STORM REPORT

Marine Tavern, Sumner

11 – 13 OCTOBER 2000

Compiled by Ken Couling
City Solutions
Christchurch City Council

2.1

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i **EXECUTIVE SUMMARY**

STORM REPORT: 11 – 13 OCTOBER 2000

Officer responsible Water Services Manager	**Author** Ken Couling, DDI 371-1388
Corporate Plan Output: Utilities Maintenance (Vol II pp 9.3.31-34)	

The purpose of this report is to describe the storm experienced by Christchurch between 11-13 October 2000, to review how the waterways and drainage system coped with the event and to identify further investigations and remedial action to improve the functioning of the waterways and drainage system should another similar storm event occur in future. The report focuses on Christchurch's waterways and drainage system not the City Council's storm emergency response which was the subject of an internal review reported elsewhere.

This agenda item is an executive summary of the technical report which has been separately circulated to Councillors.

THE STORM

Rain began falling about 10pm on Wednesday 11 October over the whole Christchurch area but within a few hours the rain intensity began to increase in the southeast sector of the city. Sustained heavy rain fell for a 12 hour period in the southeast from 3am to 3pm on Thursday 12 October.

The total rainfall depth for the storm increased markedly from approximately 40mm near the airport to 190mm recorded in Bowenvale Valley just below the Summit Road. (See Rainfall Depths map attached.)

The rainfall was accompanied by strong winds from the south. At the airport winds reached gale force by 6am on 12 October with the strongest gust of 106km/hour recorded at 3pm. Maximum wind gusts experienced on the Port Hills and over Banks Peninsula undoubtedly exceeded this recording at the airport.

With the 'epicentre' of the storm over the eastern Port Hills hill waterways discharging into the middle reaches of the Heathcote River (ie Waimea/Eastern Terrace reach) surcharged the middle reach which peaked between 1 – 2pm 12 October. Waimea and Eastern Terraces were impassable for several hours. A number of residents were evacuated as a precautionary measure. The maximum flood level was within 100mm of the lowest house floor levels.

The storm was an extreme event for hill waterways from Bowenvale Valley to Sumner. Elsewhere throughout the City rivers, waterways and the piped drainage system generally satisfactorily. In the Bexley area, the amount of rainfall overwhelmed the capacity of the two stormwater pumping stations discharging to the Avon River. Water ponded on streets up to a maximum depth of about 400mm and on private properties until water levels were gradually drawn down by the pumps.

The highest ever peak discharge of 6 cubic metres/second was recorded at the flume at Bowenvale Valley. Many hill waterways overtopped their banks which caused flooding, debris and sediment deposition on private property. The specific cause of overtopping was generally debris blockages at culvert and pipeline inlets, especially those with inlet gratings. Blockages with serious consequences occurred in Barnett Park, Redcliffs; Nayland Street at Richmond Hill Road, Sumner; and Upper Sumnervale Drive, Sumner. Reports of water entering eight houses in Redcliffs and up to 12 houses and commercial premises in Sumner village resulted from these overflows.

The October storm was an extreme event in terms of wind and rain depth and intensity falling in the southeast sector of the City. The wind generated a lot of debris which was available to block waterways at pipe inlets and gratings resulting in overflows.

SYSTEM OPERATION

Christchurch people awoke on 12 October to a lot of damage to trees on private property and on public streets. Initially the City Council response through its roading contractors in particular concentrated on restoring road access blocked by fallen trees. The drainage contractor responded in accordance with normal wet weather procedures which involve inspection, clearing and monitoring of critical inlet and debris grates throughout the waterways and drainage system. With the exception of hill waterways the waterways and drainage system assisted by normal wet weather procedures by the contractor performed satisfactorily. Even in the Bexley area where prolonged ponding of stormwater occurred the pumps operated as expected throughout the event.

Problems arose in some hill waterway catchments where the contractors normal wet weather resources became overwhelmed by the quantity of debris building up on critical inlet grates resulting in waterway overflows. Procedures for dealing with critical locations are spelt out clearly in the maintenance contract documents. However, by the time it was realised that the problem areas were concentrated in Redcliffs and Sumner and additional men and machinery were diverted from elsewhere by City Care, some significant overflows had already occurred.

It should be noted that many gratings performed well (for example the pipe inlet grating in Basil Place, McCormacks Bay) and men and machinery were on hand at many critical grates successfully clearing debris to avert greater overflows and more serious flood damage (for example the Sumner Flood Relief pipeline inlet grating at Wakefield Avenue from which 3.5 tonnes of debris was removed).

DISCUSSION OF MAJOR ISSUES

Storm Return Period

A stormwater drainage system is designed to a certain standard often expressed as Annual Exceedence Probability (AEP). This is expressed as the probability in percentage terms that an event will be equalled or exceeded in any one year. For example, our stormwater piping system and artificial waterways are designed to a 20% AEP standard on the flat. This means that there is a 1 in 5 chance in any one year that the drainage system will be overtopped. This design event is often called the five year storm. Waterways and pipelines on the Port Hills are designed to a 5% AEP standard, ie a 20 year design storm standard in terms of capacity. However, because steep hill waterways are prone to erosion, slips, blockage etc the effective design standard is similar to on the flat. Under more extreme storm conditions the waterways and drainage system is expected to overtop. Designers should ensure that a safe secondary flow path exists for system overflows where they are likely to occur. The performance of the waterways and drainage system during a storm needs to be judged against the expected design standard of the system.

At the Botanic Gardens rain gauge the October storm was a 25% AEP event (ie four year event) for a duration of 15 hours. The waterways and drainage system is expected to cope effectively with an event of this magnitude or slightly greater and it did except in the southeast. The rainfall recorded at the Bowenvale Avenue flume during the most intense 12-15 hours during the storm is assessed as a 2.5% AEP occurrence (ie 40 year rainfall event). The peak discharge measured was also assessed to have a similar probability of occurrence.

Peak flood discharge along the Waimea/Eastern Terrace reach of the Heathcote River reached approximately 10% AEP (ie 10 year flood) but observed maximum water levels were higher than expected for this discharge. The surcharge caused by the six cubic metres/second peak inflow into the river from Bowenvale Valley and restriction to flow caused by fallen trees across the river downstream are considered the most likely explanations for this circumstance. Storm runoff exceeded the design capacity of the stormwater and drainage system in some catchments in the southeast of the City, especially in hill catchments from Bowenvale to Sumner. Some overflows of sediment and debris laden stormwater must be expected in these circumstances but improvements can be made to inlet structures and storm procedures to reduce the frequency of overflows. This is discussed in following sections.

Inlet Structures on Hill Waterways

The drainage design concept on most of our hill waterways presents some fundamental difficulties for the designer. Steep open channels on the Port Hills convey stormwater at high velocity to a pipe inlet structure located at or about the point of change of grade at the foot of the hills. Stormwater is then conveyed by the outfall pipeline on a flat grade to a river, estuary or sea outlet. Outlets affected by high tide require flapgates or other backflow prevention devices. Fundamental problems with such a system include: bypass and overtopping of the pipeline inlet structure due to bank erosion by high velocity water or debris blockage, sedimentation deposition in the outfall pipeline because of quiescent conditions resulting from flat gradients and submerged outlets during high tide and street flooding during extreme high tides caused by backflow through faulty or obstructed outlet flapgates.

An open waterway extending from the hills to the receiving waters crossed by generously sized culverts and bridges with a generous buffer between the waterway and urban development is a much more effective and reliable design concept. Of course, an outlet gate structure would still be required at outfalls affected by high tide.

This concept should be followed where possible. However, in the common situation where urban development has occurred over existing outfall pipelines satisfactory functioning will be reliant upon well designed inlet structures, well organised storm emergency procedures and the provision of safe secondary flow paths away from critical locations such as pipeline inlet structures. Further investigations and improvements in these three aspects are recommended later in this report. (Refer to Sections 3.1 to 3.5 of the Technical Report for more details.)

Bexley

The two stormwater pumping stations at Bexley located in Waitahi and Wairoa Streets were overwhelmed by storm runoff, however, unlike some previous events both pumps operated throughout the storm without blockage.

Stormwater ponding is inevitable during an extreme storm. Pumping capacity needs to be sufficient to significantly reduce serious flood damage and is considered adequate. Some controlled flood storage capacity has been provided recently in the Waitahi Street catchment by Knights Pond immediately west of the expressway corridor. Wairoa Street catchment would also benefit from some controlled flood storage capacity if a suitable ponding site can be found.

Backflow prevention devices on all pipe outfalls from Bexley to the Avon River should also be checked. (Refer to Section 3.8 of the Technical Report for more details.)

Heathcote River Middle Reaches

According to a flow gauging carried out on the Heathcote River at Buxton Terrace by Environment Canterbury staff at approximately 1pm on 12 October the observed flood water level was approximately 300mm higher than expected for the discharge calculated.

Fallen trees across the river downstream are considered to be the most likely cause for this elevation in flood level, however this conclusion needs to be confirmed by ongoing investigations. Alternative hypotheses are that the river bed level may have risen during the recent years, Environment Canterbury miscalculated the discharge or denser planting on the riverbanks over recent years has increased the 'roughness' of the flood channel.

This issue is being investigated thoroughly because the risk of flood water entering low lying houses along this reach of the river would be increased significantly if this situation is repeated during future major storms. (Refer to Section 3.6 of the Technical Report for more details.)

Operational Procedures

Discussions are ongoing with the drainage contractor to improve our storm emergency procedures related to keeping inlet structures on hill waterways clear of debris. Earlier identification of problem areas and the diversion of additional men and machinery to those locations is the key to a more effective response in future. The collection and dissemination of reliable up-to-date information amongst City Council and contracting personnel is an important ingredient of the improvements to operational procedures under consideration. Discussions are also continuing over whether there should be a role for local wardens.

Operational procedures for opening and closing the gates of the Woolston Tidal Barrage need to be confirmed and communicated to all personnel involved. The circumstances in which the gates should be closed against an incoming tide during an extreme high tide cycle needs to be identified. (Refer to Sections 2.1 and 2.2 of the Technical Report for more details.)

Cost Implications

Some additional costs will be incurred against this years operations budget directly related to the October storm. Additional planning and investigations costs up to approx $50,000 is anticipated. Additional costs for storm response will be payable to the drainage contractor. Some of the storm related cost may be able to be met by under-expenditure in other activities this financial year.

The waterways and drainage system suffered little damage during the October storm which necessitates renewals and replacements. However, many drainage improvements are recommended in this report and recommendations for additional works will result from planning and investigations underway. Fortuitously the catchments where most of the flood damage occurred—Barnett Park/Rifle Range Drain, Redcliffs and Richmond Hill Road waterway, Sumner were already subject to drainage improvement planning and design. Capital works have not begun on either scheme. We now have the opportunity to review both schemes in the light of a volume of information gathered during the October storm. It is hoped that additional capital works recommended can be funded largely by substitution for other projects of lower priority.

FUTURE ACTION

In respect of Christchurch's waterways and drainage system and its planning, design and operation in the light of the October 2000 storm the following actions are proposed:

Planning, Investigation and Design

(a) Debris trapping and pipeline inlet grating design for hill waterways be reviewed and revised design criteria be included in the new Waterways, Wetlands and Drainage Guide.

(b) All critical existing debris traps, inlet structures and grates on hill waterways be audited in terms of the design review above and a prioritised schedule of improvement works be prepared.

(c) The reason for elevated flood levels along the Waimea/Eastern Terrace reach of the Heathcote River be determined by further investigation.

System Operation

(a) Storm emergency procedures (including communication protocol) for critical inlet structures and grates be reviewed. Consideration should be given to what role, if any, suitably experienced local residents should have in keeping critical structures free from blockage and providing early warning of trouble.

(b) The operating procedures for opening and closing the Woolston Tidal Barrage be confirmed and all personnel involved be acquainted with the procedure.

Site Specific Recommendations

(a) Sumner—Sumnervale, Sumner waterway and flood relief pipe:

  (i) The feasibility of installing a debris trap on the Sumner waterway in Sumnervale Reserve be investigated and installed if the results of the investigation are favourable.

  (ii) Investigation into a cost effective technique for removing sediment from the Sumner Flood Relief pipe be continued and reported by June 2001.

(b) Sumner—Richmond Hill Road waterway:

  (i) Stormwater pipelines in the flooded area be inspected for sediment accumulation and methods for sediment removal be investigated if necessary.

