MWH now part of Stantec

Client Ref: Consent No. 2002.369

28 September 2017

Otago Regional Council
Private Bag 1954
DUNEDIN 9054

Attention: **Chris Shaw**
Manager Consents

Dear Chris

Application for Resource Consent - Milton Wastewater Treatment Plant

Please find enclosed a consent application and assessment of environmental effects for a replacement consent for Consent No. 2002.369, which authorises the discharge of untreated sewage from the Milton Wastewater Treatment Plant to the Tokomairiro River. The existing consent expires on 31 December 2017.

Clutha District Council has arranged separate payment of the deposit for this application. The reference for the payment will be Milton Wastewater Treatment Plant Bypass Discharge – Consent Application.

Yours sincerely

Frances Lojkine
Principal Planner
Stantec New Zealand

Encl.: Resource Consent Application

Copy to: Clutha District Council, P O Box 25, Rosebank Terrace, Balclutha 9240. Attention: Kate Beswarick

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MILTON WASTEWATER TREATMENT PLANT BYPASS DISCHARGE - RESOURCE CONSENT APPLICATION AND ASSESSMENT OF ENVIRONMENTAL EFFECTS

PREPARED FOR CLUTHA DISTRICT COUNCIL

September 2017

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REVISION SCHEDULE

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			Prepared by	Checked by	Reviewed by	Approved by
1	26/9/17	Stantec review	FL	JD	JD, SB	RS

Clutha District Council

Milton Wastewater Treatment Plant Bypass Discharge - Resource Consent Application and Assessment of Environmental Effects

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Resource Management Act 1991 – Form 9

Application for Resource Consent under Section 88 of the Resource Management Act 1991.

To: Otago Regional Council
Private Bag 1954
Dunedin 9054

From: Clutha District Council
1 Rosebank Terrace
Balclutha 9230

(Please note different address for service at the end of this form)

Clutha District Council applies for the resource consent described below:

1. The name and address of the owner of the land to which this application relates is:

   Clutha District Council, 1 Rosebank Terrace, Balclutha 9230

2. The location to which this application relates is:

Legal description	Lot 45-50 and Pt Lot 51-53 Blk IX DP 104, Sec 143 Blk XVII Tokomairiro Survey District and Pt Lot 3 DP 1018 (Milton Wastewater Treatment Plant)
Physical address	Bruce Street, Milton, Otago
Grid reference	At or about NZMS 260 H45:748-487

3. The type of resource consent sought is:

   A **discharge permit** to intermittently discharge screened community sewage combined with stormwater to the Tokomairiro River

4. Description of the activity to which this application relates:

   The discharge of screened community sewage to the Tokomairiro River where the inflows to the Milton Wastewater Treatment Plant exceed the plant's capacity associated with rainfall events. The activity is more fully described in section 2 of the attached Assessment of Environmental Effects.

5. Additional resource consents required:

   No other resource consents have been identified as necessary in association with this application. Clutha District Council holds Consent 2007.090, which authorises the discharge of treated wastewater from the Milton Wastewater Treatment Plant to the Tokomairiro River, and Consent 2007.091, which

authorises the discharge of contaminants from wastewater treatment and disposal to air from the plant. The wastewater treatment plant is designated for "sewage treatment" in the Clutha District Plan.

6. Attached, in accordance with Section 88 and the Fourth Schedule of the Resource Management Act 1991, is an assessment of effects on the environment in the detail that corresponds with the scale and significance of effects that the proposed activity may have on the environment.

7. Additional information (if any), required to be included in the application by the regional plan or regulations is set out in the AEE sections of this document.

.....

Signature of applicant or person authorised to sign on behalf of applicant

Frances Lojkine

Date: 29 September 2017

Address for service of applicant:

Stantec NZ Ltd

PO Box 13 052

CHRISTCHURCH, 8141

Attention: Frances Lojkine

(please cc all correspondence to Clutha District Council, P O Box 25, Rosebank Terrace, Balclutha 9240, Attention: Kate Beswarick)

Direct Dial:	03 341 4736
Cellphone:	021 283 1941
Email:	frances.lojkine@stantec.com

Fourth Schedule Checklist

The following table identifies the matters required to be included in resource consent applications under the Fourth Schedule of the Resource Management Act 1991, and their location in this application document.

Information Required	Relevant Section in this Report
Description of the activity.	**Section 2.2**
Description of the site at which the activity is to occur.	**Section 2**
Full name and address of each owner or occupier of the site.	Refer to **Form 9, page i**
Description of any other activities that are part of the proposal to which the application relates.	**Section 2**
Description of any resource consents required for the proposal to which the application relates.	**Section 4.1**
An assessment of the activity against the matters set out in Part 2.	**Section 11.6.1**
An assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b), including: a. Any relevant objectives, policies or rules in a document; and b. Any relevant requirements, conditions or permissions in any rules in a document; and c. Any other relevant requirements in a document (for example, in a national environmental standard or other regulations).	**Section 11** covers relevant: • National policy statements • National environmental standards • Regional Policy Statement for Otago • Regional Plan: Water for Otago • Kāi Tahu ki Otago Natural Resource Management Plan 2005
If any permitted activity is part of the proposal to which the application relates, a description of the permitted activity that demonstrates that it complies with the requirements, conditions, and permissions for the permitted activity.	**Section 4.2**
If the application is affected by section 124 or 165ZH(1)(c) (which relate to existing resource consents), an assessment of the value of the investment of the existing consent holder (for the purposes of section 104(2A).	**Section 2**
If the activity is to occur in an area within the scope of a planning document prepared by a customary marine title group under section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011, an assessment of the activity against any resource management matters set out in that planning document (for the purpose of section 104(2B)).	Not applicable
If it is likely that the activity will result in any significant adverse effects on the environment, a description of any possible alternative locations or methods for undertaking the activity.	**Section 7**
An assessment of the actual or potential effect on the environment of the activity.	**Section 6**
If the activity includes the use of hazardous installations, an assessment of any risks to the environment that are likely to arise from such use.	The activity does not include the use of hazardous installations.
If the activity includes the discharge of any contaminant, a description of: i. The nature of the discharge and the sensitivity of the receiving environment to adverse effects; and	**Sections 3, 5 and 7**

Information Required	Relevant Section in this Report
ii. Any possible alternative methods of discharge, including discharge into any other receiving environment.	
A description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effects.	**Section 8**
Identification of the persons affected by the activity, any consultation undertaken, and any response to the views of any person consulted.	**Section 9**
If the scale and significance of the activity's effects are such that monitoring is required, a description of how and by whom the effects will be monitored if the activity is approved.	**Section 8**
If the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).	Not applicable – no relevant applications received by the Crown (reference: Ministry of Justice website)
Any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects.	**Section 6**
Any physical effect on the locality, including any landscape and visual effects.	**Sections 6.1.5** and **6.4**
Any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity.	**Section 6.2**
Any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations.	**Section 6**
Any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants.	**Sections 3, 5** and **7**
Any risk to the neighbourhood, the wider community, or the environment through natural hazards or hazardous installations.	Not applicable

1. Introduction

1.1 Background

Milton is a small township with a population of approximately 2500, located in South Otago. The township, the small settlement of Tokoiti to the southeast, and the Otago Corrections Facility to the north are serviced by the Milton Wastewater Treatment Plant (the MWWTP), located on the southern edge of Milton on the true left bank of the Tokomairiro River.

The MWWTP was constructed in 1965 and its operation was authorised as a 'notified use' under the transitional provisions of the Resource Management Act 1991 (the RMA) until 2001, when the following resource consents were obtained:

- a discharge permit (Consent No. 2001.755) to authorise the discharge of up to 850 m^3/day of treated sewage to the Tokomairiro River; and
- a discharge permit (Consent N0. 2002.369) to intermittently discharge untreated sewage mixed with stormwater to the Tokomairiro River in heavy rainfall events (referred to hereafter as the bypass discharge).

The application for these two resource consents noted that there was excessive infiltration of stormwater into the sewer system in wet weather. The average dry weather flow was noted as being approximately 500 m^3/day, with wet weather flows as high as 10,000 m^3/day. While sewage flows typically increase in wet weather, they are generally anticipated to increase by a factor of approximately 5 times the average flow, which in the case of the MWWTP would equate to a wet weather flow of approximately 2500 m^3/day. Wet weather flows in Milton can therefore increase by a factor of approximately 18, which poses particular challenges for managing sewage treatment during periods of wet weather.

Both of the permits applied for in 2001 were issued with an expiry date of 31 December 2017. Since that time the MWWTP has been subject to a number of upgrades, and in 2007 a new discharge permit was applied for, to authorise the discharge of up to 1650 m^3/day of treated sewage to the Tokomairiro River. The substantial increase in the volume for the new permit resulted from the addition of pre-treated sewage from the Otago Regional Corrections Facility constructed to the north of Milton in 2007. That consent (Consent No. 2007.090) has an expiry date of 2044.

Consent No. 2002.369 for the untreated sewage discharge is approaching its expiry date and a replacement consent is now sought through this application. As outlined in this application document, some changes have been made to the discharge since the current consent was granted, and works have been completed. Further works are planned to reduce the number of discharges that occur.

1.2 Purpose of this Document

The purpose of this document is to provide the information required to support the application for the replacement consent now sought. This includes a description of the bypass discharges from the MWWTP, an assessment of the actual and potential effects on the environment of the discharge and an outline of proposed mitigation measures to reduce the incidence and/or effects of the discharge.

This document includes an Assessment of Environmental Effects (AEE) which has been prepared in accordance with the Fourth Schedule and section 88 of the Resource Management Act 1991 (the RMA), and provides information in support of the resource consent application. The scope of the resource consents sought is set out in detail in section 4.1 of this report.

2. Milton Wastewater Treatment Plant

2.1 Location

The MWWTP is located on Bruce Street, Milton, adjacent to the true left bank of the Tokomairiro River, as shown in Figure 2-1. The discharge is via a single pipe to the middle of the Tokomairiro River channel, immediately downstream of the confluence of the East and West Branches.

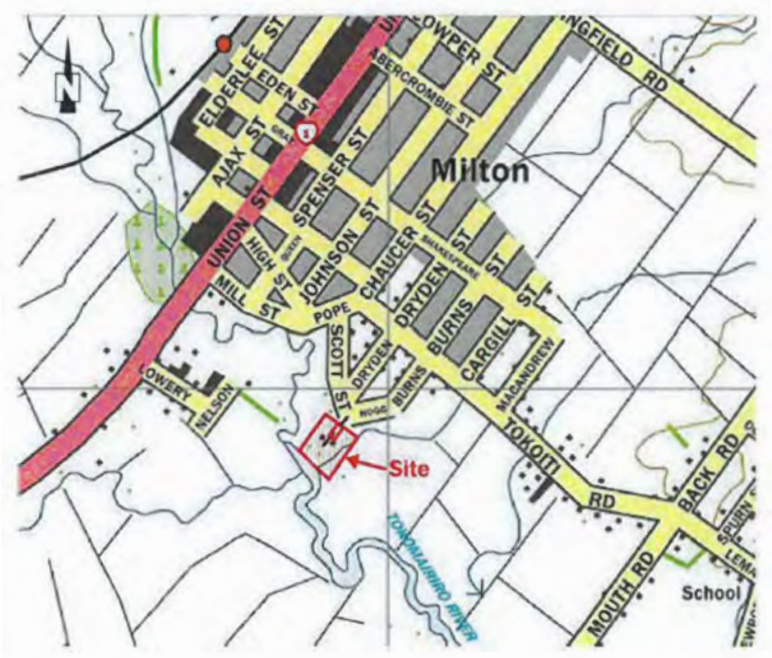


Figure 2-1: Milton Wastewater Treatment Plant Location

2.2 Plant and Bypass Discharge Description

The sewage treatment process at the MWWTP (see Figure 2-2) consists of screening, Imhoff tanks, tricking filters, humus tanks, a surface flow wetland, and UV treatment, prior to a discharge directly to the Tokomairiro River. The MWWTP represents a significant investment for the Clutha District Council, with a replacement value of between $4 million and $5 million (Clutha District Council, Sewerage Scheme Activity Management Plan, 2015).

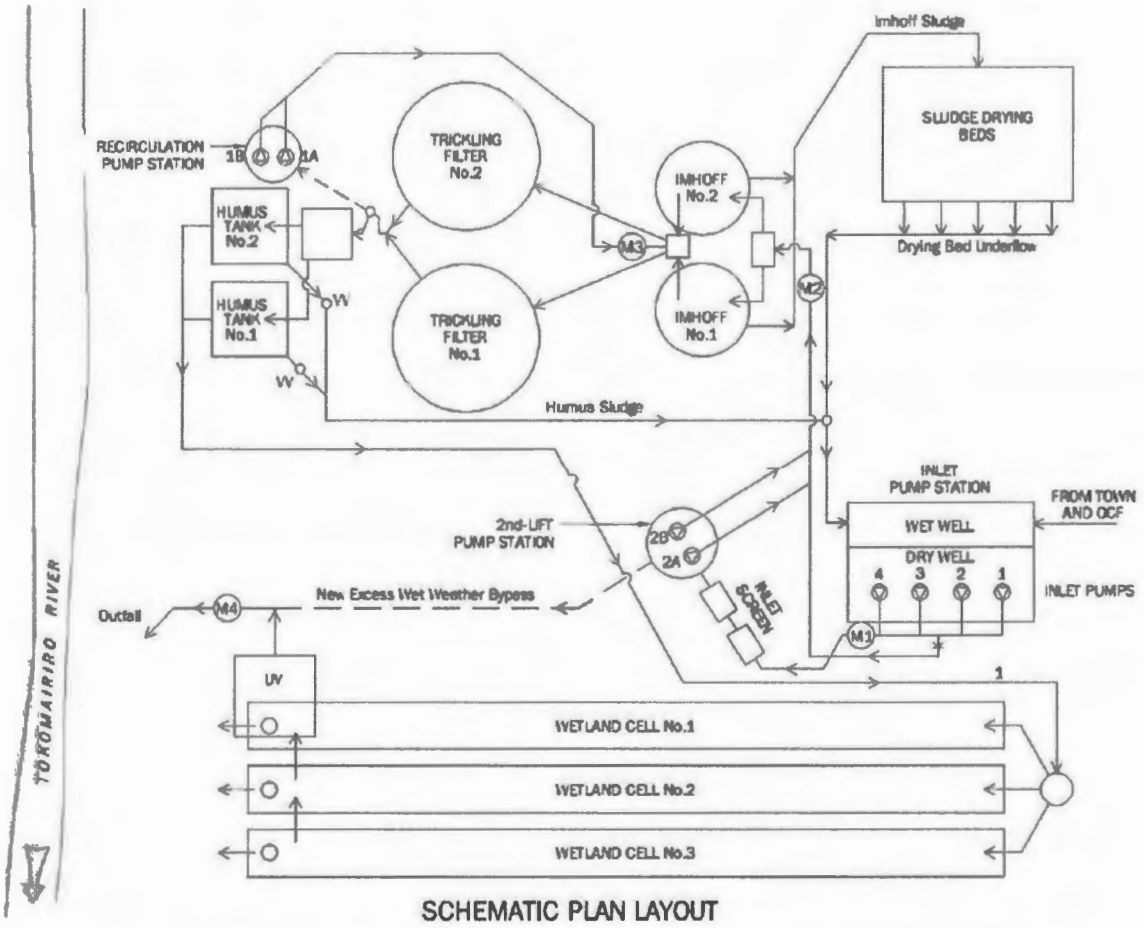


Figure 2-2: Milton Wastewater Treatment Plant Schematic

A brief description of the treatment process, including identifying how and where in the system bypass discharges occur is as follows:

- the wastewater stream from the Milton township and the Otago Corrections Facility is conveyed by gravity to a wet well at the head of the plant;
- wastewater is pumped from the inlet wet well to a step screen, which separates solids from the waste. This flow is measured by meter 1 (M1). The step screen is designed to receive and screen all flows from the inlet wet well up to a maximum of 125 l/s. Flow greater than this would bypass the screen, but to date no flows greater than 125 l/s have been measured coming into the plant;
- from the step screen, the wastewater passes through a weir tank (which acts to balance the flow) before dropping into the 2nd lift pump chamber;
- the 2nd lift pumps pump the waste to the top of the Imhoff tanks, with the flow being measured by meter 2 (M2). The 2nd lift pumps have a maximum capacity of 40 l/s, set in order to avoid overflowing of the humus tanks that operate later in the treatment process. When flows exceed 40 l/s into the 2nd lift pump chamber the pumps can no longer pump all of the wastewater to treatment and a bypass occurs. Flows of between 40 l/s and 125 l/s are therefore screened prior to discharge to the Tokomairiro River, but are otherwise not treated;
- the Imhoff tanks settle solids in the wastewater to the sludge zone in the base of the tanks and provide primary clarification and breakdown of solids (sludge digestion). The waste liquid passes through the Imhoff tanks and gravitates from the outlet chamber to either of the two trickling filters;

- the wastewater is distributed evenly across the two trickling filters, where it receives further treatment. Once the wastewater has passed through the trickling filters it gravitates to a splitter chamber, which divides the flow and recirculates the majority of it (90%) back through the trickling filters;
- wastewater that is not recirculated (10% of the flow from the trickling filters) flows to the humus tanks, which are secondary settlement tanks that settle out any remaining solids and any biomass that has sloughed off the trickling filters. From the humus tanks the wastewater flows to the inlet of the three wetland cells;
- having flowed through the wetland and received some final treatment, the wastewater passes through two banks of UV lights for disinfection prior to discharging to the Tokomairiro River. The bypass pipeline from the 2nd lift pump station joins the discharge pipeline just after the UV treatment, so when a bypass is occurring, the treated wastewater flows and the screened wastewater and stormwater flows combine at this point and are discharged together via the outfall to the Tokomairiro River.

The bypass discharge is not currently measured directly when it occurs. The flow is instead calculated by subtracting the M2 flow from the M1 flow.

2.3 Works to Reduce Frequency of Bypass Discharges

When consents were first granted for the MWWTP in 2002 the Otago Regional Council recognised the difficulty of addressing the level of stormwater infiltration into the wastewater system. Consent conditions were imposed on Consent No. 2002.369 requiring Clutha District Council to provide a stormwater management plan to set out the investigations and projected works to reduce stormwater infiltration, and two updates of that plan over the course of the consent to advise on progress with works. A copy of the initial stormwater management plan, and the two subsequent updates, is attached to this application document as Appendix A.

The size of the stormwater inflow and infiltration issue is illustrated by the work carried out by MWH New Zealand Ltd in 2001 (attached to this application document as Appendix B). Modelling of Milton's stormwater system as part of that work led to the conclusion that the system is unable to cope with a 1 in 5 year rainfall event, and that significant overland flow occurs in what are relatively small rainfall events. The 2001 Milton Stormwater Strategy included an estimate that between $1.3M – $1.8M of capital works would be required to address the issues identified, although even with the completion of all of the identified works, some minor overland flow would continue to occur in a 1 in 5 year rainfall event. Events larger than a 1 in 5 year rainfall event would continue to result in overland flow and likely inflow and infiltration to the sewer system.

The 2001 Milton Stormwater Strategy was reviewed by Opus and further options developed in late 2004 (attached to this application document as Appendix C). This review identified increased costs for one of the major components of the 2001 Stormwater Strategy (the Dryden Street rural diversion) and identified an additional $760,000 of works to address flooding in southern Milton adjacent to the Tokomairiro River, bringing the total costs of improving the stormwater system to its design standard to $2M - $2.5M.

To date, the following works identified in the 2001 and 2004 reports have been undertaken:

- construction of the Dryden Street rural diversion, to divert runoff from a large rural area to the east of Milton. This runoff previously entered the Milton stormwater system at the top end of Dryden Street, but due to capacity problems at the inlet (see p6 of the 2004 Opus report in Appendix B) frequently caused overland flow down Dryden Street in rainfall events as small as a 1 in 5 year return period. Flows are now diverted into existing rural drains that discharge to the Tokomairiro River downstream of Milton. This work was completed in 2010;
- construction of the Mill Street floodbank and pump station, to protect the southern area of Milton from flooding from the Tokomairiro River in a 1 in 50 year return period flood event and to maintain discharges of stormwater from the stormwater system to the river when the outlet is submerged by river flows. The floodbank was constructed in 2009-10 and the pump station in 2010.

While the 2001 and 2004 reports identified works to upgrade the capacity of the Milton stormwater system to its design capacity, both the Clutha District Council and the Otago Regional Council have recognised the contribution by larger events than 1 in 5 year rainfall events to flooding in Milton (and the likely occurrence of bypass discharges). In response, the two councils have developed *Milton 2060: Flood Risk Management Strategy for Milton and the Tokomairiro Plain*. This strategy sets out two major actions for Clutha District Council that are relevant to the occurrence of bypass discharges:

- identifying and remedying restrictions within the stormwater network, and its outlets to the Tokomairiro River;

- sealing the wastewater collection system to reduce infiltration and contamination of stormwater.

Both actions are identified as ongoing programmes of work throughout the life of the Milton 2060 Strategy, and would therefore not expect to be completed before 2060.

In addition, under the stormwater management plan, the following works have commenced:

- monitoring of flows at the MWWTP to assess the reduction of foul sewer flows during heavy rainfall events – occurrences of bypass discharges were recorded between 2004 and 2006 along with rainfall at the Glenledi weather station, and provided to the Otago Regional Council. Following the plant upgrade in 2009 and 2010, the telemetered calculation of the occurrence and daily volume of bypass flows have been provided to the Otago Regional Council. The occurrence of bypass flows is discussed in section 5 of this application document on the basis of this data. To date there has been no measureable improvement in the number of bypass discharges occurring, but as noted above the size of the remediation works required in Milton even to upgrade the stormwater system to its design capacity are such that this is not surprising;
- smoke testing of the existing sewer reticulation network in Milton was carried out between 20 June 2011 and 4 August 2011. Initial indications from the testing were that 53 properties were observed to either have a direct connection or discharge stormwater directly to the sewer. Thirty five properties have been inspected and 19 that were found to have stormwater drains connected to the sewer have been required to rectify the situation. The remaining 18 properties will be inspected within the next year and property owners will be required to remove any direct connections of stormwater to the sewer system;
- CCTV inspection of lengths of sewer and stormwater reticulation (selected both randomly and on the basis of historical reports of problems) were completed in 2007 and 2008. Remedial works were identified in a number of areas, but are a lower priority than addressing the stormwater capacity problems, flooding of areas of Milton during higher river levels and direct connections of stormwater to the sewers, as infiltration is believed to be contributing the least to the occurrence of bypass flows.

In summary, significant works have been undertaken over the course of the current consent to identify and understand the inflow and infiltration issues in Milton, and several major projects have been completed to try to reduce the occurrence of bypass discharges. However, the magnitude of the inflow and infiltration issues mean that it is likely to be a long term process to address as far as possible the causes, and ultimately reduce the scale and frequency of bypass discharges. Further work proposed for the term of the replacement consent now sought is outlined in section 8 of this application document.

3. Receiving Environment – Tokomairiro River

3.1 Catchment description

The Tokomairiro River catchment is 403 km² in area, and extends from Toko Mouth on the south Otago coast approximately 30 km inland to the north and northwest. The river splits into two branches (East and West Branches) at Milton, 21 km from the coast (see Figure 3-1). The East Branch has a catchment area of approximately 139 km² and the West Branch has a catchment area of approximately 201 km² (Otago Regional Council, 2014).

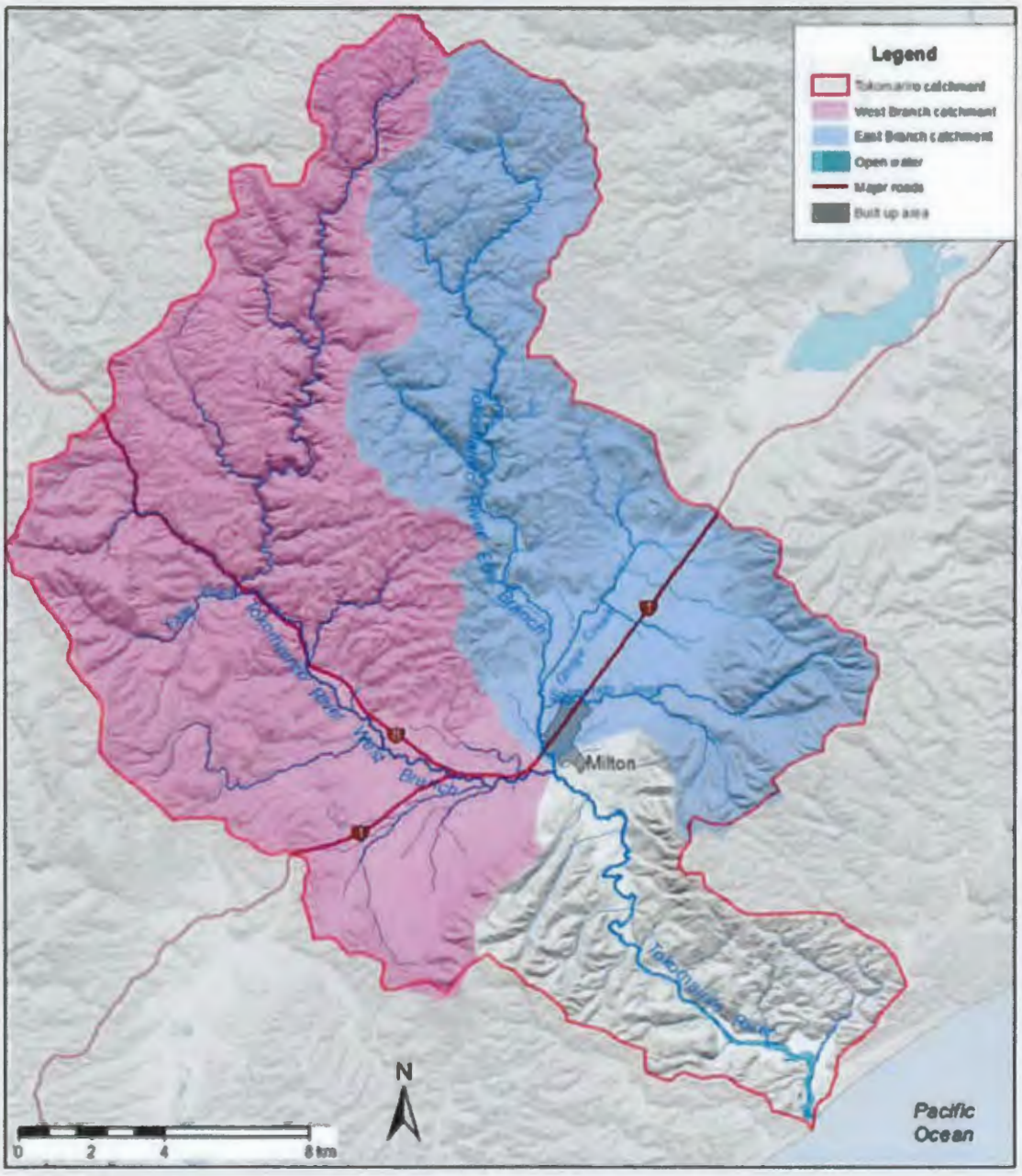


Figure 3-1: Tokomairiro River Catchment East and West Branches (Source: Management of Flows for Aquatic Ecosystems in the Tokomairiro River, September 2014)

Sheep and beef farming is the dominant land use in the catchment, with dairying on the Tokomairiro Plain. There are also substantial areas of commercial forestry in the catchment, particularly in the upper catchment areas of both branches, where they rise in Berwick Forest. The Otago Coast Forest covers some of the tributaries of the East Branch as well. Land cover in the catchment is illustrated in Figure 3-2.

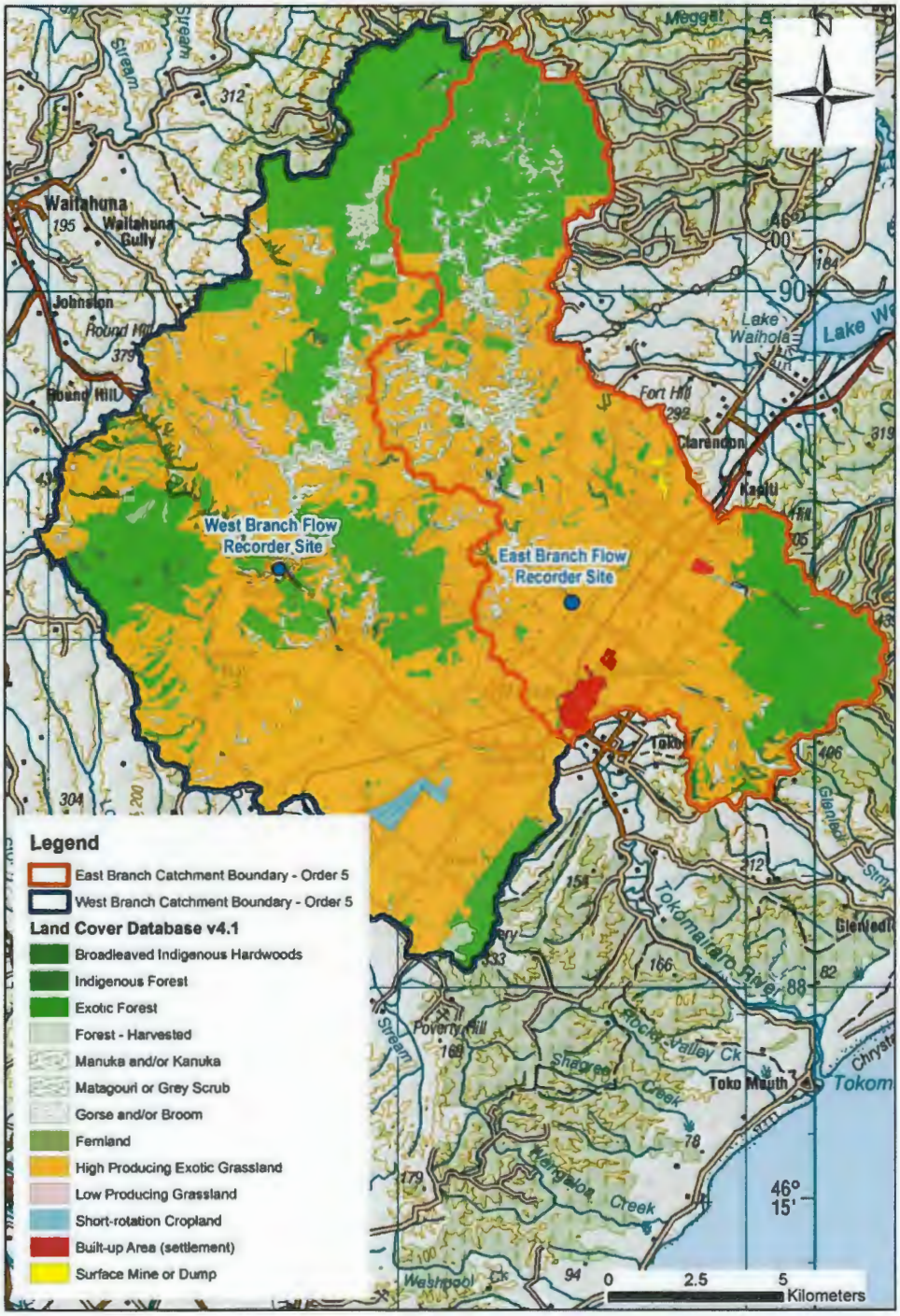


Figure 3-2: Land cover in the catchments of the East and West Branches of the Tokomairiro River (Source: Landcover Database v4.1)

3.2 Rainfall

The Tokomairiro River catchment has a cool-dry climate, with a mean daily temperature at Milton of 10°C, mean monthly minimum of 0.3°C in July and a monthly maximum of 20.4°C in February. Annual rainfall at Lovells Flat on the southwestern border of the Tokomairiro River catchment is approximately 750 mm/year, with a tendency for more rainfall in summer months (Otago Regional Council, 2014). Temperature and rainfall records are shown in Table 3-1 and Table 3-2.

Table 3-1: Mean monthly temperature (°C), mean daily minimum air temperature (°C) and mean daily maximum air temperature (°C) at the Milton weather station (1971-2000) (Source: ORC, 2014)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	14.8	14.8	13.0	10.4	7.6	5.2	4.8	6.2	8.4	10.4	11.9	13.8
Minimum	9.4	9.2	7.5	5.1	2.9	0.9	0.3	1.3	3.3	5.3	6.6	8.6
Maximum	20.0	20.4	18.5	15.8	12.3	9.6	9.2	11.0	13.5	15.5	17.2	19.0

Table 3-2: Mean monthly rainfall (mm) at Lovells Flat weather station (1981-2010) (Source: ORC, 2014)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
70	74	63	54	70	63	56	49	53	64	58	79	752

Flood events in the Tokomairiro River catchment are generally caused by persistent rain-bearing easterlies, with continual rainfall over several days saturating the soil, leading to rapid runoff. Generally these types of events occur in late summer to late autumn, although they can occur at any time of the year.

Figure 3-3 shows the distribution of rainfall across the catchment in a severe storm in July 2007. What is noticeable in this event is that the heaviest rainfall fell in a band along the low-lying area between Milton and Waihola. A similar pattern occurred in a major April 2006 event. Anecdotal evidence suggests that rainfall is often more intense through this low-lying part of the catchment (Otago Regional Council and Clutha District Council, 2012).

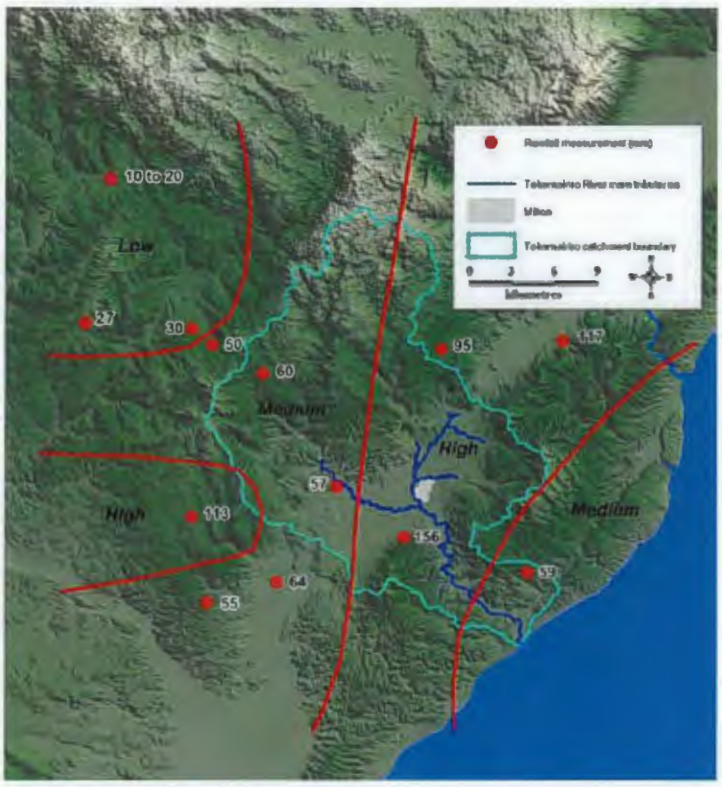


Figure 3-3: Rainfall totals (mm) at manual rain-gauge stations on 29 and 30 July 2007. Isohyets are shown as thick red lines, separating areas of low (<40mm), medium and high (>100mm) rainfall intensity during this period (Source: OCR and CDC, 2012)

3.3 River flows

River flow information is limited to one long-term river monitoring site on the West Branch of the Tokomairiro River at SH8, commissioned in 1981. The flow record for this monitoring site up to November 2011 (as used in *Milton 2060*) is shown in Figure 3-4.

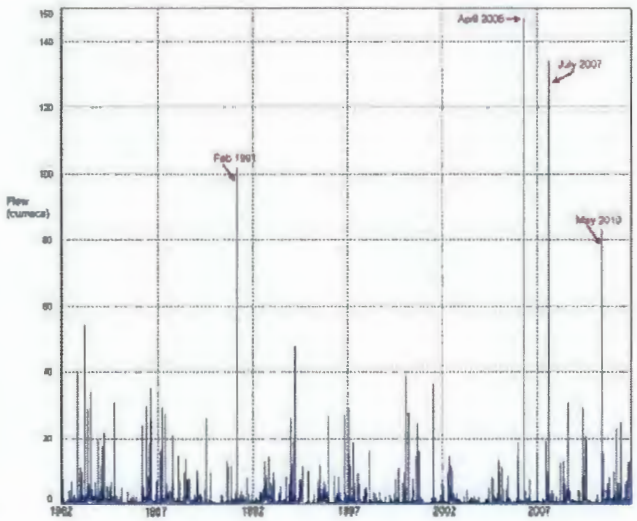


Figure 3-4: Flow record for the Tokomairiro River at West Branch Bridge, December 1981 to November 2011 (Source: Milton 2060)

The Otago Regional Council report *Management Flows for Aquatic Ecosystems in the Tokomairiro River* (September 2014) provides long-term flow statistics for the Tokomairiro River at the West Branch SH8 bridge flow recorder, as shown in Table 3-3.

Table 3-3: Long-term flow statistics for the Tokomairiro River at the West Branch SH8 bridge flow recorder (1981-2013)

Minimum flow (l/s)	7-day MALF (l/s)	Median flow (l/s)	Mean flow (l/s)	Maximum flow (l/s)
44	162	450	786	147,360

As part of that study the Otago Regional Council also calculated a synthetic flow record for the main stem of the Tokomairiro River at Coal Gully Road, which is located 6.4 km downstream of the discharge from the MWWTP. The flow statistics from that synthetic record are shown in Table 3-4.

Table 3-4: Flow statistics for the Tokomairiro River at Goal Gully Road based on a synthetic flow record (1981-2013)

Minimum flow (l/s)	7-day MALF (l/s)	Median flow (l/s)	Mean flow (l/s)	Maximum flow (l/s)
244	1,029	2,524	4,288	753,409

Note: Mean and median flows are daily averages, while minimum and maximum flows are instantaneous flows.

While the 2014 Otago Regional Council investigation provides flow statistics for the East Branch at the SH1 bridge (just upstream of the discharge point) and the West Branch at the confluence, these cover only the 2011/2012 hydrological year. There are therefore no long term flow records in close proximity to the MWWTP and a synthetic flow record has had to be generated for assessment of the potential effects of the bypass discharge.

A continuous flow record is available for the West Branch flow recorder site from 1981 to the present. Three to four flow records per month are available for the Lisnatunny flow recorder site from 1982 until 1989, and a small number of flow records are available for the years 2011 and 2012 (the period over which the Otago Regional Council 2014 study investigations were conducted). The flow at the MWWTP discharge point will be the sum of the West and East Branch flows at the point of the confluence.

Figure 3-5 below shows the location of each flow recorder site in relation to the discharge location. The West Branch flow recorder site is located at State Highway 8, approximately 15 kilometres upstream of the discharge. The East Branch flow recorder is located at Lisnatunny, approximately 4 kilometres upstream of the discharge.

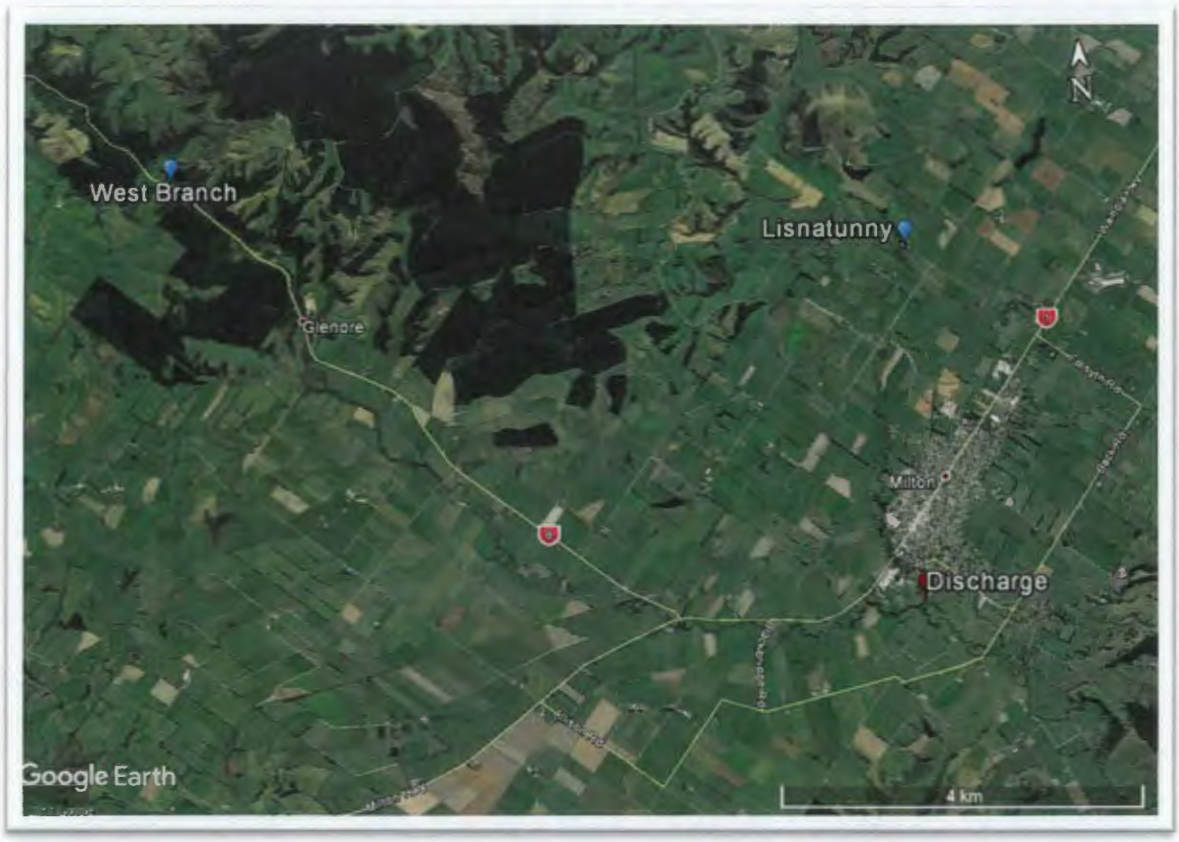


Figure 3-5: Flow recorder site locations

The Otago Regional Council developed a synthetic flow record to estimate the Tokomairiro River flow at Coal Gully Road, as outlined in Appendix 1 of the *Management Flows for Aquatic Ecosystems in the Tokomairiro River*, 2014. This synthetic record was calculated by scaling the West Branch flows by the ratio of the total West Branch catchment area to the West Branch catchment area upstream of the flow recorder site (ratio = 2.85). A synthetic dataset was then derived for the Lisnatunny record using the regression between the flows at the West Branch bridge flow recorder and the five hour shifted flows recorded at Lisnatunny between 8 February 2012 and 24 February 2012, as shown in Equation 3-1 below.

$$Lisnatunny=-0.0166(West\ Branch)^2 + 1.1393(West\ Branch)$$

Equation 3-1: Regression between West Branch and 5hr shifted Lisnatunny flows (source: Management Flows for Aquatic Ecosystems in the Tokomairiro River, 2014)

This equation was then applied to flows up to 35 m^3/s at the West Branch site and then this dataset was scaled-up based on the ratio of the total catchment area of the East Branch to the catchment area upstream of the Lisnatunny recorder site (ratio=2.11).

