# Remarkables Ski Area Expansion Project
# Doolans Creek Right Branch Wastewater Report

Prepared for:
NZSki Limited

Date: April 2026

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# Revision Schedule

[redacted]

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# Code of Conduct

The author of revision 3 of this report is Derek Chinn. Derek is Senior Principal Engineer whose qualifications are BE, Chartered Professional Engineer (Civil and Structural), Chartered Member of Engineering New Zealand, Fellow of Engineering New Zealand and he is on the International Professional Engineers Register.

Derek has 38 years' experience in a wide variety of Civil Engineering projects. He has designed and supervised the design of numerous water supply, stormwater and wastewater pump stations. He has been the design manager for a variety of water and wastewater systems. He has been instrumental in developing the strategy for layout and implementation of a number of high profile three waters infrastructure projects. Currently he is the independent technical reviewer for the Queenstown Lakes District Council for a variety of projects including the Shotover Wastewater disposal project, the wastewater rising main along Frankton Track in Queenstown, the refurbishment of the Marine Parade Wastewater Pump Station, the recently completed Recreation Ground Wastewater pump station, and the 6m deep Robins Road Wastewater Pipeline Upgrade which is currently under construction.

Dereks specific area of interest is alpine engineering and ski area infrastructure. He has been the recipient of industry awards for his design of Plateau Hut and the Stocking Stream toilets, both in Aoraki Mt Cook National Park. His design of the Whare Kea Lodge in the Mount Asping Area was formally identified as the 'best ski lodge in New Zealand'. He has been an expert witness in a high court hearing in relation to ski area infrastructure. He was made a Fellow of Engineering New Zealand and a Life Member of the New Zealand Alpine Club as a result of his contribution to alpine engineering.

I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. This report (revision 3)
has been prepared in compliance with that Code, as if it was expert evidence presented in proceedings before the Environment Court. Unless I state otherwise, this report is within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this report.

Prepared by: [redacted]

Reviewed by:

Approved by:

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# Executive Summary

This report evaluates wastewater management solutions within Doolans Creek Right Branch basin as part of the Remarkables Ski Area Expansion Project. There is a peak of 2,500 visitors per day predicted to use the Doolans Creek Right Branch facilities.

Various alternatives to manage wastewater within Doolans Creek Right Branch basin have been assessed. The intention is to provide robust, scalable, and consentable wastewater systems to serve increased visitor numbers in challenging alpine conditions, while protecting sensitive environments.

This document addresses only the management of wastewater generated in the Doolans Creek Right Branch basin. Treatment of wastewater in the Rastus Burn Catchment is addressed in the report 'Remarkables Ski Area Doolans Expansion Wastewater Treatment and Disposal Feasibility Report'.

## Doolans Creek Right Branch recommended option

This report recommends that NZSki pump wastewater from the Doolans Creek Right Branch to the Rastus Burn facilities via a rising main (using multiple staged pump stations) to 'Helicopter Ridge', and a falling main from Helicopter Ridge via the Curvey Basin, to the base building.

The benefits of this option are identified as:

- Scalable, avoids onsite disposal in sensitive areas, aligns with consentable corridors, minimises environmental risk compared to other alternatives.

The following alternatives were considered but are not recommended:

- Drum containment and manual transport: Suitable only as a short-term interim measure, impractical for high volumes.
- Onsite treatment and land disposal: High risk of environmental contamination, operational challenges, and unlikely to gain consent.

## Rastus Burn catchment alternatives:

A separate feasibility assessment is being prepared for the treatment of all development wastewater within the Rastus Burn Base area. Treatment of wastewater in the Rastus Burn is outside the scope of this document, however for clarity, the following alternatives are expected to be considered to receive the additional flows and loads from the Doolans catchment.

1. Alternative 1: Upgrade existing system (increase septic volume, discharge to multiple basins)
2. Alternative 2a: Pipe effluent to a new treatment plant and disposal field in Trojan-owned land
3. Alternative 2b: Pipe to holding tank and connect to Hanleys Farm
4. Alternative 3: New onsite secondary treatment and land disposal at the ski field
5. Alternative 4: New treatment plant and discharge into Council network downstream of Hanleys Farm

# Acronyms / Abbreviations

| Acronym / Abbreviation | Full Name |
|---|---|
| AEE | Assessment of Environmental Effects |
| ARV | Air release valves |
| BGL | Below ground level |
| $CBOD_5$ | Carbonaceous Biochemical Oxygen Demand over 5 days |
| COP | Coefficient of Performance for a heat pump |
| DI | Ductile iron |
| DIR | Design irrigation rate |
| DLR | Design loading rate |
| DoC | Department of Conservation |
| D R Phosphorus | Dissolved reactive phosphorus |
| FBBR | Floating bed bioreactor |
| GAC | Granular activated carbon |
| HADES | Hydraulic and Design Engineering Systems |
| L | Litres |
| LAS | Land application system |
| LASE | Land application system envelope |
| MCA | Multi-criteria analysis |
| MDPE | Medium density polyethylene |
| MBBR | Moving bed bioreactor |
| NZBC | New Zealand Building Code |
| NZTA | New Zealand Transport Agency |
| NZUAG | New Zealand Utilities Advisory Group |
| ORC | Otago Regional Council |
| OWMS | Onsite wastewater management system |
| P.e. | Population equivalent |
| PN | Nominal pressure rating |
| PS | Pump station |
| QLDC | Queenstown Lakes District Council |
| RMA | Resource Management Act 1991 |
| TN | Total nitrogen |
| TP | Total phosphorus |
| TSS | Total suspended solids |
| WWTP | Wastewater treatment plant |

Table

# 2 Introduction

This concept report is one of a number of reports produced by Stantec on various Engineering related elements for the proposed development of the Remarkables Ski Area Expansion Project. This report specifically addresses the issue of wastewater management within the upper Doolans Creek Right Branch basin to a concept level only. This report is not to be relied on as a detailed design or for construction purposes. This report does not address treatment of wastewater treatment at the existing Rastus Burn facilities - treatment of wastewater within the Rastus Burn Catchment is addressed separately in the report 'Remarkables Ski Area Doolans Expansion Wastewater Treatment and Disposal Feasibility Report'.

The Rastus Burn Basin (where existing facilities are located) and the upper Doolans Creek Right Branch basin (where the increase in skiable area is proposed) is shown in Figure 1.

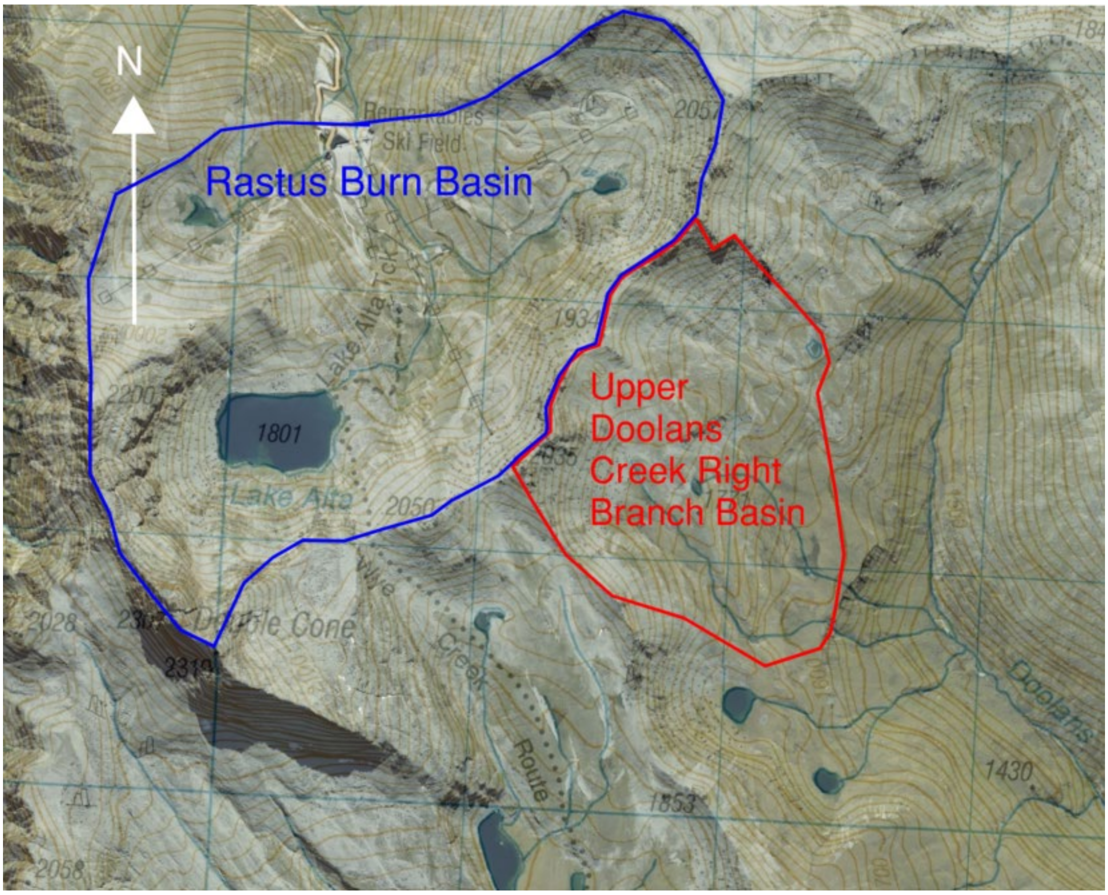



*Figure 1. Overall view of the area of existing Remarkables Operation and the Expansion Area*

Currently, NZSki operates the Remarkables Ski Area with maximum daily visitor numbers up to approximately 4,000 people. The proposed expansion into the Doolans Creek Right Branch is intended to increase total visitor numbers to approximately 6,000 with up to approximately 2,500 visitors within the Doolans Creek Right Branch.

Management of wastewater in an alpine environment is challenging due to a variety of factors, including but not limited to:

- Significant seasonal variation in visitor numbers.

- Winter low temperatures which coincide with maximum visitor numbers.
- Steep topography with significant height differences.
- Operation and maintenance access challenges due to overlying snow during winter.
- The sensitive existing alpine natural environment.

This report describes the options available for addressing wastewater within the Doolans Creek Right Branch, including the expected wastewater generated daily during peak season and how this flow will be managed. Several options to address wastewater generation from the facilities within the Doolans Creek Right Branch have been examined.

The lowest risk option to address wastewater within the Doolans Creek Right Branch is to pump the wastewater over 'Helicopter Ridge' to the Rastus Burn catchment for treatment and disposal. This approach allows all of the wastewater generated within the Remarkables Ski Area (both within Doolans Creek Right Branch and the Rastus Burn area) to be treated and disposed of within a single, more efficient and accessible location.

Operating an independent wastewater treatment plant and disposal system within the Doolans Creek Right Branch is complex and higher risk option than pumping to a single treatment plant in the Rastus Burn. The specific challenges of a wastewater treatment system in the Doolans Creek Right Branch include the following.

- There is no existing treated wastewater discharge into the Doolans Creek Right Branch.
- Operation of two separate, and potentially different process, plants within one ski area.
- Issues of access for operation and maintenance of an onsite wastewater management system (OWMS), as the Doolans Creek Right Branch only has wheeled vehicle access during the summer season. Even during summer access is not suitable for all vehicles such as standard sucker trucks.
- The proximity of bedrock to the surface in many locations in the basin which limit the suitability for land disposal.
- Limited available space for a treatment plant and land disposal area.

Consequently, we find that the most practical option is to pump wastewater from the proposed Doolans facilities to Helicopter Ridge via a pumping main laid in the formed ski trails. Once at Helicopter Ridge, we propose the wastewater drains to the existing Rastus Burn Base Building via a falling main laid in the Curvey Basin trail.

# 3 Existing Environment

The Doolans Creek Right Branch is to the south-east of the existing developed Remarkables Ski Area. Currently the Doolans Creek Right Branch, where the expansion of the Remarkables ski field is proposed, is an unmodified environment and contains no infrastructure or onsite wastewater discharges. The overall site infrastructure is shown in Figure 2.

