

# MEMORANDUM

TO:	Clutha District Council	Job No.:	000873
ATTENTION:	Jules Witt	Date:	20 December 2024
FROM:	Melanie Stevenson	Page 1 of 13	
SUBJECT:	Hospital Creek Flooding 2 <sup>nd</sup> - 5 <sup>th</sup> October 2024 - Review	Reference:	MEMO 24-12-20 MKS 000873

## 1.0 Introduction

Fluent Solutions has been engaged by the Clutha District Council to provide a high level review of the October 2024 rainfall event that resulted in flooding of the industrial area in the vicinity of Frances and High Street, Balclutha. This area lies in the lower Hospital Creek catchment and is serviced by the Hospital Creek Stormwater System.

This review has involved meeting the affected business owners, Councillors, Council staff, operations staff, discussions with contractors and a high-level technical assessment of the factors that exacerbated flooding during the event. This memorandum presents the findings of the review and provides recommendations to help mitigate future flooding of the area.

## 2.0 Hospital Creek Stormwater System Description

The Hospital Creek Stormwater system drains a 402Ha catchment area comprising of:

- Upper Catchment - 304 Ha rural catchment area
- Lower catchment - 98 Ha urban catchment area.

The catchment area is shown in Figure 2.1 below.



**Figure 2.1: Hospital Creek Stormwater Catchment**

MEMORANDUM

Figure 2.2 shows the layout of the Hospital Creek Stormwater system.

Stormwater runoff flows from the upper rural catchment area are attenuated within the Hospital Creek Detention Basin.

Downstream of the detention embankment, Hospital Creek is conveyed via an open channel through flat farmland before entering a 1200mm diameter pipeline.

The pipeline discharges to an open channel near the Clutha River before either being gravity piped through to the Clutha River or pumped to the Clutha River, via the Hospital Creek Pump Station.

The system is described in further detail below.



Figure 2.2: Hospital Creek Stormwater System

## 2.1 Hospital Creek Detention Basin

Stormwater runoff flows from the upper catchment area are attenuated within the Hospital Creek Detention Basin that was constructed in 1984 to alleviate flooding to businesses and residential properties adjacent Hospital Creek. The detention basin contains a low level 450mm diameter pipeline through the embankment that allows normal flows from Hospital Creek to pass through. However, when the flow rate exceeds the 450mm pipeline capacity, excess water ponds behind the embankment. There is also a knife gate valve installed on the pipeline that allows adjustment of the flow rate from the full flow to no flow.

When the basin is completely full, it is designed to overtop via a spillway, into the Clutha River on the northern flood bank.

The flow rates from the Hospital Creek System downstream of the basin vary depending on the water level in the basin and the opening of the valve. An assessment of the flowrate through the pipeline indicates that a fully open valve will convey around 600-830 L/sec<sup>1</sup>. If the basin and embankment were not constructed and the stormwater runoff from the upper catchment was left unattenuated, the catchment flows from this system would be significantly more than this<sup>2</sup>.

## 2.2 Hospital Creek Pipeline

The Hospital Creek stormwater pipeline is a 1200mm diameter concrete pipeline that conveys the creek through the urban Balclutha area. This was built in 2007 to replace an open channel system. A screened culvert with wingwalls is located at the head of the pipeline. A series of scruffy domes are located along the length of the pipeline in the lower catchment that allow drainage into the pipeline, but also allows water to surcharge out of the pipeline. Surcharging of the pipeline via the scruffy domes occurred during the October flood event.

A high-level assessment of the capacity of this pipeline indicates the pipeline has the capacity to convey an estimated 2,100 L/sec without surcharging.

## 2.3 Gravity Outfall

The gravity outfall comprises a 1200mm diameter concrete pipe with the flood gate that prevents the Clutha River backing up into Balclutha when the river levels are elevated. This gate has a chain wind up system that allows the gate to be held open if required, to improve drainage from Hospital Creek.