This record was then combined and scaled to provide a flow record at coal gully road, which is located 5.5 km downstream of the East and West Branch confluence.

For the purpose of this assessment, a synthetic record of daily river flows at the discharge site for the period 2010 to present was developed using the methodology outlined above, except that the flow record has not been scaled to derive the flows at Coal Gully Road, which is downstream of the discharge. The synthetic record for the East Branch has been derived from the record provided for the West branch as outlined above. It should be noted that the West branch flow record accessed was the average daily flow and therefore the synthetic East Branch flow is also the average daily flow.

Generally the flows correlate well at low flows, but the correlation is not as good during high flows, as demonstrated by analysis of recent significant rainfall events. The methodology employed by the Otago Regional Council and outlined above states that Equation 3-1 is not applied to flows above 35 m^3/s in the West Branch. For the purpose of this assessment the equation has been applied to flows above this rate, however it should be noted that this will provide an indication only of the flow at the discharge location at these elevated flow rates. There were three occasions during the data record when flows above 35 m^3/s were recorded at the West Branch flow recorder site: 17 June 2013, 4 June 2015 and the 22 July 2017.

Figure 3-6 plots the flow calculated as outlined above for the Tokomairiro River at the confluence of the East and West Branches, which equates to the expected flow at the point of discharge for the MWWTP.

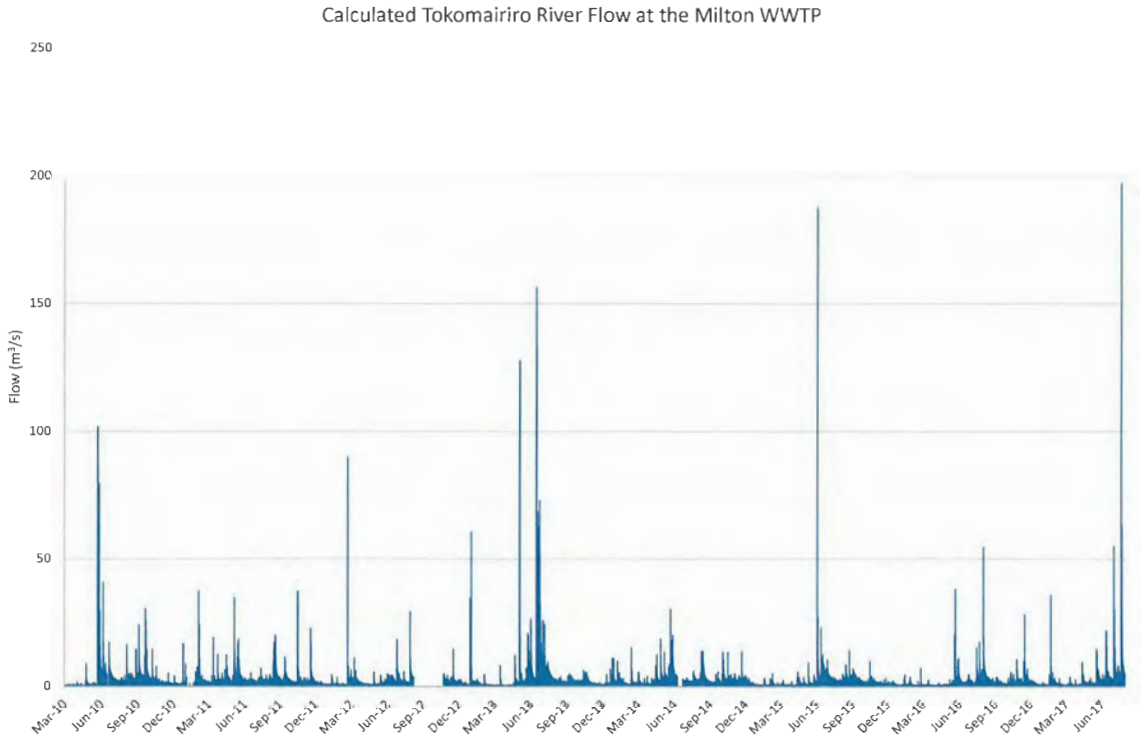


Figure 3-6: Calculated Tokomairiro River flow after the confluence of the East and West Branches

The calculation as defined above provides an estimate flow from March 2010 to July 2017. The flow record from the West Branch site (on which the calculated flow is based) contains two gaps, from the 11 August 2012 to 25 October 2012 and from the 11 June 2014 to 24 June 2014. The first was due to a logger programming fault and the stilling well intake being blocked which caused the data in this period to be unusable. The second was due to a fault with the NRT unit, which was replaced by a new unit.

This calculated flow record has been used to estimate the expected dilution at the time of the bypass events to assist with the assessment of the effects of the bypass on the receiving environment.

The median flow at the MWWTP discharge point calculated over the data period used for this assessment was 2.38 m^3/s with a minimum flow of 0.48 m^3/s and a maximum flow of 197 m^3/s. The maximum flow was associated with a very high rainfall event which occurred in July 2017 and resulted in a state of emergency being declared across the country due to flooding. The 90th percentile flow for the record was 6.56 m^3/s and gives a more meaningful indication of high flows as this removes the very high peaks in the data record.

3.4 Water Quality

The Otago Regional Council undertakes surface water monitoring at a number of sites around the Otago Region as part of its State of the Environment (SOE) monitoring programme. There are two water quality sites on the Tokomairiro River, one at Lisnatunny and one on the West Branch (approximately 15 kilometres upstream of the discharge) (Figure 3-5). There are no Tokomairiro River water quality sampling sites downstream of the discharge.

The report *Water Quality and Ecosystem Health in Otago 2016* was accessed from the Otago Regional Council's website to provide a summary of water quality in the Tokomairiro River for the purposes of understanding water quality upstream of the discharge. *Water Quality and Ecosystem Health in Otago 2016* summarises the water quality parameters sampled and presents the results as a five year 80th percentile during flows that are at or below the median flow for the water body. This makes the data directly comparable with the receiving water limits outlined in Schedule 15 of the Regional Plan: Water for Otago (see Table 3-5). Exceedances of the Schedule 15 limits are highlighted in red.

The Schedule 15 standards were derived from a number of sources:

- The *E.coli* standard was based on the limits for the Grade B classification in the 2003 Recreation Guidelines[1], which have been incorporated into the National Policy Statement for Freshwater Management (Freshwater NPS) as the boundary of the attribute state A standard for human health (the highest grade).
- The nitrate-nitrate-nitrogen standard is taken from the ANZECC default trigger value for physical and chemical stressors in lowland rivers.
- The ammoniacal nitrogen value was developed as a target to protect waterways from animal effluent.
- The dissolved reactive phosphorus limit was based on controlling periphyton biomass as outlined in Biggs, 2000.
- The turbidity value is related to the clarity of the water but is not referenced to a specific guideline.

In general a water body that is able to meet the Schedule 15 standards would be considered to have good water quality, which is suitable for contact recreation and which would support a healthy aquatic ecosystem.

Clutha District Council is required under its treated wastewater discharge consent (2007.090_V1) to monitor the Tokomairiro River 50 m upstream of the MWWTP discharge within each of the East and West Branches and 70 m downstream of the MWWTP discharge. A total of 21 samples have been collected between 2012 and 2017. The flow within the river at the discharge, as calculated by the method outlined in section 3.3, was used to identify which samples were collected above and below the median flow. A total of 11 samples were collected when the flow in the river was below the median flow and these results have been summarised in Table 3-5 below.

Table 3-5: Tokomairiro River water quality, during flows at or below the median flow (summarised as 80th percentile unless otherwise stated)

Data Source	ORC SOE Data		CDC Consent Monitoring			Schedule 15 Limit
Parameter	Toko. at Lisnatunny East Branch	Toko. at West Branch Bridge	Toko 50m u/s east (median)	Toko 50m u/s west (median)	Toko 70m d/s (median)	
Nitrite-nitrate-nitrogen (mg/L)	0.30	0.32	0.29 (0.19)	0.39 (0.24)	0.43 (0.28)	0.444
Ammoniacal-nitrogen (mg/L)	0.023	0.011	0.05 (0.03)	0.04 (0.03)	0.21 (0.16)	0.10

[1] "*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*" Published in June 2002 by the Ministry for the Environment, and updated in June 2003

Data Source	ORC SOE Data		CDC Consent Monitoring			Schedule 15 Limit
Parameter	Toko. at Lisnatunny East Branch	Toko. at West Branch Bridge	Toko 50m u/s east (median)	Toko 50m u/s west (median)	Toko 70m d/s (median)	
Dissolved Reactive Phosphorus (mg/L)	0.024	0.012	0.02 (0.01)	0.02 (0.01)	0.09 (0.05)	0.026
Escherichia coli (cfu/100mL)	502	340	1200 (410)	920 (410)	690 (460)	260
Turbidity (NTU)	4.00	2.76	5.7 (3.5)	5.0 (3.4)	5.4 (3.8)	5
Total nitrogen (mg/L)	0.490	0.542	0.73 (0.60)	0.75 (0.60)	0.91 (0.82)	n/a
Total phosphorus (mg/L)	0.053	0.031	0.06 (0.04)	0.06 (0.05)	0.16 (0.11)	n/a

In general the concentration of the parameters assessed are lower at the West Branch site, than the East Branch at Lisnatunny site. This is likely to be because the West Branch site is further upstream and is less impacted by surrounding land uses.

All parameters meet the Schedule 15 limits at both SOE sites with the exception of *E.coli* and the Tokomairiro River at the SOE sites has therefore been categorised by the Otago Regional Council as having 'good' water quality.

The MWWTP consent required monitoring indicates that water quality degrades between the ORC SOE monitoring sites and 50 m upstream of the MWWTP discharge in each branch and in particular the East Branch. This suggests that land uses upstream of the MWWTP are contributing to reduced water quality within the Tokomairiro River. The upstream sites do not meet the Schedule 15 standards for *E.coli* and turbidity and there was minimal difference between the upstream and downstream locations for these two parameters.

The concentrations of all forms of nitrogen and phosphorus increased between the upstream and downstream locations. One monitoring occasion during flows below median flow coincided with a bypass discharge, and the water quality results for this event were consistent with other events monitored[2]

As noted above ten of the 21 consent required water quality samples were collected during flows greater than the median river flow. One sampling event on 1st August 2012 occurred when the average daily instantaneous flow is estimated to have been 29 m^3/s. The remaining sampling events occurred when flows were between 3 m^3/s and 6 m^3/s.

Table 3-6 below presents the consent required monitoring results during river flow above the median. These results have also been compared to the Schedule 15 standards but it should be noted that these standards are not directly relevant as they have been developed for flows below the median. The difference to the less than median flow data set is also noted.

[2] It should be noted however that it is not known when the water quality sampling was undertaken and therefore it cannot be confirmed whether the sampling actually occurred at the same time as the bypass. The bypass occurred at 2:07pm and lasted less than a minute and hence may be an artefact of the data rather than an actual bypass as discussed in Section 5.

Table 3-6: Tokomairiro River water quality, during flows above the median flow (summarised as 80th percentile unless otherwise stated)

Data Source	CDC Consent Monitoring				
Parameter	Toko 50m u/s east (median)	Toko 50m u/s west (median)	Toko 70m d/s (median)	Schedule 15 RPW Limit	Comparison to less than median flow concentrations
Nitrite-nitrate-nitrogen (mg/L)	1.45 (0.77)	1.31 (0.80)	1.39 (0.80)	0.444	Increase
Ammoniacal-nitrogen (mg/L)	0.07 (0.05)	0.04 (0.04)	0.10 (0.07)	0.10	Decrease
Dissolved Reactive Phosphorus (mg/L)	0.02 (0.02)	0.03 (0.02)	0.03 (0.03)	0.026	Decrease
Escherichia coli (cfu/100mL)	2400 (690)	1600 (685)	1840 (995)	260	Increase
Turbidity (NTU)	14.4 (11.5)	14.2 (8.3)	14.6 (9.5)	5	Increase
Total nitrogen (mg/L)	2.10 (1.37)	1.86 (1.18)	2.04 (1.47)	n/a	Increase
Total phosphorus (mg/L)	0.07 (0.07)	0.07 (0.06)	0.09 (0.08)	n/a	Decrease

The upstream sites exceeded the plan standards in at least one of the two branches for nitrite-nitrate-nitrogen, dissolved reactive phosphorus, *E.coli* and turbidity. Compared to Table 3-5 it is noticeable that water quality in the Tokomairiro River decreases for these contaminants as flows increase.

An assessment of the effect of the bypass discharge on the receiving environment has been discussed in section 6 of this application document.

3.5 Ecology

3.5.1 Benthic Macroinvertebrates

The Otago Regional Council also conducts macroinvertebrate, periphyton and fish monitoring. The results of this monitoring are summarised in *Water Quality and Ecosystem Health in Otago 2016*.

Macroinvertebrate sampling is an important indicator of stream health, the Macroinvertebrate Community Index (MCI) and Semi-Qualitative Macroinvertebrate Community Index (SQMCI) are used by the Otago Regional Council to assess stream health. Two sites on the Tokomairiro River were sampled for macroinvertebrates, the West Branch and the Tokomairiro at Coal Gully Road. The location of both these sites relative to the MWWTP discharge is shown in Figure 3-7 below.

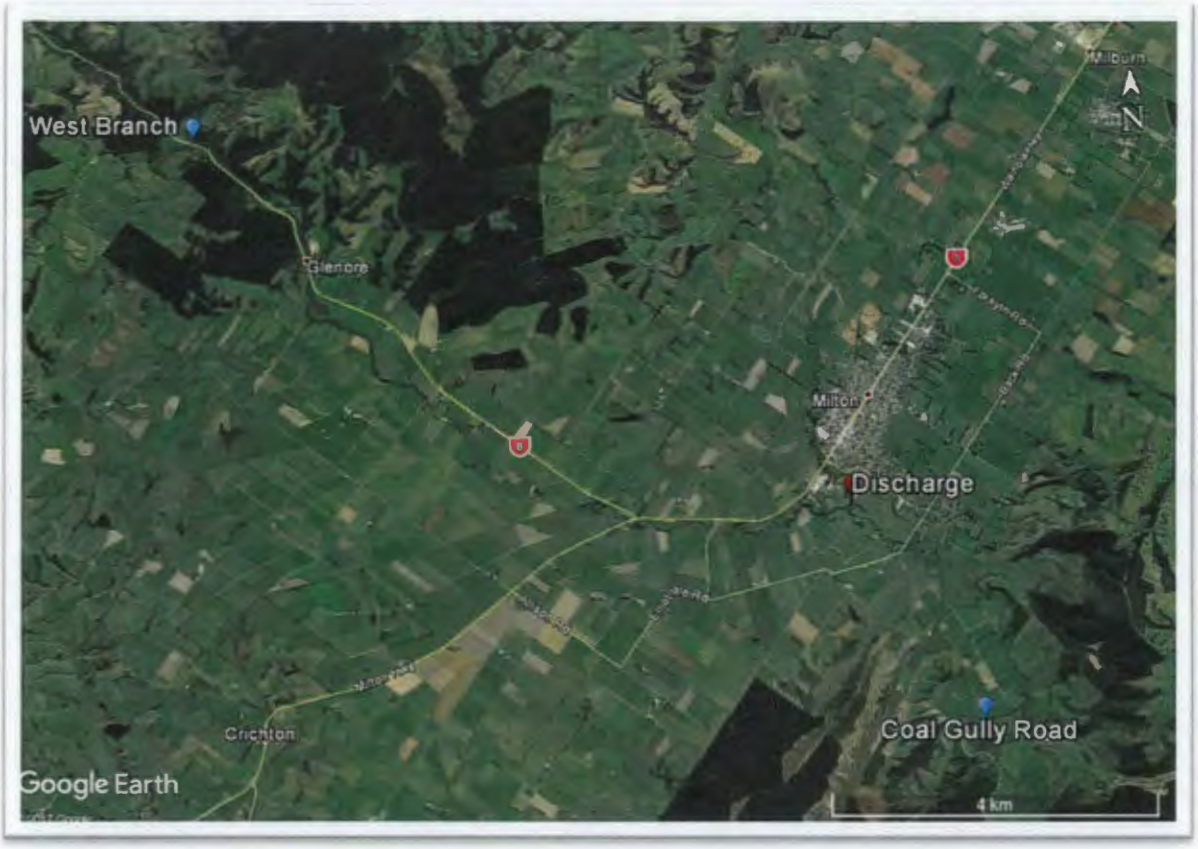


Figure 3-7: Macroinvertebrate Monitoring Locations

The MCI applies a pollution tolerance score to macroinvertebrate species based on their sensitivity to pollution. Species highly sensitive to pollution, score highly and are only likely to be found in water bodies with good water quality. A high MCI score therefore indicates that the water quality of the site is 'good'. The SQMCI is also based on the ratios of sensitive to tolerant taxa, however SQMCI scores are weighted by abundance of each taxa as opposed to the MCI which do not take account of abundance. Similarly to the MCI, a higher SQMCI is considered to indicate 'good' water quality.

The report also records the number of taxa found at each location and an EPT[3] richness score. EPT taxa are particularly sensitive to pollution, including fine sediment and nutrient enrichment and therefore the abundance of these taxa can also be used as an indicator of stream health.

The MCI and SQMCI scores are grouped into four categories; 'excellent', 'good', 'fair' and 'poor' water quality. Results that indicate 'good' water quality are highlighted in green in Table 3-7 below, results indicating 'fair' water quality are highlighted in yellow and results indicating 'poor' water quality are highlighted in red.

Table 3-7: Macroinvertebrate Results for the Tokomairiro River

Parameter	Toko. at West Branch	Toko. at Coal Gully Road
No. Taxa	25	13
EPT Richness	13	5
MCI	114	85
SQMCI	4.5	2.7

[3] Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).

The results indicate a decrease in the number of taxa found, EPT richness and MCI and SQMCI values between the West Branch and Coal Gully Road sites. This indicates that the water quality degrades between these two sites.

The *Management Flows for Aquatic Ecosystems in the Tokomairiro River* report, 2014 stated that the sediment composition at the West Branch site was markedly different to the two other sites [including Coal Gully Road], with much coarser substrate with bedrock, boulders and cobble present in addition to gravel. In contrast the main stem [Coal Gully Road] had a bed composed primarily of gravels and fine gravels which supported abundant macrophytes. It should be noted that the bed substrate composition will affect the macroinvertebrate composition and that this change may partially explain the decline in sensitive taxa between the two sites.

Ryder Consulting Ltd has undertaken benthic macroinvertebrate samples within the vicinity of the MWWTP outfall annually since 2012. These surveys assessed the benthic macroinvertebrate community composition 50 metres upstream of the discharge, 75 metres downstream of the discharge and 140 metres downstream of the discharge.

The surveys show consistent results at all four sites with MCI and SQMCI scores indicating poor to fair water quality. The low MCI and SQMCI scores are predominantly attributed to the presence and high abundances of low scoring snail and worm taxa, in combination with low abundances of EPT taxa.

There have been mixed results in invertebrate community differences between the three sampling locations, however in general lower scores have been consistently recorded at the downstream site 1 (75 metres downstream). Ryder Consulting states that a slower flowing, deeper channel is largely responsible for the difference in invertebrate species composition at the site 75 metres downstream of the outfall. The May 2015 survey stated that this appeared to be supported by an increase in damselfly larvae at the site, which are typically found in standing water bodies. The report also noted that there were a higher proportion of fine silts compared to the sites upstream and further downstream which as discussed above can result in a different macroinvertebrate community composition, and generally favours more pollutant tolerant taxa.

In general the diversity of macroinvertebrates as well as the MCI and SQMCI scores at downstream site 2 (140 metres downstream) showed a statistically significant increase from the upstream site which indicates that the MWWTP discharge is not having a significant adverse effect on the community composition. Table 3-8 below summarises the sampling results from each year.

Table 3-8: Tokomairiro River Macroinvertebrate Community Sampling Results Summary (Ryder Consulting)

	50m Upstream		75m Downstream		140m Downstream	
Year	MCI	SQMCI	MCI	SQMCI	MCI	SQMCI
2012	[illegible]	[illegible]	[illegible]	[illegible]	81	[illegible]
2013	[illegible]	[illegible]	[illegible]	[illegible]	85	4.2
2014	88	[illegible]	[illegible]	[illegible]	94	[illegible]
2015	[illegible]	[illegible]	[illegible]	[illegible]	83	[illegible]
2016	81	[illegible]	[illegible]	[illegible]	83	[illegible]

Note red shading highlights results that indicate poor water quality and yellow highlight indicates fair water quality.

3.5.2 Biological Growth

As part of the ORC SOE monitoring reporting in 2016, algal samples are also collected from sites around the Otago Region, including the Tokomairiro River at the West Branch and Coal Gully Road sites. Excessive quantities of periphyton growth can reduce the amenity of waterways and can be used as an indicator of nutrient enrichment within the water body. It is noted however that substrate composition, flows, light, invertebrate grazing and water temperature can all also affect quantities of periphyton growth.

The relative abundance of diatoms, filamentous algae, cyanobacteria and phytoplankton were noted at each site, using an abundance score from 1 (rare) to 8 (dominant) based on the protocols developed by Biggs and Kilroy (2000). The results for the Tokomairiro River are summarised in Table 3-9 below.

Assessment of algal cover to determine compliance with the coverage standards in Schedule 15 of the Regional Plan: Water for Otago was not reported in the 2016 summary.

Table 3-9: Tokomairiro Biological Growth

	Toko. West Branch	Toko. Coal Gully Road
Diatoms		
Achnanthidium	2	2
Cocconeis	1	1
Frustulia	3	
Gomphoneis	3	3
Melosira	7	5
Naviculoid diatom	2	3
Nitzschia	2	
Synedra	2	3
Filamentous Algae, Cyanobacteria and Phytoplankton		
Audouinella		3
Oscillatoria/Phormidium	2	
Placoma		3
Rivularia		1
Closterium	3	
Cosmarium	1	

Schedule 15 of the Regional Plan: Water for Otago states that filamentous algae in rivers should cover less than 30% of the river bed and that floating algae should not reduce water clarity. The monitoring outlined above did not include measurements of periphyton % cover and cannot be assessed against this standard. Nevertheless, the most abundant species can give an indication of nutrient enrichment, in particular the monitoring presented in Table 3-9 above indicates that *Melosira* is the most abundant species in both samples. The Stream Periphyton Monitoring Manual (Biggs, 2000) states that *Melosira varians* is the only *Melosira* species found in New Zealand and is found throughout the country in slow to medium flowing open lowland streams and can dominate the periphyton community in moderately enriched situations.

It should be noted however that this species has been reported as both a 'clean water species' and 'moderately polluted water species'.

3.5.3 Fish

The 2016 report on the ORC SOE monitoring, also summarised the results of electric fishing which was undertaken at 19 sites, in 17 streams across the Otago Region. The Tokomairiro River was not sampled as part of this programme and therefore the results have not been discussed further.

The *Management Flows for Aquatic Ecosystems in the Tokomairiro River*, report identifies the species of fish found within the Tokomairiro River catchment along with their conservation status (Table 3-10). The report indicates that 13 fish have been recorded within the catchment, 12 of which are native. Of the 12 native fish, six species are listed as endangered.

Table 3-10: Fish species found in the Tokomairiro River catchment

Common Name	Scientific Name	Conservation Status
Brown trout	*Salmo trutta*	Introduced and naturalised
Longfin eel	*Angullia dieffenbachii*	Declining
Shortfin eel	*Angullia australis*	Not threatened
Lamprey	*Geotria australis*	Declining

Common Name	Scientific Name	Conservation Status
Common smelt	*Retropinna retropinna*	Not threatened
Inanga	*Galaxias maculatus*	Declining
Eldon's galaxias	*Galaxias eldoni*	Nationally endangered
Clutha flathead galaxias	*Galaxias* sp. D	Nationally vulnerable
Redfin bully	*Gobiomorphus huttoni*	Declining
Common bully	*Gobiomorphus cotidianus*	Not threatened
Upland bully	*Gobiomorphus breviceps*	Not threatened
Black flounder	*Rhombosolea retiaria*	Not threatened
Yellow-eye mullet	*Aldrichetta forsteri*	Not threatened

The New Zealand Freshwater Fish Database was also searched and five additional species were identified, the banded kokopu (not threatened), freshwater mussel, koura, freshwater shrimp and perch (introduced naturalised). Yellow-eyed mullet are generally an estuarine species, but are often found significantly upstream of the coast and therefore could be present at the discharge location.

3.6 Summary

The Tokomairiro River water quality is already degraded directly upstream of the discharge and does not meet the *E.coli* and turbidity standards in the Regional Plan: Water for Otago. Monitoring data upstream and downstream of the discharge and benthic macroinvertebrate results indicate that in general there is little difference between upstream and downstream of the existing discharges from the MWWTP.

It is recognised that the Tokomairiro River holds significant intrinsic values and supports a number of native species, including several endangered native fish species. It is also recognised that the Otago Regional Council have set targets to improve the water quality of the river as a whole.

4. Statutory Framework

4.1 Resource Consents Required

Table 4-1 summarises the resource consents required from the Otago Regional Council for the discharge of intermittently treated sewage from the Milton Wastewater Treatment Plant to the Tokomairiro River under the rules of the Regional Plan: Water for Otago.

Table 4-1: Resource consents required

Activity	RPW Rule	Activity Status	Activity Description
Intermittent discharge of screened sewage to the Tokomairiro River	12A.2.1	Discretionary	Except as provided for by Rules 12.A.1.1 to 12.A.1.4, the discharge of human sewage to water, or onto or into land in circumstances where it may enter water, is a ***discretionary*** activity.

4.2 Permitted Activities

The bypass discharge occurs through the same discharge outfall as the treated wastewater discharge authorised by Consent No. 2007.090. The use of this outfall is permitted, as outlined in Table 4-2.

Table 4-2: Permitted activities

Activity	RPW Rule	Rule standards	Comment
Use of an existing outfall for the intermittent discharge of partially treated sewage to the Tokomairiro River	13.1.1.1	(a) The structure is lawfully established; and (b) In the case of a change in use, the effects of the new use of the structure are the same or similar in character, intensity and scale as the preceding use; and (c) Measures are taken to avoid animal waste entering the lake, river or Regionally Significant Wetland; and (d) The structure is maintained in good repair.	(a) Construction of the new outfall was a permitted activity (b) No change of use is proposed (c) The MWWTP site is fenced to ensure animals cannot access it (d) The outfall structure is maintained as required.

4.3 Statutory Tests

Section 104 of the RMA sets out the matters a consent authority must, subject to Part 2 of the RMA, have regard to when considering resource consent applications. The matters that are relevant in considering this application are outlined in Table 4-3.

Table 4-3: Statutory tests

Section 104 requirement			Relevant section of this report
(a)	any actual and potential effects on the environment of allowing the activity		Section 6
(b)	(i)	any relevant provisions of a national environmental standard	Not applicable
	(ii)	any relevant provisions of other regulations	Not applicable
	(iii)	any relevant provisions of a national policy statement (National Policy Statement for Freshwater Management)	Section 11
	(iv)	any relevant provisions of a New Zealand coastal policy statement	Not applicable

Section 104 requirement	Relevant section of this report
(v) any relevant provisions of a regional policy statement or proposed regional policy statement (Regional Policy Statement for Otago)	Section 11
(vi) any relevant provisions of a plan or proposed plan (Regional Plan: Water for Otago)	Section 11
(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application	Section 6

5. Analysis of Available Data

5.1 Data record

As discussed in section 2 of this report, there has been no direct method for recording bypass discharges at the MWWTP, and hence the volume and occurrence of discharges must be interpreted from other available data.

Clutha District Council currently measures the bypass discharge using data from Meter 1 (M1), located between the inlet pump well pumps and the step screen, and Meter 2 (M2) located on the rising pipe to the Imhoff tanks. The bypass discharge is calculated within the recording system on site by subtracting the flow rate at M2 from the flow rate at M1. In times of normal plant operation, the flow rate at M2 should be the same as the flow rate at M1 and no bypass discharge occurs. Where M1 records a flow rate that exceeds M2 a bypass discharge is recorded.

The data is recorded in the system at the following intervals, whichever is the smallest:

- every hour; or
- when the flow rate at M1 or M2 changes by more than 7.5 l/s from the preceding recording.

Previous consent applications have acknowledged difficulties with the recording of flows at that plant, because of the age of the meters being used at the time. When the MWWTP was upgraded in 2009-2010 three new meters were installed (M1, M3 and M4). From this date the system of recording bypass discharges described above has been used. Accounting for the commissioning of the upgrade, reasonable information is available from M1 and M2 from 2011 onwards, and this information has been used to assess the effects of the discharge.

The available data has been transformed from an instantaneous flow rate to a daily volume for the purposes of analysis. As noted above, the logging system records an instantaneous rate at hourly intervals unless the flow rate changes, in which case the flow rate can be recorded as frequently as every minute. This results in significant variation in the instantaneous flow record, to an extent that comparison against flows in the Tokomairiro River would be meaningless. Daily volumes therefore provide a more meaningful assessment. For the purposes of this consent application, the daily bypass volume has been determined by multiplying the time interval between each recording and the next by the instantaneous flow rate of the initial record. These volumes are then summed for each day to provide an estimate of the daily bypass volume.

Clutha District Council has made improvements to the bypass weir to record more accurately the overflows, by calibrating the overflow float in the 2nd lift pumps chamber and installing a weir and level sensor to calculate flows. The level sensor will be connected to the telemetry system at the plant for alarms (when overflows occur) and data collection.

5.2 Causes of Bypass Discharges

There are believed to be a number of potential causes of the bypasses as recorded, and it should be noted that due to the challenges in the data set, not all of the bypass discharges recorded may actually have occurred. Reasons for bypass discharges being recorded are:

1. wet weather bypasses, these are highlighted in the data set where associated with rainfall events, defined as more than 5 mm of rainfall in a 72 hour period[4]. This includes all the significant Daily Bypass Volumes recorded between 2011 and 2017;
2. bypass discharges recorded directly after rainfall events, where infiltration from saturated ground into the sewers continues to result in an increased flow to the MWWTP even though it is no longer raining;
3. inconsistencies in the measurements between M1 and M2. The two flow meters are different, with the M2 flow meter being much older, and likely measuring at a different accuracy to the other meters. This is likely to result in differences between the recorded flow rates. These differences are being recorded by the system in the instantaneous record, where they may instead be artefacts of the measurement system, and no bypass discharge is actually occurring;

[4] A wet weather bypass event has been defined as an event that occurs on a day when the total rainfall for that day, the previous day and the next day is greater than 5mm. The next day is included because the rainfall record gives that rainfall at 9am of each day and therefore including the next day captures rainfall events that occurred overnight.

4. minor bypasses (actual or measurement artefact) may be a result of a power fluctuations, or the information systems being rebooted.

The latter three causes of recorded bypass discharges have been classified as 'other bypasses'.

In addition, the sludge from the MWWTP is discharged to a manhole just upstream of the MWWTP by truck approximately twice a week. Whilst the inlet pump well pumps are able to transfer the rapid flow increase resulting from the discharge from the truck, the second lift pump chamber pumps are often not and hence there is a bypass of the water treatment sludge and associated raw sewage from the weir tank and second lift pump chamber. The sludge disposal records have been reviewed from September 2016 to June 2017 and all bypasses which were a result of this cause have been identified. "Sludge bypasses" accounted for 105 of the total of 1,634 bypass records during the period assessed. The total volume of these "sludge bypasses" was 0.7% of the total volume bypassed over that time period (i.e. while "sludge bypasses" account for approximately 7% of the number of bypass discharges, their short duration and small volume means that they make up less than 1% of the total volume of bypass discharges).

Clutha District Council has changed to change the operation of the inlet pump well pumps such that they will not overload the second lift chamber pumps in these conditions and hence this type of bypass will not occur in the term of the replacement consent now sought.

Measures to address the inconsistencies in the data and resolve the minor bypass discharges are outlined in section 8 of this report. For the purposes of assessment, the rest of this assessment of effects therefore considers only the wet weather discharges.

Furthermore, there are a number of discharges in the record that occur for less than a minute (the shortest bypass discharge being 14 seconds long). Discharges of less than a minute are expected to be artefacts of the data record. These discharges have been excluded from the analysis presented in section 5.4 and have not been considered in the assessment of effects undertaken.

5.3 Correlation of Wet Weather Bypass Discharges with Rainfall

Due to the variability in the instantaneous record the available data was summarised into a daily volume, as described in section 5.1. Daily volumes were summed to give the total monthly bypass volumes, which were plotted against the sum of monthly rainfall to check the correlation between rainfall and bypass discharges as shown in Figure 5-1.

Figure 5-1 presents wet weather bypass volumes (green) and other bypass volumes (red) as stacked bars so that the proportionate volume of other bypasses to wet weather bypasses can also be identified. This demonstrates, as noted above, that the other bypasses are a very small proportion by volume of all the bypasses (generally because they occur for a shorter duration and at lower flow rates).

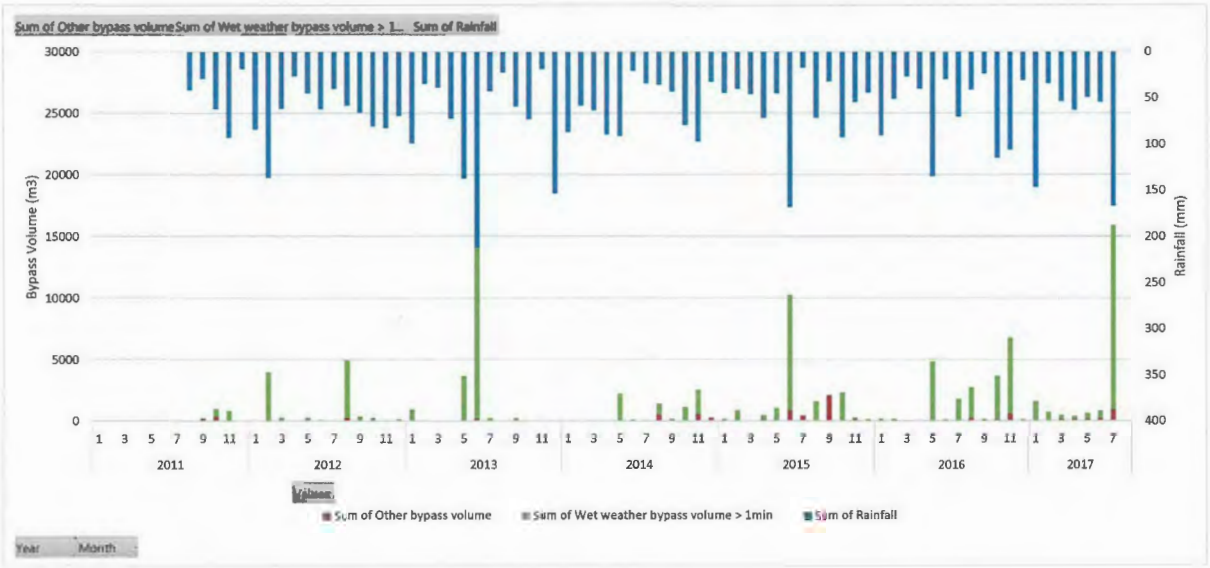


Figure 5-1: Total Monthly Rainfall Against Total Monthly Wet Weather and Dry Weather Bypasses[5]

[55] The gap in the bypass discharge record from late 2013 to May 2014 covers a period when a PLC and telemetry was being established on site and data recording was therefore not as reliable.

Figure 5-1 demonstrates a reasonable correlation between rainfall and the occurrence of bypass discharges. It also demonstrates the challenges with stormwater infiltration and inflow into the sewers in Milton, in that in most months where there is any volume of rainfall, bypass discharges are occurring. The relatively short duration of the bypass discharges means however that while they are more frequent than anticipated in terms of the number of days on which there is a bypass, in total the MWWTP is bypassing for no more than 3% of the time.

Figure 5-2 provides a snapshot of the record outlined in Figure 5-1, for the month of July 2017. It more clearly demonstrates the correlation of bypass discharges with rainfall, that bypass discharges are occurring even in very small rainfall events, and that a bypass discharge can occur for some days after a large rainfall event such as that which occurred in late July 2017, as water gradually drains from the soil, but continues to infiltrate the sewers.

Figure 5-2 also shows that on some occasions a bypass discharge occurs at the beginning of a rainfall event when there is little rain, such as on the 2 July 2017. This is because the MWWTP flows are influenced by stormwater run-off in an urban catchment, which sheds water faster than a rural catchment, which is then piped with the wastewater to the plant. The high flows are not immediately reflected in the Tokomairiro River because there is a large catchment upstream which retains some of the rainfall before the flows in the river begin to rise.

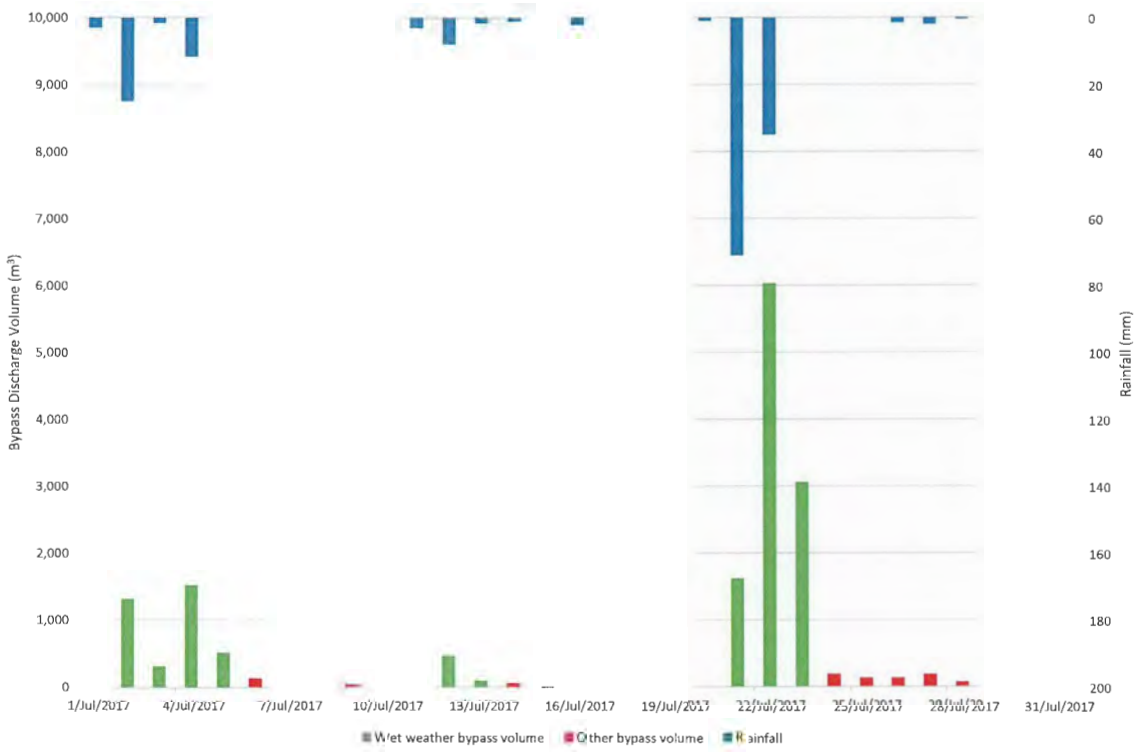


Figure 5-2: July 2017 Bypass Volumes and Rainfall

5.4 Available Dilution for and Duration of Wet Weather Bypass Discharges

The available dilution within the Tokomairiro River at the time of each wet weather bypass discharge has been calculated and summarised to provide an indication of the typical dilution factor during bypass events. The available dilution was calculated on a daily basis as the volume of flow in the river for the duration of the bypass event divided by the volume of the bypass discharge. The level of dilution within the Tokomairiro River is relevant to considering the effects of the discharge on water quality and the aquatic environment. Table 5-1 summarises the available dilution during wet weather events over the course of the available data.

Table 5-1: Available dilutions during wet weather bypass events

Year	Minimum Dilution	25%ile Dilution	Median Dilution	75%ile Dilution	Maximum Dilution
2011 (part)	91	406	1,936	5,620	11,179
2012	19	133	216	327	4,800
2013	38	245	474	1,720	5,315
2014	58	149	247	482	6,722
2015	27	76	197	531	7,675
2016	18	107	194	586	14,030
2017	34	104	194	735	3,345
Overall	18	118	251	659	14,030

Some wet weather events only resulted in low dilution factors, reflecting the fact that a bypass discharge was occurring in periods of relatively light rainfall, while larger wet weather events, such as the prolonged wet period between 9 May and the middle of June 2016 resulted in dilutions of more than 14,000 fold.

Note that the dilution factors used in the assessment that follows do not take into account background water quality but instead indicate the dilution factor required to reduce the concentration in the discharge to the specified level if the concentration is not already elevated in the receiving environment. This allows an assessment of effects on dissolved oxygen and ammoniacal nitrogen toxicity, as levels in the receiving environment of biochemical oxygen demand and ammoniacal nitrogen are sufficiently low. For E.coli, the dilution factors provide an indication of the level of dilution necessary, but the assessment notes the already poor quality of the Tokomairiro River.

In general the bypass events that occurred at low dilutions, also only occurred for very short durations. For example the minimum dilution bypass event in 2016 had a duration of only one minute. Minimum, mean and maximum durations for bypass discharges are shown in Table 5-2. Note the maximum duration is the greatest number of days across which a bypass was occurring for all of or almost all of each day. Note the minimum duration is given in minutes, the mean in hours and the maximum in days.

Table 5-2: Typical durations of untreated wastewater in minutes, hours and days[6]

Year	Minimum Duration (minutes)	25%ile Duration (minutes	Median Duration (hours)	75%ile Duration (hours)	Maximum Duration (days)
2011 (part)	2.6	86	6.1	14.7	6.0
2012	1.4	7	0.9	3.3	0.69 (16.5 hours)
2013	1.0	27	1.5	9.5	3.0
2014	1.1	7	0.4	2.2	0.83 (20 hours)
2015	1.2	12	1.0	3.1	1.0
2016	1.0	11	1.0	9.1	1.0
2017	3.1	33	3.6	9.4	5.0

[6] It is noted that bypasses of less than 1 min duration have been excluded from the data set, as it is assumed that they are either artefacts of the data or will be removed by the anticipated changes to the management of the MWWTP.

Table 5-3 summarises the number of wet weather bypass discharges over the period of available data and provides an indication of the dilution available with reference to the required dilution for the effects discussed in section 6.

Table 5-3: Number of Wet weather bypass events that achieve the relevant dilutions

Year	Number of Bypass Events				
	Total	<34 Fold Dilution	<45 Fold Dilution	<800 Fold Dilution	<3800 Fold Dilution
2011 (part)	10	0	0	3	6
2012	33	1	2	19	20
2013	33	0	1	20	30
2014	42	0	0	37	40
2015	56	3	6	48	55
2016	77	1	4	61	71
2017	37	0	1	27	36
Total	288	5	14	215	258

5.5 Typical Discharge Quality

There is currently no requirement to monitor the quality of the untreated wastewater which enters the MWWTP and therefore the quality of the bypass discharges is unknown. Table 5-4 summarises the quality of the MWWTP influent as outlined in the 2007 consent application for the upgraded plant. Where a contaminant value was not available from that application, typical concentrations have been identified from sources which report expected quality for New Zealand wastewater.

It should be noted that bypass events are predominantly the result of inflow and infiltration of stormwater into the wastewater network. Some dilution of the influent will occur during these events and the numbers presented below are therefore likely to be conservative.