  (ii) The planning, investigation and design already underway for joint Richmond Hill Road and waterway improvements include a range of options which will mitigate the flood damage caused by an event similar to the October storm. (Options involving a suite of planning, system operation and maintenance and improvement works to be developed in consultation with the community.)

(c) Redcliffs—Barnett Park and Rifle Range Drain:

  (i) The planning measures and drainage improvements identified in the 1999 report and budgeted for this financial year be implemented.

  (ii) A debris trap on Rifle Range Drain in Barnett Park at or above Bayfield Avenue be investigated and installed if the results of the investigation are favourable.

  (iii) The bunding between the pipeline inlet grating beside the Scout Den in Barnett Park be raised and the secondary flow path from the inlet grating west into Barnett Park carpark be reshaped to reduce the risk of the diversion swale overflowing east into private properties on Wakatu Terrace.

(iv) The feasibility of installing drain plugs in the estuary seawall for private properties opposite Barnett Park be investigated (if the results of the investigation are favourable the City Council should offer to meet a share of the cost of installation).

(d) Other Port Hills catchments:

(i) A debris trap on Bridle Path waterway above Bridle Path Road be investigated and installed if the results of the investigations are favourable.

(ii) A formal secondary flow path be formed between Bridle Path Road and the Heathcote Domain play area.

(iii) Additional trash racks located upstream from the inlet grating on Alderson Avenue be investigated and installed if the results of the investigation are favourable.

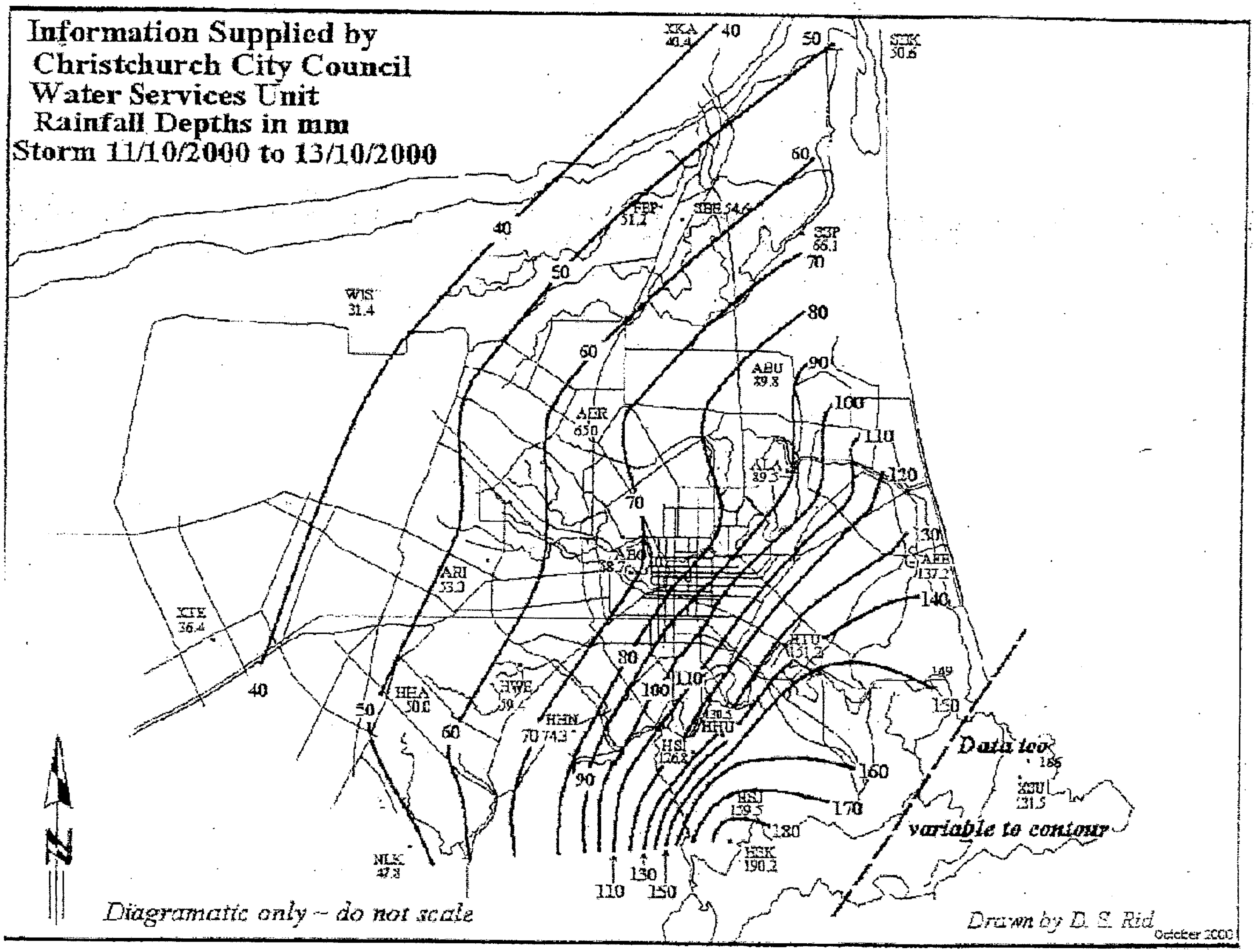
(e) Bexley:

(i) The 225 mm diameter pipeline connecting the Waitaki Street pumping station catchment to the Wairoa Street pumping station catchment along Pages Road be disconnected at its high point to restrict flood overflows from the Waitaki Street catchment ponding in the Wairoa Street catchment.

(ii) The effectiveness of backflow prevention (ie pipe outlet flapgates to the Avon River) be checked and any improvements, including maintenance procedures necessary, carried out. Opportunities for control of ponding within the Wairoa Street pumping station catchment be investigated.

Recommendation: The Parks and Recreation Committee note that some additional operational expenditure which may not be able to be funded by substitution is likely to be incurred this financial year on investigations and emergency response directly related to the October storm. Capital expenditure on improvements necessary in the light of what happened during the storm are likely to be funded by substitution in place of lower priority projects.

Chairman's Recommendation: That the above recommendation be adopted.


Information Supplied by
Christchurch City Council
Water Services Unit
Rainfall Depths in mm
Storm 11/10/2000 to 13/10/2000
Data too
variable to contour
Diagramatic only – do not scale
Drawn by D. S. Rid
October 2000
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
WIS 31.4
ABU 39.8
AER 65.0
ALA 39.5
ARI 53.0
HEA 50.0
HWE 59.4
HHN 74.3
HTU 151.2
HHU
HS 126.8
HSK 190.2
NLK 47.8
AEE 137.2
149

Storm Report: 11-13 October 2000

The Water Services Manager submitted a report describing the storm experienced by Christchurch between 11-13 October 2000, reviewing how the waterways and drainage system coped with the event and identifying further investigations and remedial action to improve the functioning of the waterways and drainage system should another similar storm event occur in future. The report focused on Christchurch's waterways and drainage system not the City Council's storm emergency response which was the subject of an internal review reported elsewhere.

The Committee noted that some additional operational expenditure which may not be able to be funded by substitution is likely to be incurred this financial year on investigations and emergency response directly related to the October storm. Capital expenditure on improvements necessary in the light of what happened during the storm are likely to be funded by substitution in place of lower priority projects.

The Committee **decided:**

1. That the Water Services Manager report back to the Committee on the measures and costs for mitigating the drainage problems in Sumner, Redcliffs and Heathcote.

2. That debris trays be constructed in Barnett Park, located well upstream of the pipeline inlet grating.

3. That the bunding between the pipeline inlet grating and Wakatu Avenue private properties to the east be raised and the secondary flow path from the grating west to the Barnett Park car park be reshaped.

4. That greater inlet capacity be provided to the 1,200mm pipeline in Main Road with good tidal backflow control by way of additional sumps and grates along Main Road.

5. That during significant storm events, a designated team be available to remain in the locality throughout the storm, to clear sump grates, keep the Barnett Park inlet clear, watch for swale overflows and ensure all tidal outlets are clear and working.

6. That the feasibility of installing removable drain plugs in the sea wall for Main Road properties opposite Barnett Park be investigated.

7. That, to assist any future reassessment of flood risk in the area, the survey data received from residents be followed up to better determine final insurance claim costs associated with this storm event.

8. That consideration be given to retaining the services of a local drainlayer to take responsibility for periodic inspections and minor clearing of all inlet grates and grills to estuary outfall piping for the area; especially during high tide and storm events.

Technical Reports

	ABO Return periods												
	1hr	2hr	3hr	4hr	5hr	6hr	9hr	12hr	13hr	14hr	15hr	16hr	17hr
1	1.0												
2	4.1	5.1											
3	3.0	7.1	8.1										
4	2.5	5.5	9.6	10.6									
5	1.5	4.0	7.0	11.1	12.1								
6	2.9	4.4	6.9	9.9	14.0	15.0							
7	3.1	6.0	7.5	10.0	13.0	17.1							
8	3.8	6.9	9.8	11.3	13.8	16.8							
9	4.0	7.8	10.9	13.8	15.3	17.8	25.9						
10	5.5	9.5	13.3	16.4	19.3	20.8	30.4						
11	4.4	9.9	13.9	17.7	20.8	23.7	30.7						
12	5.6	10.0	15.5	19.5	23.3	26.4	33.3	41.4					
13	3.5	9.1	13.5	19.0	23.0	26.8	34.3	43.9	44.9				
14	6.6	10.1	15.7	20.1	25.6	29.6	39.4	46.4	50.5	51.5			
15	4.8	11.4	14.9	20.5	24.9	30.4	41.3	48.2	51.2	55.3	56.3		
16	3.0	7.8	14.4	17.9	23.5	27.9	41.2	48.7	51.2	54.2	58.3	59.3	
17	1.0	4.0	8.8	15.4	18.9	24.5	38.4	48.2	49.7	52.2	55.2	59.3	60.3
Max	6.6	11.4	15.7	20.5	25.6	30.4	41.3	48.7	51.2	55.3	58.3	59.3	60.3
Intensity	6.60	5.70	5.23	5.13	5.12	5.07	4.59	4.06	3.94	3.95	3.89	3.71	3.55
						2	2	2	2	2	2	2	2
						4.72	3.82	3.29	3.16	3.05	2.96	2.87	2.795
						5	5	5	5	5	5	5	5
						6.37	5.32	4.67	4.49	4.33	4.19	4.05	3.935
						0.210101	0.512593	0.556763	0.585309	0.703125	0.753388	0.708686	0.659701
	<2	<2	<2	<2	<2	2.4	3.2	3.3	3.4	3.8	4.0	3.8	3.7

1 HYDRO-METEOROLOGY

Rain began falling about 10:00pm on Wednesday 11 October over the whole Christchurch area, but within a few hours the intensity began to increase in the south-east sector of the city. The Meteorological Office had issued a strong wind warning, but had not predicted extreme rainfall depths. At the airport, winds reached gale force (over 60km/hr) by 6.00am, with gusts to 90km/hr. The strongest winds were during the period from 9.00am to 3.00pm, with the strongest gust of 106km/hr recorded at 3.00pm. The Met Office has advised that there was also heavy rain and high winds out on Banks Peninsula.

During the early hours of Thursday morning, and continuing during the day, high winds caused much tree damage, blocking rivers, streams and roads and bringing down power wires. By 7.30am on 12 October, the rainfall intensities around the Port Hills east of Colombo Street had increased to more than 10mm/hr, and significant runoff was quickly filling the rivers. By that time, the Heathcote River had flooded onto the roadway at Eastern Terrace just below the Bowenvale Avenue bridge, and the rainfall distribution over the city was becoming evident. The city map showing the total rainfall depths during the event demonstrates the marked difference from 40mm in the far north-west to over 150mm in the south-eastern suburbs. This pattern was consistent through the storm event.