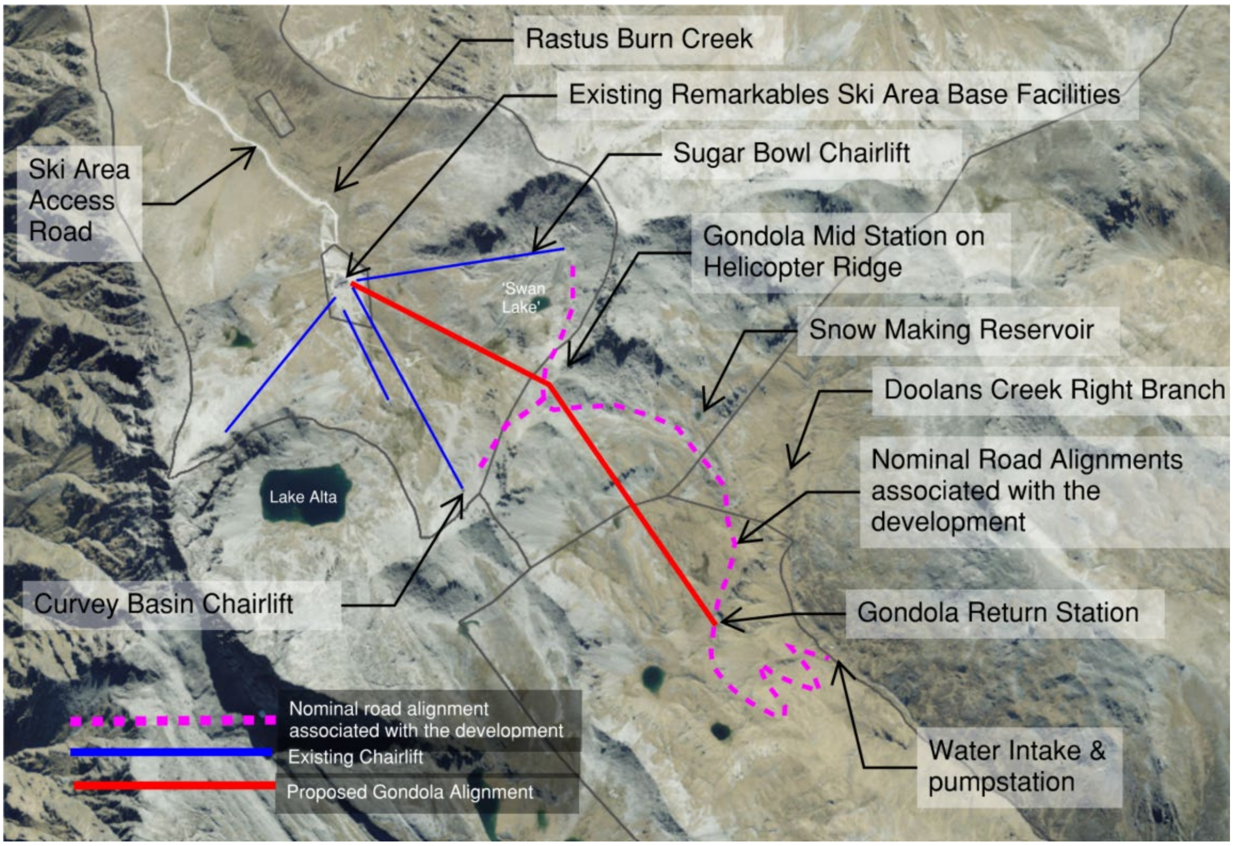



*Figure 2. Significant elements of existing, and new, infrastructure associated with the Expansion Project*

The Rastus Burn catchment contains the existing Remarkables Ski Area and the associated development and modifications. These facilities include the following elements:

- the access road,
- base area buildings which currently provide food and beverage facilities for up to 4,000 visitors daily,
- maintenance facilities,
- ski patrol and medical facilities building,
- four chairlifts,
- three surface conveyor lifts,
- snow making infrastructure,
- formed ski trails and access roads,

- water intake infrastructure in Lake Alta and in the Rastus Burn Creek,
- and a primary wastewater treatment system involving wastewater disposal via rapid infiltration basins downstream of the existing base building facilities.

# 4 Addressing Wastewater in an Alpine Environment

The issue to be addressed is the provision of a robust, scalable, and environmentally compliant wastewater system for the Doolans Expansion at Remarkables Ski Area.

This must accommodate significant increases in visitor numbers.

- up to 6,000 per day total at all the Remarkables facilities,
- 2,500 skiers per day expected in the Doolans Catchment,

The system must operate reliably in challenging alpine conditions and protect sensitive ecological values. The solution must address long-term requirements (seasonal and peaky daily flows and loads), while meeting relevant statutory and consent obligations to apply for a fast-track consent. Key challenges include terrain constraints, freezing risk, operational complexity and futureproofing for evolving regulatory standards.

This concept report covers the domestic effluent flows and loads from the Doolans Creek catchment, and the Rastus Burn Feasibility assessment is covered in the document 'Remarkables Ski Area Doolans Expansion Wastewater Treatment and Disposal Feasibility Report'.

## 4.1 Wastewater Flow Generated in Doolans Creek Right Branch

The forecasted wastewater flow from the Doolans Creek Right Branch is shown in the table below. The figure of 34 litres/person/day is based on existing flow data for the Remarkables Ski Area plus recorded and published data for other ski areas. In the case of the Doolans Creek Right Branch, this flow rate may be conservative as it is anticipated that part of the wastewater flow generated by each visitor will be within the Rastus Burn area and thus wastewater generated within Doolans Creek Right Branch by visitors may be less than 34 l/person/day.

*Table 1. Doolans forecasted wastewater flows*

| Doolans Occupancy | Skiers/day NZSki predicted numbers | L/Person/Day | L/day |
|---|---|---|---|
| final | 2,500 | 34 | 85,000 |

# 5 The Recommended Option to Address Wastewater in the Doolans Creek Right Branch

A number of options have been identified and reviewed to address wastewater within the Doolans Creek Right Branch. The recommended option is as follows:

- Pump effluent over the hill from the proposed Doolans expansion to the existing/upgraded Rastus Burn wastewater system. This is shown in Figure 3 and Figure 4.

This option involves implementing a system capable of pumping the final flows from the inception. This system would use a combination of an initial single stage macerating centrifugal pump station and two subsequent pump stations using high head ‘progressive cavity’ pumps. Single stage centrifugal pumps not suited to high head pumping and an impractically large number of pump stations would be required to lift the wastewater to Helicopter Ridge if centrifugal pumps were used exclusively.

This concept would involve three pump stations as described below.

- An initial macerating centrifugal pump station (PS1) which would be in a below ground manhole. Wastewater from the various facilities would drain by gravity to this pump station. This pump station would pump to the first ‘progressive cavity’ pump station.
- Two above ground ‘progressive cavity’ pump stations (PS2 and PS3) to lift the wastewater to Helicopter Ridge. Each of these pump stations would contain two skid-mounted above ground pumps in a ‘duty-assist’ arrangement. There would be a small pump house building to house the pumps.
- At each of the two progressive cavity pump stations, incoming wastewater would enter a vented entrance manhole chamber. From this chamber, wastewater will proceed into the progressive cavity pumps wither via suction into the progressive cavity pumps or via boosting with secondary centrifugal pumps. The selection of methodology of either booster pump or suction is a detailed design consideration.
- Each pump station will include a below ground storage chamber, which will allow the volume of the pumping line above to be drained and stored within the chamber. This will allow maintenance of the rising main above. The storage chamber can be drained to the entrance chamber manhole and subsequently pumped away once maintenance actives are complete.
- Odour from the initial macerating pump pumpstation at the Doolans return station facilities will have a short residence time and odour is not anticipated to be a significant issue. This will be vented via a stack on the carrier stacking building.
- Odour at each of the two progressive pumpstations is a potential issue. Overnight the wastewater will be resident in each of the rising mains and odour issues may result from anaerobic bacteria production of hydrogen sulphide. This is potentially more prevalent at the beginning and end of the season where visitor numbers are at the minimum, and the resulting wastewater retention time within the rising mains is greater. Each of the two progressive cavity pump stations, and the receiving manhole at Helicopter Ridge, will have a stack with passive proprietary mixed media odour filters. The selection of the specific filter is a detailed design consideration.

The progressive cavity pumps are cylindrical shaped, approximately 2m long, and are skid mounted. Due to their shape, progressive cavity pumps are not suited to installation in a manhole. In addition, to allow inspection and winter maintenance, the pumps will be surface mounted and contained within an insulated shed structure. We anticipate that this shed will be 4m long, approximately 2m wide, and 3m high. The shed would be constructed from Colorsteel-clad insulated panels.

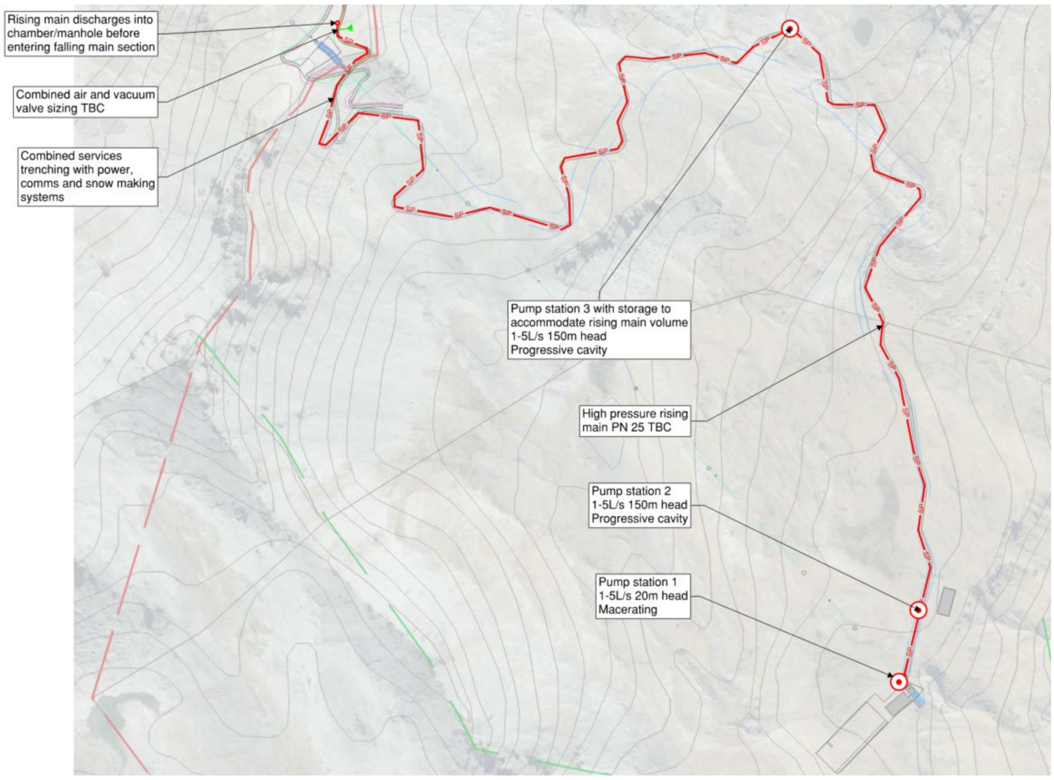



*Figure 3. Pumping infrastructure from the Gondola Return Facilities to Helicopter Ridge*

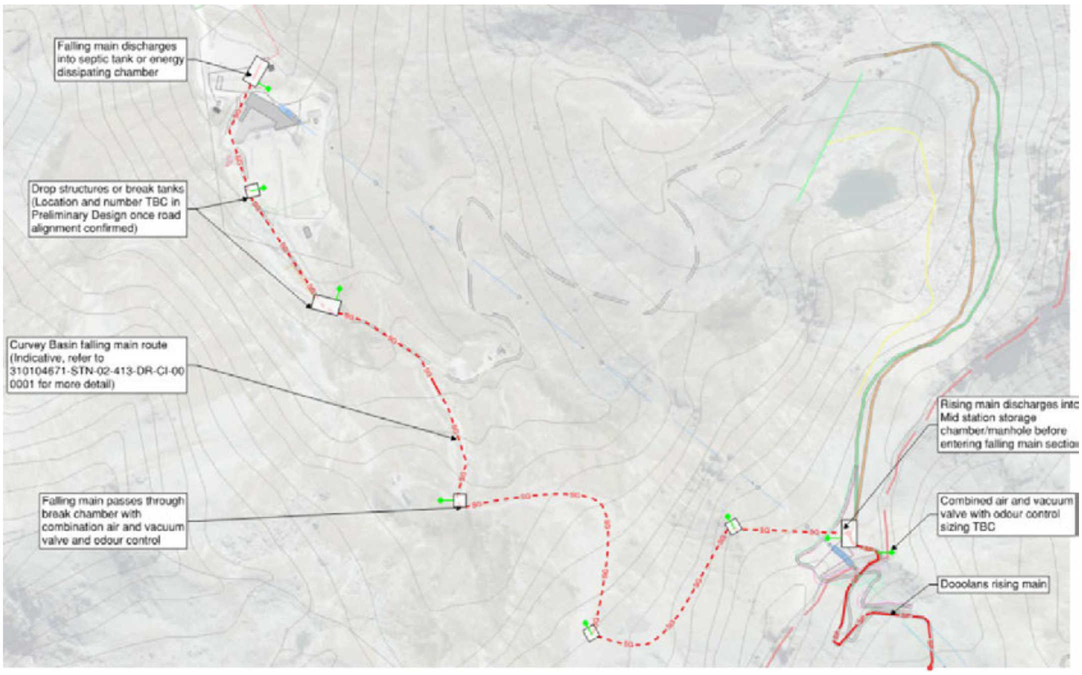



*Figure 4. Falling main pipework route from Helicopter Ridge to the Rastus Burn base infrastructure*

# 6 Standards or Statutory Requirements for Secondary and Tertiary Treatment & Discharge Systems

We do not recommend onsite treatment and disposal in the Doolans Creek Right Branch for a variety of reasons, including difficulty of achieving consistent operation within consent limits.

Table 2 contains values provided by Innoflow from comparable consented local developments at Jack's Point, Mt. Cardrona Station, Coronet Peak and Gibbston Valley Winery. It is anticipated that if similar consent values are applied to Doolans Creek Right Branch, they will be challenging to achieve consistently. This is due to the remoteness of the treatment plant, low temperatures in the Doolans Creek Right Branch, and significant variations in seasonal flow.

*Table 2. Estimated discharge limits*

| Estimated discharge limit | Value | Unit |
|---|---|---|
| $cBOD_5$ < | 20 | mg/L |
| TSS < | 30 | mg/L |
| TN < | 30 | mg/L |
| TP < | 15 | mg/L |
| E. coli < | 1,000 | MPN/100 mL |

Total nitrogen (TN) is expected to be the limiting parameter influencing system design complexity and energy demand, particularly under cold conditions.