Table 5-4: Typical Concentrations of Untreated Wastewater

Constituent	Average	90th Percentile
Total suspended Solids (mg/L)	250	410
Biochemical Oxygen Demand (mg/L)	190	260
Total Phosphorus (mg/L)	7.6	9.0
Ammoniacal Nitrogen (mg/L)	40[7]	
Faecal Coliforms (cfu/100mL)	10,000 – 1,000,000[8]	

5.6 Summary

The available data record has been analysed and an estimation made of the occurrence, volume, duration and quality of bypass discharges for the purposes of analysis. The data appear to show that the MWWTP is bypassing more frequently than would be expected, and at lower river flows than is desirable to minimise effects. Some caution needs to be exercised in reaching this conclusion however, as a direct

[7] The ammoniacal nitrogen concentrations reported in the 2002 and 2007 consent applications have not been used for this assessment because they were based on limited samples, and it is considered that the concentrations reported are low compared to typical untreated wastewater quality. *Wastewater Engineering Treatment and Reuse* (Fourth Edition) does not report typical ammoniacal nitrogen concentrations but does provide a total nitrogen concentration. The 'medium' strength concentration for total nitrogen has therefore been used in this assessment. This is conservative because it assumes that all the nitrogen is in the ammoniacal nitrogen form.

[8] Influent quality was not available for faecal coliforms and therefore the range for 'medium strength' wastewater was taken from *Wastewater Engineering and Treatment and Reuse* (Fourth Edition). The 'medium' strength number has been used because this takes into account some inflow and infiltration from stormwater.

recording of the bypass discharge is not available and there are known issues with the method by which bypass discharges are calculated. These issues have been rectified by recent work carried out by Clutha District Council to more directly record the occurrence of bypass discharges.

The assessment of effects that follows can therefore be considered as significantly conservative, as it is based on a synthetic flow record for the Tokomairiro River, estimates of the occurrence and volume of bypass discharges at any given river flow, and a conservative identification of likely wastewater quality.

6. Assessment of Effects on the Environment

6.1 Effects on Water Quality

6.1.1 Microbiological Water Quality

Public health

The Otago Regional Council monitors the water quality at popular marine and freshwater sites during summer to assess whether the water quality is good enough to support contact recreation. Freshwater sites are given a grade based on the concentration of *E.coli* in the water, a result of less than 260 cfu/100mL is considered an A grade, a result of between 261 and 550 cfu/100mL is considered a B grade and a result of more than 550 cfu/100mL is considered a C grade.

There are no sites on the Tokomairiro River that are monitored for suitability for contact recreation, however the water quality results presented in section 3.4 indicate that the upper reaches of the river would be considered a B grade river, but that microbiological water quality in the river just above the discharge point has declined to C grade.

Schedule 15 of the Regional Plan: Water for Otago records that the receiving water target for the Tokomairiro River for *E.coli* is that 80% of samples collected at a site, when flows are at or below median flow, over a rolling 5-year period, are equal to or less than 260 cfu/100mL, with the target to be achieved by 31 March 2025.

The approach proposed by Clutha District Council to managing the effects of bypass discharges on microbiological water quality therefore focuses on confirming whether discharges are occurring at flows below median flow and then undertaking works to as far as possible eliminate those discharges.

Untreated wastewater is expected to have a typical *E. coli* concentration of 1,000,000 cfu/100mL. This assumption is based on a reference for typical wastewater, as no analysis of the actual bypass discharge quality is available. The analysis is therefore likely to be conservative.

During median flows the East Branch 50 m upstream of the discharge recorded an 80th percentile value of 1,200 cfu/100mL between 2012 and 2017. This means that the background water quality already exceeds the plan standard. In addition, it should be noted that the majority of bypass discharges occur during high rainfall when the river flow is high. Table 3-6 indicates that the upstream concentration of *E.coli* during these events is higher, with an 80th percentile concentration of 2,400 cfu/100mL.

It would take a dilution of around 800 to reduce a discharge with an *E.coli* concentration of 1,000,000 cfu/100mL to below 1,200 cfu/100mL. In most years this level of dilution is not available in the Tokomairiro River, although as shown in Table 5-1, in 2011 sufficient dilution would have been available for more than 50% of the bypass discharges, in 2013 sufficient dilution would have been available for more than 25% of the bypass discharges, and in 2017 sufficient dilution would have been available for approximately 25% of the bypass discharges if the levels of microbiological contaminants were not already elevated. However, based on the poor existing microbiological water quality of the Tokomairiro River there will never be sufficient dilution to ensure that water quality does not decrease during bypass discharges, and as a result risks to public health for the duration of the bypass discharges would increase.

In considering effects on public health, the duration of the discharge has some relevance. For most years the median duration for bypass discharges was approximately 1 hour, and for three of these four years, the 75th percentile duration was less than 3 hours. While risks to public health will increase during bypass discharges, the increased risk will generally only be present for relatively short periods of time.

Clutha District Council acknowledges that the Otago Regional Council has a programme to improve water quality in the Tokomairiro River, and that the National Policy Statement for Freshwater Management(NPS-FM) requires that water quality in surface water bodies be maintained and enhanced. To assess effects on the river as water quality improves, in order for the discharge to meet the Regional Plan: Water Schedule 15 standards for *E.coli*, a much higher dilution than for the existing water quality would be required (in the region of 3,800 fold). As outlined in Table 5-3, very few of the bypass discharges over the last six years would have had sufficient dilution available to meet that standard, even if the receiving environment had been of sufficiently good quality.

Clutha District Council is committed to playing its part in improving water quality in the river. Two measures are proposed by Clutha District Council to address the potentially increased risk to public health from the bypass discharges:

- First, direct recording of the bypass discharge will be instituted to determine over a period of 2 years, an accurate understanding of the actual frequency and volume of the bypass discharges, rather than

the estimation which has been undertaken for this assessment. These volumes can then be compared to the calculated flows in the Tokomairiro River at the discharge point using the relationship developed by the Otago Regional Council to determine the actual effects for each discharge event. Sampling will also be undertaken of the bypasses to enable a better understanding of the quality of the discharge.

- Second, the existing programme of works to remedy inflow and infiltration in Milton will be used to prioritise works to reduce the occurrence of bypass discharges and investigation of potential improvements within the MWWTP will be undertaken to better manage flows through the plant. These measures will be implemented from the granting of the consent, so that by the time the effect of Otago Regional Council and landowner initiatives to improve water quality in the Tokomairiro River have had effect, substantial improvements will have been made in terms of bypass discharges as well.

As required by Consent No. 2007.090 for the dry weather discharge, signage is maintained at the discharge point to warn river users of the public health risks of contact recreation in the Tokomairiro River. The current water quality in the lower Tokomairiro River is generally not suitable for contact recreation, and this situation is likely to continue for some years, until both upstream water quality improves and further measures are instituted to reduce bypass discharges from the MWWTP.

Stock Drinking Water

The Australian and New Zealand Guidelines for Freshwater and Marine Water Quality, 2000 (the ANZECC 2000 guidelines) state that drinking water for stock should contain a median of less than 100 thermotolerant coliforms per 100 mL. A dilution factor of 10,000 would therefore be required for the discharge to meet this standard.

The guideline is based on faecal coliforms which include bacteria of non-faecal origin and because the threshold is very low and would be expected to be exceeded in some natural situations. For context the 1992 ANZECC guidelines included a faecal coliform standard of 1,000 cfu/100mL, as a geometric mean.

Aquanet Consulting Limited discussed the validity of the current ANZECC guideline value in a report prepared for Greater Wellington Regional Council to provide recommendations on plan standards. The report recommends a guideline for stock drinking water of 550 cfu/100mL (as a single sample maximum), based on work completed for Horizons Regional Council during the process undertaken to derive the One Plan, plan standards. The report also notes that this standard should only be applied to river flows at or below three times the median flow.

Typical untreated wastewater would therefore require a dilution of 1800 to meet a stock drinking water standard of 550 cfu/100mL. As noted above in terms of effects on public health, because the microbiological quality of the Tokomairiro River is already poor, the required level of dilution is not available. Effects would have been mitigated however by the relatively short duration of many of the events. During bypass discharges water in the Tokomairiro River will not be suitable for consumption by stock, and risks to stock health will increase.

However, it is important to note that upstream sites within the Tokomairiro River monitored by Clutha District Council also fail to meet either of these standards, and therefore currently the water quality of the Tokomairiro River is not suitable for stock drinking water, irrespective of whether the discharge is occurring.

Measures to reduce the incidence of bypass discharges will also help to reduce the amount of time that the Tokomairiro River will not be suitable for stock consumption.

6.1.2 Dissolved Oxygen

A biological oxygen demand (BOD) of less than 10 in a discharge is not expected to have a discernable effect on the oxygen concentration in the receiving environment. The percentage saturation of dissolved oxygen in surface water is important for the ecosystem because sufficient oxygen is required for many of the species that inhabit the river. Low dissolved oxygen concentrations can stress both fish and macroinvertebrates and may result in changes in community composition to more tolerant species, or in extreme cases a loss of biodiversity within the water body.

The MWWTP untreated wastewater had a 90th percentile BOD concentration of 260 mg/L. A 34 fold dilution would therefore be sufficient to ensure no adverse effects on the dissolved oxygen content of the Tokomairiro River.

As shown in Table 5-3 above, there were five wet weather bypass events that occurred when the available dilution was less than 34. Of these five events, all occurred when the river was below median flow, however three of the five events occurred for less than six minutes and therefore it is expected that the effect is negligible. The remaining two events occurred on 23 February 2012 and 3 June 2015 and the discharge lasted from 16 and 15 hours respectively.

It is therefore expected that for the vast majority of discharges the effect on dissolved oxygen levels in the receiving environment will be minor.

Any discharges which do cause a decrease in the saturated oxygen levels in the river will only result in a localised depression. As the discharge mixes with more river water further downstream the effect of the elevated BOD concentration will reduce until there has been sufficient dilution to reduce the concentration to a negligible level. In addition, fish species are mobile and able to sense plumes of water which have a level of contaminants which may cause adverse effects and therefore will avoid the plume for the short duration that it is causing oxygen levels to be depleted.

Works to reduce the frequency of bypass discharges during periods of lighter rainfall will serve to further reduce the potential for adverse effects on dissolved oxygen levels in the Tokomairiro River.

6.1.3 Toxicity

The primary contaminant of concern within the wastewater from a toxicity perspective is ammoniacal nitrogen. The untreated wastewater is expected to have an ammoniacal nitrogen concentration of approximately 40 mg/L. The ANZECC trigger value for ammoniacal nitrogen toxicity at 95% protection is 0.9 mg/L, and is considered appropriate for assessing effects on the Tokomairiro River, as the trigger value should be applied to slightly to moderately disturbed ecosystems. The trigger value for ammoniacal nitrogen is based on chronic rather than acute toxicity and therefore elevations above this concentration for short durations are considered unlikely to cause toxicity effects.

A dilution of 45-fold would be required to reduce the typical concentration of ammoniacal nitrogen in the discharge to below the ANZECC 2000 toxicity trigger value.

As per Table 5-3 above, there were 14 bypass events where the available dilution was less than 45 during the data record available. Of the 14 events, nine occurred for less than an hour, with six occurring for less than six minutes. The remaining five events resulted in discharges for between two and 16 hours.

Over the five year data record, therefore there were only five events which occurred for longer than an hour at a time when the available dilution was less than that required to meet the ANZECC toxicity guideline. Only three of these events occurred for longer than three hours. As discussed above the ANZECC toxicity trigger value is based on chronic, rather than acute toxicity and therefore short duration discharges are unlikely to result in toxicity effects in the river.

As discussed in section 3.5.1 the benthic macroinvertebrate surveys undertaken by Ryder Consulting indicate that the permanent discharge from the MWWTP is not resulting in a decrease in abundance or community composition of benthic macroinvertebrates 140 m downstream of the discharge, and there are therefore no obvious signs of toxicity effects as a result of the bypass discharges.

Works to reduce the frequency of bypass discharges will serve to further reduce the potential for toxicity effects in the Tokomairiro River.

6.1.4 Nutrients

As summarised in Table 3-5 the ORC has set limits for nutrients in Schedule 15. The standards for nutrients are based on values which are considered to control periphyton biomass and therefore minimise nutrient effects in the receiving water.

It is noted that the MWWTP is not a nutrient reducing plant, this means that in terms of nutrients the bypass discharge does not represent a change from the consented treated wastewater discharge. It is considered therefore that there are no additional effects from nutrient enrichment as a result of the bypass flows.

6.1.5 Amenity Values

Turbidity can be used to assess amenity values because it gives an indication of the clarity of the discharge and receiving environment. Schedule 15 sets a standard of 5 NTU for turbidity within the Tokomairiro River. The influent quality data available provides the concentration of total suspended solids but does not assess turbidity. While total suspended solids can be used as a measure of clarity (given that high concentrations of suspended matter within the water will reduce the visual clarity) it is not directly relatable to turbidity.

As an alternative method of assessment, the consent required monitoring undertaken by Clutha District Council summarised in Table 3-5 and Table 3-6 indicates that turbidity at the downstream site decreases or is comparable to both the East and West Branch upstream monitoring locations. In addition, as would be expected turbidity increases in the Tokomairiro River significantly during high flows (as shown in Table 3-6). For the larger volume bypass discharges that occur during high river flows when the receiving water is already turbid, the discharge will not be conspicuous beyond reasonable mixing.

Clutha District Council will be working to reduce the number of bypass discharges occurring at low flows when the discharge is most likely to have an effect on clarity and therefore amenity values.

Any bypass discharges are screened, which will remove inorganic objects from the flow, however there may still be the potential for scums and foams within the river due to the nature of untreated wastewater. To date, Clutha District Council has received no complaints of visual effects, such as debris or scums and foams, as a result of bypass discharges in the Tokomairiro River, and a review of the Otago Regional Council's consent files also did not highlight any complaints since the MWWTP was upgraded in 2009-2010. No scums or foams from bypass discharges have been observed in the Tokomairiro River by Clutha District Council staff or the contractor who operates the plant.

In order to confirm the lack of complaints, visual monitoring of the discharge location during bypass events is proposed on a monthly basis for one year and then three monthly thereafter. Details of the proposed monitoring is outlined in section 8.1.

6.2 Effects on Aquatic Ecosystems

6.2.1 Benthic Macroinvertebrates

As discussed in section 3.5.1 Ryder Consulting undertook a benthic macroinvertebrate survey in 2012 at one location upstream of the discharge and two locations downstream of the discharge. The survey did not find a statistically significant difference between the upstream and downstream locations, which suggests that the discharge of both the treated wastewater and the bypass flows are not having an appreciable effect on the macroinvertebrate community within the Tokomairiro River.

In addition as discussed in section 6.1.3 toxicity effects from elevated concentrations of ammoniacal nitrogen are considered unlikely as the discharge rarely occurs for a significant duration below a dilution at which effects are likely to occur.

6.2.2 Fish

The Otago Regional Council and the New Zealand Freshwater Fish Database identify 13 native species which live in the Tokomairiro River catchment. A number of these native species are considered endangered, with the most critical being the Eldon's galaxias which is classified as 'nationally endangered'.

The bypass discharges are intermittent in nature and are generally of a short duration, which will minimise impact on fish species. Analysis contained in section 6.1.2 of this application document indicates that the bypass discharges will not have a significant impact on the percentage saturation of oxygen within the river. In addition the number of events during which the ammoniacal nitrogen concentration would not be sufficiently diluted to meet the ANZECC toxicity trigger value are limited and mostly of very short duration. The measures described in section 8 will be undertaken to reduce this number further.

Deposition of fine sediment may affect fish due the smothering effect on the habitat (resulting in the interstitial spaces between the rocks in the substrate filling with fine material). The bypass discharge is expected to have a suspended sediment concentration of approximately 410 mg/L. However, the great majority of bypass events occur at times of high river flow when fine sediment is likely to be rapidly dispersed downstream rather that deposited on the stream bed. In addition, the habitat of the river downstream of the discharge is characterised by finer substrate as discussed in section 3.5.1.

6.3 Effects on Cultural Values

The MWWTP is within the rohe of Te Rūnanga o Ōtākou, and Hokonui Rūnanga also has interests in the Tokomairiro area. The Regional Plan: Water for Otago notes a number of Kāi Tahu beliefs, values and uses of the Tokomairiro River as follows:

- kaitiakitanga;
- mauri;
- waahi tapu and/or waiwhakaheke;
- waahi taoka;
- mahika kai;
- kohanga;
- trails;

- cultural materials.

No specific tāngata whenua values are identified for the Tokomairiro River in the Kāi Tahu ki Otago Natural Resource Management Plan 2005, but values, issues, objectives and policies are identified for water resources in general.

Surface waterbodies such as the Tokomairiro River are a significant feature of the Otago region. Water plays a significant role in the spiritual beliefs and cultural traditions of Kāi Tahu, and loss and degradation of water resources through discharges is a significant issue. The Kāi Tahu ki Otago Natural Resource Management Plan 2005 seeks that there be no discharge of human waste directly to water.

The intermittent discharge of screened sewage from the MWWTP will have unavoidable effects on Kāi Tahu values for the Tokomairiro River. Tāngata whenua representatives have previously been involved in a Wastewater Working Party that the Clutha District Council established to advise on all its wastewater discharges, and have twice previously considered the discharge from the MWWTP to the Tokomairiro River. While acknowledging that a discharge of human waste directly to surface water is not considered appropriate by tāngata whenua, on both occasions the Working Party process has concluded that the discharge should continue, principally because of the volume of stormwater inflow and infiltration making discharge to land impractical and uneconomic.

Clutha District Council is committed to minimising as far as possible bypass discharges from the MWWTP. The Milton 2060 Strategy includes an objective of sealing the wastewater system in flood-prone areas of Milton, and over time the occurrence of bypass discharges is expected to decrease.

6.4 Erosion, Scour and Deposition

The original discharge was on the true left bank of the Tokomairiro River, but it was moved to a mid-channel discharge in 2009-10. Given the mid-channel location of the discharge pipe no erosion, scour or deposition of the banks of the river is anticipated, and no significant effects are anticipated on the bed of the river due to the normal behaviour of wastewater plumes.

6.5 Summary

Three bypass discharges since 2011 occurred at times when the dilution available in the Tokomairiro River indicates a potential effect in the receiving environment in terms of oxygen depletion and toxicity effects, but benthic surveys do not suggest that adverse effects occurred. Effects in terms of oxygen depletion and toxicity are therefore not anticipated for continued occurrence of bypass discharges. The bypass discharges will not significantly affect the nutrient load discharged from the MWWTP.

The assessment has indicated that the bypass discharges may result in increased bacteria (*E.coli*) concentrations in the receiving water above the current background. This could cause issues with public health and stock drinking. However, the Tokomairiro River does not currently comply with the relevant guidelines for these uses, and signage and communication with users downstream is proposed to minimise the potential risks. The proposed monitoring will improve the understanding of the actual incidence, and hence risk, of bypass discharges, which will then be minimised by the proposed works.

At present, the Tokomairiro River is not suitable for contact recreation upstream or downstream of the MWWTP. As Otago Regional Council and landowner initiatives improve water quality in the catchment, works proposed by Clutha District Council to reduce the occurrence of bypass discharges should also contribute to reducing public health risk in the river.

Surveys indicate that benthic macroinvertebrate community composition and abundance increase 140 m downstream of the discharge. Macroinvertebrates are used as an indicator of stream health and to date the discharges have not resulted in a significant adverse effect on the aquatic ecosystem of the Tokomairiro River between comparable sites upstream and downstream of the MWWTP.

Cultural values will be adversely affected by the discharge and the best way to manage this and other effects is to continue to undertake works that will reduce the number of discharge events, and particularly those occurring at lower flows.

There are not expected to be any erosion, scour or deposition effects.

7. Alternatives

Alternatives to the discharge of treated sewage from the MWWTP have been considered twice before, in around 2000 when the plant was first consented, and in 2009 when it was upgraded. On both occasions the Wastewater Working Party involved in considering alternatives recognised that discharge to water is the only practical solution until the stormwater inflow and infiltration issues are addressed. As the treated wastewater discharge is to water, the bypass discharges therefore also have to be to water.

The discharge has been improved since the current consent was granted, by the installation of screening of all inflows up to 125 L/s, prior to discharge.

Alternatives to reduce the volume and occurrence of bypass discharges include the selected option of trying to remedy inflow and infiltration problems, and the possibility of on-site buffer storage to store stormwater impacted flows and gradually treating the collected influent through the MWWTP process. The often large volumes of influent during rainfall events, and the risk of odour discharges from stored influent mean that this option is not currently practical.

Passing the increased volumes of influent through the existing treatment at the MWWTP is not possible without substantial and costly upgrades to the plant, and it is doubtful that the plant could handle volumes 3.5 – 6 times the current peak dry weather flow.

Effective treatment of a screened bypass flow in-pipe prior to discharge would need to be specifically investigated for the MWWTP. Bearing in mind in particular tangata whenua objectives for the cessation of discharges to water, Clutha District Council considers it to be more effective and efficient to focus initially on reducing the number of discharges, rather than investigating treatment.

8. Monitoring and Mitigation

8.1 Proposed Mitigation

As noted earlier in this report, seven primary measures are proposed to mitigate the effects of the bypass discharges from the MWWTP:

- works to implement direct measurement and recording of duration and volume of the bypass flow are underway and will be completed by the end of October 2017 in order to gain a more accurate understanding of the frequency and volume of bypass discharges. The existing weir in the bypass manhole provides a suitable location for this to occur;
- an electronic rain gauge will be installed at the site, in order to better correlate rainfall in Milton with the occurrence of bypass discharges;
- a programme of regular grab sampling of bypass discharges will be established, in order to characterise the quality of the discharge in different return period rainfall events, to assist with understanding the level of dilution needed in order to minimise effects of bypass discharges in the Tokomairiro River;
- process control improvements will be implemented to regulate the inlet pump well pumps against the 2nd lift chamber pumps, in order to eliminate as far as possible minor bypass discharges occurring when the two sets of pumps are out of sync;
- disposal of backwash sludge from the Milton Water Treatment Plant will be managed to ensure that no accidental bypass discharges occur;
- the 2001 and 2004 investigations into addressing capacity issues in the Milton stormwater system will be reviewed, to develop a programme of works to first reduce bypass discharges during periods of lighter rainfall, with the initial aim of eliminating discharges to the Tokomairiro River when it is flowing at below its median flow, and then gradually reducing the occurrence of bypass discharges during heavier rainfall events;
- inspection of properties identified as having stormwater discharges connected directly to the Milton sewers will be completed within the next 12 months, and works to remedy these discharges will be agreed with the landowners, likely within the next 2 years;
- implementation of the works required by the Milton 2060 Strategy will continue.

As noted in previous consent applications, remedying the stormwater inflow and infiltration problems in Milton, and thus reducing the occurrence of bypass discharges will be a long term and expensive undertaking for Clutha District Council, and both the Clutha District Council and the Otago Regional Council have acknowledged that the issues are not likely to be resolved before 2060, with the preparation of the Milton 2060 Strategy. Consent No. 2007.090, which authorises the dry weather discharge, expires in 2044, and a term of consent to match is sought for the consent to authorise the bypass discharges – that is, a term of 27 years.

8.2 Monitoring

The following monitoring is proposed to be undertaken and reported to the Otago Regional Council:

- Records of the occurrence, volume and duration of bypass discharges will be kept by direct metering of the bypass discharge;
- Records of daily rainfall at the site will be kept, to enable correlation with the occurrence of recorded bypass discharges;
- Regular grab sampling of bypass discharges will be undertaken in order to characterise the quality of the discharges;
- Water quality monitoring upstream and downstream of the discharge will be undertaken when the Tokomairiro River is below median flow, to continue to characterise the effects of the discharge on the river at periods of lower flow;
- Visual monitoring to confirm the absence of amenity effects downstream of the discharge will also be undertaken regularly.

9. Consultation

The following parties have been identified as having an interest in this application:

- immediately adjacent landowners:
  - Albert Clarke, Toko Mouth Road, Milton
  - SM Trustees Limited, 120 Elliotvale Road, Milton
  - P A Duthie Ltd, 70 Toko Mouth Road, Milton
- Kāi Tahu ki Otago Ltd, on behalf of Te Rūnanga o Otākou and Hokonui Rūnanga
- Fish and Game Otago
- Department of Conservation
- Public Health South

Initial discussions have been held with Kāi Tahu ki Otago Ltd, Fish and Game Otago and Public Health South to identify any issues of particular concern or interest. All parties were interested in measures proposed to reduce the occurrence of bypass discharges, and Fish and Game suggested that an adaptive management approach may be a useful way of managing the discharge moving forward. Fish and Game also raised the importance of trout spawning habitat as a more sensitive type of habitat to the effects of discharges.

Clutha District Council has suggested that a Wastewater Working Group should be re-established to provide a forum for discussion of wastewater issues in the district on an ongoing basis, and each of the parties consulted expressed support for this.

All interested parties will be sent a copy of the application when it is lodged with the Otago Regional Council, and Clutha District Council intends to continue discussions with these parties throughout the processing of the application.

10. Proposed Consent Conditions

The following conditions are proposed for the replacement consent to intermittently discharge screened wastewater to the Tokomairiro River from the Milton Wastewater Treatment Plant:

- This consent shall only be exercised during rainfall events when the treatment plant capacity is exceeded.
- Within three months of the grant of this consent, the volume and duration of bypass discharges to the Tokomairiro River shall be measured to an accuracy of +/- 5 percent.
- Records of the occurrence, volume and duration of bypass discharges shall be kept and provided to the Consent Authority by 30 June each year, and be made available on request. Recording of the volume and duration of bypass discharges shall be by direct electronic monitoring of the bypass discharge.
- Records of daily rainfall at the site shall be kept and provided with the records required by Condition 1 to the Consent Authority by 30 June each year, and be made available on request.
- The discharge to the Tokomairiro River shall not give rise to any of the following adverse effects beyond 70 metres downstream of the discharge location:

  (a) The production of any conspicuous oil or grease films, scums or foams or floatable or suspended material; or

  (b) Any conspicuous change in colour or visual clarity; or

  (c) Any emission of objectionable odour; or

  (d) Any significant adverse effects on aquatic life.

- Once a month for the first year after the grant of this consent, and then at three monthly intervals thereafter, during a bypass event that coincides with a flow in the Tokomairiro River that is equal to or less than the median flow, the following shall be recorded:

  (a) Rainfall in the preceding 24 hour, 72 hour and 10 day periods at the rain gauge installed on site;

  (b) Water level within the Tokomairiro River at the discharge location;

  and

  (c) A grab sample of the bypass flow will be collected and analysed for the following parameters:

    (i) Temperature (field measurement)
    (ii) pH
    (iii) Electrical conductivity
    (iv) Biochemical oxygen demand
    (v) Total ammoniacal nitrogen
    (vi) *Escherichia coli*

  (d) The following monitoring shall be undertaken at two sites 50 metres upstream of the discharge (one in the West Branch and one in the East Branch) and one site 70 metres downstream of the discharge;

    (i) A photograph of each location at the time of sampling;
    (ii) At each sampling location, qualitative assessment of the flow in the river at the sampling location as low, medium or high;
    (iii) At the downstream sampling location, observations of any conspicuous oil or grease films, scums or foams or floatable or suspended material, including litter, resulting from the discharge (supported by photographic evidence);
    (iv) At each sampling location collection of a water quality sample that shall be analysed for the following parameters:
      a. Temperature (field measurement)
      b. pH
      c. Electrical conductivity
      d. Dissolved oxygen (as mg/L and percentage saturation)
      e. Total ammoniacal nitrogen
      f. *Escherichia coli*

- Three years after the granting of this consent, the consent holder shall provide a report to the Consent Authority outlining:

(a) The results of the monitoring outlined in the condition above;

(b) An assessment of the frequency, volume and duration of bypass discharges, and the dilution available for bypass discharges in the Tokomairiro River;

(c) A programme of works for reducing the frequency, volume and duration of bypass discharges and a timetable for implementing the works and reporting to the Consent Authority on the effectiveness of the works.

- The Consent Authority may in accordance with section 128 and 129 of the Resource Management Act 1991 serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary of the commencement of this consent or of receiving any monitoring results, for the purpose of:

  (a) Determining whether the conditions of this consent are adequate to deal with any adverse effects on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which became evident after the date of commencement of the consent; or

  (b) Amending any wastewater or receiving water monitoring programme, if the results indicate that the monitoring programme is inadequate;

  (c) Requiring the adoption of the best practicable option to remove or reduce any adverse effect on the environment.

11. Statutory Assessment

11.1 National Policy Statement for Freshwater Management 2014

The National Policy Statement for Freshwater Management 2014 (as amended in 2017) sets out national direction for the management of fresh water. Table 11-1 provides an assessment of the bypass discharges from the MWWTP against the objectives and policies of the NPS-FM.

Table 11-1: Assessment of relevant provisions of the NPS-FM

Provision	Assessment
Objective A1 *To safeguard:* *(a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and* *(b) the health of people and communities, as affected by contact with fresh water;* *in sustainably managing the use and development of land, and of discharges of contaminants.*	Based on benthic surveys completed for the MWWTP, and the generally short term nature of each bypass discharge, no significant adverse effects on the existing life-supporting capacity, ecosystem processes and indigenous species of the Tokomairiro River are anticipated as a result of the bypass discharges. The current water quality of the Tokomairiro River is such that there is a risk to public health in any contact with freshwater. The current water quality is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. The applicant is proposing to gather information to better understand the occurrence of bypass discharges (and therefore the risk to public health) and then to implement a series of improvement works to both the sewerage and stormwater systems in Milton to reduce bypass discharges. The overall aim is that bypass discharges would only occur infrequently, and only at river flows where sufficient dilution is available to avoid adverse effects on human health. In the interim, signage and notification to the public will identify the increased risk to public health.
Objective A2 *The overall quality of fresh water within a freshwater management unit is maintained or improved while:* *a) protecting the significant values of outstanding freshwater bodies;* *b) protecting the significant values of wetlands; and* *c) improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over-allocated.*	The Tokomairiro River catchment is defined as a freshwater management unit within the Regional Plan: Water for Otago. The current water quality in the river is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. No changes are proposed to the bypass discharges that would worsen them in terms of scale or frequency from the current situation, and the overall water quality in the Tokomairiro River will therefore be maintained. In addition, recognising that the existing water quality has been degraded by human activities, and exceeds limits set in Schedule 15 of the Regional Plan: Water for Otago, the applicant acknowledges the need to significantly improve the occurrence and frequency of bypass discharges, in order for the discharge to be consistent with Objective A2 of the NPS-FM in relation to improving the water quality of the Tokomairiro River. The Tokomairiro River is not identified as an outstanding freshwater body, and no wetlands will be affected by the bypass discharges.
Objective A3	The aim of the works that the applicant will undertake will be to reduce the frequency of bypass discharges

Provision	Assessment
The quality of fresh water within a freshwater management unit is improved so it is suitable for primary contact more often, unless: *a) regional targets established under Policy A6(b) have been achieved; or* *b) naturally occurring processes mean further improvement is not possible.*	to achieve a more usual situation of the MWWTP bypassing only in heavy rainfall events when flows in the Tokomairiro River have increased and primary contact is not possible, which would result in improvement of water quality in the river except in circumstances where it is not suitable for primary contact due to the natural effects of rainfall events.

11.2 Regional Policy Statement for Otago 2008

The Regional Policy Statement for Otago 2008 (the RPS) is operative. The RPS sets the direction for future management of Otago's natural and physical resources, and provides the foundation for development of regional plans and district plans.

Table 11-2 provides an assessment of the bypass discharges from the MWWTP against the objectives and policies of the RPS.

Table 11-2: Assessment of relevant provisions of the Regional Policy Statement for Otago 1998

Provision	Assessment
Objective 4.4.2 Waahi Taoka (Treasured Resources) *To recognise and provide for the special significance that all taoka play in the culture of Kai Tahu.*	Mahika Kai (places where food has historically been procured or produced) and Wai (All water) are listed as waahi taoka in the explanation to Objective 4.4.2. While the current occurrence of bypass discharges from the MWWTP will be adversely affecting the Maori values associated with Wai, the applicant proposes to reduce the frequency of the discharge through a programme of investigations and works, to reduce these effects as far as possible. The applicant is not aware of any specific mahinga kai values in the Tokomairiro River in the area that may be affected by bypass discharges, but the programme of investigations and works referred to above will assist in reducing any effects.
Objective 4.4.3 Wai (Water) *To recognise the principle of wairua and mauri in the management of Otago's water bodies.*	The applicant is consulting with Kāi Tahu ki Otago Ltd on behalf of local rūnanga to determine the approach that is necessary to address wairua and mauri in the Tokomairiro River.
Objective 4.4.4 Mahika Kai (Places where food is produced or procured) *To maintain and enhance mahika kai and access to their traditional resources.*	The existing discharge of treated wastewater from the MWWTP, and the bypass discharges, will be affecting access to any mahinga kai resources in the lower Tokomairiro River due to the offensive caused to cultural values by discharging human sewage to freshwater. The applicant is not aware of any specific mahinga kai values in the Tokomairiro River in the area that may be affected by bypass discharges, but the programme of investigations and works referred to above has the aim of improving water quality and will therefore improve the environment for mahika kai species.

Provision	Assessment
Objective 4.4.5 Kaitiakitanga (Guardianship) *To incorporate the concept and spirit of kaitiakitanga in the management of Otago's natural and physical resources in a way consistent with the values of Kāi Tahu.*	The applicant is consulting with Kāi Tahu ki Otago Ltd on behalf of local rūnanga, recognising their kaitiaki role for the Tokomairiro River.
Objective 6.4.2 *To maintain and enhance the quality of Otago's water resources in order to meet the present and reasonably foreseeable needs of Otago's communities.*	Objective 6.4.2 recognises the different values and expectations of water users and the need to integrate water quality and land use management. The current water quality in the Tokomairiro River is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. No changes are proposed to the bypass discharges that would worsen them in terms of scale or frequency from the current situation, and the overall water quality in the Tokomairiro River will therefore be maintained. In addition, recognising that the existing water quality is relatively poor directly upstream of the MWWTP, and exceeds limits set in Schedule 15 of the Regional Plan: Water for Otago, the applicant acknowledges the need to significantly improve the occurrence and frequency of bypass discharges, in order to enhance the water quality of the Tokomairiro River. The Milton community has an expectation that the MWWTP will continue to operate and that sewage collection infrastructure will be maintained throughout the township. Local water users expect that water quality in the Tokomairiro River will improve from its current state. Recognising this, the applicant is proposing to undertake works to reduce the scale and frequency of bypass discharges.
Objective 6.4.3 *To safeguard the life-supporting capacity of Otago's water resources through protecting the quantity and quality of those water resources.*	Based on benthic surveys completed for the MWWTP, and the frequently short term nature of bypass discharges, no significant adverse effects on the existing life-supporting capacity, are anticipated as a result of the bypass discharges. Measures to improve water quality by reducing the occurrence of bypass discharges will further assist to safeguard life-supporting capacity.
Objective 6.4.4 *To maintain and enhance the ecological, intrinsic, amenity and cultural values of Otago's water resources.*	The bypass discharges from the MWWTP are existing discharges. Ecological values of the Tokomairiro River have not been shown to be significantly affected by the existing discharges from the MWWTP. Intrinsic and cultural values will be affected by the discharge, but the applicant is proposing works to reduce the occurrence of bypass discharges, in order to improve those values as much as is practicable. No complaints about amenity effects of the discharges have been received by the Clutha District Council.
Policy 6.5.1 *To recognise and provide for the relationship Kāi Tahu have with the water resource in Otago through:*	While the applicant is proposing to develop a programme of works to reduce the occurrence of bypass discharges at the MWWTP, which will be a significant improvement on the current situation, it is unlikely that discharges will be able to be entirely eliminated, as stormwater inflow during times of very

Provision	Assessment
(a) Working toward eliminating human waste and other pollutants from entering all water bodies; and ...	heavy rainfall will continue to pose a risk of overwhelming the plant capacity to treat inflowing wastewater and there are practical limitations on what can be achieved through engineering works.
Policy 6.5.5 *To promote a reduction in the adverse effects of contaminant discharges into Otago's water bodies through:* ...	This policy has been superceded by policies and water quality targets and limits developed by the Otago Regional Council in the Regional Plan: Water for Otago, as discussed below.

11.3 Proposed Regional Policy Statement for Otago

The RPS is currently under review. The Proposed Regional Policy Statement for Otago (the pRPS) was notified on 23 May 2015 and Council decisions were released on 1 October 2016. The pRPS aims to ensure Otago's natural and built resources are managed well, now and for the future. Twenty-six appeals were received, and so the provisions of the Council decisions version of the pRPS have been assessed in relation to the bypass discharges.

Table 11-3 provides an assessment of the bypass discharges from the MWWTP against the objectives and policies of the RPS.

Table 11-3: Assessment of relevant provisions of the Proposed Regional Policy Statement for Otago 2016 (Council decisions version)

Provision	Assessment
Objective 1.1 *Recognise and provide for the integrated management of natural and physical resources to support the wellbeing of people and communities in Otago.* ***Policy 1.1.3 Social and cultural wellbeing and health and safety*** *Provide for the social and cultural wellbeing and health and safety of Otago's people and communities when undertaking the...use...of natural and physical resources by all of the following:* *a) Recognising and providing for Kāi Tahu values;* *b) Taking into account the values of other cultures;* *c) Taking into account the diverse needs of Otago's people and communities;* *d) Promoting good quality and accessible infrastructure and public services;* *e) Avoiding significant adverse effects of activities on human health.*	The MWWTP provides for the health and safety of the Milton community by collecting and disposing of sewage from the township. However, the bypass discharges from the MWWTP will have an effect on Kāi Tahu values, and may increase public health risks during the period of bypass discharges. Parts of Policy 1.1.3 are therefore currently mutually exclusive for the MWWTP. However, the applicant is proposing to develop a programme of works to reduce the occurrence of bypass discharges at the MWWTP, thus decreasing the risk to public health, and addressing cultural values as far as practicable.
Objective 2.2 *Kāi Tahu values, interests and customary resources are recognised and provided for.* ***Policy 2.2.1 Kāi Tahu wellbeing*** *Manage the natural environment to support Kāi Tahu wellbeing by all of the following:*	Schedule 1A of the pRPS lists the following Kāi Tahu values and interests: • Ki Uta Ki Tai • Rakatirataka • Kaitiakitaka • Tikaka • Taoka • Mahika Kai

Provision	Assessment
a) *Ensuring the sustainable management of resources supports their customary uses and cultural values in Schedules 1A and B;* b) *Safeguarding the life-supporting capacity of natural resources.*	Schedule 1B lists interests specific to particular papatipu rūnaka. The two rūnaka with interests in the Tokomairiro catchment are Te Rūnanga o Ōtākou and Hokonui Rūnanga. The applicant is undertaking consultation with Kāi Tahu ki Otago Ltd on behalf of local rūnanga to identify values that apply to the Tokomairiro River, and how their sustainable management can be ensured. Based on benthic surveys completed for the MWWTP, and the frequently short term nature of bypass discharges, no significant adverse effects on the existing life-supporting capacity, are anticipated as a result of the bypass discharges.
Objective 3.1 *The values of Otago's natural resources are recognised, maintained and enhanced* ***Policy 3.1.1 Fresh water*** *Manage fresh water to achieve all of the following:* a) *Maintain or enhance ecosystem health in all Otago aquifers, and rivers, lakes, wetlands, and their margins;* b) *Maintain or enhance the range and extent of habitats provided by fresh water, including the habitat of trout and salmon;* … e) *Maintain good water quality…or enhance it where it has been degraded;* … h) *Maintain or enhance the quality and reliability of existing drinking and stock water supplies;* … j) *Maintain or enhance the amenity and landscape values of rivers, lakes, and wetlands;* …	Based on benthic surveys completed for the MWWTP, and the frequently short term nature of each bypass discharge, no significant adverse effects on ecosystem health or habitats are anticipated as a result of the bypass discharges. The current water quality in the Tokomairiro River is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. No changes are proposed to the bypass discharges that would worsen them in terms of scale or frequency from the current situation, and the overall water quality in the Tokomairiro River will therefore be maintained. In addition, recognising that the existing water quality is relatively poor directly upstream of the MWWTP, and exceeds limits set in Schedule 15 of the Regional Plan: Water for Otago, the applicant acknowledges the need to significantly improve the occurrence and frequency of bypass discharges, in order to enhance the water quality of the Tokomairiro River. The Milton community water supply is located upstream of the discharges from the MWWTP so will not be affected by the bypass discharges. There are no community water supply takes downstream of the MWWTP discharge point. The existing water quality of the Tokomairiro River is such that it is not expected that any individual is sourcing drinking water from the river downstream of the MWWTP. While bypass discharges mean that water from the river is not suitable for stock, immediately upstream of the discharges from the MWWTP the Tokomairiro is not currently suitable for stock drinking. As overall water quality improves in the river, the works programme to be developed by the applicant will result in a reduction in bypass discharges and reduce effects on stock drinking water quality. The Clutha District Council is not aware of any amenity value concerns as a result of the bypass discharges.
Policy 3.1.9 Ecosystems and indigenous biological diversity	Based on benthic surveys completed for the MWWTP, and the frequently short term nature of

Provision	Assessment
Manage ecosystems and indigenous biological diversity in terrestrial, freshwater and marine environments to achieve all of the following: *a) Maintain or enhance ecosystem health and indigenous biological diversity;* ... *e) Recognise and provide for natural resources and processes that support indigenous biological diversity;* *f) Maintain or enhance habitats of indigenous species and the habitat of trout and salmon that are important for recreational, commercial, cultural or customary purposes;* ...	bypass discharges, no significant adverse effects on ecosystem health or habitats are anticipated as a result of the bypass discharges. While water quality will be affected by bypass discharges, the effects will be temporary.
Objective 4.3 *Infrastructure is managed and developed in a sustainable way* ***Policy 4.3.1 Managing infrastructure activities*** *Manage infrastructure activities, to achieve all of the following:* *a) Maintaining or enhancing the health and safety of the community;* *b) Avoiding, remedying or mitigating adverse effects of those activities on existing land uses, including cumulative adverse effects on natural and physical resources;* *c) Supporting economic, social and community activities;* *d) Improving efficiency of use of natural resources;* *e) Protecting infrastructure corridors for infrastructure needs, now and for the future;* *f) Increasing the ability of communities to respond and adapt to emergencies, and disruptive or natural hazard events;* *g) Protecting the functional and operational requirements of lifeline utilities and essential or emergency services.*	It is not clear from Objective 4.3 what managing and developing infrastructure in a 'sustainable way' means, but implementing Policy 4.3.1 should ensure that the objective is achieved. In terms of Policy 4.3.1, the MWWTP provides for the health and safety of the Milton community by collecting and disposing of sewage from the township, and supports the economic, social and community activities of the township. Policy 4.3.3, while relevant only to nationally and regionally significant infrastructure, provides guidance that in considering infrastructure, adverse effects should be avoided, remedied or mitigated. Clutha District Council's focus in relation to the application for replacement consent for the bypass discharges from the MWWTP is to remedy effects by reducing the scale and frequency of bypass discharges to a point where they are only occurring in times where river flow is high and effects will be minor.
Objective 5.4 *Adverse effects of using and enjoying Otago's natural and physical resources are minimised* ***Policy 5.4.1 Objectionable discharges*** *Manage discharges that are objectionable or offence to Kāi Tahu and/or the wider community by:* *a) Avoiding significant adverse effects of those discharges;* *b) Avoiding, remedying or mitigating other adverse effects of those discharges.*	The applicant acknowledges that discharges of screened sewage are not desirable, and are particularly offensive to Kāi Tahu and should be avoided as far as practicable, but the level of inflow and infiltration into the Milton sewerage system means that it is currently impracticable to avoid bypass discharges at the MWWTP. When bypass discharges occur and sufficient dilution is available, significant adverse effects on community values can be avoided, but at times of insufficient dilution it is not currently possible. The applicant is therefore proposing to develop a programme of works to reduce the occurrence of bypass discharges as far as practicable.