Anecdotal evidence indicates that flows through the flood gate can start being affected when the flow in the Clutha River at Balclutha is in the order of 1,200m<sup>3</sup>/sec<sup>3</sup>.

Following the October 2024 event, a log was found on top of the chain that may have been causing the gate to not be fully closed. See Figure 2.3 below.

Survey information confirms that the flood level during the October event was around 1.6m above the flood gate which would have been high enough to shift the log into this position.

<sup>1</sup> With a detention basin water level depth of 2-4m.

<sup>2</sup> In the order of 11,000 L/sec for a 100 year event.

<sup>3</sup> Jules Witt comment based on backflow that occurred on 26<sup>th</sup> October 2024 through open flood gate.



**Figure 2.3: Log on Flood gate at Gravity Discharge**

## 2.4 Hospital Creek Pump Station

The Hospital Creek Pump Station is located at the end of the Hospital Creek Channel adjacent the Owaka Highway. The pump station contains 2 MacEwans flood pumps<sup>4</sup> that switch on/off automatically based on upstream water levels in the channel. The intention is that when gravity drainage is not adequate, the pumps will turn on to increase drainage from Hospital Creek. When the Clutha River water level is elevated above the drainage levels in Hospital Creek, drainage from Hospital Creek is solely reliant on the operation of the pump station as the gravity discharge pipeline flood gate will be closed.

The pumps each discharge to a chamber adjacent the pump station that then drains to the Clutha River via a 1200mm diameter pipe. There is a flap gate on each pump discharge, but no apparent flood gate on the discharge at the Clutha River.

Following the October event, it was detected that the flap gate on the larger pump was jammed open and water from the Clutha River was flowing back through the pump chamber and pump, and into the inlet channel.

<sup>4</sup> The pumps were serviced in 2020.

A high level assessment indicates that these pumps should have the following estimated flow capacities based on 2m discharge head:

- Small Pump (MacEwans 12/14 B+4) - 220 L/sec
- Larger pump (MacEwans 18/22 C+4) - 620 L/sec

The total capacity of the pump station therefore has a theoretical capacity of around 840 L/sec however there is no flow monitoring on the discharge pipeline to confirm whether the pumps operate at this capacity. These pumps are also very old and may not be operating efficiently.

## 2.5 Operations of the Hospital Creek System

The Hospital Creek System is relatively simple. There are a limited number of operations and maintenance activities that need to be completed to ensure it is working effectively.

These are:

- Closing the Hospital Creek Basin detention valve when the downstream Hospital Creek drainage system is at capacity (either partially or fully depending on downstream drainage performance)
- Opening the valve to drain the upper catchment following a flood event, when the downstream flooding has subsided
- Ensuring the pump station is operational by addressing faults, cleaning screens, regular servicing
- Checking all flood/flap gates are operating (normally properly closed but can freely open) and are clear of debris
- Pipelines and grates are free of debris

## 3.0 The Event (2<sup>nd</sup> - 5<sup>th</sup> October 2024)

The October 2024 weather event brought rain-bearing easterly winds that affected the coastal areas of the Otago region including North Otago, Dunedin, and the Clutha District.

The storm event impacted the coastal areas of the Clutha District with surface flooding causing the closure of 65 roads due to flooding and landslips and affecting the operation of several wastewater pumping stations and wastewater treatment plants.

A State of Emergency was in place from the around 1pm on Friday 4<sup>th</sup> October until around midday Sunday 6<sup>th</sup> October.

### 3.1 Balclutha Rainfall

Rainfall<sup>5</sup> started falling on the morning of Wednesday 2<sup>nd</sup> October at 9am local time and it continued to rain at various intensities until it finally stopped raining around 11pm on Friday the 4<sup>th</sup> of October. The most intense rainfall period occurred on the Friday, between 8am to 12 noon, with peak intensity occurring over the hour between 9am and 10am. The rainfall data is presented in Figure 3.1 below.