The Assessment of Environmental Effects (AEE) produced by Mitchell Daysh Limited is expected to cover and provide feedback to this design based on the following, but not limited to:

- Resource Management Act 1991 (RMA) – Section 15 compliance.
- Otago Regional Council (ORC) Regional Plan: Water for Otago – Check permitted activity rules or apply for resource consent.
- QLDC Three Waters Bylaw 2020 – Local compliance confirmed.
- Cultural and stakeholder input.
- Others as determined by others.

Both the New Zealand Building Code (NZBC) G13 and AS 3500 refer to AS/NZS 1547:2012 for the design of onsite wastewater systems. The concepts proposed in this report follow this standard regarding system design and loading rates.

- AS/NZS 1547:2012 – On-site wastewater system design.
- NZBC G13 – Foul water drainage compliance.
- AS 3500 – Plumbing and drainage installation.

If a secondary or tertiary on site treatment system was to be implemented, the following requirements apply to the location of the treated water disposal site:

- ≥ 20 m from surface water.
- ≥ 50 m from water abstraction bores.
- ≥ 1 m vertical separation to groundwater.
- Outside drinking water protection zones.

At high level, the land application system envelopes (LASEs) proposed in this report have been located to generally comply with these separation distances based on the information available at the time of writing.

# 7 Description of Options Considered for Doolans Wastewater Management

The following alternative wastewater options have been identified and considered within the Doolans Creek Right Branch.

## 7.1 Alternative 1 (the recommended option): Transfer to Rastus Burn WWTP via rising and falling mains

Alternative 1 involves constructing a rising main with staged pumping from the proposed Doolans expansion, connecting into a falling main down to the Rastus Burn Base Building from Helicopter Ridge. Progressive cavity pump stations with initial macerating can lift about 150-200m and the total height gain is 365m. Consequently, two duty-standby staged progressive cavity pump stations would be required. Systems will be arranged as follows:

- Screening tank with macerating/grinder pump to intercept flushable wipes or sanitary products.
- Two duty-standby high head progressive cavity pump stations with 150-200m of lifting capacity.
- Receiving tank at the mid station on Helicopter Ridge.
- Falling main with energy dissipating manholes or drop structures to reduce velocity and contain main's volume to allow drain down.
- Connection into existing manhole upstream of the existing septic tanks.
- Air management systems at chambers and pump stations.
    - Air release and odour control units.
    - Vacuum breakers.

## 7.2 Alternative 2: Transfer to Rastus Burn WWTP via 750L drums carried on gondola to Helicopter Ridge, falling main to Rastus Burn

Alternative 2 involves removing wastewater for in drums carried on the proposed Doolans Access gondola. In alpine mountaineering, collecting wastewater in drums for removal by helicopter is commonly employed. To improve the efficiency of this alternative, the volume of water can be minimised by providing non-flushing toilets and hand sanitiser. The wastewater would be collected in drums mounted in a wheeled cradle, then transported in the gondola cars to either a manhole at the top of the falling main at Helicopter Ridge or to the wastewater system at the Rastus Burn facilities. The drums would be drained by a valved stub at the base of the drum, which could be connected to a drainpipe into the manhole using 'camloc' couplings.

Discharging the drums at Helicopter Ridge will require the proposed falling main.

Assuming the use of non-flushing toilets, each person would produce 2-7.5 litres of wastewater (toilet waste with no hand washing). At the expected initial occupancy of 1,000 people, this produces approximately 2,000-7,500 litres per day. This volume is equivalent to three to ten x 750-litre Devan tanks, which are the type of drum that DoC uses.

It is unlikely to be a sought-after job to handle drums of waste on the gondola, and the use of drums involves an increased risk of spillage at lower temperatures. It is also considered inappropriate to take drums of waste to visitor access areas and handle these drums through the lower gondola terminal and Rastus Burn Base Building.

Note:

- Non-flushing toilets and hand sanitiser reduces the expected number of tanks requiring carrying out, however would detract from the overall visitor experience.
- In comparison, flushing toilets and hand-washing facilities could require 5 to 35 x 750-litre drums of effluent to be removed per day. This could impact the availability of the Doolans Access gondola to carry visitors into and out of the Doolans Creek Right Branch.

## 7.3 Alternative 3: Onsite primary treatment & land application (septic + trenches)

Alternative 3 involves onsite effluent disposal. This option would involve total capture, treatment (primary settling) and disposal of the treated effluent onsite in the Doolans Creek Right Branch. Primary treatment would be by septic tanks. Treated wastewater would then be pumped to an effluent disposal field. The effluent disposal field would be in existing soils and gravel, located between the wetland seeps and ephemeral waterways to the north of the proposed Gondola Return Station Facilities. We note that there are numerous exposures of the underlying bedrock around the site. It is likely that proximity of bedrock to the surface is a contributing factor to the presence of the wetland areas and seepage. As a result, disposal of treated wastewater to land may not be possible in many areas. Therefore, this alternative is considered unfeasible due to the high likelihood of ground and surface water contamination, along with possible seeping of effluent to the surface (daylighting).

## 7.4 Alternative 4: Onsite secondary treatment & land application (aerated/textile with heating & driplines)

This option is the same as Alternative 3 but includes secondary treatment of the wastewater. To achieve secondary treatment, the wastewater would be heated by heat pumps. Similar to Alternative 3, treated wastewater would be discharged to land. This is contingent on a suitable site for disposal being located.

Like Alternative 3, this alternative considered to be unfeasible due to the high likelihood of ground and surface water contamination and effluent daylighting.

## 7.5 Discussion of Risks

The risks associated with each alternative were discussed with NZSki and are expanded on in Table 3. Alternative 1's high initial CAPEX is offset by the reduced risk and ability to be upgraded as the usage increases and is the proposed alternative for the Doolan Catchment.

*Table 3. Doolans Creek Right Branch key risks. Expanded on from first discussion with NZSki*

| **Alternative 1 - Rising main to Helicopter Ridge, Falling main to existing Rastus Burn Carpark** |
|---|
| Multiple pump stations may flood downstream components if control systems fail. |
| Trenching is challenging on steep terrain and may involve trenching in rock |
| Displacing native fauna and flora. |
| High velocity wastewater flowing down the hill is stirred up and can result in foul odour and pipework damage. |
| Pipework route relies on suitable ground conditions. |
| High initial cost to install system. |
| Specialist high-head pumps are required to achieve required lift. |

| **Alternative 2 – 750-litre drums carried on gondola service carrier to Helicopter Ridge, falling main to existing Rastus Burn septic tanks** |
|---|
| Unlikely to be suitable due to high maintenance requiring hourly tank removal and emptying on a typical day. |
| Risk of untreated effluent dropping onto hillside. |
| Camlock connections and exposed valves are known to ice up in low temperatures, increasing risk of spills or inability to drain. |
| Risks associated with heavy moving equipment and cranes to move effluent. |
| Frozen tanks not emptying (the Department of Conservation rely on a water blaster to clean out the tanks) |
| Reduced chairlift capacity due to tank holders replacing skiers. |

| **Alternative 3 - Onsite primary effluent treatment and disposal - septic and trenches** |
|---|
| Extremely unlikely to be consentable due to very high risk of contamination and impact to the sensitive environment. |
| Toilet blocks have high strength effluent resulting in a high risk related to nitrate plume generation. |
| Odour risks. |
| Maintenance risks in low temperatures. |
| Risks associated with practicality to empty when snow on ground. |
| Damaged if ground movement occurs. |
| The site is unsuitable for effluent disposal without thorough cultural, hydrogeological works and AEEs. |

| **Alternative 4 - Onsite secondary effluent treatment and disposal with heating and dripperlines** |
|---|
| Unlikely to be consentable due to depth to bedrock, multiple groundwater seeps, sensitive environment, discharge entering water. |
| Toilet blocks have high strength effluent resulting in a high risk related to nitrate plume generation. |
| Damaged if ground movement occurs. |
| Requires heating, increased load and energy demand. |
| Risk of small diameter pipework freezing. |
| Risks of failure when overloaded. |
| The site is unsuitable for effluent disposal without thorough cultural, hydrogeological works and AEEs. |

# 8 Ranking of the Alternatives

To rank the alternatives, a comparison of the various alternatives and their criteria is shown via a multi-criteria analysis (MCA) in Table 4. The technical aspects in the multi-criteria analysis do not include cultural, ecological or other disciplines which may change feasibility and balance.

Colour coding has been used to indicate the ranking of each alternative, with green indicating a more desirable ranking and red indicating a lower, less desirable ranking.

*Table 4. Doolans Preliminary Technical Multi-Criteria Analysis*

| | Suitability | Constructability | Shock loads and startup | Environmental impact | Overall Risk | Operability | Consentability | CAPEX | OPEX | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Alternative 1 - Rising main to Helicopter Ridge, Falling main to existing Rastus Burn Carpark** | | | | | | | | | | |
| **Alternative 2 - 750Ltr drums carried on gondola service carrier to Helicopter Ridge, falling main to existing Rastus Burn septic tanks** | | | | | | | | | | |
| **Alternative 3 - Onsite primary effluent treatment and disposal - septic and trenches** | | | | | | | | | | |
| **Alternative 4 - Onsite secondary effluent treatment and disposal - aerated/ textile with heating and dripper lines** | | | | | | | | | | |

## 8.1 MCA Criteria Commentary

The criteria for the consideration of the alternative options are listed in the MCA in Table 4. We elaborate on these criteria as follows:

1. Suitability: the pumps, pipe diameter and resulting velocity will be selected to minimise retention time and thus will match the rates.
2. Constructability: The pumping out infrastructure has a smaller footprint than a treatment plant which will require a disposal field with associated excavation in potentially sensitive terrain.
3. Shock loads and startup: A pumping system is superior to other systems in its ability to cope with variable loading and flow.

4. Environmental impact: The pumping out option has a significantly lower environmental footprint than other systems which involve onsite disposal in the Doolans Creek Right Branch. With the pumping option, all wastewater flows can be collected and treated by a single larger and more efficient plant within the Rastus Burn Catchment.

5. Overall risk: The risk associated with pumping the wastewater from the proposed Doolans Base Area to a single facility in the Rastus Burn Catchment is significantly less than the risk associated with having two independent systems. In addition, the smaller plant at the proposed Doolans Base Area would not have access for wheeled vehicles during winter (such as maintenance, delivery or sucker trucks). Even during summer, access is not suitable for all vehicles.

6. Operability: It is easier to pump out wastewater from the Doolans Creek Right Branch basin and operate a single, larger, wastewater treatment plant than to operate two separate and different sized wastewater treatment plants.

7. Consentability: An assessment has been made on the ability to obtain a consent for the options and the ongoing risks associated with consistently meeting consent conditions

8. CAPEX: The installation costs of a pumped system are comparable to the installation of a secondary treatment system in Doolans Creek Right Branch.

9. OPEX: Effort will be required to operate and maintain the initial macerating pump station and two progressive cavity pump stations. However, the input required is considered to be less than operating a stand-alone wastewater treatment plant and land application field within the Doolans Creek Right Branch basin.

# 9 On-site Treatment Technologies Investigated for Alternatives 3 & 4

Various wastewater treatment technologies have been investigated for on-site treatment at the Doolans facilities site. These technologies are summarised in the table below. We have investigated the cost, nutrient removal capability, footprint size, power consumption, service support and maintenance options for each of the technologies and compared them in Table 5:

*Table 5. Treatment technology comparison*

| Treatment technology | Cost | Maintenance complexity (alpine conditions) | Containerised module alternative | Nutrient reduction | Power consumption | Footprint | NZ service agents |
|---|---|---|---|---|---|---|---|
| Septic tank | $ | Low | No | None/poor | Low | Small | Most drainlayers |
| Textile - Packed Bed Reactor - Innoflow | $$$$ | Moderate | MBBRa | Good | Moderate | Large | Yes, and local |
| Aerated - Fixed Bed Biological Reactor - ClearFox | $$$ | Moderate | ClearFox FBBR | Good/moderate | Moderate/high | Medium | Not yet |
| Membrane Aerated Biofilm Reactor | $$$$$ | Complex | Not available | Excellent | High | Large | Unknown |

# 10 Detailed Description of Alternative Options for Wastewater

This section describes the key components of each alternative option considered.

## 10.1 Alternative 1: Pumping to the Rastus Burn (The Recommended Option)

Alternative 1 consists of a rising main laid in the access road from the proposed Doolans Base Area to the proposed Mid-Station at Helicopter Ridge, and a falling main from Mid-Station to the existing Rastus Burn wastewater system via the Curvey Basin Trails.

### 10.1.1 Rising Main

There is only one practical rising main route between the Gondola Return Station facilities and Helicopter ridge, as the pipeline route is required to follow the access road to minimise disturbance. The height gain between the proposed Doolans Base Area and proposed Mid-Station at Helicopter ridge is 365m, as per the route described in Figure 3 and Figure 5. This route will be refined in future design stages.


*Figure 5. Simplified rising main route elevation profile, retrieved from QLDC GIS. This profile will be refined in future design stages*

Multiple rising main routes have been considered, drawing from summer and winter areal imagery, contour maps and LIDAR hill shade models. Rising mains outside of the access road would trigger additional earthworks in sensitive areas and have been discounted from the proposed solution.

