)
- buried telecom cable (approx location)

CADFILE:	Site Plan.xar	DRAWN	RC 05/2023
SCALE: (AT A3 SIZE)	As shown (approx)	DRAFTING CHECKED	MTW 05/2023
PROJECT No.:	230385	APPROVED	MTW 05/2023

GEOSOLVE
ENGINEERING CONSULTANTS

JKS Paddock Ltd
Geotechnical Investigation
195 & 245 Wakari Rd, Dunedin
Site Plan

FIG No: Figure 1

REV. 1

Appendix B: Investigation Data

HAND AUGER LOG

HOLE NO.: AH1

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404443 mE, 4919651 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		2, 2, 2, 4, 7, 4, 4, 5, 8, 6, 7, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.3 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:30 pm

HAND AUGER LOG

HOLE NO.: AH2

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404423 mE, 4919657 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.4 m			TS	3, 3, 2		Groundwater Not Encountered
RESIDUAL VOLCANIC SOIL	Silty CLAY with minor gravel, brown. Firm, moist, low plasticity, gravel, fine to coarse, subangular basalt. 0.8 m		0.5		3, 2, 3, 3		
COMPLETELY WEATHERED DUNEDIN VOLCANIC GROUP	Clayey SILT with minor gravel, brown with purple grey mottle. Stiff, moist, non-plastic, gravel, fine to coarse, subangular basalt. 1.0 m		1.0		6, 9, 4, 17 >>		
	End Of Hole: 0.95 m		1.5				

PHOTO(S)

REMARKS

Refusal at 0.95 m - auger spinning on hard surface. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:34 pm

HAND AUGER LOG

HOLE NO.: AH3

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404383 mE, 4919736 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		1, 2, 2, 3, 3, 2, 4, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 0.9 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:36 pm

HAND AUGER LOG

HOLE NO.: AH4

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404321 mE, 4919769 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS	1, 1		
RESIDUAL VOLCANIC SOIL	Silty CLAY with a trace of gravel, brown. Firm to stiff, moist, low plasticity, gravel, fine, subangular basalt. 0.6 m		0.5		3, 6, 8		
COMPLETELY WEATHERED DUNEDIN VOLCANIC GROUP	Clayey SILT with minor gravel and a trace of sand, brown with purple grey mottle. Stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 0.9 m				7, 16 >>		
	End Of Hole: 0.85 m		1.0				Groundwater Not Encountered
			1.5				

PHOTO(S)

REMARKS

Refusal at 0.85 m - auger spinning on hard surface. No groundwater encountered. 2 attempts at Scala test - first attempt refused at 0.5 m.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:39 pm

HAND AUGER LOG

HOLE NO.: AH5

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404337 mE, 4919801 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		1, 2, 3, 4, 5, 9, 6, 10, 8		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:44 pm

HAND AUGER LOG

HOLE NO.: AH6

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404323 mE, 4919912 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND
TOPSOIL	Organic SILT with minor clay and a trace of gravel, brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS
RESIDUAL VOLCANIC SOIL	Silty CLAY with minor gravel and a trace of sand, brown. Firm, moist, low plasticity, sand, fine; gravel, fine, subangular basalt. 0.7 m		0.5	
	Clayey SILT with minor gravel and a trace of sand, brown. Firm. Stiff from 1.0 m, moist, non-plastic, sand, fine; gravel, fine, subangular basalt. 1.4 m		1.0	
	End Of Hole: 1.40 m		1.5	

SCALA PENETROMETER (Blows / 100 mm)

1 2 2 2 2 2 3 3 4 5 7 12 16 >>

SHEAR STRENGTH (kPa) Vane: 50 100 150 200 Values

WATER

Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.4 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:49 pm

HAND AUGER LOG

HOLE NO.: AH7

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404418 mE, 4919837 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		2, 2, 2, 3, 3, 4, 3, 5, 10, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.1 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:54 pm

HAND AUGER LOG

HOLE NO.: AH8

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404491 mE, 4919724 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC

START DATE: 22/06/2023
END DATE: 22/06/2023
LOGGED BY: RC
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		2 2 2 2 3 3 3 3 3 5 12		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:57 pm

HAND AUGER LOG

HOLE NO.: AH9

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404574 mE, 4919768 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.2 m		
RESIDUAL VOLCANIC SOIL	Clayey SILT with a trace of gravel, brown. Firm to stiff, moist, non-plastic, gravel, fine to medium, subangular basalt. 0.5 m		0.5
	Clayey SILT with minor gravel and a trace of sand, orange brown mottled. Stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 0.7 m		
	End Of Hole: 0.65 m		1.0
			1.5

LEGEND: TS

SCALA PENETROMETER (Blows / 100 mm): 1, 3, 2, 3, 5, 5, 7, 6, 8, 11, 20 >>

SHEAR STRENGTH (kPa) Vane: 50, 100, 150, 200 — Values

WATER: Groundwater Not Encountered

PHOTO(S)

REMARKS

Test is at base of shallow swale. Unable to penetrate beyond 0.65 m - auger grinding on gravel/cobbles? No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:03 pm

HAND AUGER LOG

HOLE NO.: AH10

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404577 mE, 4919793 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		2 2 2 2 3 20 >>		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. 2 attempts made, both with instant refusals (boulders?)

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:06 pm

HAND AUGER LOG

HOLE NO.: AH11

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404507 mE, 4919830 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS
COLLUVIUM	SILT with minor clay and a trace of gravel, light brown. Stiff, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.7 m		0.5	
	SILT with minor gravel and a trace of clay, light brown. Stiff to very stiff, moist, non-plastic, gravel, fine to coarse, subrounded to subangular basalt. 0.8 m			
	End Of Hole: 0.80 m		1.0	
			1.5	

SCALA PENETROMETER (Blows / 100 mm)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
	2	2	4	3	5		8		10			18 >>	

SHEAR STRENGTH (kPa) Vane: 50 100 150 200 Values

WATER

Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 0.8 m - auger grinding on gravels. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:09 pm

HAND AUGER LOG

HOLE NO.: AH12

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404547 mE, 4919865 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC

START DATE: 22/06/2023
END DATE: 22/06/2023
LOGGED BY: RC
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		1, 3, 2, 3, 3, 3, 3, 3, 3, 7, 15		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.2 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:12 pm

HAND AUGER LOG

HOLE NO.: AH13

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 21/06/2023

COORDINATES: 1404500 mE, 4919923 mN (NZTM2000)

EQUIPMENT: Hand auger & Scala penetrometer

END DATE: 21/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: WW

ELEVATION: Existing ground level

OPERATOR: RC/WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets and remnant organic fragments. 0.4 m				1, 2, 1		
COLLUVIUM	SILT with a trace of clay, sand and gravel, light brown. Stiff to very stiff, moist, non-plastic, sand, fine; gravel, gravel, fine, subangular basalt. 1.1 m		0.5		3, 4, 5, 6, 7, 11, 15		Groundwater Not Encountered
	SILT, light grey. Stiff to very stiff, moist, non-plastic. 1.4 m		1.0				
	SILT with minor gravel and sand, light grey orange mottled. Stiff to very stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 1.7 m		1.5				
	End Of Hole: 1.65 m						

PHOTO(S)

REMARKS

Test is at base of shallow swale. Unable to penetrate beyond 1.65 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:15 pm

HAND AUGER LOG

HOLE NO.: AH14

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404416 mE, 4919928 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		1, 2, 2, 2, 2, 2, 3, 4, 9, 12, 10, 20 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.25 m - hammer bouncing.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:17 pm

HAND AUGER LOG

HOLE NO.: AH15

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404429 mE, 4919973 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC

START DATE: 22/06/2023

END DATE: 22/06/2023

LOGGED BY: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		1 2 3 2 4 4 4 5 6 8 9 12 15	50 100 150 200	Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:20 pm

HAND AUGER LOG

HOLE NO.: AH16

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404502 mE, 4920009 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Hand auger & Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC/WW

START DATE: 21/06/2023
END DATE: 21/06/2023
LOGGED BY: WW
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND
TOPSOIL	Organic SILT with a trace of clay and gravel, dark brown. Soft to firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS
COLLUVIUM	SILT with a trace of sand and gravel, brown. Stiff to very stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 1.2 m		0.5 1.0	
	End Of Hole: 1.20 m		1.5	

SCALA PENETROMETER (Blows / 100 mm)

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

SHEAR STRENGTH (kPa) Vane: 50 100 150 200 Values

WATER

Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.2 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:23 pm

HAND AUGER LOG

HOLE NO.: AH17

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404597 mE, 4919990 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL
TOPSOIL	Organic SILT with a trace of clay and gravel, dark brown. Very soft, wet to saturated, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m		
ALLUVIAL SILT	Clayey SILT with a trace of gravel and sand, light grey. Firm. Stiff to very stiff from 0.8 m, moist. Saturated at 0.7 m, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 1.3 m		0.5, 1.0, 1.5
	End Of Hole: 1.30 m		

LEGEND

SCALA PENETROMETER (Blows / 100 mm)

1 1 1 2 3 4 6 8 13 18 >>

SHEAR STRENGTH (kPa) Vane: 50 100 150 200 Values

WATER 21/06/2023

PHOTO(S)

REMARKS

Test is in an area of wet and pugged ground. Unable to penetrate beyond 1.3 m - increasingly stiff material. Hole filled with water to within 50 mm of surface at end of excavation.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:26 pm

HAND AUGER LOG

HOLE NO.: AH18

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404589 mE, 4919962 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC

START DATE: 22/06/2023
END DATE: 22/06/2023
LOGGED BY: RC
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		1, 2, 2, 1, 2, 1, 2, 3, 4, 4, 6, 7, 8	50, 100, 150, 200	Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:28 pm

HAND AUGER LOG

HOLE NO.: AH19

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404623 mE, 4919894 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Hand auger & Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC/WW

START DATE: 21/06/2023
END DATE: 21/06/2023
LOGGED BY: WW
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
UNCONTROLLED FILL	SILT with minor sand and gravel, brown and dark brown mottled. Firm, moist, non-plastic, sand, fine to coarse; gravel, fine to coarse, subangular to subrounded basalt and quartz clasts. Minor charcoal and ash. A trace of rootlets.		0.5		3, 3, 4, 3, 3, 5, 3		Groundwater Not Encountered
	0.7 m SILT with minor sand and gravel, light grey brown. Stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subrounded to subangular basalt. Highly organic light grey silt inclusions.				3, 3, 2		
BURIED TOPSOIL	1.0 m Organic SILT with a trace of sand and gravel, dark brown. Stiff, moist, non-plastic, sand, fine; gravel, fine, subangular basalt. A trace of rootlets and remnant organic fragments.		1.0		5, 6, 6		
RESIDUAL VOLCANIC SOIL	1.3 m SILT with minor clay and a trace of sand and gravel, brown orange mottled. Stiff to very stiff, moist, non-plastic, sand, fine; gravel, fine, subangular basalt.		1.5		7, 8, 10, 11		
	1.7 m End Of Hole: 1.70 m				15		

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.7 m - auger grinding on gravels/cobbles? No groundwater encountered. 2 attempts at Scala test - first attempt refused at 0.6 m (concrete?). Second attempt had instant refusal at 1.8 m (cobble?) Land owner reports likely concrete within fill material.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:31 pm

HAND AUGER LOG

HOLE NO.: AH20

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404642 mE, 4920015 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Hand auger & Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC/WW

START DATE: 21/06/2023
END DATE: 21/06/2023
LOGGED BY: WW
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL
TOPSOIL	Organic SILT with a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine to coarse, subangular basalt. A trace of rootlets and remnant organic fragments. 0.3 m		
COLLUVIUM	SILT with minor/trace sand and a trace of gravel, light brown. Firm becoming stiff to very stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 1.1 m		0.5 1.0
	End Of Hole: 1.10 m		1.5

LEGEND: TS

SCALA PENETROMETER (Blows / 100 mm)

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

SHEAR STRENGTH (kPa) Vane: Values

50	100	150	200

WATER: Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.1 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:34 pm

HAND AUGER LOG

HOLE NO.: AH21

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404709 mE, 4919972 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC

START DATE: 22/06/2023

END DATE: 22/06/2023

LOGGED BY: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		1 2 2 2 2 3 4 5 6 9 11 15		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.3 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:37 pm

HAND AUGER LOG

HOLE NO.: AH22

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404770 mE, 4919924 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND
TOPSOIL	Organic SILT with a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine to coarse, subangular basalt. A trace of rootlets. 0.3 m			TS
COLLUVIUM	SILT with a trace of sand and gravel, light brown. Firm to stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subrounded to subangular basalt. 0.4 m			TS
RESIDUAL VOLCANIC SOIL	SILT with a trace of sand and gravel, orange brown mottled. Stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 0.7 m		0.5	TS
	SILT, light grey. Stiff to very stiff, moist, non-plastic. 1.4 m		1.0	TS
	End Of Hole: 1.40 m		1.5	

SCALA PENETROMETER (Blows / 100 mm)

Depth (m)	Blows / 100 mm
0.0 – 0.3	1
0.3 – 0.4	2
0.4 – 0.5	2
0.5 – 0.6	3
0.6 – 0.7	4
0.7 – 0.8	5
0.8 – 0.9	5
0.9 – 1.0	9
1.0 – 1.1	12
1.1 – 1.4	17 >>

SHEAR STRENGTH (kPa) Vane: Values

WATER

Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.4 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:39 pm

HAND AUGER LOG

HOLE NO.: AH23

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404673 mE, 4919871 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		1, 2, 2, 2, 3, 3, 3, 20 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. 2 attempts made, both with instant refusals (boulders?). First attempt refused at 0.7 m.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:42 pm

HAND AUGER LOG

HOLE NO.: AH24

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 21/06/2023

COORDINATES: 1404716 mE, 4919836 mN (NZTM2000)

EQUIPMENT: Hand auger & Scala penetrometer

END DATE: 21/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: WW

ELEVATION: Existing ground level

OPERATOR: RC/WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor gravel and a trace of sand, dark brown. Soft to firm, moist, non-plastic, sand, fine; gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS	2		
COLLUVIUM	SILT with a trace of sand and gravel, light brown. Stiff to very stiff, moist, non-plastic, sand, fine; gravel, fine, subangular basalt. A trace of rootlets. 0.9 m		0.5		4, 3, 4, 7, 11		
	End Of Hole: 0.85 m		1.0		17 >>		Groundwater Not Encountered
			1.5				

Scala penetrometer axis: 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Shear strength (kPa) Vane: 50 100 150 200 Values

PHOTO(S)

REMARKS

Unable to penetrate beyond 0.85 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:53:45 pm

195 Wakari Road, Dunedin

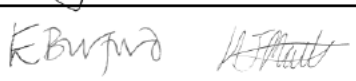
Integrated Catchment Management Plan for Subdivision Consent

October 2023

Fluent SOLUTIONS

195 Wakari Road, Dunedin

Integrated Catchment Management Plan for Subdivision Consent

Task	Responsibility	Signature
Project Manager:	Anthony Steel	
Plan Prepared By:	Hopcyn Mathews Emma Burford	
Plan Reviewed By:	Anthony Steel	
Plan Approved For Issue By:	Anthony Steel	

Issue Date	Revision No.	Author	Checked	Approved
26-10-2023	1	EB/HM	AS	AS

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Job No.: 000792
Date: 26 October 2023
Reference: RP 23-10-30 EB 000792.Docx

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195 Wakari Road, Dunedin

Integrated Catchment Management Plan for Subdivision Consent

APPENDICES

APPENDIX 1

Geotechnical Report - 195 & 245 Wakari Road Dunedin
Geosolve - July 2023

1.0 Introduction

Fluent Solutions has been engaged to prepare an Integrated Catchment Management Plan (ICMP) to support a residential subdivision consent application to Dunedin City Council (DCC) for a new development at 195 Wakari Road, Dunedin.

The subdivision site is located within recently rezoned residential land off Wakari Road. The site is within a New Development Mapped Area as defined in the DCC 2GP.

2.0 Location and Description of Site

The site is located to the north of Dunedin City, on the northern side of Wakari Road, presented in Figure 2.1 below.

Figure 2.1: Site Location

The 9.6 hectare sloping site sits above established residential lots on the northwest side of Wakari Road. A description of the existing site characteristics and photographs of predeveloped site are presented in Section 4 below.

3.0 Dunedin City Council 2GP Requirements

The development site is located within a New Development Mapped Area (NDMA) within the DCC 2GP, presented in Figure 3.1 below. The extent of the development relating to this report is highlighted in light blue.