<sup>5</sup> As measured at the Balclutha Rain Gauge - ORC

An analysis of the rainfall depth duration to provide the estimated ARI (annual return interval) using historic rainfall is presented below. The rainfall experienced at the Balclutha rain gauge places the 24 hour rainfall at approximately a 25 year event. For the shorter duration rainfall (that would impact the Hospital Creek System), the rainfall intensity is considered to be representative of a storm having less than a 10 year ARI.

Duration (hour)	Depth (mm)	Estimated ARI
1	7.5	<2 year
2	14	2 year
6	35	10 year
12	57.5	20 year
24	80	25 year
48	102	25 year

It is worth noting that the rainfall data collected at the Inch Clutha weather station indicates a much larger event with the 24 hour event estimated to be 250 year event. This indicates that the storm was significantly worse closer to the coast but also highlights the variability in rainfall that can occur within a relatively short distance. Based on this, it is possible that Hospital Creek may have received more rainfall than is indicated by the Balclutha rain gauge records.

### 3.2 Clutha River Flows

As discussed above, water levels in the Clutha River have an impact on drainage from the Hospital Creek stormwater system. Therefore, when considering the performance of the system and the possible cause of flooding, it is important to understand what the Clutha River was doing during the flood event.

Figure 3.1 below, displays the flows in the Clutha River in comparison to the Balclutha rainfall data.

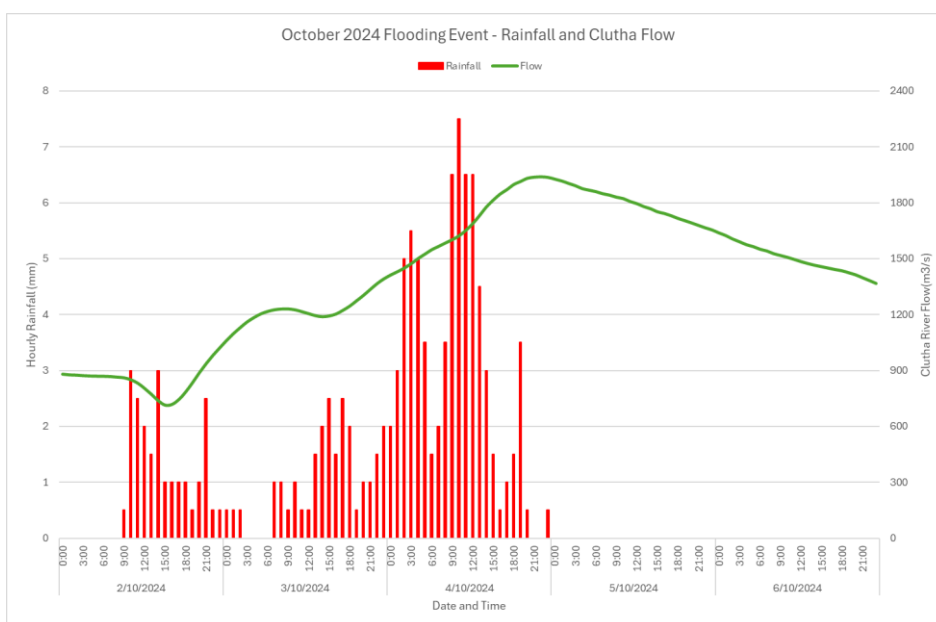


Figure 3.1: October 2024 Graph of Rainfall versus Clutha River Levels

MEMORANDUM

River gauging information at the Balclutha site indicates that the Clutha River was rising steadily throughout the rainfall event and peaked around 1940m<sup>3</sup>/sec at 10pm on Friday, 4<sup>th</sup> October, at a similar time to the rain stopping. When rainfall at Balclutha was at its most intense, the Clutha River was flowing at around 1,600 to 1,700m<sup>3</sup>/sec.

Drainage from the Hospital Creek gravity discharge would start to be affected at a flow of approximately 1,200m<sup>3</sup>/sec. This would have occurred in the early hours of 3<sup>rd</sup> October before the higher intensity rain occurred.