Key elements of the rising main system are summarised below:

- Length ≈ 2.6 km
- Elevation gain ≈ 365 m

- Elevation loss ≈ 13 m
- Duty assist flows 1.5-3 L/s
- Wastewater 1-10 °C
- Approx 2,250-2,750m (subject to final road alignment)
- Under access road is likely the only consentable route for trenching
- Several downhill sections (negative gradient) 13-25m at $5^0$
- Passes through some steep rocky ground that may trigger realignment
- Maximum gradient approximately $24^0$

#### 10.1.1.1 Pump Stations

The proposed pumping arrangement is as follows, with the key proposed design parameters summarised in Table 6:

1. Gravity effluent from the proposed Doolans Gondola Return Station Facilities enters pump station 1 (PS1). PS1 will have an arrangement of duty-standby centrifugal macerating pumps, which will act as the macerating step.
2. Pump station 2 (PS2) will be located adjacent to PS1. The proposed 75,000L tanks connected to PS2 provide 24hr storage volume plus the volume of the pipeline above should this need to be drained for maintenance.
3. Pump station 3 (PS3) is nominally located adjacent to the proposed reservoir between the proposed Doolans Base Area and the proposed Mid-Station at Helicopter Ridge. PS3 will be accessible via the proposed 4WD access track. The indicative position of PS3 is shown on Figure 3.
4. PS1 pumps into PS2 at a similar elevation as the Gondola Return Station Facilities. PS2 and PS3 use an arrangement of duty-standby progressive cavity pumps where effluent is lifted through high pressure pipework to Mid-Station on Helicopter Ridge.
5. A manhole or chamber at Mid-Station will receive flow from the rising main and will discharge into the falling main.
6. The falling main drops to the existing septic tanks at the Rastus Burn base building.

*Table 6. Doolans pump stations and receiving chamber*

| Pump Station | Type | Elevation (m) | Height to summit (m) | Lift required | Distance of pumped line (km) | Head Range (m) | Rising Main Diameter (ID mm) | Flow Rate |
|---|---|---|---|---|---|---|---|---|
| PS1 | Macerating vortex | 1584 | 343.2 | 20.5 | 0.21 | 25-30 | 67.4 | 3-6 |
| PS2 | Progressive cavity | 1605 | 322.6 | 151.1 | 1.29 | 175-200 | 76.4 | 1.5-3 |
| PS3 | Progressive cavity | 1756 | 171.5 | 171.7 | 1.11 | 190-220 | 76.4 | 1.5-3 |
| Receiving chamber | Buried fibreglass or concrete | 1927 | 0 | 0 | 3.61 | N/A | 76.4 | 1.5-3 |

**Pump Design Considerations – Macerating pump**

Centrifugal macerating pumps are required in the first pump station to shred rags and other debris to prevent blockages in pumps and pipelines further downstream in the process. Centrifugal pumps cannot deliver the high head that progressive cavity pumps can produce. Consequently, PS1 will use centrifugal macerating pumps and PS2 and PS3 will employ progressive cavity pumps. Examples of these pumps are shown in Figure 6 and Figure 7.

Based on a flexible, modular design, the Flygt grinder pump range cover an extensive performance range. These submersible single-stage centrifugal pumps share the same discharge diameter, which makes it easy to select one of the interchangeable impellers to precisely
match your head and flow requirements now – and easily change it later. High efficiency minimizes electricial equipment installation costs and subsequent energy consumption.

**Pump capacity, 50 Hz**

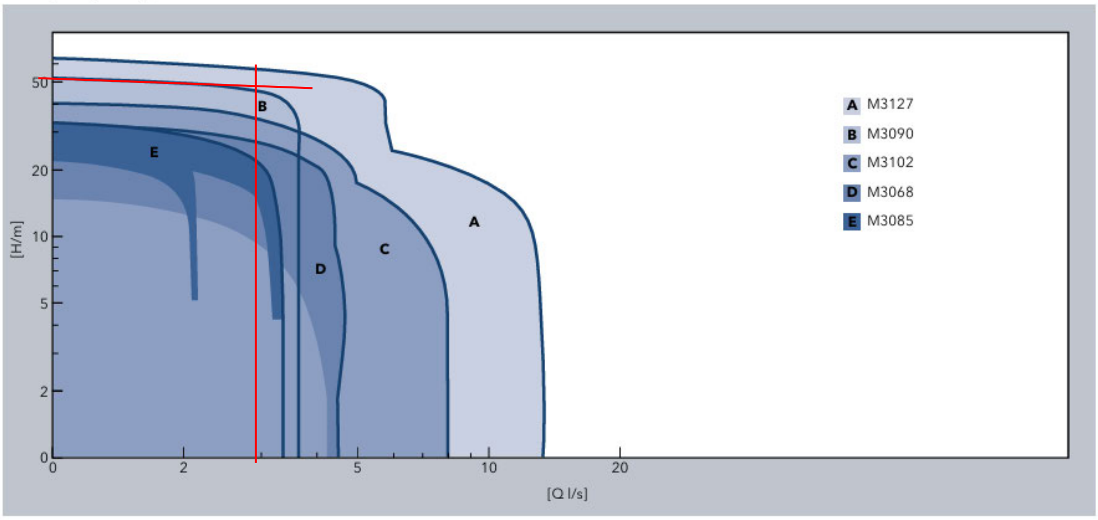



*Figure 6. Pump curves for macerating wastewater pumps, 50m is the maximum practical lift for PS1*

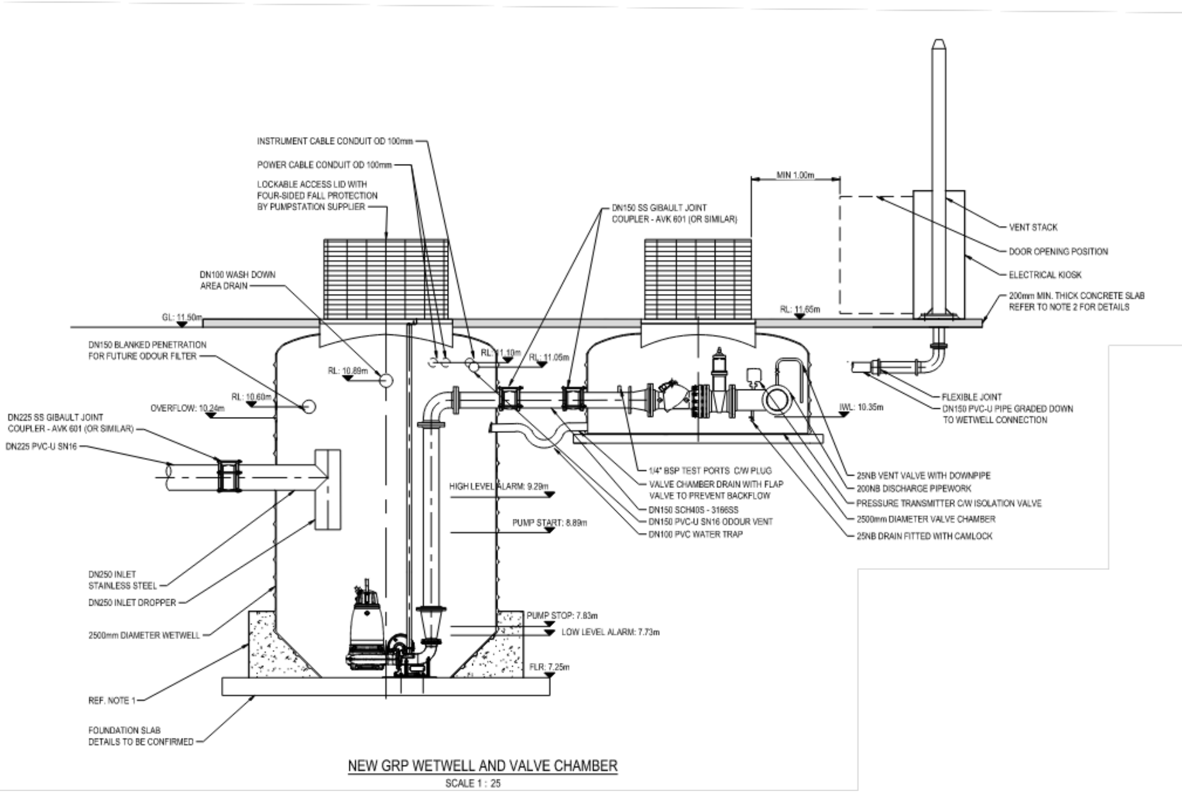



*Figure 7. Example pump station arrangement for PS1 using centrifugal macerating pumps and a separate valve chamber*

**Pump Design Considerations – Progressive Cavity pump**

Progressive cavity pumps can achieve a much higher head when compared to centrifugal pumps. An example is shown in Figure 8 and Figure 9. However, a macerator is required upstream of progressive cavity pumps to shred debris.


*Figure 8. Example progressive cavity pumps*

| | |
|---|---|
| | P9509 |
| Model | CE046MS1R4 |
| Quantity | One |
| Duty | 3.0l/s @ 260m |
| Speed | 474rpm |
| Motor kW | 11.0kW |
| Macerator | Yes |
| Model | M18C7N 4.0kW |

*Figure 9. Performance characteristics of an 11kW progressive cavity pumpstation (PS2 and PS3) Note the 260m duty point.*

**Design Considerations for Alpine Conditions**

Progressive cavity pumps are sensitive to temperature fluctuations and require an insulated building or enclosure. To maintain consistent pumping performance, temperature control is required.

Exposed pipework, valving and ancillaries within the pump sheds and externally will require the following:

- Fully clad in a weatherproof metal jacket.
- Heat tracing wire to prevent freezing.

Flowrates for the progressive cavity pump stations require further development during future design stages to ensure minimal storage is used during peak flows.

#### 10.1.1.2 Rising Main Material and Pressure Class

Pipe material and pressure class have been assessed to confirm that appropriate options exist to suit the operating and worst-case pressure conditions for the staged rising main from PS1 to Mid-Station at Helicopter Ridge:

1. PS1 to PS2: PN16 or PN25 coiled PE100 pipe.
2. PS2 to PS3: PN25 coiled PE100 pipe under normal conditions; PN35 ductile iron (DI) if upstream network drains to PS2
3. PS3 to Mid-Station: PN25 coiled PE100 or PN35 DI

The PN35 DI alternative for PS2 to PS3 provides additional safety margin for static head scenarios beyond HDPE capability. These selections will be confirmed during detailed design to ensure system integrity under abnormal conditions and transient pressure events.

**Design Considerations for Alpine Conditions**

Insulated pipes resist cold longer than uninsulated ones but will eventually cool to ambient temperatures. Heat trace wires to prevent freezing in pipes, tanks, and equipment by replacing heat lost through insulation. Example heating systems are shown in Figure 10.

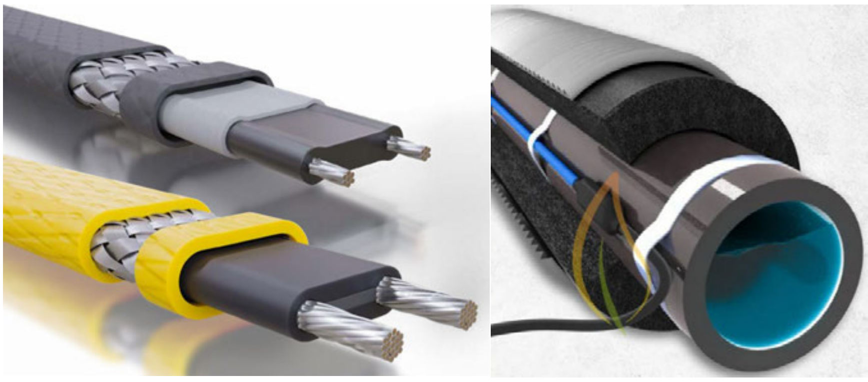


*Figure 10. SnoTrace RGS Self-Regulating Trace Heating and a side mounted installation example*

#### 10.1.1.3 Odour Control

Odour control is required at vented chambers, at high points in the mains where air could accumulate, at air release/vacuum valves, and at the pump stations. All hardware should be housed in insulated, weatherproof enclosures with drainage to prevent icing. Where vents extend above the ground and/or snow line, goose neck vents with an odour cartridge or similar are recommended.

**Preferred Alternative – Granulated Activated Carbon (GAC)**

- Compact and reliable in low temperatures
- Performance based on physical adsorption, not biological activity
- Key cold-weather risks: condensation and icing reducing airflow and media capacity
- Mitigation: design units for drainage and cold-climate operation

**Not Preferred – Wood Biofilter**

- Relies on biological activity, which drops in near freezing temperatures
- Risk of media freezing, which results in variable performance and higher maintenance

**Not Preferred – Single-Pass Vertical Filter**

- Large footprint, difficult to insulate
- High freezing risk, with added complexity for heating and enclosure

#### 10.1.1.4 Air Valves with Surge Protection

Combination air valves are required at high points and strategic locations on the pipeline to manage air during filling, draining, and normal operation. These valves perform three key functions:

- Air release: Continuous discharge of small air pockets under pressure to prevent air accumulation and maintain hydraulic efficiency.
- Air admission: Rapid intake of air during pipeline draining or sudden pressure drops to prevent vacuum conditions and pipe collapse.
- Air discharge: High-capacity venting during pipeline filling to avoid pressure surges and uncontrolled air expulsion.

**Design Considerations for Alpine Conditions**

- Enclosure: Valves should be installed in insulated, weatherproof chambers with drainage to prevent freezing and condensate buildup.
- Sizing: Select valve orifice capacity based on maximum filling and draining rates to ensure adequate air flow without excessive pressure differential.
- Protection: Provide screened outlets to prevent debris ingress and wildlife interference.
- Transient Control: Position valves to minimise water hammer risk during rapid air release and admission events.

