Attachment (f)

MWH

BUILDING A BETTER WORLD

Millbrook Resort Zone - Dalgleish Farm Extension

Prepared for Millbrook Resort

February 2015

QUALITY STATEMENT

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Millbrook Resort

Millbrook Resort Zone - Dalgleish Farm Extension

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1 Introduction

1.1 Purpose of Report

This engineering assessment has been prepared to support the application by Millbrook Country Club Ltd for an extension to the Millbrook Resort Zone to allow residential development of land (known as Dalgleish Farm) at the western end of Millbrook Resort.

The report addresses the feasibility of developing the Dalgleish Farm site and servicing residential development in this area. This has been based on a notional concept for the development comprising of approximately 50 residential units and 9 holes of golf.

The assessment addresses all engineering issues including road access, water supply for the properties, wastewater collection, surface water runoff and flood risk. This assessment includes the need for new services as required to service the developments in compliance with the Queenstown Lakes District Councils (QLDC) Proposed District Plan and Subdivision Standards. Infrastructure constructed for Millbrook West is generally intended to be retained in the ownership of Millbrook Infrastructure Company Ltd, a company wholly owned by Millbrook Country Club Ltd.

1.2 Background

The area of the proposed Dalgeish Farm extension to the Millbrook Resort Zone lies on the south side of Malaghans Road, immediately to the west of the existing Millbrook Resort. The area to be rezoned is approximately 66.8 hectares.

A development concept has been prepared (see Appendix 1) for this area. This concept allows for approximately 50 residential units within an area of 9 golf holes, and has been used as the basis of the assessment. However, this assessment is equally applicable to alternative developments of a similar scale.

The area of the proposed plan change is currently zoned as Rural General and is un-serviced by reticulated infrastructure. The existing house in on Dalgleish Farm is serviced by bore water and on-site sewage treatment and disposal.

Development of this land will require that new infrastructure be established.

In general, services are available at the boundary of the Dalgleish Farm area as a result of the works completed for earlier stages of Millbrook West. Infrastructure installed for previous stages of Millbrook West also caters for future stages of the Millbrook West development, and includes sufficient capacity for the proposed development of Dalgleish Farm. Development of Dalgleish Farm can be serviced by infrastructure being extended into the extended zone.

1.3 Development Size

The following table summarises the size of the established Millbrook Resort in terms of equivalent residential units, including consented stages of the Millbrook West development. These unit numbers were used in assessing the impact of Millbrook West on existing infrastructure, particularly water supply and wastewater infrastructure already serving Millbrook.

Table 1-1 : Established Millbrook Resort

Description	Unit type	Number of equivalent residential units
Residential Dwellings in the foundation resort, east of resort facilities	Hotel Villas	48
	Cottages	58
	Existing Homes (including Streamside)	45
Visitor Accommodation (equivalent residential units for water and wastewater demand)	Village Inn (51 accommodation units with no kitchen or laundry)	20
Resort Facilities (equivalent residential units for water and wastewater demand)	Hotel and resort operation (including allowance for staff)	6
	Restaurants and bars	25
	Health and Fitness Centre	9
	Spa	2
	Golf Operations	10
Millbrook West	Stage 1 Residential lots	59
	Stage 2B Residential lots	9
	Stage 2A Residential lots (consented but not constructed)	4
	Stage 3A Residential lots	20
	Stage 3B Residential lots(consented and under construction)	23
Total Existing Equivalent Lots		**338**

The following allowance was made for further residential units when assessing the infrastructure needs for future stages of Millbrook West.

Table 1-2 : Potential Future Development of Millbrook Resort (Millbrook West)

Description	Number of residential units
Millbrook West Stage 3C	15
Millbrook West Area A	23
Millbrook West Area D	59
Potential future development, including contingency	82
Total Estimated Equivalent Future Lots	**179**

These numbers of residential units are a prudent estimate of the potential infrastructure demand for the purposes of planning at this time. Only the units in the existing development and the proposed Stage 3C are confirmed numbers.

Millbrook Country Club has two agreements in place with QLDC for the supply of water and for the disposal of waste water for 5,000 day and night visitors at the Resort, without further headworks fees.

This substantially exceeds estimated potential dwelling occupants, village inn guests and day visitor numbers.

The proposed development on Dalgleish Farm is within the allowance for possible future development (82 lots) used for planning and providing services to Millbrook West. There is capacity within the infrastructure provided for Millbrook West to service the residential development proposed for Dalgleish Farm, subject to suitable extension of infrastructure.

1.4 Summary of Feasibility of Services

Servicing of the development of Dalgleish Farm is feasible as follows:

- Potable and fire fighting water supply connected to the existing Arrowtown reticulated supply via Millbrook Resort
- Irrigation water supply from the Arrow Irrigation Company
- Wastewater pumped or gravity fed to existing pump stations in Arrowtown's wastewater network, via Millbrook Resort
- Surface water drainage to Mill Creek
- Road access from Malaghan Road and Streamside Land in Millbrook West.

These means of servicing are further detailed in the relevant sections of this report.

2 Water Supply

2.1 Existing Potable Water Supply Infrastructure

There is an existing water supply for the Millbrook Resort, commissioned in 1996, from the QLDC Arrowtown public water supply reservoir. The pipeline from Arrowtown comprises approximately 2km of 225mm-diameter uPVC main direct from the Arrowtown reservoir. The main runs from the reservoir along Durham and Berkshire Streets, onto the Lake Hayes-Arrowtown Road and enters the resort via Butel Road. The main reduces to 200mm diameter at the intersection of Butel Road and Orchard Hill Road, inside the resort. Reticulation mains varying from 200mm diameter to 50mm diameter are used within the established resort to service properties and facilities there.

Millbrook West is serviced by connection from the existing 200mm diameter trunk main near to the spa at the western end of the main resort area.

2.2 Potable Water Network Capacity

Analysis of the capacity of the water supply in Millbrook Resort to service the Millbrook West development was initially done in 2006. This showed that initial stages of Millbrook West could be supplied from the existing supply without upgrade. The results of the 2006 modelling can be summarised as follows:

- The 223 lots (including equivalents) established at Millbrook Resort at the time had adequate residual peak hour pressure and Class W3 fire flow
- The modelling showed that 159 new lots of the Millbrook West development could be connected to the existing water supply network and still meet the minimum peak hour pressure of 300kPa and Class W3 fire flows, without any upgrade to the existing Millbrook Resort infrastructure.

After completion of approximately 100 lots in Stages 1 to 3A, Tonkin and Taylor Ltd (T&T) were engaged in 2013 to check the levels of service for the proposed Millbrook development. This modelling was initially carried out to determine the implications of the addition of 23 lots in Stage 3B to the existing Millbrook West Development. Findings of the modelling are recorded in their report entitled *Results of water modelling for Millbrook Resort, Arrowtown, dated 11th October 2013, T&T reference 51557.005* (included in Appendix 2*)*. Their report takes into account the entire 294 lot proposed Millbrook West development, including contingencies and potential future development not already part of the Millbrook West concept. This effectively includes capacity sufficient for the proposed development of Dalgleish Farm.

The following modelling acceptance criteria were adopted:

- Pressure during the Peak Hour Demand period is ≥ 300kPa to meet Queenstown Lakes District Council (QLDC) amendments and modifications to NZS 4404:2004
- Class FW2 fire flow is available to meet the New Zealand Fire Service Fire Fighting Water Supplies Code of Practice, SNZ PAS 4509:2008 for non-sprinkled structures for housing, including single family dwellings, multi-unit dwellings, but excludes multi-storey apartment blocks as contained in table 1 of the code.

The demand for the entire Millbrook West development was added into the network analysis model for Arrowtown. T&T calculated this demand as 294 lots with 3 people per lot using 700 litres each day. The demand criterion for the reticulation during modelling was the following based on QLDC's amendments and modifications to NZS 4404:2004:

- Peak Hour Flow = 6.6 x Average Daily Flow (ADF) to meet the 300kPa minimum pressure at peak hour flow
- Peak Day Demand = 3.3 x ADF, to meet Class FW2 fire flow and 100kPa minimum residual pressure at the hydrant.

The demand condition used for the reticulation during fire flow modelling is 3.3 x ADF which equates to the peak daily flow. Fire flow requirements are in accordance with the New Zealand Fire Service Fire Fighting Water Supplies Code of Practice, SNZ PAS 4509:2008.

The T&T modelling shows that upgrades are required to the Millbrook Resort water reticulation network to meet fire flow requirements and the QLDC's requirement for minimum pressures being ≥ 300kPa within the proposed Stage 3B development and subsequent stages. Pressure levels of service will otherwise not be met within Stage 3B, and any dwellings above 425m at location JP-2b.

A number of potential upgrades were proposed in the report, of which Millbrook Resort chose to utilise a booster pump station to raise the levels of service to the accepted standard. This booster pump station is to be located at node JP-1 on the T&T model, adjacent to the Millbrook Spa.

2.3 Water Supply to Dalgleish Farm

Millbrook again engaged T&T to undertake the modelling to determine the operating points for the booster pump station adjacent to the Millbrook Spa and the design philosophy for the network to enable the design levels of service to be met within the full potential Millbrook West Development, including Dalgleish Farm. Their report is appended and entitled *Water supply modelling for booster station design for Millbrook Resort, Arrowtown, dated 27th May 2014 T&T reference 51557.005*.

The ground elevations to which water would be supplied within Dalgleish Farm is significantly higher and more distant than the area of the existing Millbrook Resort Zone. Initial analysis for the proposed booster pump adjacent to Millbrook Spa showed that the head to which the pump station would need to operate to also service the Dalgleish Farm would be significantly increased, and would breach the permitted QLDC maximum pressure of 900kPa. Therefore, if Dalgleish Farm is developed in the future to the west of Millbrook's existing boundaries then a second booster pump station will be required so that QLDC's maximum allowable water network pressure of 900kPa is not breached.

The second booster pump station would likely be nominally located at JP-5b2, in the vicinity the lower areas of Dalgleish Farm. Modelling has included the flows required to all areas on the suction side of the proposed second pump station in that vicinity to meet the required levels of service.

Design is being completed for the booster pump station adjacent to the Millbrook Spa. The operating and duty points for this pump station includes providing sufficient flows beyond the Millbrook boundaries and Millbrook Resort Zone, but supplying sufficient pressures only to the elevation of the proposed location of any second booster pump station.

A second pump station will then be required to service Dalgleish Farm if that is developed for housing.

2.4 Potable Water Distribution

There are three feasible options for potable and fire fighting water supply within the Dalgleish Farm:

1. Booster pump station at the lower level of Dalgleish Farm, supplying piped reticulation mains to the residential areas, including 100mm or 150mm diameter primary fire fighting mains and 50mm diameter rider mains
2. A lift pump station at the lower level of Dalgleish Farm, supplying a high level reservoir that in turn supplies piped reticulation mains to the residential areas, including 100mm or 150mm diameter primary fire fighting mains and 50mm diameter rider mains
3. A lift pump station at the lower level of Dalgleish Farm, supplying on-site storage reservoirs for residential lots that carry storage for fire fighting use and for domestic use.

It is anticipated that the Option 1 for a supply pressurised by a booster pump station would be adopted to best suit the development proposed.

2.5 Non-potable Water Supply for Irrigation

Millbrook Resort is able to obtain irrigation water from the Arrow Irrigation Scheme under water rights in place to supply 558million litres of water per annum (based on a right to 62 hectares of water, 900mm deep).

Current demand for irrigation water is 120million litres per annum to irrigate the resort and 27 holes of golf. There is therefore adequate additional supply of irrigation water to irrigate the new 9-hole golf course and landscaped open spaces on Dalgleish Farm. The Arrow Irrigation Scheme crosses Dalgleish Farm and new irrigation systems can be constructed to distribute water to the new development.

2.6 Conclusion

In conclusion, housing development on Dalgleish Farm will be able to be serviced for water supply from the existing network in Millbrook following completion of the upgrade to the existing supply with a booster pump station serving Millbrook West and a second pump serving Dalgleish Farm.

3 Wastewater Collection and Disposal

3.1 Overview

The Millbrook development has a network of collection sewers that drain to a pumping station located near to the former 18th green (now called the Arrow #9 green) and the Millbrook Village. Sewage is pumped from here via a 150mm diameter rising main that discharges to a QLDC sewer in Lake Hayes Road near to the southern boundary of Millbrook.

The existing pumping station was intended at the time of its design to cater for the full potential development of Millbrook, with allowance for 5000 day and night visitors. The pumping station was constructed with a blanked inlet connection under the 18th fairway for extension to the Millbrook West area.

Assessment of the feasibility of servicing Dalgleish Farm for wastewater is therefore based on:

- The capacity of the existing pumping system and the need for any upgrade
- The extension of piped reticulation into the Dalgleish Farm area.