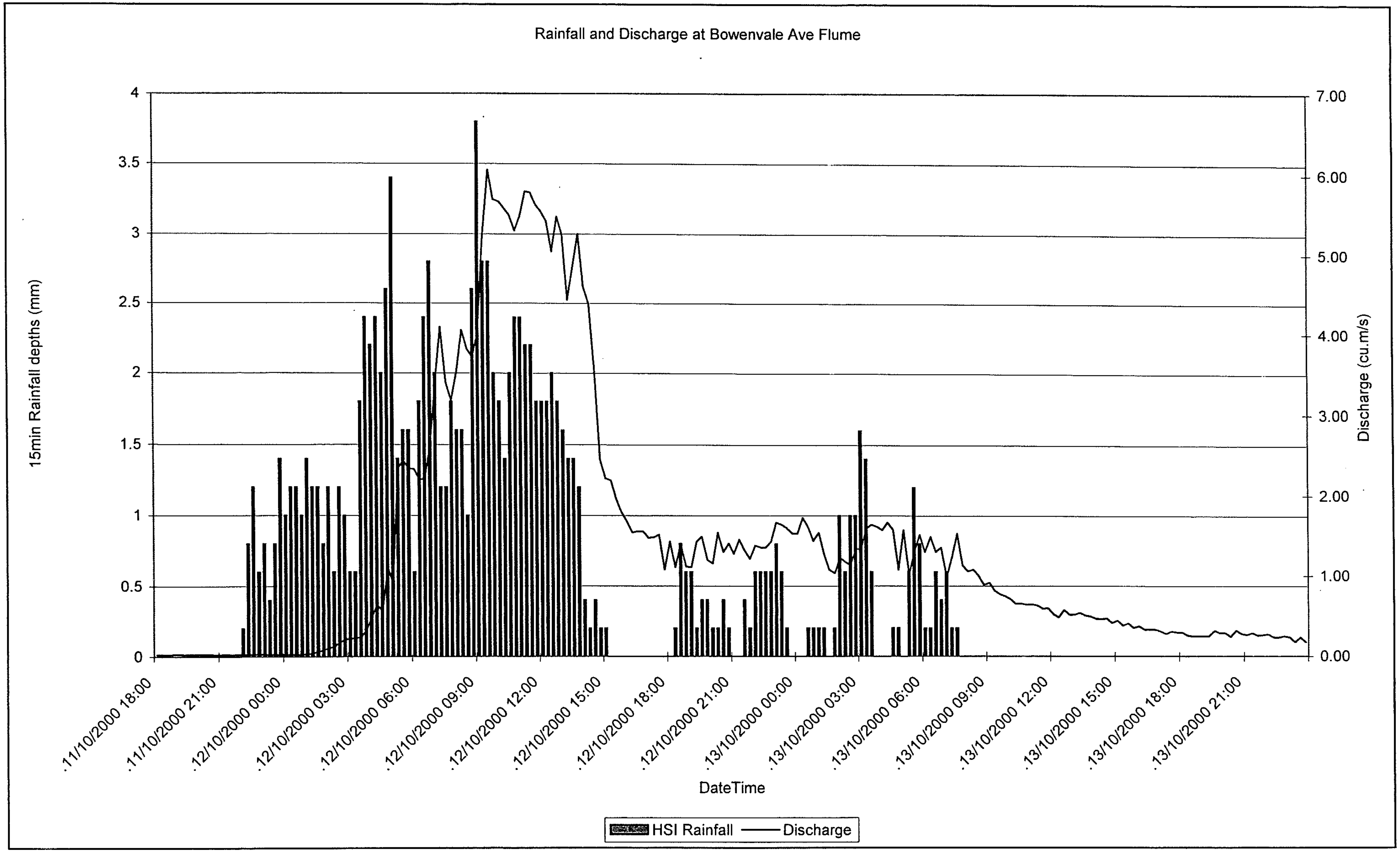
The greatest rainfall depths recorded were in Bowenvale Valley just below the Summit Road, where altitude and the spillover rainfall from Sugarloaf boosted the total to over 190mm. Throughout the suburbs from Huntsbury to Sumner, the rainfall was very heavy, with strong wind effects causing significant differences between adjacent recorders. For this reason, the map does not show depth contouring for this area.

During the rest of Thursday morning, the Heathcote River continued to rise to serious levels, flooding many streets, properties and garages. No reports of water entering houses were recorded.

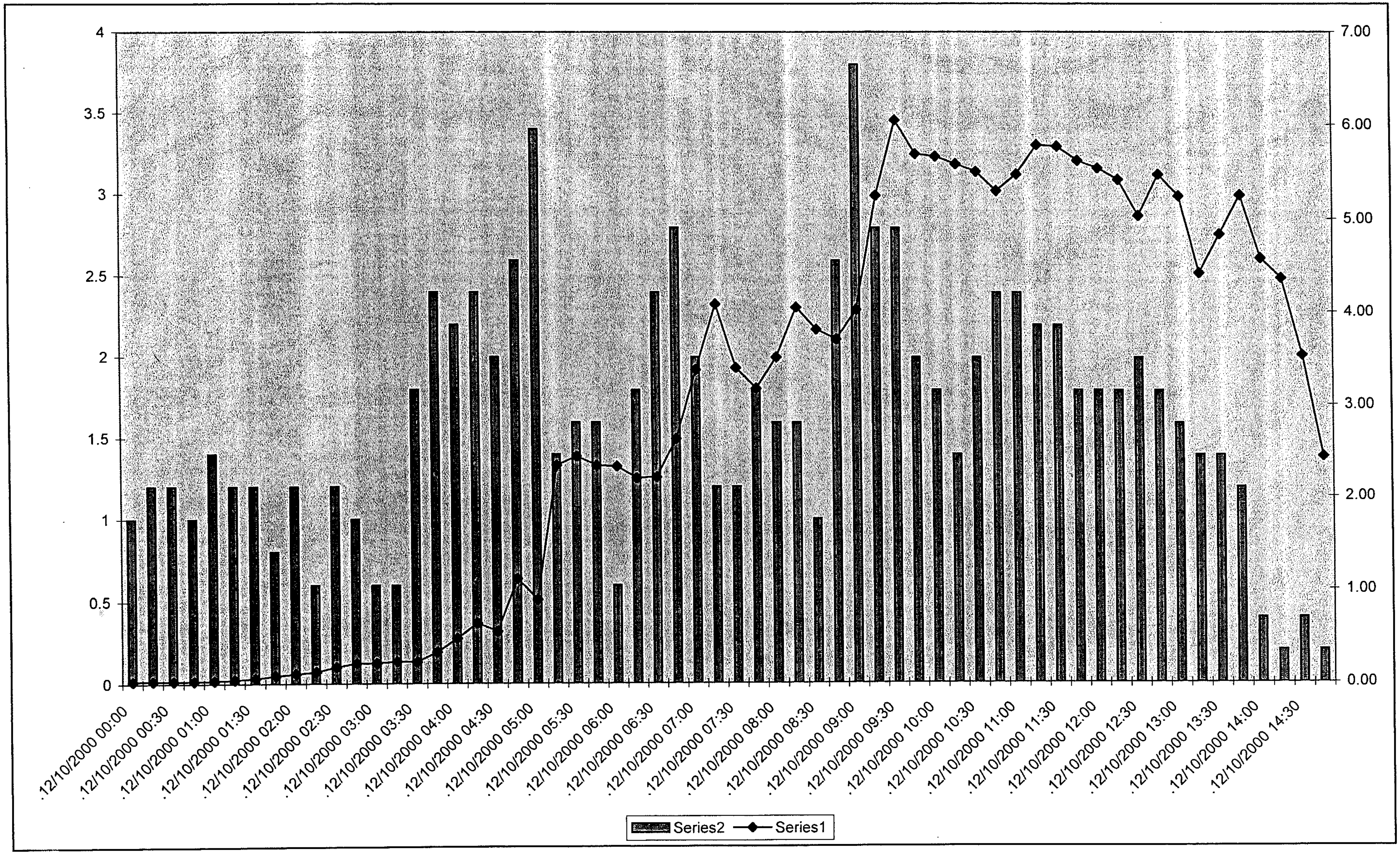
The estimated return period for a rainfall event depends on the duration and the location, and this was especially noticeable in this event. The estimated return period for the maximum 15 hours of heavy rainfall varied from less than four years at Botanic Gardens (see following table) and westward, to approximately 40 years in the southeastern suburbs.

At the recording flume at the head of Bowenvale Avenue, the discharge from the valley responded rapidly to changes in local rainfall, and peaked at 6.0 cu.m/s at 9.30am (see charts 2 and 6 following). The rainfall in Bowenvale eased rapidly over the hour to 2.00pm and the discharge made a similar drop an hour later. Just above the Bowenvale flume, the central gabion of a drop structure was torn out and the rock distributed downstream. However, the sediment trap caught many tonnes of debris.

Sheet1 Chart 2



Sheet2 Chart 6



2 SYSTEM OPERATION

2.1 Waterways and Drainage System

Operations Overview

The waterways and drainage performance were significantly affected by the nature of the storm.

The initial Meteorological warning advised that very strong winds were expected through the Canterbury region. This advice did not suggest that heavy rainfalls were likely. The intensity of rainfall that arrived and location of the storm centre which raised predicted tide levels some 500mm were major factors in the performance of the drainage system

Tree damage from the high winds was a major aspect during the early stage of the storm and the contractors response to this comprised a major portion of their workload throughout the storm. This impacted on the staff resources and influenced the normal waterway wet weather grate clearing operation of City Care. This had major implications for the areas of very high rainfall in the south east region of the City.

Debris Grate Clearance

The significant variation in rainfall across the city – ranging from 31mm to 190 mm over the 36 hour period – was an additional problem for City Care staff involved with the grate clearing work.

The waterway system includes some 270 debris grates which have been prioritised for wet weather clearance into super critical (54), critical (66) and normal rankings (balance). In normal wet weather City Care staff maintain all debris grates with out any difficulty. The tree damage and intensity of rainfall in some areas overwhelmed the available staff resources.

In particular the inlet grates at Sumner, Barnett Park, the Heathcote Valley, and Alderson Avenue were major problems and overflows occurred with water entering some properties.

Stormwater Pumping Station Operations

There were some particular problems with the pumping stations 203 & 204 located in the Bexley area. These areas are subject to separate reports on station performance.

Generally the utility system comprising pumping stations and retention basins performed satisfactorily. However there were some brief periods when pump capacity was exceeded.

The Woolston Barrage which was opened in accordance with the normal storm response early in the storm was closed briefly to try and combat the extreme high tide influence. This action was ineffective and the gates reopened.

Stormwater Reticulation

Problems were experienced with getting water into the pipe systems due to blockage of grate inlets. In some cases pipe capacity was inadequate for the storm intensity and secondary flows occurred. Particular problems areas were the Sumner area and Barnett Park. The high tide level also influenced the ability of some outlets to discharge to high storm flows

Lessons to be learnt

The developing nature of the storm with localised very intense rainfall areas in the south east of the city meant that inadequate staff numbers were available to service the debris grates in those areas. The situation could have been improved by early communication to City Care of the need to increase staff numbers at the problem sites. Better communications within City Care would have assisted the transfer of information from staff who had past knowledge of problem areas to less experienced or newly appointed staff.

During the height of the storm some grates were impossible to clean due to the high water flows and secondary flows eventuated. It is imperative to identify these secondary flow paths and ensure that they are preserved and maintained as required. It should be recognised by designers and the community that there will always be a storm event that overwhelms a drainage system at some time

The design of inlet structures particularly in steep hill catchments needs to be reviewed. In many cases the grates on the pipe inlets are intended to be safety barriers rather than debris traps. In extreme events the grates can become impossible to clear or may pose major danger to staff trying to clear them. An example of a good inlet grate design can be seen at Basil Place at the foot of the Glenstrae water course

2.2 Barrage

The sequence of events at the barrage through the storm was as follows:

Two gates were open for regular clearing of debris on 11/10/00 from 09:10 to 14:15

Four gates were open because of high rainfall on 12/10/00 from 07:40 to 14:45

Pages Road staff were instructed to close the gates to stop the rising tide raising upstream levels. At about 15:15 on 12/10/00 it was noticed on the SCADA that the gates were closed and the upstream level was about 370mm greater than the downstream level. One of the Pages Road staff relayed this information to Civic Offices. After the level differential information was digested, the instruction was given to open the gates again.

The gates were open from 15:45 on 12/10/00 until 16:00 on 13/10/00 after the trusty pumping station 20 High Water alarm disappeared at 14:42 on 13/10/00.

Pumping station 20 High Water alarm was from 06:24 on 12/10/00 to 14:42 on 13/10/00.