**Preferred Valve Type**

- Combination air and vacuum valves with large orifice for vacuum protection and small orifice for continuous air release.
- Anti-slam internals to prevent water hammer or pressure spikes.
- Materials and seals rated for low-temperature operation and corrosion resistance.

### 10.1.2 Falling Main to Base Area

Four route options for the falling main to convey wastewater via gravity flow between Helicopter Ridge and the Rastus Burn Base area have been investigated. These four options are shown in Figure 11 and are described as follows:

1. **Preferred Route Option 1** Shown in yellow below. A falling main from Helicopter Ridge to west and down the slope to the Curvey Basin trails

2. **Route Option 2** Shown in red below. falling along the Return Ski Trail from Helicopter Ridge to the top of Sugar Bowl lift and down the Sugar Bowl Trails. This has significant issues as the route of the main has both high and low points

3. **Route Option 3** Shown in blue below. A falling main on the initial part of the Return Ski Trail but diverging from the return trail and following the Sugar Bowl Trails, in order to avoid areas where the in the Return Trail rises to The Sugar Bowl top Station

4. **Route Option 4** Shown in green below. A route following the initial part of the Return Ski Trail and then cut below 'Swan Lake' to the lower section of the Sugar Bowl Trails

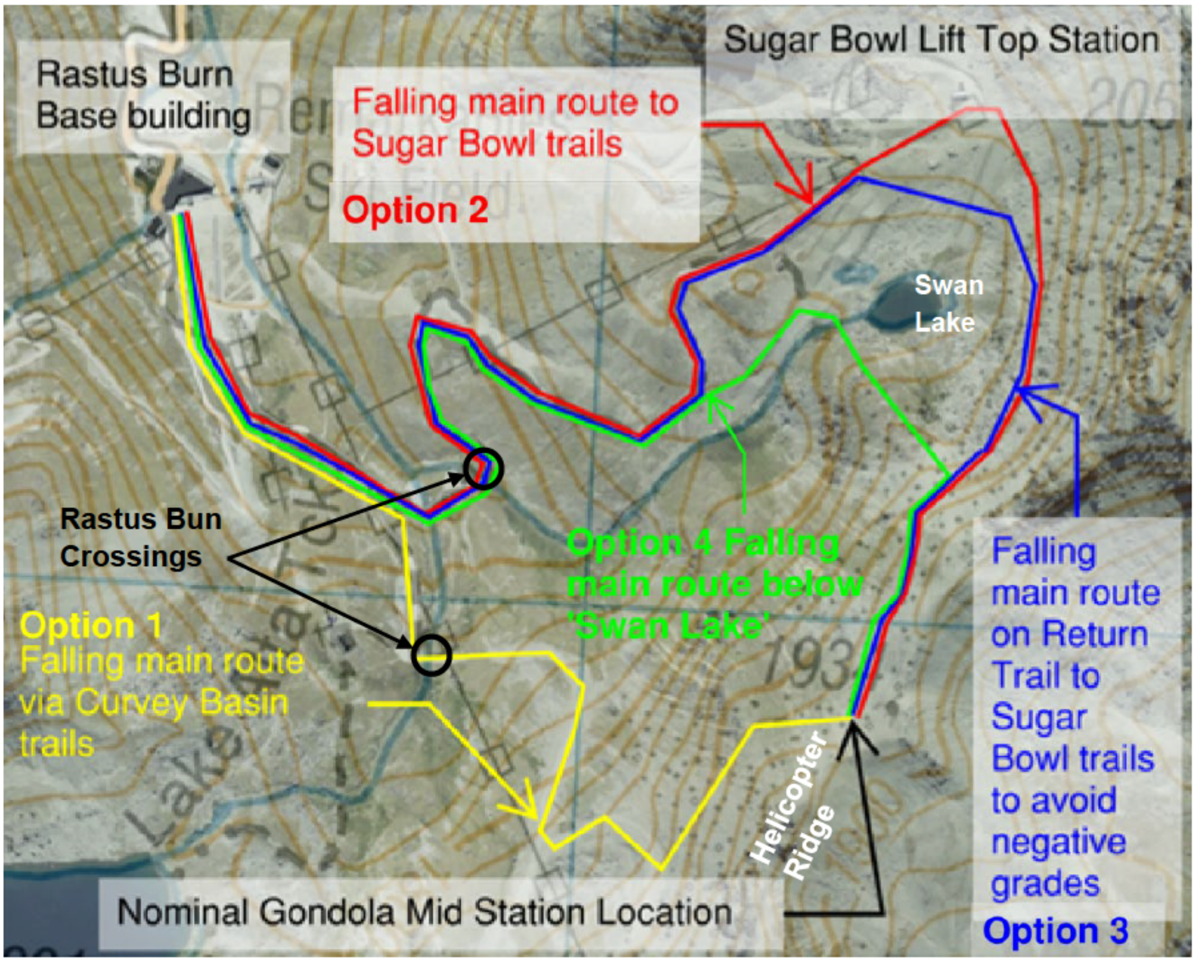



*Figure 11: Potential falling main routes from Helicopter Ridge to Rastus Burn Base Building*

#### 10.1.2.1 Rastus Burn Crossing

The requirement to cross the Rastus Burn Stream is common to all options. Option 1, the preferred option, crosses the Rastus Burn Stream highest upstream location where the flow is least. Crossing points for Options 2,3 and 4 are further downstream and are more difficult to achieve. For Option 1, this crossing is proposed at the existing 'Splash Crossing' (ford) location where the access road to Curvey Basin crosses the Rastus Burn stream. There are other service crossings beneath the creek in the vicinity, including snow making and power. This crossing will be achieved by sandbagging the Rastus Burn Stream upstream and redirecting flow into a temporary pipe, then laying the falling main pipe in a trench excavated across the channel. Buried Remo Mattress scour protection will be provided. The location of the Option 1 proposed pipeline crossing at the Rastus Burn Stream is shown in Figure 12.

*Figure 12: Location of the proposed Option 1 wastewater pipeline crossing at the Rastus Burn Stream*

#### 10.1.2.2 Route Option 1 – Preferred Route Falling Main to Curvey Basin Trails

The preferred wastewater falling main route follows the proposed 4WD access track from Mid-Station to Curvey Basin and then follows along a route along the existing Curvey Basin trails to the Rastus Burn Base Building facilities, as shown in Figure 13. This alignment is preferred because:

- It is consistently downhill,
- It does not require syphons,
- It is shorter than the alternatives,
- The higher location where it crosses the Rastus Burn is less disruptive and complex than the crossing required for the three other options considered.

This alignment includes the risks common to all falling main alignments which include,

- freezing of residual water,
- air valve failure due to ice,
- odour release during venting,
- uneven loading of the downstream treatment system in the Rastus Burn.
- Hydraulic jumps at steep discharges which can entrain air and cause turbulence,

Stilling chambers, submerged inlets, and baffles will be incorporated in the design to spread inflow evenly and reduce dynamic hydraulic effects. Secondary containment plus high-level alarms at break tanks will be incorporated to reduce/mitigate leakage risk.


*Figure 13: Oblique view and long section of the preferred falling main route via the Curvey Basin trails*

#### 10.1.2.3 Route Option 2 - Falling Main to Top of Sugar Bowl Basin

This option follows the route of the proposed access road and skier return trail between Helicopter Ridge and the Top Station of the Sugar Bowl Basin Chairlift, then follows the route of the existing Sugar Bowl access roads as shown in Figure 14. This route has high and low points and is not desirable for both this reason and its length.

Key parameters

- Length 3,610m
- Several uphill sections (where there is negative gradient)
- Passes through some steep rocky ground that may trigger realignment

The proposed falling main route from Helicopter Ridge to the existing Rastus Burn Base Building area would likely require pumping if sections of uphill slope are present.


*Figure 14. Option 2 layout and long section showing localised low and high points*

**Option 2 Falling Main Characteristics**

The falling main has been modelled in HADES to provide an indicative capacity of the proposed pipeline under three scenarios:

1. Minimum pumped flow – 1.5L/s
    a. Capacity of 64,800L over 12 hours pumping
2. Maximum pumped flow – 3L/s
    a. Capacity of 129,600L over 12 hours pumping
3. Flushing flow – 6L/s

The falling main is characterised by a steep section of pipework and two uphill sections (section 4 and section 7) as noted in Table 7 below. Through the use of appropriately sized and installed pipework and air management systems, inverted siphons can theoretically span small sections of negative gradient pipework. Both sections are approximately 9-10m in height and when modelled, may be accommodated without pump stations. However, the use of inverted siphons results in significant additional risks that are expected to be unpalatable for NZSki. Wherever possible, inverted siphons should be avoided.

*Table 7. Falling main characteristics by section*

| Section | Name of section | Cumulative Distance (km) | Section length (m) | Elevation (m) | Section Fall (m) |
|---|---|---|---|---|---|
| 1 | Mid-Station | 0.00 | 0 | 1923.2 | 0.0 |
| 2 | Top of first drop | 0.34 | 341 | 1918.0 | 5.2 |
| 3 | Bottom of first dip | 0.51 | 169 | 1865.6 | 52.4 |
| 4 | Crest of first dip | 0.58 | 70 | 1875.0 | -9.4 |
| 5 | Start of second crest | 0.84 | 259 | 1866.0 | 9.0 |
| 6 | Bottom of second dip | 0.89 | 50 | 1855.5 | 10.5 |
| 7 | Top of second crest | 0.96 | 70 | 1865.4 | -9.9 |
| 8 | Access road 1 | 1.55 | 590 | 1802.5 | 62.9 |
| 9 | Access road 2 | 2.00 | 450 | 1734.4 | 68.0 |
| 10 | Access road 3 | 2.22 | 219 | 1686.4 | 48.0 |
| 11 | End of flat section | 2.62 | 400 | 1675.8 | 10.7 |

#### 10.1.2.4 Route Option 3 -Falling Main Route on Return Ski Trail and Into Terrain Park

This option follows the proposed trail between Helicopter Ridge and the top of Sugar Bowl but deviates away from the trail route into the existing terrain park, as shown in Figure 15 and Figure 16. This deviation would maintain a falling grade on the pipeline and therefore avoid inverted siphons.

This is a technically feasible route. Although it avoids the inverted syphons required of option 2, it traverses the terrain park, and it is still a similar length to option 2.


*Figure 15: Option 3 Falling main route through terrain park*

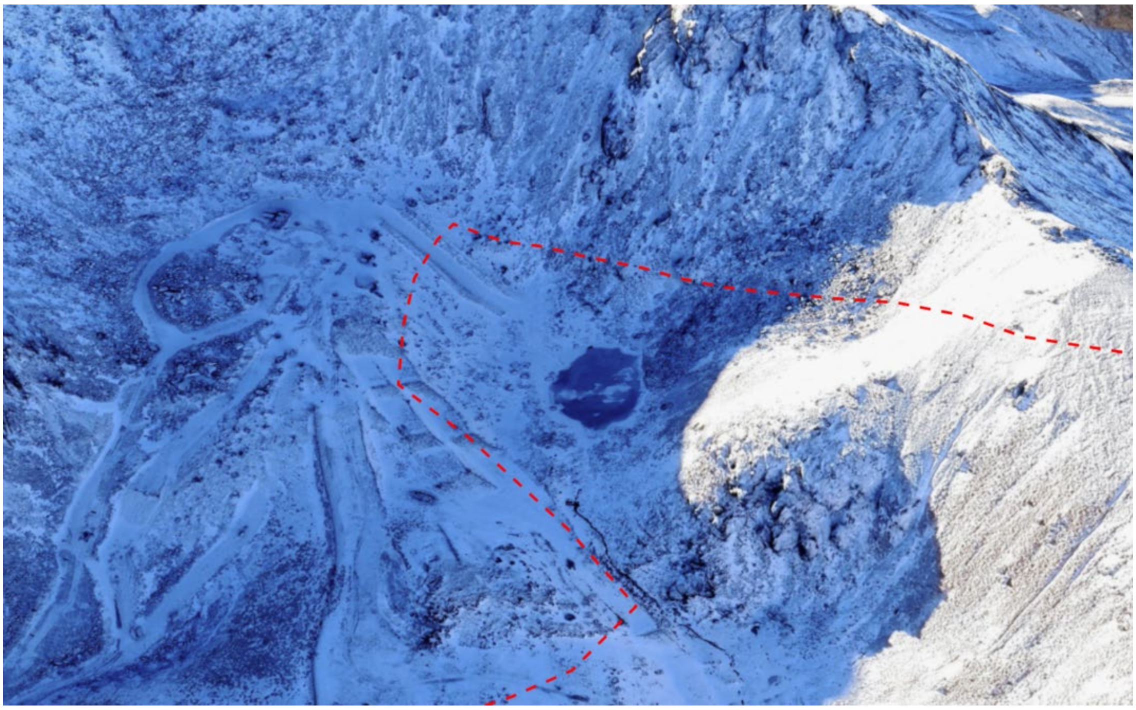


*Figure 16: Nominal Option 3 Route and the terrain park features*

#### 10.1.2.5 Route Option 4 - Falling Main Route on Return Ski Trail and Below Swan Lake

A route below ‘Swan Lake’ was investigated. This route has advantages over the two potential routes which traverse above the lake. This route is shown in Figure 17 below.


*Figure 17. Potential falling main route below Swan Lake*

This route requires steep trenching down to the crossing of the stream from Swan Lake plus a crossing of the Rastus Burn which is common to all options. Thus, this route option offers no benefits over the preferred route option.

### 10.1.3 Effects and Risks Associated with Pumping of Wastewater

The effects associated with pumping of wastewater from the Doolans Creek Right Branch to the Rastus Burn are identified in Table 8.