11.4 Regional Plan: Water for Otago

The Regional Plan: Water for Otago (the RPW) promotes the sustainable management of Otago's water resources, and contains policies and methods to address issues of use, development and protection of Otago's freshwater resources, including the beds and margins of water bodies.

Table 11-4 provides an assessment of the bypass discharges from the MWWTP against the objectives and policies of the RPW.

Table 11-4: Assessment of relevant provisions of the Regional Pplan: Water for Otago (updated to 1 May 2014)

Provision	Assessment
Objective 5.3.1 *To maintain or enhance the natural and human use values, identified in Schedules 1A, 1B and 1C, that are supported by Otago's lakes and rivers.*	The Lower Tokomairiro River main stem is identified as having the following values in Schedule 1A: Psand, Psilt, Pgravel, Pplant, Psize, Ppass, Hspawn(t), Hriparian, Hjuve(t), Eel, Trout, Fishdiv It is not clear however where the lower river main stem is located. It is possible that it is located below Tokoiti where the river becomes more constrained as it passes through the coastal hills, and if this is the case the bypass discharges from the MWWTP will have occurred upstream and will have attained sufficient dilution to ensure that no significant effects on the identified values occur. On this basis the values of the Lower Tokomairiro River will continue to be maintained.
Objective 5.3.2 *To maintain or enhance the spiritual and cultural beliefs, values and uses of significance to Kāi Tahu, identified in Schedule 1D, as these relate to Otago's lakes and rivers.*	In relation to the spiritual and cultural beliefs, values and uses of significance to Kāi Tahu listed in Schedule 1D the following are identified for the Tokomairiro River: • Kaitiakitanga • Mauri • Waahi tapu and/or Waiwhakaheke • Waahi taoka • Mahika kai • Kohanga • Trails • Cultural materials The applicant is consulting with Kāi Tahu ki Otago Ltd on behalf of local rūnanga to determine the approach that is necessary to address these values. The bypass discharges will be having an adverse effect on spiritual and cultural beliefs and values of Kāi Tahu.
Objective 5.3.4 *To maintain or enhance the amenity values associated with Otago's lakes and rivers and their margins.*	While bypass discharges could theoretically result in effects on amenity values during times of insufficient dilution, Clutha District Council has not received any complaints during the term of the current consent. A visual observation consent condition is proposed to further assess effects on amenity values and implement measures to address effects if they are occurring.
Objective 5.3.6	The principal reasons for Objective 5.3.6 note that it has been adopted to ensure continued access to Otago's water for a range of existing uses. For the current time, the MWWTP needs to be able to

Provision	Assessment
To provide for the sustainable use and development of Otago's water bodies, and the beds and margins of Otago's lakes and rivers.	discharge to the Tokomairiro River and to discharge bypass flows during rainfall in order to protect human health within Milton township, and the treatment plant infrastructure from damage.
Policy 5.4.2 *In the management of any activity involving surface water, groundwater or the bed or margin or any lake or river, to give priority to avoiding, in preference to remedying or mitigating:* *(1) Adverse effects on:* *(a) Natural values identified in Schedule 1A;* *...* *(d) Spiritual and cultural beliefs, values and uses of significance to Kāi Tahu identified in Schedule 1D;* *(f) Amenity values supported by any water body; and* *(2) Causing or exacerbating flooding, erosion, land instability, sedimentation or property damage.*	The effects of bypass discharges from the MWWTP on the matters listed in Policy 5.4.2(1) have been discussed above in relation to the relevant objectives. Significant adverse effects on the identified natural values and amenity values are not anticipated. Until the programme of works to reduce the occurrence of bypass discharges is fully implemented, avoiding adverse effects on spiritual and cultural beliefs, values and uses of significance to Kāi Tahu is not practicable. The applicant is consulting with Kāi Tahu ki Otago Ltd on behalf of local rūnanga to determine the approach that is necessary to address these values. Flooding, erosion, land instability, sedimentation or property damage are not anticipated as a result of the bypass discharges.
Policy 5.4.9 *To have particular regard to the following qualities or characteristics of lakes and rivers, and their margins, when considering adverse effects on amenity values:* *(a) Aesthetic values associated with the lake or river; and* *(b) Recreational opportunities provided by the lake or river, or its margins*	As noted previously, Clutha District Council is not aware of any effects on aesthetic values as a result of the bypass discharges. The Lower Tokomairiro River has recreational values, particularly in relation to fishing, although this does not appear to occur in the immediate vicinity of the discharge point. Effects of the bypass discharges will decrease the further an activity occurs downstream of the discharge point.
Objective 7A.1 *To maintain water quality in Otago lakes, rivers, wetlands, and groundwater, but enhance water quality where it is degraded.*	The current water quality in the Tokomairiro River is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. No changes are proposed to the bypass discharges that would worsen them in terms of scale or frequency from the current situation, and the overall water quality in the Tokomairiro River will therefore be maintained. In addition, recognising that the existing water quality is relatively poor directly upstream of the MWWTP, and exceeds limits set in Schedule 15 of the Regional Plan: Water for Otago, the applicant acknowledges the need to significantly improve the occurrence and frequency of bypass discharges, in order to enhance the water quality of the Tokomairiro River. The applicant is proposing to develop a programme of works to reduce the occurrence of bypass discharges at the MWWTP, which should enhance water quality in the Tokomairiro River.
Policy 7.B.1 *Manage the quality of water in Otago lakes, rivers, wetlands and groundwater by:*	Table 15.2 of Schedule 15 sets receiving water limits and targets for the Tokomairiro River. The river is noted as meeting most of the targets currently, with the exception of the *E.coli* limit, which is not required to be met until 2025.

Provision	Assessment
(a) Describing, in Table 15.1 of Schedule 15, characteristics indicative of good water quality; and *(b) Setting, in Table 15.2 of Schedule 15, receiving water numerical limits and targets for achieving good water quality; and* *(c) Maintaining, from the dates specified in Schedule 15, good water quality; and* *(d) Enhancing water quality where it does not meet Schedule 15 limits, to meet those limits by the date specified in the Schedule; and* *(e) Recognising the differences in the effects and management of point and non-point source discharges; and* *(f) Recognising discharge effects on groundwater; and* *(g) Promoting the discharge of contaminants to land in preference to water.*	Between now and 2025, the applicant intends to develop a programme of works to address the occurrence of bypass discharges, seeking to reduce them to occasions when there is sufficient rainfall that there are also sufficient flows in the Tokomairiro River. As noted in section 7 of this report, the possibility of discharging wastewater to land for Milton has been considered on two previous occasions, but is not currently practical because of the level of stormwater inflow and infiltration into the sewerage system.
Policy 7.B.6 *When assessing any consent to discharge contaminants to water, consider the need for and the extent of any zone for physical mixing, within which water will not meet the characteristics and limits described in Schedule 15, by taking account of:* *(a) The sensitivity of the receiving environment; and* *(b) The natural and human use values, including Kāi Tahu values; and* *(c) The natural character of the water body; and* *(d) The amenity values supported by the water body; and* *(e) The physical processes acting on the area of discharge; and* *(f) The particular discharge, including contaminant type, concentration and volume; and* *(g) The provision of cost-effective community infrastructure; and* *(h) Good quality water as described in Schedule 15.*	Because bypass discharges are occurring at the same time as treated wastewater discharges from the MWWTP, it is proposed that the same mixing zone applies to the bypass discharges, that is, 70 m downstream of the discharge point.
Policy 7.C.1 *When considering applications for resource consents to discharge contaminants to water, to have regard to opportunities to enhance the existing water quality of the receiving water body at any location for which the existing water quality can be considered degraded in terms of its capacity to support its natural and human use values.*	Receiving water monitoring conducted by Clutha District Council for the treated wastewater discharge from the MWWTP indicates that the water quality in the Tokomairiro River directly upstream of the discharges from the plant is degraded. A joint approach between the Otago Regional Council, Clutha District Council and landowners in the catchment will therefore be necessary to improve water quality. The applicant is proposing to develop a programme of works to reduce the occurrence of bypass discharges at the MWWTP, which should enhance water quality in the Tokomairiro River.

Provision	Assessment
Policy 7.C.2 *When considering applications for resource consents to discharge contaminants to water, or onto or into land in circumstances which may result in any contaminant entering water, to have regard to:* *(a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects;* *(b) The financial implications, and the effects on the environment of the proposed method of discharge when compared with alternative means; and* *(c) The current state of technical knowledge and the likelihood that the proposed method of discharge can be successfully applied.*	The bypass discharges are composed of screened wastewater, mixed with stormwater. The receiving environment of the Tokomairiro River is not currently particularly good, with poor water quality and a low quality macroinvertebrate community. In terms of water quality, the sensitivity of the receiving environment would be summarised as the river is an unmodified but already impacted sensitive receiving environment. In terms of the benthic communities, the invertebrate community is degraded upstream, having lost most or all of the sensitive taxa, and the receiving environment therefore has low sensitivity to further changes. In 2001 estimates of the costs to improve the Milton stormwater system to a point where significant overland flow would not occur in a 1 in 5 year rainfall event were in the region of $2.3million, and this would not fully address the inflow and infiltration issues in Milton. While there will be adverse effects of bypass discharges in times of insufficient dilution, the volume of discharge means that land disposal is not currently feasible. The proposed method of discharge has operated successfully during the term of the current consent. It was designed based on the current technical knowledge of effects of greater flows through the treatment process, and the likelihood that the treatment process would be significantly affected by increasing flow through the plant. Options for altering the discharge process by, for example, installing storage to address some or all storm flows or investigating available treatment options for the discharge will be included in the work proposed by Clutha District Council to address the bypass discharges.
Policy 7.C.3 *When considering any resource consent to discharge a contaminant to water, to have regard to any relevant standards and guidelines in imposing conditions on the discharge consent.*	Relevant standards and guidelines have been referred to in the assessment contained in section 6 of this document.
Policy 7.C.4 *The duration of any new resource consent for an existing discharge of contaminants will take account of the anticipated adverse effects of the discharge on any natural and human use value supported by an affected water body, and:* *(a) Will be up to 35 years where the discharge will meet the water quality standard required to support that value for the duration of the resource consent;* *(b) Will be no more than 15 years where the discharge does not meet the water quality standard required to support that value but will progressively meet that standard within the duration of the resource consent;*	Policy 7.C.4 suggests that a term of 5 years would be granted to the consent being sought by this application. However, as noted above, the natural and human use values currently supported by the Tokomairiro River are not expected to be significantly adversely affected by the bypass discharges. While the applicant is committed to addressing the bypass discharges and reducing their occurrence, the scale of the stormwater inflow and infiltration into the sewerage system means that it will not be possible to resolve the issues within 5 years. A term of 27 years is therefore being sought, to match the term of the dry weather discharge from the MWWTP.

Provision	Assessment
(c) Will be no more than 5 years where the discharge does not meet the water quality standard required to support that value; and *(d) No resource consent, subsequent to one issued under (c), will be issued if the discharge still does not meet the water quality standard required to support that value.*	

11.5 Kāi Tahu ki Otago Natural Resource Management Plan

The Kāi Tahu ki Otago Natural Resource Management Plan 2005 (the NRMP) reflects the holistic Kāi Tahu ki Otago philosophy of resource management through its kaupapa of 'Ki Uta ki Tai' (Mountains to the Sea). The NRMP expresses Kāi Tahu values, knowledge and perspectives on natural resource and environmental management issues.

The NRMP is based on the values of:

- Wai Māori/Wai Tai
- Wāhi Tapu
- Cultural Landscapes
- Mahika Kai and Biodiversity
- Air and Atmosphere
- Coastal Environment
- Pounamu

Chapter 5 Otago Region provides a full description of each value, and lists general issues, objectives and policies for each value. In addition, catchment chapters identify specific values in geographical catchments of the Otago Region. In relation to the MWWTP, the Tokomairiro River is not listed in a catchment chapter of the NRMP. The bypass discharge have therefore been assessed against the relevant objectives and policies contained in Chapter 5 Otago Region.

Table 11-5 provides an assessment of the bypass discharges from the MWWTP against the objectives and policies of the RPW.

Table 11-5: Assessment of relevant provisions of the Kāi Tahu ki Otago Natural Resource Management Plan 2005

Provision	Assessment
5.2 Overall objectives *i. The rakātirataka and kaitiakitaka of Kāi Tahu ki Otago is recognised and supported.*	Clutha District Council recognises the kaitiaki role of Kāi Tahu ki Otago in the Tokomairiro River and is in consultation with Kāi Tahu ki Otago Ltd on behalf of local rūnanga to establish ways in which this can be recognised and supported.
5.3.3 Wai Māori General Objectives *ii. The waters of the Otago Catchment are healthy and support Kāi Tahu ki Otago customs.* *iii. There is no discharge of human waste directly to water.* *iv. Contaminants being discharged directly or indirectly to water are reduced.*	The existing water quality of the Tokomairiro River directly above the discharge point is below Regional Plan: Water for Otago standards for nitrogen, phosphorus, *E.coli* and turbidity and is not likely to support Kāi Tahu ki Otago customs in the immediate vicinity of the MWWTP. The existing bypass discharges will be contributing to decreased water quality in relation to *E.coli* levels. Recognising this, the applicant is proposing to develop a programme of works to reduce the scale and frequency of bypass discharges to assist in improving the quality of the Tokomairiro

Provision	Assessment
	River so that it can support Kāi Tahu ki Otago customs for the majority of the time. During periods of high rainfall, it is likely to be impracticable to avoid bypass discharges, and for the duration of these discharges there will be an adverse effect on the exercise of Kāi Tahu ki Otago customs. Clutha District Council recognises the Kāi Tahu ki Otago objective for no discharge of human waste directly to water, but it is currently not practicable to achieve this objective in relation to the MWWTP.
5.3.4 Wai Māori General Policies *1. To require an assessment of instream values for all activities affecting water.*	The effects of the bypass discharges on instream values are discussed in section 6 of this application document.
4. To protect and restore the mauri of all water.	The bypass discharges will affect the mauri of the Tokomairiro River. Clutha District Council is proposed to reduce the scale and frequency of bypass discharges as far as practicable to avoid effects on mauri, but recognises that a complete avoidance, and therefore complete protection and restoration of the mauri of the Tokomairiro River will not be possible while discharges to the river continue.
8. To require land disposal for human effluent and contaminants.	Land disposal for the treated wastewater from the MWWTP has been considered, but discarded, on two separate occasions since 2001. Until the stormwater inflow and infiltration issues can be fully addressed in Milton, which is likely to take a significant period of time, land disposal will not be practicable.
9. To require consideration of alternatives and use of new technology for discharge renewal consents.	A discussion of alternatives is contained in section 7 of this application document. Clutha District Council will continue to investigate new technology as it undertakes works to reduce the scale and frequency of the bypass discharges.
13. To require monitoring of all discharges be undertaken on a regular basis and all information, including an independent analysis of monitoring results, be made available to Kāi Tahu ki Otago upon request.	Proposed monitoring of the discharge and the receiving environment is outlined in section 8.2 of this application document. Clutha District Council is happy to provide monitoring information to Kāi Tahu ki Otago if requested.
14. To encourage Management Plans for all discharge activities that detail the procedure for containing spills and including plans for extraordinary events. *15. To require all discharge systems be well maintained and regularly serviced. Copies of all service and maintenance records should be available to Kāi Tahu ki Otago upon request.*	The MWWTP is operated under an Operations and Maintenance Manual which sets out emergency procedures and requirements for regular maintenance of the plant.
17. To require visible signage informing people of the discharge area; such signs are to be written in Māori as well as English.	Signage is currently maintained by the discharge point into the Tokomairiro River, although currently only in English
5.5.3 Mahika Kai and Biodiversity Objectives *i. Habitats and the wider needs of mahika kai, taoka species and other species of*	Section 3.5.3 of this application document outlines the fish species found in the Tokomairiro River, some of which will be mahika kai. Effects on fish habitat and

Provision	Assessment
importance to Kāi Tahu ki Otago are protected. *ii. Mahika kai resources are healthy and abundant within the Otago Region.* *iii. Indigenous plant and animal communities and the ecological processes that ensure their survival are recognised and protected to restore and improve indigenous biodiversity within the Otago Region.*	ecological needs are not anticipated as a result of the bypass discharges, as discussed in section 6.2.2 of this application document, nor are adverse effects anticipated on the health and abundance of species specifically as a result of the bypass discharges. The overall poor condition of the Tokomairiro River may currently be affecting mahika kai species. To assist with the overall catchment approach to improving water quality, Clutha District Council is proposing to develop a programme of works to reduce the scale and frequency of bypass discharges, which should contribute to improving mahika kai resources in the river. Section 6 of this application document discusses effects on ecological processes and concludes that the existing discharge is not having a significant adverse effect, which should result in their protection into the future.
5.5.4 Mahika Kai and Biodiversity General Policies *7. To require that all assessments of effects on the environment include an assessment of the impacts of the proposed activity on mahika kai.*	Section 6.2 of this application document contains an assessment of the impacts of the proposed activity on aquatic ecology, which will include mahika kai species.

11.6 Resource Management Act 1991

11.6.1 Part 2

The assessment required by section 104 of the RMA is subject to Part 2 of the Act, which sets out the purpose and principles. Section 5 of the RMA outlines its purpose. Section 6 sets out matters of national importance, section 7 outlines 'other' matters and section 8 requires those exercising functions and powers under the RMA to take into account the principles of the Treaty of Waitangi. Table 11-6 provides an assessment of the works that require resource consent against the requirements of Part 2 of the RMA.

Table 11-6: RMA Part 2 assessment

Provision	Assessment
Section 5	
In this Act, sustainable management means managing the use, development and protection of natural and physical resources in a way or at a rate that allows people and communities to provide for their social, economic and cultural wellbeing and for their health and safety, while...	The MWWTP provides for the health and safety of the Milton community by collecting and disposing of sewage from the township, and supports the economic, social and community activities of the township.
Section 5(2)(a)	
Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations	The development and implementation of a programme of works to reduce the scale and frequency of bypass discharges from the MWWTP will improve the ability of the Tokomairiro River to meet the needs of future generations.
Section 5(2)(b)	

Provision	Assessment
Safeguarding the life-supporting capacity of air, water, soil, and ecosystems	No significant effects on the life-supporting capacity of the Tokomairiro River is anticipated, on the basis of benthic surveys conducted over the last five years and the short-term nature of each bypass discharge.
Section 5(2)(c)	
Avoiding, remedying or mitigating any adverse effects of activities on the environment	Clutha District Council's focus in relation to the application for replacement consent for the bypass discharges from the MWWTP is to remedy effects by reducing the scale and frequency of bypass discharges to a point where they are only occurring in times where river flow is high and effects will be minor.
Section 6(a)	
The preservation of the natural character of...rivers and their margins, and the protection of them from inappropriate subdivision, use and development	The Tokomairiro River in the vicinity of the MWWTP is not an area of high natural character. Nevertheless, what natural character there is needs to be preserved. Significant adverse effects are not anticipated, as the bypass discharges are screened, each discharge is generally relatively short term and the Clutha District Council is not aware of any amenity effects as a result of bypass discharges.
Section 6(c)	
The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.	The Tokomairiro River provides habitat for a number of indigenous fish species, some of them rare. Benthic surveys undertaken over the last five years have not identified any significant habitat in the vicinity of the MWWTP, and have not noted any significant effects on benthic communities as a result of the discharges from the plant.
Section 6(e) and section 7(a)	
The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga. *Kaitiakitanga*	Any discharge of sewage to freshwater will affect the relationship of Maori and their culture and traditions with the water resource. Clutha District Council is consulting with Kāi Tahu Ki Otago Ltd on behalf of local rūnanga to addresses Iwi concerns about the bypass discharges as far as practicable.
Section 7(c)	
The maintenance and enhancement of amenity values	Each bypass discharge is generally short-term in nature. Clutha District Council is not aware of any amenity effects in the Tokomairiro River as a result of bypass discharges, and the wastewater is screened prior to discharge. A visual observation condition is proposed for the replacement consent sought by this application, to ensure that if any adverse effects do occur they can be addressed.
Section 7(d)	
Intrinsic values of ecosystems	Benthic surveys undertaken over the last five years have not identified any significant habitat in the vicinity of the MWWTP, and have not noted any significant effects on benthic communities as a

Provision	Assessment
	result of the discharges from the plant. Fish resident in the area are not expected to be significantly affected by the bypass discharges.
Section 7(f)	
Maintenance and enhancement of the quality of the environment	The current water quality in the Tokomairiro River is a result of both land uses above the MWWTP and the two discharges from the plant, which have been occurring since 1965. No changes are proposed to the bypass discharges that would worsen them in terms of scale or frequency from the current situation, and the overall water quality in the Tokomairiro River will therefore be maintained. In addition, recognising that the existing water quality is relatively poor directly upstream of the MWWTP, and exceeds limits set in Schedule 15 of the Regional Plan: Water for Otago, the applicant acknowledges the need to significantly improve the occurrence and frequency of bypass discharges, in order to enhance the water quality of the Tokomairiro River.
Section 7(h)	
The protection of the habitat of trout and salmon	The Regional Plan: Water for Otago notes that the Tokomairiro River has spawning and juvenile habitat values for trout. Benthic surveys over the last five years have shown no significant effects on habitat downstream of the discharges from the MWWTP, and there is no evidence of spawning habitat in the immediate vicinity of the discharges.
Section 8	
In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi.	Clutha District Council is consulting with Kāi Tahu Ki Otago Ltd on behalf of local rūnanga to addresses Iwi concerns about the bypass discharges as far as practicable.

11.6.2 Section 105 and Section 107

Section 105 of the RMA states that if an application is for a discharge permit to do something that would contravene section 15 of the Act, the consent authority must have regard to:

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(b) the applicant's reasons for the proposed choice; and

(c) any possible alternative methods of discharge, including discharge into any other receiving environment.

The bypass discharges are composed of screened wastewater, mixed with stormwater. The receiving environment of the Tokomairiro River is not currently particularly good, with poor water quality and a low quality macroinvertebrate community. In terms of water quality, the sensitivity of the receiving environment would be summarised as the river is an unmodified but already impacted sensitive receiving environment. In terms of the benthic communities, the invertebrate community is degraded upstream, having lost most or all of the sensitive taxa, and the receiving environment therefore has low sensitivity to further changes.

As the discharge of treated wastewater from the MWWTP occurs to the Tokomairiro River and holds consent until 2044, and because of the scale of stormwater inflow and infiltration to the Milton sewerage

system, the applicant has chosen to apply for a replacement consent to continue the existing bypass discharges to the Tokomairiro River.

The volume of the bypass discharges during heavy rainfall events, and the absence of practicable alternative receiving environments means that there is currently no practical alternative to the discharge for which consent is being sought.

Section 107 of the RMA states that a consent authority shall not grant a discharge permit for something that would contravene section 15 of the RMA if, after reasonable mixing, it is likely to give rise to any of a series of identified effects. As outlined in section 5 of this report, the majority of effects listed in section 107(1) are not expected to occur as a result of the bypass discharges, but the Tokomairiro River, which is currently not suitable for consumption by farm animals, will have its water quality for those purposes further reduced. However, as the water quality in the Tokomairiro River upstream of the discharge point is currently not suitable for stock drinking water, the bypass discharge itself will not render the river unsuitable for consumption by farm animals. Consent can therefore be granted, although it is noted that the applicant proposes to develop a programme of works to reduce the occurrence of bypass discharges with the aim of avoiding section 107 effects in the Tokomairiro River once its water quality has improved.

12. Conclusion

The Clutha District Council is seeking a discharge permit to replace an existing consent that authorises bypass discharges of wastewater at the Milton Wastewater Treatment Plant. Some improvements have been made to the discharge since the current consent was granted – bypass discharges are now screened, and works have been undertaken in Milton to investigate and remedy some instances of inflow and to address flooding problems close to the Tokomairiro River. However, significant work still needs to be done to resolve the issues and reduce the occurrence of bypass discharges.

Bypass discharges are not currently directly measured. Using a process of subtracting the reading from the meter measuring the inflow to the treatment process from the reading from the meter at the inlet wet well at the head of the treatment plant, suggests that bypass discharges are occurring frequently. Caution needs to be exercised in considering this record as accurate, as there are known issues with differences in the accuracy of each of the meters, and the structure of the bypass discharge pipeline means that short-term recorded discharges may not always occur. With that caution in mind, the effects of the bypass discharges have been considered by comparing the discharge volume to river flow in the Tokomairiro River, from a synthetic flow record generated as part of this application.

In terms of *E.coli* levels in the bypass discharges, while the existing receiving environment quality is not high, the level of dilution required to avoid increasing risks to public health during bypass discharges are not available often in the Tokomairiro River, and the river will also continue to be unsuitable for stock drinking water. Sufficient dilution is generally available for ammoniacal nitrogen, and the bypass discharges make little difference to the nutrient that is already added to the river by the wastewater treatment plant, as the Milton plant is not a nutrient reducing plant.

While water quality during bypass discharges with insufficient dilution will be temporarily affected, benthic surveys conducted for the Milton Wastewater Treatment Plant over the last 5 years have not shown any significant adverse effects as a result of the discharges (both the bypass discharges and the treated wastewater discharge).

Clutha District Council acknowledges that the Otago Regional Council has a programme to improve water quality in the Tokomairiro River, and that objectives and policies of the Regional Plan: Water for Otago set water quality standards for the river. Clutha District Council is therefore proposing to develop a programme of works to address as far as possible the occurrence of bypass discharges, in order to contribute to improving the water quality of the Tokomairiro River.

Appendices

Appendix A Stormwater Management Plans

CLUTHA DISTRICT COUNCIL

PROGRAMME OF WORKS FOR REDUCTION OF STORMWATER IN MILTON FOUL SEWER

November 2003

1.0 Introduction

The Milton Sewage Treatment Plant has recently received new consents to discharge treated sewage and bypass a mixture of stromwater and treated sewage to the Tokomairiro river. The latter consent is necessary because the calculated dry weather flow for the plant is approximately 500 m3/d, based on the population served, which suggests a wet weather flow of about 2,500 m3/d. However, the actual average flow is approximately 750 m3/d and peak flows are estimated to be 10,000 m3/d.

These flows indicate that stormwater is entering the system to a much greater degree than is usual. Council is addressing this issue which is also targetted in the conditions of the second of the above consents, Otago Regional Council Consent No 2002.369. Condition 2 reads:

> "The consent holder shall provide a stormwater management plan that sets out the investigations and works projected for the reduction of stormwater infiltration into the sewage treatment system. The plan shall be provided to the consent Authority by 1 June 2003 and it shall be updated by 1 June 2008, and 1 June 2013."

This is the plan required by this condition and it describes Council's intentions concerning stormwater entering the Milton foul sewer system. It has been prepared somewhat later than the first date required by the consent condition. This has been occasioned by delays experienced in engagement of Consultants and preparing the work programme this year. The delay, while regrettable, has allowed this plan to be more definitive about the work programme than would have otherwise been possible.

2.0 Background

Stormwater entering a foul sewer system is a problem because it increases the quantity of sewage which needs to be disposed of. It can overload treatment plants and increase the volume of discharges to the environment.

There are three ways stormwater gets into the foul sewer:

2.1 "Surface flow" entering directly through manhole lids and gully traps. This occurs during times of surface flooding.

2.2 "Infiltration" of groundwater to sewers through poorly sealed or failed joints, failed pipes, etc, either public or private sewers.

2.3 "Direct entry" via illegal stormwater connections to the foul sewer, eg downpipes to gully traps.

No study has been done to identify which of these factors is having the major effect in Milton. It is almost certain that each of them will be contributing, but the extent is uncertain. It may be that the contribution from one factor is so small as not to warrant any work to remove it. However, it is known that Milton

suffers regular surface flooding which indicates that the present stormwater system is unable to provide the level of protection expected nowadays. This, coupled with the infrequent need to deal with high flows at the sewage treatment plant (additional pumping has been required to bypass excess flow 5 times in three years), strongly suggests that surface flow is a significant contributor.

3.0 Strategy

As noted above, it is suspected that surface flow is a significant contributor to excess foul sewer flows. As controlling surface flooding also provides a direct benefit to the community, surface flow has been identified as the first aspect to attack.

Council is presently investigating asset condition in a targetted manner where it suspects poor condition is causing problems. Milton is one of these areas. For foul sewers, this necessitates inspection through the use of CCTV. The assessment of asset condition will identify locations where excessive infiltration will be occurring.

These two factors mean that a strategy has been adopted which will tackle the sources of stormwater in the following order:

1. Reduce surface flooding, commence monitoring effects.
2. Investigate infiltration.
3. Remedy infiltration where appropriate.
4. Investigate and remedy direct entry.
5. Dependent on monitoring results from 1., do further work to reduce surface flooding.

It needs to be noted that direct entry is usually a bigger contributor to stormwater entering foul sewers than infiltration. However, the influence of other projects in other locations makes it logical to investigate Milton infiltration at the same time. This is the reason infiltration is being assessed prior to direct entry, but the latter will follow quickly once funding is provided by Council.

Items 1-3 and 5 are likely to involve solely public assets and will be publicly funded. Item 4 is likely to identify illegal connections mostly on private property and its remedial work will be privately funded, but the Council has the power to require the work to be done.

4.0 Tasks

Further details on the projects below are attached as an appendix, where available.

4.1 Reduce Surface Flooding and Monitor

This task is separated into a number of projects:

(a) Investigate incidence of flooding in Milton, identify existing stormwater reticulation system and determine works required to provide a suitable level of flood protection and thus control of surface water. This work has been briefed to MWH and draft report and recommendations received. Two stages of stormwater improvement are proposed.

(b) Model the Tokomairiro River to determine flood flows and levels in the channel around Milton. This work has been briefed in a joint project to the Otago Regional Council, results are presently awaited.

(c) Review the results of (a) and (b), finalise recommended work. This work has been briefed to Opus International Consultants as a part of their recently awarded Utilities Network Professional Services contract. Complete by15 February 2003, but is dependent on project (b) being completed prior.

(d) Design, tender and construct stage 1 of the recommended work from (c). Design and contract management has been briefed to Opus. Completion aimed to 30 June 2003, provision for the work, estimated to cost approximately $900,000, has been made in the 2003-04 Annual Plan..

(e) Monitor results by comparing flows through the Milton STP with local rainfall. Measurement of flows through the plant commenced in June 2003. It was found then that the old flow measuring equipment was entirely unreliable. Council operates a weather station in the hills at Glenledi, about 6km east of Milton, which records rainfall in half-hour Intervals. This station is suitable for the purpose. Matching daily flows and rainfall is a current, ongoing activity.

(f) Evaluate monitoring results and determine whether stage 2 works are required. Any stage 2 works required would then be subject to Council's Annual Planning process.

Note that it will be some time before the effectiveness of the work can be established because of the intermittent nature of rain storms. It may be up to 5 years before any definitive comment can be made on the effectiveness of stage 1 and an assessment made of whether stage 2 is required.

4.2 Investigate and Remedy Infiltration

Again, there are a number of projects associated with this task:

(a) Inspect sewers using CCTV and evaluate results. This is to be done via a contract in the first half of calendar 2004.

(b) Investigate condition of water mains to determine level and location of leakage. This has been briefed to Opus.

(c) Review stormwater, foul sewer CCTV and water main condition results to identify any common or cross-boundary matters (eg water leaking from a water main to the sewer). This has been briefed to Opus.

(d) Establish and budget for a programme of improvement works, if any. This will form a part of Council's planning process.

4.3 Investigate and Remedy Direct Entry

This task will necessitate a single project which will be included in the Council's 2004-05 Annual Plan. Its progression is dependent on Council decisions on that Plan.

(a) Smoke test all private sewers to identify infiltration and, primarily, direct entry. Inspect properties for smoke, illegal connections and gully trap surrounds. Follow up all properties with illegal or poor drainage to ensure owners rectify. To be briefed and commence in 2004-05.

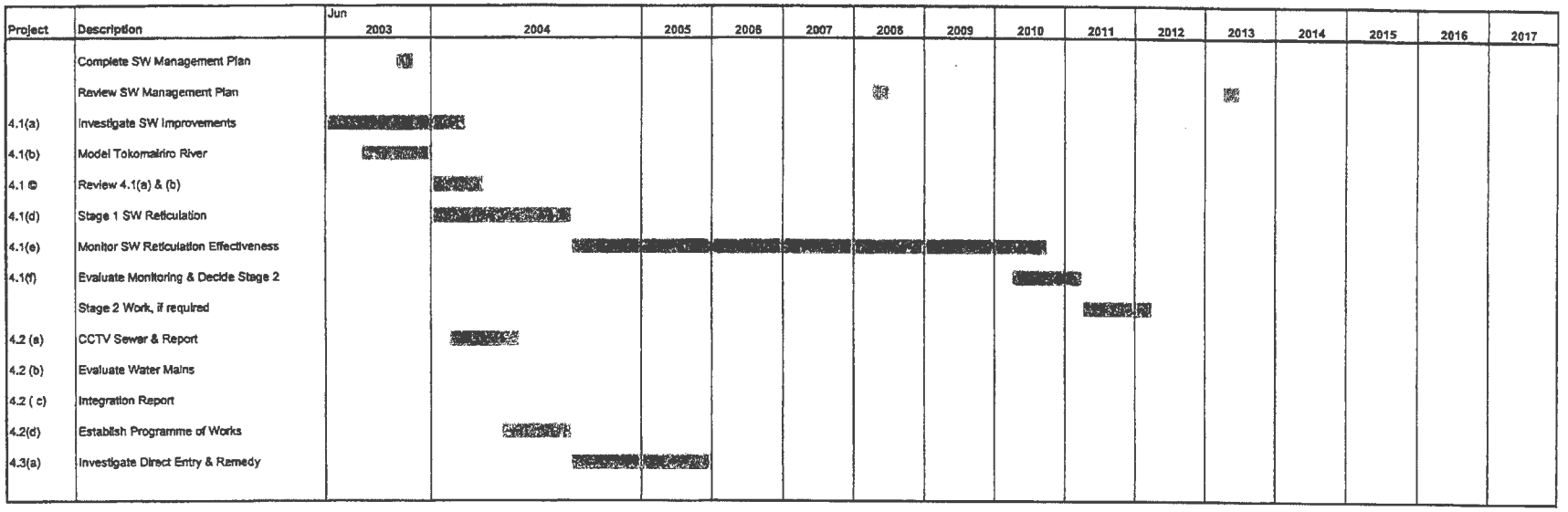
5.0 Long Term Council Community Plan (LTCCP)

This plan is required by the Local Government Act 2002. The strategy and tasks above will be considered as a part of the preparation of that plan. In future, it is anticipated that Annual Plans will flow from the LTCCP. While this plan sets out work programmes, the decisions on proceeding are always contingent on Council meeting its overall planning and financial obligations.

6.0 Summary Programme

A summary programme set out as Gantt chart is attached.

REDUCTION OF STORMWATER IN MILTON FOUL SEWERS - PRGRAMME OF WORKS



Date: 20-Nov-03

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MILTON SEWAGE SYSTEM

STORMWATER MANAGEMENT PLAN

SEPTEMBER 2012

Milton Sewage System

Stormwater Management Plan

September 2012

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1 Introduction

This report is an update on the works described in the Milton Wastewater Treatment Plant (WWTP) Stormwater Management Plan (SMP) prepared in July 2011.

Condition No. 2 of Consent No. 2002.369 requires three SMPs to be provided to the Consent Authority in 2003, 2008 and 2013. The initial SMP for this consent was prepared in 2003 with an update in 2010.

Condition No. 17 of Consent No. 2007.090_V1 requires the Council to develop a programme to investigate and minimise the amount of stormwater entering the sewage reticulation system. This programme is to be documented and reported to the Consent Authority within 12 months of the commencement of this consent followed with annual updates for the subsequent five years ie in 2010, 2011, 2012, 2013, 2014 and 2015.

Given that the intentions of the two consents' conditions are the same, the Consenting Authority (the Otago Regional Council) and Clutha District Council agreed that one SMP would be adequate to meet the requirements of the two consents.

2 Works Progress

The table below summarizes the relevant tasks identified in the last SMP with notes on the progress made and further works planned. The progress updates are highlighted to facilitate reference.

In addition to the tabulated tasks the Otago Regional Council (ORC) and the Clutha District Council have proposed the Milton 2060 Flood Risk Management Strategy, the objectives of which include the investigation and implementation of flood risk reduction measures. This would in turn reduce the quantity of the Inflow and Infiltration into the sewage system.

Item	Tasks	Update Notes	Comment
1.	IMPROVEMENT WORKS ON EXISTING STORMWATER RETICULATION SYSTEM Ref: 2003 Previous SMP Section 4.1 (a) & (c).	Multi-stage improvement works were recommended by the Consultant, of which the Stage 1 works, the Pump Station and Floodbank, are now complete. Subsequent stages will be dependent on the effectiveness of the Stage 1 works and the "surface flow reduction" measures described in (2) below. ***2012 UPDATE*** *Information on rain events and flooding occurrences continue to be recorded in conjunction with the performance of the stormwater and wastewater systems.*	The aim of these works is to provide a suitable level of surface flooding reduction.

Item	Tasks	Update Notes	Comment
2.	REDUCE SURFACE FLOODING Ref: 2003 SMP Section 4.1(b), (c) & (d). Model of the Tokomairiro River was carried out as a joint ORC/CDC project to determine the flood flows and channels around Milton township.	The following were identified to reduce surface flooding and hence the amount entering the sewage treatment system. • Surface flow diversion between Springfield Rd and Tokoiti Rd was completed in 2009. • Flood bank along the true left bank of the Tokomairiro River between the SH1 road bridge and Milton WWTP site completed in November 2010. • Pump Station at the flood bank was completed in November 2010. ***2012 UPDATE*** *Since the last reporting period the new SW Pump Station was activated on 14/08/12 from about 11pm to 11am on 15/08/12.*	 • This reduces the amount of surface water reaching the Milton township reticulation. • This reduces surface flooding in the low lying areas of Milton when river level rises. • This is to pump SW from the township reticulation to the river when high river level prevents free discharge to the river. ***2012 UPDATE*** *No surface flooding in areas previously susceptible were recorded during this reporting period.*
3.	MONITOR FLOWS AT WWTP TO ASSESS THE REDUCTION OF FOUL SEWER FLOWS DURING HEAVY RAINFALL EVENTS Ref: Previous SMP Section 4.1 (e) & (f). Collate and analyse rainfall data from Glenledi weather station and flow measurements at the Milton WWTP.	This is an on-going activity, the evaluation of which will be used to base further works on sources of excess flows entering sewage treatment system. Comparison of collated rainfall data from Glenledi weather station with sewage flows at Milton WWTP will be undertaken. ***2012 UPDATE*** *Collation & analysis of data continuing.*	The outcome of this assessment will influence the implementation of the subsequent stages of improvement works on the existing SW reticulation system. ***2012 UPDATE*** *The evaluation of the data collected will be used to further develop the I&I Control strategy*

Item	Tasks	Update Notes	Comment
4.	INVESTIGATIVE WORKS ON THE CONDITION OF EXISTING SEWER RETICULATION Ref: Previous SMP Section 4.2(a), (c) & (d).	CCTV inspection works on length of stormwater and foul sewers selected at random and those with historical problems were completed in 2007/2008. Details of further investigative works will be finalized and remedial works programme established in 2011, the implementation of which will be staged to suit available funding. ***2012 UPDATE*** ***Smoke Testing*** *– The smoke testing of the existing sewer reticulation network in the Milton Township was carried out between 20/6/11 and 4/8/11.* *Relevant information from the Smoke Testing result will be used to provide base information for the separation of SW and foul sewers.*	Condition assessment of existing foul sewer reticulation using CCTV inspection. • To assess the condition of existing sewers • To ascertain the appropriate remedial and maintenance works. ***2012 UPDATE*** *In October 2011 ProjectMax of Auckland was engaged to review the CCTV inspections of Milton sewers and stormwater mains which include the assessment of the defects and serviceability that affect the pipelines performance with regard to high infiltration.*

Item	Tasks	Update Notes	Comment
5.	SEPARATION OF STORMWATER AND FOUL SEWER The aim is to eliminate direct entry of surface water into foul sewer reticulation due to incorrect or illegal connections.	A programme to investigate this will be prepared in 2011, with implementation planned for 2012. Private sewers will be included in this investigation. ***2012 UPDATE*** *Rectification works on the sewers from the outcome of the smoke testing and related building compliance works are continuing.* *About 800 properties & business premises are connected to the sewer reticulation. The initial indication from the test and above ground observation was that fifty three of these were observed to either have a direct connection or discharge directly to the sewer. A list of these premises was used to carry out further investigation and rectification works.* *At the time of writing this report some 18 properties remain to be assessed. Out of the 35 properties inspected, 19 were found to have their stormwater drains connected to the sewer.*	Ref: Previous SMP Section 4.3(a). ***2012 UPDATE*** *Separation of SW and foul sewer will be included in the I&I Control strategy.*
6.	CONDITION ASSESSMENT OF EXISTING WATER MAINS Ref: Previous SMP Section 4.2(b). Leaks from water mains may contribute to infiltration into waste water system.	Investigation of a section of Milton water reticulation network was carried out in 2008, with large leaks identified and remedied. Further such investigations in other parts of Milton may be scheduled in stages as appropriate. ***2012 UPDATE*** *Investigative works and monitoring of the sewage system are on-going.*	Ref: Previous SMP Section 4.2(b). Results of further investigation may identify major leakage, which will be remedied accordingly. However, contribution to sewage overflows is expected to be minimal.

3 Future Update

The next update of this SMP will be prepared in 2013 as per condition 17 of Consent No. 2007.090_V1.

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MILTON WASTEWATER

STORMWATER MANAGEMENT PLAN

December 2016

Milton Wastewater

Stormwater Management Plan

December 2016

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2 **Works Progress** 2

1 Introduction

This report is an update on the works described in the Milton Wastewater Treatment Plant (WWTP) Stormwater Management Plan (SMP) prepared in September 2012.

Condition No. 2 of Consent No. 2002.369 requires three SMPs to be provided to the Consent Authority in 2003, 2008 and 2013.

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Given that the intentions of the two consents' conditions are the same, the Consenting Authority (the Otago Regional Council) and Clutha District Council agreed that one Stormwater Management Plan would be adequate to meet the requirements of the two consents.

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Item	Tasks	Update Notes	Comment
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Item	Tasks	Update Notes	Comment
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Item	Tasks	Update Notes	Comment
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Item	Tasks	Update Notes	Comment
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Appendix B Milton Stormwater Strategy 2001

Clutha District Council

Milton Stormwater Strategy

November 2001

MWH
MONTGOMERY WATSON HARZA

This report has been prepared solely for the benefit of Clutha District Council. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval or to fulfil a legal requirement.