The level differential never rose above about 370mm that Alan Beard noticed so the 600mm mentioned by a diligent resident (Douglas Royds) seems excessive. Alan Beard drove around Richardson Terrace and then to the Barrage at 18:00 on the 12/10/00. The river was high and flowing fast. The estimated velocity through the Barrage was about 1 m/s. The level on the staff was RL9.4 m.

It is apparent that those directing the gate opening and closing from Civic Offices need to have a better understanding of their intended flood operation in an event like this one. It also appears that a copy of the Barrage Operation and Maintenance manual was not to hand. This includes pages on flood operation and emergency operation. Because the Woolston Loop remains open all the time the barrage has limited ability to shut out tides except under extreme tides with low river flow. It is intended that this situation be better defined and incorporated into an updated manual. It is also recommended that a copy of this manual be kept on line for easier reference.

2.3 City Streets

The purpose of this report is to outline the effects that the 12 October storm had on the City Streets assets.

On 12 October 2000 strong winds and heavy rain hit Christchurch. By 9.00am it was obvious that this was a major storm and the Water Services/City Street Minor Emergency Room and procedures were put in place. Within a very short time this was escalated and the operations room was sent up in the form set out in the Civil Defence Manual. There were approximately 30 staff from the City Streets Unit involved in two shifts between 9.00am and 8.00pm This number was made up of 12 field staff and 18 office staff.

Minor surface flooding was city-wide, with intensive flooding around the Heathcote River and Sumner area (as the rainfall chart show) and flooding in the Brighton (tidal) area. The flooding of the streets was mainly due to the drainage systems being full to capacity, drains being blocked by fallen trees or minor slips. City Streets contractors were kept busy mainly investigating flooding inquires by the public, assisting the public, ensuring site of fallen trees are safe to the public, providing feedback to the Control Room on conditions, clearing slips and closing roads.

Major cleanup after the storm was mostly the clearing of trees and stumps removal of silt and debris from streets, footpaths and sumps. Structural damage to City Streets assets was very limited with only one major retaining wall failure (dry stone wall on Evans Pass Road).

Investigation into the replacement of this wall has been extended to include the drainage system on Evan Pass Road as the failure of these channels and culvert lead to the collapse of the wall and extensive flooding in Sumnervale Drive.

The cost of the storm for the City Streets Unit is approximately $550,000. This is made up of $210,000 of emergency responds on the Thursday, Friday and Saturday (including $100,000 cost incurred by the Parks Unit in attending fallen trees on behalf of City Streets). $340,000 clean-up costs including $100,000 Evans Pass drainage improvement and rebuilding of the retaining wall, $100,000 for clearing of trees from Scarborough Road, Mt Pleasant Road and Dyers Pass Road (Parks Unit) and $140,000 general clean-up of silt and debris from channel footpaths, carrageways and from sumps.

3 CATCHMENT FLOODING REPORTS

3.1 Sumner—Sumnervale, Sumner Waterway and Flood Relief Pipe

Description

Sumner experienced rainfall[1] averaging 7.5 mm/hour between 5 am and 1 pm on 12 October 2000. 90mm fell during this time. The rainfall then halved until 3pm and then essentially stopped for 4-5 hours, allowing flooding to abate.

Hillside runoff increased until about 2pm, bringing down quantities of silt and rubble apparently more often washed from hillsides than derived from slips. Water and debris decreased with decreasing rainfall after 2pm.

In the early morning

- City Care were called by the Police to clear a blockage in the outlet from the silt trap at the foot of the Edwin Moulders Track. Water had covered Heberden Avenue.

By mid morning

- A catch pit at the junction of Heberden Avenue and Arnold Street had blocked with rubble sending water across the road and into number 36A Heberden Avenue 1-2 cm above floor level. A wall on the property prevented drainage into the Sumner Stream.
- The access culvert into Sumnervale Reserve at the head of Lower Sumnervale Drive was partially blocked with scrub, sending water down Lower Sumnervale Drive. The water was across the road crown on flatter portions of the road. This water flowed down Wakefield Avenue and through private property to pond on Van Asch Street.
- Water from Evans Pass Road, unable to enter blocked entry points, gathered in the channel and was diverted over the bank by slips in the water table. The water ran through through Upper Sumnervale Drive properties but did not enter houses. It was eventually redirected by sandbagging during the latter part of the afternoon.
- Much of the water arriving at the foot of Evans Pass Road made its way down Wakefield Avenue.
- The Sumner Stream upstream of Wakefield Avenue carried a flow which never exceeded the capacity of the Sumner Flood Relief Pipe, although it nearly overflowed before noon due to partial blockage of the debris grate. This was cleared by City Care and some 3.5 tonnes of debris were removed.

After noon

- The Sumner Stream peaked at around 4pm. This drain was a little over-full and entered properties. Number 38 Heberden Avenue is particularly low lying and its occupants evacuated with flood water rising to verandah level. Water rose to 90mm below floor level. The 36A Heberden Ave house was flooded, but from hillside runoff, not from the drain.
- No 3 Clark Street was flooded by water flowing down the road, and no. 57 Arnold Street is reported to have been similarly flooded.

[1] measured at the Sumner gauge

- The Sumner Stream was gauged throughout the day by NIWA: its rating curve was updated and peak flow was reliably established. NIWA judged that flows were not influenced by tides.

The State of the Drains

After the event I made a brief investigation of the prior state of the main drainage paths, the Sumner Stream and the Sumner Flood Relief Pipe (SFRP). Of particular interest was the possibility that alleged sedimentation had reduced drain capacity and exacerbated flooding.

The SFR Pipe did not surcharge. Its very large inlet grate almost blocked, mostly with uprooted grasses, but an overflow was averted by City Care. The pipe is holding sediment, quite a lot of which was deposited during the storm.

The Sumner Stream does not appear to have been significantly restricted by sediment. Staff report that the drain is regularly inspected and cleaned and that channel changes over the last ten years have not been significant.

Conclusions

My observations on the day, supported by information gathered since, suggest that the drainage system coped adequately with the storm although water was in places hindered from entering the system because of unusual amounts of debris. Water that could not be trapped by sumps accumulated on roads, and was particularly noticeable on Van Asch Street. The Sumner Stream downstream of Van Asch College did not quite have the capacity to carry the discharge and water accumulated on properties although it did not flood houses. The Sumner Stream could function better as a secondary flow path if it were not so constricted by culvert headwalls, fences, private retaining walls and other restrictions within private properties. Hillside runoff will always bring down sufficient sediment and vegetation to overwhelm normal sized traps. The obvious remedy would be to provide space for flood ponding and secondary flow paths, and introduce vegetative barriers to trap debris. The proximity of houses to the hillsides and watercourses would, however, make this concept extremely difficult to implement.

3.2 Technical Report Summary: Lower Richmond Hill Catchment

What Happened

During the 12 October storm, some of Nayland Street, Wakefield Avenue and Marriner Street area experienced flooding. Several houses and commercial properties had floodwaters enter above floor level. Confirmation surveys have yet to be completed, but early indications are that about ten properties had water at or above floor level. Structural flooding ranged from minor seepage just above floorboards to over 100mm above floor level.

The floodwaters came from the Richmond Hill Catchment. This approximate 110ha catchment has most of its surface waters concentrated and collected by an open channel. The stormwater for the last 300m from an Intake at 12 Nayland St is discharged to a sea outlet by Cave Rock via a 1350mm pipeline.

This catchment has three main ‘pinch' points/ trouble spots.

There is a grate at the uphill side of the culvert under the Richmond Hill Road hairpin, about 300m upstream of the 12 Nayland Street Intake. This grate is prone to blocking. Any overflow would flow down Richmond Hill Road towards Nayland Street where it will have difficulty entering the open waterway or Intake structure. Any blockage event at the grate has the likelihood of causing a similar flooding event to the 12 October storm assuming a similar intensity storm. Fortunately this grate performed adequately during this particular storm.

12 Nayland Street's Intake grate at the transition from the open waterway to the 1350mm pipe is small, difficult to access and prone to blockage. Substantial quantities of stormwater did bypass and overflow from this grate between about 7:30am on 12 October and 2.30am on 13 October.

Stormwater overflowed from the 12 Nayland Street intake because of a suspected combination of partial/substantial grate blockage and high intensity flows possibly greater than the pipe capacity. This and having no acceptable secondary flow path was the major cause of the flooding shown on the plan. Other contributing factors include lost pipe capacity from the stormwater's heavy silt and debris content and higher than normal tidal events.

By Cave Rock, the 1350mm outlet has a flapvalve prone to sand blockage. Sand levels have varied by about 2m over the last decade and 3m over the last few decades. Before the flap valve was installed, turbulent seas used to wash large rocks from the erosion protection works up the pipeline causing blockages. The flapvalve has recently been fitted with a waterjet to remove sand from the downstream side. This flapvalve appears to have functioned adequately during the 12 October storm event but any unobserved gate resistance would have reduced the pipeline capacity.

Because of the high intensity winds, this storm event blew a lot of wind blown debris into the waterways where much of it was carried into the grates. It appears as if the drainage maintenance crew was under resourced, having to deal with several critical areas during the storm in difficult dangerous conditions. The central city experienced much less rainfall; this may have contributed to what the Sumner Police considered a delayed response from Council staff.

The two nearby rain gauges in Woolston and Sumner village recorded different intensity data.

Based on the Botanic Gardens Rainfall figures:

Woolston gauge recorded approximately 50year rainfall events for a 12.5 hour period from 2.30am on 12 October, and the
Sumner Gauge recorded a 15year rainfall event for a 19-hour return period from 9pm on 11 October, although this period contained a more intense 13 hour 30year event.

Provisional adjustments to local catchment variations by Water Services Unit indicate generally a 40 year event at Woolston. Given the wide range in storm intensity recorded and the likely range even within the Richmond Hill Catchment's storm intensity from sea level to the top of the catchment, it is difficult to give a conclusive storm return period.

Computer 'Mouse modelling' of the rainfall event is yet to be completed, but this will give a better idea of what length of time the 1350mm pipeline was under capacity.

It is fortunate the flooding did not cause further damage e.g. a 50 car basement car park could have easily flooded also with minor additional sump blockage.

Suggested Remedial Action

Further Survey works are being undertaken to assess the extent of the flooding. Once this data is transferred to the plans, it will be easier to confirm what further investigations are necessary. Investigations on ways to improve the three identified trouble areas are likely to be needed. As well as further investigations, the community desires and other Council Units desires will affect what drainage works are undertaken in the near future. There are already plans to involve the Community in a combined City Streets and Water Services initiative for lower Richmond Hill Road, Nayland Street and Wakefield Avenue streetworks with the first meeting planned for the end of November. The outcome of Parks Unit initiatives to have better surfing in the area will substantially impact on the effectiveness of several of the Sumner Outfalls.

Likely additional drainage Capital Works may involve:

(a) Improving, shifting and enlarging the 12 Nayland Street intake grate or relocating in combination with extending the 1350mm pipe upstream and flap valves on all sidelines.
(b) Large diameter pipes down Nayland Street towards Wakefield with several large sumps for secondary flow capture. Subject to computer modelling, there may be a case made to extend this pipeline to the 750mm Hardwicke St main.
(c) Improving and/or extending the 1350mm pipe Outlet in conjunction with an improved gate and gate/beach access.
(d) Better secondary flow provision at the Richmond Hill hairpin grate possibly combined with a dual purpose public access under the road and/or road reshaping.
(e) Extensive planting works in any public land the upper rural valley.
(f) Allocating/purchasing an area of land for debris capture near the intake in conjunction with stabilising the channel bed and some of the catchment area. 12 Nayland Street and/or the Bowling Club properties should be considered.
(g) Additional sumps/flap valves outside 22 Marriner Street.

Until works are finalised and prioritised, estimates can not be made but desired long-term works are likely to cost in the order of over a million dollars and involve substantial consultation time.