*Table 8. Effects associated with pumping*

| Effect | Description | Mitigation Measure |
|---|---|---|
| Visual amenity | Above ground pump station building required to allow winter access and maintenance of pumps | The environment is modified and includes snow making guns and pump buildings thus the buildings are not incompatible with the environment. The buildings will be of the minimum footprint and height practical and will be an environmentally neutral colour such as ‘ironsand’ or ‘karaka’ which match the surrounding exposed rock and match existing building colours. |
| Noise | Audible operation of the pumps | The pump operation noise is not significant and will be attenuated by the insulated building. It is likely that the pump operation will be barely audible immediately outside each pump building |
| Odour | Smell associated with filling of the pump chamber displacing existing air | The wastewater retention time is not significant and thus there is insufficient time for the anaerobic conditions associated with odour to develop. The initial macerating centrifugal pump station (PS1) will be vented to a stack likely to be mounted on the roof of the Carrier Stacking building as the wastewater in this location has had insufficient time for anaerobic conditions to develop. The |

| | | |
|---|---|---|
| | | two progressive cavity pump stations (PS2 and PS3) are in locations where wastewater may have been held in the rising mains for a sufficient time for odour issues to develop. The inlet wells for these pump stations will be vented through stacks with proprietary odour control units. |

The risks and risk mitigation measures associated with pumping wastewater from the Doolans Creek Right Branch facilities are listed in Table 9.

*Table 9. Risks and risk mitigation measures associated with pumping*

| Risk | Description | Mitigation Measure |
|---|---|---|
| Power outage | Power outage may cause pumps to stop | Emergency generation for the ski area is provided and will automatically start if there is an outage |
| Mechanical failure of pump | Pump fails to operate | Duty and assist pumps will be provided at each pump station. The pump operation will be cycled between pumps to ensure that each pump is operating. Should one pump fail, the other can take over. Spares of motors and seals, as well as high-wear items such as stators and rotors will be held on site, should replacement be required. |
| Mechanical damage to pipeline | Pipeline rupture | External damage to the pipeline during operation is considered unlikely due to the depth of the pipeline. Should this happen, the pipe may be drained to the storage at the pump station below to minimise spills and to facilitate repair. |
| Avalanche damage to pump building | Building inundated by snow avalanche | The Remarkables Ski Area operates a robust avalanche control programme intended to avoid significant avalanche danger developing. In addition, the proposed facilities are located within areas not currently believed to be exposed to significant avalanche risk, the Doolans Return Station area being protected by the avalanche run out provided by the terrace and the upper site has protection provided by the adjacent snow making reservoir. |
| Wind damage to building | Potential for significant wind damage | The buildings will be designed in accordance with the relevant materials standard and designed to result the wind loadings required from NZS 1170.2 ‘Structural Design Actions, Part 2 Wind Actions’ |
| Inclement weather obstructing access | Unable to access pump buildings | In such circumstances there would be limited or no people in the Doolans area and thus any wastewater generation would be stored in the tanks should there be an issue with the pumps |
| Communications failure | Failure in communications systems to pump stations | Each pump station function and status is monitored remotely. The communications systems have redundancy, and the pump operation will not be dependent on the communications system. Monitoring systems will be alarmed. |

## 10.2 Alternative 2: Human Waste Removal in Individual Wastewater Holding Tanks

Alternative 2 covers the option of collecting human waste in drums and removing the drums from site for disposal of the waste at either the gravity wastewater pipeline at Helicopter Ridge, or disposal at the Rastus Burn base building has been considered.

Drum containment toilets are an innovative approach which has been employed at a number of high alpine mountaineering huts. This system involves movable polyethylene tanks to collect the waste and then removal of the tanks for appropriate disposal of the waste off site. The system is ideally suited for extremely remote locations that experience low flows and high strength effluent loading and cold weather conditions. Example systems are shown in Figure 18.

This alternative relies on wastewater generation being kept to a minimum by avoiding the requirement for flushing or water for handwashing. Hand sanitizer is frequently used in such facilities.

Unlike other alternatives discussed in this report, this system would only be suitable initially when visitor numbers are low and would not be suitable for the ultimate number of visitors. When the ultimate visitor numbers are reached an alternative flushing system would be required and the volume would be too high to be practical to be managed in this manner.

*Figure 18. Examples of alpine drum containment toilets.*

Where multiple tanks are filled each day, it will become too labour intensive to move these tanks, and alternative solutions will be required. Drums will also take up space on the gondola and intensive labour input (hourly) during peak days, this option is not considered suitable as a permanent solution.

Drum containers would be lifted via gondola to the mid-station and emptied into the gravity drainage system at Helicopter Ridge or at the Rastus Burn Station via a camlock connection, as shown in Figure 19. It is not desirable to transport the waste drums through the Rastus Burn Base Facilities.

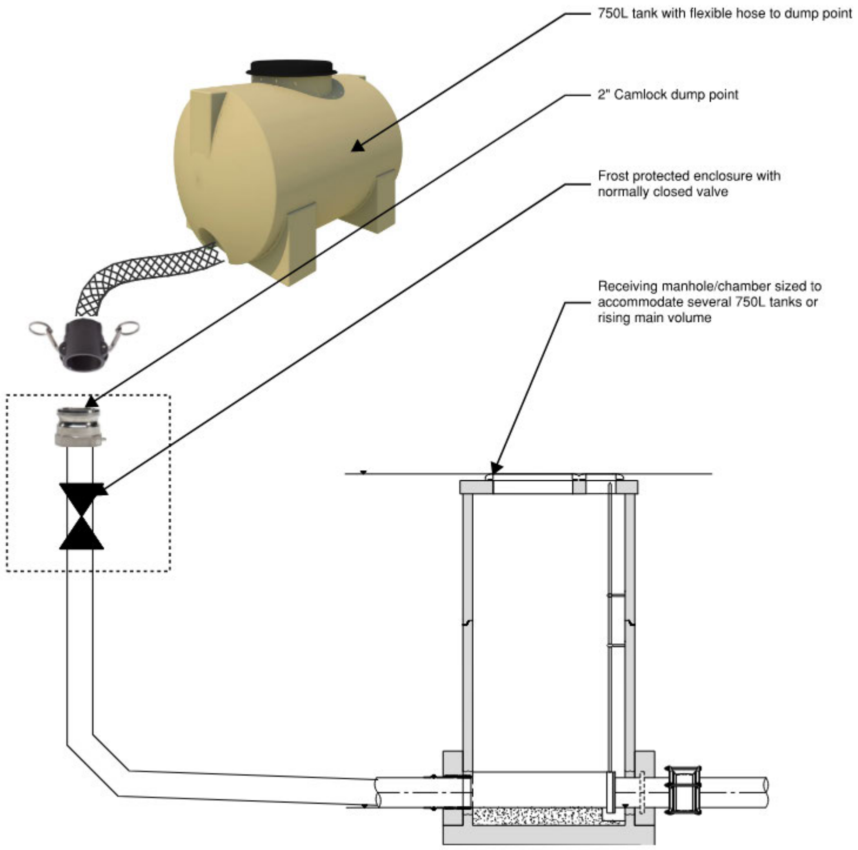



*Figure 19. Indicative dump point and receiving tank/manhole*

### 10.2.1 Mid-Station Receiving Location

The receiving tank would be located in the mid-station area on Helicopter Ridge, shown in Figure 20, from where collected waste could be flushed into the gravity system. Further depth to rock assessments would be required to determine the feasible maximum depth.

*Figure 20. Mid-Station terminal location at Helicopter Ridge*

Gravity drainage from the mid station is expected to be achieved through a gravity main with air breakers at key points on this line.

## 10.3 Alternative 3: Primary Treatment and Onsite Disposal

Alternative 3 consists of septic tanks which discharge into rapid infiltration basins or disposal fields. This is a similar process to what currently exists in the Rastus Burn catchment.

Primary treatment systems provide minimal treatment (such systems remove solids and floatable separation) of the influent and do not provide sufficient treatment to remove either Nitrogen or Phosphorus. As such this option has been discounted as being a viable solution.

## 10.4 Alternative 4: Secondary Treatment and Onsite Disposal

Like Alternative 3, Alternative 4 aims to treat and dispose of effluent within the Doolans Creek Right Branch using secondary or advanced secondary treatment technologies.

Stantec has little confidence that application of treated onsite in the Doolans Creek Right Branch is feasible. To support this conclusion, Stantec explored secondary treatment technologies and onsite disposal alternatives in the following sections. The limitations for Alternative 4 are summarised at the end of this section.

### 10.4.1 Doolans Creek Right Branch site conditions

Doolans Creek Right Branch is dominated by scree slopes, wetlands, cushion fields and wetland seepage areas which have been identified as sensitive environments. Examples of these are shown in Figure 21. An area of tussock grassland has been selected containing a potential land application system envelope (LASE) that may accommodate an effluent disposal area. This area and is outlined in purple in Figure 22.

*Figure 21. Doolans terminal location and tussocks*

Figure 22 shows the steep ground below the return station and exposed rock where groundwater seeps from the bedrock and permeable layer above.

*Figure 22. Looking down to gondola return left, and right below return station*

The key risk associated with onsite disposal in the Doolans Creek Right Branch is the daylighting of effluent after disposal – where it resurfaces after disposal. The blue areas in fig 23 are pooling water or wetland seepage where the existing hydraulic capacity of the soil has already been exceeded

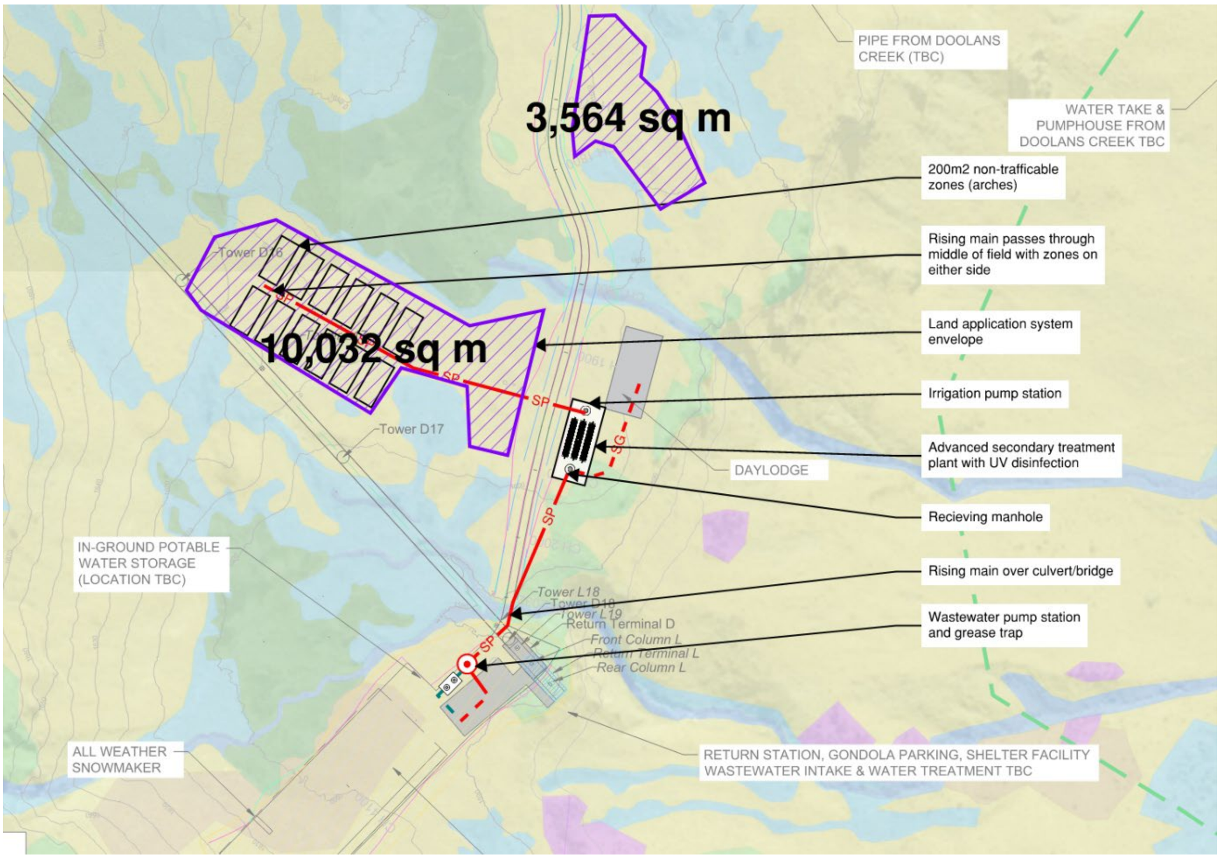



*Figure 23. Doolans onsite wastewater and two LASEs*

## 10.4.2 Treatment Technologies

This section comments on secondary treatment options proposed by design and build suppliers, Innoflow and ClearFox. In preparing for their proposals, suppliers were asked to conform to the Standards or Statutory Requirements laid out in Section 6.

Containerised solutions have been considered due to improved access for maintenance when the ground is under snow cover. Innoflow proposed containerised or in-ground concrete moving bed bioreactor (MBBR) and textile systems for this project, which can be modular and airlifted into remote locations. An example MBBR is shown in Figure 24.