3.2 Estimated Wastewater Generation

The wastewater volume that will be generated from a residential development is usually estimated based on an assumed 2.5 people per dwelling and generation of 250 litres of wastewater per person per day. In new residential subdivisions such as Millbrook with a new sewer network constructed with modern materials, infiltration is usually very small so that there is very little increase in wastewater flow as a result of wet weather. It would therefore be expected that the average volume of wastewater that would be generated by the completed Millbrook West development (including contingency) of 294 lots would be about 184m^3/d.

However, Queenstown Lakes District Council specifies the following design parameters for residential subdivisions in the district:

- An occupancy of 3.5 persons
- A sewage generation of 300L/person/day
- A dry weather diurnal peak flow factor of 2.5
- A dilution/infiltration factor of 2 for wet weather.

Based on these parameters the Average Daily Flow (ADF) of wastewater generated by the completed Millbrook West development (including contingency) of 294 lots would be about 309m^3/d – or 3.6 l/s. In wet weather during peak flow periods, the flow will peak at 64m^3/hour, or 18 l/s.

Accordingly, allowance is made for daily peaks and potential infiltration in the detailed design of the sewerage system (pumps, sewers, wet wells and rising main design). Below are tables which have figures for the ADF and Peak Wet Weather Flow (PWWF) for the existing development, and for future stages of Millbrook West.

Table 3-1 : Millbrook Resort Foul Water Flow to Pump Station

Area	Lot Equivalent	ADF (cum/day)	Wet Weather Peak Flow (l/s)
Current Committed Development Proposals:			
Foundation Resort + Millbrook West Stage 1 + Stage 2 + Stage 3A + Stage 3B + Stage 3C	353	370	21.5
Future Development:			
Foundation Resort + Full Millbrook West Development	435	454	26.3
Foundation Resort + Full Millbrook West Development + Contingency	517	542	31

The wastewater generated by the full resort development when complete is up to 26.3 l/s in peak periods during wet weather as shown in Table 3-1 above.

3.3 Existing Wastewater Pumping System

The existing wastewater pumping station at Millbrook Village consists of two pumps in a duty/standby arrangement. The pumps are ABS Model AFP1001M220/4-42 rated at 25kW at 2800rpm. The data for the wastewater system flow is in Table 3-2 below:

Table 3-2 : Pump Station Data

Name	Data
Rising Main diameter	150mm
Rising main length	1284m
Gravity main diameter	150mm
Gravity Main length	170m
Gravity Main Grade	1/30
Static Head	14m
Friction Head (at design flow of 28 l/s)	16.5m
Total Head	30.5m

The capacity of the pumps has been calculated from the manufacturers pump curves. A duty point and system curve is attached as Appendix 3 for the above data. It shows that the two pumps can pump a flow of 28 l/s as a maximum flow for the present system in a duty-assist arrangement.

The 28 l/s pump capacity is well in excess of the flow of 21.5 l/s from the existing committed development. It is adequate for a flow in excess of that from the entire future Millbrook West development flow of 26.3 l/s. However, the existing pumps may need to be upgraded if all development proceeds as allowed for, including all potential future development and contingency. Such an upgrade is feasible, and may include changes to pump controls and additional storage if needed.

The capacity of the gravity main at the outlet of the rising main (running full) from Wallingford Charts is 43 l/s and as such does not need to be upgraded.

3.4 Wastewater Reticulation to Dalgleish Farm

Sufficient additional capacity has been provided in the pipe network in Millbrook West to convey wastewater flows from Dalgleish Farm to the pump station at Millbrook Village. As part of that network, a pump station is currently being designed adjacent to the Millbrook West Stage 3B area that is currently under construction. This pump station can also serve future Millbrook West development further to the west and it will include additional capacity that can provide for Dalgleish Farm.

All areas of the Dalgleish Farm development are not able to drain by gravity sewer to the existing reticulation constructed as part of earlier stages of Millbrook West. A second pump station will be required at the lower levels of Dalgleish Farm to lift sewage from those areas to the pump station near Stage 3B.

Higher areas of Dalgleish Farm are able to drain by gravity sewer to the existing reticulation in Millbrook West or to the additional pump station in the lower area of Dalgleish Farm, as best suits the final layout of any development.

A network of gravity pipes can be provided to collect wastewater from all properties in the Dalgleish development. The actual layout and design details would be set to the requirements of later detailed design. Pipe sizes will be 150mm diameter. The rolling profile of the topography of Dalgleish Farm means that there may be some local low-points within a development there that may require additional pump stations to supplement this gravity network.

Alternative sewer systems are also feasible and may be appropriate depending on the final development proposals. This could include pressure sewer systems, where a small pump station on each property discharges to small diameter pumping mains.

3.5 Conclusion

The proposed housing developed on Dalgleish Farm will be able to be serviced for wastewater disposal using gravity and pumped systems discharging to the reticulation network in Millbrook West. Upgrade of the pumps in the existing wastewater pumping station at Millbrook Village may be needed in the future if all development within Millbrook Resort Zone proceeds as proposed.

4 Drainage and Flood Mitigation

4.1 Surface Water Drainage Overview

The Dalgleish Farm site lies on an east-west aligned valley and ridge comprising three main parts:

- On the northern portion, lower level areas of Mill Creek and adjacent floodplain and alluvial fans, with low to moderate gradient slopes
- On the southern portion, an elevated irregular platform approximately 75-100m above Mill Creek, with moderately sloping ridge and ephemeral stream features
- Areas of steeper slopes occur on the valley flanks between these two parts.

The majority of the site drains to Mill Creek. The exception is a very small area on the southern boundary of the property that lies at the head of south-facing slopes.

The area of Dalgleish Farm is approximately 67 hectares and the area of Millbrook West is 90 hectares. The area of the Mill Creek catchment at Millbrook Village is approximately 2550 hectares.

A comprehensive concept for stormwater management has been developed as part of Millbrook West. Surface water drainage from Dalgleish Farm can be managed in accordance with that concept. This comprises a pipe and surface channel system to collect and drain water from the development that as far as possible follows the existing overland drainage patterns. The drainage system is overland as much as possible. This approach makes best use of the natural features of the site, as well as providing means to limit peak runoff and to treat potential contaminants in the stormwater runoff. The main components of the Millbrook West drainage patterns are as follows:

- Drainage of roads to surface swales. These swales are be drained by sumps and pipe connections to surface water channels, or directly to those surface water channels if possible
- Access lanes to lots and courtyard areas adjacent to houses are drained to kerb and channel or swales and to sumps, with pipe connections to surface water channels
- Building platforms are provided with a connection to a piped collection system. Pipelines will discharge to surface water channels
- Drainage is to the ephemeral gullies that drain through the golf course areas to ultimately discharge to Mill Creek. Some soakage to ground will occur in swales.

These systems for drainage patterns and stormwater management, discharges of stormwater are expected to comply with the requirements for a Permitted Activity under the *Regional Plan – Water* and therefore consents from Otago Regional Council for stormwater discharges are not likely to be required.

4.2 Potential Increase in Peak Runoff

The development of roads and residential areas will have a potential increase in stormwater runoff as a result of a decrease of site permeability if no other controls were in place. However, the use of surface drainage swales, landscaping and stormwater ponds, and in channel controls will mitigate the increase in peak flows.

A small area of Dalgleish Farm drains towards the south to neighbouring pasture. Runoff from roofs and developed areas here can either be directed northwards to the stormwater systems on the balance of the Farm that drain to Mill Creek, or to detention areas prior to discharge to the south.

The 67 hectares of the Dalgleish Farm area is approximately 2.6% of the total catchment of 2550 hectares for Mill Creek at Millbrook, but the area of development for roads and housing is less than 0.5% of the Mill Creek catchment. Any potential increase in peak discharge to Mill Creek will be minimal because the upstream catchment runoffs are far greater and peak flows from the developed area are mitigated by the on-site stormwater controls.

The potential effects on flood risk downstream on surrounding land or in Mill Creek are therefore minimal.

4.3 Stormwater Quality

The stormwater system can incorporate provisions to trap potential contaminants prior to discharge to Mill Creek. This can be based on:

- Swale drains and overland flowpaths as the primary means of stormwater collection and conveyance of road areas
- Small local wetlands and ponding areas as part of the landscaping along the main overland flow paths
- Landscaping ponds in the golf course
- Sumps in courtyard areas at entrances to garages and residences.

There are no areas of high risk as a source of major contamination within the proposed development.

4.4 Flood Risk

The majority of proposed building sites are located in areas in the southern part of Dalgleish Farm that are elevated on slopes above overland flow paths, and are outside any area of potential flood risk.

Approximately 6 building lots are proposed in areas of potential flood risk on the south side of Mill Creek. Building platforms in these locations may need to be constructed so that they are elevated slightly to be above peak flood levels. The creek in this vicinity has low banks (in comparison to other reaches downstream in Millbrook Resort); some improvement of the channel profile would therefore also assist in reducing the potential for flooding of adjacent areas. The proposed development plan includes adequate areas as golf course or open space that are available to ensure normal and peak flows can be safely passed outside the areas proposed for residential use. This is described further in Section 4.5.

The nature of any works in Mill Creek and the adjacent flood plain would be similar to those already undertaken as part of the Millbrook West area, and it is therefore expected that construction works of a similar type could be undertaken with minimal environmental impact.

Two ephemeral stream paths terminate in alluvial fans on the right bank of Mill Creek in the vicinity of proposed building sites. To mitigate flood risk to the adjacent building sites, it will be necessary to provide a defined channel for these ephemeral flows and ensure that the building platforms are elevated above peak flows.

4.5 Mill Creek Catchment

The Mill Creek catchment takes in the southern slopes of the mountain range that includes Coronet Peak and the upper part of the downlands between Arrowtown and the Shotover River. The catchment above the Millbrook Resort site includes the steep tussock covered and forested slopes of the Coronet Peak range. The steep upper slopes drain to a relatively flat valley containing Mill Creek where land is predominantly used for farming.

It is not expected that the runoff characteristics of the catchment will change significantly over the next 50 years. The District Plan of Queenstown Lakes District Council sees current land uses in the area essentially maintained.

4.5.1 Hydrological Records

The hydrological data for this report is based on reports by others, which use statistical analysis and interpretation of 12 years of data from the Otago Regional Council (ORC), for the local ORC water level recording station (WLR). These records are at the WLR site downstream of Millbrook, which is commonly referred to as the 'fishtrap'. These records are contained in Appendix 4 in the form of a letter from the ORC. The part of the Mill Creek catchment contributing to Mill Creek at the Millbrook Resort site is 71% of the total 'fishtrap'catchment.

4.5.2 Flood Return Period Estimates

The flood flows for the respective return periods provided by the ORC have been adjusted for the catchment area contributing to the Millbrook Resort site and are presented in Table 4.1 below. The area downstream of the Millbrook West development, developed as part of Millbrook Resort (known as the Village Inn Waterway, built to Water Permit (WP) No 3804) and the realignment of Mill Creek, and new bridges and culverts in Millbrook West immediately to the east of Dalgleish Farm have all been designed to accommodate these flows.

Table 4-1: Mill Creek Hydrological Data Adjusted for the Millbrook Resort Site

Dry Weather Flows	Magnitude (cum/s)
100 year ARI flow	6.6
50 year ARI flow	5.9
2 year ARI flow	2.5

Notes
1. Flow at site = 0.71 x Flow at the WLR site (fishtrap)
2. Appendix 4 contains data for the WLR site (fishtrap)

4.5.3 Functional Requirements for Mill Creek Waterway

The realigned channel of Mill Creek adjacent to the Coronet Nine 6th Hole, immediately to the east of Dalgleish Farm, was designed to accommodate the 100-year ARI design storm flow of 6.6 cum/sec at an average grade of 1 in 600. This required an average 'wetted' channel cross section of 4.9 square metres. In a very basic form this equates to a channel of 6m width and 1.7m depth (including freeboard) as shown in the following figure.

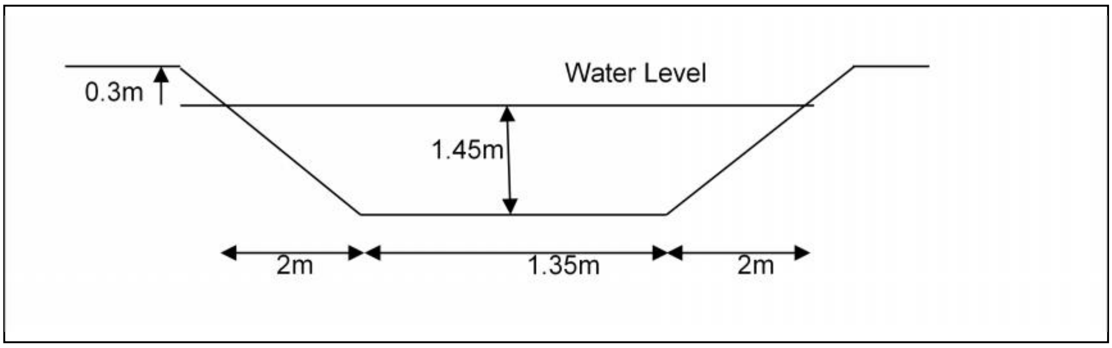


Figure 4.1: Basic Channel geometry required to flow 100 year ARI design storm at 1/600 grade

The channel itself is not exactly trapezoidal as shown, as its geometry has been formed to be more that of a natural waterway and to vary along the alignment. A similar channel can be ensured in Dalgleish Farm.