In the meantime other actions needed include:

- Improving flood data transfer via either SCADA or digital cameras at trouble spots. Having data accessible from the internet would help give flood
- Ensuring minimum dwelling floor levels of 12.0m are enforced in the block bounded by Nayland Street, Marriner Street and Wakefield Avenue
- Sharing flood contingency plan information with local police/fire brigade
- Remove recently deposited silt from the 1350mm pipe etc before it hardens
- Communicating with manager of large Marriner/Esplanade apartment block on the risk of flood waters entering the large basement garage
- Ensuring City Care/Water Services Unit flood response systems are practised and
- Ensure sufficient specialist flood control City Care resources are allocated during floods


RICHMOND HILL WATERWAY FLOODING (12/10/2000)
PLAN
1:1000 (for A1 sheet)
12 Oct. 2000 Predicted High Tide 10.0m, Actual High Tide 10.4m
Predicted Low Tide 8.3m
No 1
No 2
Marriner St near Richmond Hill walkway ~ 1pm 12Oct00
No 3
No 4
No 5
No 6
No 7
No 8
OVERVIEW OF FLOODED AREA
13/10/2000 (One day after storm)
South Pacific Ocean
Sea ROW
ESPLANADE
MARRINER STREET
NAYLAND STREET
BURGESS STREET
WAKEFIELD
AVENUE
STOKE STREET
HARDWICKE STREET
WIGGINS STREET
RICHMOND HILL ROAD
RICHMOND HILL OPEN WATERWAY
THE ZIG ZAG TRACK
ARANONI
CAVE ROCK OUTLET
HIGH TIDE LINE TAKEN FROM AERIAL PHOTOS DATED 1990 + OR - 5 METRES
WL 11.80
WL 11.85
WL 11.90
WL 12.05
WL 11.92
WL 11.88
WL 11.68
WL 11.55
WL 11.56
WL 11.82
WL 11.70
WL 11.51
WL 11.62
WL 11.38
Intake
LEGEND
HOUSE FLOOR LEVEL
GARAGE FLOOR LEVEL
GROUND/KERB LEVEL
CENTRE OF THE ROAD LEVEL
INVERT LEVEL OF ROAD CHANNEL
STORMWATER PIPE
REPORTED HOUSE/COMMERCIAL PROPERTY FLOOR LEVEL FLOODED
FLOOR SAVED BY SANDBAGGING
ESTIMATED BEST MAXIMUM FLOOD LIMIT FROM AVAILABLE DATA
NUMBER & DIRECTION OF PHOTOGRAPH TAKEN
PENDING STREET WORKS 2001
NOTES :
1. Plan only shows major flooding associated with the Richmond hill waterway overflow.
2. Not all properties have an up to date dwelling profile shown. Some house numbers may not be correct.
3. High water mark information and 'house floor level flooded' data assessed November and December 2000.
4. 1977 flood recorded rl 11.6m in Marriner street.
Date 14/12/00
File Number DG007701
Drawing & Project Number 22490/03 sht. 1

- Ensure drainage advisers are in the field during heavy storm events and have the authority to direct City Care priorities and maintenance operations

3.3 Redcliffs—Barnett Park and Rifle Range Drain

Background

A detailed investigation has recently been completed for the Water Services Unit, "Rifle Range Catchment Flood Relief Investigation" which provides a sound basis for analysing the 11-13 October 2000 storm event.

Redcliff properties in Wakatu Avenue, Bayview Road, and Main Road, which lie within the 314 hectare Rifle Range catchment, suffer from periodic surface flooding. This is due to much of the area being within a low-lying basin, which in places is lower than regular annual occurrence high tide events. Flooding over this area arises from tidal backflow, and secondary overflows from the Rifle Range Drain Diversion within Barnett Park.

The capacity of the existing primary drainage system provides up to a five year return period level of service, but its performance is dependent on tide level. Because of the size, topography, shape and nature of the catchment, there are two critical storm event durations for any particular return period. The short duration, high-intensity storm is critical for the lower lying 12 hectare residential subcatchment. More extensive, area wide flooding however comes from the longer duration, lower intensity storm events, where saturated rural hillside contributes considerable runoff to the low- lying residential zone.

Rainfall 11–13 October 2000

Data from two rainfall recording stations was analysed for the period 11-13 October; Tunnel Road (HTU) and Sumner (XSU).

The rainfall event over the full 30 hour plus storm period equates to a return period event in excess of 30 years. Hydrological modelling of the Barnett Park subcatchment of Rifle Range Drain suggests the critical storm duration for this catchment is between 4.5 and 8 hours.

Considering both sets of rainfall data and selecting the highest intensity 4.5 hour rainfall period within the 30 hour storm it can be concluded:

- from the Sumner record a design storm equivalent to a 4 to 5 year return period with about 30mm of rainfall falling over the 4.5 hours

- the Tunnel Road record gives 50mm of rain fall, equivalent to a 10 year return period design storm

This critical 4.5 hour period of rain did however follow some 7-8 hours of lower intensity rainfall. This would have resulted in saturated soils over the catchment prior to the critical 4.5 hour period which would likely have increased runoff. Allowing an increase in design flows of 20% because of the antecedent rainfall, it is probable we had a 5 to 10 year return period flood event during the storm.

The higher intensity rainfall, up to 8.5mm per hour, at Sumner fell over pretty much a continuous 9 hour period. Peak flows at Main Road Redcliffs would therefore have occurred during the period from about 5am to 2pm on Thursday 12 October 2000.

A more definitive answer to what return period of flooding actually occurred would require modelling of the catchment using actual rainfall data.

Tide Cycle

On Thursday 12 October 2000, high tides peaked at around 5am and 5pm. This is fortunate in that most of the peak storm flow period identified above, would have occurred over a falling or low tide cycle.

Field Observations and Resident Survey

Returns

To help confirm and expand the observations made by Council staff over 12 October, a survey questionnaire was sent to more than 200 Redcliff properties. There have been 74 replies received to date. From the comments offered, the majority of respondents felt that the main contributing factor to the flooding was due to blockage of drain grates, both to the culvert in Barnett Park and storm water drains on the roads around the park (especially Main Road, Wakatu Avenue and Bay View Road).

Most respondents felt that better monitoring and maintenance (removal of debris from drains) of the storm water system would be more beneficial than an upgrade of the systems capacity. This is highlighted by several comments that the floodwaters receded after the drain entrances were cleared, especially in Barnett Park, and that Council workers should have concentrated on this rather than sandbagging properties.

Many respondents referred to an earlier proposal to construct retention ponds at the head on Barnet Park and felt that this would be a good idea.

Some respondents highlighted areas that were prone to flooding during "reasonable" rainfall. In particular the drain near the corner of Main and Bay View roads, and properties on the Estuary side of Main Road where flood water could not get away from behind the sea wall.

Observations on flooding period, flood levels, estimated costs to residents etc, are tabulated in the attached table.

Whilst flooding was first noticed by residents from as early as 6:30am, typically most considered "real" flooding occurred in the late morning, early afternoon.

Estimates of when flood waters receded are typically mid afternoon, after the Barnett Park grate has cleared. This was also a period when the rainfall intensity decreased significantly (down to just 1 to 2mm per hour from 7.5mm per hour).

Telephone conversations with locals confirm their collective assessment that there did not appear to be a capacity problem in the existing system. Flooding was in their view caused by blockage. Indeed the action of several locals in clearing blocked sumps etc during the storm is to be commended.

Maintenance staff reported being called to Barnet Park at 1pm on 12 October and worked with locals to clear the swale overflow grate of an estimated one cubic metre of tussocks, grass, gorse, branches etc.

Extended Flooding

From the survey returns, we have estimated floodwaters could have got as high as between RL 10.9m to 11m at Main Road Redcliffs. At RL 11m, it could be expected that 11 houses and 42 garages in the Main Road Wakautu and Bay View Road area might have floodwaters at or over floor levels (ignoring any wave action from passing vehicles). At RL 10.9m three houses and 36 garages might be affected. Respondents to the survey indicate that flood water entered 8 houses and 24 garages.

Elsewhere along the Rifle Range Drain sections were flooded. Apart from the low lying properties off Wakatu Avenue near Main Road most other Wakatu Avenue properties fared well because the Barnett swale did not overflow along its length except at the blocked grating. Some overflow did however occur at the Rifle Range/Swale junction at the top of Bay View Road.

Another "flood prone" area, Cliff Street, appears to has escaped any significant flooding because peak flood flows were typically coincident with low tide levels.

The estimated flooding costs given by respondents is somewhere between $22,500 and $49,000. Referring to the Catchment Investigation flood costs from such an event would put the cost at about $185,500 (based on the work of "Armstrong D 1982: Some Depth Damage Relationships for the April 1981 Flood in Paeroa, New Zealand") Recent Depth/Damage Relationship Costing for the Heathcote River Flood.

As some residents described the 'in-house' flooding as marginal, the Paeroa based costs may be a little conservative. It will be worthwhile following up on 'final costs' by getting back to residents who experienced "in house" flooding and confirming their costs.

The RL 10.9m to RL 11.0m flood level is typical of what would be expected from a 10 year return period long duration storm flood event occurring during a lower tide cycle, with the existing drainage system operating to capacity. Further the topographic level of this part of Redcliffs is such that flooding would likely only get 100mm or so (RL 11.1m) higher, even with more extreme events. At that point, secondary drainage paths to the Estuary become available.

Capacity of the Existing Storm Drainage System

Hydraulic assessment of the Rifle Range Drainage System, including the Barnett Park Swale, suggests a combined capacity of 2.5 to 3.7 m^3/s dependant on tide level (some 2 to 2.9 m^3/sec being carried by the Barnett Park Swale). Peak 5 year return period flows are calculated to be 3.7m^3/s for a critical 4.5 hour duration storm.

Observations and estimates of flow in the swale at about 2:30 to 3pm on 12 October 2000 would put the flow at 1.7 m^3/s to 2.5 m^3/s. This is within the swale's capacity and consistent with what could be expected under 5 year Return Period flows. These flow rates are however close to the pipe outfall's capacity. Inspection of the 1,200mm pipe outfall from Barnett Park has shown the pipeline to be clear of any significant situation. Further, tide levels were low during the peak flooding period. This would suggest therefore that the flooding experienced came primarily from blockage of the Barnett Park pipeline inlet. That blockage was compounded by the huge volume of wind blown debris produced during the storm.

Budgeted Works

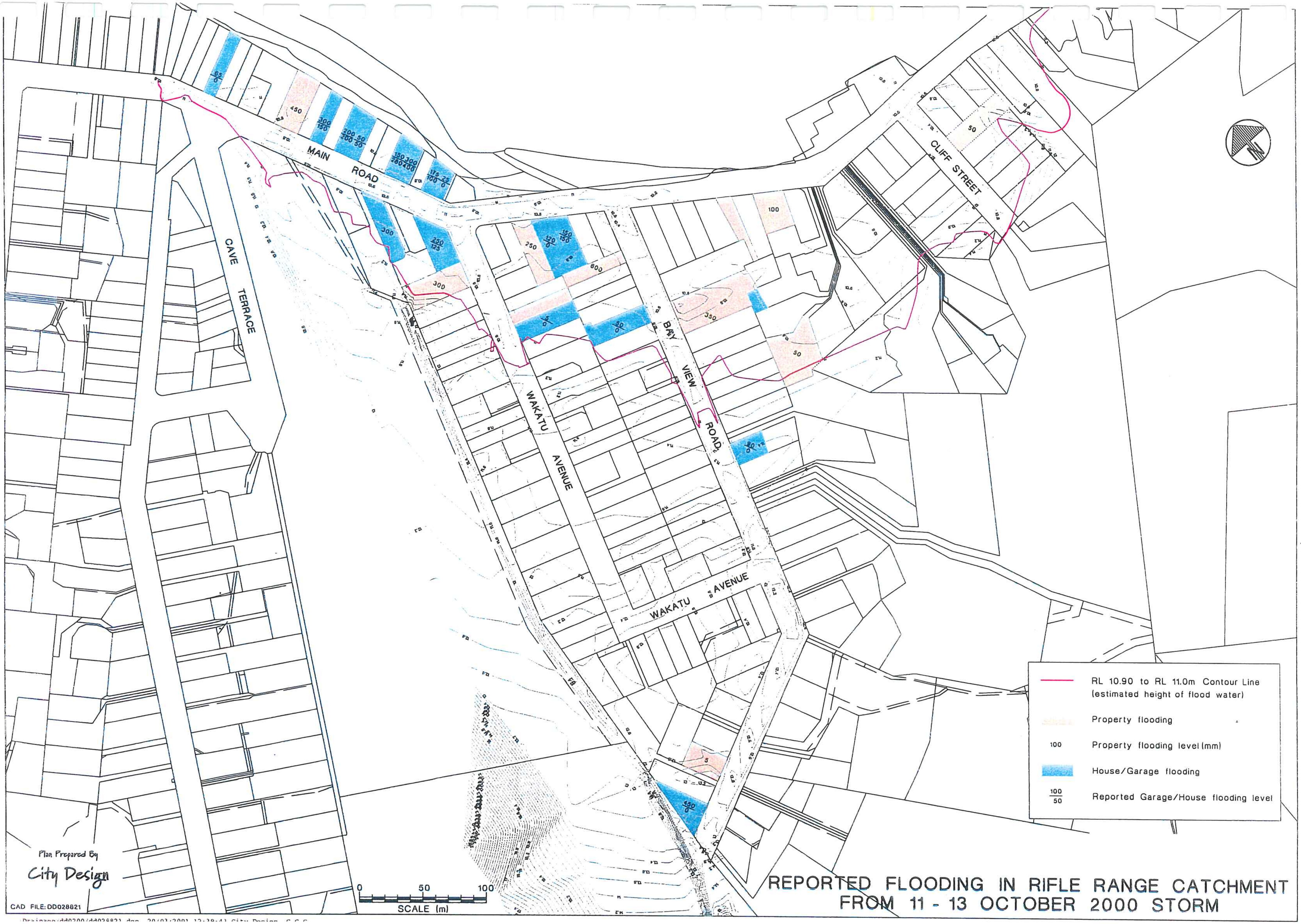
Drainage improvement works recommended in the 1999 report to the Council are included in the 2000/01 budget. These works will:

- Improve the Rifle Range/Barnett Park Swale junction, including the raising of embankments
- Add additional sump inlet capacity to the 1,200mm pipeline, at the Barnett Park/Main Road boundary, to improve capture of overflow from the inlet
- Improve tidal control at Cliff Street.

