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Report

Prince of Wales/Omāroro Reservoir - Stormwater Assessment

Prepared for

Prepared by CH2M Beca Ltd

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Revision History

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Document Acceptance

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on behalf of	CH2M Beca Ltd		

Contents

1 Introduction

Wellington Water proposes to construct a buried 35,000 m³ (35 ML) reservoir in Prince of Wales Park in the Mount Cook area, Wellington. Preliminary Design was carried out by CH2M Beca Ltd (Beca) in 2013. Since then further consultation with stakeholders has been carried out.

This report is to provide information on the operational phase stormwater management and flood risk management for the Prince of Wales reservoir, in support of Town Belt Act and Resource Consent applications.

Stormwater management during construction is not included in this report. It is covered by a separate erosion and sediment control management plan.

2 Site Description

The proposed Prince of Wales reservoir site is located within the Prince of Wales Park, in the Town Belt, Mount Cook, Wellington. Refer to Figure 1 for a location plan.

The proposed reservoir site is within an existing spur, and the 35 ML reinforced concrete (pre-stressed, post-tension) will be buried within the spur. A photo of the site is included in Figure 2.

Figure 1 - Site location plan

Figure 2 - Photo of proposed reservoir site – an existing spur

There are two sports fields within the Prince of Wales Park adjacent to the reservoir site, the Upper Field to the north of the reservoir site and the Lower Field to the south-east. These two fields are connected by an access road. These sports fields, the access road and the existing site contours (from LiDAR) are shown in Figure 3.

The reservoir site will be accessed via Rolleston Street. The pipework into and out of the reservoir will be via Hargreaves Street and across the Upper Field.

Figure 3 -Existing site contours (Base diagram source: Wellington CIty GIS)

3 Stormwater System and Waterways

The existing stormwater flow paths and watercourses are shown in Figure 4. The existing stormwater system includes:

- Kerb and channel and stormwater pipework in the roads
- An open waterway (a tributary of Waitangi Stream), in the gully to the west of the reservoir spur, discharging to the Rolleston St stormwater system
- Drains along the edges of the Upper Field, discharging to Rolleston St and the Papawai Stream
- The Papawai Stream, which runs along the western edge of the Lower Field.

There are existing capacity issues with the stormwater system in Rolleston St, and an upgrade of the pipework at the bottom of Rolleston St and the Wallace St intersection is currently in detailed design. Earlier work on sizing this upgrade was carried out by Aecom and is documented in the Rolleston Street Stormwater Renewal Design Report, dated October 2013. The commissioning (putting into operation) of the Prince of Wales/Omāroro Reservoir will be contingent on completion of the planned upgrades to the stormwater pipe

system, as these are required to support the operation and management of the reservoir. The timing the Prince of Wales/Omāroro Reservoir will be influenced by consenting and funding approval.

Figure 4- Existing flow paths and watercourses

4 Regional and District Plans and Standards

4.1 Regional and District Plans

For stormwater, the relevant council plans under the Resource Management Act are:

- Wellington Regional Council *Proposed Natural Resources Plan*
- Wellington Regional Council *Regional Freshwater Plan*
- Wellington City Council *District Plan*

The site is also subject to approvals under the Wellington Town Belt Act.

Refer to the Planning Assessment for further information.

4.2 Technical Standards

The three waters design standard for the Porirua, Hutt, Upper Hutt and Wellington cities is the *Regional Standard for Water Services*, November 2012.

The *Regional Standard for Water Services* requires that for Wellington city, in residential areas, the primary stormwater system is designed for the 10% Annual Exceedance Probability (AEP) event[1], and the secondary system is designed for the 1% AEP event[2].

It is noted that the *Regional Standard for Water Services* has a lower standard for primary system for open space/reserves at 50% AEP event, but no standard for the secondary system for open space/reserves. As the Prince of Wales site is located within a residential area and any stormwater not managed within the site could cause nuisance or flooding on the adjacent residential properties, the residential standard has been adopted.

5 Flood Information

There are existing flooding issues in the area of the site including in:

- Papawai Stream
- Salisbury Terrace
- Rolleston Street

5.1 Papawai Stream

It is understood that there are existing flooding issues, with the Papawai Stream spilling over the Lower Field and onto the residential land to the east. A bund has been constructed along the edge of the Papawai Stream adjacent to the Lower Field. We understand that this bund has been designed to contain the 10 %AEP event within the stream before spilling onto the fields[3]. In larger events, the bund would be overtopped (at its low point) and water would spill over the Lower Field and the land below.