4.6 Conclusion

Satisfactory stormwater drainage for the proposed Dalgleish Farm development is feasible. Similar stormwater management approaches to those already adopted for Millbrook West are suitable for adoption on this site.

There are potential flood risks in areas adjacent to Mill Creek. These are able to be mitigated by design of appropriate design of building platform locations and levels, stream channels and flood channels. Final concepts will need to be determined in detailed design.

5 Roads

5.1 Access Roads in Dalgleish Farm

Access to the site is available from roads in Millbrook West.

The main road to the high level sites on the southern part of Dalgleish Farm is proposed to follow an existing farm track. The gradients on this track are suitable for permanent road access, and a road in accordance with QLDC standards can be constructed on this route.

The road alignment proposed to the western-most part of the proposed development crosses a steep sided gully. A suitable road can be constructed here as an embankment fill, with an embankment height of the order of 7-10metres as necessary to match adjacent final ground levels.

5.2 Site Entrance from Malaghan Road

Access is proposed from a new road off Streamside Lane which has an entrance off Malaghan Road at the western end of the existing Millbrook development. The intersection at Malaghan Road has been designed and constructed in accordance with Diagram 4 of Appendix 7 of the Operative District Plan. This design is also applicable as access for Dalgleish Farm as well as the remainder of Millbrook West.

Sight distances have been measured at the entrance location. Measured sight distances are as follows:

- To the west (Queenstown) – 500metres
- To the east (Arrowtown) – 405metres.

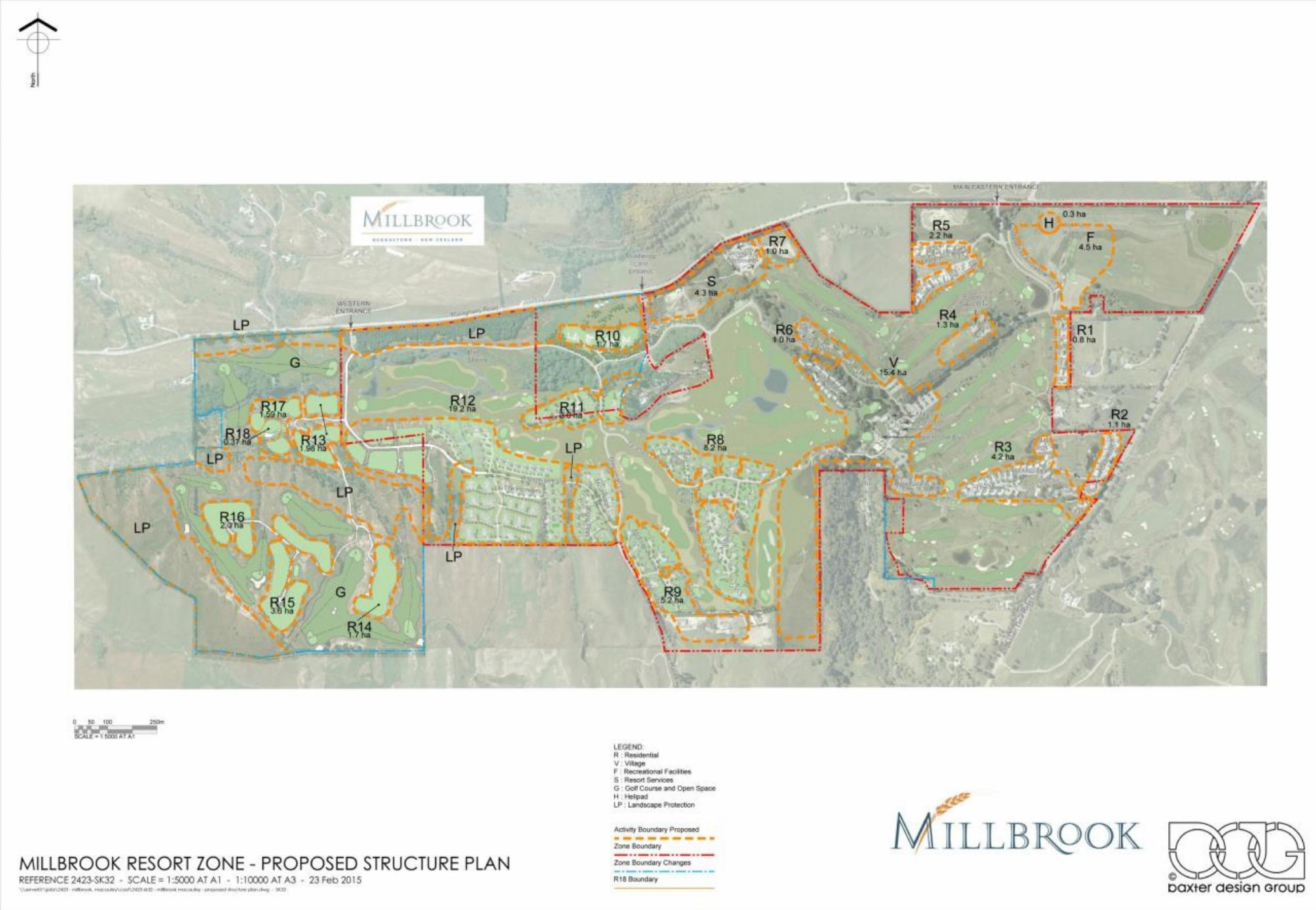
The requirements for sight distances set out in the Operative District Plan are therefore achieved.

6 Liquefaction Risk

QLDC hazards register records indicate that there are some areas of Dalgleish Farm that fall within a zone of “Probably Low Risk” for liquefaction hazard in a seismic event (Liquefaction Category LIC 1 (P)). Site investigations are required to confirm whether this is the case.

Investigation of the potential for liquefaction, and subsequent design against this risk is a relatively straightforward process. Should site investigations confirm that a risk of liquefaction exists, then that risk can be engineered out with some certainty. This is a site-specific design issue, where the precise locations for the proposed dwellings, size of the structures and nature of the foundations all play a factor in the choice of associated remedial and foundation options. This potential for liquefaction must be addressed at building consent stage.

Appendix 1 Dalgleish Farm – Proposed Structure Plan


North
MILLBROOK
WESTERN ENTRANCE
MAIN EASTERN ENTRANCE
LP
G
R17
1.59 ha
R18
0.37 ha
R13
1.98 ha
R12
19.2 ha
R10
1.7 ha
R11
3.6 ha
S
4.3 ha
R7
1.0 ha
R6
1.0 ha
V
15.4 ha
R8
8.2 ha
R9
5.2 ha
R16
2.0 ha
R15
3.6 ha
R14
1.7 ha
R5
2.2 ha
H
0.3 ha
F
4.5 ha
R4
1.3 ha
R1
0.8 ha
R2
1.1 ha
R3
4.2 ha
0 50 100 250m
SCALE = 1:5000 AT A1
LEGEND:
R : Residential
V : Village
F : Recreational Facilities
S : Resort Services
G : Golf Course and Open Space
H : Helipad
LP : Landscape Protection
Activity Boundary Proposed
Zone Boundary
Zone Boundary Changes
R18 Boundary
MILLBROOK RESORT ZONE - PROPOSED STRUCTURE PLAN
REFERENCE 2423-SK32 - SCALE = 1:5000 AT A1 - 1:10000 AT A3 - 23 Feb 2015
baxter design group

Appendix 2 Tonkin & Taylor Water Supply Modelling Reports

Tonkin & Taylor

Fax

To:	MWH New Zealand Ltd	**Your fax no:**	03 477 0616
Attention:	James Cramer Roberts	**T&T job no:**	50620.078
From:	Simon Rodwell	**Reply fax no:**	03 353 4401
Page:	1 of 8	**Date:**	01 Sep 2006
Subject:	Water Modelling for proposed 294 lots, Millbrook Resort, (Land to the West Dev.)		

James, following the email we received from you, 22 August 2006, and in accordance with your request and our conditions of engagement, we have completed the water supply modelling with regard to checking residual pressures and availability of Class W3 fire flow at the proposed 294 Lot Land to the West Development, Millbrook Resort, Arrowtown.

The objective of the work was to carry out a preliminary pipe size design such that:

- Pressure during the Peak Hour Demand period is at least 300 kPa.
- Class W3 fire flow is available to meet the required Queenstown Lakes District Council standards.

Methodology

We have added the demand of the development into the Watercad network analysis model for Arrowtown 2006 and 2026, last updated February 2006. This was calculated by Tonkin & Taylor as 294 lots with 3 people per lot using 700 litres each a day. The average daily demand was allocated to nodes as set out in your Millbrook Potable Water Supply Lot Diagram, which we have attached to this report. The existing number of lots or lot equivalents is around 223 giving a fully developed Millbrook Resort with around 517 lots.

The resulting Average Daily Flows (ADF) of 294 lots is 7.15 l/s was calculated and applied to the model.

The model was run for four scenarios:

- A). Existing Millbrook Resort with 223 Lot equivalents, existing water pipes (ADF of 5.42 l/s).
- B). Up to Node 4b, 382 lots for Millbrook Resort without trunk main or booster pump upgrades.
- C). Proposed Millbrook Resort with 517 Lot equivalents, no upgrades (ADF of 12.57 l/s).
- D). Proposed Millbrook Resort with 517 Lots, possible trunk main upgrades (ADF of 12.57 l/s).

The demand criterion for the Queenstown reticulation during modelling was: 6.6 x Average Daily Flow (ADF) to meet the 300 kPa minimum pressure and 3.3 x ADF, to meet Class W3 fire flow and 100 kPa minimum residual pressure at the hydrant.

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PO Box 13-055, Christchurch, Ph: 64-3-353 4400, Fax: 64-3-353 4401, Email: chch@tonkin.co.nz, Website: www.tonkin.co.nz

The demand condition used for the Queenstown reticulation during fire flow modelling is 3.3 x ADF which equates to the peak daily flow. Fire flow requirements are in accordance with the New Zealand Fire Service Fire Fighting Water Supplies Code of Practice, SNZ PAS 4509:2003.

Results

The results are shown below in Tables 1 & 2 and in the figures attached to this document.

Summary of figures:

i. Figures 1 & 2 – Site location plan Revision 0 Sep 06

Table 1 – Availability of Peak Hour Pressure s

Scenario Peak Hour Demand:	A) Existing 223 Lot Equivalents Residual Pressure (kPa)	B) 382 Lots – up to Node JP 4b - no upgrades. Residual Pressure (kPa)	C) Proposed 517 Lots – no upgrades Residual Pressure (kPa)	D) Proposed 517 Lots – trunk main upgrade. Residual Pressure (kPa)
Node J-71	598 > 300 OK	579 > 300 OK	400 > 300	579 > 300
Node J-74	510 > 300 OK	491 > 300 OK	312 > 300	491 > 300
Node J-105	454 > 300 OK	435 > 300 OK	256 needs booster	435 > 300
Node J-107	455 > 300 OK	435 > 300 OK	257 needs booster	435 > 300
Node J-108	454 > 300 OK	435 > 300 OK	256 needs booster	435 > 300
Node J-109	592 > 300 OK	541 > 300 OK	251 needs booster	541 > 300
Node J-110	635 > 300 OK	589 > 300 OK	324 > 300	589 > 300
Node J-114	615 > 300 OK	558 > 300 OK	293 needs booster	558 > 300
Node J-115	614 > 300 OK	557 > 300 OK	293 needs booster	557 > 300
Node J-116	615 > 300 OK	569 > 300 OK	304 > 300	569 > 300
Node J-117	558 > 300 OK	507 > 300 OK	217 needs booster	507 > 300
Node J-118	614 > 300 OK	557 > 300 OK	293 needs booster	557 > 300
Node J-980	616 > 300 OK	571 > 300 OK	310 > 300	571 > 300
Node JP-1	NA	493 > 300 OK	203 needs booster	493 > 300
Node JP-1a	NA	410 > 300 OK	119 needs booster	410 > 300
Node JP-1b	NA	337 > 300 OK	46 needs booster	337 > 300
Node JP-2	NA	453 > 300 OK	186 needs booster	476 > 300
Node JP-2a	NA	329 > 300 OK	61 needs booster	352 > 300
Node JP-2b	NA	309 > 300 OK	41 needs booster	331 > 300
Node JP-3	NA	420 > 300 OK	152 needs booster	442 > 300
Node JP-4	NA	383 > 300 OK	115 needs booster	405 > 300
Node JP-4a	NA	378 > 300 OK	111 needs booster	401 > 300
Node JP-4b	NA	397 > 300 OK	130 needs booster	420 > 300
Node JP-5	NA	NA	-2 needs booster	288 needs booster
Node JP-5a	NA	NA	58 needs booster	348 > 300
Node JP-5b	NA	NA	-35 needs booster	254 needs booster
Node JP-5c	NA	NA	-166 needs booster	123 needs booster
Node JP-5d	NA	NA	-50 needs booster	239 needs booster
Node JP-6	NA	NA	-68 needs booster	222 needs booster

Refer to Figures 1 & 2 for node locations.