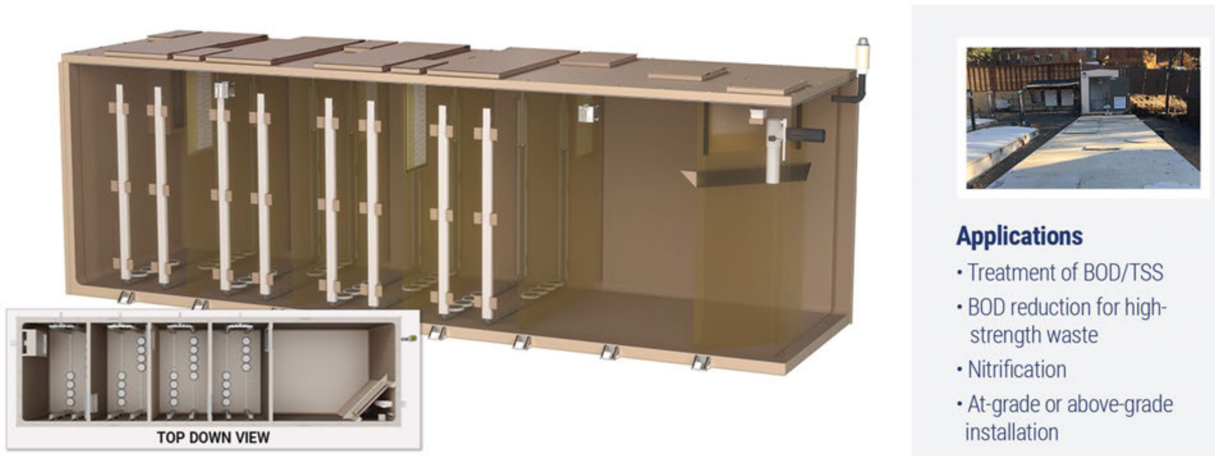



*Figure 24. Innoflow MBBR system*

ClearFox installed a 30m$^3$/day floating bed bioreactor (FBBR) system with two containers in Antarctica, as shown in Figure 25. With temperatures as low as -35 °C, the system required extra insulation, pipe trace heaters, and sensors that automatically control heating of the wastewater. Hynds (the Clearfox agent) noted that an insulated container solution is not expected to require heating for this project. Stantec disagrees and as such, heating is still assumed to be required.


*Figure 25. ClearFox FBBR and installation in the Antarctic*

### 10.4.3 Wastewater Heating

As biological activity reduces in cold temperatures, heating of the wastewater is required. All components of the heated system must be well insulated to mitigate heat loss to the ground and air, including:

1. Insulating pipework
2. Insulating chambers and tanks upstream of and including the biological treatment process
3. Insulating covers etc.

Wastewater heating alternatives are discussed in Table 11. To prevent unwanted cooling of the wastewater flow, all non-sanitary wastewater (such as backwash from water filters) would be directed away from the domestic wastewater treatment system.

Table 10. Wastewater heating alternatives

| System Type | Coefficient of Performance (COP) Range | Typical Installed Cost (NZD/kW) | Pros | Cons |
|---|---|---|---|---|
| **Air Source Heat Pump (ASHP)** | 2.0 – 3.5 (drops sharply below 0°C) | \$800 – \$1,200 | • Lowest upfront cost; minimal land disturbance<br>• Easy maintenance; outdoor accessibility<br>• Modular – scalable by adding units | • Major performance risk in alpine cold; COP falls during peak demand<br>• Highest operating cost due to low winter COP<br>• Requires defrost cycles in wet/cold conditions |
| **Ground Source Heat Pump (GSHP)** | 3.0 – 4.5 (stable year-round) | \$1,800 – \$3,000 | • Highest efficiency; reliable COP (~4.0)<br>• Lowest operating cost and $CO_2$ emissions<br>• Long lifespan (loops 50+ years)<br>• Performance unaffected by air temperature | • Highest upfront cost; drilling or slinky loops<br>• Large land area required; site disruption.<br>• Complex design and installation<br>• Longer payback period |
| **Thermodynamic Solar (Refrigerant Panel)** | 2.5 – 3.5* | \$1,200 – \$1,800 | • Works at night and under snow<br>• Decent mid-range efficiency in cold conditions<br>• Simple system; few moving parts<br>• Can benefit from solar gain on sunny days | • Scaling to Doolans and Rastus heating load requires large panel array<br>• Significant roof/ground footprint; aesthetic impact<br>• Potential icing reduces efficiency<br>• Primarily suited for hot water, not large process heating |

*The Coefficient of Performance (COP) for a heat pump equals the useful heat output divided by the electrical power input. COP for thermodynamic systems varies with ambient air but can remain functional under snow and at night.

*Figure 26. Pipe arrangement in a slinky ground loop - Central Heating NZ*

*Figure 27. Solar Thermodynamic Panels at Cardrona Valley WW Treatment Plant – Alternative Energy Company*

### 10.4.4 Discharge Field Options

This section addresses various options for discharge fields. Discharge fields are either:

1. Disposal fields which are not intended to provide treatment
2. Treatment fields where the field forms part of the treatment process

To assist with scoping, typical Design Loading Rates (DLR) have been assumed as per Table 10.

*Table 11. Doolans wastewater flows and required trench area*

| Doolans Occupancy | Skiers/day | L/Person/Day | L/day | Design Loading Rate (DLR) mm/day | Basal area of trenches required $m^2$ | Lineal metres of dripperlines |
|---|---|---|---|---|---|---|
| **Ultimate occupancy** | **2,500** | **34** | **83,835** | **25** | **3,353** | **33,534** |

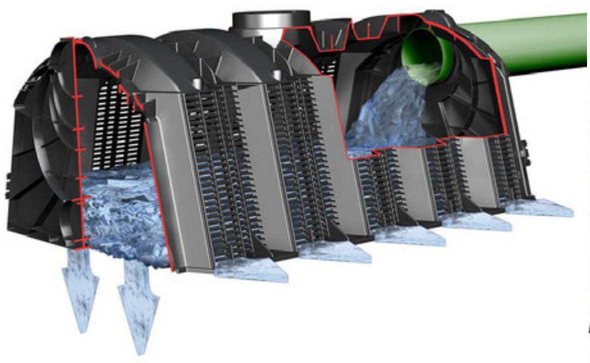
DLRs are assumed as "Category 3 – Moderately drained soils" and require robust onsite testing and long-term verification in future design stages. Areas provided in Table 10 are to convey minimum areas required if all wastewater flow enters new disposal fields.

Both land disposal systems (arches) loaded at 25mm/day and dripperlines loaded at 2.5mm/day were considered for this catchment.

#### 10.4.4.1 Disposal fields

Disposal fields include rapid infiltration basins, trenches, adsorption trenches, arched disposal beds etc. Examples of disposal field system are shown in Figure 28 and Figure 29. Features include:

- Dispose of effluent through rapid infiltration with minimal emphasis on treatment
- High application rates 10-50mm/day possible if ground conditions allow
- Unsuitable for sensitive environments or where groundwater contamination could occur
- Can store effluent in gravel or arches
- Trafficable



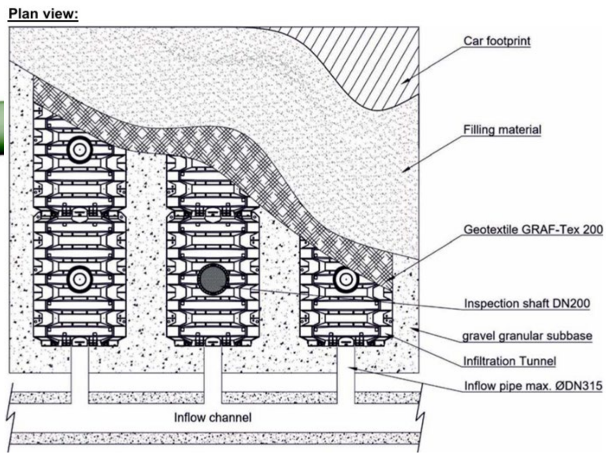


*Figure 28. Graf infiltration trench*

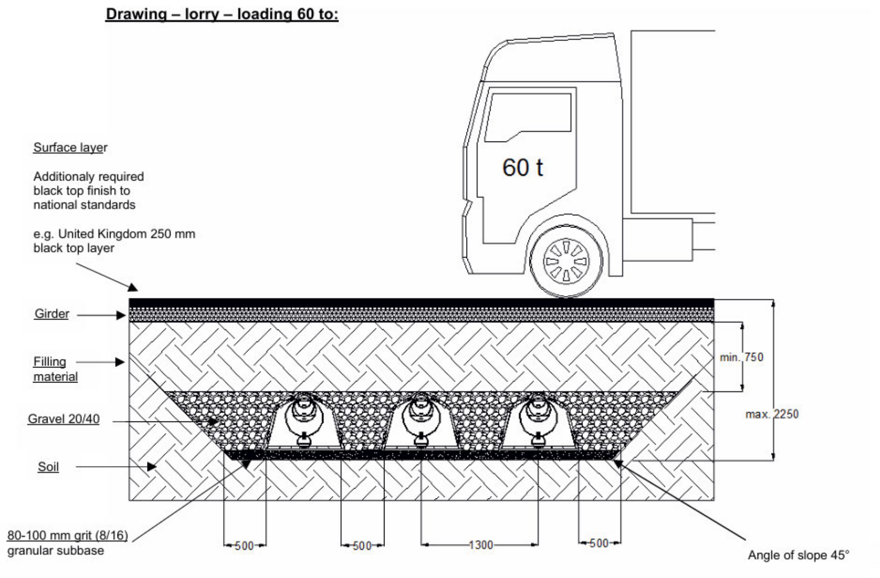



*Figure 29. Graf trafficable infiltration trench*

### 10.4.4.2 Treatment fields

Treatment fields include pressure compensating dripperlines (PCDI), discharge control trenches with 2A sand (graded media) etc. Examples of disposal field system are shown in Figure 30 and Figure 31. Features include:

- Installed in top layer of soil where microbiome assists in improving effluent applied to ground
- Low application rates 2-5mm/day (dripperlines) 5-30mm/day (2A trenches, sometimes up to 50mm/day)
- Large land area requirement. From Table 10, over 33,500m$^2$ of land area would be required. This does not take into account the slope reduction factor, which would increase the area required. An area of around 13,500 m$^2$ was identified in Figure 22, making dripperline treatment fields an unfeasible option
- Dripperline pipework is typically small diameter thin-walled pipework – fragile and prone to freezing
- Not trafficable and requires fencing off

Due to the large land area required for treatment fields, disposal fields are the only feasible land application system to accommodate increased effluent flows and loads.

*Figure 30. Netafim Bioline PCDI dripperline*

*Figure 31. Purple PCDI lines and effluent arch over EcoTrench - Bray Brothers Drainage, designed by Marc Jensen*

### 10.4.5 Limitation on Doolans Creek Right Branch Site Treatment Technologies

Potentially viable treatment systems are available to treat wastewater at the Gondola Return Station facilities. But operation and maintenance of a facility in such a location will be challenging. Achieving successful land application of treated wastewater in this location will be a significant challenge if not both impractically difficult and unreliable. Therefore, Alternative 4 has been discarded from further consideration for the following reasons:

- The large footprint required
- The sensitive nature of the site and the apparent proximity of the underling rock visible in Figure 21 making the satisfactory implementation of land disposal a risk
- The fragility of the dripper lines (if selected) and the associated risk of damage to the lines both from freezing and from physical impact
- The complexity and issues associated by secondary treatment systems which will require heating the wastewater for satisfactory treatment.
- The limited access to the site for both maintenance and operation. In particular during winter when wheeled vehicle access is impossible.
- Maintenance and operation of a remote secondary treatment system in the Doolans Creek Right Branch would require specific expertise not currently employed by NZSki. It is likely that a specialised subcontractor would be required to operate and maintain a secondary treatment plant in this location. Expertise in cold climate treatment systems and disposal in such an inaccessible alpine environment is not widely available and represents a risk for this alternative.

# 11 Key Benefits, Risks and Cost of Each Alternative

### Alternative 1 (the recommended option): Rising main to Helicopter Ridge, falling main to existing Rastus Burn carpark

- Pros: Scalable, avoids manual waste handling, aligns with consentable corridor. Avoids discharge in Doolans catchment
- Cons: operational complexity due to multiple pump stations, elevation gain and fall Requires the implementation of all pipelines and pump stations immediately and does not allow for staged implementation.
- Unknowns: Few significant unknowns

### Alternative 2: 750L drums carried on gondola to Helicopter Ridge, falling main to Rastus Burn

- Pros: Practical only for a short-term initial solution but not suitable for ultimate visitor numbers, removes need for rising main and pump stations from Alternative 1.
- Cons: Unfeasible for ultimate visitor numbers.
- Unknowns: Expected volumes, freezing of tanks, methodology for moving tanks on gondola and operational logistics.

### Alternative 3: Onsite primary treatment & land disposal (septic + trenches)

- Pros: Simpler infrastructure than other alternatives.
- Cons: High environmental and consent risk, Gondola Return Station Facilities would require another system, poor shock-load resilience, odour issues, unacceptable surface water contamination risk, Gondola Return Station Facilities system has no access to pump out.
- Unknowns: Subsurface conditions, wetland seepage, suitable disposal location, design loading, regulator acceptance.
- Ultimately, this option is considered to be unfeasible

### Alternative 4: Onsite secondary treatment & land disposal (aerated/textile with heating & driplines)

- Pros: Higher treatment than septic, network independent.
- Cons: Maintenance intensive, heating required, disposal field easily damaged by freezing or mechanical impact, consent and environmental risk remain, high risk of groundwater and surface water contamination.
- Unknowns: Land area requirement, soils category, operational requirements, consent conditions and access for maintenance when buried in snow.
- Ultimately, this option is considered to be unfeasible

# 12 Summary of Recommended Option to Inform Preliminary Design

### 12.1.1 Rising Main (Doolans Base Sation → Mid-Station)

The following section outlines the required components for the section of rising main from the Doolans base station to the middle station on Helicopter Ridge.