There are also erosion issues in the Papawai Stream, with an area of significant erosion damage next to the clubrooms on the Lower Field. Calibre Consulting (Calibre) has carried out a design to address the erosion in this area, including bank reinstatement and protection, and re-grading a reach of the stream.

This work is being carried out independent of the Prince of Wales/Omāroro Reservoir development.

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[1] *Regional Standard for Water Services*, Table 4.1 Primary Level of Protection (AEP)

[2] *Regional Standard for Water Services*, Table 4.2 Secondary System Level of Protection (AEP)

[3] Oggie Krajl, Calibre consulting, personal communication, 16 March 2017.

5.2 Salisbury Terrace

It is also understood that there are existing flooding issues with Salisbury Terrace, particularly at 12 Salisbury Terrace. Calibre has designed changes to the drainage in the area to mitigate this flooding. Calibre's design includes: changes to the pipework around the clubrooms on the Lower Field connecting to the stormwater network; a swale along the eastern edge of the Lower Field discharging to this new pipework; new kerb and channel and stormwater pipework at the 12 Salisbury Terrace corner. This work is being carried out independent of the Prince of Wales/Omāroro Reservoir development, but will need to be considered in finalising the drainage design for the Lower Field.

5.3 Rolleston Street

As noted in section 3, the Rolleston St pipework is under capacity and is scheduled to be upgraded. The commissioning of the proposed Prince of Wales/Omāroro Reservoir will be contingent on this pipeline upgrade being completed.

6 Proposed Development

The reservoir will be buried, and the finished ground surface will be grassed (top of the spur) and planted (slopes and gullies) as at present. The shape of the ground surface will differ slightly from the existing.

There will be a sealed accessway from Rolleston Street to the reservoir.

The Upper and Lower Fields will be raised, using material excavated from the reservoir site, and re-graded so that the Upper Field drains towards side drains discharging to Rolleston Street and the Lower Field drains towards side drains that discharge into Papawai Stream.

Both fields will be used for temporarily stockpiling excavated reservoir site material that will be used for reservoir backfilling and burial following reservoir construction. Following reservoir construction the playing fields will be reinstated and be fully grassed (as at present).

7 Flood Risk Management

In terms of flood risk management the following cases have been considered for the reservoir development:

- Large rainfall event and associated stormwater runoff off the site (secondary flow event, 1% AEP)
- Scour flow or drain down of the reservoir (i.e.operations staff draining the reservoir of water, discharging to the stormwater system to enable inspection, maintenance and/or repair of the reservoir)
- Overflow from the reservoir (if due to a controls failure, the reservoir is full but the pumps below continue to pump water up to the reservoir).

Note that a seismic event (earthquake) leading to either a structural failure of the reservoir or a failure of the reservoir pipework is not included in the list above. This is because:

- The reservoir will be designed as a water retaining structure, with a 100 year design life, with Importance Level (IL) 4[4], and as such will be designed with SLS2[5] seismic loads equivalent to a 1,000 year return period earthquake. The likelihood of structural failure will be very low.
- The reservoir pipework will include flexible joints and a seismically activated shut-off valve at the reservoir. The likelihood of pipework failure will be low.

8 Stormwater Management Approach

8.1 Conveyance

The reservoir will be buried within the spur and the surface grassed and planted. Runoff from the spur will be to gullies below, as at present. As the finished surface above the developed reservoir will be grassed (as the spur is at present), the reservoir will not increase the runoff (peak flow or volume) from the site. It will, however, result in changes to the shape of the spur which will slightly modify the runoff split between the slopes/gullies. No formal drainage (pipes or drains) will be constructed in these gullies.

Primary stormwater runoff from the reservoir accessway will be piped to Rolleston Street, and secondary flow will be directed to Rolleston Street, as happens at present from this area.

The Upper and Lower Fields will be raised (using material excavated from the reservoir site) and reshaped. Primary and secondary flow will be conveyed by drains along the sides of the fields, with the Upper Field discharging to Rolleston Street and the Lower Field discharging to the Papawai Stream. Once the fields are reshaped some parts of the Upper Field which currently drain to Hargreaves Street will drain to Rolleston Street.

8.2 Treatment

No formal water quality treatment is proposed. The only new impervious area at the site is the new reservoir accessway, which has an area of approximately 530 m². This accessway will be used by maintenance vehicles for inspection and maintenance on an infrequent basis (approximately fortnightly), but will not have regular traffic and therefore contaminant loads will be minimal. No hazardous substances or fuel will be stored at the site.