Recommendations

The current works proposed should be proceeded with. Additional recommendations are:

- Investigate construction of a debris trays in Barnett Park located well upsteam of the pipeline inlet grating
- Raise the bunding between the pipeline inlet grating and Wakatu Avenue private properties to the east and reshape the secondary flow path from the grating west to the Barnett Park car park
- Provide even greater inlet capacity to the 1,200mm pipeline in Main Road, with good tidal backflow control by way of additional sumps and grates along Main Road
- During significant storm events, have a designated team available to remain in the locality throughout the storm, to clear sump grates, keep the Barnett Park inlet clear, watch for swale overflows, and ensure all tidal outlets are clear and working.
- Investigate the feasibility of installing removable drain plugs in the sea wall for Main Road properties opposite Barnett Park
- Follow up on the survey data received from residents to better determine final insurance claim costs associated with this storm event. This will assist any future reassessment of flood risk in the area.
- Consider retaining the services of a local drainlayer to take responsibility for periodic inspections and minor clearing of all inlet grates and grills to estuary outfall piping for the area; especially during high tide and storm events.



REPORTED FLOODING IN RIFLE RANGE CATCHMENT FROM 11 - 13 OCTOBER 2000 STORM

Summary of October storm survey replies from Redcliffs residents within the Rifle Range Drain catchment

Street Number	Time when flooding first noticed	Time when flooding started to recede	Approximate water level (mm)			Approximate damage ($)		Insurance claim	Garage RL (m)	House RL (m)	Estimated RL of floodwater (m)	Estimated flood RL = 11m	
			Section	Garage	House	Minimum	Maximum					Water level above in garage floor(m)	Water level above in house floor (m)
Main Road													
115	3:00 PM	Shortly after 3:00 PM		50									
117	1:00 PM		300		100	5000	10000	Yes					
119/121	8:00 AM	After breaching sea wall		200	Marginal	1000	2000	Yes					
125	Early afternoon	After breaching sea wall		650									
137	11:00 AM	2:30 PM		50					10.888	11.780	10.938	0.113	
143	12:30 PM	6:30 PM		300	150	TBA		Yes	10.870	10.860	11.090	0.130	0.140
147				175	175	10000	20000	Yes	10.760	10.890	11.000	0.240	0.110
149	12:45 PM			50	50	1000	2000	Yes	10.810	10.920	10.915	0.190	0.080
155		2:20 PM		150	280				10.868	10.878	11.088	0.132	0.122
157	10:00 AM			300	400				10.838	11.158	11.348	0.162	-0.158
161	3:30 PM	6:00 PM		175	100	TBA							
198/4	8:00 AM	6:00 PM						Yes					
202A/1	12:30 PM	4:30 PM		100		500	2000	Yes	10.920	11.020	11.020	0.080	-0.020
200	9:00 AM					200	1000						
204/3	11:30 AM	4:00 PM	300	150		TBA		Yes	10.900	11.080	11.050	0.100	-0.080
210	12:00 PM	4:00 PM	250	100					10.600	11.150	10.700	0.400	-0.150
212	Early morning	5:00 PM		100		500	2000	Yes	10.700	11.410	10.800	-0.300	-0.410
214	12:30 PM	3:00 PM	200	150									
218		7:30 PM		75					10.700	11.090	10.775	0.300	-0.090
222	8:00 AM	After high tide							10.683			0.317	
226	3:30 PM	5:45 PM							10.861			0.139	
228	5:00 PM	13/10 AM							10.771			0.229	
230	7:00 AM	13-Oct							10.596			0.404	
232	12:30 PM	4:00 PM							10.756			0.244	
234	7:00 AM	13/10 AM	50										
Wakatu Avenue													
2	11:30 AM	4:30 PM	250	250									
10		2:00 PM	300			500	1000						
13	1:30 PM	6:30 PM											
15	12:00 PM	1 week	100	5									
23													
34	3:00 PM	13-Oct	Surface										
39	2:00 PM	4:30 PM				500	1000	Yes					
41	Early afternoon	4:45 PM											
45	12:30 PM					200	1000	Yes					
49	1:00 PM	5:00 PM											
52	8:00 AM	Several days											
64	3:00 PM												
66	8:00 AM	4:00 PM											
90	13-Oct	14-Oct				0	200						
Bay View Road													
1	11:30 AM	4:30 PM	25										
2	2:00 PM	5:00 PM	100			500	500						
9		After high tide											
10	9:00 AM	5:00 PM	75	50									
13													
21	Afternoon	Used pump after 2 days	130	90					11.228	11.928	11.318	-0.228	-0.928
23	Morning 13/10		175										
30		5:30 PM											
31													
46	Mid-afternoon 12/10	Thursday evening											

52	1:00 PM	4:00 PM	50										
54		5:00 PM											
67A													
71		Evening 12/10											
87	7:00 AM	13-Oct											
97	Late morning 12/10	4:30 PM											
99	10:30 AM	5:00 PM											
Cliff Street													
3	10:00 AM	1 hour before high tide	20										
Monks Bay Lane													
2	10:00 AM	6:00 PM	Minor										
7	Morning 12/10		150										
9	10:00 AM												
10	Mid-morning 13/10												
Address not supplied													
	12:00 PM	Evening 12/10											
	11:30 AM		300	300									
	12/10 PM	14/10 AM	150										
	13/10 AM	Evening 13/10											
	12:00 PM			250		2000	5000	Yes					
	1:30 PM	4:30 PM	180										
	10:30 AM	After high tide		25									
	1:00 PM	Evening 12/10											
	6:30 AM	2:00 PM											
	2:00 PM	4:00 PM		300									
	1:30 PM	4:40 PM				0	200						
	3:00 PM	5:30 PM											
-	11:30 AM	5-6 days	500	75									
					Total	21900	47900			Average	11.003		

3.4 Heathcote and Avoca Valleys

Heathcote

The Heathcote Valley is a catchment of 517 hectares, some 373 hectares of which is hillside under reserve, horticultural or pastoral use. Eighty-five hectares of the catchment lies within a low-lying tidally influenced floodplain. Hydraulic modelling of the catchment indicates the critical duration storm for flood flows within the floodplain is a long duration low intensity event of about 12 hours.

Interpretation of rainfall data from the Tunnel Road station indicates the equivalent of a 20 year flood event would have occurred over 12 hours during the 30 plus hour October storm event.

Flood plain contours from an extensive topographical survey of the valley floor are held by the Council. From photographic record of the 11 – 13 October storm event, the extent of flooding is consistent with which might be expected from a 10 to 20 year event, with flood levels up to about R.L 10.6m.

This flooding is consistent with historical flooding in the valley, being extensive in surface area but not deep. No buildings were seriously threatened.

Some problems were encountered with the drainage network with inlet blockages to the Heathcote Valley drain at the Bridle Path Road/Martindales Road corner, and at the Bridle Path waterway inlet at the Bridle Path Road/Port Hills Road corner. Secondary flows from those blockages were able to re-enter the system further down stream.

The Heathcote Valley drainage system and its capacity potential is well understood. Further, significant development has to date been kept from the floodplain, thereby avoiding high flood associated costs.

The Council are in the process of developing a drainage strategy for the valley which will protect much of the floodplain and accept the regular flooding.

Avoca

Like the Heathcote Valley, the Avoca Valley stream drains a large, 536 hectare, hillside catchment. It also has a large low-lying tidally influenced floodplain, susceptible to regular flooding. Hydraulic modelling of the catchment indicates the critical storm duration to be between 3 and 6 hours. Using the Tunnel Road rainfall records, the storm could be categorised at about a 10-year return period storm.

Apart from some significant erosion reported at 69 Avoca Valley Road, the stream stayed generally confined within its banks. Minor erosion was also evident at the inlet to the new pond in Duncan Park, where backwater effects from the lower floodplain lifted the pond level to about R.L. 11.0m. Its normal operating level is about R.L. 9.3m, however the pond design allows for regular rises in pond level.

Within the floodplain, east of the Tunnel Road, extensive, but shallow surface flooding occurred. The flooding was consistent with that predicted for a 5 – 10 year return period event.

Like the Heathcote, the Council is in the process of developing a long term strategy for the flood plain area. The Council has recently purchased land off Scruttons Road to better effect long term sustainable land use for the area.

3.5 Other Port Hills Catchments

The Storm

This was a storm that combined very strong winds with heavy rain. As a result considerable vegetative litter was on the move in the waterways causing the many hillside grates to block and reblock after clearance.

A post-storm inspection from the summit road revealed hillside slippage to be relatively minor (other than onto Taylors Mistake Road) and not a major contributor to the screen blockage problems.

The basic conclusion is that improvements are needed in flood operation, maintenance and monitoring of all grates on hillside waterways. In general this should include primary trash racks with adequate holding capacity and, for those sites for which the consequences of overtopping are significant, perhaps the addition of remote water level monitoring to enable the control centre to have direct access to that hazard information.

Taylors Mistake

The main problem in Taylors Mistake lay with mud from the numerous slips on Taylors Mistake Road being picked up by the storm flow and overwhelming the drainage outlets. At the foot of the hill in behind the Surf Club there is a depression formed behind the building and foreshore sand. Normally this drains via a limited capacity soakage chamber but during the storm this was overwhelmed and well coated in mud. This resulted in water entering the surf club garage. Flooding was relieved in the end by surf club members excavating a slot across the beach.

Further flooding took place in the overflow carpark due to the ill-defined main valley channel meandering off into the carpark. This was not really an issue during the storm but water continuing to trickle through here since has become an issue due to the need for the carpark to be available. The Parks Unit is proposing to resolve this by formalising a planted swale along the carpark eastern margin.

Lower Taylors Mistake Road is scheduled for upgrading by City Streets this financial year. A new improved outfall is proposed to divert stormwater runoff along a swale in the northern edge of the overflow carpark and discharging into the main Taylors Mistake Stream. The need for roadside bank structural support is also recognised.

Further up Taylors Mistake Road the main gully culverts appeared to operate without blockage—unlike in the past. Improvements made to these appear to have helped although large slips present in places do not seem to have moved in the recent storm—presumably because the storm event was not of sufficient duration to bring about full saturation.

Glenstrae Valley (Basil Place)

This channel has been designed to (hopefully) stay together in a 20 year event and has been sized to contain a 50 year flow even with full urbanisation of the catchment. Flows above the 20 year $5m^3/s$ event will run down Basil Place. In the 12 October event it seems that the flow peak was less than $2m^3/s$, that the debris conveyed by the flow was not great and that the very large (4x4m) downhill sloping screen had no difficulty coping with the flow and debris without spillage.

Mt Pleasant Stream (Aratoro Place)

This site was notable in that it did not overflow as it has done in the past and this was despite having what is considered to be an inadequate screen! It may be that this was a more sheltered valley and secondly that slippages did not develop on the slopes adjacent to the waterway.