Quality Assurance Statement	
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Clutha District Council
Milton Stormwater Strategy

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1. Introduction

Parts of Milton suffer from localised surface flooding in high intensity rainfall. There is a perception that the stormwater system does not have the capacity to provide the level of service expected.

Clutha District Council has identified the need to develop a strategy for improvement of their stormwater assets to provide the necessary tools for long term planning.

The aim of this study is to:

- Develop a model of the Milton stormwater system.
- Assess 1 in 5 year and 1 in 50 year design storms.
- Assess the performance of the stormwater system in the design storms.
- Consider options to mitigate flooding.
- Prepare a strategy to improve the stormwater system and plan for future works.

2. Terms of Reference

The scope of this report is defined in the Clutha District Council Tender for Professional Services "Contract 408: Professional Services – Stormwater Investigations and Capital Works", December 2000. The main features are as follows:

- Investigation of existing Council records.
- Field inspection for verification of stormwater system.
- Confirmation of connectivity and broad condition rating for handling stormwater flows.
- Development of system model including investigations based on design storms
- Projection of design flows.
- Modelling of the system to size services for design flow.
- Preliminary estimation of improvement works.
- Recommendations for prioritising improvement works.

3. Existing Stormwater System

3.1 Nature of the System

Milton is a community built on the banks of the Tokomairiro River. The general fall of the Milton Urban Area catchment is towards the river or to tributary creeks. The stormwater sub-catchments are predominantly flat and are mainly serviced by roadside kerb and channels and pipe networks. There are no clearly defined natural valleys or ridgelines so the catchment watersheds are quite subtle. The roads often run along ridgelines, separating stormwater catchments.

The layout of the Milton stormwater system is shown in Appendix A, Figures 1a, 1b and 1c.

Within Milton there are three main stormwater catchments and pipe networks, as shown in Appendix A, Figure 2. For the purpose of this study these catchments are called:

- Helensbrook,
- West Milton, and
- East Milton.

The first catchment is the Helensbrook catchment. This catchment is to the north of central Milton, beyond Salmonds Creek. The primary network is a series of pipes that discharge to an open channel in the north, and via an open channel to Salmonds Creek in the south.

The second catchment is the West Milton catchment. This catchment extends from Salmonds Creek in the north to the Tokomairiro River in the south. Union Street (State Highway One) forms a high point through the Milton Urban Area that separates stormwater catchments and defines the eastern extent of the West Milton catchment. Stormwater runoff is collected in this catchment by roadside kerb and channels before entering the pipe network. The main collector pipe runs down Ajax Street from the north and discharges to the Tokomairiro River. This catchment is predominantly residential, but also contains areas of commercial development. This includes sections of the shopping area along Union Street.

The third catchment is the East Milton catchment. This catchment also extends from Salmonds Creek in the north to the Tokomairiro River in the south and is bordered to the west by Union Street. Stormwater runoff is collected in this catchment by roadside kerb and channels or water tables before entering the pipe network. The main collector pipes run down Spenser and Chaucer Streets from the north and discharge to the Tokomairiro River close to the Pope/High Street intersection. This catchment is predominantly residential, but also contains areas of commercial development along Union Street.

Some properties in Milton have buildings built in potentially flood prone areas. These areas may become inundated during periods where high water levels in the Tokomairiro River coincide with high return period events in the Milton Stormwater catchment. People's houses and buildings on these properties are therefore at risk. This is particularly the case is the southern area of Milton.

3.2 Known Flooding Problems

Known flooding problems were discussed with Council staff during the initial phase of the stormwater investigation study. The following list of known stormwater control issues was compiled at that time based on anecdotal evidence and documented occurrences of flooding. The locations of the known flooding problems are shown in Appendix A, Figure 1a, 1b and 1c.

Flooding at Transport Yard (Helensbrook Catchment)
Surface flooding and flooding of the Transport yard at Constitution Avenue. This property lies at the low point in the local collection system where sumps collect runoff from the kerb and channel.

Dryden Street Flooding (East Milton Catchment)
Surface flooding occurs on the road and through the properties at the northern end of Dryden Street. Runoff from a large rural catchment runs down the line of Dryden Street. This runoff results in overland flow where the primary drainage system is unable to handle the stormwater.

Surface Flooding at the Milton RSA (East Milton Catchment)
The RSA at the corner of Ossian and Union Streets has experienced flooding in the carpark behind the property.

Jura Street/Ajax Street Surface Flooding (West Milton Catchment)
Surface flooding of both the road and adjacent properties at the Jura Street/Ajax Street intersection has been reported. The perception is that this part of the primary drainage network does not have enough capacity to handle the stormwater runoff.

Surface Flooding at Pope Street/Mill Street (East Milton Catchment)
The East Milton catchment drains towards this intersection before draining to the Tokomairiro River. The perception is that when the river level is high the collected stormwater runoff cannot drain freely.

3.3 Existing Available Data

The available data used during this study was obtained from the following sources:

System Plans: Stormwater plans provided by Council, namely;
Milton Borough Council Stormwater Loan Proposal 1973
Milton Borough Council Stormwater Proposals 1961
Miscellaneous plans regarding system upgrades

Operation Reports: Reports and letters regarding stormwater issues raised by local residents and operational staff.

Digital Information: Aerial photos, digitised system plans and parcel boundaries for the Milton Urban area.

The Otago Regional Council (ORC) has supplied information regarding the east branch of the Tokomairiro River. The two year flood level in the Tokomairiro River was estimated by the ORC to be in the order of RL 109.3m. This estimation was made some 15 years ago and may not now represent what is the situation in the Tokomairiro River.

A plan of the ORC's intentions to divert foreign surface water away from the town and into the Tokomairiro River has also been provided. This plan is dated March 1992. Parts of the lower reaches of proposed works have already been completed from the Tokomairiro River to the top end of Macandrew Street. The extension of these works to divert surface water away from the north end of Dryden Street has not yet been completed.

We have found some information in existing plans that is in conflict with other sources when reviewing the data. Some verification was required to differentiate the information.

3.4 Asset Field Survey

Modelling a stormwater system requires a high level of detail. There was not enough information on invert levels, condition or the layout of the system available at the Council, therefore, additional field survey was needed.

We conducted a field survey to get details of:

- Invert levels of incoming and outgoing pipes
- Pipe size and material
- For open channels, typical profile
- Lid and ground levels

The field survey team used global positioning to record open channel profiles, lid levels, and ground levels.

We were able to pick up a large number of the stormwater system assets in the field survey. Some assets indicated as 'existing' in plans could not be found by either the Council maintenance contractors or us. These sites may have been built over, buried or otherwise sealed particularly where the drainage system crosses private property. All reasonable steps were taken to locate these sites at the time of the field survey.

The legacy of what appeared to be an historic stormwater system running through parts of Milton was identified during the field survey. Particular effort was made to find out whether these parts of the system are still in service and to trace the path either to a connection to identified stormwater pipes or to an outfall. In some cases it was not possible to confirm whether these parts of the system are still operational and have not, therefore, been included in the analysis of the Milton stormwater system. This is a conservative approach, as analysis of the primary drainage system will therefore be based on what has been identified as the operational stormwater drainage system.

The field survey took particular note of the outfalls or discharges to the Tokomairiro River due to the potential flooding of the southern area of Milton. One thing in particular that was noted was that no outfall was protected from reverse flow from the Tokomairiro River by flood gates.

4. Modelling of the Existing Stormwater System

4.1 Modelling Strategy

The Milton stormwater system has been modelled using MOUSE, a dynamic modelling software package. MOUSE incorporates a Surface Runoff Model to calculate runoff from rainfall, and a Pipe Flow Model to route the runoff through the reticulation system.

The modelling strategy adopted can be summarised as follows:

1. Develop the Surface Runoff Model
2. Develop the Pipe Flow model
3. Run design storms through the model to assess the existing system performance.
4. Develop and model improvement options

The development and modelling of improvement options are discussed in Section 7.

4.2 Surface Runoff Model

The surface runoff model provides a representation of the rainfall runoff from each catchment calculated using the "Modified Rational Method" approach.

Aerial photography was used to assess catchment type. We assigned a catchment type to each sub-catchment in the Milton urban area that best described the predominant land use. We then used this assessment to allocate a runoff coefficient for calculation of the rainfall runoff. A summary of runoff coefficients is provided below in Table 4.1.

Table 4.1: Surface Runoff Model Runoff Coefficients

Catchment Type	Runoff Coefficient
Rural – includes open grassed spaces, pasture land, and areas of light scrub cover	0.30
Commercial/Industrial – includes shopping areas and built up commercial zones	0.65
Residential	0.50

The runoff coefficients contained in Table 4.1 are from the New Zealand Building Code 2000: Section E1: Surface Water. This is an industry approved standard and the rainfall coefficients listed are consistent with figures in similar stormwater projects.

Further refinement of the runoff coefficients could be achieved if the stormwater system model was calibrated using actual flow data. Actual flow data was not available as part of this study. Therefore the runoff coefficients identified in Table 4.1 have been used. These provide a more conservative assessment of the catchment runoff than may actually occur.

The initial condition of the catchments was also considered when deriving runoff parameters. The initial conditions are a combination of the following:

- Surface Storage and Wetting - rainfall stored in puddles.
- Infiltration.
- Evaporation (rarely significant).

We have assumed that the catchments are at saturation before the storm event in this study. This means that surface storage is full and no more rainfall can enter the soil by infiltration. Therefore, all runoff from the catchments enters the stormwater system, providing a conservative representation.

The future growth within Milton has been accounted for in areas of existing residential development. We have assigned a higher runoff rate of a residential catchment to properties that are currently open space with no development and adjacent to or between residential properties. The exceptions are park areas and school playing fields. This is a conservative approach and makes allowance for potential future development in the existing Milton urban area.

4.3 Pipe Flow Model

The pipe flow model uses a dynamic wave calculation to route the stormwater flow through the reticulation system. It takes the predicted runoff flows calculated in the Surface Runoff Model and routes it through the piped and open drain system.

The MOUSE model uses the following data to represent the system:

- Manhole coordinates and depths.
- Pipe diameter and invert level.
- Channel cross-section information.
- Pipe or channel upstream and downstream connectivity.
- Outlet invert and downstream boundary conditions.

The parameters required for the pipe flow model include:

- Pipe roughness, assessed globally for this study is Mannings n=0.014
- Channel roughness, assessed globally for this study as Mannings n=0.030
- Overland flow roughness, assessed globally for this study as Mannings n=0.014
- Manhole headlosses, individually assessed for this study dependent on geometry of the manhole (i.e. higher headlosses at manholes with multiple pipe junctions or changes in direction than those without).

The extent of the modelled system is shown in Appendix A, Figure 1a, 1b, and 1c. The model includes the manholes, pipes and open channels within the Milton urban stormwater system. Individual stormwater sumps and sump leader pipes are not included unless there are specific areas where detail is required.

A representation of the road networks has been included as part of this study to simulate the effects of flooding manholes and the migration of overland flows in the stormwater system. Where the primary system is not sufficient to drain the catchment, the resulting surface flooding may be retained in the representation of the overland flows down the road network. The stormwater flow then continues to a point where either the stormwater can re-enter the primary system or ponding would occur. This is a coarse representation of the overland flowpaths and does not include all possible routes. It does demonstrate the extent to which overland flow may occur and the possible path the flow would take. It should not be taken as an exact representation of surface flood levels.

The primary drainage system drains to either the Tokomairiro River or its tributaries such as Salmonds Creek. Therefore, there are potentially backwater effects at the downstream boundaries of the model resulting from the flood levels in the Tokomairiro River. While average river levels would not flood the existing outlets, there will be times when the river is in flood and the outlets are fully or partially drowned.

We consulted with the Otago Regional Council to find out about river levels. They could not provide a high level of information, however they did provide a flood level in a 1 in 2 year return period event (RL 109.3m). This information is based on an estimate made more than 15 years ago. More recent information was annotated on drainage plans provided by Clutha District Council. This plan shows recorded river levels for an

event in 1972 of RL 111.02m and an event in 1992 of RL 110.03m. Although no statistical analysis has been undertaken for the return period of these river levels, they are actual recorded levels that the river has reached within recent memory. A downstream flooded river level of RL 110.03 has therefore been adopted for the purpose of modelling flooded river conditions for this project.

4.4 Design Storms

The design storms used in this investigation are the 1 in 5 year event and the 1 in 50 year event.

High Intensity Rainfall Design System (HIRDS version 1.5b) software package, developed by NIWA, was used to predict the statistical rainfall for Milton. This package contains a database of rainfall information for gauges around New Zealand and interpolates rainfall predictions for any site between rain gauges.

The HIRDS predictions for Milton are shown in Table 4.2.

Table 4.2 HIRDS Rainfall Prediction for Milton

Annual Recurrence Interval –ARI	Rainfall Depths at the Various Storm Durations and Storm Frequencies										
	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	6	8	9	12	17	21	28	37	49	61	67
5	8	10	13	17	23	27	37	49	65	81	90
10	9	12	15	20	27	32	44	58	76	94	105
20	10	14	17	23	30	36	50	65	86	107	119
30	11	15	18	24	32	39	53	70	92	115	127
50	12	16	20	26	35	42	57	76	100	124	137
60	13	17	20	27	36	43	59	78	102	127	141
70	13	17	21	28	36	44	60	79	105	130	144
80	13	18	21	28	37	45	61	81	107	132	147
90	13	18	22	29	38	45	62	82	108	134	149
100	14	18	22	29	38	46	63	83	110	136	151

HIRDS is a widely used and useful rainfall prediction tool, however it is necessary to understand the limitations of the outputs provided. These include:

- The system interpolates rainfall information between rain gauges based on isohyet contours. This may give rise to errors associated with local irregularities in rainfall patterns.
- The system uses only 20 years of data between 1960 and 1980. Recent indications in the industry suggest that the 1990's in particular have been wetter than normal. There are also climate change theories that indicate our weather patterns may be changing around the country. Therefore, the rainfall predictions may change if a larger data-set that included the last 20 years was analysed.

Additional rainfall data for the only automatic rain gauge in the Clutha area was analysed to assess the implications of the limited dataset. The conclusion from this analysis is that the best confidence that can be placed on the rainfall predictions from HIRDS is ±20%.

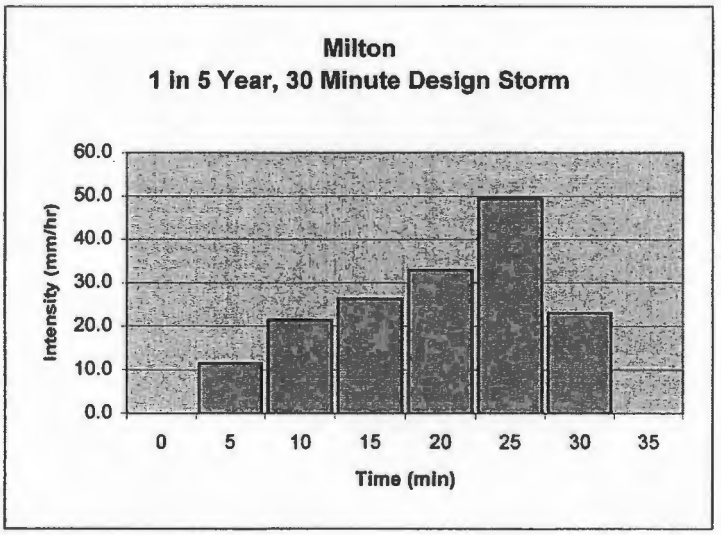
For the purposes of this study the rainfall depths have been increased by approximately 20%, as shown in Table 4.3.

Table 4.3: Design Rainfall Intensities (20 Minute Events)

Storm Frequency	Adjusted Rainfall (mm/hr)
1 in 5 year	36
1 in 50 year	58

Actual storm events do not have constant rainfall intensity throughout the event. Rainfall profiles have been used to represent the effect of an actual storm event in the catchment. These profiles, for events of different duration, are based on the statistical analysis of Auckland rainfall over a 30 year period. These profiles provide a good representation of a typical rainfall pattern even though there may be some temporal differences between rainfalls of the two regions. The rainfall profile used for Milton is shown below in Figure 4.1.

Figure 4.1: Milton 1 in 5 Year, 30 Minute Design Storm



4.5 Critical Duration Storm Event

To assess the critical duration for the reticulation system, a series of 1 in 5 year storms have been run and the level of flooding in the system reviewed. The storm duration's tested include 10 minute, 20 minute, 30 minute, 60 minute and 120 minute storms. The model predictions show that the critical duration for the system is between 20 to 30 minutes for the 1 in 5 year event. The 30 minute storms cause higher flood levels in the lower parts of the catchment than the 20 minute storms. The 30 minute storm has been selected as the design storm duration.

4.6 Model Fitness for Purpose

We have developed the Milton stormwater system model using the best information available. This information has come from field survey and system plans. We have estimated manhole locations and interpolated pipe inverts and details where assets could not be accessed. Any further field survey to validate the assumptions in the model would require extensive work to locate buried manholes and potholing to locate and confirm positions of pipes.

We have coarsely verified the model against existing known stormwater control problems described in Section 3.2. Each of the listed problems is displayed in the model results, for both the 1 in 5 year and 1 in 50 year storm events, from the flooding at the southern area of Milton around Pope Street and Mill Street to the surface flooding at the Ajax Street and Jura Street intersection.

The model provides an appropriate representation of the Milton stormwater system given the limitations of available information and budget. The representation of the overland flow paths is coarse and should not be taken as exact.

5. Performance of Existing System

The performance of the system has been assessed based on three different scenarios:

- 1 in 5 year return period event without flooded river conditions,
- 1 in 5 year return period event with flooded river conditions, and
- 1 in 50 year return period event without flooded river conditions.

The results of these simulated events are shown in Appendix A, Figures 3, 4 and 5 respectively.

The following commentary summarises the results shown in Appendix A, Figures 3, 4 and 5.

In general, the problems identified under 1 in 50 year storm event conditions are an amplification of the problems identified under 1 in 5 year storm event conditions. We could not identify any significant new problem areas.

A clear indication from the representation of the Milton stormwater system in a 1 in 5 year event is that the primary drainage system does not have enough capacity to handle the runoff from local sub catchments. This appears to be made worse by incoming flow from other parts of the system.

The primary drainage system along Helensbrook Road is not able to handle the incoming flow. Surface flooding is predicted in this area, which is verified by anecdotal evidence. Any surface flooding generated will either collect around the catch pits until spare capacity becomes available or continue down the kerb and channel system until an alternative drainage path could be found.

The stormwater system in the West Milton Catchment is also under-sized. A moderate amount of surface flooding is predicted throughout the catchment resulting in stormwater flow down overland flow paths. A high level of flooding is predicted around the northern area of this catchment, towards Cross Street. This appears to be the result of insufficient capacity to handle the flows in the continuation pipes down Ajax Street.

The surface flooding from the manholes and sumps along Ajax Street appears to result in overland flow, a flow that is likely to travel down the line of the kerb and channel. This has been recorded in historic services records with observed flooding at the intersection Ajax Street and Jura Street.

The drainage system along Union Street appears to be undersized and unable to handle the flows from the local sub catchments. The flow capacity of the pipes to the southern end of Union Street is restricted due to flat or negative grades and reducing diameters. This is especially the case around High Street and Ossian Street intersections. Any surface flooding would tend to accumulate around these intersections or drain to local low lying areas. This has been observed with flooding in the carpark area of the Milton RSA at the Ossian Street/Union Street intersection.

The stormwater system servicing the East Milton catchment appears to have little spare capacity. Overland flows are predicted throughout the catchment, the most significant of which occurs along the Dryden Street. This overland flow results from the runoff from both local sub-catchments and the large rural catchment to the east of Milton. High levels of flooding are predicted, along with large amounts of overland flow. This has historically been the worst affected area of Milton and been identified as a significant issue as far back as the existence of the Otago Catchment Board.

The flows along Dryden Street add significant pressure to the primary drainage system through to the outlet to the Tokomairiro River. This is identified in the model results as high flood levels around the intersection of Moore Street and Pope Street. Once again, this has been identified in historic accounts of surface flooding in Milton.

The stormwater runoff down Dryden Street is not the only source of stormwater flows contributing to the flooding at the southern end of Milton. The entire West Milton catchment drains to this area before discharging to the Tokomairiro River. The primary drainage system throughout the catchment appears to be running at or beyond pipe full capacity resulting in surface flooding and a high level of overland flows. The level of flooding appears to get significantly worse as the primary system approaches the

downstream end. High levels of flooding are predicted at local low points around the Shakespeare/Spenser Streets and the Ossian/Spenser Streets intersections.

Local flooding appears to occur at the sumps on McKechnie Street. Service reports have recorded this in the past although the extent of the flooding was not identified.

The 1 in 5 year return period rainfall event shows significant flooding and overland flow throughout Milton even without representing a flooded river at the boundaries of the model. This would indicate that the primary drainage system is restricted in terms of both pipe capacity and drainage paths even without considering flooded river conditions.

The effects on the drainage system due to flooded river conditions are most noticeable in the south of Milton. The higher river level restrict the ability of the runoff collected in the East and West Milton catchments to discharge into the Tokomairiro River through the primary drainage system. The extent of additional flooding due to raised river levels is highlighted in Appendix A, Figure 4. As would be expected from the service records, the level of surface flooding around High Street/Pope Street and Ossian Street increases when the river is in flood.

It should be noted that the ground levels of the southern end of Milton are higher than a flood level of RL 110.03m in the Tokomairiro River. This means that in the event of the raised river level represented there would be no water that flows up through the sumps in Milton.

There are locations in Milton where there would appear to be heavy surface flooding in the 1 in 50 year event. These locations are mainly in the south Milton area along the main collection pipe down Spenser Street, along Ossian Street and down to the Pope Street outfall. There are local lying areas along the pipe route down Spenser Street where stormwater is likely to accumulate if the primary drainage system is not able to carry the flows.

6. Discussion of Existing System Performance

The existing Milton stormwater system is unable to successfully drain the expected runoff of the design storm events. There are very few parts of the system that are able to cope under the conditions of a 1 in 5 year return period storm event, and fewer still under the conditions of a 1 in 50 year return period storm event. The worst effected areas are around Dryden Street, the High/Pope Street intersection and the Spenser Street section of the system.

As could be expected, the 1 in 50 year storm event completely inundates the primary stormwater system and significant overland flow is predicted. This is consistent with many urban areas in New Zealand where primary stormwater systems have been conventionally designed to a 1 in 2 year to 1 in 5 year level of service. Moves in stormwater system planning have led to consideration of more extreme (less frequent but more intense) storms like the 1 in 50 year storm events so that overland flow paths

are considered and buildings are protected from inundation when surface flooding occurs.

There are locations identified in the model that have heavy flooding in a 1 in 50 year rainfall event. As mentioned previously, these locations are predominantly in the south Milton area. There are topographical features such as road crests that act as barriers to overland flow and result in the accumulation of stormwater. We would recommend that the Council check that house floor levels are above the topographical features that cause the water to pond in the vicinity of the locations of heavy flooding shown. This should be done as a separate task in addition to the proposed improvements in this strategy.

We have not conducted a statistical analysis of the return period of the scenario modelled for a raised river level. The probability of a 1 in 5 year rainfall event in the Milton stormwater catchment occurring at the same time as the Tokomairiro River is in flood is expected to be less frequent than a 1 in 5 year return period. The effective return period would be something more like 1 in 10 years.

For the purposes of this report, the proposed upgrades have been developed to relieve the identified flooding problems in the 1 in 5 year storm event and provide for overland flows in more intense storms. The 1 in 5 year storm event modelled with raised river levels will also be considered to ensure that the proposed improvements do not result in additional surface flooding.

7. System Improvement Options

7.1 Improvement Strategy

The development of improvement options for the stormwater system problems identified in Milton are based on providing a least cost option while still providing sufficient capacity to handle design flows.

Where possible, it is considered preferable to provide overland flow paths for excess stormwater to flow when the primary stormwater system is exceeded. This avoids the need to install costly, large capacity pipes underground. However, constructing overland flow paths in developed residential areas can be difficult and expensive.

Options that have been considered include:

- **Do Nothing**

- **Increase Drainage System Capacity**
  - Optimise existing drainage system
  - Replace existing drains with larger capacity pipes
  - Install duplicate drains to supplement existing capacity
  - Provide overland flow path

- **Reduce Inflow**
  - Detention storage in catchment
  - Divert flow from part of the catchment

- **Non-hydraulic Solutions**
  - Change planning zones

The recommended improvement solution to any one of the identified stormwater system problems may be a combination of one or more of these options.

We have used the design flows of a 1 in 5 year storm event to size improvement options for the stormwater system. We have considered the effects of a 1 in 50 year storm event to confirm that improvements improve the effectiveness of the system and surface flooding is, where possible, contained within controlled overland flow paths. We have also considered the effects of a 1 in 5 year storm event with raised river levels to ensure that proposed improvements do not lead to additional surface flooding.

Note: The costs presented in the following sections are preliminary estimates only and do not include consent costs, costs of negotiations with affected parties or GST unless specifically stated.

7.2 Improvement Options – Dryden Street

One area of significant historic surface flooding is along and around Dryden Street in the south of Milton. There is a large rural catchment that drains towards and down the line of Dryden Street. During periods of prolonged rainfall, the runoff from this catchment can completely inundate Dryden Street. The properties have been built on the overland flow path for the rural catchment and, for the most part, lie lower than the crest of the road.

The most practical solution to this problem is to divert the runoff from the rural catchment away from Dryden Street to an alternative discharge to the Tokomairiro River. The existing drainage system would then only have to cope with the runoff from local properties.

Records show that this proposed solution has been considered since before 1982 when a proposal was made to the then Milton Borough Council and Otago Catchment Board. Since that time the Otago Regional Council has begun works to divert foreign surface water away from the town and in particular the Dryden Street area. This has been held up due to negotiations with the local land owner, on whose land the Otago Regional Council plan to construct a diversion channel.

The channel would be approximately 750m long and connect to the section of the alternative drainage system already constructed. The estimated cost of constructing the open channel is approximately $25,000, although this is likely to be greater once negotiations with the local land owner are considered. There may be an opportunity to share this cost with the Otago Regional Council, however, for the purposes of this study we will assume Clutha District Council meets the full cost.

The effect of diverting the foreign surface water from the rural catchment away from Dryden Street is shown in Appendix A, Figure 6. The benefits are not only in the Dryden Street area but also at and around the Pope Street outfall. Diversion of the rural catchment runoff relieves the primary drainage system around Dryden Street. This also reduces the contributing flows to Moore Street and Pope Street. This can be seen in Figure 6 as reduced surface flooding and lower levels of overland flow.

For the purposes of developing potential solutions for the remainder of the Milton Stormwater Catchment it has been assumed that the plan to divert the rural catchment runoff away from Dryden Street will be adopted.

Dryden Street Rural Catchment Diversion Estimated Cost $25,000

7.3 Improvement Options – Helensbrook Catchment

7.3.1 Helensbrook Road Relief

Service records and anecdotal evidence provided by Council have identified local surface flooding in the Helensbrook Catchment. The southern section of the pipe

network in the Helensbrook catchment does not have enough capacity to handle the runoff from the local sub catchments which results in surface flooding. Increasing the carrying capacity of the existing pipe system from Constitution Ave to State Highway One could relieve this problem. Two options have been considered to provide this increase in capacity.

The first option is to provide a duplicate pipe along the same alignment as the existing pipe. The existing pipe would still be maintained to maximise the drainage from the collection system. This option would require a duplicate pipe in the order of Ø375mm for a length of 110m, and at a cost of approximately $35,000.

The second option we considered was constructing an open drainage channel along the southern side of Helensbrook Road. This side of the road does not currently have constructed kerb and channel and would therefore be an alternative to providing full piped flow to State Highway One. A Ø375mm culvert would be placed beneath the road to the open channel providing relief of the existing primary drainage system in this area. This is a lesser cost option than providing full piped relief, at a cost of approximately $12,000, and is therefore recommended. The alignment for this option is shown in Appendix A, Figures 7-12.

The discharge from the existing downstream manhole will need to be upgraded whichever of these two options is selected. There is currently what appears to be a restriction at the discharge to the open channel system that runs parallel to State Highway One. The result is surface flooding at collection points north along the state highway. The solution would be to upgrade the discharge to the existing open channel by placing a Ø450mm culvert beneath Helensbrook Road. The cost of constructing this relief pipe is included in the above estimates.

Helensbrook Channel Diversion Estimated Cost $12,000

7.3.2 Helensbrook Channel Upgrade

Providing relief to the primary drainage system is only part of the solution for the Helensbrook Catchment. The recommendations mentioned above would result in the greater flows to be handled by the open channel that runs parallel to State Highway One and discharges into Salmonds Creek. There is currently a Ø300mm culvert beneath a vehicle accessway that would act as a throttle to increased flows in the channel. This would need to be replaced with a Ø600mm culvert to handle the expected design flows. This is shown in Appendix A, Figures 7-12.

Helensbrook Channel Upgrade Estimated Cost $3,000

7.4 Improvement Options – West Milton Catchment

7.4.1 Elderlee Street Diversion

The primary drainage system in the north of the West Milton Catchment is not able to handle the stormwater runoff collected from the surrounding sub catchments. There is no spare capacity in the current main collection pipe that runs down Ajax Street. Service records have identified that surface flooding occurs at the Ajax Street and Jura Street intersection. This is likely to be the result of overland flows resulting from the lack of the capacity in the main collection pipe.

Two options have been considered to provide relief for this main collection pipe, upgrading the current capacity and diverting the upstream stormwater sub catchments. We have considered each of these options with the assumption that one of the plans discussed in Section 7.5.1 is implemented, diverting stormwater towards a collection system along the railway reserve.

The existing main collection pipe is predominantly Ø450mm in the northern section of the West Milton catchment. Upgrading the capacity would require a duplicate Ø600mm stormwater pipe to be laid parallel to the existing pipe down Ajax Street to connect with the stormwater diversion pipelines. The difficulty with this option is that work would take place in the vicinity of the existing stormwater pipeline and that the existing manholes could not practically be reused to connect the new pipes.

An alternative option would be to divert the upstream sub catchments into a Ø600mm stormwater pipe running down Elderlee Street to connect with the stormwater diversion pipelines. This would achieve the same result at a similar cost as laying the pipeline down Ajax Street without interfering with the existing main collection pipeline. This option is shown in Appendix A, Figures 7-12.

Elderlee Street Diversion Estimated Cost $218,000

7.4.2 Cross Street Diversion

With the Elderlee Street diversion in place it would be possible to relieve parts of the system that currently do not have enough capacity to handle the expected design flows. One such part of the system is along Cross Street. The current stormwater drainage system along Cross Street converges on the Cross Street/Ajax Street intersection. This appears to be a bottleneck in the existing system. Diverting the stormwater sub catchments around Coronation Court and the western end of Cross Street appears to help relieve this problem. This is shown in Appendix A, Figures 7-9.

There may, however, be a benefit to diverting more of the runoff collected to this intersection onto the Elderlee Street Diversion. To achieve this a Ø450mm pipe would need to be laid from Ajax Street to Elderlee Street. This is shown in Appendix A, Figures 10-12.

There appears to be marginal benefit with this option. Therefore it may be best to approach this proposed option once the benefits of other options are identified.

Cross Street Diversion Estimated Cost $40,000

7.4.3 Ajax Street Relief

As stated above, service records have identified that surface flooding occurs at the Ajax Street and Jura Street intersection. Installing a diversion pipe down Elderlee Street provides some relief to the remaining collection system in the West Milton Catchment. Cross connections or relief lines can be made from other parts of the stormwater catchment to best use this diversion pipe.

A relief pipe from the existing main collection pipe at Ajax Street and Jura Street intersection to the Elderlee Street Diversion pipe will allow accumulated surface water to be drawn away from the intersection. This would require a Ø375mm pipe down Jura Street and is shown in Appendix A, Figures 7-12.

Ajax Street Relief Estimated Cost $30,000

7.4.4 Elderlee Street Relief

With proposed new main collection pipes installed, it may be possible to provide some relief to other parts of the West Milton Catchment. One area that may benefit from additional stormwater relief is the southern end Elderlee Street. Minor surface flooding had been identified in past service records but had been attributed to blockages rather than lack of capacity. The modelled design storms suggest that there may actually be a capacity problem in this part of the system.

A pipe down Grey Street could be installed to relieve the existing system in the event of the heavy surface flooding. This would be a Ø300mm pipe and is shown in Appendix A, Figures 7-12. A larger diameter pipe could be installed at a marginal extra cost to divert a greater amount of the runoff from local stormwater sub catchments.

Elderlee Street Relief Estimated Cost $17,000

7.4.5 Arthur Street Diversion

One of the stormwater problems identified by Council early in the planning of this project was surface ponding in the carpark behind the Milton RSA on the corner of Union Street and Ossian Street. This problem appears to be the result of two particular issues that need to be resolved.

Firstly, there appears to be very little capacity to handle the design flows in the existing stormwater system down Union Street. There is a bottleneck in the vicinity of the High Street and Union Street intersection that results in surcharging in the system upstream and, consequently, surface flooding.

Secondly, the carpark of the Milton RSA is a local low area and it is likely that any surface runoff will accumulate at this point.

We have looked at two ways to address this problem. The first consideration was to provide a dedicated discharge to the Tokomairiro River from the RSA carpark. This would require a sump in the carpark and laying a Ø300mm pipe down Union Street to the Tokomairiro River. This would provide relief from surface flooding in the carpark but would not address the issue of capacity in the existing system.

The second option we considered was to combine the drainage of the Milton RSA carpark with improvements to drainage at the southern end of Union Street. In this way the capacity restrictions can be addressed and the surface flows can be drawn way from Union Street. This could be achieved by increasing the size of the drainage pipes along Union Street from the Ossian Street intersection to Arthur Street, laying the pipes at such a depth to allow free drainage from the RSA carpark, and diverting the stormwater along Arthur Street to the existing outfall.

We have considered laying this diversion pipe down Union Street to the Tokomairiro River. We would not recommend this option as it would require a greater length of pipe at additional cost and would require a greater amount construction work in the vicinity of the State Highway.

Arthur Street Diversion Estimated Cost $71,000

7.5 Improvement Options – East Milton Catchment

7.5.1 South Milton Stormwater Relief

The major problems identified in the East Milton catchment revolve around surface flooding in the south of Milton. The primary drainage system in this area of the catchment is not able to handle the runoff from the contributing sub catchments. This is made worse by incoming flows from sub catchments further up the system. The magnitude of the problem in this catchment means that a major improvement to the system needs to be done.

We have considered two options for providing relief to the primary drainage system in the south Milton area, and compare them as follows:

1. Sub Catchment Diversion : Providing a piped diversion across Milton to an alternative outfall. This pipeline is to intersect all main pipe routes and divert runoff collected in the upstream catchments. This option would still allow a small amount of overland flow provided the anticipated overland flow route is along the roadside kerb and channel network. For the purposes of this report this option has been called the Abercrombie Diversion. The results for this option are summarised in Appendix A, Figures 7, 8 and 9.

2. Increasing Existing Capacity : Upgrading the primary drainage system to relieve the existing drainage system by providing parallel large diameter pipes. Cross-connections would be provided from the existing system where there is a lack of capacity, diverting upstream catchments. For the purposes of this report this option has been referred to as Parallel Relief Pipes. The results for this option are summarised in Appendix A, Figures 10, 11 and 12.

Abercrombie Diversion

Under the Abercrombie Diversion option a large diameter pipe would be laid across on a line along Abercrombie Street to either the east or west of Milton to divert the upstream sub catchment flows. We quickly identified that discharging to the east of Milton would not be practical as the pipe would need to be laid against the natural lie of the land and it would be difficult to provide an adequate drainage path.

Our proposed diversion line therefore runs along Abercrombie Street from Chaucer Street in the east to Union Street in the west intersecting with existing stormwater pipes in between. The route then passes down an accessway between buildings on Union Street, crossing Ajax Street and Elderlee Street, before running adjacent to the railway reserve to the Tokomairiro River. The alignment of this pipe is shown in Appendix A, Figures 7, 8 and 9.

Benefits with this option are that:

- Cross-connections could be made to other parts of the system to divert flow away where the system does not have enough capacity.
- Existing pipes could still be utilised.
- The amount of stormwater reaching the south Milton area would be greatly reduced.

The main drawbacks of this option relate to the size of pipe required and the depth to invert of the main collection pipe. The proposed pipeline would need to be Ø1,200mm for a majority of its length to provide drainage of the upper catchments of both the West and East Milton Catchments. There are significant costs associated with installing pipes of this size. Also, the typical invert level of the main collection pipe would be 3 metres below ground level to provide the necessary drainage and diversions from existing pipes.

We have considered constructing an open channel to carry the stormwater once it reaches the railway reserve to reduce costs. This is not seen as possible as the channel would need to be approximately 3 metres deep. At this depth and with the proposed proximity to the railway line, this channel would need to be supported and would likely cost more than a piped option.

The proposed pipe route passes through accessways between Union and Ajax Streets and between Ajax and Elderlee Streets. This is seen as the most likely route for the collection pipe as it avoids significant works to place new large pipes down Union Street. There are space restrictions with constructing down these accessways as they are very narrow and are in close proximity to buildings. A further consideration is the

likelihood of existing services, such as water, sewer and power, passing down the accessways. We have not specifically identified whether services exist, but we have allowed a lump sum in the cost estimate for the replacement of possible services.

Abercrombie Diversion Estimated Cost $930,000

One further option may be to avoid the accessways entirely and run the main collection pipe down Union Street to Eden Street and continue to the outfall from there. This would incur greater costs as diversion and upgrade works in the West Milton Catchment would need to be extended to the alternative alignment. This would incur an additional cost of approximately $120,000.

Parallel Relief Pipes

Under the Parallel Relief Pipes option a large diameter pipe would be laid down Johnson Street from Springfield Road to Shakespeare Street, then down Shakespeare Street to Chaucer Street and on to a new outfall parallel to the existing outfall. This would provide relief to the East Milton catchment as cross-connections could be made from the existing stormwater system where there is no spare capacity. A second large diameter pipeline would be installed along the railway reserve to the west of Milton. This would perform a similar role allowing cross connections to be made to relieve the existing pipelines in the West Milton catchment. For the purposes of this report these large diameter pipelines have nominally been called the Johnson Street Bypass and the Western Diversion respectively.

The alignment of these pipes is shown in Appendix A, Figures 10, 11 and 12.

Benefits with this option are that:

- Cross-connections could be made to other parts of the system to divert flow away where the system does not have enough capacity
- Existing pipes could still be utilised
- The amount of stormwater reaching the flood prone south Milton area through the existing system would be greatly reduced

The main drawback of this option, as with the Abercrombie Diversion option, relates to the size of pipe required for the main collection pipes. The proposed pipelines would need to be a combination of Ø750mm, Ø825mm, Ø900mm and Ø1,200mm pipes. There are significant costs associated with installing pipes of these sizes.

Another drawback is the discharge point for the Johnson Street Bypass, which is adjacent to the existing outfall. This diversion line still channels flow towards the flood prone south area of Milton, as opposed to the proposed outfall for the Abercrombie Diversion option which discharges to the west of Milton.

The estimated costs below for the Johnson Street Bypass allows for three cross-connection from the existing stormwater pipes along Spenser Street and connection to the Union Street stormwater system.

Johnson Street Bypass Estimated Cost $1,080,000
Western Diversion Estimated Cost $390,000

Parallel Relief Pipes Combined Estimated Cost $1,470,000

We have allowed in each of these estimated costs a preliminary amount of $30,000 for the negotiations with land owners and TranzRail for laying pipelines to the west of Milton. This is an estimate only and may vary depending on the nature of the negotiations.

Each of these options diverts a substantial amount of the stormwater runoff from the existing stormwater system in the south of Milton, helping to relieve observed flooding problems. Each of the options also provides similar performance, with the Abercrombie Diversion option providing greater relief along Union Street and the West Milton catchment, while the Parallel Relief Pipes option provides greater relief along Johnson Street and Chaucer Street.

Of these options we recommend the Abercrombie Diversion which, based on estimated costs, appears to be less costly to implement.

Taking the stormwater runoff away by diversion does not fix all the problems downstream. We needed to consider other options to solve particular issues in the East Milton Catchment.

7.5.2 Union Street Relief

A way needs to be found to relieve the stormwater system along Union Street whichever of the two options in Section 7.5.1 is selected. The model indicates that the existing stormwater system is not able to handle the design flows of a 1 in 5 year event and that overland flow could be expected.

The Arthur Street Diversion mentioned in Section 7.4.5 goes some way to relieving the surface flooding at the south end of Union Street. The remainder of the stormwater system along Union Street still appears to be unable to handle the runoff from the local stormwater sub catchments even with this diversion in place.

We have considered two options to solve this problem. The first consideration was to replace the existing pipe with larger diameter pipe for the length of Union Street to remove all surface water. We believe that this would not provide an economic solution, as it would involve the installation of approximately 900m of new pipe constructed along Union Street. An alternative option is to allow a small amount of surface flow in the Union Street kerb and channel up to Abercrombie Street and upgrade the catchpits at this intersection to divert the collected runoff into either system as described in Section 7.5.1.

Union Street Relief Estimated Cost$6,000

7.5.3 McKechnie Street Diversion

There are sections of the East Milton catchment primary drainage system that appear to not have enough capacity and may require some local solutions to either increase capacity to the main stormwater collection pipes or the cater for potential surface flooding. One such area is in McKechnie Street. Past service records have referred to surface flooding in this area. This appears to be due to insufficient capacity in the existing stormwater pipes.

One option is to divert the stormwater catchment to an alternative outfall. We have looked at the possibility of the diverting the runoff from the McKechnie Street area into Salmonds Creek. This is not possible as the fall of the catchment is away from Salmonds Creek making difficult to provide gravity drainage of the collected surface runoff to Salmonds Creek.

An alternative option is to provide greater drainage capacity from McKechnie Street to the main collection pipes. This would involve a diversion line along McKechnie Street and onto Keinan Ave. A small amount of surface ponding may still occur in a 1 in 5 year event as the main collection pipes have little spare capacity. This may be acceptable, as it appears that any surface ponding would be contained in the kerb and channel network.

McKechnie Street Diversion Estimated Cost $60,000

7.5.4 Keinan Ave and Johnson Street Upgrade

Another section of the East Milton catchment that appears to not have enough capacity is along the southern end of Keinan Ave. There are no detailed service records that we have been identified regarding stormwater flooding along Keinan Ave. It would appear from modelling the section of the stormwater system at the southern end of Keinan Ave that there is not enough capacity to handle the design flows.

We have considered options to provide relief to this section of the stormwater system. One option was increasing the capacity of the existing pipes by providing a duplicate Ø300mm pipe system. This would allow greater drainage to the Springfield Road intersection.

Another consideration when looking at the indicated flooding along Keinan Street is the effect of the downstream pipe flows on the ability of the runoff to get away. The current direction of the primary drainage system from Keinan Street is towards the main collection pipes along Spenser Street. These Spenser Street pipes have little spare capacity even with the implementation of the either of the options discussed in Section 7.5.1. The implication is that surface flooding would still occur.

Should the Parallel Pipe Relief option be selected then an alternative drainage path would be provided down Johnson Street. If the Abercrombie Diversion option is selected then we would recommend that the primary drainage system along Johnson Street be upgraded at least between Springfield Road and Abercrombie Street. This would firstly provide diversion of the drainage pipes along Keinan Street and would

secondly provide additional drainage of the stormwater runoff from sub catchments along Johnson Street.