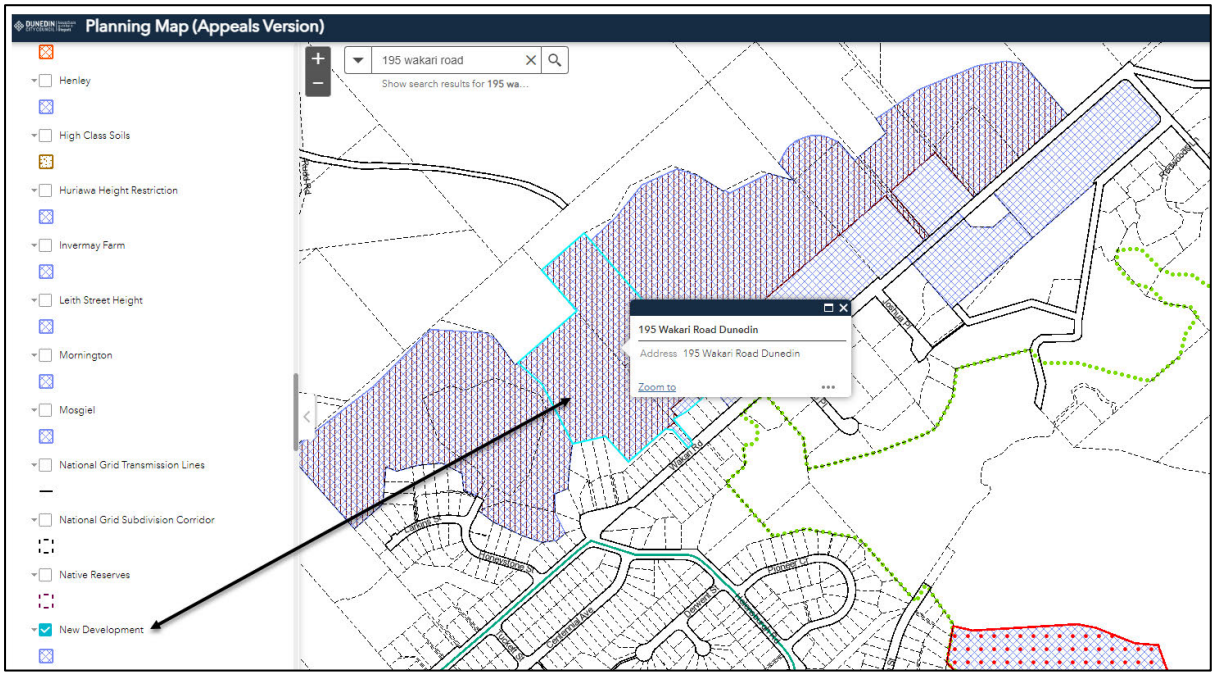


Figure 3.1: New Development Mapped Area and Site Location. Extracted from DCC 2GP.

Rule 9.9X of the DCC 2GP requires that integrated stormwater management plans for all NDMA's must address the whole NDMA area and demonstrate how policy 9.2.1.Y, below, can be achieved.

The ICMP for this development meets the requirements of Policy 9.2.1.Y presented in Figure 3.2 below.

Policy 9.2.1.Y	Only allow subdivision activities, multi-unit development, supported living facilities or development that contravenes Rule 9.3.7.AA in a **new development mapped area** where: a. an integrated stormwater management plan that is designed for the whole NDMA has been prepared, and stormwater management system(s) for all parts of the NDMA that are hydrologically connected to the area proposed for subdivision will ensure there is no increase in the peak stormwater discharge rate from the NDMA into the stormwater public infrastructure, or into a private stormwater system (at any point) between pre-development and post-development; or b. where this is not practicable, any adverse effects from an increase in discharge on the stormwater system are no more than minor.

Figure 3.2: Policy 9.2.1.Y extracted from DCC 2GP

The following sections of this report demonstrate compliance with the requirements of Policy 9.2.1.Y as noted below:

- The stormwater catchment area related to this subdivision site does not impact on the remainder of the NDMA.
- The ICMP for the subdivision site does not impact on the wider NDMA area.
- This proposed low impact stormwater management plan has been modelled and calculated such that post development flows leaving the site are less than predevelopment flows and therefore do not impact any public or private stormwater infrastructure beyond what is currently occurring in the pre-development case.

4.0 Existing Pre-Development Features

The predevelopment use of the site is low impact agricultural use; pasture for grazing and grass cut for hay. Access to the site is via an existing road reserve located between 191 and 197 Wakari Road as shown in Figure 4.1. The Bain Reserve is located at 197 Wakari Road, northeast of the entrance. The majority of the site slopes at an approximate 5-10 degrees down to the east-southeast towards an existing ephemeral watercourse feeding into an existing culvert running under Wakari Road on the southeastern boundary located between 205 and 225 Wakari Road.

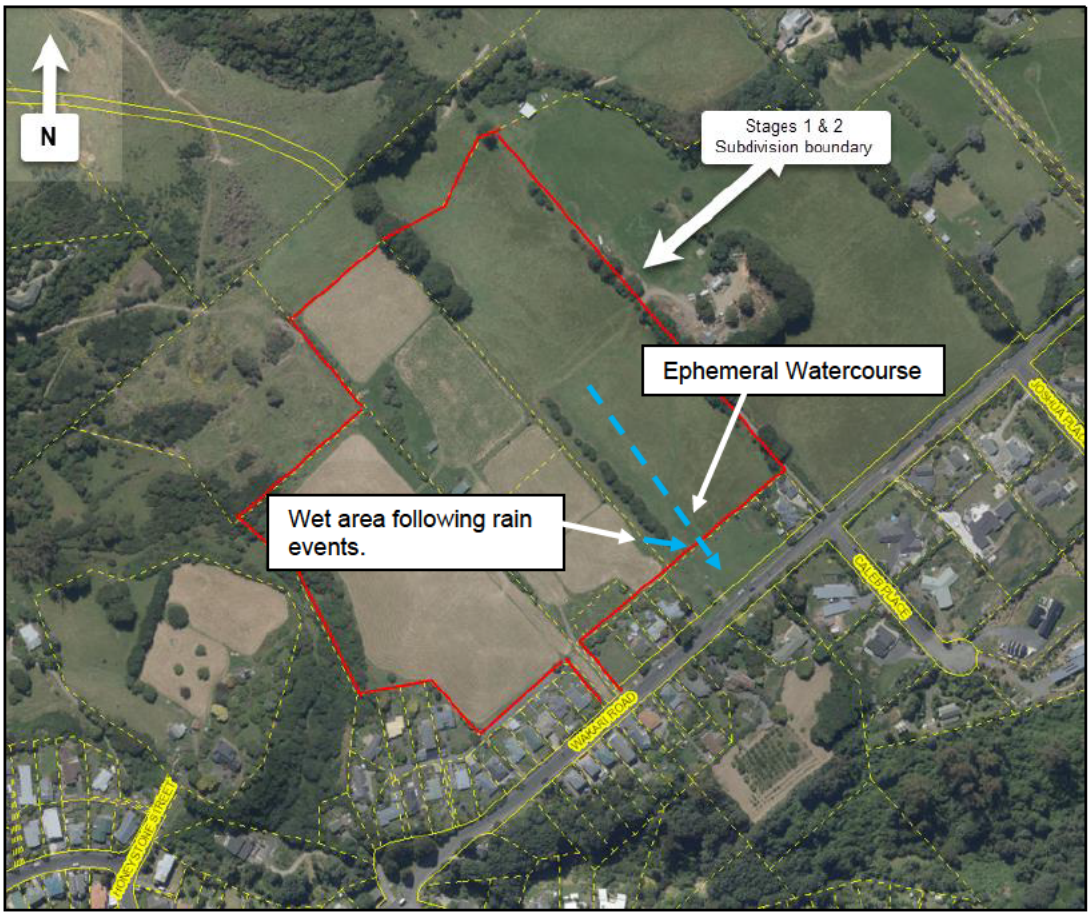


Figure 4.1: Extent of Development Site

4.1 Site Coverage

The site is pervious comprising pasture, some cabbage trees and macrocarpa trees and some small bushes. The access track adjacent to Bain Reserve is gravel. There are a few small sheds located on the site but with no hard stand areas associated to them.

The area is proposed to be developed in two stages as described later in this report. The 36 lots proposed for Stage 1 of the development will be located at the southwestern end of the site and will be accessed off the existing Wakari Road access noted above. An image of Stage 1 of the proposed development is presented later in this report.

Photos of the site are presented in Figures 4.2 to 4.6 below.

Figure 4.2: Development Site Looking Northwest from Access Road

Figure 4.3: Development Site Looking Southeast towards Access Road

Figures 4.4 and 4.5: Western Stream Gully and Upper Hill Catchment

Figure 4.6: View Looking Down Ephemeral Watercourse Located in Stage 2 Land

4.2 Soils

4.2.1 General

A geotechnical evaluation of the site has been undertaken by geotechnical engineering company - Geosolve Ltd (Geosolve). A copy of their report is presented in the Appendices. The soils found and described in their investigations have also been further confirmed by referencing the Landcare Research Smaps online. These are described further below.

4.2.2 Geosolve Limited Investigations

Geosolve completed onsite investigations to inform their Geotechnical Report developed in July 2023.

Geosolve found that colluvium and volcanic soils underly the site. Geosolve also observed silty clays, with some gravel and traces of sand present in various test pits.

Their report states that the site is naturally free-draining and there are no major areas of saturated ground apart from the lower reaches of the ephemeral watercourse near the southern corner of Stage 2 and an area near the north boundary, where spring flows are evident. One area of wet pugged ground was identified within Stage 2 development area, presented in Figure 4.7 below. No wet areas are identified in the Stage 1 area.
Test Pits AH1-8 are located within the Stage 1 area; test pit profiles are presented in the attached report.

Groundwater was not observed in any of the test pits within the development site.

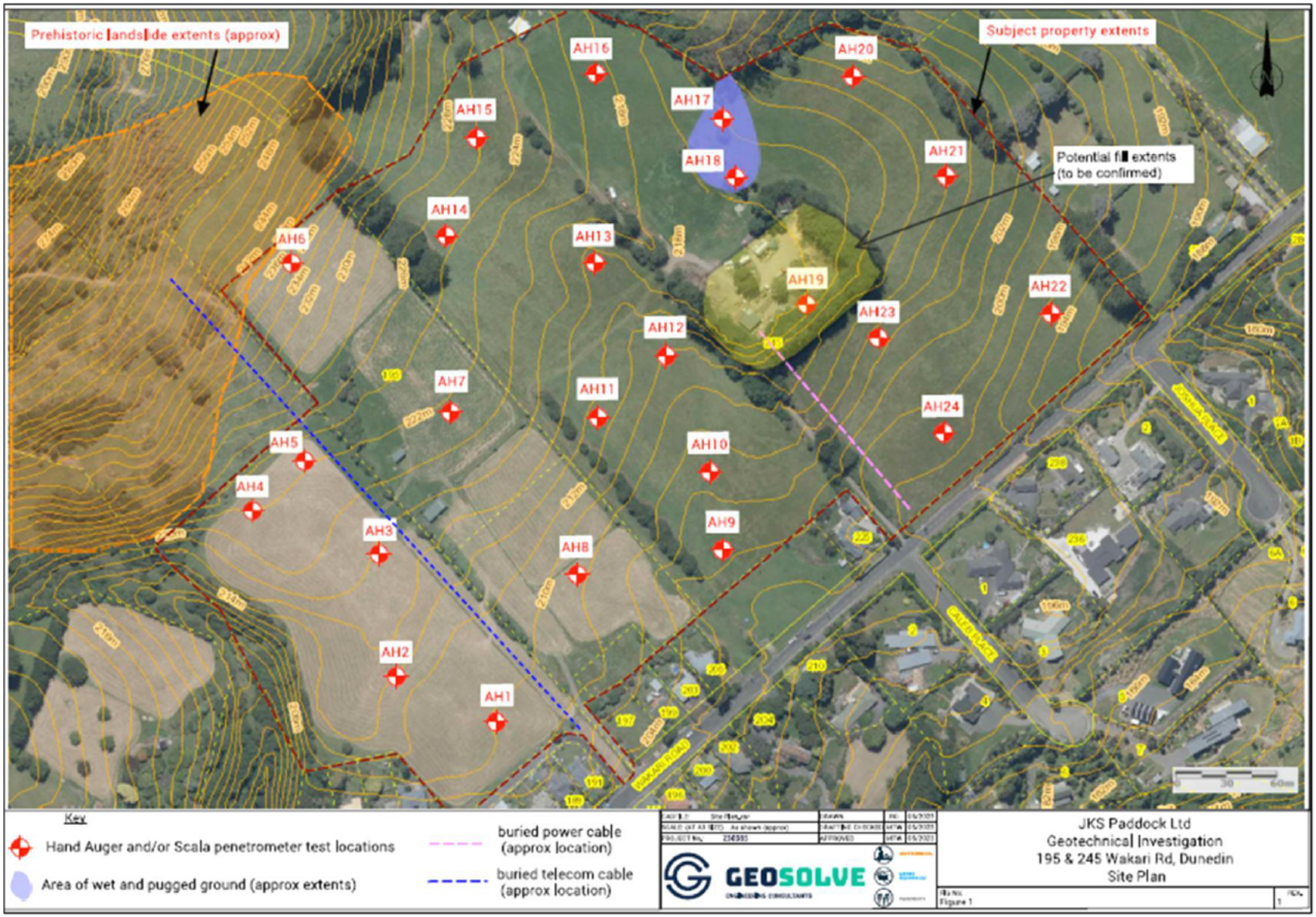


Figure 4.7: Geotechnical Investigations - Test Pit Locations - Extracted from Geosolve Report

4.2.3 Landcare Research Smaps

The Landcare Research Smap for the proposed development area is presented in Figure 4.8 below.

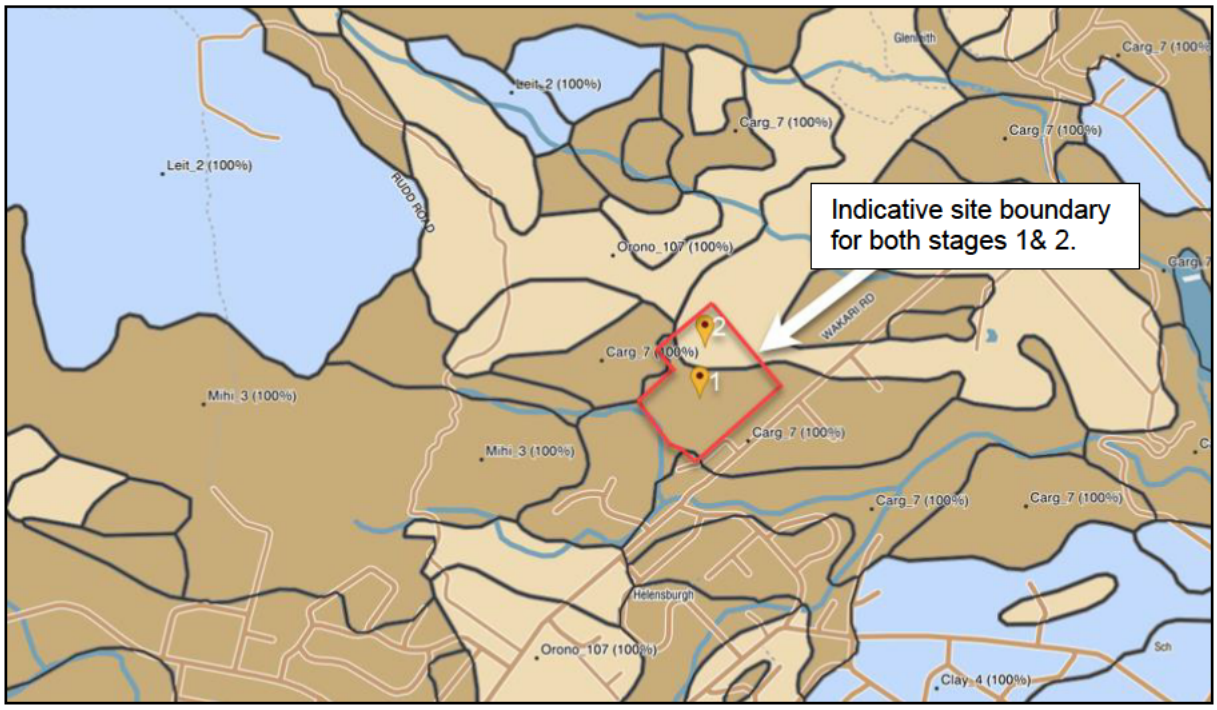


Figure 4.8: Site Location and Soils Map (soil types pinned 1 & 2). Extracted from Smaps online.