Table 2 – Availability of Class W3 Fire Flow (25l/s)				
Scenario **Peak Day Demand:**	**A) Existing 223 Lot Equivalents Residual Pressure (kPa)**	**B) 382 Lots – up to Node JP 4b - no upgrades. Residual Pressure (kPa)**	**C) Proposed 517 Lots – no upgrades Residual Pressure (kPa)**	**D) Proposed 517 Lots – trunk main upgrade. Residual Pressure (kPa)**
Node JP-1	NA	377 > 100	321 > 100	529 > 100
Node JP-1a	NA	219 > 100	200 > 100	418 > 100
Node JP-1b	NA	10 needs loop	-50 needs loop	166 > 100
Node JP-2	NA	338 > 100	264 > 100	472 > 100
Node JP-2a	NA	40 needs loop	-32 needs loop	175 > 100
Node JP-2b	NA	-50 needs loop	-172 needs loop	75 needs loop
Node JP-3	NA	301 > 100	308 > 100	416 > 100
Node JP-4	NA	254 > 100	135 > 100	343 > 100
Node JP-4a	NA	153 > 100	34 needs booster	242 > 100
Node JP-4b	NA	101> 100	-63 needs booster	151 > 100
Node JP-5	NA	NA	-25 needs booster	226 > 100
Node JP-5a	NA	NA	8 needs booster	216 > 100
Node JP-5b	NA	NA	-370 needs booster	-162 needs booster
Node JP-5c	NA	NA	-628 needs booster	-420 needs booster
Node JP-5d	NA	NA	-542 needs booster	-334 needs booster
Node JP-6	NA	NA	-304 needs booster	-97 needs booster

Refer to Figure 1 for node locations.

A) The existing 223 lot equivalents at Millbrook resort have adequate residual peak hour pressure and Class W3 fire flow.

B) The modelling shows that the first 159 lots of the Land to the West development i.e. up to Node JP-4b could be connected to the existing water supply network and meet the minimum peak hour pressure of 300 kPa. However, to provide Class W3 fire flow to Nodes JP-1b, JP-2a and JP-2b an additional 100mm pipe is required between Nodes JP-1b and JP-2b

C) The results from the model indicate that the existing water supply network to Millbrook from Arrowtown can not provide sufficient peak hour pressure or Class W3 fire flow for the additional 294 lots proposed as part of the Land to the West development without upgrades. The extra peak hour flow demanded in a fully developed Land to the West will result in peak hour pressures dropping below 300 kPa effectively from Node J-71 onwards. A booster pump placed before Node J-71 could be designed to provide sufficient pressure during peak hour flows and fire flow to the proposed 517 lots.

D.) The modelling indicates that as an alternative to a booster pump at Node J-71 a trunk main upgrade from the Arrowtown Reservoir to Node J-109 comprising a 200mm diameter pipe and a booster pump at Node JP-5 would also provide adequate peak hour pressures and Class W3 fire flow.

Please note that the model is a numerical representation of the physical reality, and subsequently bears some uncertainty. The determination of demands and peaking factors involved assumptions regarding the patterns of water use in the township, and are an approximation of the physical reality.

T&T job no: 50620.078 4

We hope this answers your questions, if you wish to discuss these results please feel welcome to contact Simon Rodwell on 03 353 4400.

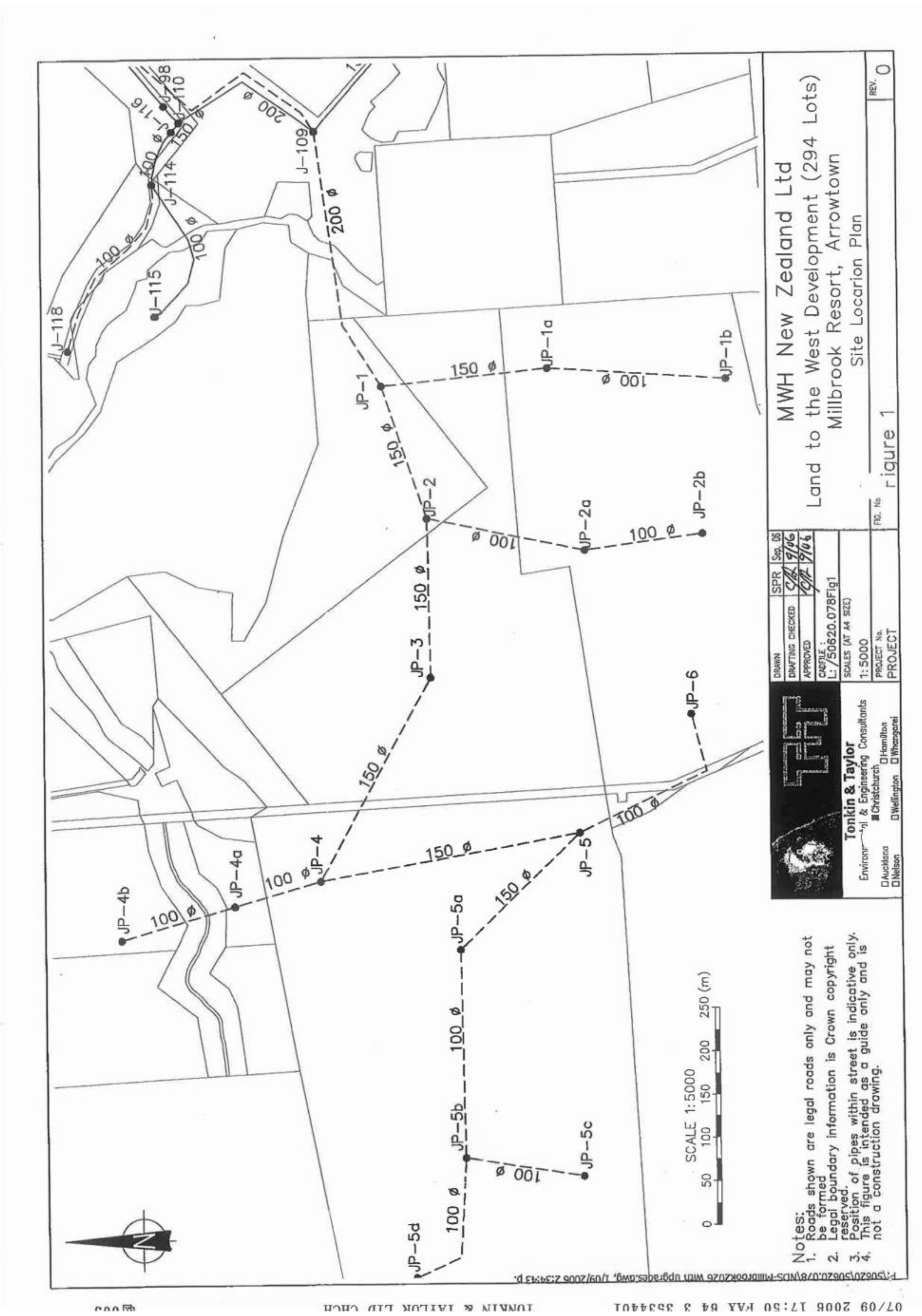
Yours faithfully,

TONKIN & TAYLOR LTD

Grant Lovell

CHRISTCHURCH GROUP MANAGER

07 September 2006 P:\50817\50817.005\spr-streamside-waterchk-fax2.doc


MWH New Zealand Ltd
Land to the West Development (294 Lots)
Millbrook Resort, Arrowtown
Site Locarion Plan
Figure 1
Tonkin & Taylor
SCALE 1:5000
0 50 100 150 200 250 (m)
Notes:
1. Roads shown are legal roads only and may not be formed
2. Legal boundary information is Crown copyright reserved.
3. Position of pipes within street is indicative only.
4. This figure is intended as a guide only and is not a construction drawing.
JP-1
JP-1a
JP-1b
JP-2
JP-2a
JP-2b
JP-3
JP-4
JP-4a
JP-4b
JP-5
JP-5a
JP-5b
JP-5c
JP-5d
JP-6
J-109
J-114
J-115
J-118
200 ø
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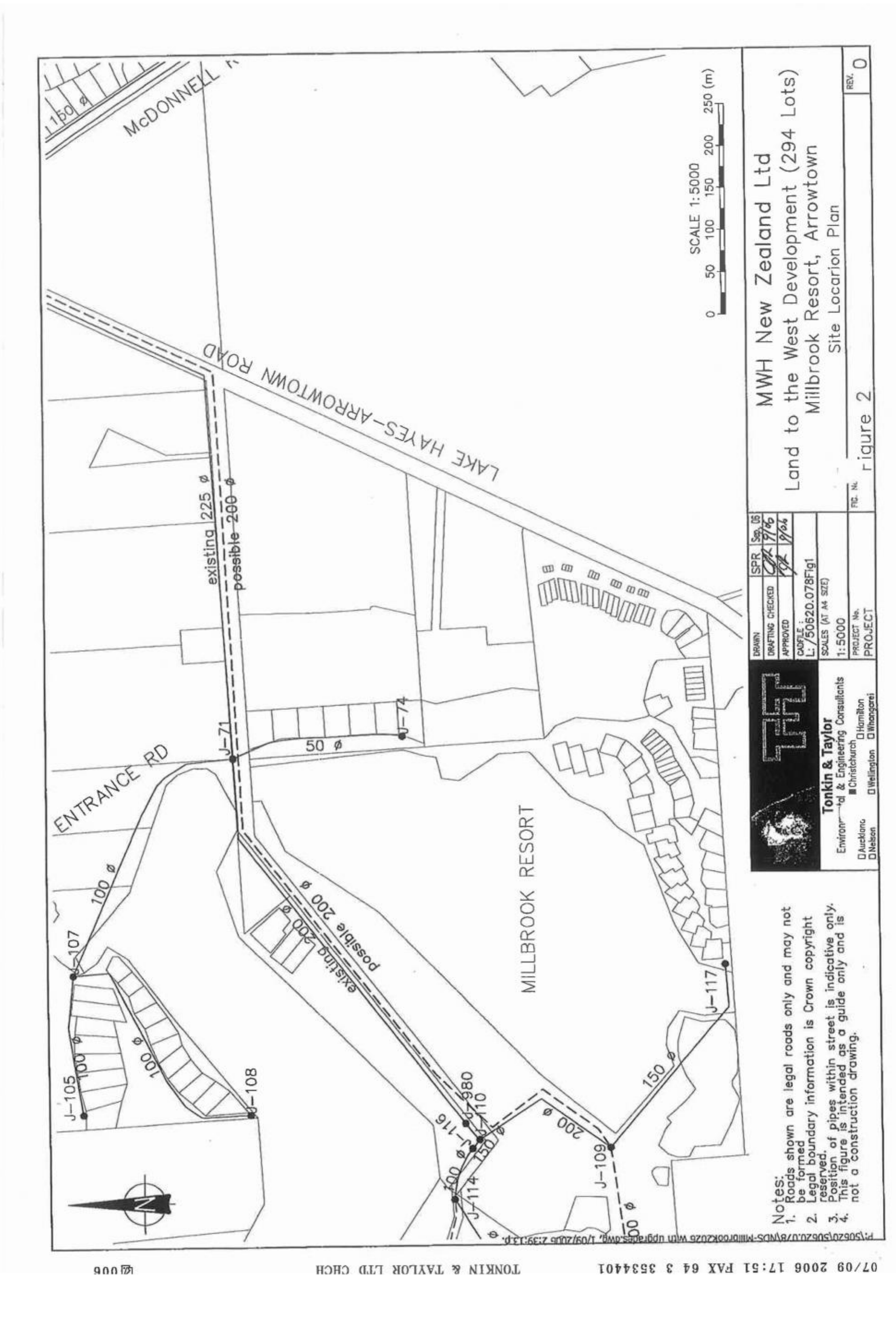
MWH New Zealand Ltd
Land to the West Development (294 Lots)
Millbrook Resort, Arrowtown
Site Locarion Plan
Figure 2
SCALE 1:5000
0 50 100 150 200 250 (m)
Tonkin & Taylor
Environmental & Engineering Consultants
1:5000
LAKE HAYES–ARROWTOWN ROAD
McDONNELL RD
ENTRANCE RD
MILLBROOK RESORT
existing 225 ø
possible 200 ø
existing 200 ø
possible 200 ø
50 ø
100 ø
150 ø
200 ø
J–71
J–74
J–105
J–107
J–108
J–109
J–110
J–114
J–116
J–117
Notes:
1. Roads shown are legal roads only and may not be formed
2. Legal boundary information is Crown copyright reserved.
3. Position of pipes within street is indicative only.
4. This figure is intended as a guide only and is not a construction drawing.
07/09 2006 17:51 FAX 64 3 3534401
TONKIN & TAYLOR LTD CHCH

Tonkin & Taylor

T&T Ref: 51557.005
11 October 2013

Millbrook Country Club Ltd.
c/- MWH New Zealand Ltd
265 Princes Street
Dunedin 9054

Attention: Peter White

Dear Peter

Results of water modelling for Millbrook Resort, Arrowtown

Following your email received 24 September, and in accordance with your request and our conditions of engagement, we have run our Arrowtown water supply model to check the levels of service for the proposed development at Millbrook Resort, Arrowtown. This work was performed for Millbrook Country Club Ltd as our client.