Of these options we would recommend that the Johnson Street Upgrade be constructed prior to the Keinan Street Upgrade. In this way the benefits of the Johnson Street upgrade on reducing levels of the surface water in Keinan Street can be identified before money is spent on upgrading the Keinan Street primary drainage system.

Johnson Street Upgrade Estimated Cost	$140,000
Keinan Street Upgrade Estimated Cost	$41,000

7.5.5 Ossian Street Relief Sewer

Implementing either the Abercrombie Diversion or the Parallel Relief Pipe option reduces the amount of incoming flow from stormwater sub catchments in the north of the East Milton Catchment. Even with this flow reduced there still appears to be some pressure placed on the primary drainage system in the south Milton area. A particular location where potential surface flooding may occur is around Spenser Street between Ossian Street and Shakespeare Street. This is a local low lying area within the East Milton catchment.

We have considered two options to relieve the surface flooding in this area. The first option was to provide a pipe to the existing outfall and the second was to provide a pipe to an alternative outfall. Each option is similar in approach. We have concentrated on diverting part of the flow to an alternative outfall because diverting the flow to the existing outfall is would require a greater length of pipe and, therefore, greater cost.

We considered combining relief of the Ossian Street and Spenser Street intersection with upgrade works for the Arthur Street Diversion as described in Section 7.4.5. This would provide a saving in the length of pipe installed, however, the relative invert levels would not allow sufficient gravity drainage from the Ossian Street and Spenser Street intersection.

An alterative we have identified is the installing a Ø450mm relief pipe from the Ossian Street and Spenser Street intersection to a new outfall along the line of Queen Street.

Ossian Street Relief Sewer Estimated Cost	$107,000

7.5.6 Moore Street Outfall

Part of the Parallel Relief Pipes option is the construction of a new outfall parallel to the existing outfall along Pope Street. If this option was not selected then we would recommend that an outfall be installed from Moore Street to help relieve the lower part of the system. The existing outfall does not appear to be able to handle the runoff from the local sub catchments. Installing a duplicate outfall will help to relieve pressure on the existing outfall.

Moore Street Outfall Estimated Cost	$105,000

It may be worth noting that during the field survey we identified what appeared to be part of a past stormwater system running parallel to and to the south of the current stormwater system along Moore Street. We could not locate where this pipe originated or where it may have discharged. Prior to implementing any plans to upgrade the outfall structure as described for the Moore Street outfall option, it would be worthwhile further investigating whether this system can be used. This may involve tests such as dye trials to locate an outfall and flow testing to check the capacity of the pipes.

7.6 Preliminary Estimation of Improvement Works

We have used the model of the Milton Stormwater System to size improvement options to handle the design flows. The sizes of the pipes and channels (identified in Appendix A: Figures 7 - 12) have been optimised to provide the required level of service but to minimise the cost where possible.

A breakdown of the preliminary costs is in Appendix B.

We have not allowed for the following items in the preliminary costs:

- Required Consents
- GST
- Negotiations with landowners for the construction of earthworks on their land unless specifically stated.

We have included the following estimates for each of the capital works:

- Professional fees: approximately 6% of the total capital works
- Contingency and P&G: approximately 20% of the total capital works.

Each of the preliminary costs is an initial estimate only. These costs need to be revised during detailed design. The improvement options we have recommended and their associated preliminary costs are summarised in Section 7.7.

7.7 Summary of Improvement Works

7.7.1 Dryden Street

Dryden Street Rural Catchment Diversion
Construction of 750m of Open Channel

Dryden Street Total **$25,000**

7.7.2 Helensbrook Catchment

Helensbrook Open Channel Capacity
Replacement pipe system
- 10m of Ø600mm pipe — $3,000

Helensbrook Open Channel Diversion
Channel Diversion and Discharge Upgrade
- 15m of Ø375mm pipe
- 15m of Ø450mm pipe
- 110m of open channel — $12,000

Helensbrook Catchment Total — **$15,000**

7.7.3 West Milton Catchment

Elderlee Street Diversion
- 4 new sumps
- 420m of Ø600mm pipe — $218,000

Cross Street Diversion
- 120m of Ø450mm pipe — $40,000

Ajax Street Relief
- 120m of Ø375mm pipe — $30,000

Elderlee Street Relief
- 80m of Ø300mm pipe — $17,000

Arthur Street Diversion
- Sump connection from RSA carpark
- 1 additional new sump
- 40m of Ø300mm pipe
- 65m of Ø375mm pipe
- 125m of Ø450mm pipe — $71,000

West Milton Catchment Total — **$376,000**

7.7.4 East Milton Catchment

Abercrombie Diversion
- 10 new sumps
- 130m of Ø450mm pipe
- 135m of Ø600mm pipe
- 900m of Ø1,200mm pipe — $930,000

Union Street Relief
- 1 new sump
- 12m of Ø450mm pipe — $6,000

McKechnie Street Diversion
- 2 new sumps
- 250m of Ø300mm pipe $60,000

Johnson Street Upgrade
- 4 new sumps
- 400m of Ø450mm pipe $140,000

Keinan Street Upgrade
- 2 new sumps
- 160m of Ø300mm pipe $41,000

Ossian Street Relief Sewer
- 2 new sumps
- 320m of Ø450mm pipe $107,000

Moore Street Outfall
- 1 new sump
- 205m of Ø600mm pipe $105,000

East Milton Catchment Total **$1,389,000**

7.7.5 Total Cost of Recommended Improvement Options

Dryden Street Total	$ 25,000
Helensbrook Catchment Total	$ 15,000
West Milton Catchment Total	$ 376,000
East Milton Catchment Total	$1,389,000
Total Cost of Recommended Improvement Options	**$1,805,000**

8. Prioritisation of Improvement Works

8.1 Prioritisation Strategy

The options we have recommended cannot all be implemented at once. There are limitations of time and funding. It is necessary to develop a staged implementation of the options. We have considered ways to prioritise the options to provide the greatest benefit at the least cost.

We recommend that the improvement options are prioritised as proposed in the following sections. The Council may consider that improvement options should be implemented either sooner or later than the prioritisation we have recommended below.

8.2 Priority One

The purpose of the options to be completed in Priority One is to relieve the existing system and take pressure off parts that have existing problems.

- Dryden Street Rural Catchment Diversion: One ongoing stormwater control issue in Milton is surface flooding in the vicinity of Dryden Street. This proposed option would reduce runoff from the rural catchment and therefore reduce the amount of surface flooding in Dryden Street during significant events.

  Estimated Cost: $25,000

- Abercrombie Diversion: This is the most expensive initial investment in providing solutions for the existing problems in Milton. It is also one of two options that will have the biggest impact on reducing surface flooding within Milton. We recommend that this diversion of sub catchment runoff be one of the first options implemented. This will help to reduce the stormwater to the southern area of Milton. It may also be possible to stage the implementation of this option by first installing the Ø1,200mm pipe through to the Spenser Street stormwater system and then extend to Johnson Street and Chaucer Street at a later stage.

  Estimated Cost: $930,000

Estimated Total Cost for Priority One: $955,000

8.3 Priority Two

The implementation options we have recommended as Priority Two focus more on solving specific stormwater problems.

- Helensbrook Open Channel Capacity and Diversion: Implementing this option will allow greater capacity within the Helensbrook primary drainage system and therefore help to reduce surface flooding.

  Estimated Cost: $15,000

- Ossian Street Relief Sewer: Installing this relief sewer will provide greater relief to the southern area of Milton especially at the southern end of Spenser Street.

  Estimated Cost: $107,000

- Elderlee Street Diversion: This sewer will provide relief to the collection system that currently runs down Ajax Street which has been identified as an existing area where flooding currently occurs.

  Estimated Cost: $218,000

- Ajax Street Relief: A relief sewer between the current stormwater system and the proposed Elderlee Street Diversion will provide increased drainage of reported surface flooding at the Jura Street and Ajax Street intersection.

  Estimated Cost: $30,000

- Arthur Street Diversion: This option targets the reported flooding in the vicinity of the Union Street and Ossian Street intersection at the Milton RSA. An added benefit is the improvement of the drainage capacity at the southern end of Union Street.

  Estimated Cost: $71,000

- Union Street Relief: Upgrading of the Union Street drainage in the central section of Milton at low cost.

  Estimated Cost: $6,000

Estimated Total Cost for Priority Two: $447,000

8.4 Priority Three

There are still some outstanding stormwater problems to be addressed. These should follow as Priority Three options.

- Elderlee Street Relief: This upgrade option addresses local flooding problems.

  Estimated Cost: $17,000

- McKechnie Street Diversion: Diversion of stormwater runoff to relieve a particular part of the system.

  Estimated Cost: $60,000

- Johnson Street Upgrade: This upgrade option provides a drainage path for the diversion of stormwater and relief to local stormwater sub catchments.

  Estimated Cost: $140,000

- Keinan Street Upgrade: This upgrade option addresses local flooding problems.

  Estimated Cost: $41,000

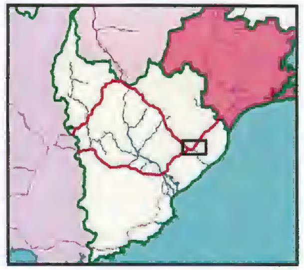
- Moore Street Outfall: This upgrade option will help relieve potential surface in the lower area of the East Milton catchment. This should be considered only if the remnant of the past system is ruled out as an alternative drainage path.

  Estimated Cost: $105,000

Estimated Total Cost for Priority Three: $332,000

Appendix A: Plans and Figures

Figure 1a



Location Plan

Key:

- Pipe Infrastructure
- Open Channels
- Represented Overland Flow Paths
- Known Flooding Problems

Clutha District Council
Milton Stormwater Strategy

Modelled Existing Stormwater System

MWH
MONTGOMERY WATSON HARZA

Drawn SDB	Chk'd RTL		
Approved			
Scale NTS		REVISION	
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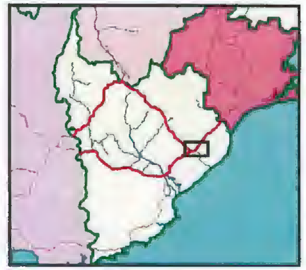
Figure 1b



Location Plan

Key:

- Pipe Infrastructure
- Open Channels
- Represented Overland Flow Paths
- Known Flooding Problems

Clutha District Council
Milton Stormwater Strategy

Modelled Existing Stormwater System

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Date 30 October 2001		A	

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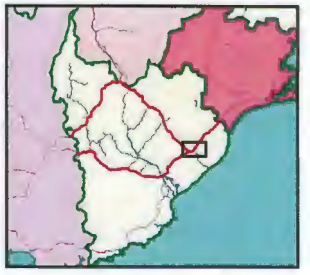
Figure 1c



Location Plan

Key:

- Pipe Infrastructure
- Open Channels
- Represented Overland Flow Paths
- Known Flooding Problems

Clutha District Council
Milton Stormwater Strategy

Modelled Existing Stormwater System

MWH
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Figure 2

Location Plan

Key:

- Pipe Infrastructure
- Open Channels
- Represented Overland Flow Paths
- Helensbrook Catchment
- East Milton Catchment
- West Milton Catchment

Clutha District Council
Milton Stormwater Strategy

Stormwater Catchment Plan

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Figure 3

Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Clutha District Council
Milton Stormwater Strategy

Existing Stormwater System:
1 in 5 Year Storm Event

MWH
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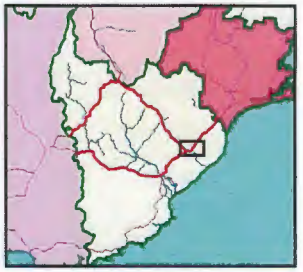
Figure 4



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Area influenced by Raised River Levels causing additional surface ponding

Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Clutha District Council
Milton Stormwater Strategy
Existing Stormwater System:
1 in 5 Year Storm Event
Raised River Level (RL 110.03)

MWH
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Figure 5

Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Clutha District Council
Milton Stormwater Strategy

Existing Stormwater System:
1 in 50 Year Storm Event

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Figure 6

Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Clutha District Council
Milton Stormwater Strategy
Existing Stormwater System:
1 in 5 Year Storm Event
Dryden St Rural Catchment Diversion

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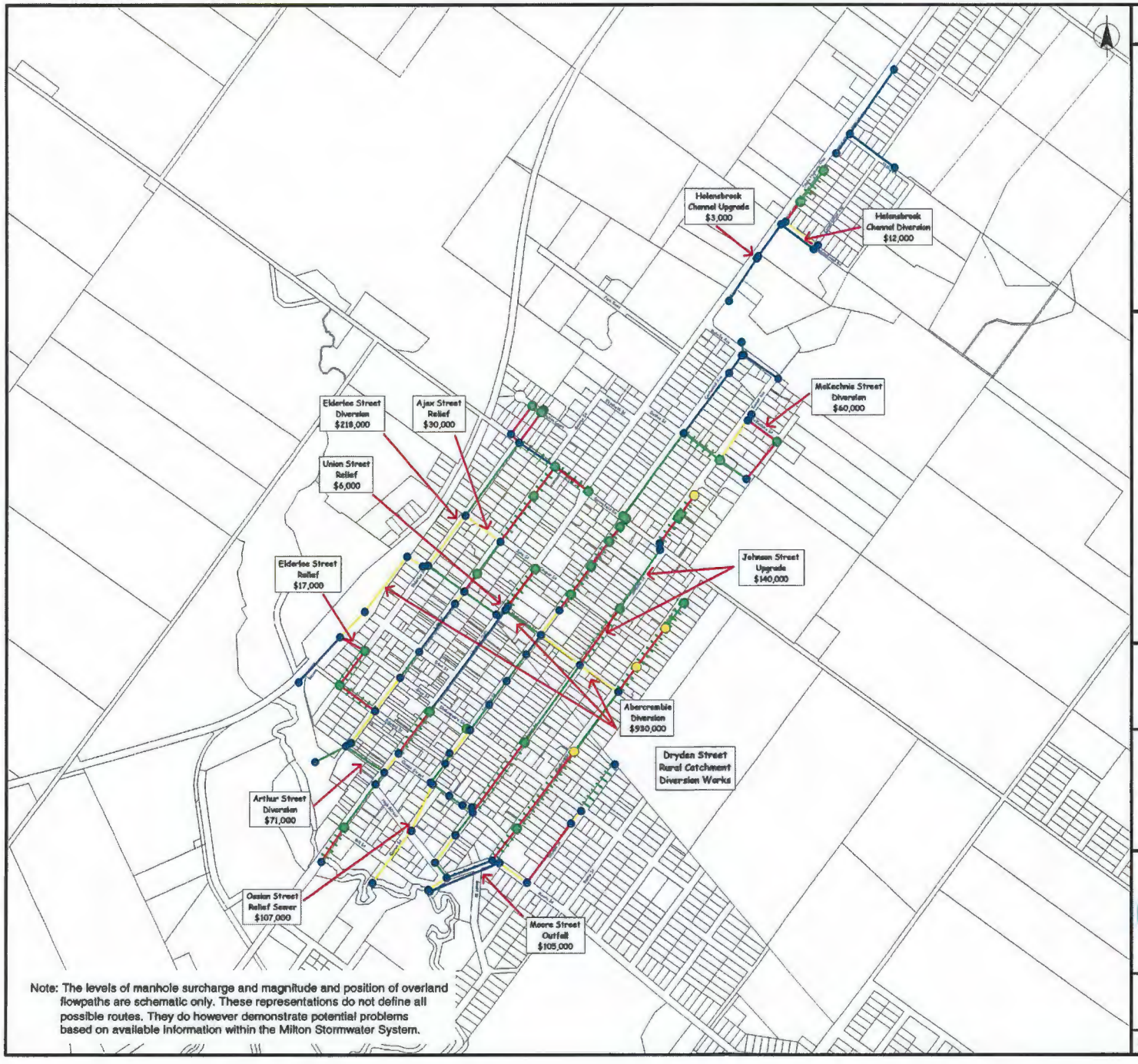
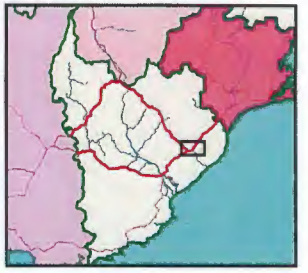


Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Figure 7



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy

Abercrombie Diversion:
1 in 5 Year Storm Event

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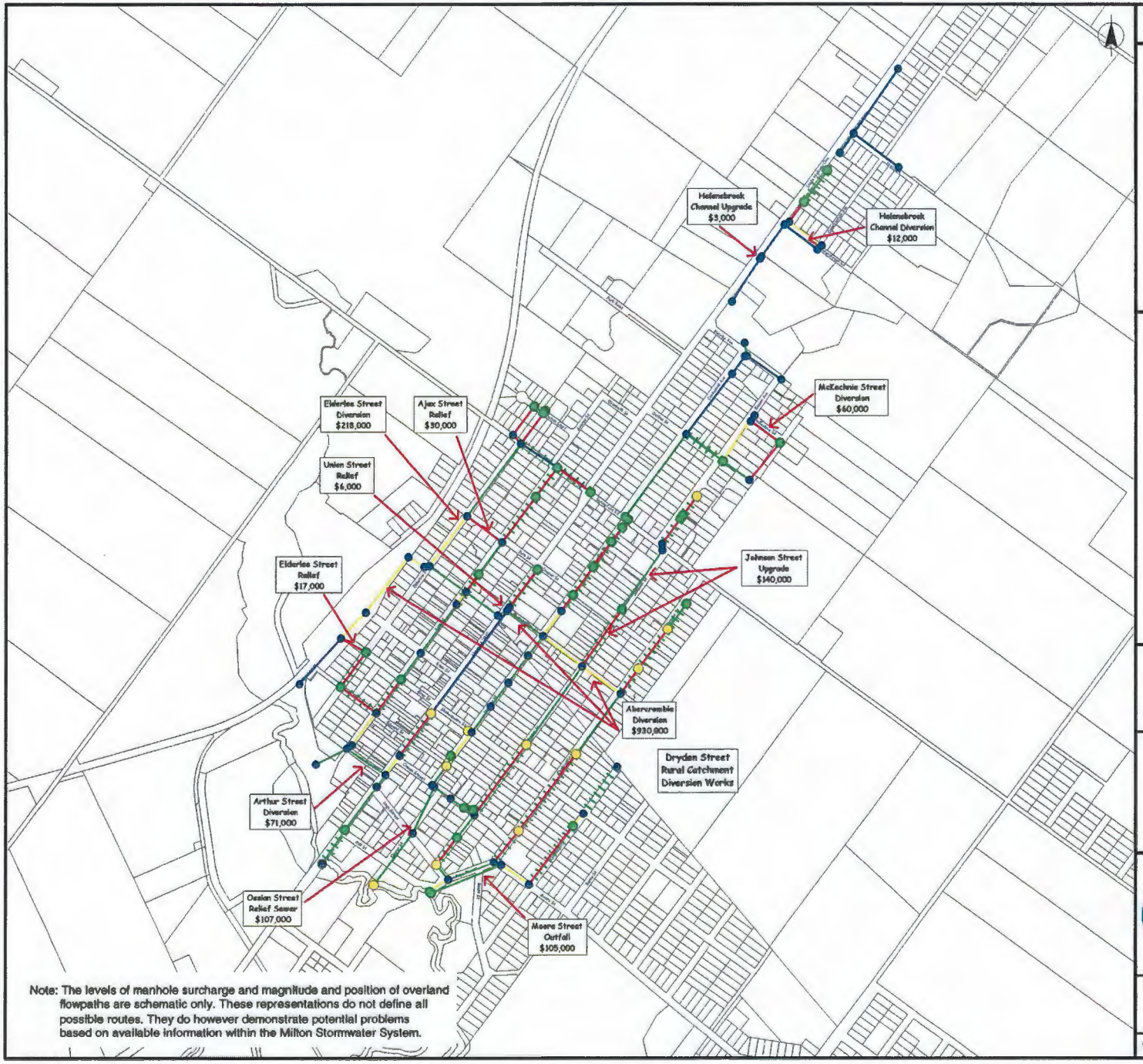
Figure 8



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy
Abercrombie Diversion:
1 in 5 Year Storm Event
Raised River Level (RL 110.03)

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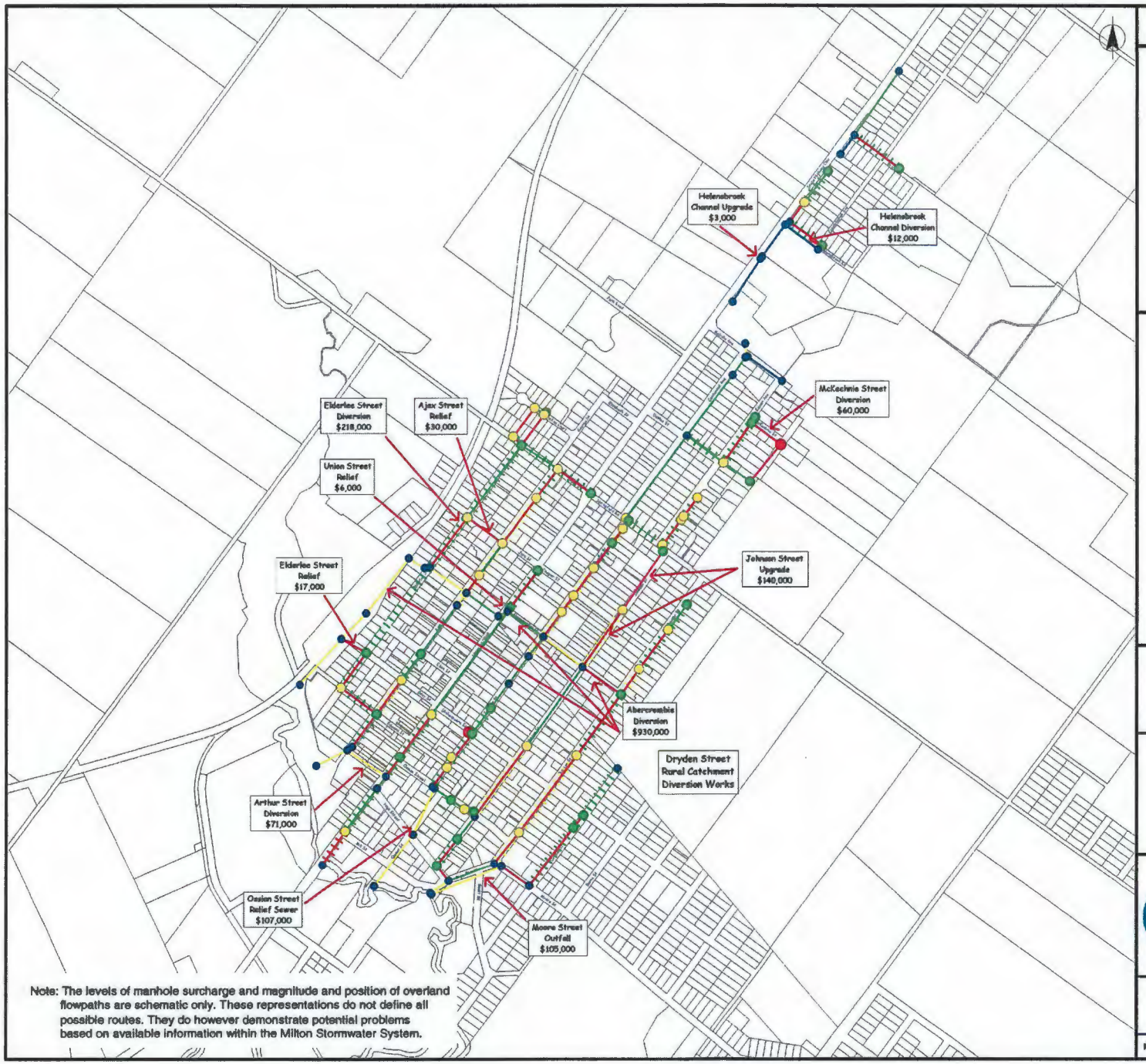

Figure 9

Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy

Abercrombie Diversion:
1 in 50 Year Storm Event

MWH
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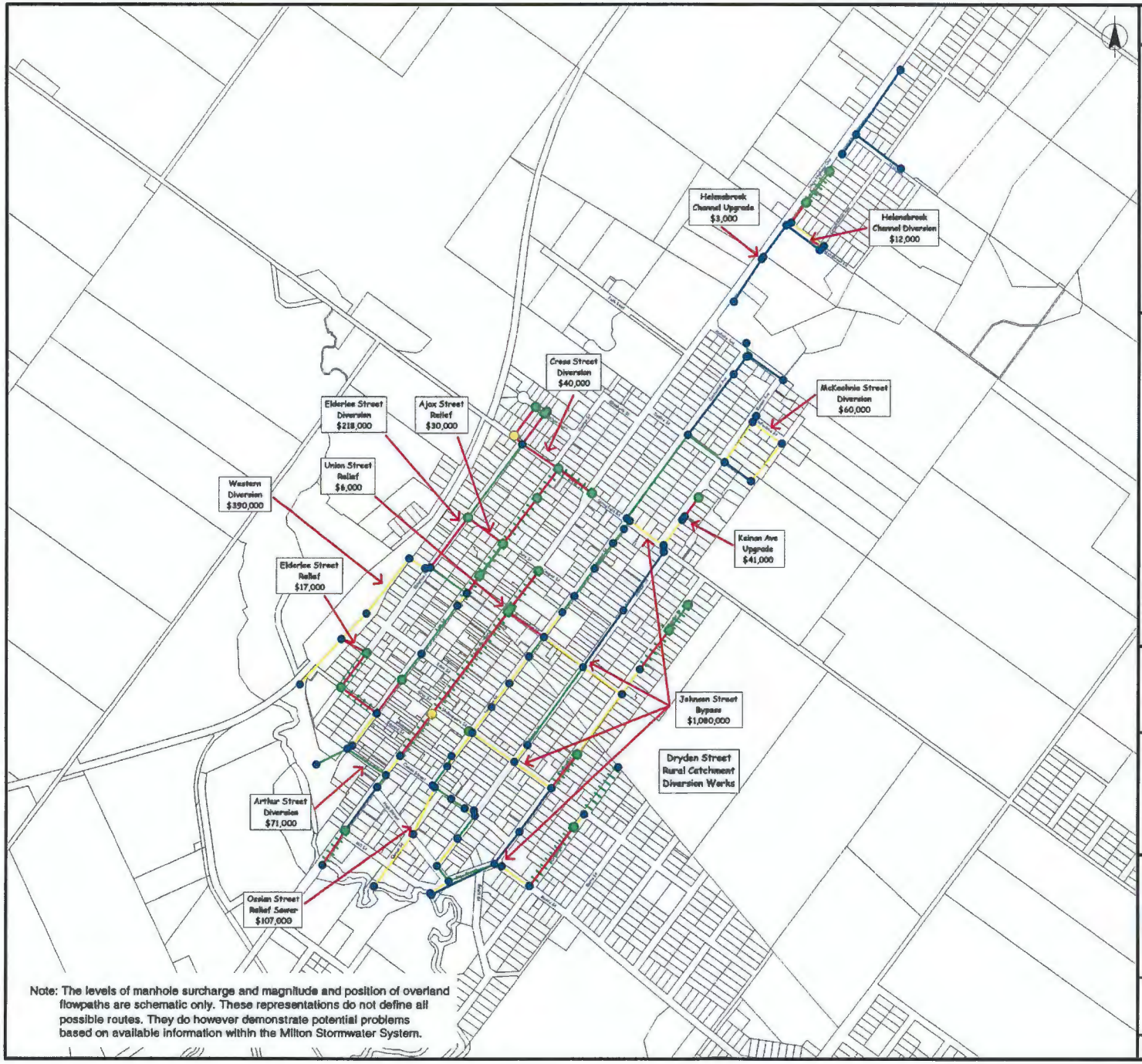
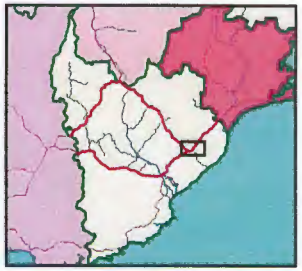


Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Figure 10



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy

Parallel Relief Pipes:
1 in 5 Year Storm Event

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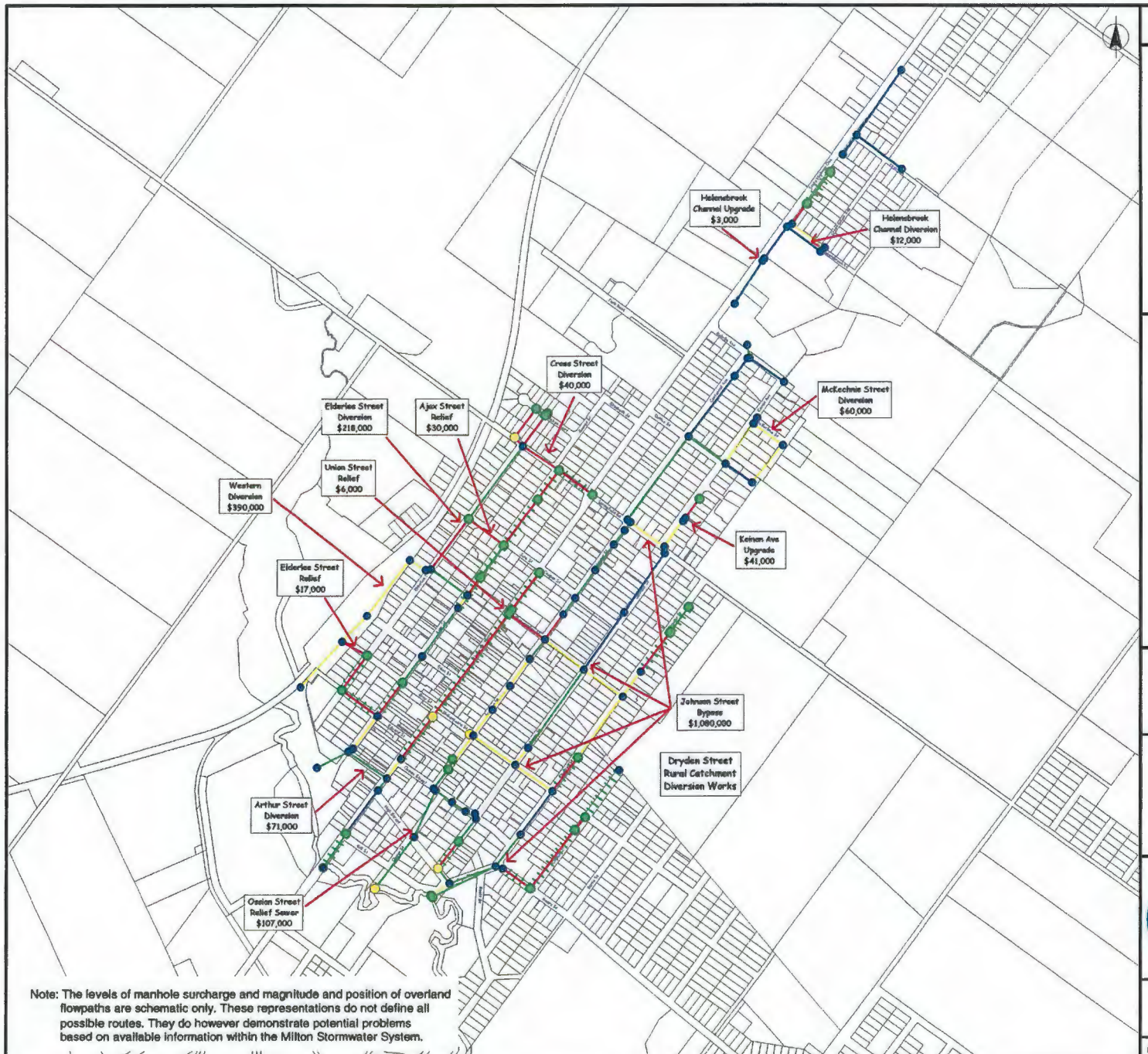
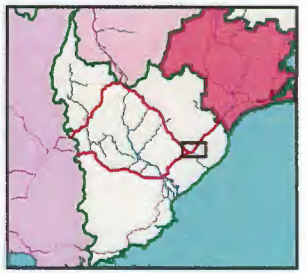


Note: The levels of manhole surcharge and magnitude and position of overland flowpaths are schematic only. These representations do not define all possible routes. They do however demonstrate potential problems based on available information within the Milton Stormwater System.

Figure 11



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy
Parallel Relief Pipes:
1 in 5 Year Storm Event
Raised River Level (RL 110.03)

MWH
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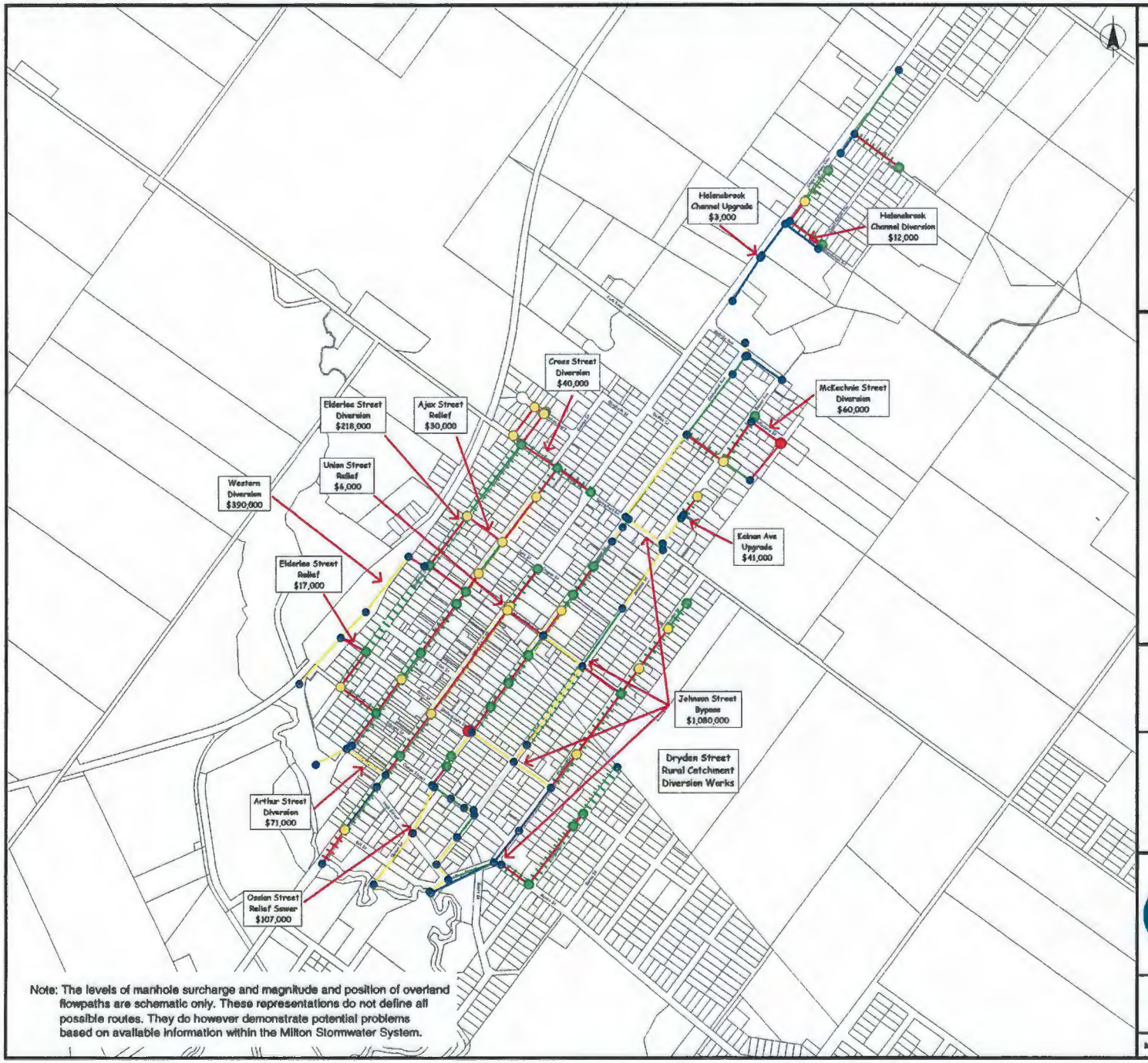
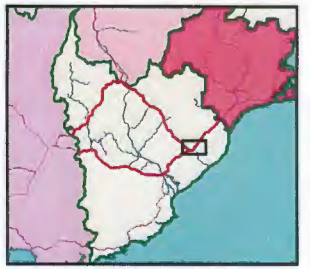


Figure 12



Location Plan

Manhole Surcharge

- Heavy Surface Flooding
- Moderate Surface Flooding
- Minor Surface Flooding
- No Surcharge

System Performance

- Restricted Flow due to Downstream Conditions
- Under Capacity, Surcharge above Soffit
- Sufficient Capacity
- Under Capacity, Surcharge above Ground Level

Overland Flow

- Significant Overland Flow
- Moderate Overland Flow
- Minor Overland Flow

Clutha District Council
Milton Stormwater Strategy

Parallel Relief Pipes:
1 in 50 Year Storm Event

MWH
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Appendix B: Estimated Cost Calculations

Dryden Street

Dryden Street Diversion Works

Description	Unit	Quantity	Reference	Rate	Cost
Earthworks/Open Channel	m	750		$27	$ 20,250
				Engineering Design @ 6%	$ 1,215
				P&G and Contingency @ 20%	$ 4,050
				Total	$ 25,515

Helensbrook Catchment

Helensbrook Open Channel Capacity

Description	Unit	Quantity	Reference	Rate	Cost
New Pipes	m	7	600	$390	$ 2,730
				Engineering Design @ 6%	$ 164
				P&G and Contingency @ 20%	$ 546
				Total	$ 3,440

Helensbrook Pipeline Upgrade

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	1		$1,130	$ 1,130
Labour	No.	1		$1,500	$ 1,500
New Pipes	m	108	375	$200	$ 21,600
	m	15	450	$250	$ 3,750
				Engineering Design @ 6%	$ 1,679
				P&G and Contingency @ 20%	$ 5,596
				Total	$ 35,255

Helensbrook Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Culverts	m	15	375	$200	$ 3,000
New Open Channels	m	112		$27	$ 3,024
New Pipes	m	15	450	$250	$ 3,750
				Engineering Design @ 6%	$ 586
				P&G and Contingency @ 20%	$ 1,955
				Total	$ 12,315

West Milton Catchment

Elderlee Street Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	4		$1,130	$ 4,520
Labour	No.	4		$1,500	$ 6,000
New Pipes	m	417	600	$390	$ 162,630
				Engineering Design @ 6%	$ 10,389
				P&G and Contingency @ 20%	$ 34,630
				Total	$ 218,169

Cross Street Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	1		$1,130	$ 1,130
Labour	No.	1		$1,500	$ 1,500
New Pipes	m	117	450	$250	$ 29,250
				Engineering Design @ 6%	$ 1,913
				P&G and Contingency @ 20%	$ 6,376
				Total	$ 40,169

Ajax Street Relief

Description	Unit	Quantity	Reference	Rate	Cost
New Pipes	m	120	375	$200	$ 24,000
				Engineering Design @ 6%	$ 1,440
				P&G and Contingency @ 20%	$ 4,800
				Total	$ 30,240

Elderlee Street Relief

Description	Unit	Quantity	Reference	Rate	Cost
New Pipes	m	78	300	$170	$ 13,260
				Engineering Design @ 6%	$ 796
				P&G and Contingency @ 20%	$ 2,652
				Total	$ 16,708

Arthur Street Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	2		$1,130	$ 2,260
Labour	No.	2		$1,500	$ 3,000
New Pipes	m	40	300	$170	$ 6,800
	m	66	375	$200	$ 13,200
	m	125	450	$250	$ 31,250
				Engineering Design @ 6%	$ 3,391
				P&G and Contingency @ 20%	$ 11,302
				Total	$ 71,203

East Milton Catchment

Abercrombie Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	10		$1,130	$ 11,300
Labour	No.	10		$1,500	$ 15,000
New Pipes	m	130	450	$250	$ 32,500
	m	134	600	$390	$ 52,260
	m	896	1200	$645	$ 577,920
Land Negotiations	LS				$ 30,000
Relocation of Services	LS				$ 20,000
				Engineering Design @ 6%	$ 44,339
				P&G and Contingency @ 20%	$ 147,796
				Total	$ 931,115

Abercrombie Diversion - Eden Street Alignment

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	10		$1,130	$ 11,300
Labour	No.	10		$1,500	$ 15,000
New Pipes	m	130	450	$250	$ 32,500
	m	134	600	$390	$ 52,260
	m	896	1200	$645	$ 577,920
	m	150	450	$250	$ 37,500
	m	200	600	$390	$ 78,000
Land Negotiations	LS				$ 30,000
				Engineering Design @ 6%	$ 50,069
				P&G and Contingency @ 20%	$ 166,896
				Total	$1,051,445

Parallel Relief Pipes - Johnson Street Bypass

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	10		$1,130	$ 11,300
Labour	No.	10		$1,500	$ 15,000
New Pipes	m	249	450	$250	$ 62,250
Spenser Street Relief	m	387	450	$250	$ 96,750
	m	212	600	$390	$ 82,680
	m	191	750	$455	$ 86,905
	m	728	900	$520	$ 378,560
	m	190	1200	$645	$ 122,550
				Engineering Design @ 6%	$ 51,360
				P&G and Contingency @ 20%	$ 171,199
				Total	$1,078,554

Parallel Relief Pipes - Western Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Pipes	m	121	450	$250	$ 30,250
	m	520	825	$480	$ 249,600
Land Negotiations	LS				$ 30,000
				Engineering Design @ 6%	$ 18,591
				P&G and Contingency @ 20%	$ 61,970
				Total	$ 390,411

Union Street Relief

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	1		$1,130	$ 1,130
Labour	No.	1		$1,500	$ 1,500
New Pipes	m	12	375	$200	$ 2,400
				Engineering Design @ 6%	$ 302
				P&G and Contingency @ 20%	$ 1,006
				Total	$ 6,338

Johnson Street Upgrade

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	4		$1,130	$ 4,520
Labour	No.	4		$1,500	$ 6,000
New Pipes	m	403	450	$250	$ 100,750
				Engineering Design @ 6%	$ 6,676
				P&G and Contingency @ 20%	$ 22,254
				Total	$ 140,200

Keinan Ave Upgrade

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	2		$1,130	$ 2,260
Labour	No.	2		$1,500	$ 3,000
New Pipes	m	160	300	$170	$ 27,200
				Engineering Design @ 6%	$ 1,948
				P&G and Contingency @ 20%	$ 6,492
				Total	$ 40,900

McKechnie Street Diversion

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	2		$1,130	$ 2,260
Labour	No.	2		$1,500	$ 3,000
New Pipes	m	251	300	$170	$ 42,670
				Engineering Design @ 6%	$ 2,876
				P&G and Contingency @ 20%	$ 9,586
				Total	$ 60,392

Ossian Street Relief

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	2		$1,130	$ 2,260
Labour	No.	2		$1,500	$ 3,000
New Pipes	m	318	450	$250	$ 79,500
				Engineering Design @ 6%	$ 5,086
				P&G and Contingency @ 20%	$ 16,952
				Total	$ 106,798

Moore Street Outfall

Description	Unit	Quantity	Reference	Rate	Cost
New Sump	No.	1		$1,130	$ 1,130
Labour	No.	1		$1,500	$ 1,500
New Pipes	m	206	600	$390	$ 80,340
				Engineering Design @ 6%	$ 4,978
				P&G and Contingency @ 20%	$ 16,594
				Total	$ 104,542

Appendix C Issues and Options Study Milton Stormwater Upgrades (2004)

Clutha District Council

Issues and Options Study
Milton Stormwater Upgrades

Clutha District Council

Issues and Options Study
Milton Stormwater Upgrades

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Executive Summary

Opus recommends that Clutha District Council construct the Dryden Street diversion, install stop banks along the Tokomairiro River and a stormwater pump station at the Pope Street and Mill Street intersections, together with some localised pipe system upgrading. The pump station and stop banks, combined with the Dryden St diversion, will provide a higher level of flood protection for Milton within the allocated budget.