### 3.3 Flooding and Response

The characteristics of the flooding experienced in the Hospital Creek System and industrial areas, as well as the responses from Council and Civil Defence are presented in Table 3.1 below.

The extent of flooding is indicated in Figure 3.2. It should be noted that this includes flooding to several businesses as well as some residential properties on Ryrie Street.

A survey of the flood event indicates that flood levels in the industrial area were at an elevation of approximately RL 5.9m. This is similar to the surveyed peak flood level in the Clutha River.



Figure 3.2: Approximate Flood Extent October 2024 - Flood Level around 5.9m NZVD2016

MEMORANDUM

**Table 3.1: Timeline and Flooding and Responses**

Date	Time	Flooding	CDC Response
Thursday 3 <sup>rd</sup> October	5pm		Council sets up Partial Emergency Operations Centre (EOC) at Council in response to ORC Flood Alert and heavy rainfall warning across coastal and southern rivers.
	Around 11pm	No sign of surface flooding in Balclutha, however a rising water table was noticed in the evening in Frances Street area.	CDC decides to close down EOC overnight and reassemble early morning as there was no sign of flooding. Hospital Creek pumps checked. Two faults occurred on larger pump due to frequent on/off but is reset by operational staff and pump continues operation. Screens cleared as required <sup>6</sup> .
Friday 4 <sup>th</sup> October	7.30am	The first sign of noticeable surface flooding was reported by Mike Christie. Water was starting to pond around mudtank outside 10 Frances St. Water is also seen near the top of the scruffy dome on Frances St.	CDC reassembles in Council Offices around 7-7.30am. CDC operational staff organise Electrical Contractor (Jason Sheppard) to change setting on large pumps to prevent faults.
	7.30-10am	Water continues to rise rapidly in the Frances Street area and by 10am water is through buildings.  Water in the Hospital Creek detention basin increased to around half full when the valve was closed.  Jason Sheppard (Electrician) reported that there was about 200mm of floodwaters above pump station floor when he visited site. The exact timing of this is unknown.	8.30am - Council partially closes valve on outlet from Hospital Creek detention basin. 9.11am <sup>7</sup> - Council (Peter Faulkner) shuts valve completely - however there is some leakage. 9.35am - SouthRoads (Council Contractor close Frances St) in response to CDC <sup>8</sup> and local request. Jason Sheppard (Electrician) fixes fault on pump in the morning.
	10am-12pm	Flood levels continue to rise quickly with up to 600mm of flood water in lower lying properties and damage to plant and equipment.	
	12pm-midnight	Local opinion is that the rate water level increase slows down with the flood levels reaching its peak at around 7-8pm.	At 1.05pm CDC declares a Civil Defence Emergency. Media release issued at 2.17pm.
Saturday 5 <sup>th</sup> October	Midnight to 7am	Flood levels remain relatively stagnant with no obvious flood relief.	At 1am – Civil Defence calls Fire Brigade to start pumping.
	7am-2pm	Flood levels eased.	Fire Brigade pump water from the Hospital Creek Channel to the Clutha River. Jason Lyall states 1,000m <sup>3</sup> pumped over 7 hours. This is in the order of 40 L/sec.
	2pm	Floodwaters cleared and clean up begins.	Fire Brigade stops pumping.
Sunday 6 <sup>th</sup> October	12pm		Civil Defence Emergency lifted.

<sup>6</sup> Screenings during event not of significance

<sup>7</sup> Timing specifically known based on GPS recordings on truck. Councillor also witness to Peter Faulkner on site at the time.

<sup>8</sup> CDC sent email at 9.30am.

MEMORANDUM



### 3.4 Hospital Creek Pump Station Operation

An assessment of the pump station records indicates the following:

- The small pump started running just before midnight on 2<sup>nd</sup> October and ran through to 13<sup>th</sup> October at around 10pm.
- The large pump started operating at 9pm on 3<sup>rd</sup> October and stopped running full time at 5.15pm on 5<sup>th</sup> October.