Modelling was initially carried out to check the implications of the addition 23 lots in Section 3B to the existing development, without the installation of the recommended upgrades outlined in the Water Modelling for proposed 294 lots, Millbrook Resort, (Land to the West Dev.), September 2006 report. Advice on the required reticulation in order to achieve levels of service within the development with the additional 20 lots in Stage 3B, and how the development should be further progressed on the basis of reticulation is outlined in the report below.

Modelling proceeded on the basis of the existing 315 lots in the proposed development, as detailed in the drawings provided by you (email dated 19/08/2013). The Arrowtown network around the development is shown in Figure 1, attached.

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PO Box 5271, Wellesley St, Auckland 1141, Ph: 64-9-355 6000, Fax: 64-9-307 0265, Email: auck@tonkin.co.nz, Website: www.tonkin.co.nz

Modelling methodology

The modelled demand scenarios used to determine levels of service for the Arrowtown water supply network were

- **Peak day demand** - To determine whether available fire flows meet fire fighting requirements [1], and
- **Peak hour demand** - To determine whether minimum residual pressures at each connection are ≥ 300 kPa [2]

Demands

The average daily flow (ADF) demand was calculated assuming an average population of. 3 people per residential dwelling and an average daily water consumption of i.e. 700 litres per person per day, as per Queenstown Lakes District Council requirements as per the 2006 report. Development demands during the peak day and peak hour demand scenarios were calculated as follows

- Peak day flow (PDF) = 3.3 x ADF
- Peak hour flow (PHF) = 6.6 x ADF

Table 1 Design demands for Arrowtown development

Development	Number of dwellings	Average daily flow (ADF)		Peak day flow (PDF)		Peak hour flow (PHF)	
		m^3/day	*l/sec*	m^3/day	*l/sec*	$m^3/hour$	*l/sec*
Existing	223	467	5.4	1550	17.9	128.8	35.8
	92	190	2.2	640	7.4	53.1	14.8
Stage 3B	23	52	0.6	164	1.9	13.3	3.7
Remaining Development	179	376	4.3	1244	14.4	103	28.7

We have added the demand of the existing 315 and proposed 23 lots in Stage 3B into our Mike Urban PDF EPS network analysis model for Arrowtown, last updated December 2011. Demands were entered into the model at the nodes shown in Figure 2, attached. Demands for the Arrowtown network outside of Millbrook Resort development are taken from 2010-2011 SCADA data.

Modelling results

Stage 3B

Modelling results are presented in Table 1 below. Note that these results relate to the Millbrook Resort development alone with 2011 demands, and do not include demands from other proposed developments within Arrowtown modelled by Tonkin & Taylor.

[1] Fire flow requirements are in accordance with SNZ PAS 4509:2008, *"New Zealand Fire Service Fire Fighting Water Supplies Code of Practice"*.

[2] The minimum residual pressure requirement is as set out in Queenstown Lakes District Council Amendments and Modifications (2005) to NZS 4404:2004 , *"Land Development and Subdivision Engineering"*.

Table 1 Minimum pressures and fire flow availability

Nodes assessed	Residual pressure (kPa) [1]		Fire flow available (l/sec) [2]	
	Without upgrades	With proposed 200mm trunk main upgrade	Without upgrades	With proposed 200mm trunk main upgrade
JP-1	490 ≥ 300 **OK**	530 ≥ 300 **OK**	52.0 ≥ 25 **OK**	65.0 ≥ 25 **OK**
JP-2	485 ≥ 300 **OK**	520 ≥ 300 **OK**	45.8 ≥ 25 **OK**	57.2 ≥ 25 **OK**
JP-2a	355 ≥ 300 **OK**	395 ≥ 300 **OK**	34.8 ≥ 25 **OK**	43.8 ≥ 25 **OK**
JP-2b	300 ≥ 300 **OK**	330 ≥ 300 **OK**	23.8 ≥ 25 **OK**	29.1 ≥ 25 **OK**
JP-3	480 ≥ 300 **OK**	520 ≥ 300 **OK**	43.3 ≥ 25 **OK**	53.1 ≥ 25 **OK**
JP-4	460 ≥ 300 **OK**	500 ≥ 300 **OK**	39.9 ≥ 25 **OK**	48.4 ≥ 25 **OK**
JP-4a	485 ≥ 300 **OK**	525 ≥ 300 **OK**	36.5 ≥ 25 **OK**	44.0 ≥ 25 **OK**
JP-4b	490 ≥ 300 **OK**	530 ≥ 300 **OK**	37.2 ≥ 25 **OK**	43.7 ≥ 25 **OK**
JP-5	350 ≥ 300 **OK**	390 ≥ 300 **OK**	32.2 ≥ 25 **OK**	39.2 ≥ 25 **OK**
JP-5a	330 ≥ 300 **OK**	370 ≥ 300 **OK**	27.3 ≥ 25 **OK**	33.3 ≥ 25 **OK**
JP-5b	290 ≤ 300 **NOT OK**	330 ≥ 300 **OK**	16.7 ≥ 12.5 **OK**	19.4 ≥ 12.5 **OK**
JP-5c	130 ≤ 300 **NOT OK**	170 ≤ 300 **NOT OK**	7.9 ≤ 12.5 **NOT OK**	10.4 ≤ 12.5 **NOT OK**
JP-5d	265 ≤ 300 **NOT OK**	305 ≥ 300 **OK**	13.6 ≥ 12.5 **OK**	15.7 ≥ 12.5 **OK**
JP-6	315 ≥ 300 **OK**	355 ≥ 300 **OK**	26.8 ≥ 25 **OK**	32.5 ≥ 25 **OK**

(1) A minimum residual peak hour pressure of 300 kPa is required as per QLDC amendments to NZS 4404:2004.

(2) A total of 25 l/sec is required from within 270 m of each non-sprinklered, residential dwelling for Class FW2 fire fighting as per SNZ PAS 4509:2008.

(3) A minimum of 12.5 l/sec is required from each hydrant as per SNZ PAS 4509:2008.

Without upgrades

Without any of the upgrades outlined in the 2006 report (booster pump at J-71 or trunk main upgrade and booster station at JP-5), modelling shows that during the 2011 design peak hour demand scenario, the residual pressures in the development will be at least 130 kPa. Hence, the Queenstown Lakes District Council (QLDC) requirement for minimum pressures being ≥ 300 kPa is not met within the proposed development. Pressure levels of service will not be met within Stage 3B, and any dwellings above 425m at location JP-2b

Modelling also shows that a minimum of Class FW2 fire flow cannot be achieved at Stage 3B during the 2011 design peak day demand scenario, as required for FW3 development. Throughout the remainder of the development however, the standard is achieved. All remaining hydrants can deliver at least 12.5 l/sec within 135 m of the proposed lots, with the remaining 12.5 l/sec available from within 270 m (total of 25 l/sec as required for FW2 firefighting).

With proposed trunk main upgrade

With the installation of an additional 200mm trunk main, modelling shows that during the 2011 design peak hour demand scenario, the residual pressures in the development will be at least 170 kPa. Hence, the Queenstown Lakes District Council (QLDC) requirement for minimum pressures being ≥ 300 kPa is not met within the proposed development. Pressure levels of service will not be met within Stage 3B. The addition of the proposed trunk main will increase the pressures within Millbrook Resort by around 40 kPa.

Modelling also shows that a minimum of Class FW2 fire flow cannot be achieved at Stage 3B during the 2011 design peak day demand scenario, as required for FW3 development. Throughout the remainder of the development however, the standard is achieved. All remaining hydrants can deliver at least 12.5 l/sec within 135 m of the proposed lots, with the remaining 12.5 l/sec available from within 270 m (total of 25 l/sec as required for FW2 firefighting).

Required reticulation upgrades

Addition of Stage 3B to the existing reticulation within Millbrook Resort will not cause levels of service within the remainder of Millbrook Resort to drop below council standards, as shown in table 1 above. However, due to the elevation of lots in Stage 3B, upgrades will be required in order for levels of service to be met within this section of the development. The Arrowtown reservoirs are at an elevation of 458mRL, with the highest platform of Stage 3B at 442mRL, resulting in a static pressure of less than 300 kPa.

Levels of service in Stage 3B can be met with the installation of a localised booster pump at node JP-5, provided the pump operates continually. We strongly recommend that an additional booster pump be installed for redundancy. Alternatively, a duplicate pump could be installed at the existing Arrowtown Booster Pump Station. However, this would require pressurisation of the entire Arrowtown network. Consideration of future development within Millbrook Resort will need to be considered in conjunction with development of stage 3B when determining the appropriate upgrade.

Further development

With installation of the 23 lots in stage 3B, the current reticulation layout in the western area of Millbrook Resort will be at capacity. In Table 1 it can be seen that at JP-2b, pressure levels of service will just be met when Stage 3B is carried out. Any development further to Stage 3B in Millbrook Resort will cause levels of service to be insufficient at this point, and further upgrades to the network would be required in order for levels of service to be met.

The 2006 report outlines potential options to allow for adequate levels of service within the development. A booster pump placed before J-71 could be designed to provide sufficient pressure to the development. This will require the booster station to operate continuously in order to achieve levels of service to Stage 3B. It is recommended that an additional booster pump would also be installed for redundancy.

Installation of a booster station at J-71 and JP-5 would allow for the booster station at J-71 to operate during peak hour flows only. As outlined above, levels of service in Stage 3B can be met with the installation of a localised booster pump at node JP-5, provided the pump operates continually. It is recommended that an additional booster pump would also be installed at each location for redundancy.

As outlined above, a duplicate pump could be installed at the existing Arrowtown Booster Pump Station. However, this would require pressurisation of the entire Arrowtown network.

Modelling indicates that an alternative to a booster pump at J-71 a trunk main upgrade from the Arrowtown reservoir to J-109 comprising a 200mm diameter pipe and a booster pump at JP-5 would provide adequate levels of service. Installation of the booster pump would be required before development of Stage 3B goes ahead, with the installation of the duplicate trunk main required for and further development past this point.

The appropriate upgrade will depend on any future plans for development within the area and should be discussed with QLDC.

Discussion

Modelling has been carried out on the basis of the design demands for the existing 223 lots in the eastern section of the development. However, 2011 flow data indicates that the full design demand in the area is currently not being utilised.

In order to achieve levels of service to the development with the addition of stage 3B, and further development, the three existing booster pumps located at the Arrowtown Pump Station are required to operate, as outlined in the Operating Manual[3]. This is on the basis that the full design demand is being used.

The modelling carried out incorporates the Millbrook Resort development alone with 2011 design demands, and did not include demands from other proposed developments within the Arrowtown network. As outlined in the Effects of the Arrowtown South Development report, April 2010[4], with addition of further developments to the Arrowtown network, upgrades to the existing booster station, borefields and reservoirs may be required in order to achieve levels of service throughout the township.

[3] Arrowtown Operating Manual, Duffill Watts & King Ltd, supplied to T&T by Tony Francis, 24 June 2008

[4] *Results of water supply modelling for Arrowtown South development – Effects of development connection on future network capacity*, prepared for MWH Dunedin, 28 April 2010

Applicability and Closure

The model is a numerical representation of the physical reality, and subsequently bears some uncertainty. The demands and peaking factors used are based on assumptions regarding the patterns of water use in the township, and are an approximation of the physical reality. Hence, actual demands within the network may differ from those modelled.