[4] The New Zealand Building Code Clause A3 Building importance levels defines the significance of a building by its importance level (IL), which is related to the consequences of failure. There are five levels of importance, considered by the importance of the building to society from Importance Level 1 (lowest) to Importance Level 5 (highest). IL1 buildings are "*Buildings posing low risk to human life or the environment, or a low economic cost, should the building fail*." IL5 buildings are "*Buildings whose failure poses catastrophic risk to a large area (eg, 100 km²) or a large number of people (eg, 100 000)*". The Prince of Wales/Omāroro Reservoir will be designed to IL4, which is defined as "*Buildings that are essential to post-disaster recovery or associated with hazardous facilities*".

[5] Serviceability Limit State (SLS) 2. The structure is designed so that it can continue to perform its function after an SLS2 earthquake.

8.3 Attenuation

No attenuation of peak flows or detention of runoff volume is proposed. As noted above, the only new impervious area at the site is the new reservoir accessway, which has an area of approximately 530 m² (0.05 ha), which is minor compared to the 6.6 ha catchment draining to the top of Rolleston Street (i.e. the accessway will cover 0.8% of the catchment area). The reservoir development will therefore not materially increase runoff from the site.

9 Reservoir Discharge Management Approach

The reservoir overflow and scour pipework will connect to the stormwater system in Rolleston Street.

10 Site Stormwater System

10.1 General

The catchment areas are shown in Figure 5. The design parameters are as described in section 11.

Figure 5 - Stormwater catchment areas

10.2 Site drainage

Runoff from the spur will be to gullies below, as at present. There is currently no formal drainage (pipes or drains) in these gullies, and none are proposed.

Stormwater runoff from the reservoir accessway will be piped to Rolleston Street. These pipes will be sized to convey runoff from a 10% AEP event. The reservoir accessway will also be designed to convey secondary flow in larger event, up to the 1% AEP event, to Rolleston Street.

The reservoir overflow and scour pipework will connect to the stormwater system in Rolleston Street. Secondary flow from the pipe tunnel would also be directed to Rolleston Street.

The scour pipework will be sized to a peak flow rate of 400 L/s to match the capacity of the stormwater pipe system in Rolleston Street (i.e. so that there is no overland flow if the reservoir is drained down for maintenance). Discharge can be timed for dry weather when there is no other flow in the pipes, and this requirement will be included in operation and maintenance manuals.

The controls at the water pump stations (pumping to the reservoir) and reservoir will include monitoring, controls and alarms systems to minimise the risk of reservoir overflow. In the unlikely event that the pumps continue to pump when the reservoir is full, water would flow via the overflow pipework into the Rolleston Street stormwater pipework, and once this reached capacity water would spill from the catchpits and there would be secondary overland flow along Rolleston Street.

Drains will be provided along the Lower and Upper Fields to convey stormwater runoff from the Upper Field to the Rolleston Street stormwater system and runoff from the Lower Field to the Papawai Stream and stormwater system. These drains will be sized to convey the 10% AEP flow, with secondary flow up the 1% AEP event along the drains and ponding out across the fields but not entering private property.

10.3 Rolleston Street capacity

The catchment draining to the top of Rolleston Street is approximately 6.58 ha, and the total catchment at the bottom of Rolleston Street is approximately 9.93 ha.

10.3.1 Primary system

The capacity of the proposed upgraded Rolleston Street pipe system, which will need to be installed prior to the reservoir becoming operational, has been assessed as follows, assuming a constant flow rate along the full length of the pipe:

- Flowing full (i.e. hydraulic gradient at pipe soffit) – 300 L/s
- Surcharged (i.e. hydraulic gradient above pipe soffit but still below ground level) – 400 L/s

The total runoff from the Rolleston St catchment (i.e. from the 9.93 ha catchment at the downstream end) in a 10% AEP 20 minute event has been assessed as 690 L/s. This would result in part of the pipeline being surcharged and some overland flow along the road.

10.3.2 Secondary system

Once the stormwater pipe system is full, or in the event of inlet blockage, overland (secondary) flow will occur down Rolleston St on to Wallace St. The capacity of the overland flow path down Rolleston St has been assessed as approximately 490 L/s.

11 Design Parameters

The following design parameters have been used in preparing this assessment.

11.1 Rainfall

Rainfall depths and intensities are as per *Regional Standard for Water Services (2012)* Appendix 5 plus 16% for climate change.[6] These are shown in Table 1.