Proposed Upgrades

The local community, based on a preliminary study *Milton Stormwater Strategy* (2001), prioritised two upgrades of the existing Milton stormwater system:

1. Dryden Street diversion
2. Abercrombie Street diversion

Clutha District Council (CDC) engaged Opus International Consultants (Opus) to review and upgrade the existing stormwater network computer model and confirm the appropriateness of the proposed Priority 1 upgrades from the preliminary study. The 2004/05 budget available for stormwater mitigation in Milton is approximately $900,000.

Revised Recommendations

Based on the review of the hydraulic model, surveyed floor levels, flood levels proposed by the Otago Regional Council in the Tokomairiro River and budget restraints, our revised upgrades and indicative costs in order of priority are:

1. Dryden Street diversion *$152,000*
2. Stop banks along Tokomairiro River **and** Pope Street pump station:
   - Stop banks *$87,000*
   - Pump Station *$606,000*
3. Abercrombie Street diversion **or** Union Street upgrade:
   - Abercrombie *$874,000*
   - Union Street upgrade *$772,000*

The Abercrombie diversion and Union Street upgrade have been given a lower priority than the stop banks and pump station due to the following:

- Neither alleviates surface flooding at the southern end of Milton, adjacent to the Tokomairiro River. This is an area of significant historical flooding.
- Floor levels of residential properties along Mill Street and Pope Street are lower than the Tokomairiro River 50-year flood level. Therefore stop banks are recommended to prevent the Tokomairiro River overtopping its banks and inundating property.

- When the Tokomairiro River is in flood the outlets from the primary network are submerged. In this situation, the overall network performance and the effectiveness of the Abercrombie diversion and Union Street upgrade are reduced because the piped network cannot drain.

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Appendix A – Hydraulic Model Review

Appendix B – Plans of the Proposed Upgrades

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1 Introduction

Milton is bounded by the Tokomairiro River and the town topography is generally flat, sloping towards the river and its tributaries. Areas of the town suffer from inundation by the river and also surface flooding from the town's catchments during high intensity rainfall events.

1.1 Scope

Clutha District Council engaged Opus to carry out an Issues and Options Study into the best use of the 2004/05 Milton stormwater budget. This study seeks to:

1. Review and upgrade the existing stormwater network model
2. Confirm the options prioritised as number 1, identified in the *Milton Stormwater Strategy* (2001)
3. Investigate the feasibility of stop banks and pump stations in Milton
4. Prioritise the preferred upgrades
5. Provide indicative cost estimates
6. Recommend upgrades to Clutha District Council

1.2 Background

Milton is a small rural town located in the northeast of the Clutha District and bounded by the Tokomairiro River. The town topography is generally flat, sloping towards the river and its tributaries.

Surface flooding in Milton is caused by:

1. Moderate intensity rainfall events in the Milton catchment. Pipes with insufficient capacity and flat or negative grades cause surface flooding throughout Milton's stormwater network.
2. The Tokomairiro River overtopping its banks. This event causes inundation of low-lying areas of Milton adjacent to the river.

When these two flood events coincide the effects of flooding in Milton are heightened, as the outlets from the piped reticulation are submerged and more surface water ponds at the southern end of the town.

2 Hydraulic Model

2.1 Review

As part of the scope of this report we reviewed and upgraded the preliminary hydraulic model from the *Milton Stormwater Strategy* (2001). See Appendix A for a summary of this review and the additional scenarios modelled.

2.2 Raised River Level

Surface flooding in Milton has historically occurred at the southern end of the town adjacent to the Tokomairiro River. The local perception is that raised river levels in the Tokomairiro cause this flooding (MWH, 2001).

To check that the natural rainfall runoff responses of the Tokomairiro River levels are connected to the localised Milton catchment rainfall events we looked at the correlation between peak Tokomairiro River levels and rainfall in Balclutha (the nearest rainfall gauge) [1] from 1987 to 2004. When looking at a small timeframe there are a sufficient number of high rainfall events that coincide with high river levels to support using raised river levels in the Milton stormwater Mouse models.

The level of service used for designing the reticulation upgrades for Milton was the 5-year rainfall event. To be conservative we modelled the raised river level at the corresponding 5-year river level.

Based on the Otago Regional Council report *Flood Levels of the Tokomairiro River at Milton* (2004) the following raised river levels have been modelled at the various Milton reticulation outlets:

Outlet	5-year RL (m)	10-year RL (m)	50-year RL (m)	Cross-section from ORC report
Abercrombie diversion outlet	110.71	110.95	111.49	10
Ajax Street	110.50	110.71	111.30	13
SH1	110.28	110.52	111.17	15
Pope Street	110.22	110.47	111.11	17

[1] There was no local rainfall data available for Milton.

3 Existing System

3.1 Primary Network

The existing primary stormwater network in Milton has insufficient capacity to convey the 5-year rainfall event. Surcharging along all of the main streets occurs in the 5-year event– this is exacerbated during the 10- and 50-year events.

3.2 Secondary Network

The roading network in Milton provides secondary flow paths for spilled water from the primary network. However, these paths are not formalised in Milton and surface flooding tends to occur in local low spots, rather than following the kerb and channel to the river.

3.3 Outlets

The primary network discharges to the Tokomairiro River. The Otago Regional Council (ORC) carried out a study in 2004 on the flood levels of the Tokomairiro River at various locations along the river. Based on these levels the stormwater outlets from Milton are completely submerged during the 5-year event.

3.4 River Flooding

When modelling the existing system with the river at the 5- and 10-year river flood levels, the water in the stormwater network backs up the system and increases the amount of overland flow.

During the 50-year flood the Tokomairiro River will overtop its banks and inundate the lower end of Milton. Floor levels of several dwellings adjacent to the river are below the 50-year level. Sump and manhole levels are beneath the 20- and 10-year river level.

4 Assessment of Options

The following table summarises the stormwater upgrades that were assessed as part of this Issues and Options report. The options have been ranked in order of priority. Refer to Sheets 1 - 4, Appendix B for plans of the proposed upgrades.

4.1 Summary of Options

Priority	Upgrade	Description	Flooding Areas Alleviated	Advantages	Disadvantages	Cost Estimate
1	Dryden Street diversion	Divert runoff from the eastern rural catchments via a new 750m long channel away from Dryden Street and the under capacity stormwater pipes.	▪ Dryden Street ▪ Pope Street outlet up to High Street and Ossian Street	▪ Reduces flooding along Dryden Street. ▪ Relatively inexpensive	▪ Requires permission from landowner ▪ Only solves localised problem ▪	$152,000
2 =	Stop banks	Construct 500m of stop bank along the left side of theTokomairiro River from Union Street to Pope Street.	▪ Southern end of Milton: land and private property bounded by SH1 and Scott Street, up to High Street.	▪ Properties at the southern end of Milton are protected from inundation from the river ▪ Relatively inexpensive	▪ Does not reduce flooding upstream of Ossian Street or along Union St in Commercial area because the flooding at the northern end of town is due to under capacity pipes ▪ Requires pump station	$87,000
2 =	Pump station	Construct a stormwater pump station at the intersection of Union and Pope Streets adjacent to the Tokomairiro River.	▪ Southern end of Milton: land and private property bounded by SH1 and Scott Street, up to High Street.	▪ The Pope St outlet will be clear during raised river events – therefore reducing surface flooding at the southern end of Milton	▪ Does not reduce flooding upstream of Ossian Street or along Union St in Commercial area because the flooding at the northern end of town is due to under capacity pipes ▪ Expensive	$606,000
3 =	Abercrombie diversion	New 1200ϕ pipe along Abercrombie Street to the railway line to the west of the town. Typical invert of the pipe would be 2-3m deep. Pipe discharges to Tokomairiro River, upstream of the existing outlets.	▪ Elderlee Street, Spenser Street and the top end of Union Street (SH1). ▪ The surface flooding along Johnson and Chaucer Streets will only be reduced along a small section. Towards the river, there is still extensive overland flow in the 5-year event.	▪ Reduces flooding in the middle section of Milton, between Abercrombie and Shakespeare Streets	▪ Minimal flood protection provided during raised river event ▪ Expensive ▪ Does not alleviate flooding along Union Street ▪ Pipe alignment traverses two walkways	$874,000
3 =	Union Street upgrade	New 450ϕ and 600ϕ pipe along Abercrombie Street to Union Street. Replace existing 225ϕ pipe along Union Street with a new 900ϕ pipe to the bridge outfall. Typical invert of the pipe would be 2m deep.	▪ Spenser Street and the entire length of Union Street (SH1). ▪ The surface flooding along Johnson and Chaucer Streets will only be reduced along a small section. Towards the river, there is still extensive overland flow in the 5-year event. ▪ Elderlee Street flooding will not be reduced.	▪ Reduces flooding in the middle section of Milton, between Abercrombie and Shakespeare Streets ▪ Increases capacity of pipes along the SH1 (Union Street). ▪ Possibility of funding from Transfund	▪ Less flood protection provided during raised river event ▪ Expensive ▪ Does not alleviate flooding along Elderlee Street ▪ Disruption to SH1	$772,000

4.2 Dryden Street Diversion

The Dryden Street diversion will reduce surface flooding along Dryden Street and reduce pressure on under capacity pipes at the Pope Street outfall for relatively little expense. ***We recommend CDC implement this upgrade as the number one priority.***

4.2.1 Existing System

Currently the large eastern rural catchment adjacent to the Milton Borough boundary discharges to a small inlet grill at the top end of Dryden Street – refer following photos.

Photo 1. Inlet grill

Photo 2. Rural catchment

The catchment is over 75ha and contributes peak flows of approximately 0.7 m^3/s during the 5-year rainfall event. Milton Borough Council plans from 1961 indicate an open drain along the west side of Dryden Street that has since been sealed over – see photo 3. It appears that no adequate overland flow path has been provided for the rural flows and the existing inlet-grill to the stormwater reticulation restricts the flows entering the system. The remainder of the overland flows traverse Dryden Street causing surface flooding along the street.

Photo 3. Dryden Street

4.2.2 Proposed Upgrades

The large rural catchment will be diverted from Dryden Street using cut-off banks. 750m of new open drain will divert the flows to existing drains and discharge to the Tokomairiro River downstream of the existing outlets.

The Otago Catchment Board initially recommended the Dryden Street diversion channel in 1982. Since that time the concept has remained essentially unchanged. Detailed survey will confirm the final layout.

Maintaining a stormwater drain of this nature requires very little on-going cost. Some of the affected land will need to be secured by purchase or easement.

In addition to the original proposal we recommend that the existing 450ϕ pipe from the manhole at the Pope/Moore St intersection to the Pope/Mill St intersection be upgraded to a 600ϕ concrete pipe. Currently this pipe restricts the flows from the Chaucer and Dryden St sub-catchments and causes surface flooding even assuming the Dryden St diversion proceeds. Refer to long sections in Appendix C.

4.2.3 Flooding Area Alleviated

The hydraulic network model shows that by diverting the runoff from the large eastern rural catchment surface flooding at two areas is alleviated. Firstly, surface flooding at the northeastern end of Dryden Street will be significantly reduced. Secondly, the surface flooding at the Pope Street outlet, up to High Street and Ossian Street, will be reduced. These are both areas of known flooding problems. Refer to long sections in Appendix C.

4.2.4 Construction and Design Cost Estimate

Preliminary and general	$7,000
750m of open channel	$34,100
Stormwater	$63,300
Miscellaneous	$2,000
Construction Sub Total	**$106,400**
Contingency (20%)	$21,300
Engineering design	$10,200
Detailed survey	$4,000
Land Owner Negotiations	$10,000
Total	**$151,900**

Refer to Appendix D for details of the Dryden St diversion cost estimate.

4.2.5 Resource Consents and Public Consultation

No resource consents are required to construct this drain. However, the proposed drain crosses the property of a private landowner. CDC are holding on-going discussions with the owner of the land.

4.3 Abercrombie Diversion

The Abercrombie diversion will reduce pressure on under capacity pipes in central Milton and alleviate surface flooding along Elderlee Street, Union Street, Spenser Street, Johnson Street and Chaucer Street. ***We recommend CDC implement this upgrade (or the Union St upgrade) as a lower priority when further funding becomes available.***

4.3.1 Existing System

The primary stormwater network in Milton is under capacity and the majority of pipes surcharge during the 5-year storm – refer to Figure 1, Appendix C. Overland flows are predicted throughout the catchment. Where there are no formalised overland flow paths, ponding occurs in low-lying areas and property.

Three existing outlets from the piped network discharge to the Tokomairiro River. These outlets are below the 5-year river level. Therefore the amount of flooding and overland flow, especially at the southern end of town, is increased when the Tokomairiro River is in flood.

4.3.2 Proposed Upgrades

A new 1200ϕ pipe along Abercrombie Street to the railway line to the west of the town will divert stormwater from the central section of the southern Milton catchment. Typical invert of the proposed pipe is 2-3m deep. The pipe discharges to Tokomairiro River, upstream of the existing outlets. Refer to Sheet 1, Appendix B.

A major disadvantage with choosing this new pipe alignment is that the 1200ϕ pipe must cross the State Highway and also traverse two narrow walkways between Union and Ajax Streets and Ajax and Elderlee Streets.

Photo 5. Ajax-Elderlee walkway.

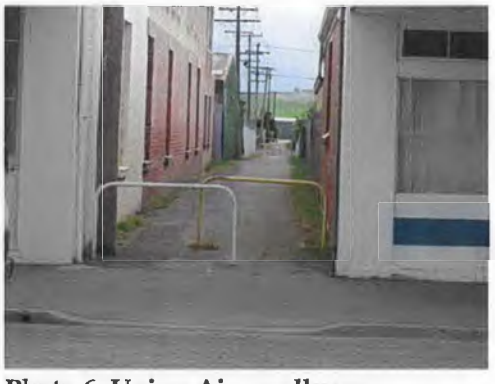


Photo 6. Union-Ajax walkway.

Another major disadvantage with the Abercrombie diversion is that flooding along the commercial area on Union Street will still occur during the 5-year rainfall event. This is the State Highway 1 from Dunedin to Invercargill. The local Roading Control Authority has received many complaints about flooding along this stretch of road.

4.3.3 Flooding Area Alleviated

The Abercrombie diversion will alleviate flooding along Elderlee Street and Spenser Street. The pipes on Union, Johnson and Chaucer Streets directly downstream of Abercrombie will not surcharge, but towards the river the pipes continue to surcharge. Refer to plan of flooding areas alleviated on Figure 5, Appendix C.

The effectiveness of the Abercrombie diversion is reduced when the outlets from the stormwater network are submerged. See Figure 7, Appendix C for a plan showing the location and relative depth of overland flow during a 5-year raised river event.

4.3.4 Construction and Design Cost Estimate

Preliminary and general	$21,000
Stormwater pipes and manholes	$633,000
Miscellaneous	$17,000
Construction Sub Total	**$671,000**
Contingency (20%)	$134,000
Engineering design	$64,000
Detailed survey	$4,000
Total	**$874,000**

Refer to Appendix D for details of the Abercrombie cost estimate.

4.3.5 Resource Consents and Public Consultation

No resource consents are required for these upgrades. However, the Otago Regional Council will need to be notified of the location and nature of the new outfall, at least seven working days prior to commencing the placement of the outfall.

4.4 Union Street Upgrade

The Union Street upgrade will reduce pressure on under capacity pipes in central Milton and alleviate surface flooding along Union Street, Spenser Street, Johnson Street and Chaucer Street. ***We recommend CDC implement this upgrade (or the Abercrombie diversion) as a lower priority when further funding becomes available.***

4.4.1 Existing System

One of the areas of significant flooding, according to the hydraulic model, occurs along Union Street, especially at the southern end of Milton adjacent to the commercial area. The model represents a 225ϕ pipe changing into a 150ϕ pipe to the outlet[2]. One of the pipes also has a negative grade. This pipe restriction and the size of these pipes cause surcharging along Union Street (see Figures 1 – 4, Appendix C).

4.4.2 Proposed Upgrade

A new 450ϕ pipe and 600ϕ pipe along Abercrombie will connect to an upgraded 900ϕ pipe along Union Street to the existing bridge outfall point. This will divert stormwater from the southern Milton catchment and alleviate flooding along Union Street. Typical invert of the proposed pipe is 2m deep. Refer to Sheet 2, Appendix B.

A major disadvantage with choosing this new pipe alignment is the disruption to the State Highway caused by replacing the existing 225ϕ pipe with the new 900ϕ pipe. However, because the State Highway is a known flooding area to the local Roading Control Authority there may be funding available from Transfund to improve the flooding along Union Street.

4.4.3 Flooding Area Alleviated

The Union Street upgrade will alleviate flooding along Union Street (SH1) and Spenser Street. The pipes on Johnson and Chaucer Streets directly downstream of Abercrombie St will not surcharge, but towards the river the pipes continue to surcharge. Refer to Figure 6, Appendix C.

As with the Abercrombie diversion the effectiveness of the Union St upgrade will be lessened when the Tokomairiro River is in flood (Figure 8, Appendix C). However, the effects of the raised river are less, as the outfall pipe is relatively steep (1:36).

The advantage of the Union Street upgrade compared to the Abercrombie diversion is that the Union Street upgrade addresses the flooding along Union Street, which is a commercial area that suffers from frequent surface flooding. However, it does not reduce flooding along Elderlee Street.

[2] Old plans of the Milton stormwater network show the 225ϕ pipe continuing to the SH1 Bridge, and adjacent to this pipe, a separate 150ϕ pipe collecting stormwater from the north-western side of Union Street and discharging at the SH1 Bridge. This needs to be confirmed on site.

4.4.4 Construction and Design Cost Estimate

Preliminary and general	$26,000
Stormwater pipes and manholes	$545,000
Miscellaneous	$22,000
Construction Sub Total	**$585,000**
Contingency (20%)	$119,000
Engineering design	$57,000
Detailed survey	$4,000
Total	**$772,000**

Refer to Appendix D for details of the Union St upgrade cost estimate.

4.4.5 Resource Consents and Public Consultation

No resource consents are required for these upgrades. However, the Otago Regional Council will need to be notified of the location and nature of the upgraded outfall, at least seven working days prior to commencing the placement of the outfall.

4.5 Stop Banks

We recommend that CDC construct 500m of stop bank along the left bank of the Tokomairiro River to reduce surface flooding at the lower end of Milton. ***We recommend CDC implement this upgrade as the number two priority in conjunction with the proposed pump station.***

4.5.1 Existing System

In 1972 the Tokomairiro River flooded to levels recorded at 111.02 [3]. This caused extensive flooding at the lower end of Milton. A survey of the floor levels (carried out in June 2004) of residential property along Mill, Pope and Scott Streets has identified at least four houses that would be inundated during the Tokomairiro River 50-year flood. Stormwater from the Milton catchment would compound this flooding.

Sump inverts at the lower end of Milton are at levels below the 50-year river level and in some instances the 20 and 10-year level. Therefore floodwater from the river also backs up the stormwater network.

The existing Pope Street outlet invert is 108.02m and does not have a flap gate. The river levels at this outlet during the 5-, 10-, 20- and 50-year ARI are 110.22m, 110.47m, 110.72m and 111.11m respectively. Therefore the outlet is submerged during all of these storm events.

4.5.2 Proposed Upgrade

To prevent floodwaters from the Tokomairiro River overtopping the river bank and inundating Milton we recommend constructing approximately 500m of stop banks along the left bank—refer to Sheet 4, Appendix B. The height of the stop banks will be set at 500 mm above the 50-year ARI flood.

Based on ORC's river modelling the maximum 50-year river level along Milton's stretch of the Tokomairiro River is 111.50m. Stop banks should not be required upstream of the State Highway Bridge as the 112m contour meets the riverbank adjacent to the bridge (based on the DTM contours). However, a short length of stop bank (about 85m) may be required upstream of the bridge to join the 112m contour—see Sheet 4, Appendix B.

A flap gate will be constructed on the end of the Pope Street outfall to prevent floodwaters from the river backing up the stormwater network.

4.5.3 Flooding Area Alleviated

Constructing stop banks along the Tokomairiro River will alleviate flooding along the land and private property bounded by SH1 and Scott Street, up to High Street. Refer to Sheet 4 , Appendix B for a plan of the area that will be potentially inundated in the 50-year Tokomairiro Flood.

[3] This level as noted on the Royds Garden Milton stormwater plan (1992)

4.5.4 Construction and Design Cost Estimate

Preliminary and general	$7,500
500m of stop bank	$36,100
Miscellaneous	$4,000
Construction Sub Total	**$48,000**
Contingency (20%)	$9,500
Engineering design	$10,000
Geotechnical investigations	$12,000
Detailed survey	$4,000
Resource consent	$4,000
Total	**$87,000**

Refer to Appendix D for details of the stop bank estimate.

4.5.5 Resource Consents and Public Consultation

Under Rule 14.3.2 of the Regional Plan: Water for Otago, the erection of any defence against water is a ***discretionary*** activity. Therefore an Otago Regional Council resource consent will be required to build the stop banks along the Tokomairiro River.

This type of resource consent will require an Assessment of Effects on the Environment and will likely require public notification or written consent from affected parties.

4.6 Pump Station

We recommend that CDC construct a stormwater pump station at the Pope and Mill Street intersection. ***We recommend CDC implement this upgrade as the number two priority in conjunction with the proposed stop banks.***

4.6.1 Existing System

During normal river-flow conditions the pipes at the southern end of Milton (along Pope, High and Johnson Streets) do not surcharge i.e. the pipes have adequate capacity provided the outfall to the Tokomairiro River is not submerged. However, pipes upstream of Ossian St surcharge during the 5-year rainfall event due to under capacity pipes.

Based on ORC's river flood levels, the Pope St outlet is submerged during the 5-year river flood. Under these submerged outlet conditions, a 5-year rainfall event will cause flooding along Pope St, High St and the lower end of Johnson St, and worsen flooding further upstream (see Figures 2 and 3, Appendix C).

If the stop banks and flap gates are built without stormwater pumps, water from Milton's eastern stormwater catchment does not have a free outfall when the Tokomairiro River floods. Hence ponding will occur along Mill and High St as the stormwater backs up the piped network and spills.

4.6.2 Proposed Upgrade

The proposed stop banks and flap gates will prevent inundation from the Tokomairiro River. A pump station is required to provide a free outfall for the eastern part of the stormwater network during river-flood events. Our hydraulic model indicates that two 50kW pumps will be required, pumping 600 L/s each against a total head of 5m. This is an initial assessment and may change after detailed analysis.

The wet well will be located at the Pope Street and Mill Street intersection, final position to be confirmed after detailed survey and geotechnical investigations. The size of the wet well will be approximately 2m x 2m x 3m. Additional storage may be provided by upgrading the existing 750ϕ outlet pipe in Pope St to a 900 or 1200ϕ pipe.

4.6.3 Flooding Area Alleviated

The property along Mill, Pope and High Streets will be protected from inundation during river-flood events. When the river is not in flood the outfall will operate by gravity as per the status quo.

Modelling of the pump station indicates that flooding upstream of Ossian Street will not be alleviated by pumping at the Pope St outlet. Flooding in this area is caused by small pipes restricting the amount of flow conveyed by the primary system. Therefore changing the outlet conditions by pumping will not increase the flows through the pipes and will not reduce flooding in the upstream catchment. To reduce this flooding either the Abercrombie

or Union St upgrades, in conjunction with localised pipe upgrades, would need to be installed to increase the existing capacity.

In conclusion, the pumps only alleviate surface flooding at the lower end of Milton when the river is in flood by providing a clear outfall for the primary system, which would be otherwise submerged. Refer to Figures 9 - 12, Appendix C.

4.6.4 Construction Cost Estimate

Preliminary and general	$14,500
2 x 50kW Grundfos pumps	$69,000
Pump station	$335,000
Stormwater pipes	$40,500
Miscellaneous	$2,000
Construction Sub Total	**$461,000**
Contingency (20%)	$92,000
Engineering design	$44,000
Geotechnical investigations	$4,000
Detailed survey	$4,000
Resource consent	$1,000
Total	**$606,000**

Refer to Appendix D for details of the pump station estimate.

4.6.5 Resource Consents and Public Consultation

Pumping stations for drainage are a restricted discretionary activity throughout the Clutha District under Rule PWN.2 of the District Plan (1998). This means that Council shall restrict the exercise of its discretion to the standard of construction and to the effect that such activities may have on amenity values.

This type of resource consent will therefore require a brief application but most likely not require public notification or written consent from affected parties.

4.7 Other Reticulation Upgrades

Priority 1 upgrades from the *Milton Stormwater Strategy* and stop banks/pump station have been assessed and prioritised as part of this issues and options report. However, even given that the pump station/stop banks are constructed and either the Abercrombie diversion or Union St upgrade, there will still be localised flooding in Milton that needs to be alleviated.

The following table summarises the priority two and three stormwater upgrades that were assessed as part of the *Milton Stormwater Strategy* (2001). This table identifies which upgrades may not be required if the upgrades recommended as part of this study are implemented. The options have NOT been ranked in order of priority. We recommend that these designs and cost estimates from the *Milton Stormwater Strategy* be confirmed after the effectiveness of the priority 1 upgrades have been confirmed.

Priority	Upgrade	Description	Flooding Areas Alleviated	Required after stop bank/pump station?	Required after Abercrombie St diversion?	Required after Union St upgrade?	Comments	Cost Estimate (from 2001)
Priority 2	Helensbrook channel upgrade & Helensbrook channel diversion	New open drain along Helensbrook Rd, upgraded discharge pipe and upgraded 600ϕ culvert.	Helensbrook catchment.	✓	✓	✓	Pump station and priority 1 upgrades will not alleviate flooding in the Helensbrook catchment. Localised upgrades in the Helensbrook sub-catchment will still be required.	$15,000
	Ossian St relief sewer	New 450ϕ outfall pipe along Queen St from the Ossian St/Spenser St intersection.	Southern end of Milton – especially southern end of Spenser Street.	✓	✓	✓	Because this new outfall would be affected by raised river levels it may be more effective to divert the Ossian St relief down High St and connect to the upgraded Pope St outfall/pump station.	$107,000
	Elderlee Street diversion	New 600ϕ pipe along Elderlee St to connect to the Abercrombie diversion.	Elderlee St and Ajax St.	✓	✓	✓	This diversion pipe will connect into the new Abercrombie St diversion pipe. Therefore if the Union St upgrade is implemented instead of the Abercrombie Diversion, this design will need to be amended.	$218,000
	Ajax St relief	New 375ϕ pipe from Ajax St to Elderlee St diversion (along Jura St)	The Ajax St/Jura St intersection.	✓	✓	✓	This diversion pipe will connect into the new Elderlee St diversion pipe. Therefore if the Union St upgrade is implemented instead of the Abercrombie Diversion, this design will need to be amended—perhaps included with the Western Diversion.	$30,000
	Arthur St diversion	Upgrade Union St pipe from Ossian St to Arthur St, and lay new pipe along Arthur St to existing outfall.	RSA flooding at the Ossian St/Union St intersection. Improves drainage capacity at southern end of Union St.	✓	✓	×	This upgrade would not be required if the Union St upgrade is implemented.	$71,000
	Union St Relief	Upgrade the sumps at the Union St/ Abercrombie St intersection.	Union St – south of Abercrombie St.	✓	✓	×	These sumps will be constructed as part of the Union St upgrade.	$6,000

Priority 3	Elderlee St relief	New 300ϕ pipe from Elderlee St to the Abercrombie diversion (along Grey St)	Southern end of Elderlee St.	✓	✓	✓	This diversion pipe will connect into the new Abercrombie St diversion pipe. Therefore if the Union St upgrade is implemented instead of the Abercrombie Diversion, this design will need to be amended.	$17,000
	McKechnie St diversion	New 300ϕ pipe from Stewart Rd to Keinan Avenue, along McKechnie St	McKechnie St.	✓	✓	✓	Pump station and priority 1 upgrades will not alleviate flooding in the McKechnie St subcatchment. Localised upgrades in this catchment will still be required.	$60,000
	Johnson St upgrade	Upgrade pipes along Johnson St between Springfield Rd and Abercrombie St.	Johnson St and Keinan St.	✓	✓	✓	Johnson St pipes restrict the flows in the Johnson St sub-catchment and need upgrading, regardless of the priority 1 upgrades.	$140,000
	Keinan St upgrade	Upgrade pipes along Keinan St and divert to upgraded Johnson St pipes.	Keinan St.	✓	✓	✓	It is recommended that the Johnson St upgrade is implemented before the Keinan St upgrade so that the benefits of the Johnson St upgrade on Keinan St flooding can be identified.	$41,000
	Moore St outfall	New outfall pipe from Moore St parallel to the existing Pope St outfall.	Relieve pressure on existing outfall and reduce flooding at the bottom end of the East catchment.	x	✓	✓	As part of the pump station the Pope St outfall will be upgraded to handle the existing 5-year flows. Therefore the new Moore St outfall would not be required.	$105,000
Alternative to Abercrombie Diversion	Western Diversion	New diversion pipe along the walkway between Ajax and Elderlee St, then down railway reserve to new outfall.	Ajax St and Elderlee St.	✓	x	✓	This upgrade was recommended as part of an alternative to the Abercrombie diversion and could be implemented as part of the Union St upgrade strategy.	$390,000
	Johnson St Bypass	New large diameter pipe on Johnson St from Springfield Rd to Shakespeare St, then down Shakespeare St and Chaucer St to a new outfall.	Southern Milton, especially along Johnson St and Chaucer St.	✓	x	✓	This upgrade was recommended as part of an alternative to the Abercrombie diversion. The proposed pump station and upgraded outfall eliminate the need for the new outfall from Chaucer St. However, the Johnson St pipes still need upgrading.	$1,080,000
	Cross St diversion	New 450ϕ pipe from Ajax St to Elderlee St along Cross St.	Cross St.	✓	x	✓	This upgrade was recommended as part of an alternative to the Abercrombie diversion and could be implemented as part of the Union St upgrade strategy.	$40,000

5 Recommendations

Based on the review of the hydraulic model, surveyed floor levels, flood levels in the Tokomairiro River and budget restraints our recommendations are:

Existing 2004/05 Budget:

Construct the Dryden Street diversion as the number one priority

Construct the stop banks and pump station as the number two priority

Future Budget:

Construct the Union Street upgrade or the Abercrombie diversion, depending on community consultation.

Upgrade or replace small sections of the stormwater network to relieve localised surface flooding (upgrades based on the *Milton Stormwater Strategy* (2001))

6 Conclusion

There are two major sources of flooding within Milton: flooding from the Tokomairiro River and flooding from the Milton stormwater catchments. Neither the existing stormwater network nor the riverbanks provide adequate levels of service during the 5-year rainfall or river-flood event.

Existing Budget

The total cost of providing protection to Milton from river inundation is approximately $910,000. The total cost of upgrading the stormwater network to convey the 5-year rainfall event is in excess of $1.5m. Therefore within the Milton 2004/05 budget for stormwater upgrades ($900,000) there is only sufficient budget to alleviate flooding from one of these two flooding scenarios.

It is our conclusion that the current budget of $900,000 is best invested by constructing the Dryden Street diversion, and building stop banks and a pump station adjacent to the Tokomairiro River. These works will provide 50-year protection from the river to the low-lying areas of Milton. The pump station will also provide a free outlet for the Pope Street outfall, thus relieving the stormwater network during rainfall events that coincide with raised levels in the Tokomairiro River.

Future Budget

The Abercrombie diversion, as prioritised by the local community, reduces surface flooding through the middle section of Milton. However, the diversion does little to alleviate flooding along the commercial area on Union Street (SH1).

As an alternative to the Abercrombie diversion we have proposed the Union Street upgrade. The concept is similar to the Abercrombie diversion, but rather than diverting water along a new 1200ϕ pipe adjacent to the railway line, the main 225ϕ pipe down Union Street could be upgraded to a 900ϕ pipe. Initial cost estimates for these two options are comparable. However, there is a possibility that Transfund could provide some funding for the works along the State Highway to protect their assets.

Therefore when further funding becomes available for stormwater upgrades we recommend community consultation to decide between these two options.

Further localised upgrades, as identified in the *Milton Stormwater Strategy,* need to be confirmed after local rainfall and river flood events and the effectiveness of the priority 1 upgrades have been assessed.

References

Montgomery Watson Harza (2001), *Milton Stormwater Strategy.*

Otago Regional Council (2004), *Flood Levels of the Tokomairiro River at Milton.*

Appendix A – Hydraulic Model Review

Hydraulic Model Review and Upgrades

Introduction

A brief technical review of the Milton stormwater computational hydrologic-hydraulic model was carried out. The purpose of this review was to ascertain the fitness of the model for use in existing system analysis and in developing preliminary flood mitigation options.

This narrative presents findings from the review and details any enhancements made to the model for use in this study.

Conceptualisation, modelling software and model set-up

The Milton stormwater model is constructed in the DHI Water and Environment MOUSE HD software. There was a final report accompanying the model digital files that detailed some of the modelling assumptions and model parameters chosen. There was, however, no clear statement of the objective of setting up the computer model. Additionally there was no evidence, hardcopy or otherwise, of the conceptualisation of the prototype system for modelling in the MOUSE HD software.

As no detailed model set-up documentation was available we have not been able to check the robustness of the model conceptualisation and set-up.

Rainfall-runoff modelling

The rainfall data used for the preliminary designs was the High Intensity Rainfall Design System (HIRDS version 1.5b NIWA software package) based on data from 1960 to 1980. The HIRDS data has since been revised and the recent version, HIRDS 2003, was chosen for use as rainfall input in to the computer model. The HIRDS 2003 rainfall data used is presented in Table 1.

Table 1. HIRDS 2003 data

	Rainfall Depth (mm) for 30 minute duration		
Storm Duration (%)	5-year	10-year	50-year
0	0.00	0.00	0.00
10	0.74	0.88	1.40
20	1.19	1.42	2.26
30	2.12	2.55	4.04
40	1.63	1.95	3.10
50	1.39	1.66	2.64
60	1.13	1.36	2.16
70	0.85	1.02	1.62
80	0.61	0.73	1.16
90	0.50	0.60	0.96
100	0.35	0.42	0.66
Total Depth	10.5	12.6	20

The rainfall-runoff process was modelled using the MOUSE model A rainfall runoff model. This applies a fixed percentage runoff volume and a time-area runoff routing model. The rainfall-runoff model A is suitable for representing the storm event runoff from the Milton catchment. There was no record, hardcopy or digital, of the subcatchments representing the catchment discretisation for hydrological modelling. Therefore we have not been able to check the robustness of the subcathment delineation and assignment of hydrological parameters in detail.

All the subcatchment MOUSE shape references (used in the time-area routing) were set to rectangular. Since the subcatchment delineations are unavailable it was not possible to assess if this shape description is representative.

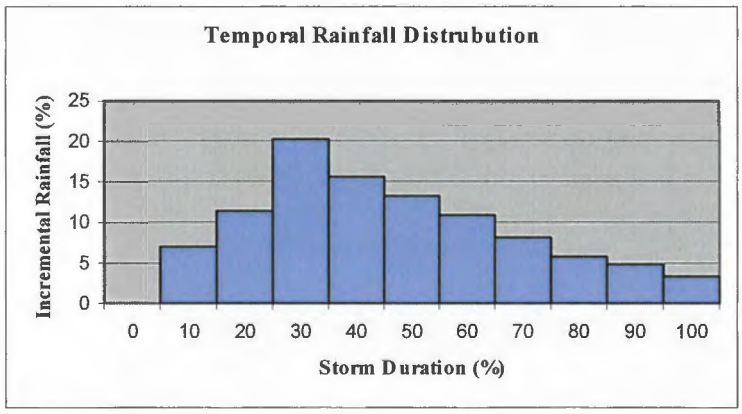
Time of concentrations (used in the time-area routing) were all set to MOUSE default values of 7 minutes. This is too low for a catchment such as Milton considering the scale of the subcatchments in the model. The time of concentration for urban catchments was changed to 20 minutes thus better representing the runoff routing for this scale of urban catchment. The 78 ha rural catchment had a time of concentration of 1 hour, which was not changed. However, such a large area lumped to a single entry point in the model is not advisable because of unrealistic loading at that node, and therefore unrealistic flooding downstream of that node.

C factors appeared to be on the low side considering the land use of the Milton subcatchment. The C factors were not adjusted upwards because of lack of information relating to the subcatchment boundaries. If it was considered prudent to update the C factors then the subcatchments would require re-definition and this is a major undertaking outside of the scope of the current study.

Rainfall Profile

The rainfall inputs in the original model were fitted with a temporal distribution based on the Auckland Regional Council TP108 24-hour super storm methodology. This is inappropriate for the Milton catchment. In the absence of any detailed local rainfall temporal patterns the ARC TP108 temporal rainfall profile was replaced with the Probable Maximum Precipitation (PMP) curve, Probable Maximum Precipitation in New Zealand, ECNZ, NZ Meteorological Service, Thomlinson & Thompson, May 1992. Figure 1 presents the temporal pattern used.

Figure 1. PMP temporal rainfall pattern



In line with the New Zealand Building Code and Clutha District Council levels of service the design storm used to assess and design the primary reticulation was the 5-year event. The 10-year storm was used to size the pump station and the 50-year event was used to check the pump station requirements and to give an indication of overland flow in habitable areas.

In the original model the 10-, 20-, 30-, 60- and 120-minute durations were tested. The critical duration was the 20-30 minute duration, depending on the part of the system being analysed. The 30-minute duration causes more flooding at the lower end of Milton, therefore this duration was selected as the design storm duration used for further analysis.

Network model

The primary and secondary networks, as represented in the hydraulic model, were based on the network modelled in the *Milton Stormwater Strategy* (2001). This data has not been independently verified. However, when the floor levels were surveyed in Milton the location and depth of some pipes were confirmed. Some pipes that were not modelled have been identified on old CDC plans. The location and size of these pipes has not been confirmed and they were not included in the model.

The model was set up as a two-layer model with the pipe network and overland flow roadways modelled. No representation or controlling effect of sumps and sump leads from the surface runoff in to the pipe network has been included in the model. One particular overland flow path has simulated velocities in the order of 20 m/s. This overland flow path is in the Helensbrook catchment and will not affect the scenarios analysed for this study. For the remainder of the catchment volume balances were inspected to assess likely instabilities resulting from steep overland flow channels and corresponding high velocities.

All of the manhole diameters are set to 1.05m. However, if the diameter of a connected link is larger than 1.05m MOUSE HD will adjust the manhole diameter to suit i.e. in instances where an overland flow path link is 15m the manhole diameter will become 15m also. This has not been altered, as it would have meant a complete remodel of the overland flow paths (basically by defining the manholes to be a two stage chamber with nominal diameters below ground and large diameters above ground). We therefore recommend that the model is not used to predict depths of overland flow.

The original model used a default hydraulic roughness (Manning's n) for smooth concrete of n=0.0118. This is too low for an existing system such as Milton. Therefore the default for smooth concrete was changed to 0.015.

Head losses were generally set to 'mean energy approach, which is suitable. However, some manhole head losses were specified as 'outlet shape' (implying use of a specific K factor for representing losses). These are thought to give conservative estimates of head loss and have not been changed.

Boundary Conditions

The raised river levels as modelled in the original MOUSE model have been updated with the revised river flood levels. Based on the Otago Regional Council report *Flood Levels of the Tokomairiro*

River at Milton (2004) the following raised river levels have been modelled at the various Milton reticulation outlets:

Outlet	5-year RL (m)	10-year RL (m)	50-year RL (m)	Cross-section from ORC report
Abercrombie diversion outlet	110.71	110.95	111.49	10
Ajax Street	110.50	110.71	111.30	13
SH1	110.28	110.52	111.17	15
Pope Street	110.22	110.47	111.11	17

Simulations

The original simulation time step was set to 60 seconds. Since the model was to used to assess potential for incorporating pumps in to the system the time step was reduced to 1 second (to reduce likely hood of instabilities resulting from pump discharge volume errors)

The original model contained an iteration problem, giving unrealistically high water levels and long flood durations when the 78ha Dryden St catchment was connected. A number of different remedies were attempted. Essentially the instability was resulting from inclusion of the large rural catchment and the reverse gradient overland flow paths. Reducing the time step and running the model for a longer duration somewhat reduced the instabilities. However, the model was most stable with the large rural catchment removed. Therefore the majority of the modelling was carried out without this large catchment connected i.e. assuming the Dryden Street diversion will go ahead.