This report has been prepared for the benefit of Millbrook Country Club Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

In addition, the modelling results presented in this report show the available levels of service for the current Arrowtown network, based on the 2011 demands, and are not a guarantee of available levels of service in the future.

We trust this modelling report meets your requirements. Please contact Janelle Cowley (jcowley@tonkin.co.nz) on 03 363 2450 if you wish to discuss these results or any other aspect of this modelling report.

Yours sincerely,

TONKIN & TAYLOR LTD

Grant Lovell
CHRISTCURCH GROUP MANAGER

Report prepared by:
Janelle Cowley
CIVIL ENGINEER

Attachments:

- **Figure 1**
- **Figure 2**

11-Oct-13
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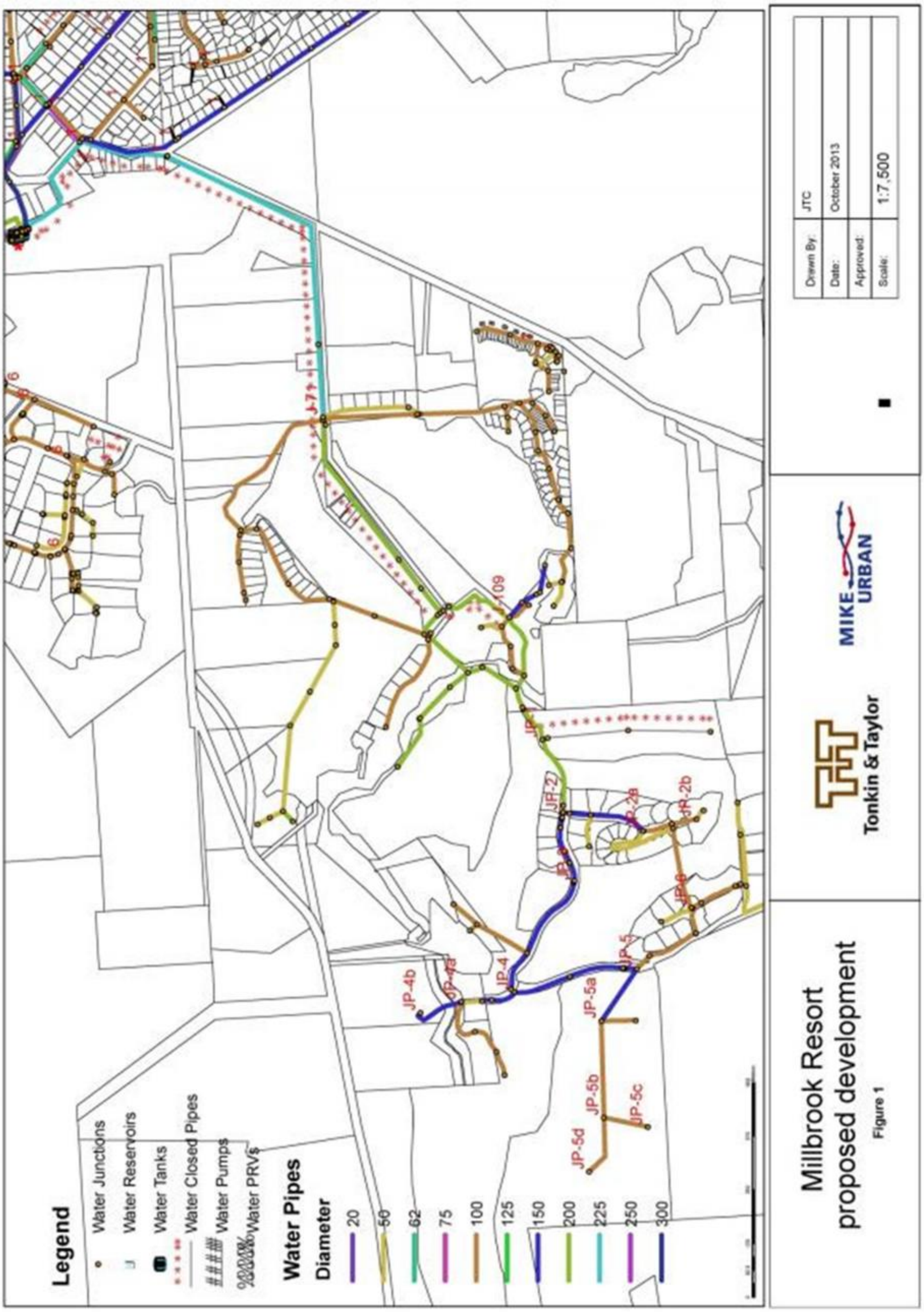
Legend
Water Junctions
Water Reservoirs
Water Tanks
Water Closed Pipes
Water Pumps
Water PRVs
Water Pipes
Diameter
20
50
62
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225
250
300
Millbrook Resort
proposed development
Figure 1
Tonkin & Taylor
MIKE URBAN
Drawn By: JTC
Date: October 2013
Approved:
Scale: 1:7,500
JP-2
JP-2a
JP-2b
JP-4
JP-4b
JP-5
JP-5a
JP-5b
JP-5c
JP-5d
JP-6
JP-7
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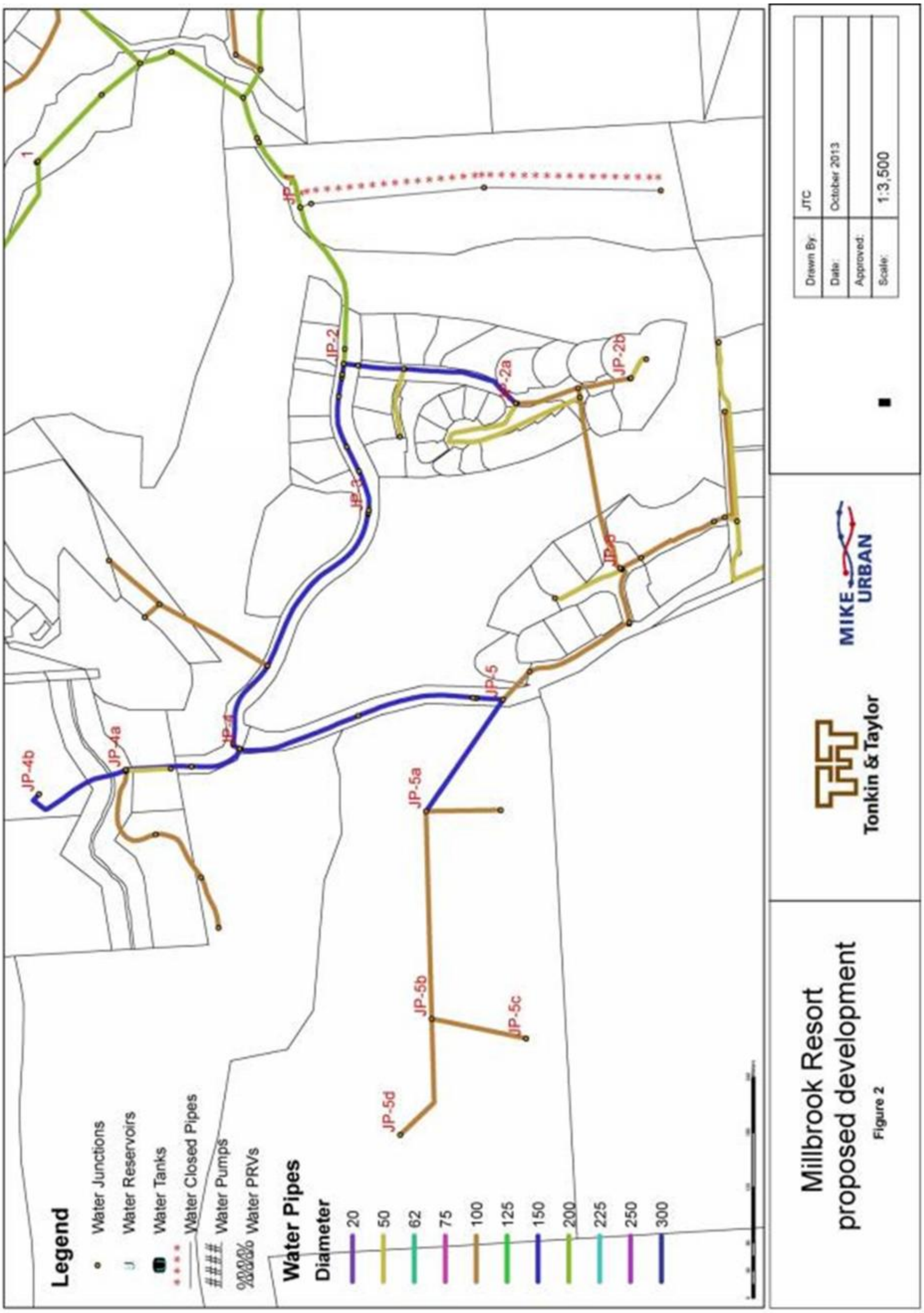
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JP-1
JP-2
JP-2a
JP-2b
JP-3
JP-4
JP-4a
JP-4b
JP-5
JP-5a
JP-5b
JP-5c
JP-5d
Drawn By: JTC
Date: October 2013
Approved:
Scale: 1:3,500
MIKE URBAN
Tonkin & Taylor
Millbrook Resort
proposed development
Figure 2

Tonkin & Taylor

T&T Ref: 51557.005
03 October 2014

Millbrook Country Club Ltd
Millbrook Resort
Malaghans Road
Arrowtown

Copy to: Peter White, MWH New Zealand Ltd

Attention: Stu Andersen

Dear Stu

Water supply modelling for booster station design for Millbrook Resort, Arrowtown

1 Introduction

As per our letter of engagement dated 12 September 2014, and in accordance with your request, we have undertaken modelling to determine the required network infrastructure to allow for levels of service to be met within the proposed development at Millbrook Resort, Arrowtown. This work was performed for Millbrook Country Club Ltd as our Client.

This modelling is further to the modelling carried out in the report *'Water supply modelling for booster station design for Millbrook Resort, Arrowtown'*, dated 27 May 2014, T&T Ref. 51557.005, and should be read in conjunction with this report.

2 Modelling outline

The purpose of this modelling was to determine the required duty points to allow for Millbrook Resort development:

i. To meet fire fighting requirements[1]; and
ii. To have a minimum residual pressures at each connection of ≥ 300 kPa [2] during the design peak hour demand scenario.

To assist in the development of the Millbrook booster station we have determine the required booster pump station duty points for the two scenarios below:

---

[1] Fire flow requirements are in accordance with SNZ PAS 4509:2008, *"New Zealand Fire Service Fire Fighting Water Supplies Code of Practice"*.

[2] The minimum residual pressure requirement is as set out in Queenstown Lakes District Council Amendments and Modifications (2005) to NZS 4404:2004, *"Land Development and Subdivision Engineering"*.

Tonkin & Taylor Ltd · Environmental and Engineering Consultants, 33 Parkhouse Rd, Wigram, Christchurch, New Zealand
PO Box 13-055, Christchurch, Ph: 64-3-363 2440, Fax: 64-3-363 2441, Email: chch@tonkin.co.nz, Website: www.tonkin.co.nz

- Millbrook West development up to and including Stage 3 F, and
- Full Millbrook West development (advised horizon of 2018).

3 Initial investigation

Modelling was initially requested to determine the duty points required to service the entire Millbrook Resort west, including the dwellings located on the Macauley land, from a booster station located at JP-1. Initial investigations indicated that with that arrangement QLDC levels of service would not be met.

The proposed booster station located at JP-1 is located at an elevation of approximately 400 mRL. The inclusion of the Macauley land brings the highest platform that the booster station is require to service up to between 465 mRL and 478 mRL. This requires a static discharge pressure from a booster station at JP-1 of approximately 94-107 m to allow for levels of service to be met, hence, pressures on the discharge side of the booster station will be above 900 kPa.

Two booster stations will be required to Service Millbrook West. Millbrook Resort advised[3] that the booster stations are to be located at JP-1 (Pump station 1), to service up to and including Stage 4, and an additional booster station (Pump Station 2), as outlined in Appendix A, Figure 2, to service the dwellings located on the Macauley land.

Modelling was carried out for design of the Pump Station 1 only, and further modelling is required in order to determine the duty points required for Pump Station 2.

4 Methodology and demands

The methodology and demands used in this analysis are as per our previously carried out report (*Water supply modelling for booster station design for Millbrook Resort, Arrowtown'*, dated 27 May 2014, T&T Ref. 51557.005). However, demand distribution had differed, with the inclusion of the Macauley land causing demand location to expand further west.