Table 1 – Relevant rainfall Intensities (from Regional Standard for Water Services, Appendix 5)

Annual Exceedance Probability (AEP)	Rainfall Intensity (mm/hour)			
	10 min duration	10 min duration plus 16% climate change	20 min duration	20 min duration plus 16% climate change
10%	59.4	68.9	43.8	50.8
2%	84.6	98.1	62.1	72.0
1%	98.4	114.1	72.3	83.9

11.2 Rational Method, Time of Concentration and Runoff Coefficients

Runoff has been calculated using the Rational Method. The Rational Method is a widely used but relatively simple method for estimating runoff, which is suitable for development sites. It is the method of choice in the Building Code Acceptable Solutions (Compliance Document E1 Surface Water).

The times of concentration for the catchments were assessed as follows:

- Upper and Lower Fields drainage – 10 minutes
- Rolleston St catchment (including reservoir site and Upper Field) – 20 minutes

The runoff coefficients used are summarised in Table 2. These are consistent with the *Regional Standard for Water Services* Table 4.4.

Table 2 - Runoff Coefficients

Area Type	Runoff Coefficient C
Impervious/fully paved areas	0.95
Urban areas - 36% and 65% impervious site coverage	0.65
Parks, reserves, green spaces, rural areas	0.35

11.3 Roughness Coefficients

The Mannings roughness coefficients used are summarised in Table 3. These are generally consistent with Table 4.5 in the *Regional Standard for Water Services*.

[6] Ministry for the Environment (2008) *Preparing for climate change: A guide for local government in New Zealand.* 16% increase in rainfall intensities for 2º C of temperature rise to 2090.

Table 3 – Roughness coefficients

Surface	Mannings n Roughness
Vegetated channel	0.045
Grassed drain	0.03
Kerb and channel and pavement	0.014
Pipes	0.013

12 Conclusions

Wellington Water proposes to construct a buried 35,000 m³ (35 ML) reservoir in Prince of Wales Park in the Mount Cook area, Wellington. The reservoir will be buried within the spur and the surface grassed and planted.

The only new impervious area at the site is the new reservoir accessway, which has an area of approximately 530 m² (0.05 ha), which is minor compared to the 6.6 ha catchment draining to the top of Rolleston Street (i.e. 0.8%). There will also be minor changes to the flow paths from the reservoir spur (due to the change in shape) and part of the Upper Field will discharge to Rolleston Street rather than Hargreaves Street. However the development will not materially increase the runoff from the catchment. The reservoir accessway will be used by maintenance vehicles, but will not have regular traffic and will generate minimal contaminant loads, and therefore no stormwater treatment is proposed.

Runoff from the spur will be to gullies below, as at present. No formal drainage (pipes or drains) will be constructed in these gullies.

Where new drainage is constructed the primary stormwater system will be sized for a 10% AEP event and the secondary system will be designed for a 1% AEP event.

Primary stormwater runoff from the reservoir accessway will be piped to Rolleston Street, and secondary flow will be directed to Rolleston Street.

The reservoir overflow and scour pipework will connect to the stormwater system in Rolleston Street, and secondary flow will be directed to Rolleston Street. The scour pipework will be sized to match the capacity of the Rolleston Street pipe system. The risk of reservoir overflow will be mitigated through monitoring, controls and alarms. In the unlikely event that the pumps continue to pump when the reservoir is full, water would flow via the overflow pipework into the Rolleston Street stormwater pipework, and once this reached capacity water would spill from the catchpits and there would be secondary overland flow along Rolleston Street.

The Upper and Lower Fields will be raised (using material excavated from the reservoir site) and reshaped as part of the project. Primary and secondary flow will be conveyed by drains along the fields, with the Upper Field discharging to Rolleston Street and the Lower Field discharging to the Papawai Stream.

The likelihood of a seismic event (earthquake) leading to either a structural failure of the reservoir or a failure of the reservoir pipework is very low. The reservoir will be designed as a water retaining structure, with Importance Level 4, and therefore the likelihood of structural failure is very low. The reservoir pipework will include flexible joints and a seismically activated shut-off valve at the reservoir, so the likelihood of pipework failure is low.

Stormwater management during construction is not included in this report, and is covered by a separate erosion and sediment control management plan.

Overall the effects of the proposed reservoir development on stormwater are very minor, and the effects of the reservoir scour flows and overflows will also be very minor.

13 References

Aecom, *Rolleston Street Stormwater Renewal Design Report*, October 2013.

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