The soil categories in the site area are described as being Cargill (pinpoint 1) and Oronoko (pinpoint 2) soils. Descriptions of these soils' texture and permeability qualities are presented below in Figures 4.9 to 4.12 below.

The majority of the subdivision site is located in Cargill soils. Landcare Research identify Cargill soils as being Loamy and at this location having gravels from 50cm depth and a rooting barrier at a depth of approximately 70cm. Permeability is stated as rapid to a depth of 25cm, moderate between 25 and 75cm depth, and with a permeability barrier at 75cm at this location.

Oronoko soils are identified as being Loamy, with no gravels or rooting barrier at this location. Permeability is identified as being rapid to a depth of 25cm, moderate between 25cm and 65cm depth, and moderately slow beyond this. No permeability barrier is identified at this location.

Both the Geosolve investigations and the Landcare research maps correlate with each other.

The permeability data presented in the Geosolve report, and information provided by Landcare Research, was used to inform the stormwater runoff modelling parameters. Modelling parameters and results are presented in later in this report.

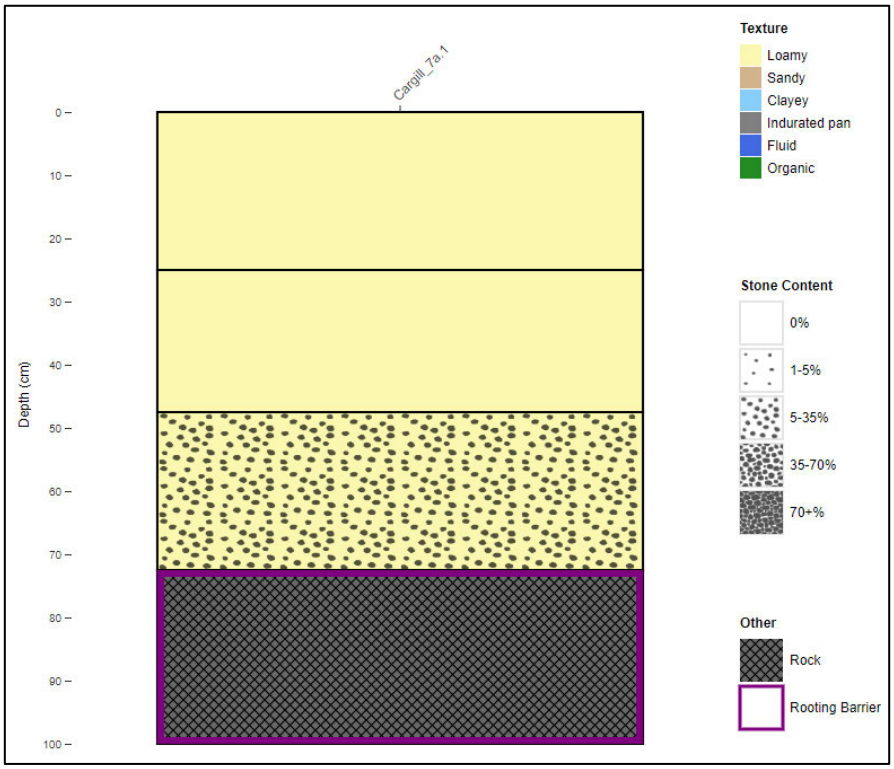


Figure 4.9: Cargill Soils Texture

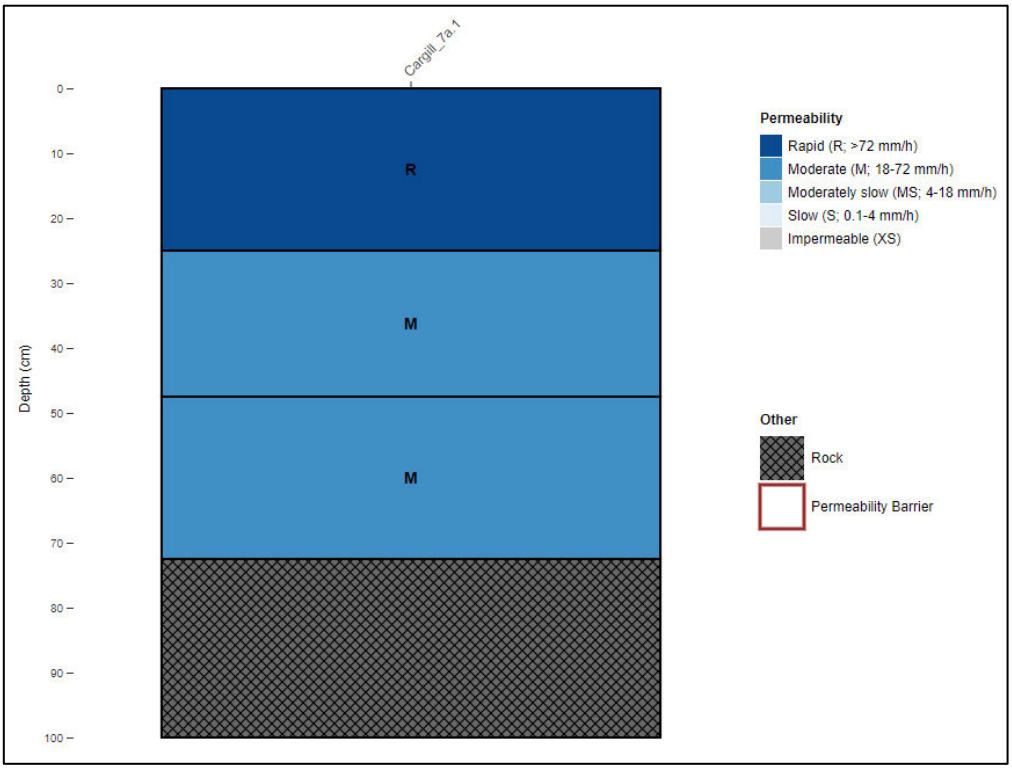


Figure 4.10: Cargill Soils Permeability

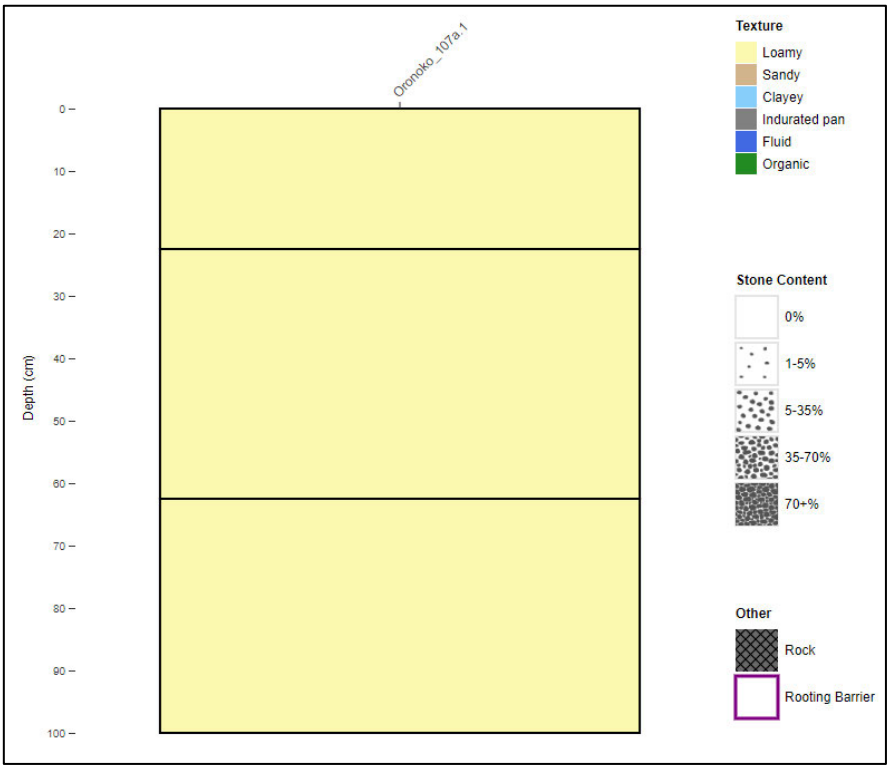


Figure 4.11: Oronoko Soils Texture

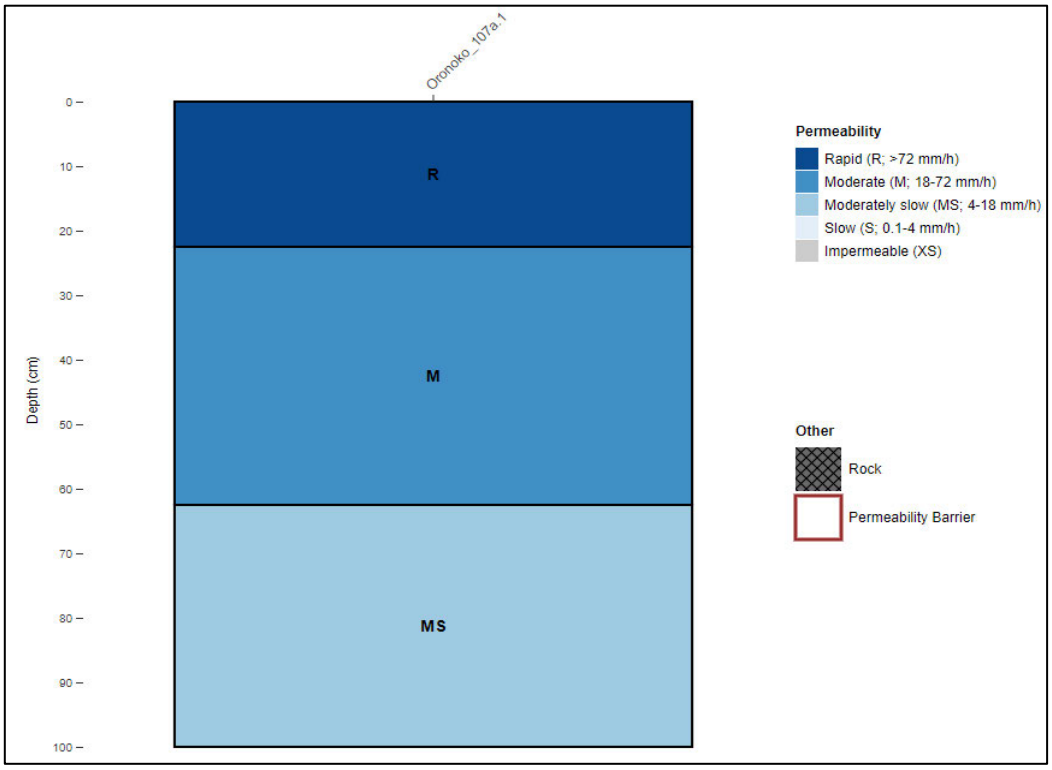


Figure 4.12: Oronoko Soils Permeability

5.0 Predevelopment Features

5.1 Upper Hillside Catchment

Stormwater runoff from rainfall flows into the top of the site from a narrow section of the upper hillside to the northwest of the site, as presented in Figure 5.1 below. The wider upper hillside area flows around the subdivision site via gullies to the north and south of the site as can be seen in Figures 5.1 and 5.2 below.

The contributing upper catchment area for this ICMP associated with both Stages 1 and 2 of the proposed development is approximately 11.26 hectares as shown in Figure 5.2. The catchment consists of grass and scrubby bushes, including land grazed by cattle and sheep.

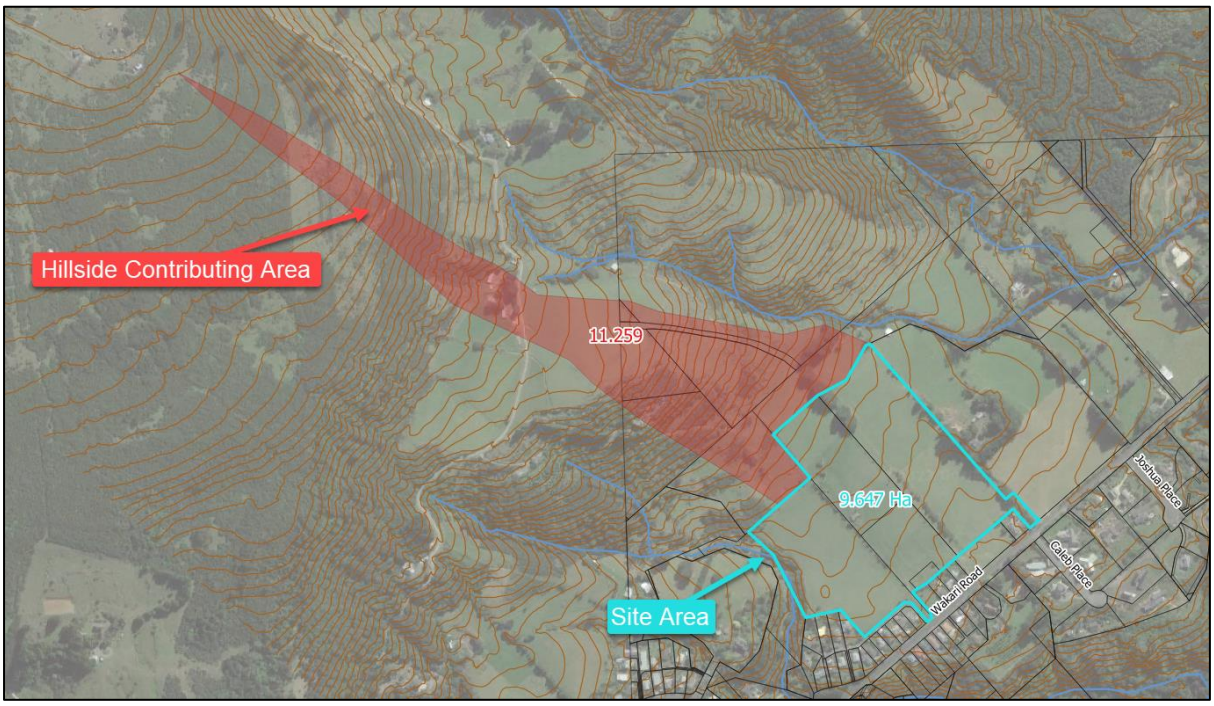


Figure 5.1: Stormwater Catchment Area

The upper hillside catchment shown in Figure 5.1 only impacts the proposed development area and does not contribute to the wider NDMA area as shown in Figure 5.2 below. As such this ICMP is a stand-alone document. The wider, upper and lower catchment areas to the east of the presented Hillside Contributing Area shown above are not considered part of this ICMP. Should further development works occur in the wider NDMA area, further ICMPs will be required.

Importantly, the proposed development of the subject site does not impact on or otherwise preclude development of other areas of the NDMA.

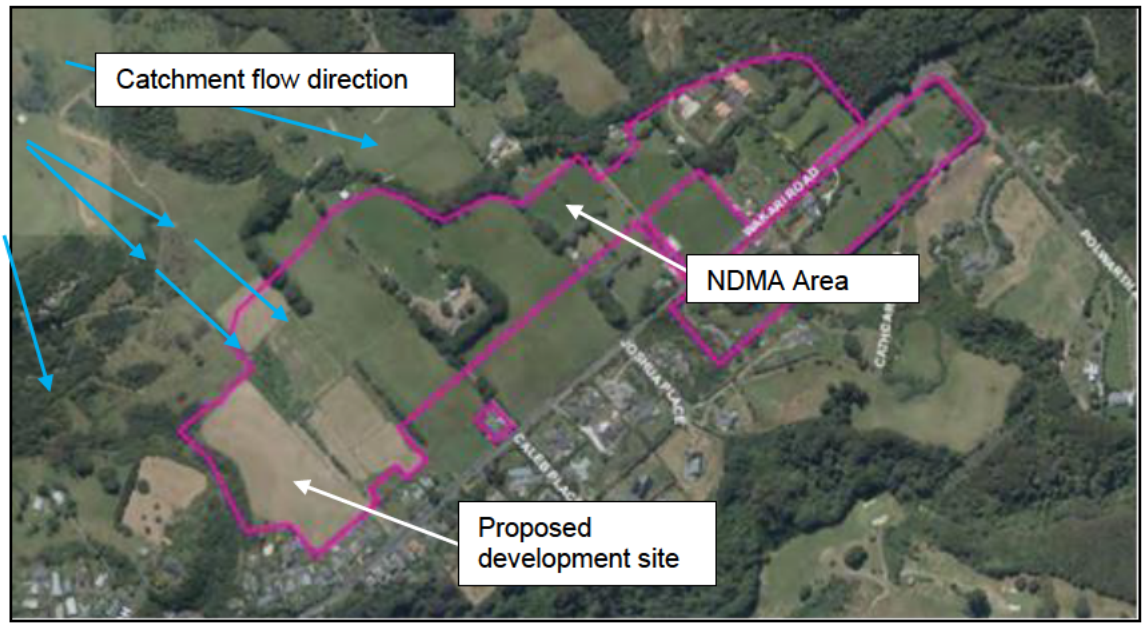


Figure 5.2: NDMA Area and Stormwater Catchment Flow Direction

A view of the lower reaches of this upper catchment area is presented in Figure 5.3 below.