Summary

In summary, there was no supporting documentation to allow the fundamental premise of the model development to be checked. Subcatchments could not be checked due to lack of graphical representation of boundaries. The model has been amended where possible and within the scope of the present study. The model is now better representative of the hydrological and hydraulic processes occurring in the Milton storm water catchment. Key areas for future model improvement are:

- Development of a site specific temporal rainfall pattern
- Inclusion of sumps and sump leads to represent hydraulic constraints to flows entering the system
- Redefinition of the sub-catchments to allow for future adjustment of the subcatchment land use

Additional Scenarios Modelled

The preliminary MOUSE models for the Milton stormwater reticulation were amended to include various river stop bank and stormwater pump station options:

- Existing system with raised river levels (5-, 10- and 50-year)
- Abercrombie Diversion with raised river levels (5-, 10- and 50-year)
- Union Street upgrades with and without raised river levels
- Pump station scenarios (with and without Abercrombie and Union St upgrades)
- Entire southern catchment upgraded with pipes sized to contain the 5-year storm (no raised river level)

Appendix B – Plans of Proposed Upgrades

Appendix C – MOUSE Plans & Long-Sections

Figure 1. Existing System (without rural catchment) - 5yr Rainfall Event

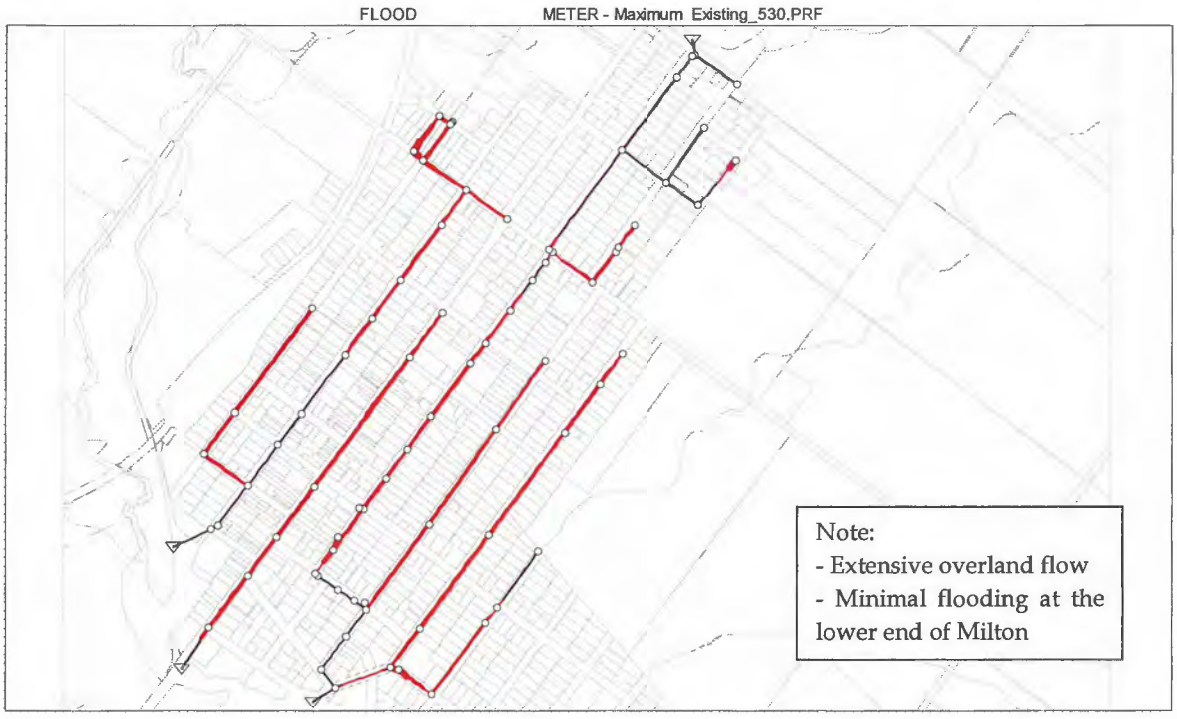
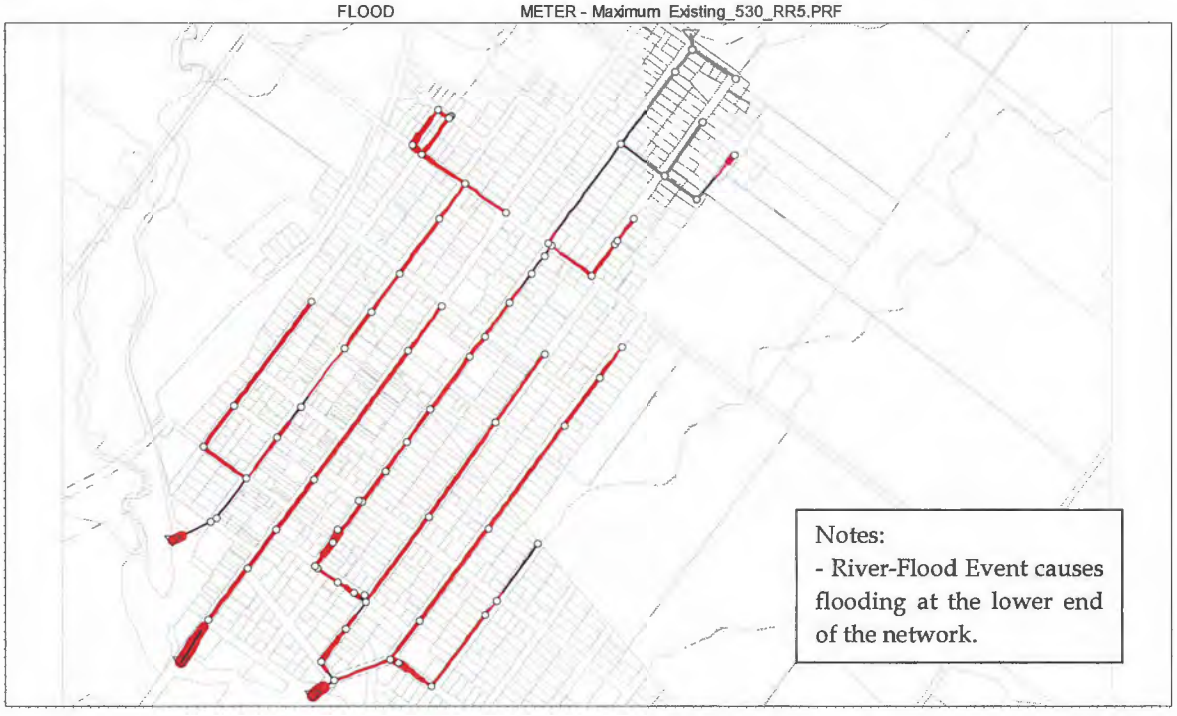


Figure 2. Existing System - 5yr Rainfall Event with 5yr River-Flood Event



Modelled Piped Network
Line thickness represents depth of overland flow

Figure 3. Existing System - 10yr Rainfall Event with 10yr River-Flood Event

Figure 4. Existing System - 50yr Rainfall Event

Modelled Piped Network
Line thickness represents depth of overland flow

Figure 5. Abercrombie Diversion - 5yr Rainfall Event

Figure 6. Union St Upgrade - 5yr Rainfall Event

Modelled Piped Network

Line thickness represents depth of overland flow

Figure 7. Abercrombie Diversion - 5yr Rainfall Event with 5yr River-Flood Event

Figure 8. Union St Upgrade - 5yr Rainfall Event with 5yr River-Flood Event

Modelled Piped Network
Line thickness represents depth of overland flow

Figure 9. 1200L/s Pump at Pope St - 5yr Rainfall Event with 5yr River-Flood Event

Figure 10. 1200L/s Pump at Pope St - 10yr Rainfall Event with 10yr River-Flood Event

Modelled Piped Network
Line thickness represents depth of overland flow

Figure 11. Abercrombie Diversion with Pump - 5yr Rainfall Event with 5yr River-Flood Event

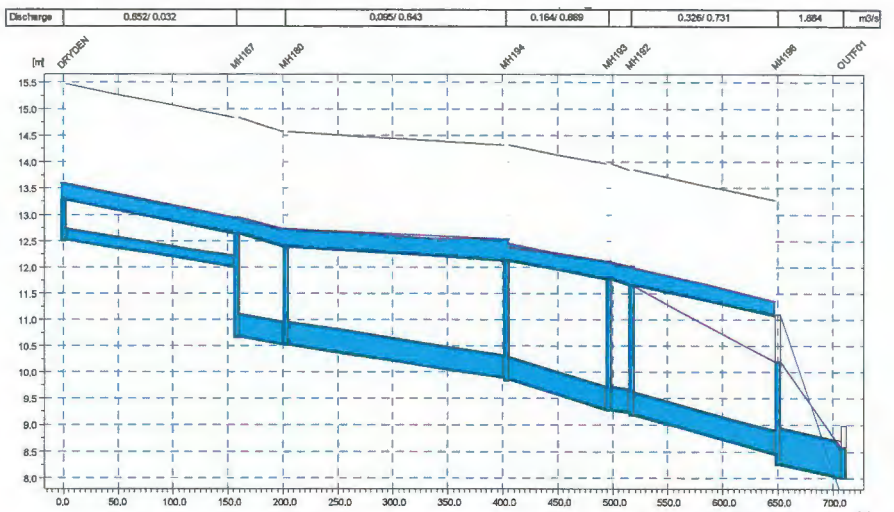
Figure 12. Union St Upgrade with Pump - 5yr Rainfall Event with 5yr River-Flood Event

Modelled Piped Network
Line thickness represents depth of overland flow

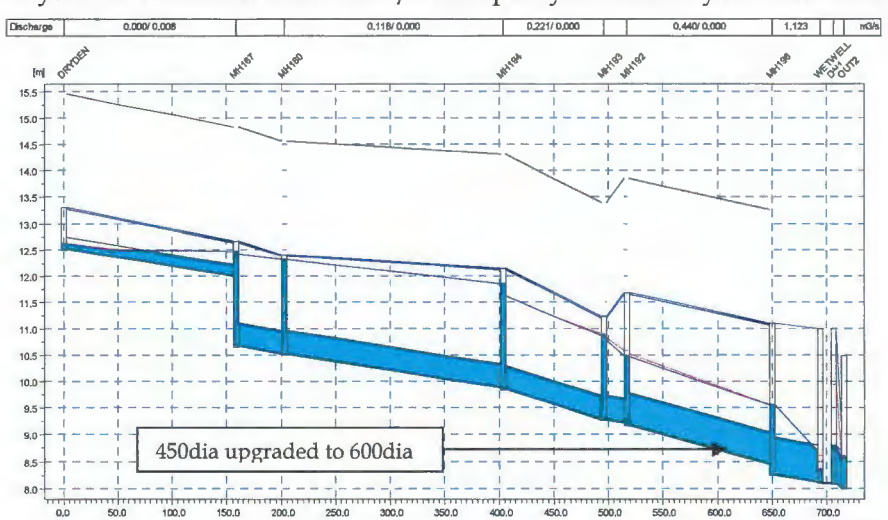
DRYDEN STREET LONG-SECTIONS:

Milton network: Dryden St long-section highlighted green

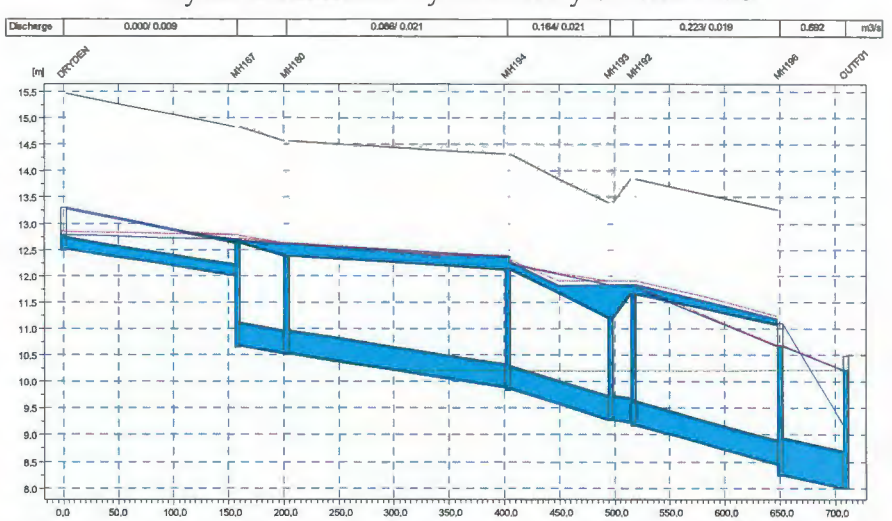
Existing system, including 78ha catchment: 5-year with 5-year river-flood



Dryden St diversion and 1200L/s Pump: 5-year with 5-year river-flood



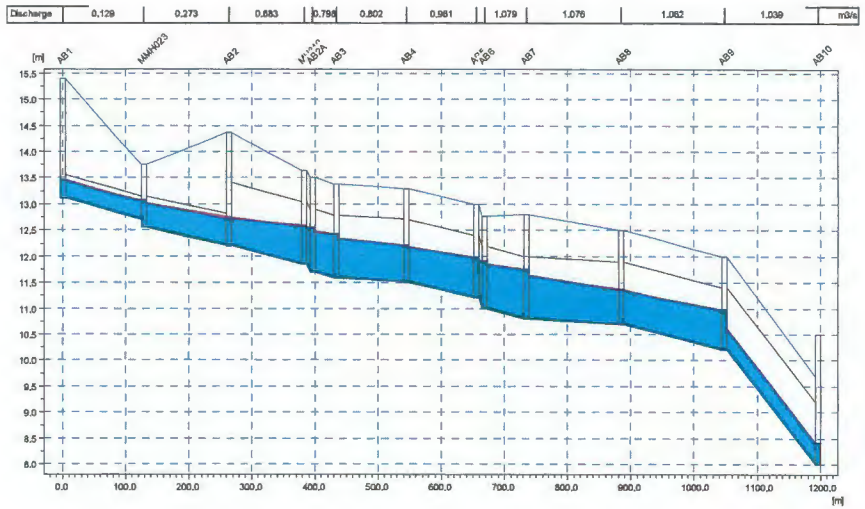
Dryden St diversion: 5-year with 5-year river-flood



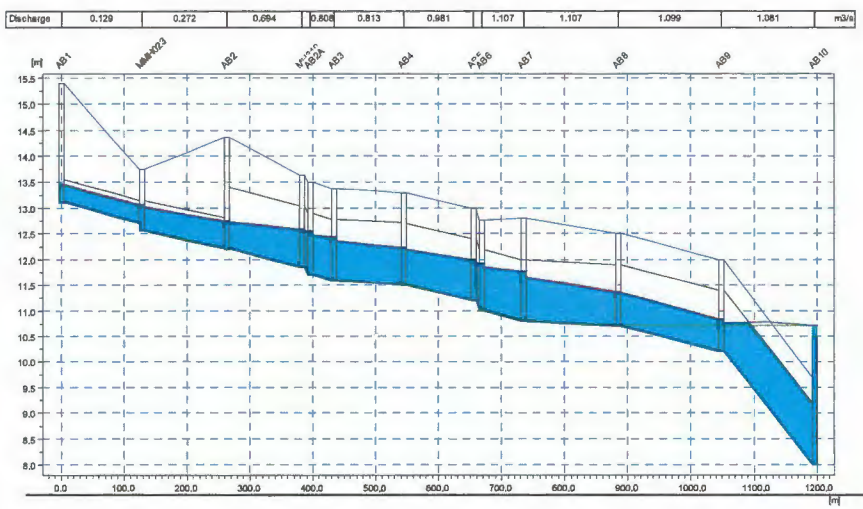
ABERCROMBIE DIVERSION LONG-SECTIONS:

Milton network: Abercrombie Diversion long-section highlighted green

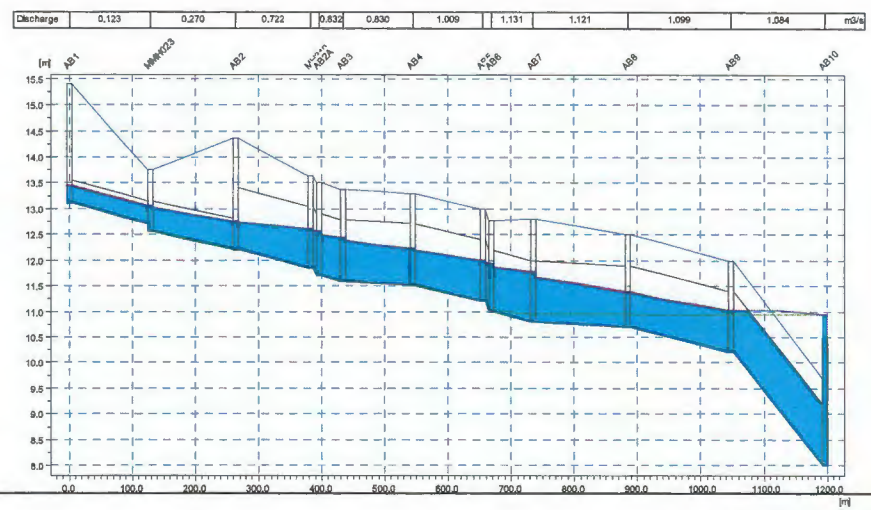
Abercrombie St diversion: 5-year



Abercrombie St diversion: 5-year with 5-year river-flood



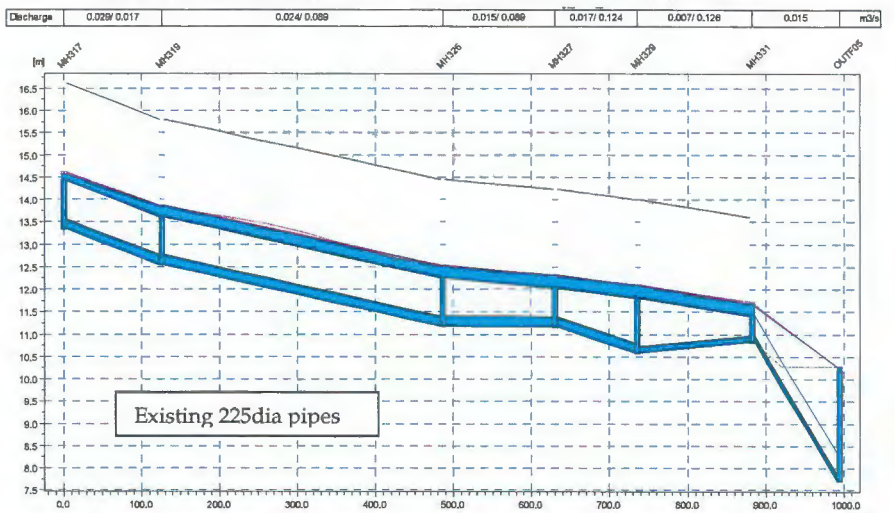
Abercrombie St diversion: 5-year with 10-year river-flood



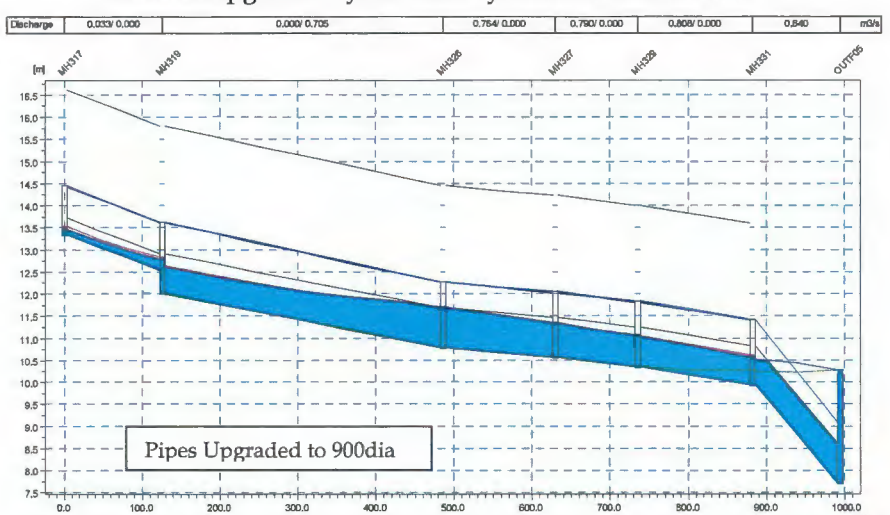
UNION STREET LONG-SECTIONS:

Milton network: Union St long-section highlighted green

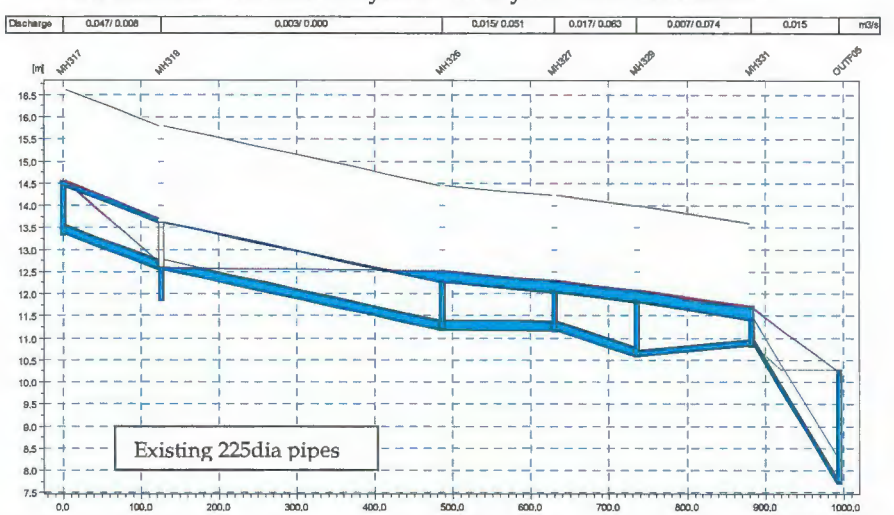
Existing system: 5-vear with 5-vear river-flood event



Union St upgrade: 5-year with 5-year river-flood event



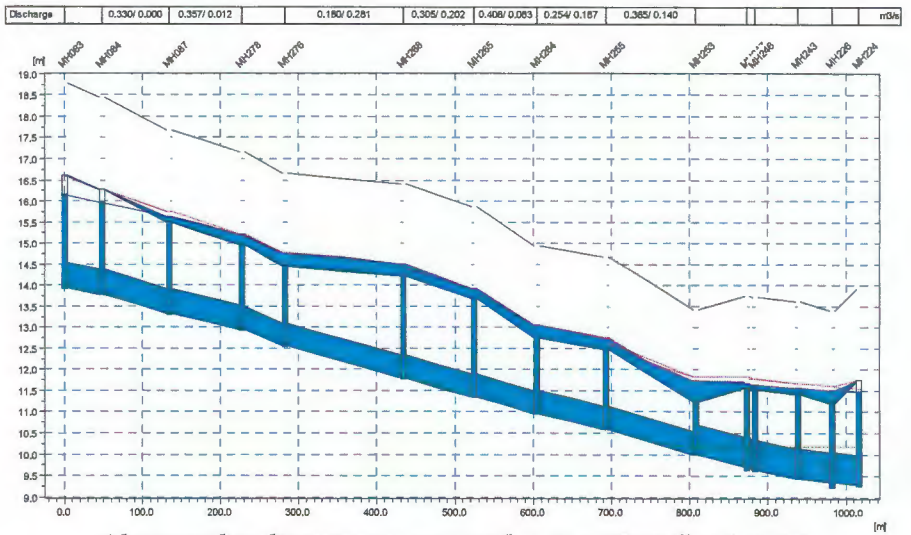
Abercrombie diversion: 5-year with 5-year river-flood event



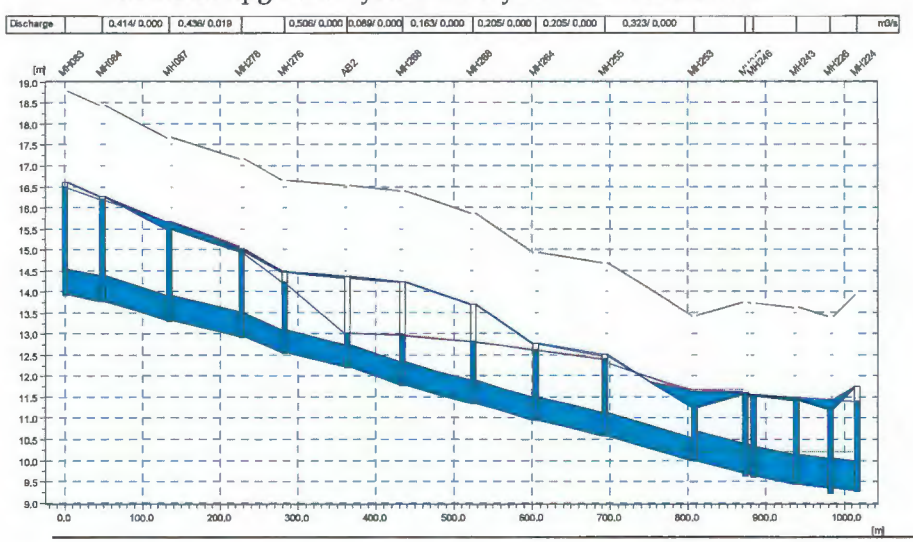
SPENCER STREET LONG-SECTIONS:

Milton network: Spencer St long-section highlighted green

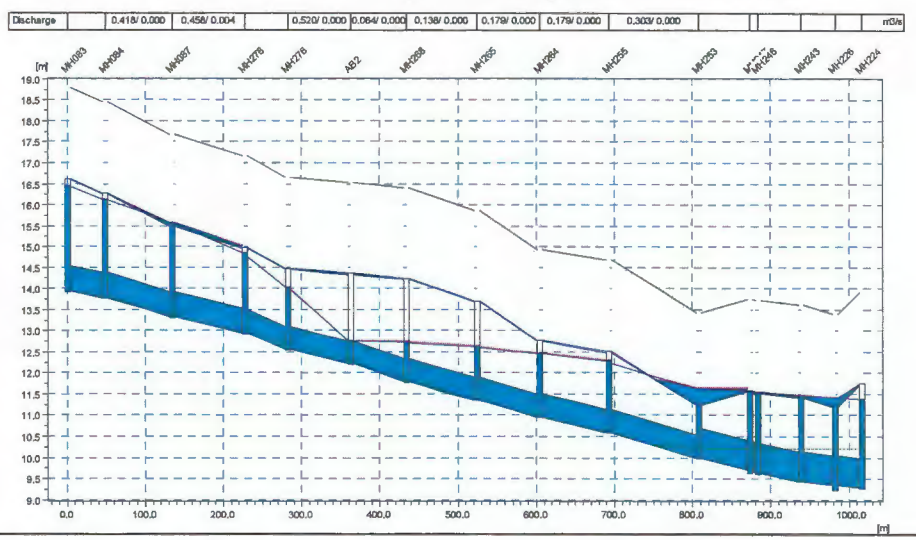
Existing system: 5-year with 5-year river-flood event



Union St upgrade: 5-year with 5-year river-flood event



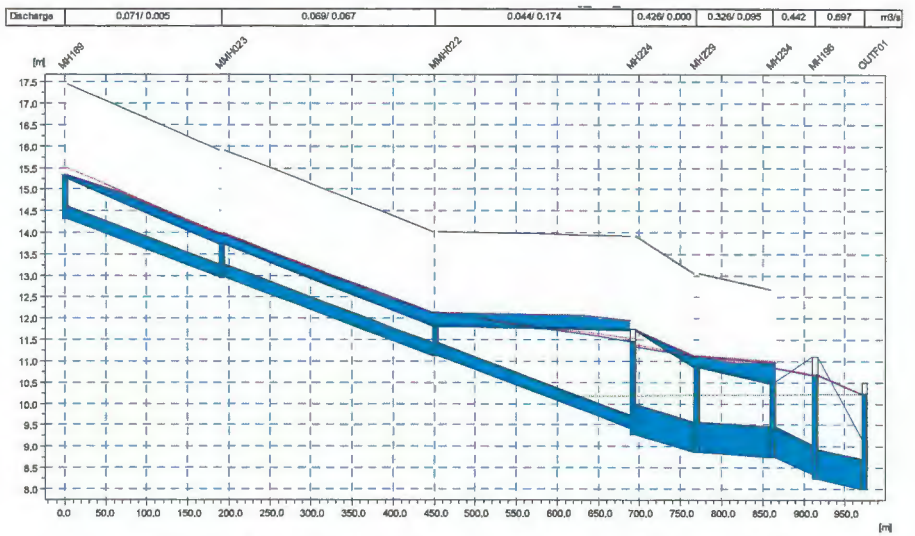
Abercrombie diversion: 5-year with 5-year river-flood event



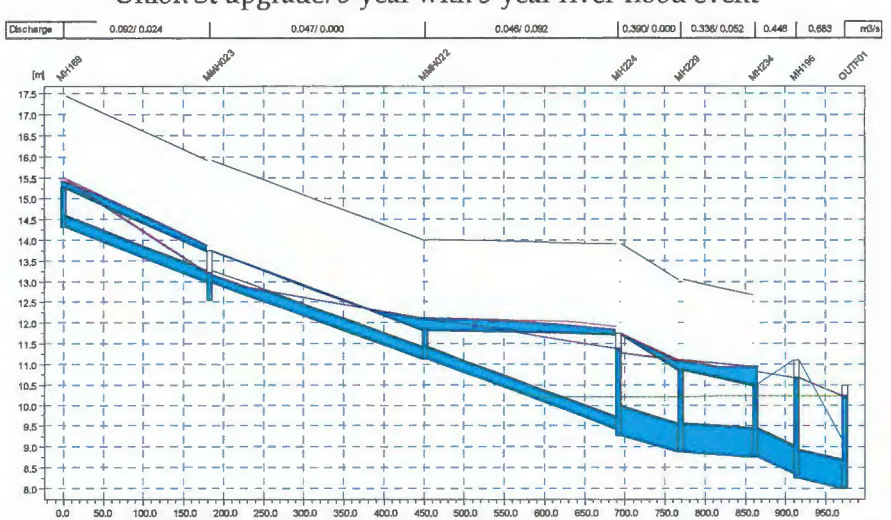
JOHNSON STREET LONG-SECTIONS:

Milton network: Spencer St long-section highlighted green

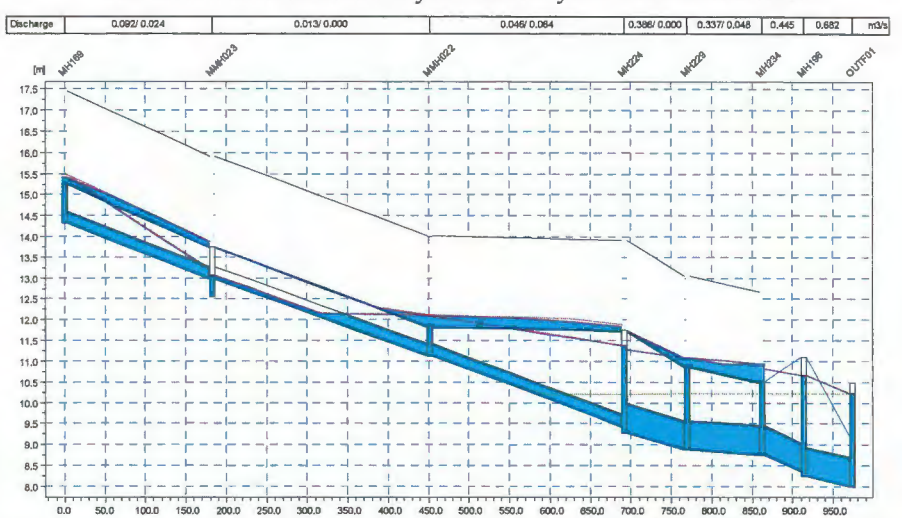
Existing system: 5-year with 5-year river-flood event



Union St upgrade: 5-year with 5-year river-flood event



Abercrombie diversion: 5-year with 5-year river-flood event

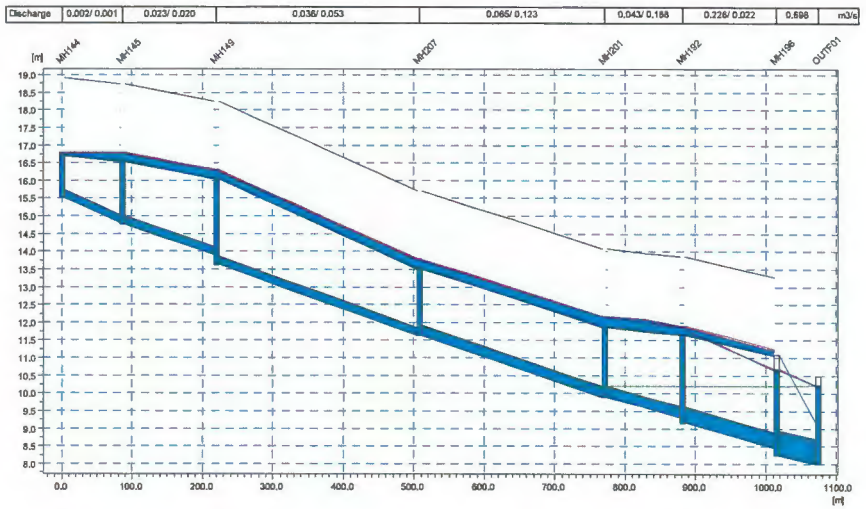


OPUS

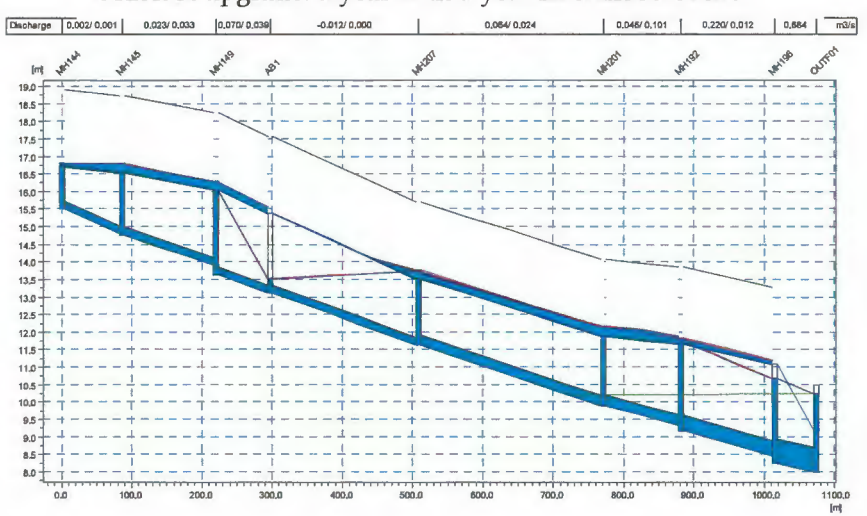
CHAUCER STREET LONG-SECTIONS:

Milton network: Spencer St long-section highlighted green

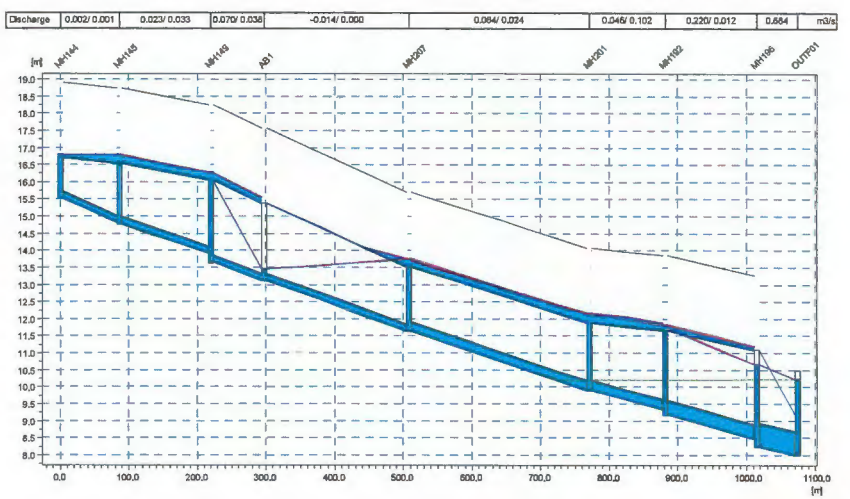
Existing system: 5-year with 5-year river-flood event



Union St upgrade: 5-year with 5-year river-flood event



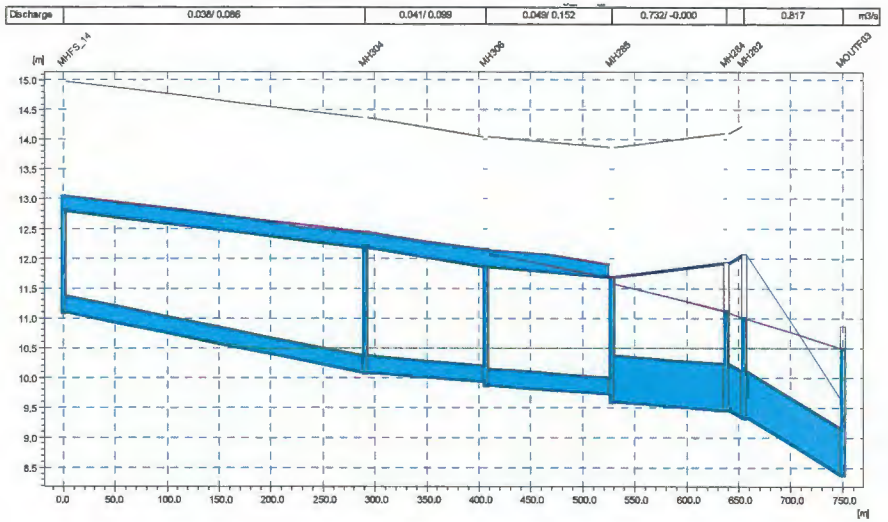
Abercrombie diversion: 5-year with 5-year river-flood event



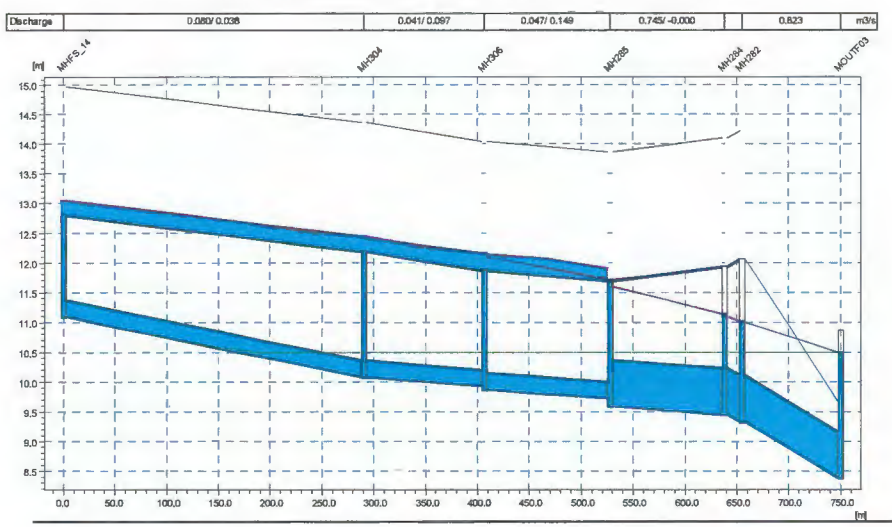
ELDERLEE STREET LONG-SECTIONS:

Milton network: Elderlee St long-section highlighted green

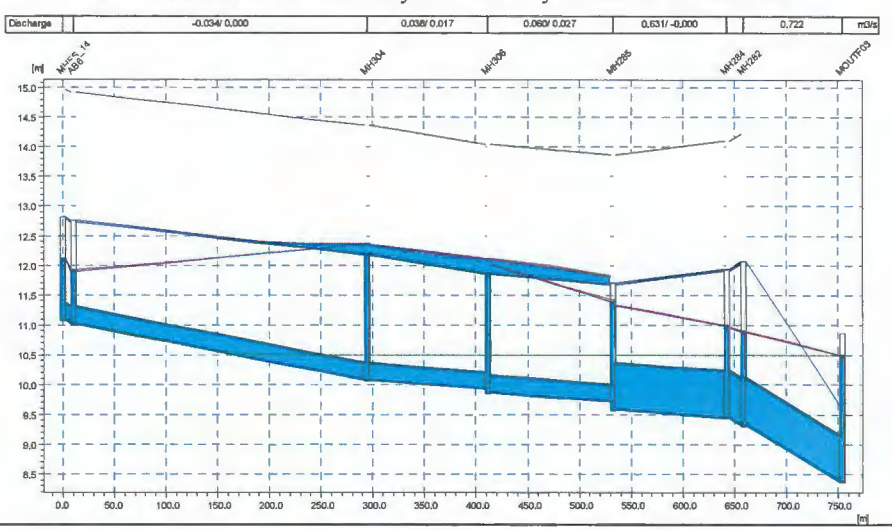
Existing system: 5-year with 5-year river-flood event



Union St upgrade: 5-year with 5-year river-flood event



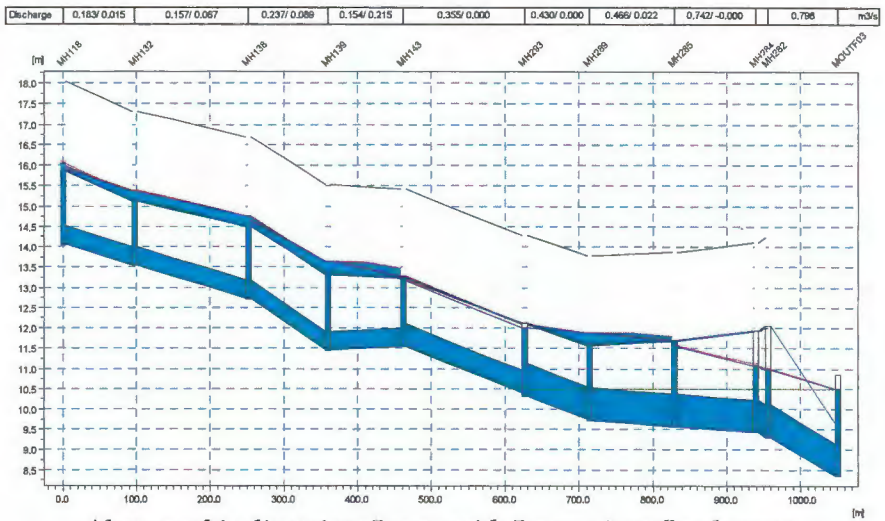
Abercrombie diversion: 5-year with 5-year river-flood event



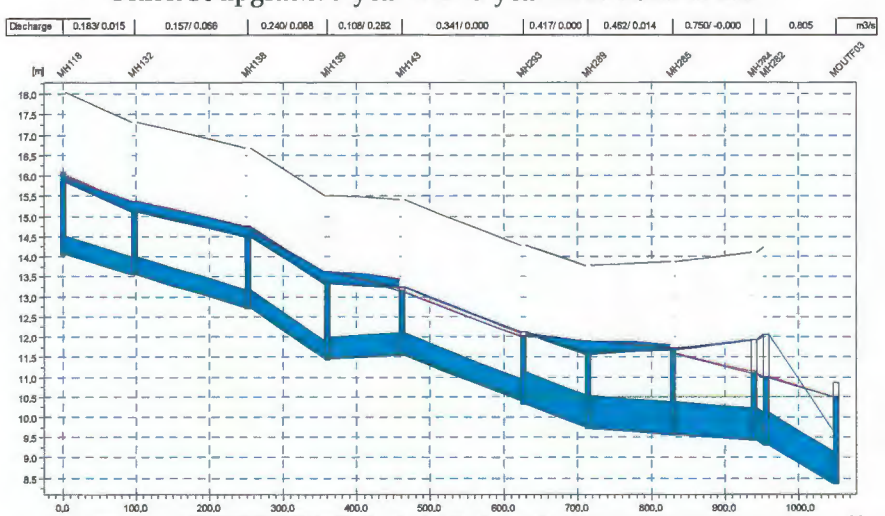
AJAX STREET LONG-SECTIONS:

Milton network: Spencer St long-section highlighted green

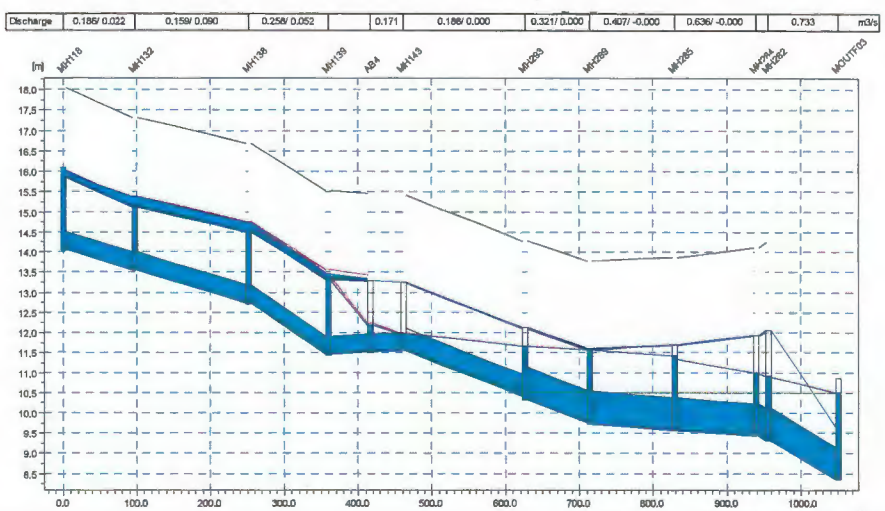
Existing system: 5-year with 5-year river-flood event



Union St upgrade: 5-year with 5-year river-flood event



Abercrombie diversion: 5-year with 5-year river-flood event



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