Bridle Path Stream

The main problem here was a blocked screen on the Bridle Path Road culvert inlet placed there because of safety concerns of the local residents. It appears that City Care at least partially cleared the screen on a couple of occasions but that it reblocked soon after their departure. Post flood it was apparent that a considerable quantity of gravel had accumulated against the bottom of the screen while during the flood there was gravel plus small rocks plus turf and branches. It seems that some flow, perhaps a quarter of the total, continued to pass through the culvert while the remainder crossed the road and ran down the road edge. Here it was contained by the Heathcote Domain playing field embankment until the playground where it was able to spill and spread out into several streams then onto and over the drop into the recently completed stream enhancement works.

This resulted in scour damage to the newly grassed areas, the loss of crusher dust on the new paths and bark from beneath the flying fox. The main channel invert remained intact as designed but is newly coated in round greywacke stones typically 65mm and down in size. These appear to have washed in from the vicinity of the Bridle Path track.

Most of the damage is superficial and readily repaired. Further, scour resistance will be enhanced after a year or so of grass root growth and soil consolidation.

Since the storm every second bar on the grate has been cut out to reduce the frequency of blockage. In addition, consideration should be given to inclusion of a large debris trapping facility somewhere upstream.

Related to this the sidechannel and swale on the eastern side of Port Hills Road presently just empties at a point where it is able to flow uncontrolled through the play area. This can occur in just about any rain event and should be sorted out.

Alderson Avenue

The major channel is the eastern branch extending 1250m in length up to Trig R at RL297 on Montgommery Spur. The lesser eastern branch is 750m in length. The entire catchment is rural in grassland and extensive tussock land but with boneseed and broom covering the lower rocky slopes. The lower section down into Alderson Reserve is relatively steep—especially the western branch below the small quarry where it falls through what appears to be tailings incorporating much small rubble along with bricks, corrugated iron and the occasional car tyre, etc.

Much of this rubble went on the move along with turf peeled off the invert and overwhelmed the two trash racks and pipe entry screen leading to considerable rubble loaded water flowing down Alderson Avenue and beyond.

These two trash racks were installed as a result of a previous blockage by an old washing machine (origin unknown!). About the same time the two fords on the access track to the reserve were reconstructed in rubble overlaid with larger packed rocks. The survived the recent storm relatively intact.

The proposal now is to install two further trash racks and to reconstruct the pipe inlet with much enlarged screen. Options for improved maintenance access will also be considered in conjunction with the soon to be extended Alderson Avenue linking to the new Stonehaven subdivision.

3.6 Heathcote River—Middle Reaches and Tributaries

Flows/Levels

1 Bowenvale Valley peak discharge at weir—recorded u 6 m^3/s cf modelling (infiltration rate 2.5mm/hr) peak of 6.3 m^3/s

Predicted 1% AEP design flow	approx	13 m^3/s
- 30 yr return period	approx	7 m^3/s
Recorded flow	= approx	25 yr return period

Average weighted rainfall in catchment approx 30-40 yr return period
Specific discharge 1.8m3/km^2 (using measured weir discharge)

2 Hoon Hay Valley Catchment

Environment Canterbury gauged @ 2.2 m^3/s @ 1130 hrs
assessed peak from weir rating @ 2.5 m^3/s
= specific discharge 0.65 m^3/s

Max water level Hoon Hay Valley Ponding Area
19.2m < 10% AEP

3 Cashmere/Worsleys Basin

Max flood level 17.61m
cf 10% AEP hydraulic design level 18.1m

4 Hendersons Ponding Area

Max flood level	18.23m
cf 10% AEP design level	18.5m

5 Cashmere Stream @ Penruddock Rise Footbridge (Reserve)

Max WL	17.59m
cf 10% AEP design level	17.8m

6 Heathcote River at Ferniehurst Street
Max recorded WL 17.035 (staff gauge reading) @ 1300 hrs
ie event < 10% AEP at Ferniehurst Street

Note: design level ≡ predicted hydraulic level

7 Heathcote River at Hunter Terrace (behind Cashmere Club) x/sect. 58

Measured flood level (from flood marks) 13.93m
cf 10% AEP predicted level 13.90m
5% AEP predicted level 14.00m

8 Heathcote River—Eastern Terrace

x/section 54
Flood level (photo) to within 100mm of flooding house No 27 Eastern Terrace floor level 14.02m
Floodwaters in under floor ≡ estimated flood level approx 13.9m
(Note: floor level 29 Eastern Terrace 13.99m)

This would indicate flood level was equivalent to a 1% AEP event. This reach is in vicinity of outlets of Bowenvale catchment, but levels exceedingly high, perhaps water levels also held up by trees in river d/s of here and possibility of increased channel roughness. Note: according to our records the section here had been flooded on at least three previous occasions (1975, 1977 and 1980) and the house evacuated 1977 but no record of have flooded.

Note: modelling indicates the middle reaches of the Heathcote in particular are quite sensitive to changes in roughness.

9 Heathcote River at Buxton Terrace

Maximum observed water level
S G read 12.81m @ 1300 hrs
+ 12.77m @ 1500 hrs

From computer modelling predicted hydraulic levels

10% AEP	12.76m
5% AEP	13.00m

⇒ indicates flood event 10% - 5% AEP

Gauging by Environment Canterbury
20.7 m^3/s @ 12.7m

Assuming a peak discharge of approx 25 m^3/s – frequency analysis indicates <10% AEP event

This seems to indicate a significant rating change—previous rating curve indicates a level of 12.7m ≡ 30 m^3/s ie approximately 10% AEP event

Environment Canterbury estimates rating changed by +0.3m - supposedly no trees d/s. A copy of the previous rating curve is attached.

Rob Connell calculated Mannings from 0.04 to 0.021 (0.04 in channel) (previously assumed 0.033)

10 Footbridge—Malcolm Avenue — soffit under water by 150mm — level to be checked.

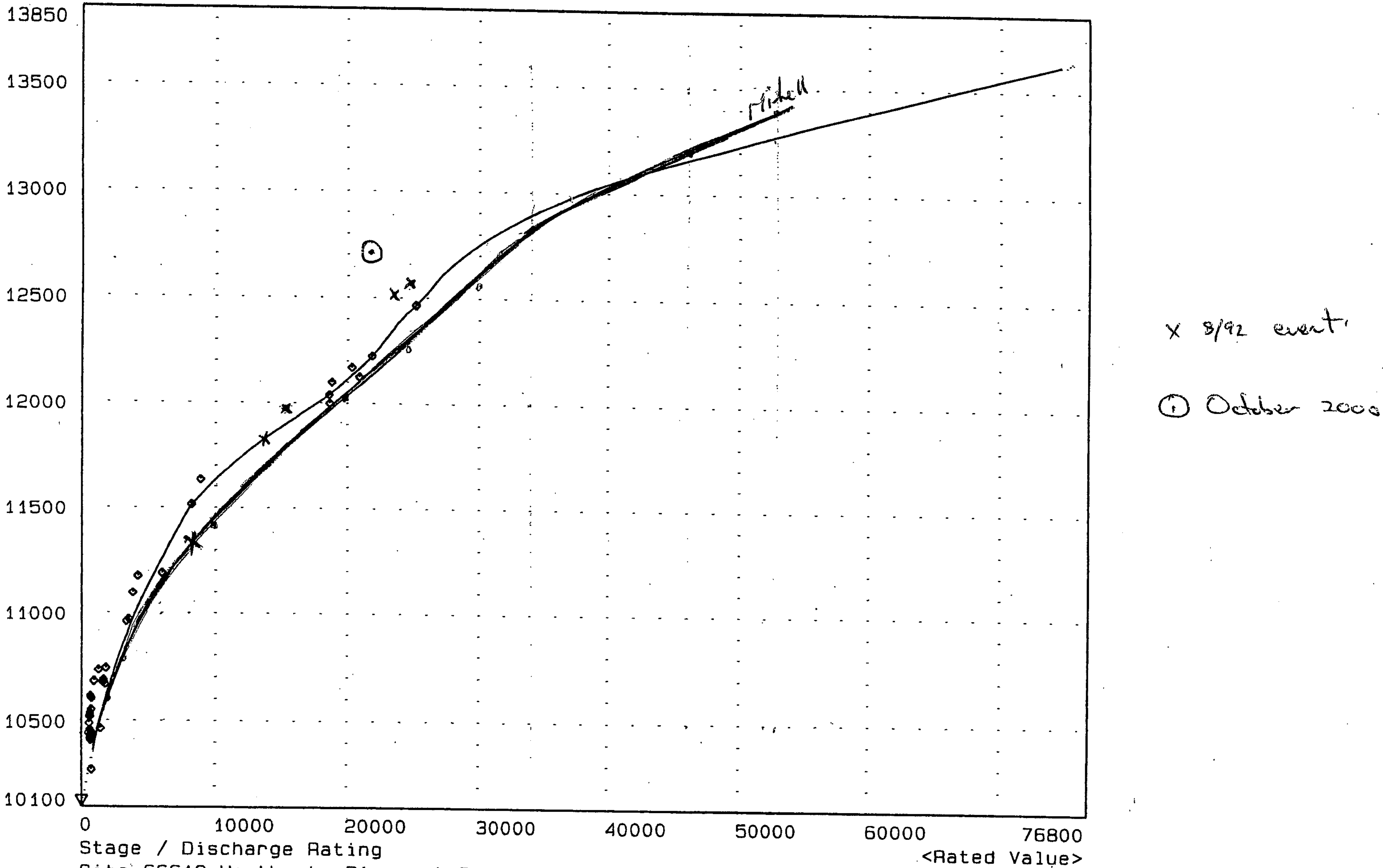
11 Heathcote River at Opawa Road

Maximum water level 11.01m @ 1600 hrs
This is equivalent to u 10% - 5% AEP event
(cf 11.3m in 1992 – very extreme tidal event)

Discussion

Generally the flows in the Heathcote upstream of Bowenvale Valley were equivalent to a 10% AEP event or less. However downstream of Bowenvale Valley the very high water levels, for not an equivalent high flow, are obviously an area of concern and requiring further investigation. While I am not aware of any house flooding on the Heathcote River the flood database needs to be rechecked for this. My best estimate for runoff from Bowenvale Valley and other Port Hills catchments to the east is equivalent to about a 25 year return period. This is based on the runoff through the Bowenbale flume. The highly variable rainfall due to altitude makes it difficult to determine with much accuracy the runoff of the Port Hills catchments using computer modelling or other rainfall/runoff calculations. Assuming the same rainfall pattern in Bowenvale Valley and other Port hills catchments runoff can be estimated by applying the specific peak discharge of $1.8m^3/km^2$.
Further investigations required include:

- x/section re-survey especially from downstream Buxton Terrace to Bowenvale Avenue
- check of event database for house inundation
- check of event database for trees across Heathcote River
- further checking of maximum flood levels downstream of Bowenvale Avenue using flood photographs taken near peak
- assessment of channel roughness—banks and channel bed
- reassessment of rating curve—Buxton Terrace site (Environment Canterbury is doing this)
- calibration of Heathcote River model with event

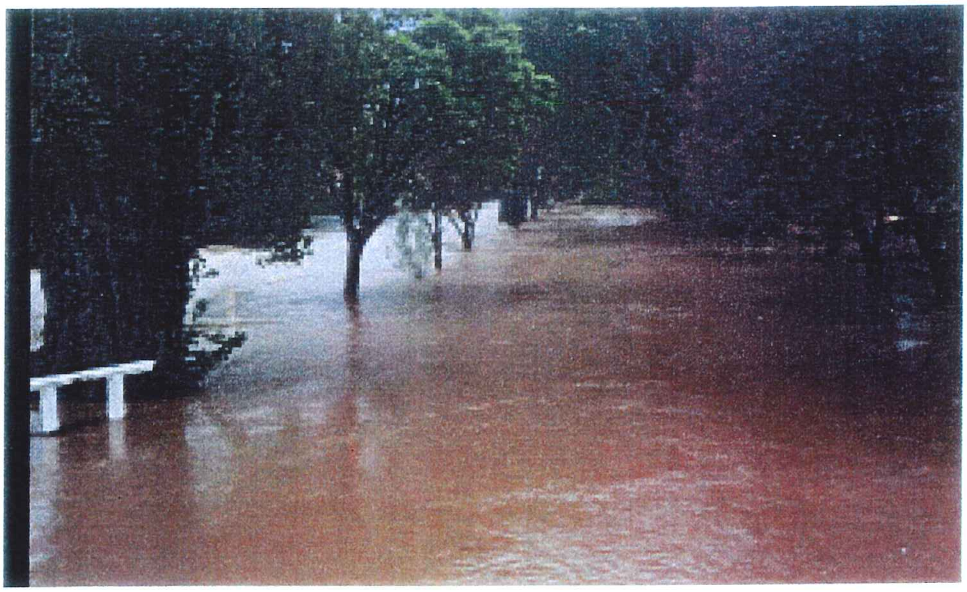


Stage / Discharge Rating
Site 66612 Heathcote River at Buxton Tce
Gaugings from 650303 121500 to 920131 240000
——— 650303 120000 Indicator Stage 10100 ◆

Heathcote River at Eastern Terrace downstream Bowenvale Avenue
12 October 2000 at 1400 hrs

Cashmere/Wolsleys Basin 13 October 2000 at 1115 hrs
(close to max W.L.