Figure 5.3: View Northwest up across Upper Catchment above the Subdivision Site

5.2 Pre-Development Flow Routes

As noted earlier, stormwater runoff flowing from upper hillside contributing area and pre-development flows from the majority of Stages 1 and 2 of the development area flow towards an existing ephemeral watercourse feeding into an existing culvert running under Wakari Road on the southeastern boundary of the adjacent Lot 2 DP513716 located between 205 and 225 Wakari Road as shown in Figure 5.4 below.

Figure 5.4: Overland Flow Directions within and around the Site

There is no existing DCC Stormwater infrastructure located within the proposed development site. Any existing infrastructure is located under Wakari Road and to the southeast of Wakari Road. The DCC stormwater networks which consist of open channels and associated culverts which convey the overland flows to either the western stream or the channel running through 210 Wakari Road (opposite Lot 2 DP513716) as shown in Figure 5.5 below. Both channels eventually end up discharging into Ross Creek.

Pre-development catchment areas within the proposed subdivision site are also presented in Figure 5.5 below. There are two catchments, a portion of the western side of the site slopes to the west towards a significant gully that drains towards a large culvert at the intersection of Helensburgh Road and Wakari Road, and the remainder of the site which flows towards the ephemeral watercourse and culvert in adjacent Lot 2 DP513716 as noted above.

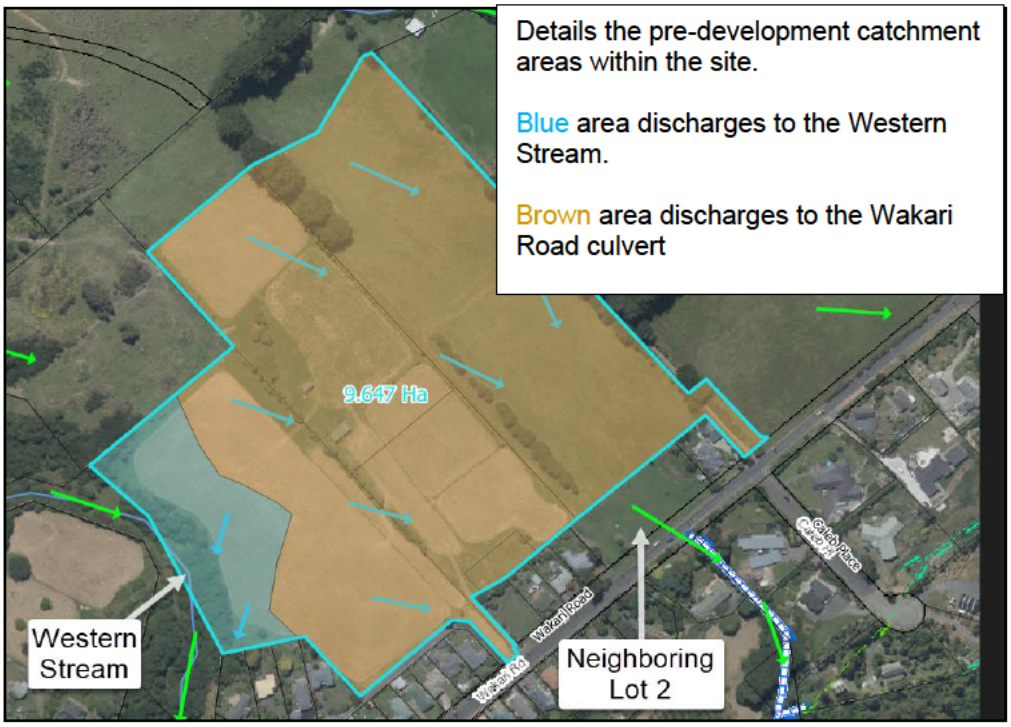


Figure 5.5: Predevelopment Catchment Areas within the Site

Figure 5.6 shows the location of Lot 2 DP513716 in relation to Stage 1 of the proposed development and the existing ground contours in the area of the ephemeral watercourse.

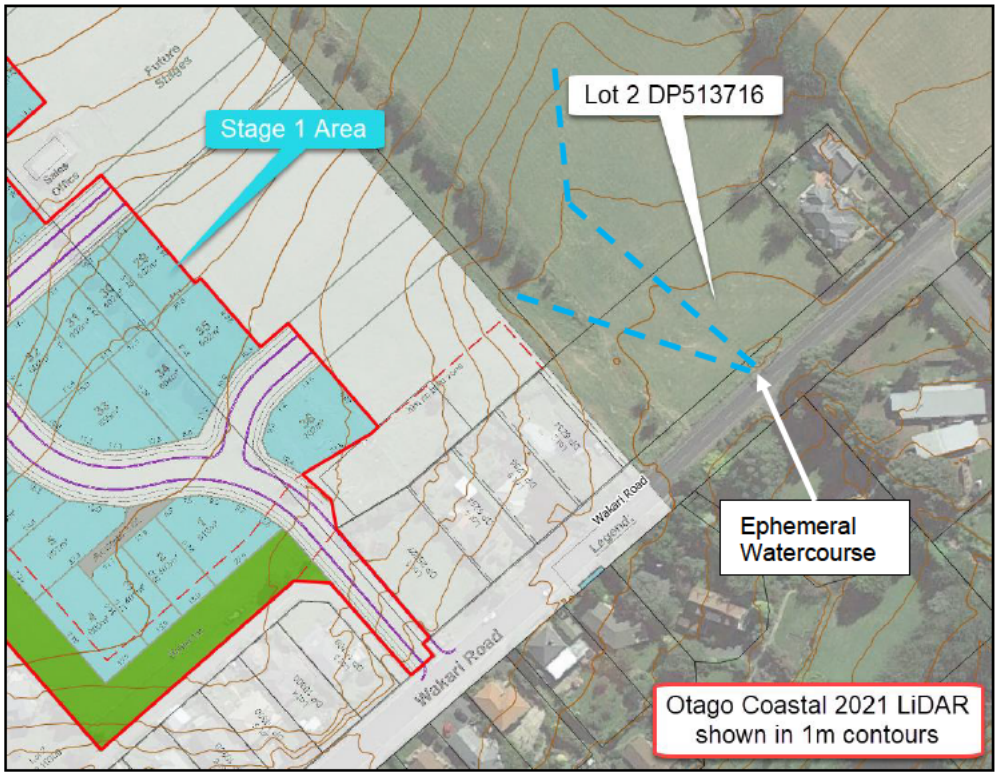


Figure 5.6: Ephemeral Watercourse and Lot 2 DP513716

Figures 5.7 to 5.9 show the ephemeral watercourse passing through Lot 2 DP513716 and the culvert inlet grating at the low point leading under Wakari Road.

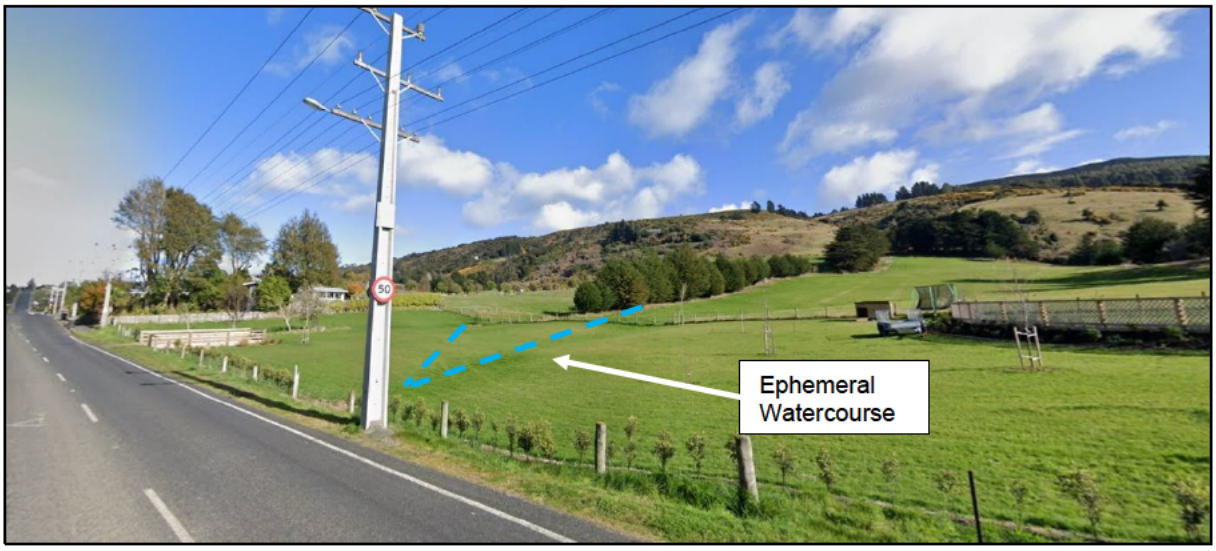
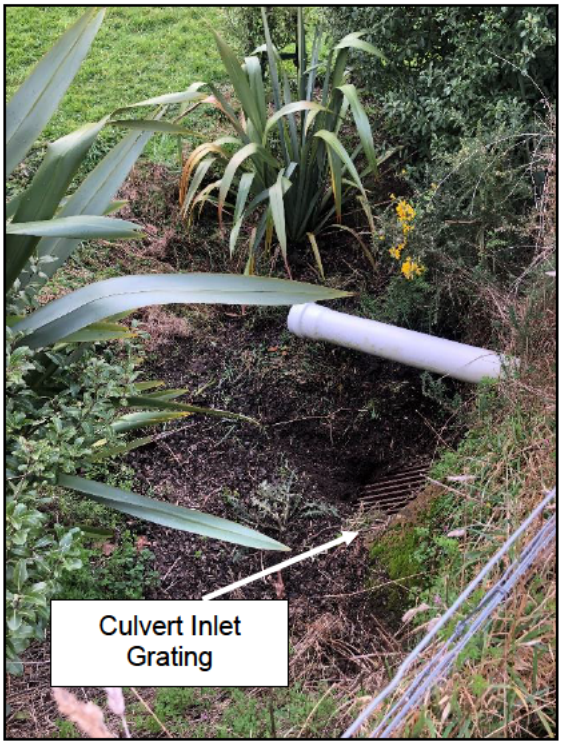


Figure 5.7: View of Low Point and Culvert Location in Lot 2 DP513716
(prior to hedge growing up, extracted from Googlemaps)



Figures 5.8 and 5.9: Grated Drain Culvert Lot 2 DP513716

The western stream gully to the west of the site is shown in Figure 4.4 and is also visible adjacent to the intersection of Wakari Road and Helensburgh Road.

6.0 Post-Development Features

6.1 Development Layout

The development site - both Stages 1 and 2 (highlighted by the light blue boundary in Figure 6.1 below) is zoned as General Residential 1 in the Dunedin City Council 2GP.

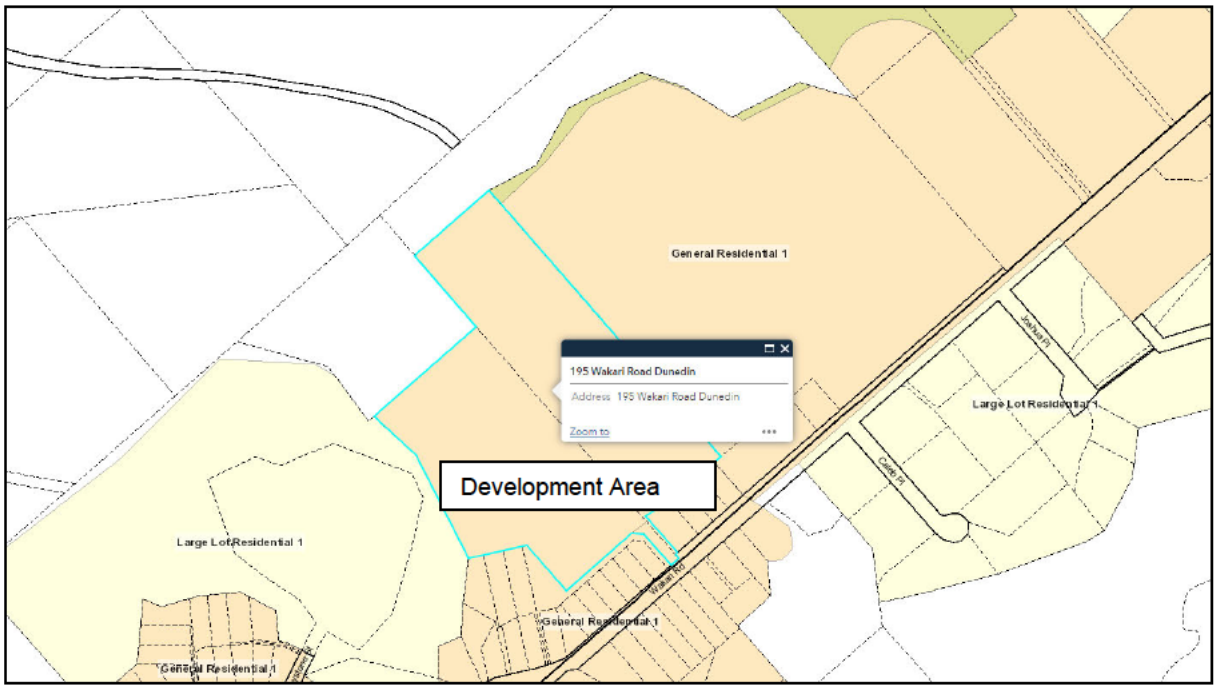


Figure 6.1: Site Location and Planning Map extracted from DCC 2GP

The proposed development is staged in two parts. The first stage, Stage 1, is a residential 36 Lot subdivision shown in Figure 6.2 below. Stage 2 of the development to the northeast consists of approximately 60 Lots. A layout plan of Stage 2 of the proposed development has not been produced. Stage 2 is shown as "future stages" in Figure 6.2.

Given the general topography and gentle contour of the site, it is intended to undertake minimal earthworks to develop both stages. It is proposed to direct any rainfall runoff along current predevelopment routes in general.

Figure 6.2: Stage 1 Proposed Development consisting of 36 Lots.

6.2 Conceptual Plan for Stage 1

The proposed stormwater management plan for the Stage 1 development consists of the following components:

- Lots larger than 600m^2 in area will have onsite detention tanks to mitigate increased post-development runoff. These detention tanks hold back peak stormwater flows and enable controlled discharge into the wider stormwater network following the storm peaks. This concept assists in keeping post development flows below predevelopment flows. Sizing will be confirmed during detailed design but will be approximately in the order of a 3,000L tank on each lot. The outlet orifice on the tanks will be sized such that the runoff from the lots is no greater than the runoff during pre-development from the same lot area. The tank outlets will drain to the piped stormwater network located in the roads.
- Lots smaller than 600m^2 will discharge stormwater directly to the piped stormwater network located in the roads.
- The roads and footpaths will also discharge their stormwater into the piped stormwater network via kerb and channels feeding into standard mudtanks.
- The piped stormwater network in the roads will be designed for 10yr ARI flows using climate change rainfall (RCP8.5 2081-2100) in accordance with the DCC COP. Pipe sizes will be confirmed during detailed design.
- The piped stormwater network in the roads will drain down towards the larger stormwater pipes feeding into the southeastern detention pond (sized for 100yr ARI storms) described below.
- The roads will be used as secondary overland flow paths within the development. Flow rates will be calculated for 100yr ARI flows (RCP8.5 2081-2100) in accordance with the DCC COP. The runoff will be collected by large mudtanks (Mega Pits or similar) near Lot 36 of the Stage 1 development and be transferred into southeastern detention pond via larger pipes that have been sized for the 100yr ARI flows.
- Runoff from Lots 1-4 will drain to a smaller detention pond (sized for 100yr ARI storms) located to the southeast of the lots before feeding to the northeast with the remainder of the flows.
- The flows exiting the detention ponds and draining towards the existing low point of the development (adjacent to Lot 2 DP513716) will be controlled by the use of flow control devices such that post development flows do not exceed predevelopment flows leaving the site in accordance with the DCC COP.
- A cut-off drain running along the northwest boundary will intercept hillside runoff flow from the upper Flagstaff catchment area and convey the water to the western stream. Most of this upper catchment is already draining there naturally in the pre-development case.
- Due to the topography of the site, lots along the Western boundary are not able to discharge runoff to the piped stormwater network in the roads. It is proposed that runoff from these lots will be mitigated by onsite detention tanks with restricted outlets. These will drain to the western stream either in pipes or shallow swales depending upon the lot owner's preference.