### 3.5 Peak Flow Assessment

An assessment of peak flows likely to be flowing from the upper and lower catchments has been completed based on using the Rational Method and the rainfall records from the October 2024 event. The results are presented in the table below.

**Table 3.2: Estimated Peak Flow Rates During the October 2024 Event**

	<b>Unattenuated</b> (assumes no Hospital Creek Basin Detention)	<b>Attenuated through 450mm Diameter Pipeline</b> (valve open)	<b>Attenuated</b> (valve closed)
Upper Catchment	2,880 L/sec	725 L/sec	25 L/sec <sup>9</sup>
Lower Catchment	1,000 L/sec	1,000 L/sec	1,000 L/sec
<b>Total Peak Flow</b>	<b>3,880 L/sec</b>	<b>1,725 L/sec</b>	<b>1,025 L/sec</b>

The estimates indicate that:

- The Hospital Creek detention system embankment outlet pipeline offered good control of the outflow during peak flow conditions.
- The closing of the valve reduced the overall flows by around 40%.
- The likely peak flow during the October 2024 event was in the order of 1,025 L/sec (as the valve was closed just prior to the peak intensity rainfall storm).

It is noted that during the October event the detention pond was partially full prior to the valve being closed indicating that it was operating to detain peak stormwater flows without the valve closure.

### 3.6 Flow verses Capacity During the Event

The peak flow assessment of the October 2024 event indicates a peak flow rate of 1,025 L/sec during the flood event. This flow would have been conveyed safely through the Hospital Creek pipeline, with an assessed capacity of around 2,100 L/sec. However, assuming the gravity drainage discharge was compromised by the water levels in the Clutha River<sup>10</sup>, the drainage from the network was reliant upon the Hospital Creek pump station. With a theoretical capacity of around 840 L/sec, the pump station would be **inadequate** to keep up with peak flows.

<sup>9</sup> allowance for leakage

<sup>10</sup> Clutha river level was in the order of 1,600 to 1,700 cumecs and would have submerged the outlet

During the time of peak flow, some flooding would have occurred as the pump station struggled to keep up. However, this would not have lasted long as rainfall intensity decreased. By around lunchtime on Friday the 4<sup>th</sup>, the pump station would have been expected to manage the drainage and clear the floodwaters relatively quickly. As reported above, this did not occur and flood waters continued to rise until the evening and did not clear until the following day.

### 3.7 Comparison with February 2020 Event

In February 2020, there was another rainfall event with more rainfall than the October 2024 event that **did not** cause the same flooding of the industrial area. The February 2020 rainfall event was of a similar duration but there was more rainfall and it was of higher intensity than in October 2024, and had a higher calculated peak flow.

The level in the Clutha River peaked at a much higher flow (3,040m<sup>3</sup>/sec) but this occurred after the rain had stopped. Also, when the peak intensity rainfall was occurring, the levels in the Clutha River were low enough to not be impeding the gravity drainage outfall<sup>11</sup> (see Figure 3.3 for flow and rainfall).

In summary, the February 2020 event did not result in flooding as the river levels would not have impeded drainage to such an extent.