The modelled demand scenarios used to determine the required duty points of the booster station pumps were

- Peak day demand - **To determine whether available fire flows meet firefighting requirements [4]; and**
- Peak hour demand - **To determine whether minimum residual pressures at each connection are ≥ 300 kPa [5].**

As per the October 2013 report, modelling took into consideration the design demand of the existing 315 currently developed lots, and also the remaining 202 lots, bringing the development to a total of 517 lots. The respective design demands are outlined in Table 1 below.

[3] Email between Grant Klyuts (MWH) and Janelle Cowley (T&T), dated 25 September 2014

[4] Fire flow requirements are in accordance with SNZ PAS 4509:2008, "*New Zealand Fire Service Fire Fighting Water Supplies Code of Practice*'

[5] The minimum residual pressure requirement is as set out in Queenstown Lakes District Council Amendments and Modifications (2005) to NZS 4404:2004, "*Land Development and Subdivision Engineering*".

Table 1: Design demands for Millbrook Resort development Booster Station located at JP-1

Development	Number of dwellings	Average daily flow (ADF)		Peak day flow (PDF)		Peak hour flow (PHF)	
		m^3/day	l/sec	m^3/day	l/sec	m^3/hour	l/sec
Existing east of booster station	223	467	5.4	1550	17.9	128.8	35.8
Existing west of booster station	92	193	2.2	638	7.4	53	14.8
Remaining up to Stage 3F(1)	74	155	1.8	513	5.9	43	11.9
Remaining Development	128	269	3.1	887	10.3	74	20.5

4.1 Pressure

4.1.1 Duty Points

Modelling has been based on achieving a minimum of 300 kPa within the area serviced by Pump Station 1. The required duty points for the booster station are outlined in Table 2 below.

Table 2: Duty points

Development (1)	Head	Flow	Suction Pressure	Outlet Pressure
	m	l/s	m	m
PD Demand up to Stage 3F	19.3	26.6	57.2	76.5
Final Design PD Demands	37.3	47.2	46.2	83.5

(1) Existing *2011 PD demands* for all of the Arrowtown network, and *design* demands of Millbrook Resort (all 517 lots)

4.2 Fire flow

The required duty point to produce FW2 within the area serviced by Pump station 1is outlined in Table 3 below.

Table 3: Firefighting duty points

Development (1)	Head	Flow	Suction Pressure	Outlet Pressure
	m	l/s	m	m
PD Demand up to Stage 3F	10.1	38.3	58.9	69
Final Design PD Demands	21.6	48.6	53.9	75.5

(1) Existing *2011 PD demands* for all of the Arrowtown network, and *design* demands of Millbrook Resort (all 517 lots)

5 Levels of service

Pressures and fireflow have been evaluated for the dwellings up to Stage 3F and also full development. The sections located in the Macauley land have not been assessed and further modelling is required to confirm levels of service at these locations. Minimum pressures outlined below are based on the booster station operating at the model duty point outlined in the above tables.

Pressure:

Modelling results are presented in Table 4 below. Modelling indicates that during the 2011 design peak hour demand scenario, the residual pressures in the development will be at least 300 kPa. Hence, the Queenstown Lakes District Council (QLDC) requirement for minimum pressures being ≥ 300 kPa is not within the proposed development with the use of a booster station.

Table 4: Minimum pressure

Nodes assessed	Residual pressure (kPa) (1)	
	Development up to Stage 3F	Full development
JP-1	690 ≥ 300 **OK**	750 ≥ 300 **OK**
JP-1a	630 ≥ 300 **OK**	690 ≥ 300 **OK**
JP-1b	570 ≥ 300 **OK**	630 ≥ 300 **OK**
JP-2	580 ≥ 300 **OK**	730 ≥ 300 **OK**
JP-2a	550 ≥ 300 **OK**	600 ≥ 300 **OK**
JP-2b	490 ≥ 300 **OK**	530 ≥ 300 **OK**
JP-3	670 ≥ 300 **OK**	720 ≥ 300 **OK**
JP-4	640 ≥ 300 **OK**	670 ≥ 300 **OK**
JP-4a	670 ≥ 300 **OK**	700 ≥ 300 **OK**
JP-4b	670 ≥ 300 **OK**	700 ≥ 300 **OK**
JP-5	520 ≥ 300 **OK**	550 ≥ 300 **OK**
JP-5a	500 ≥ 300 **OK**	510 ≥ 300 **OK**
JP-5b	460 ≥ 300 **OK**	460 ≥ 300 **OK**
JP-5b2	510 ≥ 300 **OK**	300 ≥ 300 **OK**
JP-5c	300 ≥ 300 **OK**	300 ≥ 300 **OK**
JP-5c2		500 ≥ 300 **OK**
JP-5d	530 ≥ 300 **OK**	430 ≥ 300 **OK**
JP-5d2	360 ≥ 300 **OK**	370 ≥ 300 **OK**
JP-6	490 ≥ 300 **OK**	520 ≥ 300 **OK**
JPM-1		320 ≥ 300 **OK**

(1) A minimum residual peak hour pressure of 300 kPa is required as per QLDC amendments to NZS 4404:2004.

(2) A total of 25 l/sec is required from within 270 m of each non-sprinklered, residential dwelling for Class FW2 firefighting as per SNZ PAS 4509:2008.

Fireflow:

Modelling has also shown that Class FW2 (25 l/sec) fire flow can be produced to all sections within the development. The determined duty point will allow for the minimum 25 l/s to be met at the highest platform level in Stage 3B.

6 Low flows

The booster station should be designed to provide low flows to the development. The flow duration curve for the period June 2008 to May 2011 is shown in Figure 1, Appendix B. Flow data indicates that there is a wide range of flows within the development throughout the year, with approximately 20 m^3/hr being exceeded 10 percent of the time. The 95 percentile flow is approximately 10 m^3/hr and the booster station needs to be designed to accommodate this.

7 Applicability

The model is a numerical representation of the physical reality, and subsequently bears some uncertainty. The demands and peaking factors used are based on assumptions regarding the patterns of water use in the township, and are an approximation of the physical reality. Hence, actual demands within the network may differ from those modelled.

This report has been prepared for the benefit of Millbrook Country Club Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

In addition, the modelling results presented in this report show the available levels of service for the current Arrowtown network, based on the 2011 demands, and are not a guarantee of available levels of service in the future.

We trust this modelling report meets your requirements. Please contact Janelle Cowley (jcowley@tonkin.co.nz) on 03 363 2450 if you wish to discuss these results or any other aspect of this modelling report.

Yours sincerely,

TONKIN & TAYLOR LTD

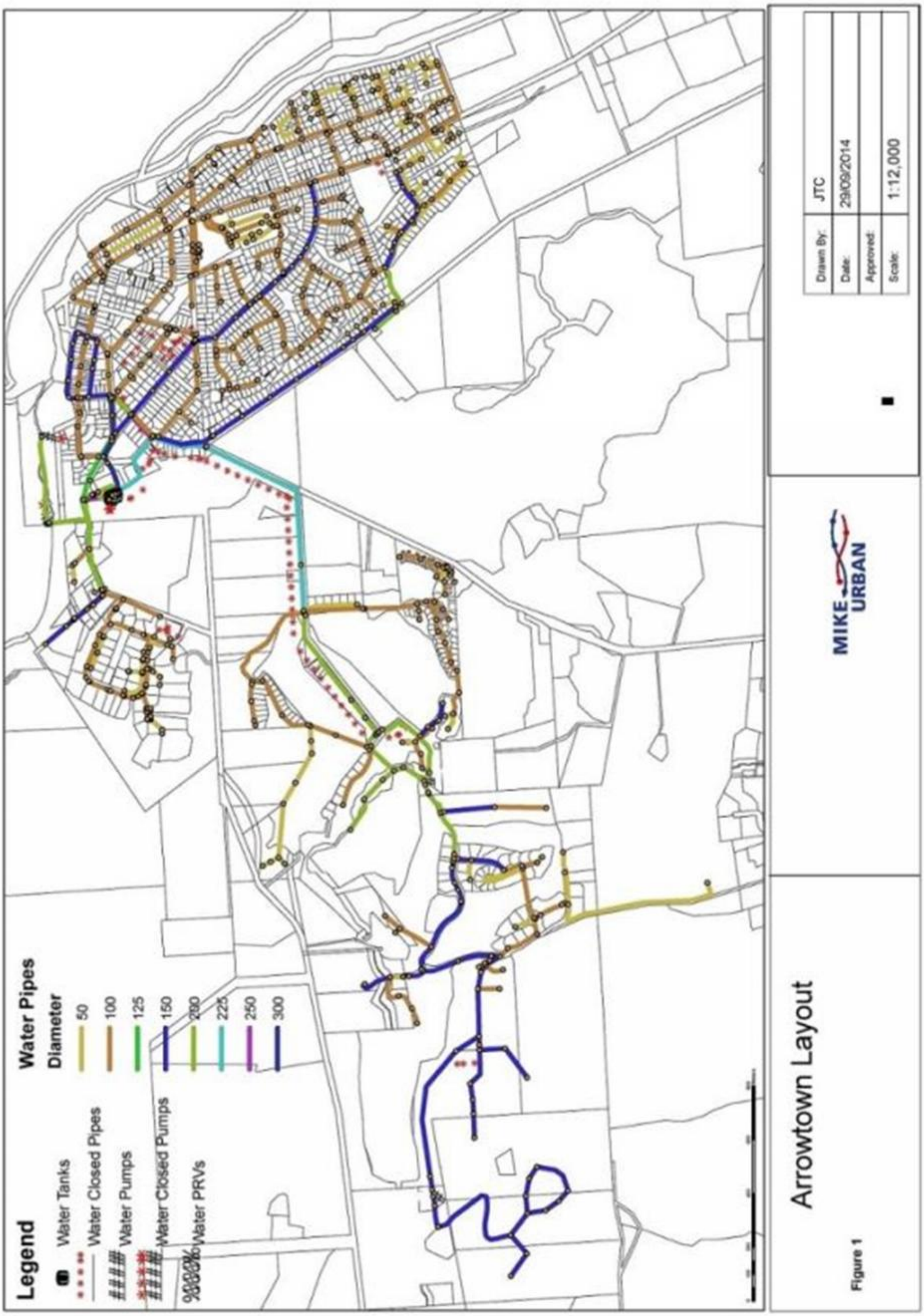
Grant Lovell

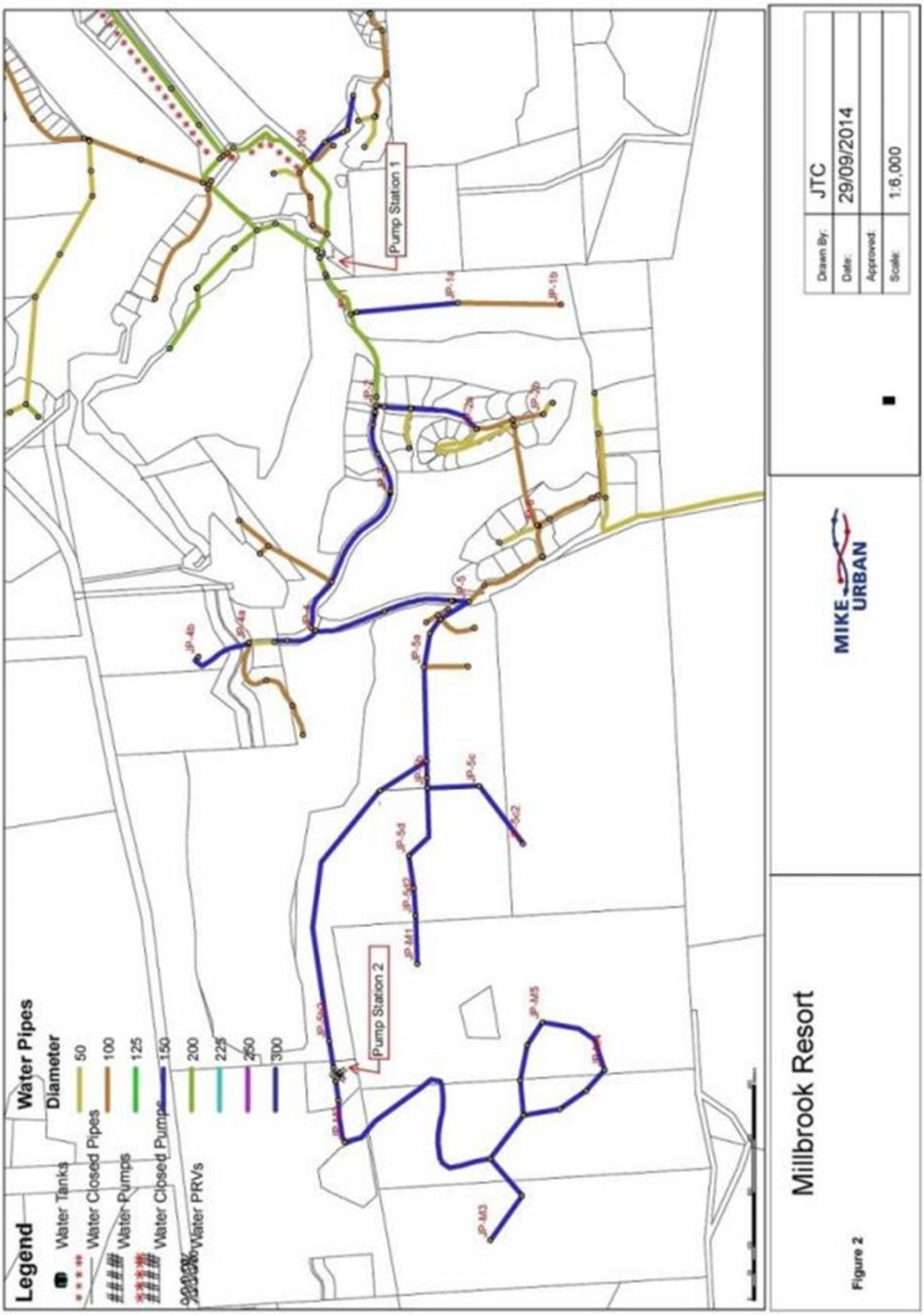
PROJECT DIRECTOR

3-Oct-14
p:\51557\51557.0050\workingmaterial\booster station\2014-09-23.jbc. millbrook resort booster station v2.docx