- Length ≈ 2.6 km
- Elevation gain ≈ 367 m
- Elevation loss ≈ 13 m
- Duty assist flows 1.5-3 L/s
- Wastewater 1-10 °C
- PS1-PS2 – PE100 PN16 or PN25 from rolls/coils to minimise joints
- PS2-PS3 –PE100 PN25 or DI PN35 pipe material TBC
- PS3 –PE100 PN16 or PN25 pipe material TBC
- Segment static heads ≤ 75% of pipework rating

1) Air management – air-release & vacuum breakers

- Provide triple-function air release valves (ARVs) to release small air, discharge large air, and admit large air on vacuum at true high points, long adverse grades, between check valves and pumps, and immediately upstream of valves/manholes.
- Size for vacuum inflow during emergency drain/pump trip to limit negative pressure to > –7 m water column and avoid column separation.
- Non-slam features to reduce surge; isolate each ARV with full-bore valves and include pressure tappings for commissioning.
- House ARVs in insulated, drained chambers with odour filters.

2) Gravity-break manholes (also provide over-pumping points)

- Function: cap pipe segment pressure (≤ 100 m static), provide air exchange, energy dissipation, and over-pumping/bypass during pipeline damage or slope instability events.
- Features: drop/impact energy dissipation with manhole large enough to contain pipe volume to drain section of pipeline, vent stack with carbon, isolation both sides, camlock bypass/tanker pump out point, scour point chamber houses camlock, flow-meter tapping.
- Locate near car park benches/laybys for safe access; provide secondary containment to prevent alpine spills.
- Preliminary spacing: at head intervals (not distance) so no leg exceeds ~80–100 m static head.

3) Odour control

- Vent treatment at ARVs and break manhole chambers using granulated activated carbon (GAC) canisters. Include cold-climate housings and condensate drainage.
- Minimise septicity and avoid stagnant pockets via flush cycles.
- Select corrosion-resistant materials (PE100 pipe; 316 SS above water line).

4) Septicity management

- Cold water helps, but long residence at 1.5-3 L/s can still allow slime and sulphide formation.
- Source control: periodic self-cleansing velocities ≥ 0.8-1.0 m/s; maintain oxygenation where possible.
- Chemical alternatives (as needed): nitrate dosing ($Ca(NO_3)_2$) to suppress sulphide; alkalinity addition ($Mg(OH)_2$/NaOH) for pH control at corrosion hotspots.

5) Flushing strategy

- Operate each pump station in assist mode for a flush cycle to drive v ≈ 1.0-1.5 m/s for a prolonged period during low-use periods and at end of season.
- After flushing, and once the main has been drained, use scour valves at true low points to dry sumps with camlock connections for the pump-out of remaining solids. Ensure no uncontrolled discharge to slopes.

6) Minimum scouring velocity (self-cleansing)

- Target ≥ 0.8–1.0 m/s episodically in the main (pressurised sewer rule-of-thumb).
- Heavy solids fall within steep rising mains, in this scenario, higher velocities are required with longer duration flushing being required.

7) Maximum velocity

- Normal operation: aim ≤ 2.0 m/s to limit head loss and surge.
- Short-term events up to ~2.3–2.4 m/s are acceptable with surge checks and non-slam valves.

8) Trench shutters / water stops on ≥ 10° slopes

- Install impermeable trench stops (concrete collars or HDPE stop boards) at ~10-20 m spacing on slopes ≥ 10°, or closer together where seepage is observed, to prevent groundwater "piping" down the trench.
- Use restrained, fully fused PE with anchor blocks at bends/grade breaks; check down-slope drag and buoyancy during wet backfill.
- Chambers installed on pad foundations with anti-floatation collars; bedding per spec with separated geotextile where fills change.

9) Separation to 33 kV HV cable (parallel and crossings)

- Maintain ≥ 1,200 mm horizontal separation to the HV cable along the parallel run.
- At crossings: 90° where practicable, provide protective slabs/ducts, keep pipe joints ≥ 1.5 m clear of crossing centre line, and as-built survey the cover to both assets.

10) New comms & fibre separation (AS/NZS 3500 & New Zealand Utilities Advisory Group (NZUAG) practice)

- Adopt not less than 500 mm horizontal and 300 mm vertical separation between the wastewater main and comms/fibre ducts, with the sewer below where possible.
- Provide warning mesh above both services and separate marker posts; confirm final offsets with the utility owners and corridor manager in detailed design.

11) Cover to pipework

- Cover to be sufficient to prevent freezing whilst suitable for installations without creating road instability.
- Depth of pipe to be below frost level. Assumed cover 900-1,500mm deep to be confirmed in future design stages.

## Pipework Capacity Snapshot (Cold Water 1–6 °C)

The rising main from PS2-PS3-Mid-Station requires higher pressure rating (PN) pipework than the rising main from PS1-PS2 to reduce the number of pump stations from the originally proposed six to two.

Assume PE100 PN25 pipework for the rising main, with ≈ +8% friction allowance for 1–6 °C vs 20 °C.

*Table 12. Rising main pipe capacity example*

| Pipe (from roll) | Approx. ID (mm) | Flow (L/s) | Velocity (m/s) | Head loss per 1 km (m) @ 1–6 °C |
|---|---|---|---|---|
| OD110 PN25 (PE100) | 76.4 | 1.5 | 0.33 | ~2 |
| | | 2 | 0.44 | ~3.4 |
| | | 2.5 | 0.55 | ~5.1 |
| | | 3 | 0.66 | ~7.2 |

Interpretation & selection:

- Smaller diameter or lower pressure rating pipework is not suitable for expected flows and loads.
- Further modelling may be completed based on pump availability to validate OD90 pipework.
- Velocities remain < 1 m/s at 1.5–3 L/s; friction losses are low (≈ 2-7 m/km).
- PN25 OD110 is suitable for expected flows and most head demand will be static elevation, not friction.

Surge & Controls (summary for concept stage)

- Model pump trip, rapid valve closure, emergency drain/air admission, and siphon break (if any).
- Use non-slam checks, VSD ramp limits, appropriately sized ARVs, and surge relief only if analysis shows exceedance of PN16. Provide pressure tappings at upstream/crest/downstream nodes for commissioning and monitoring.

### 12.1.2 Falling Main (Mid-Station → Base Station)

The following section outlines the required components for the falling main from the Mid-Station to the Base Station via a route along the Curvey Basin trails.

- Design flows (peak): 1.5-3 L/s (receive side)
- Design flows (flushing): 6-8 L/s (assumed)
- Wastewater temperature: 2–10 °C (winter and shoulder conditions)
- Pipe material/installation: OD110 MDPE PN25 from 100m rolls or DI PN35 welded sections with restrained joints at fittings/bends
- Depth: ~1.0–1.5 m cover to mitigate freezing and protect from vehicle loading (confirm with frost depth and geotechnical considerations in preliminary design)
- Break tanks: located at key head intervals; each tank sized ≥ upstream rising main internal volume + freeboard for surge and inflow control

1) Air management – combination air release & vacuum breakers

- Install triple function ARVs immediately upstream of break tanks and control valves.
- Vacuum inflow capacity to be sized to limit negative pressure to > –7 m water column during emergency drain/pump trip so column separation does not occur.
- Use non slam features; provide isolation valves and pressure tappings for commissioning.
- House ARVs in insulated, drained chambers with odour filters.
- Heat tracing may be required to prevent internals freezing.

2) Gravity break manholes/tanks

- Function: cap segment static head to within PN25-PN35 + surge allowance, provide air exchange and energy dissipation, and enable over pumping/bypass if a section is damaged.
- Sizing: Tank volume ≥ upstream falling main internal volume (pipe area × leg length) + spill freeboard (≥ 15–20% of that volume or as transient study indicates). This ensures a safe dump in fault conditions without downstream surcharge.
- Features: drop/impact dissipation, vent stack with GAC odour control, isolation valves both sides, camlock bypass/tanker point, scour valve to lined containment, flow meter tapping.
- Preliminary spacing: locate by head interval (not distance) so no leg exceeds ~80–100 m static head before another break tank/manhole.
- Complete a HADES model for the falling main to validate chamber locations to identify where freeboard allowances have been exceeded.

3) Odour control

- Fit GAC filters to vent stacks at ARV and break tank chambers; provide condensate drainage and cold climate housings.
- Limit detention via flush cycles.
- Use corrosion resistant materials (MDPE; 316 SS above the water line).

4) Septicity management

- At 0.75–2.5 L/s, velocities are sub cleansing, so periodic flush cycles are required to avoid slime, ice and solids build up/sulphide formation.
- If needed, dose nitrate ($Ca(NO_3)_2$) to suppress sulphide; consider alkalinity addition ($Mg(OH)_2$/NaOH) for pH control in high-risk locations.

5) Flushing strategy (self-flushing flows)

- Drive episodic velocities ≥ 0.8–1.0 m/s by scheduled flush cycles (e.g. brief higher flow operations or controlled flush from Mid-Station tank release or a break tank).

6) Minimum scouring velocity (self-cleansing)

- Target ≥ 0.8–1.0 m/s.

7) Maximum velocity

- Normal operation: aim ≤ 2.0 m/s to limit head loss and surge.
- Short term peaks up to ~2.3–2.4 m/s acceptable with surge checks and non-slam valves.

8) Hydraulic jumps & supercritical flows (at break tanks/outfalls)

- Where the break tank discharges as open channel onto a steep chute, flows may be supercritical; ensure energy dissipation and that hydraulic jumps have adequate venting to exhaust entrained air from the aerated effluent below the jump (dedicated vent/relief path, anti-splash baffles, and screened vents).
- Provide anti icing details on vents/chutes given 2–10 °C wastewater and alpine ambient.
- HADES modelling highlight hydraulic jumps are present:
    - At base of steep slope where gradient reduces.
    - At inlet to break tanks.

9) Trench shutters/water stops on ≥ 10° slopes

- Install impermeable trench stops (concrete collars/HDPE stop boards) every ~10–20 m on slopes ≥ 10°, or closer together where seepage is observed, to prevent groundwater piping.
- Use restrained, fully fused MDPE, anchors at bends/grade breaks; verify down slope drag/buoyancy during wet backfill.
- Install chambers on pad foundations with anti-floatation collars, if groundwater is found to be an issue; bedding per spec with geotextile separation where fills change.

10) Separation to HV and comms/fibre (if route shares services corridor)

- Maintain ≥ 1,200 mm horizontal separation to any 33 kV HV cable along parallel runs.At crossings, install at 90° where practicable, protective slabs/ducts, joints ≥ 1.5 m from crossing centreline, and as built cover survey.
- Adopt ≥ 500 mm horizontal and ≥ 300 mm vertical separation to comms/fibre per AS/NZS 3500/NZUAG practice, with the sewer below where feasible.

11) Cover & frost protection

- Provide ~1,000–1,500 mm cover as required to stay below the seasonal frost depth while remaining buildable without creating road instability; confirm depth in preliminary geotech and services design.

# 13 Operation and Maintenance

### 13.1.1 Pumping System Maintenance

Operation of the pump system from the Doolans Base Area to Helicopter Ridge and the gravity drainage system from Helicopter Ridge to the Rastus Burn base area is technology similar to NZSki's current operations and is expected to be within the skill set of NZSki staff.

### 13.1.2 Chemicals and Urinal Cakes in Wastewater Treatment Systems

Chemical usage and disposal should be minimised or avoided where possible. Such chemicals can result in significant and long-term performance related issues.

- Urinal cakes shall not be used (quaternary amine products are not biodegradable and impact nitrifiers – resulting in potential consent level exceedances)
- Bleach shall not be used.
- Toxic chemicals shall not enter the wastewater system.
- A list of chemicals and suitable cleaners can be provided by the selected treatment technology supplier.

# 14 Development to Preliminary Design for Pumping System from Doolans Creek Right Branch

This report provides our recommendation to implement a system where wastewater from the Doolans Creek Right Branch development is pumped over Helicopter Ridge to the Rastus Burn facilities for treatment. This report covers only the removal of the wastewater from the Doolans Creek Right Branch and does not address treatment in the Rastus Burn which is addressed in other documents. To develop this concept into a preliminary design the following steps will be required:

- Input into the multi-criteria assessment by other specialist areas such as cultural and environmental.
- Confirmation of alternative rising and falling main alignments for further development.
- Confirmation on rising main storage tank locations.
- Confirmation on placement of the two above ground, insulated pump sheds for PS2 and PS3.
- Geotechnical assessment of the site to confirm:
  - Foundation conditions for the pump stations, pump shed buildings, drop structures etc. are suitable.
  - Depth to rock where tanks and structures are proposed, noting that some of these structures require deep excavation.
  - Depth to groundwater for dewatering consideration.
- Rastus Burn feasibility study completed to confirm the maximum incoming flowrate and velocity for selected system.
- Confirmation of expected by-wash volumes from the Doolans facilities for freeze protection.

- Confirmation from NZSki on the expected level of automation of the wastewater systems, including automation for the new WW resource consent.
- Wastewater meter readings and occupancy numbers for 2015-2021 and 2023-2024.
- Confirmation when access to empty tanks with a sucker truck is possible. E.g. December through to March via access road.
- NZSki's sensitivity to odour along wastewater main route and any requirements for odour control systems.

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