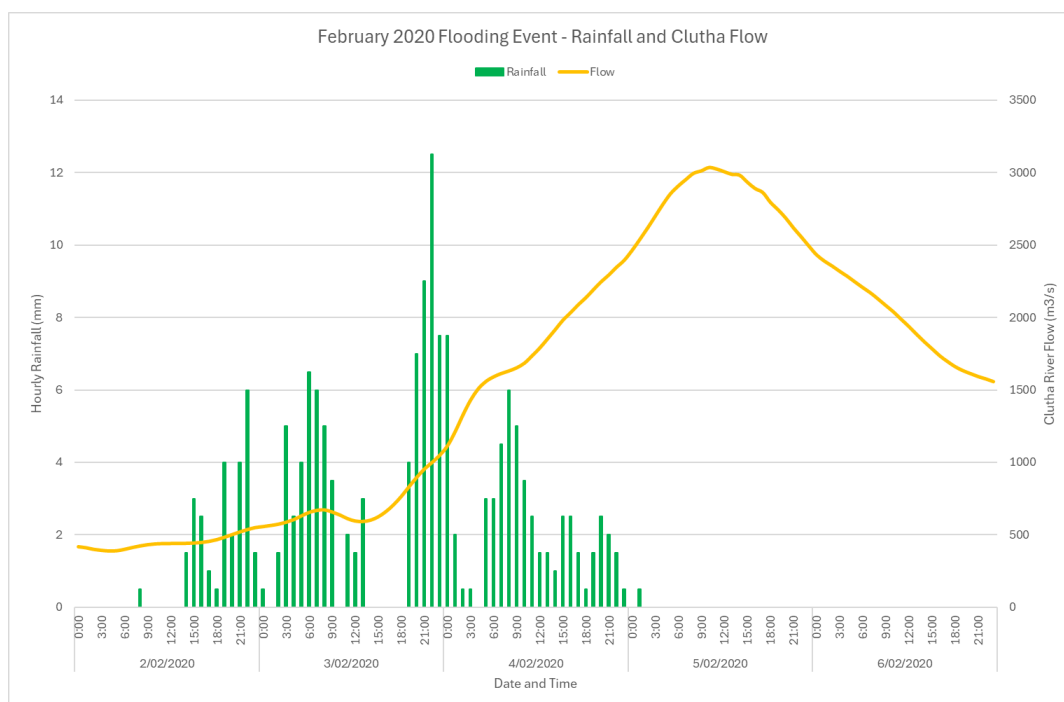


Figure 3.3: February 2020 Graph of Rainfall versus Clutha River Levels

<sup>11</sup> Less than 1,200 cumecs

## 4.0 Discussion

### 4.1 What Exacerbated the Flooding in October 2024?

The October 2024 rainfall event resulted in unexpected flooding of the industrial area adjacent Hospital Creek that caused significant damage to businesses and properties. The notable characteristic of this flood was that the floodwaters remained for almost 24 hours after the high intensity rain had subsided despite the Hospital Creek Pump Station operating.

The existing stormwater system (pipeline and pump station) should have coped much better with the flows during the October 2024, but the Hospital Creek Pump Station was not as effective as expected. Unusually, the Fire Brigade's pumping efforts noticeably reduced flood levels, despite being a fraction (<5%) of the pump station's theoretical capacity. The cause of the unprecedented flooding appears to be related to levels in the Clutha River and the ability for the pumps to drain the water. Flood level survey information indicates that the flood levels in the industrial area were similar to those in the Clutha River. While the exact cause of the flooding cannot be determined with the limited data available, possible scenarios include:

- The flood gate on the gravity discharge was partially open due to a heavy log weighing down the lifting chain, allowing water from the Clutha River to backflow into the area and making it difficult for the pumps to keep up with drainage.
- The Hospital Creek pumps were operating, but the effective pumping rate was inadequate, which could be due to a number of reasons.
- A combination of the above.

There has been a lot of speculation about the timing of the closing of the gate valve from the Hospital Creek Detention Basin and if it was closed earlier, the flooding would have been prevented. The valve was closed partially from 8:30am and fully at 9:11am on Friday. At the time, the Frances Street area was experiencing rapid rises in floodwaters, and the scruffy domes on the Hospital Creek stormwater pipeline were starting to surcharge. Closing the valve earlier may have mitigated some of this initial flooding, but it would not have prevented the subsequent flooding on Friday, October 4<sup>th</sup>, or the prolonged drainage of floodwaters.

### 4.2 Council Actions

The Council had appropriately responded to the weather forecast and the ORC River warnings on the 3<sup>rd</sup> October by setting up the Partial Emergency Operations Centre (EOC). Later in the evening of the 3<sup>rd</sup> the Partial EOC group decided to head home for the evening as the rainfall and river levels was in check. There was no real concern about the Hospital Creek System.