7.0 Stormwater Modelling and Infrastructure Sizing

The hydraulic and hydrological modelling software Infoworks ICM (Version 2024) was used to derive flood flow patterns at the site and surrounding environment using a 1D model. The following sections describe the model parameters and results in more detail.

7.1 SCS Methodology and Curve Numbers

Flows were estimated using the SCS methodology which uses Curve Numbers (CNs) to determine the perviousness of the various land surfaces. Based on the *Hydrologic Modelling System HEC-HMS Technical Reference Manual (March 2000)*, curve numbers were chosen to represent the land use conditions.

Table 7.1 below shows the modelling pre-development parameters used for the subcatchments for both Stages 1 and 2 of the entire development. The subcatchment locations and sizes are shown in Figure 5.1 earlier in the report.

Table 7.1: Pre-Development Subcatchment Parameters for Stages 1 & 2

Parameters	1D Subcatchments	
	Upper Hillside	Site Area
Area (ha)	11.3	9.6
Soil Type / Condition	Good condition	Good condition
Composite CN	74	74
Land Use Description	Woods and Brush	Woods and Brush
Time of Concentration (Tc) (minutes)	47	26
Slope (m/m)	0.197	0.100
Initial Abstraction	0.05	0.05
Runoff Volume Type	CN	CN
Initial Loss Type	SCS	SCS
Routing Model	SCS-User-Tc	SCS-User-Tc

In the pre-development case, all of the site area is classed as pervious with CN = 74.

The post-development will consist of buildings lots, roading and reserve areas. The DCC Second Generation District Plan (2GP) Rule 15.6.10 dictates the maximum building site coverage and impermeable surfaces. The development site is categorised as 'General Residential Zone' in which the maximum building site coverage should be no larger than 70%, as shown in Figure 7.1.

15.6.10 Maximum Building Site Coverage and Impermeable Surfaces

1. Development activities must not exceed the following maximum building site coverage limits:

Zone		i. Maximum building site coverage: buildings and structures with a footprint greater than 10m² (% of site)	ii. Maximum building site coverage: buildings and structures and any impermeable surfaces (% of site)
a.	General Residential 1 Zone	40%	70%
b.	General Residential 2 Zone not within the **Variation 2 mapped area**	50%	80%
X.	General Residential 2 Zone within the **Variation 2 mapped area**	50%	70%
c.	Inner City Residential Zone	60%	80%
d.	Low Density Residential Zone	35%	65%
e.	Large Lot Residential 1 and 2 Zones	30%	50%
f.	Township and Settlement Zone not within a **no DCC reticulated wastewater mapped area**	40%	70%
g.	Township and Settlement Zone within a **no DCC reticulated wastewater mapped area**	30%	50%

Figure 7.1: Maximum Impervious Surface extracted from Dunedin City Council Second Generation Plan

Post development modelling parameters are presented in Table 7.2 below.

The post-development curve number (CN) for the lots are a composite value of impervious (CN of 98) and pervious (CN of 74), applied to the impervious and pervious area percentages.

Table 7.2: Post-Development Subcatchment Parameters for Stages 1 & 2

Parameters	1D Subcatchments		
	Stage 1 Lots	Grassed Area including Stage 2 Area	Stage 1 Roads
Area (ha)	2.1	18.2	0.6
Soil Type / Condition	Good condition	Good condition	N/A Impervious
Composite CN	Composite Value based on 74 Pervious and 98 Impervious	74	98
Land Use Description	Building, Access Road and garden area	Woods and Brush	Road
Time of Concentration (Tc) (minutes)	7	26	5
Slope (m/m)	0.059	0.100	0.060
Initial Abstraction	0.05	0.05	N/A
Runoff Volume Type	CN	CN	CN
Initial Loss Type	SCS	SCS	SCS
Routing Model	SCS-User-Tc	SCS-User-Tc	SCS-User-Tc

7.2 Rainfall Data and Rainfall Hyetographs

Data was sourced from NIWA in HIRDS Version 4 at the point shown in Figure 7.2 which is representative of the rainfall falling on the contributing hillside catchment.

A series of triangular rainfall hyetographs (rainfall depth versus time graph) were developed for the design storm durations.

Figure 7.2: HIRDSv4 Rainfall Data Point and Site Location

Flows were estimated based on the rainfall design methodology using a triangular hyetograph (rainfall intensity versus time graph) set out in the DCC "Standards for Stormwater Management Plans" memo (13 June 2019). The triangular hyetograph utilises the average rainfall intensity for a given duration as the basis for design with the peak intensity being at 2 times the average intensity and occurring at 0.7 times the duration.

7.3 Climate Change

The design rainfall hyetographs included an allowance for an assumed increase in average annual temperature following the RCP8.5 climate change projection scenario for the period 2081-2100 (published by NIWA in HIRDS Version 4) as required in the Dunedin City Council "Standards for Stormwater Management Plans" memo (13 June 2019).

7.4 Storm Events

The stormwater and flood management strategy for the site has been designed for up to a 100yr ARI event, consistent with the Dunedin City Council (DCC) Code of Subdivision. The storm events were assessed for the following durations: 0.16hr (10minutes), 0.5hr, 1hr, 2hrs, 6hrs, 12hrs, and 24hrs.

7.5 Site Stormwater Collection System for Stage 1

The proposed stormwater collection system for Stage 1 is designed to collect runoff from the impervious building and roading areas. The system will be sized for the 10yr ARI (primary system) and 100yr ARI (secondary overland flow). Specific pipe sizing and design will be provided in the detailed design phase.

The stormwater collector system generally follows the road layout and is able to collect the flows from the majority of the site and discharge into the southeastern detention pond.

Lots 9-12, 14 and 15 on the western boundary (outlined in yellow in Figure 7.3) that are not able to be discharge stormwater into the stormwater network in the roads will have onsite detention tanks to compensate for the increased runoff before discharging into the western stream via pipes or open swales depending upon the lot owner's preference.

All lots greater than 600m^2 (outlined in red in Figure 7.3) will also have individual onsite detention tanks to mitigate post-development flows before discharging to the stormwater piped network in the roads.

Figure 7.3: Stage 1 Lots with Onsite Detention Tanks

7.6 Stage 1 Detention Ponds

The purpose of the detention ponds are to provide mitigation of the peak flows discharged from the site. Flows will be mitigated to pre-development levels for the 10yr and 100yr ARI events. The proposed stormwater detention ponds are located in the reserve areas at the southwestern and southeastern corner of the site, as indicatively shown in Figure 7.4. The ponds will be suitably shaped and landscaped to perform both stormwater attenuation and amenity functions. The ponds will drain towards the low point at the southeast corner of the site (in the Stage 2 land area) via flow control devices (suitably sized orifices). Runoff will then flow across Lot 2 DP513716 (as it currently does) and into the existing culvert under Wakari Road as described earlier in this report.

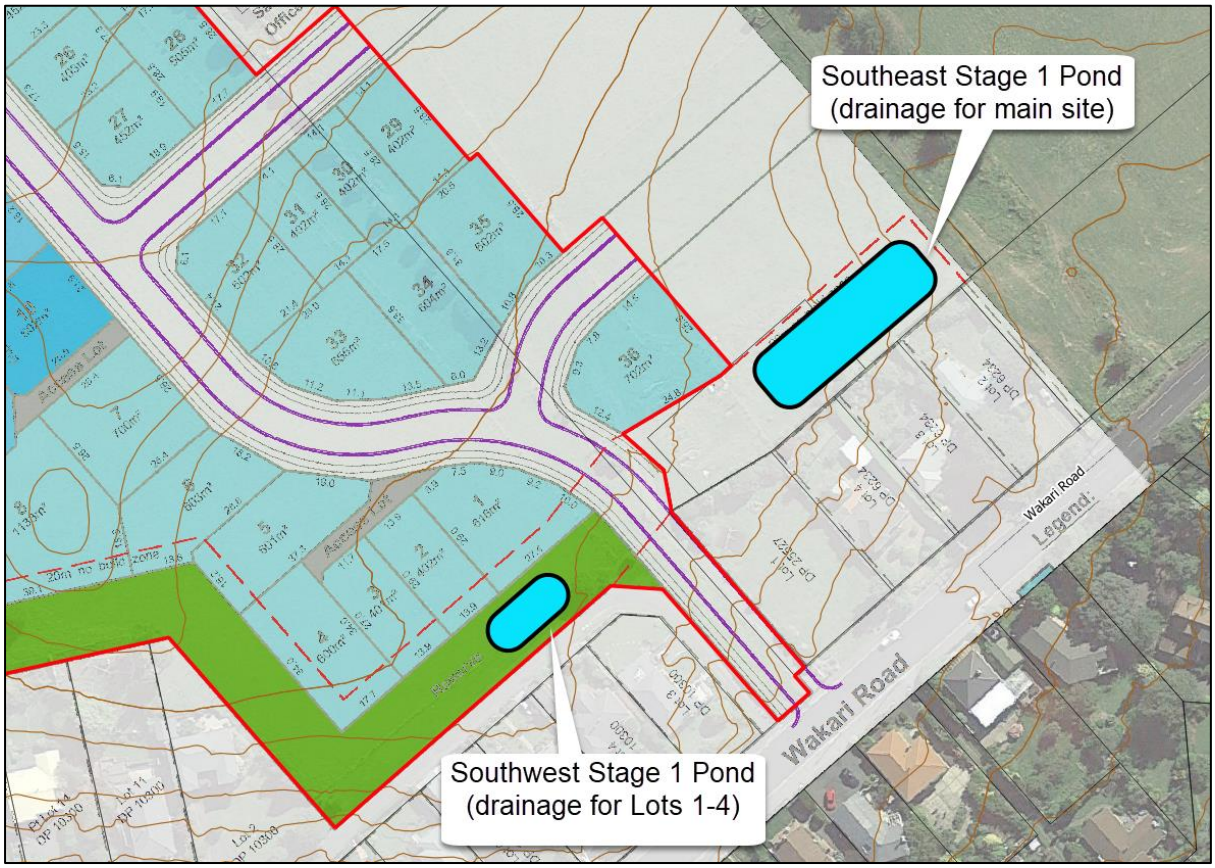


Figure 7.4: Approximate Location for Stage 1 Detention Ponds

The preliminary detention pond size and details are shown in Figure 7.5 below.

Southeast Stage 1 Pond (drainage for main site)			Southwest Stage 1 Pond (drainage for Lost 1-4)	
Base Area (m2)	300.00		Base Area (m2)	40.00
Base Length (m)	60.00		Base Length (m)	10.00
Base Width (m)	5.00		Base Width (m)	4.00
Depth (m)	2.00		Depth (m)	1.00
Side Slopes (1V:ZH - Z =)	2		Side Slopes (1V:ZH - Z =)	2
Top Area (m2)	884.00		Top Area (m2)	112.00
Top Length (m)	68.00		Top Length (m)	14.00
Top Width (m)	13.00		Top Width (m)	8.00
Base Invert Level (mAD)	200.00		Base Invert Level (mAD)	200.00
Top Invert Level (mAD)	202.00		Top Invert Level (mAD)	201.00
Total Detention Pond Volume (m3)	1,166		Total Detention Pond Volume (m3)	74
10yr Low Level Orifice (mm)	180		10yr Low Level Orifice (mm)	100
10yr Low Level Orifice Invert (mAD)	200		10yr Low Level Orifice Invert (mAD)	200.00
10yr Max RCP8.5 Water Level (mAD)	200.67		10yr Max RCP8.5 Water Level (mAD)	200.27
100yr High Level Orifice (mm)	20		100yr High Level Orifice (mm)	N/A
100yr High Level Orifice Invert (mAD)	201		100yr High Level Orifice Invert (mAD)	N/A
100yr Max RCP8.5 Water Level (mAD)	201.65		100yr Max RCP8.5 Water Level (mAD)	200.89
Utiised Detention pond Volume	841		Utiised Detention pond Volume	61
Freeboard from 100yr RCP8.5 Water Level to Top of Bank (m)	0.35		Freeboard from 100yr RCP8.5 Water Level to Top of Bank (m)	0.11

Figure 7.5: Preliminary Detention Pond Sizing and Details

7.7 Cut-Off Drain

The proposed stormwater cut-off drain located within the site in the northwest corner of Stage 1 is designed to intercept the stormwater runoff from the upstream contributing catchment and convey it to the western stream. Flows from this area currently drain to the western stream however they would pass through the proposed lots in that area. By creating a cut-off drain in this location will prevent the upstream runoff from entering the lots. The proposed location of cut-off drain and the extent of the upstream catchment are detailed in Figure 7.6 below.

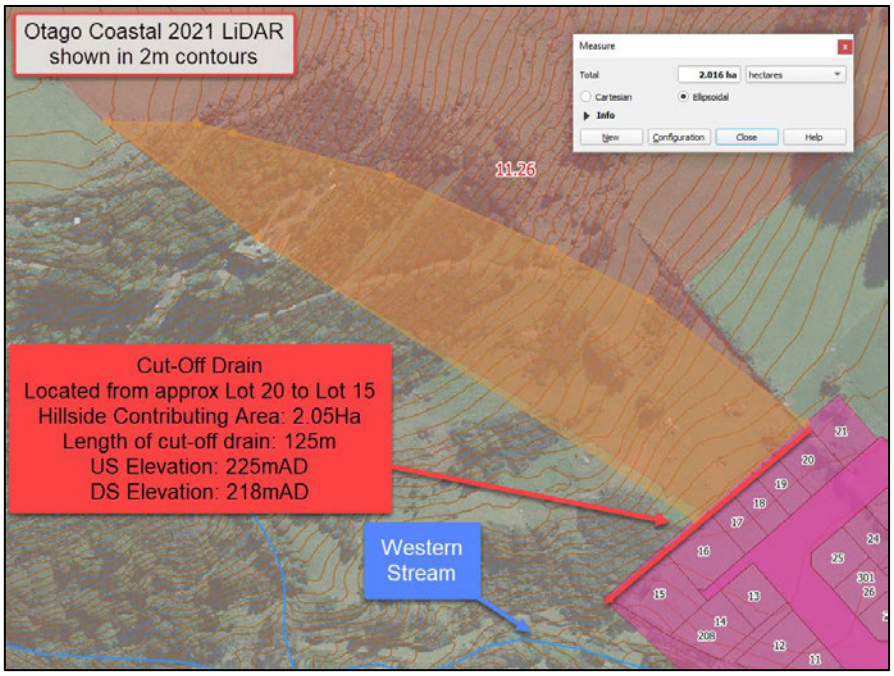


Figure 7.6: Uphill Catchment Feeding into the Cut-Off Drain

The determination of the runoff flows used to size the cut-off drain has been calculated using the Rational Method as outlined in the New Zealand Building Code presented in Figure 7.7 below.

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

$Q_c = CIA_c/360$

where

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

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

I = rainfall intensity (mm/hr).