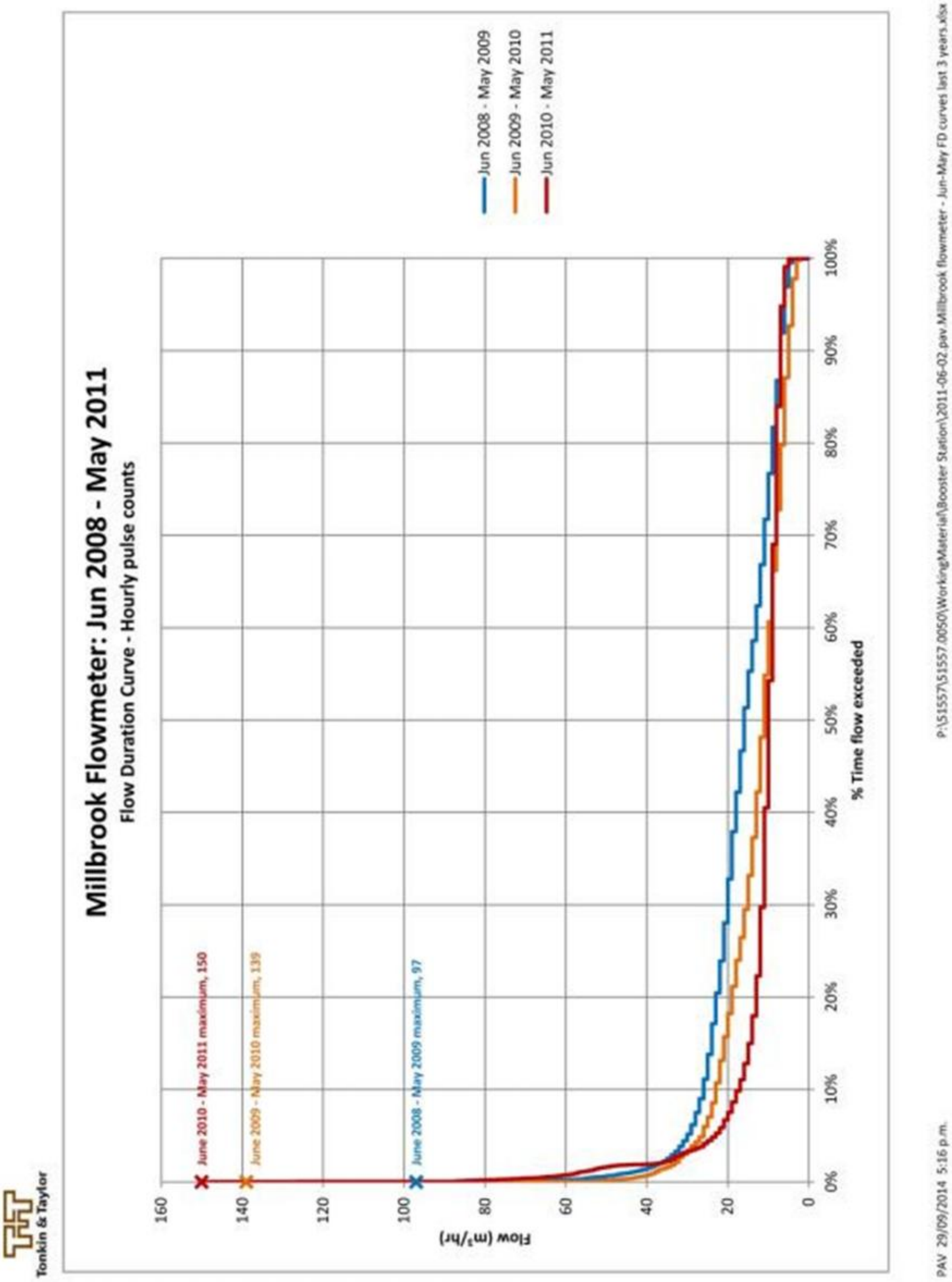
Appendix A: Millbrook Resort Layout

- **Figure 1**
- **Figure 2**


Legend
Water Tanks
Water Closed Pipes
Water Pumps
Water Closed Pumps
Water PRVs
Water Pipes
Diameter
50
100
125
150
200
225
250
300
Arrowtown Layout
Figure 1
MIKE URBAN
Drawn By: JTC
Date: 29/09/2014
Approved:
Scale: 1:12,000


Legend
Water Tanks
Water Closed Pipes
Water Pumps
Water Closed Pumps
Water PRVs
Water Pipes
Diameter
50
100
125
150
200
225
250
300
Pump Station 1
Pump Station 2
Drawn By: JTC
Date: 29/09/2014
Approved:
Scale: 1:6,000
MIKE URBAN
Millbrook Resort
Figure 2

Appendix B: Millbrook 2009-2011 FDC

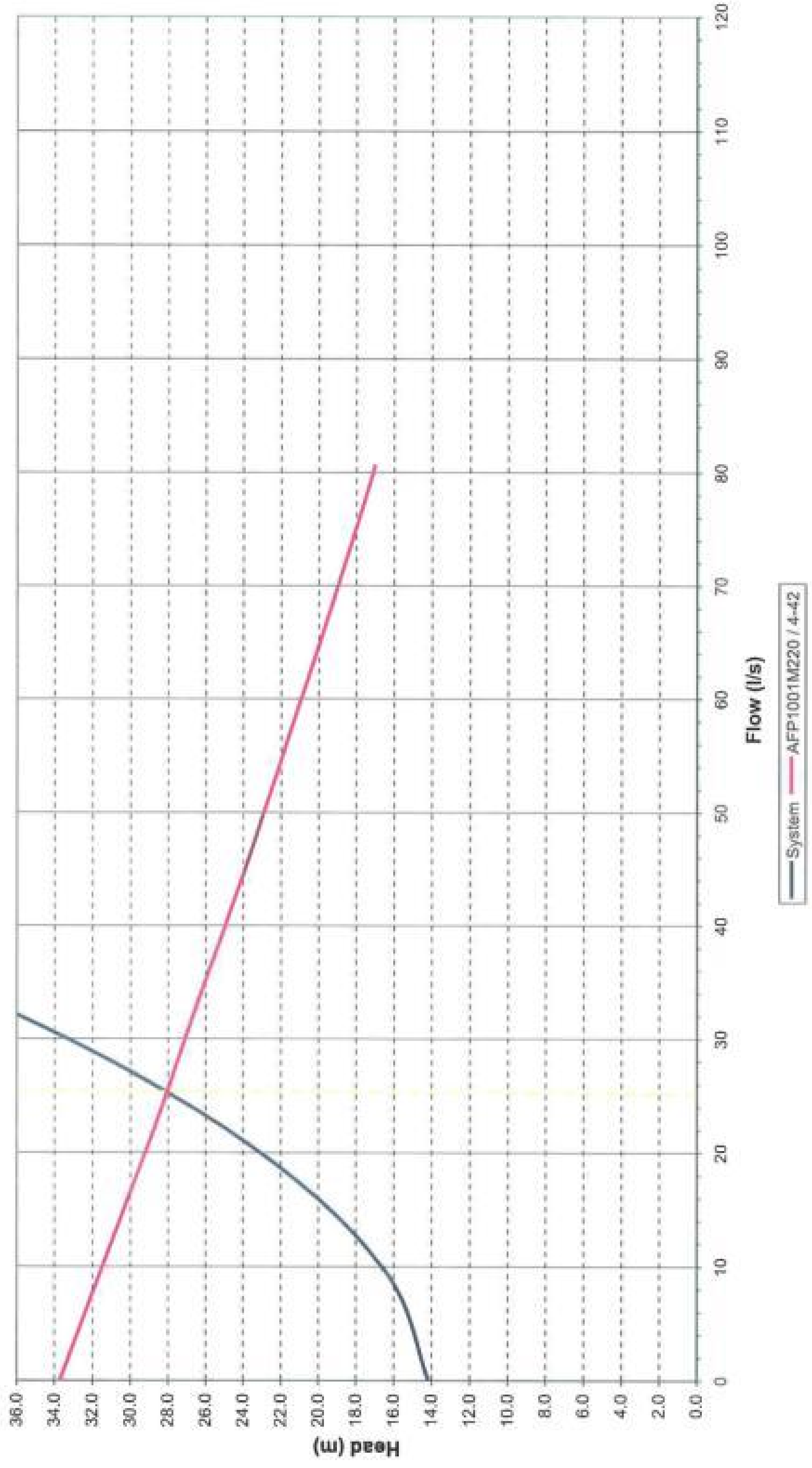

Tonkin & Taylor
Millbrook Flowmeter: Jun 2008 - May 2011
Flow Duration Curve - Hourly pulse counts
June 2010 - May 2011 maximum, 150
June 2009 - May 2010 maximum, 139
June 2008 - May 2009 maximum, 97
Jun 2008 - May 2009
Jun 2009 - May 2010
Jun 2010 - May 2011
Flow (m³/hr)
160
140
120
100
80
60
40
20
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Time flow exceeded
PAV 29/09/2014 5:16 p.m.

Appendix 3 Pumping Station Point Pump Curve

Sewage Pump Station Duty Point Graph

Project Number: Z1325700

Sewage Pumps - Duty Point



Appendix 4 Letter from Otago Regional Council Containing Mill Creek Hydrological Data

Otago Regional Council

Our reference:

HY010

23 February 1995

FILE 2493/15/2
DUFFILL, WATTS & KING LTD—Dunedin
27 FEB 1995

DIR.	REF.	REF.	ACT
	GMD		

Mr G Dent
Duffill Watts and King
P O Box 5269
Dunedin

Dear Sir

Please find enclosed a table of monthly mean flows in Mill Creek at the Fish Trap site, a listing of maximum and minimum flows recorded at the site for each year of record, and a listing of calculated peak flows for various return periods.

With regard to the monthly listing, the mean annual flow should be calculated by adding the means of each month (second last line of values) together and dividing by 12. This gives a flow of 430 litres per second.

The list of calculated peak flows for various return periods was derived using the Extreme Value type 1 (EV1) distribution and the method of probability weighted moments as described in "Flood Frequency in New Zealand" by A I McKerchar and C P Pearson, Publication No 20 of the Hydrology Centre, Christchurch, 1989. Data used were those listed in the PEXTREME listing included with this letter.

If you have any questions regarding the information please contact me.

An account for the analysis is enclosed.

Yours sincerely

D.W. Stewart

D W Stewart
Manager Hydrology
Encl
jwsl2dent - lkw sl2 dent

Mission Statement: "To promote the sustainable management of the region's resources"
70 Stafford Street, Private Bag, Dunedin. Telephone (03) 474-0827. Facsimile (03) 479-0015

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ORC 21

Otago Regional Council

<u>Peak Flow Estimates for Mill Creek at Fish Trap</u>

Return Period (yrs)	Calculated Flow (m^3s^{-1})	Standard Error ($m^3 s^{-1}$)
2	3.4	± 0.4
5	5.0	± 0.6
10	6.0	± 0.9
20	7.0	± 1.1
50	8.3	± 1.4
100	9.3	± 1.7

Values were calculated using the Extreme Value Type 1 (EV1) distribution and the method of probability weighted moments as described in the publication "Flood Frequency in New Zealand" by A I McKerchar and C P Pearson, Pulication No 20 of the Hydrology Centre, Christchurch, 1989.

jwsl2dent - lkw sl2 dent