On the morning of October 4<sup>th</sup>, the first signs of flooding in the industrial area appeared. Council operators closed the Hospital Creek valve and checked that the pumps were operating. Ordinarily, this would have been adequate for the rainfall during the October event. However, it wasn't. Floodwaters continued to rise throughout the day, and even after the rainfall had slowed considerably and stopped, the floodwaters did not recede as expected.

Many of the business owners affected by the flood were dissatisfied with the Council response to the flooding, and their communication throughout the event. The lack of communication and the response were likely influenced by the following:

- there are a number of new staff and contractors at the CDC, who were unaware of all of the infrastructure
- there are no operations and maintenance manuals for key infrastructure
- there was flooding throughout the Clutha District diverting focus elsewhere
- there is no Flood Response Plan in place
- there is no communication plan in place

The items above have been identified as recommendations for improvement, along with other issues raised in this memorandum.

## **5.0 Conclusion**

The October 2024 rain event resulted in unexpected flooding of the industrial area adjacent to Hospital Creek causing significant damage to business and properties. The notable characteristic of this flood was that the floodwaters remained for almost 24 hours after the high intensity rain had subsided despite the Hospital Creek Pump Station operating.

An assessment of the factors exacerbating the flooding indicate that it was likely due to:

- The flood gate on the Hospital Creek pipeline gravity discharge was partially open due to a heavy log weighing down the lifting chain, allowing Clutha River water to backflow into the area and making it difficult for the pumps to keep up with the drainage.
- The Hospital Creek pumps were operating, but the effective pumping rate was inadequate, which could be due to a number of reasons.
- A combination of the above.

There has been a lot of speculation about the timing of the closing of the gate valve from the Hospital Creek Detention Basin. Following the review, it is concluded that while the closing of the gate valve may have reduced some of the initial flooding, it would not have addressed the subsequent flooding on Friday the 4<sup>th</sup> October and the delayed drainage of floodwaters that occurred.

A review of Council's communication and flood response during the October event has highlighted the need for improved systems and procedures including the development of a Flood Response plan, Operational and Maintenance manuals and ensuring training of key staff. Recommendations for mitigating flooding in the future are presented in Section 6 below.

## 6.0 Recommendations

The following items are recommended:

Further Investigations:

- Complete a more thorough assessment of the performance of the MacEwans pumps at the Hospital Creek pumping station - this should include a flow test for each pump to ensure they are operating as expected.

Maintenance:

- Repair flap gate on discharge from larger pump and inspect and maintain the flap gate on the smaller pump.

Operations:

- Ensure the chain on flood gate on gravity discharge pipe allows the gate to completely lower with a further allowance for slack - to ensure logs cannot hold gate open.
- Council to develop and produce operations and maintenance manuals with clear operational procedures for the system. This should include checks to be made and frequency of checks.
- That Council implement processes to train new staff on how to operate the infrastructure.
- That Council develop a Flood Response Plan for the Hospital Creek System. This should include:
  - Actions to be completed at the various stages of weather event, such as:
    - Check the gravity pipeline flood gate is closed and free of debris
    - The pumps are fully operational
    - When the Hospital Creek Detention Basin gate valve should be closed
  - Up to date contact phone numbers of key people who are at risk of flooding or a representative
  - Contingency planning for when there is a failure of the pumps, such as bringing in a generator, or having Fire Service on call
  - A Communication Plan to ensure affected parties are notified throughout the event.

Capital:

- Add level monitoring and alarming to the Hospital Creek Pump Station.
- Improve access to flood gates and pump flap gates to allow checks and maintenance to be completed in a safe manner.
- Consider an upgrade to the pump station to ensure pumping is at sufficient capacity to provide an adequate level of service when the Clutha River is elevated.
- Investigate and implement ways to prevent backflow from the Clutha River if there is flood gate/flap gate failure during an event.