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

Figure 7.7: Rational Method Equation - Taken from New Zealand Building Code

The following site-specific parameters were used for the flow calculations:

Runoff Coefficients:

- C = 0.30 Weighted Coefficient Cut-off Drain (Woods and Brush)

HIRDS v4 Rainfall Intensity:

- I = 71mm/hr 100yr RCP8.5 (2081-2100), 10minute duration

Area of catchment:

- A = 2.05 Ha

The peak flow rate was calculated as:

- Q= 2.78 x 0.30 x 71 x 2.05 = 121 L/s

Using Mannings formula the following channel dimensions were determined to convey the estimated peak flow:

- 2m wide from top of bank to top of bank
- 0.5m wide flat section at the bottom of the swale
- 0.4m deep
- Batter slope of 1.9m
- 0.056m/m (5.6%) gradient of cut-off drain

This channel will have an estimated freeboard to the top of bank of approximately 0.3m. It is proposed however that these dimensions are confirmed at engineering detailed design phase.

7.8 Preliminary Design Modelling Results

Table 7.3 below presents pre-development and mitigated post development flows at the boundary of the development taken from the preliminary design modelling – i.e. for both the Stage 1 and 2 areas.

The mitigated post-development flows from the site, utilising detention storage to capture the roof runoff, are less than the predevelopment runoff for the estimated future RCP8.5 (2081-2100) rainfall event.

Table 7.3 Preliminary Design Modelling Results Pre and Post-development Scenarios

RCP8.5	Target Pre-development Peak Estimated Flows			Post-Development Mitigated Peak Estimated Flows						
	Draining to Lot 2 (L/s)	Western Site to Stream (L/s)	Combined Discharge (L/s)	Draining to Lot 2 (L/s)	Western Site to Stream (L/s)	Combined Discharge (L/s)	Main Detention Pond Volume (m3)	Main Detention Pond Level (mAD)	South Western Detention Pond Lots 1-4 Volume (m3)	South Western Detention Pond Lots 1-4 Level (mAD)
10	**561**	**32**	593	554	23	577	255	200.67	12.70	200.27
100	**1407**	**87**	1494	1406	62	1468	841	201.65	61.10	200.89

The proposed stormwater infrastructure designs presented in this ICMP are appropriate to the level of detail required at subdivision resource consent stage. The sizing of the detention ponds and the pre and post-development flow rates have been calculated carefully and conservatively such that any changes to the design at detailed engineering stage will only be minor.

8.0 Effects Assessment

Potential downstream environmental effects are assessed as effects of the water quantity and quality on the receiving stormwater network, on Lot 2 DP513716, and on the stream to the west of the site, which are the effective boundaries to the subject catchment.

8.1 Western Stream

Proposed Lots 9-12, 14 and 15 are located within the western subcatchment of the site which naturally flows towards the adjacent gully and western stream. These lots will have individual onsite detention tanks with restricted flow orifices which will drain to the western stream by either pipes or shallow swales depending upon the lot owner's preference.

Stormwater will not be discharged directly from any roofs or hardstanding (without mitigation) into the gully or into the western stream from these western lots or from any part of the development.

Any runoff towards the gully and stream will be controlled release from onsite stormwater detention tanks within the western Lots. This post peak drainage will be equal to or less than the current peak run off from this same western subcatchment.

The proposed cut off drain running along the northwestern each of the Stage 1 boundary will carry some catchment flows from 2.05 hectares of the upper catchment area and drain around the upper Lots 15-20 in a southwesterly direction. The ultimate drainage of this cut off drain will be down grass and bush areas towards the gully as per the predevelopment scenario.

Effects of the works described in this ICMP on the western stream are considered to be less than minor. Post-development peak flows are discharged from detention tanks at flow rates less than predevelopment flows and hence will have minimal impact on the western stream.

8.2 Neighbouring Lot 2 DP513716

The neighbouring Lot 2 DP513716, adjacent to the southeastern end of the site will continue to receive run off flows from the site as it does in the predevelopment scenario.

Flows from the Stage 1 development will be mitigated by the detention tanks and ponds with their restricted discharge control devices (orifices). Flows from the undeveloped Stage 2 area will continue to drain overland as they currently do.

Hydraulic modelling shows that peak post development flows from the site will be less than the predevelopment flows. Stormwater passing through the culvert under Wakari Road will have peak flow rates either the same or less than the current situation.

Runoff from the Stage 1 roads will pass through mudtanks and the southeastern pond which will facilitate settling of any silts or sediments.

The proposed design achieves post development flows that are less than predevelopment flows. The flows as well as the quality of discharges have been considered in this design. As such no negative impacts are expected along the stormwater route and wider receiving environment.

9.0 Conclusions

This ICMP has been written to support a residential subdivision consent application to DCC for a new development at 195 Wakari Road, Dunedin.

The 9.6 Ha development site is located within a New Development Mapped Area (NDMA) identified in the DCC 2GP in the Wakari Road area.

Rule 9.9X of the DCC 2GP requires that integrated stormwater management plans for all NDMA's must address the whole NDMA area. This ICMP complies with the requirements of DCC 2GP Policy 9.2.1.Y.

- The stormwater catchment area related to this subdivision site does not impact on the remainder of the NDMA.
- The ICMP for the subdivision site does not impact on the wider NDMA area.
- This proposed low impact stormwater management plan has been modelled and calculated such that post development flows leaving the site are less than predevelopment flows and therefore do not impact any public or private stormwater infrastructure beyond what is currently occurring in the pre-development case.

The preliminary design, the proposed stormwater control methods, the mitigation of post development flows to less than predevelopment levels and the determination that potential effects on the area and downstream environment are less than minor shows that this ICMP addresses the requirements of the DCC 2GP Policy 9.2.1.

It is recommended that the Dunedin City Council review and accept this ICMP such that detailed design can commence once the subdivision consent has been approved.

APPENDIX 1

Geotechnical Report - 195 & 245 Wakari Road Dunedin
Geosolve - July 2023

GEOSOLVE

GEOTECHNICAL

WATER RESOURCES

PAVEMENTS

Geotechnical Report

195 & 245 Wakari Road

Dunedin

Report prepared for:

JKS Paddock Limited

Report prepared by:

GeoSolve Limited

Distribution:

JKS Paddock Limited

Terramark Ltd

GeoSolve Limited (File)

July 2023

GeoSolve Ref: 230385

Revision	Issue Date	Purpose	Author	Reviewed
1	7/07/2023	Client issue	RC/MTW	MTW

GEOTECHNICAL WATER RESOURCES PAVEMENTS

Table of Contents

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1 Executive Summary

- We understand that the site has recently been rezoned to General Residential 1 under the DCC 2GP District Plan Review and subdivision is now proposed. At this early stage it appears likely that approximately 180 new residential lots may eventually be accommodated on site, however a staged approach is likely to be used.
- An engineering geological site appraisal has been undertaken with confirmatory subsurface investigations, comprising 24 hand auger and/or Scala penetrometer investigation holes, which were generally advanced to refusal at a maximum depth of 1.8 m.
- The nearest mapped potentially active faults lie within 1-2 km of the site (Kaikorai Fault and Titri Anticline). Inactive faults are also mapped on and near to the site. However, the presence of these faults does not require any specific development measures on site.
- The proposed subdivision lies adjacent to an area mapped in a 2017 GNS Science report as being a landslide with 'likely certainty, 'unknown' historic activity, and 'medium' sensitivity to destabilising influences. We note that Stantec NZ Ltd has reviewed this feature to assist Council and concluded that it is not considered a hazard to the site.
- No evidence of recent slope instability was identified during the time of our site investigations within the area of the proposed subdivision.
- Apart from the surface layer of topsoil, the site is underlain by thin colluvium or residual volcanic soil with weathered volcanic rock at relatively shallow depth. Some very localised alluvial soils were encountered (e.g., AH17) and uncontrolled fill was observed locally at AH 19 as expected based on the historical site activity.
- The primary risk factor for potential slope instability relates to potential saturation of the soils. All sources of slope saturation should be eliminated by measures such as effective swales and permanent cut-off drains upslope of the subdivision extents where required. No stormwater or wastewater should be discharged onto the slopes, and we note that infrastructure will be provided to manage this.
- We provisionally recommend designs of 2:1 (horizontal: vertical) for all cut and fill batters in areas of less than 3 m of cut/fill. Shear surfaces are likely to dictate batter angles (if encountered) and hence specific geotechnical inspection of all cuts is required during construction. Cut batters may potentially be formed steeper, subject to geotechnical inspection.
- The subsurface materials in the upper 1-2 m will be likely be relatively easy to excavate by conventional methods, however strong rock could be encountered, and this could be a significant design and constructability consideration if deep cuts are proposed.

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- We recommended that all fill (particularly under building areas and roadways) should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect.
- We recommend that all excavations, pavement subgrades and future foundation subgrades should be inspected by a geotechnical practitioner during earthworks construction to enable any further advice.
- Site-specific investigations should ideally be carried out at least in accordance with NZS 3604 for all individual lots developments when specific building plans are available, however the testing carried out to date indicates that (following stripping of topsoil), good ground as defined by NZS3604 is likely to be at depths of less than 1 m over most of the site which implies very good subgrade conditions to enable standard foundation design and construction.
- It is possible that some subsoil drainage to capture and divert spring flows may be required, but this is generally a consideration for construction when any spring flows are much easier to observe.
- We recommend that a surveyor should be engaged to determine the most appropriate alignment for the accessways. Cross-sections at critical locations should be provided by the surveyor showing cut and fill profiles. These cross-sections should be checked by a geotechnical practitioner (particularly for cuts greater than 2 m) to enable further advice on any physical support requirements or advice for fill methodologies as required.
- The testing to date indicates that pavement design and construction is likely to be straightforward, with competent subgrade available at relatively shallow depths generally below the organic topsoils. GeoSolve can provide further information on pavement design when the final alignments and cut/fill depths have been defined by the surveyor.
- We conclude that the proposed development is entirely feasible and will not create or exacerbate natural hazards on the site, or neighbouring sites, provided that the recommendations of this report are followed.

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2 Introduction

2.1 General

This report presents the results of geotechnical investigations carried out by GeoSolve Ltd in order to determine subsoil conditions and provide geotechnical advice for a proposed subdivision at 195 and 245 Wakari Road, Dunedin.

The geotechnical report discusses natural hazards, subdivision suitability, slope stability and the geotechnical ground model. Advice is provided on hazards, earthworks considerations, accessways, general geotechnical considerations and preliminary foundation recommendations for future dwellings.

The investigations were carried out for JKS Paddock Limited in accordance with GeoSolve Ltd's proposal and agreement dated 12 June 2023, which outlines the scope of work and conditions of engagement.

2.2 Development

We understand that the site has recently been rezoned to General Residential 1 under the 2GP District Plan Review.

No subdivision scheme plan is available at this stage, but we note that preliminary concepts envisage residential lot areas ranging from 400 m^2 – 1000 m^2. At this early stage it appears likely that approximately 180 new residential lots may eventually be accommodated on site, however a staged approach is likely to be used.

A preliminary sketch layout (Figure 2.1) shows a likely future reserve of approximately 1 ha along the southern and eastern margins (partly adjoining the creek).

Preliminary road alignments are shown on Figure 2.1, but detailed design is yet to be completed.

We understand that a wider integrated stormwater catchment system will be designed by others, including a likely detention pond.

At this stage, there are no specific details of the earthworks, however we note that some cut to fill methods may be considered and earthworks will be required to establish roads.

We have reviewed the supplied assessment report prepared by Stantec NZ Ltd for Council and we note that no major constraints to residential development have been identified based on their desktop review. Some reference to previous earthworks and potential contamination is mentioned, as well as a localised mapped landslide feature. Overall, a low hazard level was assigned by Stantec, with no hazards associated with slope instability and no other listed hazards which would affect development.

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Figure 2.1 – Development area bounded by yellow, with potential roads (blue) and reserve (green)

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3 Site Description

3.1 General

The subject property is located at Wakari, which is situated approximately 3 km northwest of central Dunedin. The property is accessed from Wakari Road and lies on the volcanic hillslopes of Dunedin.

The site is currently undeveloped and being used as farmland. Vegetation comprises pasture with localised mature trees, mostly within shelterbelts.

Structures include minor sheds on 195 Wakari Rd. A dwelling and associated sheds occupy part of 245 Wakari Rd where a large platform has been formed and is bounded by mature trees. That site was reportedly used historically for aged residential care. The platform appears to be largely a fill platform and we note that available contours at this stage indicate that the localised fill may be up to about 2-3 m thick. Examination of historical aerials shows that this historical development was on site as early as 1947.

The subdivision site occupies gently dissected hillslopes and slopes moderately to the east and south-east at approximately 10°. The difference in elevation between the highest and lowest surveyed parts of the site is approximately 40 m. Therefore, the overall slopes are gentle, generally between 5-10 degrees but with some locally steeper land, especially at the margins of the gully adjacent to the SW boundary.

There are some watercourses locally and these may be partly supplied by spring flow sources. There is a relatively deeply incised watercourse along the SW boundary, but the steeper land here is likely to coincide with the proposed reserve land. Another similar gully lies immediately to the NW of the site, however only minor or ephemeral streams are noted within the proposed area of development, with flow increase within these likely during heavy rainfall. We understand that these will be subject to drainage design consideration by others. The site is naturally free-draining and there are no major areas of saturated ground apart from the lower reaches of the ephemeral watercourse near the southern corner of #245 and an area near the north boundary, where spring flows are evident.

4 Geotechnical Investigations

An engineering geological site appraisal has been undertaken with confirmatory subsurface investigations. GeoSolve Ltd visited the subject property on 22 June 2023, undertaking geotechnical investigations comprising:

- 24 hand auger and/or Scala penetrometer investigation holes which were generally advanced to refusal to a maximum depth of 1.8 m.
- Reconnaissance observation of the adjacent mapped landslide, fill, surface saturation and site geomorphology.

Auger and Scala penetrometer locations and logs are contained in Appendices A and B respectively.

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5 Subsurface Conditions

5.1 Geological Setting

5.1.1 Regional Geology

The geology of the Dunedin area is dominated by volcanic rock types of basaltic to andesitic composition that were intruded through pre-existing marine sediments during Miocene times. Extensive volcanism at that time produced lava flows and bedded volcanoclastic materials were widely distributed by eruptions. The generalised stratigraphic profile comprises schist at depth, overlain by a Cretaceous to Tertiary-age sequence; initially by thin non-marine sediments and then a thick accumulation of marine sediments including sandstones and mudstones. The volcanic rock types cross-cut these sediments where vents were present and extensively mantle them where lava flows or volcanic ejecta were deposited.

More recently (Pleistocene times), the hills of Dunedin have been extensively mantled by windblown loess to depths of up to several metres. Watercourses and tidal embayments such as Otago Harbour have locally deposited alluvial, estuarine and marine deposits and generally modified the volcanic landscape by deep incision and sedimentation. Fill and refuse has been placed locally during post-settlement times. Landslips have occurred on steeper hillsides particularly where springs emerge or where fills have been placed.

5.1.2 Seismicity

Dunedin has traditionally been considered to have lower than average seismic activity when compared to other areas in New Zealand, however nearby active faults are known and strong shaking is certain to occur periodically.

Cook et al[1] states that the earthquake hazard in Dunedin is dominated by relatively infrequent moderate to large earthquakes (magnitude up to M_w 7.5) in eastern Otago, and large to very large earthquakes in the much more seismically active Fiordland and Westland regions.

The nearest active faults with demonstrated Late Quaternary movement history are the Green Island Fault and the Akatore Fault. The Green Island Fault is currently considered to be the cause of the 1974 earthquake that caused damage in Dunedin. It is mapped approximately 8 km to the southwest of the subject site, but its projection is believed to continue through South Dunedin and may run northeast up the harbour in which case it would pass within about 4 km of the site.

The nearest mapped trace of the Akatore Fault passes within about 5 km of the site. The Akatore Fault is expected to have a recurrence interval of 2-3,000 years[2]; however a recent

[1] Cook, DRL, McCahon, IF and Yetton, MD (1993). The Earthquake Hazard in Dunedin. Study funded by EQC, Research Project 91/56.

[2] Otago Regional Council (2005). Seismic Risk in the Otago Region. Report No SPT: 2004 / 23. Wellington, NZ: Opus International Consultants.

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paleoseismic study of the Akatore fault[3] found that three recent ruptures of this fault which occurred in the past 15,000 years (two of which occurred in the past 1,300 years) were preceded by a minimum 110,000 year period of quiescence, suggesting this fault exhibits strong aperiodicity of earthquake occurrence. The authors suggest it is prudent to assume that the relatively high rates of recent fault activity will continue, with an estimated recurrence interval of 450-5110 years.

Both of these faults are likely to be capable of generating magnitude 7.5 earthquakes in Dunedin.

The nearest mapped potentially active faults are shown in Figure 5.1 and these lie within 1-2 km of the site (Kaikorai Fault and Titri Anticline).

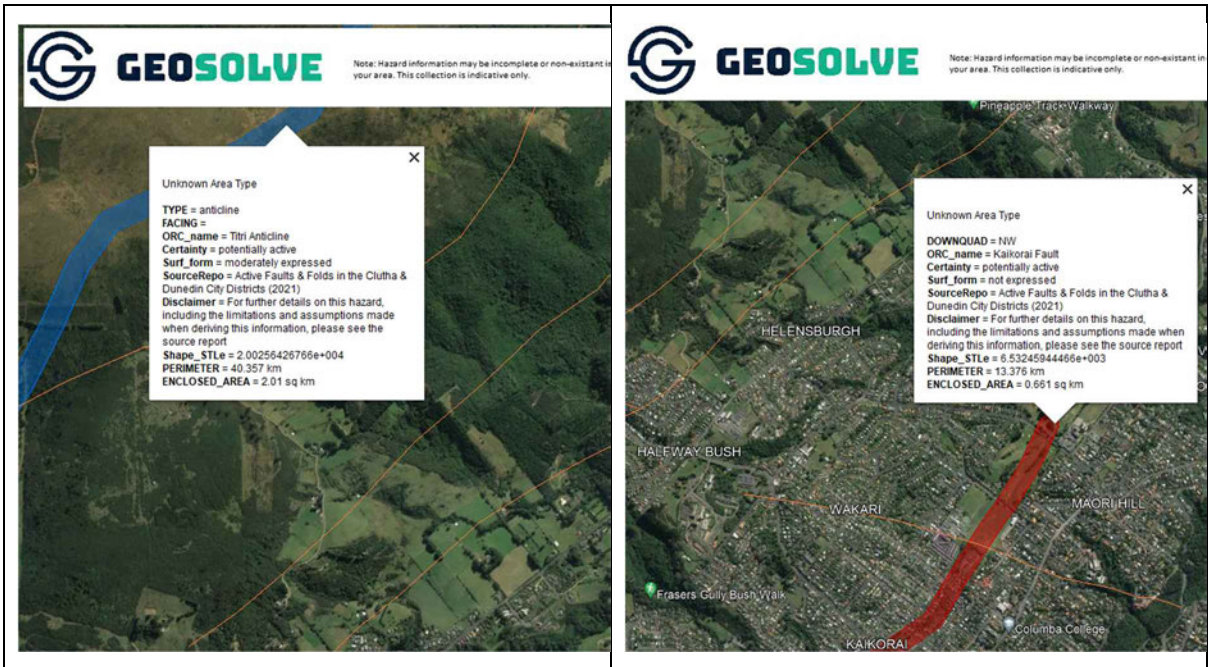

Figure 5.1 – Potentially active faults within 1-2 km of the subject site (GNS Science Ltd)

Inactive faults are also mapped on and near to the site as shown in Figure 5.2 according to GNS Science Ltd. This could mean that differing rock types are possible under the site if fault offsets are significant. The recent Canterbury earthquakes have highlighted the issue that previously unidentified faults or presumed activity status may be very significant factors in the actual future risk applying to any particular site.

It should be noted the fault terminations shown on fault trace maps are often approximations (owing to lack of data) and the presence of other active faults may be unknown because they may be obscured by overburden soils.

[3] Taylor-Silva, B.I., Stirling, M.W., Litchfield, N.J., Griffin, J.D., van den Berg, N.J., Wang, N. (2019). Paleoseismology of the Akatore Fault, Otago, New Zealand. New Zealand Journal of Geology and Geophysics, 63(2): 151-167; doi: 10.1080/00288306.2019.1645706

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Figure 5.2 – Inactive faults on or near the subject site (GNS Science Ltd)

Other known faults that have some potential to cause strong shaking in Dunedin are the Titri Fault and the North Taieri Fault, located roughly 7 km and 25 km southwest of the site, respectively.

The above faults are not included in Table 3.6 of NZS 1170.5:2004 as major faults requiring near fault factors when assessing structural design actions.

Strong ground shaking throughout the South Island is likely to be associated with a rupture of the Alpine Fault, located along the West Coast of South Island. Recent research[4] suggests there is a 75% probability of an Alpine Fault earthquake occurring within the next 50 years and an 82% probability that the next earthquake on the Alpine Fault will be of magnitude 8 or greater.

Average return periods for shaking intensity are: MM 7 = 100 years, MM 8 = 450 years and MM 9 = >2,500 years. The most recent major earthquake to affect Dunedin occurred in 1974 and produced damage consistent with MM 7 intensity.

[4] Howarth, J.D., *et al.* (2021). Spatiotemporal clustering of great earthquakes on a transform fault controlled by geometry. Nature Geoscience; doi: 10.1038/s41561-021-00721-4

5.2 Stratigraphy

The engineering geological model for the site is straightforward as described below. More detailed geotechnical description of soils is provided in the hand auger logs contained in Appendix B.

Apart from the surface layer of topsoil, the site is underlain by thin colluvium or residual volcanic soil with weathered volcanic rock at relatively shallow depth. Some very localised alluvial soils were encountered (e.g. AH17) and uncontrolled fill was observed locally at AH19 as expected based on the historical activity discussed above.

Topsoil comprises soft to firm organic SILT with traces of rootlets etc. The organic layer is between 200-400 mm thick.

The topsoil is underlain mostly by colluvium or weathered residual volcanic soils which comprise variable soils (as logged below) but generally silty CLAY or SILT with minor-trace gravel and trace sand in firm to very stiff condition.

Uncontrolled fill occurs locally near the previous area of historical development as shown on Figure 1 (appended). This was found to be 1 m thick where tested but may be up to 3 m locally (to be confirmed). The fill was underlain by an organic buried topsoil layer and thereafter by residual volcanic soils.

Weathered bedrock was frequently encountered at relatively shallow depth and is also locally visible in road cuttings (e.g. adjacent to 225 Wakari Rd). Rock is expected to lie at shallow to moderate depth below the site as indicated by the shallow penetrometer refusal depths (less than 1.8 m). Based on observation of outcrop and published geological mapping, the rock type likely comprises basaltic flow rocks of the third eruptive phase of the Dunedin Volcano, which is expected to extend to great depth.

5.3 Groundwater

No significant groundwater seepage was observed during investigations. Groundwater seepage was noted only in AH 17, which was located in an area of wet soils, and may relate to underlying spring flows.

The soils observed over the remainder of the site were predominantly moist in condition with little evidence of elevated groundwater.

Perched groundwater may develop on the contact between various soil layers with permeability contrasts.

The ephemeral watercourses would be expected to carry flow and saturate adjacent soils and runoff areas during rainfall events, but we understand that control of runoff will be addressed in a separate stormwater management plan.

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5.4 Slope Stability

The area has been mapped by Benson[5] as being underlain by Dunedin Volcanic Group basalt, a strong rock type in its unweathered form. This rock type is locally underlain by terrestrial sedimentary rock types known as the younger floodplain conglomerate, but this was not observed on site.

The proposed subdivision lies adjacent to an area mapped in a 2017 GNS Science report[6] as being a landslide with 'likely certainty, 'unknown' historic activity, and 'medium' sensitivity to destabilising influences.

We note that Stantec NZ Ltd has reviewed this feature to assist Council and concluded the following:

> The land stability hazard only affects a minute corner of the proposed area and is not considered a hazard for the site. There are no other hazards on adjacent land that may affect this site.

Figure 5.1: Landslide feature mapped within the proposed subdivision site.

Engineering geological mapping of the site (and in particular the area of the site within the above landslide feature) revealed no indicative scarps or hummocky terrain characteristic of recent land movement.

Our nearest investigation site (AH6) adjacent to this feature indicated very similar conditions to the remainder of the site, with no softening to indicate previous deposition of

[5] Benson, W.N. (1968). Dunedin District, 1:50,000. NZGS Miscellaneous Series Map 1. Department of Scientific and Industrial Research.

[6] Barrell D.J.A., Smith Lyttle B., Glassey P.J. (2017). Revised landslide database for the coastal sector of the Dunedin City district. Lower Hutt (NZ): GNS Science. 29 p. (GNS Science consultancy report; 2017/41).

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soft debris, i.e. “good ground” was encountered at 1 m with refusal at 1.5 m , most likely on weathered rock.

Review of stereoscopic photography (1947 SN399) indicates that the mapped landslide shown above is a subdued and ancient feature on the hillside above the site which may potentially be the lower reaches of an ancient, eroded debris tongue. The outline of this feature matches with that identified by the 2017 GNS Science report[7]. No obvious scarp features or hummocky terrain were identified, and no signs of recent movement were apparent on site or on aerial imagery. We also note that there is an existing dwelling within the landslide extents, and we are unaware of any damage.

Geological mapping suggests that the landslide may be associated with the contact between basalt and underlying conglomerates which have been mapped on the neighbouring hillsides but not on the subject site.

Very minor shallow landslips are also apparent on the hills above the site, but these appear shallow and would not be expected to result in a significant risk of inundation damage to the subject site.

The risk of localised slope instability over the site in general is currently interpreted to be low based on the relatively gentle undulating slopes, the presence of firm to stiff overburden soils across the site and lack of any evidence of widespread groundwater flows at shallow depths.

[7] Barrell D.J.A., Smith Lyttle B., Glassey P.J. (2017). Revised landslide database for the coastal sector of the Dunedin City district. Lower Hutt (NZ): GNS Science. 29 p. (GNS Science consultancy report; 2017/41).

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6 Engineering Considerations

6.1 General

The recommendations and opinions contained in this report are based upon ground investigation data obtained at discrete locations and historical information held on the GeoSolve database. The nature and continuity of subsoil conditions away from the investigation locations is inferred and cannot be guaranteed.

6.2 Slope Stability

Most of the site is no steeper than 15 degrees (which is generally the benchmark to trigger greater geotechnical scrutiny by Council if exceeded).

Council's geotechnical advisors (Stantec NZ Ltd) will still require assurance that potential slope suitability is adequately addressed. In particular, assurance is required that the site is suitably stable, and that the development proposal will not create or exacerbate instability on this or adjacent properties. However, we note that an assessment of "low hazards level" has already been provided by Stantec.

As discussed above, no evidence of recent slope instability was identified during the time of the site investigations within the area of the proposed subdivision.

The primary risk factor for potential slope instability relates to potential saturation of the soils. In addition, softening and general nuisance could occur where water is able to collect and infiltrate, particularly as there are natural swales located on the site. Consequently, robust site drainage is recommended. All sources of slope saturation should be eliminated by measures such as effective swales and permanent cut-off drains upslope of the subdivision extents where required, particularly above any cuts proposed and upslope of the proposed building platforms. No stormwater or wastewater should be discharged onto the slopes, and we note that infrastructure will be provided to manage this.

All drains should be designed to discharge to suitable Council-approved stormwater disposal points.

Placement of uncontrolled fill should be avoided.

Any spring flows encountered should be assessed further by a geotechnical specialist.

In the event that voids are encountered during excavations (i.e. under-runners) or any soft/wet soils, a geotechnical specialist should advise further on appropriate remediation and drainage measures.

If any lots are steeper than 15 degrees, additional recommendations apply as follows:

- All building platforms on lots where slopes exceed 15 degrees should have a site-specific cut-off drain installed upslope of the building platforms.
- All building platforms on lots where slopes exceed 15 degrees should have their building platforms specifically supervised by a geotechnical specialist with review of intended earthworks and possible additional test pitting investigations. Specific

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recommendations for development may be required and this may include minimising cuts and installation of additional subsoil drainage.

Provided the recommendations of this report are followed, particularly relating to site drainage, the risk of global slope instability across the site is interpreted to be low, based on the relatively gentle slopes, an absence of slope instability indicators, the precedent performance of the site, the general lack of shallow groundwater, the generally stiff or better conditions of the soils observed beyond about 0.5 m depth, and observation of refusal with the penetrometer at depths less than 1-2 m.

6.3 Excavations

At the time of the investigations, no earthworks plans were available, however some cut/fill earthworks are likely to be proposed, particularly for roading. General excavation recommendations are outlined below, and a geotechnical practitioner should review any earthworks plans prior to commencement to confirm that design is appropriate for the soil types encountered or whether any physical support measures are required.

No seepage was encountered during investigations and hence groundwater is unlikely to be encountered during excavations, particularly following management of site drainage. However, a geotechnical practitioner should inspect any seepage, spring flow, voids or under-runners that may be encountered during construction.

Recommendations for permanent batters are as follows. Higher cuts may require specific design.

Table 6.1 – Recommended batters for permanent cuts up to 3 m in height

Material type	Recommended maximum batter for permanent cuts less than 3 m high (horizontal to vertical)	
	Dry ground	Wet ground
Topsoil (0.2-0.4 m thick)	2 : 1	3 : 1
Colluvium and alluvium	2 : 1	3 : 1
Stiff to very stiff residual volcanic soils*	2 : 1 to 1.5:1	3 : 1

**i.e. may be formed steeper subject to inspection but provisionally we recommend designs of 2:1 for all cut batters. Shear surfaces are likely to dictate batter angles (if encountered) and hence specific geotechnical inspection of all cuts is required during construction.*

Temporary cuts may be formed at steeper angles (see below) subject to geotechnical advice.

It is possible an earthworks consent will be required, and this should be checked with Council.

We recommend that all excavations should be inspected by a geotechnical practitioner during earthworks construction, particularly as any adversely oriented shear surfaces may promote local instability.

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The subsurface materials in the upper 1-2 m will be likely be relatively easy to excavate by conventional methods, however strong rock could be encountered, and this could be a significant design and constructability consideration if deep cuts are proposed.

6.4 Fill Earthworks

We understand that earthworks including cut/fill works may be proposed for accessways and potentially to create more sub-horizontal sites for development. Once formal cut to fill plans become available, they should be reviewed by a geotechnical practitioner for further specific advice.

We recommended that all fill (particularly under building areas and roadways) should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect. Therefore, a fill specification and geotechnical supervision (including laboratory verification) should be sought at an early stage to enable a statement of suitability to be supplied. Adequate compaction is necessary to minimise future differential settlement on the proposed lots and roadways which will occupy the areas of fill.

The overburden soils could be used as engineered fill on site (during good weather and in accordance with an earthfill specification). Laboratory testing and verification will be required and boulders/cobbles/broken rock over 75 mm in size will need to be screened from engineered fill sources.

For engineered fills, the contractor will need to submit a sample of the proposed fill materials (possibly more than one) to obtain laboratory compaction curves, and in-situ Nuclear Density Meter (NDM) testing of the fill will need to be arranged. An engineer will need to specify the fill methodology and review the lab results to ensure that a statement of suitability for the fills can be issued; this will likely be required for compliance.

The subgrade of any proposed fills will need to be sub-horizontal (with benching of slopes as required) to ensure stability. A geotechnical specialist should inspect all subgrades prior to fill placement.

Maintaining the moisture content of any cohesive fill soils to achieve the required compaction will need to be addressed by the contractor. It is recommended that cut to fill soils be placed and compacted immediately as they are excavated, as stockpiling and reworking is highly likely to degrade the compaction properties of the soils.

Earthworks should only be carried out in the summer or during a period of forecast, prolonged dry weather as the soils proposed for filling are susceptible to becoming excessively moist and could rapidly become unsuitable for placement if they get wet.

Engineered fill specification and certification to NZS 4431:1989 can be provided on request.

The depth of any fill and designation of whether it is certified or uncontrolled should be available to potential purchasers of lots that coincide with fill. An as-built fill contour map should be prepared if this is the case.

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Any fill placement will require additional undercut of unsuitable soils. All topsoil, organic material, fill and any other soft and unsuitable soils should be removed prior to placement of new fill.

All certified fill batters should be formed no steeper than 2:1 (horizontal: vertical). We recommend that plans for all fill slopes should be reviewed prior to construction by a geotechnical specialist to determine whether any specific engineering assessment and design is required (e.g. steeper fills should be specifically reinforced with geogrids or physically retained). To minimise erosion, effective vegetation cover should be established on fill batters and no water flows should be directed to these slopes.

Underdrainage may be required locally within the fill subgrade (if seepage is encountered). Drainage requirements should be confirmed by a geotechnical specialist prior to any fill placement. If localised seepages are encountered, these will need to be tapped at source and conveyed via appropriately designed fabric wrapped subsoil drainage (e.g. TNZ F/6) to prevent migration of slit and to ensure long term control of groundwater conditions. Provision for future maintenance of any such drains should be in place where required (e.g. cleaning eyes at the upper extents).

6.5 Ground Retention

We understand that no retention of cuts is currently proposed however retaining walls would be suitable modes of retention for parts of any cuts or fills proposed if there are any geometrical constraints to battering at angle discussed above.

Any retaining wall proposed should be designed by a chartered professional engineer using specific geotechnical parameters to be advised upon review (and possibly requiring further investigations).

Pole walls may be difficult owing to embedment limitations where rock is shallow as expected. Gravity walls would be suitable.

Temporary slopes for retaining wall construction should be feasible battered at 1:1 provided these are within stiff soils and less than 3 m high and subject to geotechnical checks.

Groundwater was not widely identified but has the potential to develop following completion of the earthworks, in particular as a result of heavy or prolonged rainfall. To ensure potential groundwater seeps and flows are properly controlled behind any retaining walls, the following recommendations are provided:

- A minimum 0.3 m width of durable free draining granular material should be placed behind all retaining structures;
- A heavy duty non-woven geotextile cloth, such as Bidim A14, should be installed between the natural ground surface and the free draining granular material to prevent siltation and blockage of the drainage media; and
- A heavy-duty (TNZ F/2 Class 500) perforated pipe should be installed within the drainage material at the base of all retaining structures to minimise the risk of

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excessive groundwater pressures developing. This drainage pipe should be connected to the permanent piped storm water system.

The safety implications of working under temporary cuts will need to be adequately addressed.

Further comment on retention can be provided once earthworks plans have been finalised and reviewed by a geotechnical practitioner.

6.6 Settlement and Foundations

As part of the future building consent stage, site-specific investigations should be carried out by the future owners, at least in accordance with NZS 3604 for all individual lots when specific building plans are available. However, the testing carried out to date indicates that (following stripping of topsoil), good ground as defined by NZS3604 is likely to be at depths of less than 1 m over most of the site which implies very good subgrade conditions to enable standard foundation design and construction.

Upon removal of topsoil and localised fill etc, all foundations on in-situ soils are expected to be mostly on firm to very stiff overburden soils or weathered rock. These materials will provide good bearing for conventional spread footings or shallow pile foundations. It will likely be straightforward to design footing for lower bearing capacity if required.

There is some very localised older uncontrolled fill on site as shown provisionally on the appended site plan. This should be defined in greater detail as part of subdivision works and practical options for development over the filled area includes removal of the fill or utilising specific foundation design of foundations.

Any new fill that is utilised as bearing for foundations should be placed and compacted in accordance with NZS4431:1989. If engineered fill is proposed for building sites, as discussed above, then standard foundations in accordance with NZS 3604 on those lots are likely to be appropriate once certified, however we recommend confirmatory site-specific investigations should still be carried out in accordance with NZS 3604 to confirm this on a site-specific basis.

All unsuitable materials identified in foundation excavations and soils with evidence of voids or those softened by exposure to water should be undercut and replaced with engineered fill during construction or otherwise piled foundations would be required (including under floor slabs unless designed for spanning by a structural engineer). Any foundation areas affected by seepage will require specific assessment.

It is recommended all foundation excavations be inspected by a suitably qualified and experienced geotechnical specialist to confirm the conditions are in accordance with the assumptions and recommendations provided in this report (and future site-specific reports for individual lots) and that all design assumptions have been met.

If any remnant fill is uncertified then this should be for reserve or yard areas only unless specific foundation design is carried out for any structures. If buried services are required in uncertified fill, then specific detailing will be required to address settlement issues.

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6.7 General Site Preparation Advice

Robust site drainage is recommended as above to minimise the potential for softening of the soils during seasonally variable weather conditions, storms etc.

During the earthworks operations all topsoil, organic matter, fill and other unsuitable materials should be removed from the construction areas in accordance with the recommendations of NZS 4431:1989.

Owing to the moderately erodible nature of some of the soils present across the site, sediment control measures should be instigated during earthworks construction.

Water should not be allowed to pond or collect near or on any pavement or foundation slab subgrades. Positive grading of the subgrades should be undertaken to prevent water ingress or ponding.

All fill that is utilised as bearing for foundations should be placed and compacted in accordance with the recommendations of NZS 4431:1989 and certification provided to that effect. An earthfill specification can be provided on request.

We recommend topsoil stripping and subsequent earthworks be undertaken only when a suitable interval of fair weather is expected, or during the earthworks construction season.

6.8 Groundwater Issues

The watertable is expected to lie well below the likely excavation levels and floor levels of future dwellings. Dewatering or other groundwater-related construction issues are therefore unlikely to be required. The potential for groundwater issues can be minimised by implementing the surface drainage, as discussed above. It is important that GeoSolve be contacted should there be any seepage, spring flow or under-runners encountered during construction.

It is possible that some subsoil drainage to capture and divert spring flows may be required but this is generally a consideration for construction when any spring flows are much easier to observe.

6.9 Surface Runoff and Drainage

During earthworks construction a cut-off drain should be installed at the crest of the main cut slopes to avoid upslope surface runoff eroding the slopes. This drain should be carefully detailed to ensure that flows into the drains do not lead to saturation of the subsoil (e.g. by ensuring sufficient gradients in drains and/or lining the base of the drain). Additionally, depending on the design adopted a second drain may need to be installed at the base of the main cuts to intercept any slope surface runoff.

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6.10 Accessway and Pavements

We understand that a series of new access roads will be constructed off Wakari Road to serve the subdivision. Conceptual roads are indicated in Figure 2.1.

We recommend that a surveyor should be engaged to determine the most appropriate alignment for the accessways. Cross-sections at critical locations should be provided by the surveyor showing cut and fill profiles. These cross-sections should be checked by a geotechnical practitioner (particularly for cuts greater than 2 m) to enable further advice on any physical support requirements or advice for fill methodologies as required, however the batter advice above is likely to enable design at most locations.

The roads should be contoured appropriately to allow surface runoff to fall to a contour drain or equivalent in order to intercept any surface runoff.

Topsoil stripping should be carried out over the road alignments and all remaining soft and/or unsuitable materials (e.g. fill, root systems etc) which are exposed during preparation of pavement subgrade should be excavated and replaced with engineered fill.

The testing to date indicates that pavement design and construction is likely to be straightforward, with competent subgrade available at relatively shallow depths below the organic topsoils. GeoSolve can provide further information on pavement design when the final alignments and cut/fill depths have been defined by the surveyor.

Construction of the accessway should be carried out under the supervision of a geotechnical practitioner. Any seepage encountered will require appropriate drainage measures during the earthworks.

It may be that engineered fill is required locally for stream crossings etc and in this case the advice in Section 6.4 should be followed.

6.11 Site Subsoil Category

The following geotechnical information has been used to characterise the site subsoil class in respect of NZS 1170.5:2004 Structural Design Actions:

Based on the best available information, we consider the site subsoil class in terms of NZS 1170.5:2004 Clause 3.1.3 to be Class C (Shallow soil).

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7 Neighbouring Structures/Hazards

Seismic: A risk of seismic activity has been identified for the region as a whole, as discussed in Section 5.1.2 and appropriate allowance should be made for seismic loading during detailed design of the proposed development, but there are no site-specific constraints.

Liquefaction: Owing to the density and type of soil encountered and no occurrences of groundwater on site, the risk of liquefaction is expected to be very low. The site is mapped as Domain A with respect to liquefaction "ground predominately underlain by rock or firm sediments'.

Landslide and slope stability hazard: This has been discussed above in Sections 5.4 and 6.2.

Expansive Soil: As the soils examined during our investigations were non-plastic or exhibited a low plasticity, have minimal clay content (as determined by our visual inspection only), the soils are unlikely to exhibit shrink/swell behaviour, but this should be confirmed for all future building platforms in accordance with the relevant standard (NZS 3604).

Flood hazard has not been assessed in this study but is unlikely in this hillslope setting, provided that upslope flow paths and swales are well controlled. We understand that inputs including a full stormwater management plan will be prepared to address potential flood hazards.

Distances to adjoining structures: No adverse geotechnical implications apply for neighbouring properties during construction of the subdivision provided the above excavation considerations are noted.

Aquifers: No aquifer resource will be adversely affected by the development.

Erosion and Sediment Control: The site presents some potential to generate silt runoff and this would naturally drain downslope, potentially to watercourses. Only the least amount of subsoil should be exposed at any stage and surfacing established as soon as practical. Silt runoff should not be permitted to enter any watercourse. We recommend advice be sought from a qualified specialist where compliance with local and regional erosion and sediment control regulations is uncertain.

Noise: Rock-breaking and/or blasting is unlikely to be required.

Dust: Regular dampening of soil materials with sprinklers should be effective if required.

Vibration: No vibration induced settlement is expected in these soil types; however, any works that create vibrations should be subject to geotechnical advice. Neighbouring structures should be considered by the contractor with respect to vibration effects and further advice sought if there is any uncertainty.

Soil Contamination: This is beyond our scope and a specialist may be required to check fills or if any other evidence of contaminated soils is found.

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8 Applicability

This report has been prepared for the sole use of our client, JKS Paddock Ltd, with respect to the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts, without our prior review and written agreement.

Investigations have been undertaken at discrete locations in accordance with the brief provided. It must be appreciated that the nature and continuity of subsoil conditions away from the investigation locations cannot be guaranteed.

During construction, foundation excavations should be examined by an inspector or engineer competent to confirm that subsurface conditions encountered throughout are compatible with the findings of this report. It is important that we be contacted if there is any variation in subsoil conditions from those described in this report.

Report prepared by:

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Mark Walrond
Senior Engineering Geologist

Appendices: Appendix A – Site Plan - Figure 1
Appendix B – Investigation Data – AH 1-24 [24p]

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Appendix A: Site Plan

Key

- Hand Auger and/or Scala penetrometer test locations
- Area of wet and pugged ground (approx extents)
- buried power cable (approx location)
- buried telecom cable (approx location)

CADFILE:	Site Plan.xar	DRAWN	RC 05/2023
SCALE: (AT A3 SIZE)	As shown (approx)	DRAFTING CHECKED	MTW 05/2023
PROJECT No.:	230385	APPROVED	MTW 05/2023

GEOSOLVE
ENGINEERING CONSULTANTS

JKS Paddock Ltd
Geotechnical Investigation
195 & 245 Wakari Rd, Dunedin
Site Plan

FIG No: Figure 1

REV. 1

Appendix B: Investigation Data

HAND AUGER LOG

HOLE NO.: AH1

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404443 mE, 4919651 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		2, 2, 2, 4, 7, 4, 4, 5, 8, 6, 7, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.3 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:30 pm

HAND AUGER LOG

HOLE NO.: AH2

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404423 mE, 4919657 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.4 m			TS	3, 3, 2		Groundwater Not Encountered
RESIDUAL VOLCANIC SOIL	Silty CLAY with minor gravel, brown. Firm, moist, low plasticity, gravel, fine to coarse, subangular basalt. 0.8 m		0.5		3, 2, 3, 3		
COMPLETELY WEATHERED DUNEDIN VOLCANIC GROUP	Clayey SILT with minor gravel, brown with purple grey mottle. Stiff, moist, non-plastic, gravel, fine to coarse, subangular basalt. 1.0 m		1.0		6, 9, 4, 17 >>		
	End Of Hole: 0.95 m		1.5				

PHOTO(S)

REMARKS

Refusal at 0.95 m - auger spinning on hard surface. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:34 pm

HAND AUGER LOG

HOLE NO.: AH3

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404383 mE, 4919736 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		1, 2, 2, 3, 3, 2, 4, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 0.9 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:36 pm

HAND AUGER LOG

HOLE NO.: AH4

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404321 mE, 4919769 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
TOPSOIL	Organic SILT with minor clay and a trace of gravel, dark brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS	1, 1		
RESIDUAL VOLCANIC SOIL	Silty CLAY with a trace of gravel, brown. Firm to stiff, moist, low plasticity, gravel, fine, subangular basalt. 0.6 m		0.5		3, 6, 8		
COMPLETELY WEATHERED DUNEDIN VOLCANIC GROUP	Clayey SILT with minor gravel and a trace of sand, brown with purple grey mottle. Stiff, moist, non-plastic, sand, fine; gravel, fine to coarse, subangular basalt. 0.9 m				7, 16 >>		
	End Of Hole: 0.85 m		1.0				Groundwater Not Encountered
			1.5				

PHOTO(S)

REMARKS

Refusal at 0.85 m - auger spinning on hard surface. No groundwater encountered. 2 attempts at Scala test - first attempt refused at 0.5 m.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:39 pm

HAND AUGER LOG

HOLE NO.: AH5

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404337 mE, 4919801 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		1, 2, 3, 4, 5, 9, 6, 10, 8		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:44 pm

HAND AUGER LOG

HOLE NO.: AH6

CLIENT: JKS PADDOCK Ltd

PROJECT: WAKARI195-245

JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road

COORDINATES: 1404323 mE, 4919912 mN (NZTM2000)

LOCATION METHOD: Handheld GPS

ELEVATION: Existing ground level

CONTRACTOR: GeoSolve

EQUIPMENT: Hand auger & Scala penetrometer

ACCURACY: ± 3 m

OPERATOR: RC/WW

START DATE: 21/06/2023

END DATE: 21/06/2023

LOGGED BY: WW

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND
TOPSOIL	Organic SILT with minor clay and a trace of gravel, brown. Very soft becoming firm, moist, non-plastic, gravel, fine, subangular basalt. A trace of rootlets. 0.3 m			TS
RESIDUAL VOLCANIC SOIL	Silty CLAY with minor gravel and a trace of sand, brown. Firm, moist, low plasticity, sand, fine; gravel, fine, subangular basalt. 0.7 m		0.5	
	Clayey SILT with minor gravel and a trace of sand, brown. Firm. Stiff from 1.0 m, moist, non-plastic, sand, fine; gravel, fine, subangular basalt. 1.4 m		1.0	
	End Of Hole: 1.40 m		1.5	

SCALA PENETROMETER (Blows / 100 mm)

1 2 2 2 2 2 3 3 4 5 7 12 16 >>

SHEAR STRENGTH (kPa) Vane: 50 100 150 200 Values

WATER

Groundwater Not Encountered

PHOTO(S)

REMARKS

Unable to penetrate beyond 1.4 m - increasingly stiff material. No groundwater encountered.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:49 pm

HAND AUGER LOG

HOLE NO.: AH7

CLIENT: JKS PADDOCK Ltd

JOB NO.: 230385

PROJECT: WAKARI195-245

SITE LOCATION: 195-245 Wakari Road

CONTRACTOR: GeoSolve

START DATE: 22/06/2023

COORDINATES: 1404418 mE, 4919837 mN (NZTM2000)

EQUIPMENT: Scala penetrometer

END DATE: 22/06/2023

LOCATION METHOD: Handheld GPS

ACCURACY: ± 3 m

LOGGED BY: RC

ELEVATION: Existing ground level

OPERATOR: RC

CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5		2, 2, 2, 3, 3, 4, 3, 5, 10, 17 >>		Groundwater Not Encountered
			1.0				
			1.5				

PHOTO(S)

REMARKS

Scala test only. Refusal at 1.1 m with high blow count.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:54 pm

HAND AUGER LOG

HOLE NO.: AH8

CLIENT: JKS PADDOCK Ltd
PROJECT: WAKARI195-245
JOB NO.: 230385

SITE LOCATION: 195-245 Wakari Road
COORDINATES: 1404491 mE, 4919724 mN (NZTM2000)
LOCATION METHOD: Handheld GPS
ELEVATION: Existing ground level

CONTRACTOR: GeoSolve
EQUIPMENT: Scala penetrometer
ACCURACY: ± 3 m
OPERATOR: RC

START DATE: 22/06/2023
END DATE: 22/06/2023
LOGGED BY: RC
CHECKED DATE: 23/06/2023

SOIL / ROCK TYPE	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH / RL	LEGEND	SCALA PENETROMETER (Blows / 100 mm)	SHEAR STRENGTH (kPa) Vane: Values	WATER
			0.5 1.0 1.5		2 2 2 2 3 3 3 3 3 5 12		Groundwater Not Encountered

PHOTO(S)

REMARKS

Scala test only. Terminated at target depth.

WATER

- Standing Water Level
- Out flow
- In flow

Generated with CORE-GS by Geroc - Test Pit x Hand Auger - scala & vane bars - 26/06/2023 1:52:57 pm