Hoon Hay Basin 13 October 2000 at 1215 hrs



Heathcote River at Buxton Terrace looking downstream
12 October 2000 at 1630 hrs
Staff gauge 12.7m

Buxton Terrace looking upstream

Heathcote River at Farnley Reserve
12 October 2000 at 1400 hrs

3.7 Milns Estate Subdivision

Introduction

The total catchment area of this sub-division is approximately 10 hectares. A ponding basin of approximately 375 metres long and 20 m wide has been constructed at the southern boundary of the catchment in order to accommodate the storm water runoff from the catchment. The ponding basin is separated by two weirs in order to utilise the full capacity of the basin. At the downstream of the pond, a 300mm pipe connects the lower pond and the existing 900mm-pipe culvert across the Milnes Road.

Observation during the rainfall event

On 12 October a team from ESU headed by Ron Harris inspected the site and the ponding area. A number of photos of flooding were taken by them around the basin and within the catchment. Although the entire pond was full and flood level extended close to the section at the lower end of the basin, there was no real flooding in this area. On 13 October Ian Johnson and I have visited the site and observed that the upper two ponds were empty while the lower pond was almost full. Floodwater from the lower pond was discharging through the outlet pipe without any blockage.

Hydraulic Model

An hydraulic model was developed for the drainage system in order to assess the capacity and effectiveness of the ponding basin provided for this development. The hydraulic model was simulated using the recorded rain data and calibrated the flood levels against the observed levels (eye estimation from the photos) and found satisfactory.

3.8 Bexley Catchment

The Bexley catchment is approximately 93 ha. It is made up of two major subcatchments: Knight's Drain (43ha) and Pumping Station 203 (50ha). Surface flooding occurred in both catchments on Oct 12 2000.

Rainfall

The available rainfall data for the catchment is limited. 137mm of rain was recorded at Bridge St (1.5km away) and 90mm was recorded at PS205 (3km away). The 103mm that fell in a 12 hour period at Bridge Street is about a 50yr event.

For the purposes of this report, the rainfall data from the two locations has been linearly interpolated. This results in an estimated total rainfall of 121mm over 36 hours in the Bexley catchment.

River Levels

Nothing exceptional. The likely maximum river level was ~10.6m. There was no overtopping of the stopbank ~RL 11.2m. Calculations show that it was unlikely that any significant backflow occurred from unflapped pipes or leaking flapvalves.

Flooding

Extensive surface flooding occurred at Bexley Road, Pages Road (at Knights Drain crossover), Wairoa Street, Waitaki Street (possibly) and possibly others. Some houses were evacuated at Wairoa Street.

Street flood levels	–10.1m Bexley/Waitaki,	cf typical section levels ~ 10.15m
	- 10.3m Pages/Knights	cf typical section levels ~ 10.17m
	- 10.2m Brook/Wairoa	cf typical section levels ~ 10.19m

Stormwater flooded several sections and garages, but is not believed to have entered any houses. Estimated maximum flood depths are approximately 200mm for properties and 400mm for roads.

Surface flooding was apparent in a site visit by Council engineers at about 3pm on 12 October. Alan Beard, Pumping and Maintenance Manager, observed that most flooding was gone by 9am Friday 13.

The maximum flood level reached in this event would not flood the proposed design levels for the new Woolston Burwood Expressway.

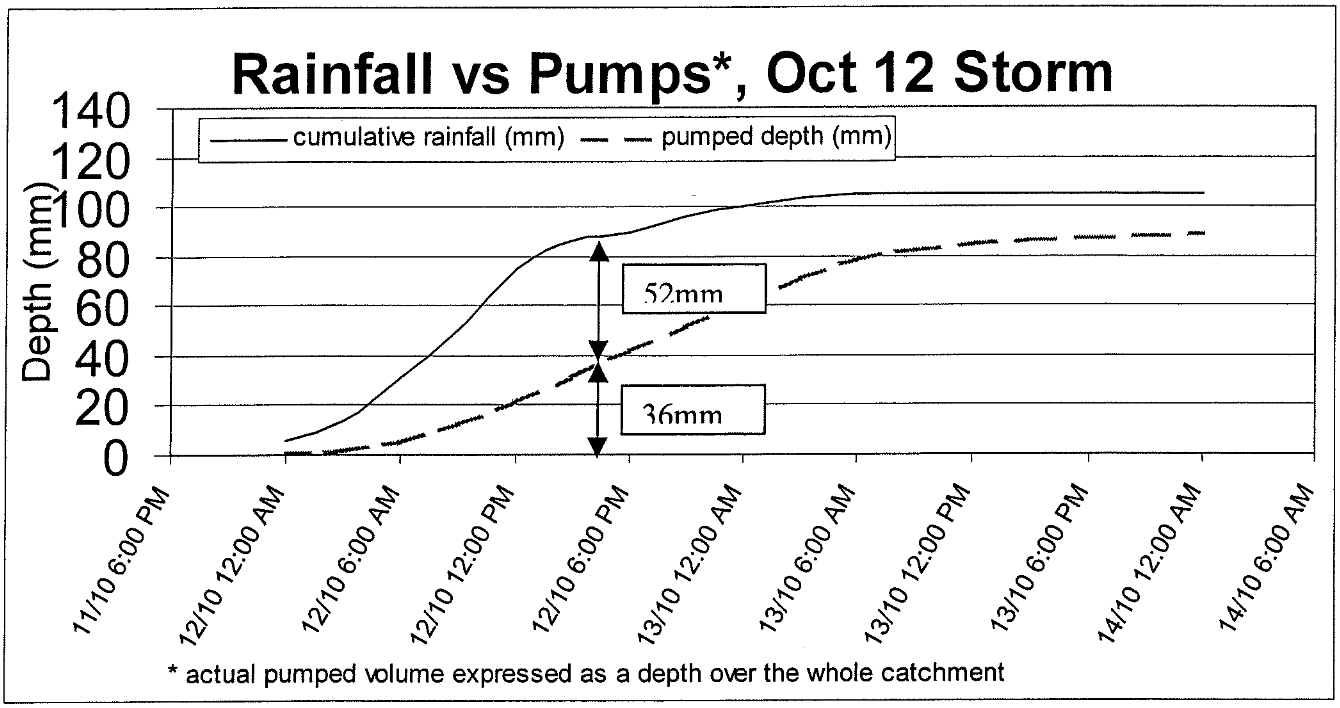
Pump Stations

The combined pump theoretical capacities is about 3.3mm/hr for the Bexley catchment, or 79mm in a 24 hour period. This is equivalent to a 5 year, 24 hour storm.

Together the two stations pumped approximately 79,000m^3 until the larger pumps ran only intermittently (indicating most of the ponding was gone). The larger pumps ran for approximately 30 hours almost continuously.

PS204 (Knights)	= 44 000m^3
PS 203 (Wairoa)	= 35 000m^3
Total	= 79 000m^3

Another 13 000m^3 was pumped to the end of 16 October as the catchment continued to drain. This total pumped volume is equivalent to 104mm of rainfall at a 0.95 runoff coefficient.



The above graph plots the rain fallen versus the pumps' efforts to remove it. If the rain fallen is greater than amount removed by the pumps, the difference must be stored in the catchment.

The above example shows that at 4pm on 12 October, a total of 88mm of rain (36mm+52mm) had fallen on the Bexley catchment, but the pumps had only managed to pump out 36mm. The other 52mm was ponding and causing the flooding in the catchment. Clearly, the intense rainfall has exceeded the pump capacities to remove the stormwater.

It is worth noting that for the storage required, the maximum flood level reached compares well with expected flood level calculations. It is also notable that when the pump graph begins to level off, at about 9am on Fri day13, was about the time that flooding was no longer a problem.

It is not known how much, if any, gravity outfall of stormwater there was from the catchment. This would reduce the amount of storage required in the catchment.

There was a bearing lubrication problem with Pump 1 at PS203. This pump's capacity is 200 l/s. It was not turned on until 10am on 12 October.

According to Alan Beard, Pumping and Maintenance Manager, the pump station intakes appeared to remain free of debris – an improvement on past flooding events.

Stormwater Infrastructure

The infrastructure appears to have been overcome solely on the basis of the intensity of the storm.

There is currently a physical link between the two catchments, a 225mm diameter pipe along Pages Road. This is likely to have taken water from Knights Drain towards PS203, making the situation worse at PS203.

It is not known whether the sewers contributed to flooding. There were no reports of sewage in the streets. It is more likely that the sewerage system helped remove stormwater away from the catchment.

The flapvalve at Knights Drain still leaks. Water backflowing from the Avon River is a significant risk for the Bexley outlet to the Avon River catchment. All of the pipes' outlets need to prevent backflow from the river to behind the stopbank.

Conclusions

The rainfall event exceeded the design standard of the pumps. In order to prevent this level of flooding reoccurring in a similar event, a larger pumping capacity would need to be installed.

Recommendations

It is recommended that:

1. The 225mm 'link pipe' along Pages Road is sealed or removed at its high point.
2. A visual inspection be undertaken along the Avon River bank at low tide to check that all pipes are flapped.
3. Discuss with Alan Beard the seriousness (or otherwise) of the flapvalve issues at Knight's Drain.
4. Options for an increase in controlled ponding within Bexley catchments are investigated.

4 BUILDING CONTROL

Repairs to private property due to storm damage is usually under the direction of insurance companies with the Earthquake Commission being the lead agency for matters relating to landslip damage.

Repairs would not normally require a Building Consent and the Council has not been provided at this stage with copies of reports commissioned by the insurers.

In areas which could be prone to slippage such as the eastern side of Heberden Avenue, warnings of the potential are provided by PIMs and LIMs and geotechnical reports and certification by geotechnical consultants are required as part of the Building Consent process. Protection works that are required have to be designed and certified by an experienced engineer.

The effects of the October storm will be part of the consideration by engineers when designing protection works.

5.0 CUSTOMER RESPONSE

Statistics

During the period extending over 12 and 13 October 2000, **1290 entries** were recorded into the City Streets database. These entries ranged from fallen trees, to slips, to flooded roads and properties, to sewage overflows and to odd ball ones like "my dog 'Storm' has gone missing"!!

*A selection of keywords, **namely**, "water, flood, sump, stream, drain, river, pipe, pump, creek, bridge, storm, slips and gutter", were entered into the database to extract the **"drainage"** component of the data entered.*

The net result was that 651 drainage entries were extracted out of the 1290 entered. Of these 651 entries, 229 are property related. In addition to these 229 entries another 150 have been received subsequent to the storm and require field follow up. The remaining 422 are mostly road related and will be referred to the relevant Teams in City Streets and Water Services to assess and action as appropriate to ensure that the storm event will see a closure.

Field Investigations

Seven teams were dispatched into the field to report on the flooding give feedback and follow up urgent pleas of help. Special emphasis was placed on:

(a) Marking high water levels so that modelling variables could be compared with the actual storm event.
(b) Extent of ponded areas and reasons for ponding.
(c) Damaged services and structures.
(d) Blockages and slips – trees, gratings etc
(e) Sewer overflows.

The results of the field investigations have generally been dispatched to other teams to action as appropriate.

Of special note was that:

- The conclusion from the general feedback received was that in the majority of cases (away from the reaches of the two main rivers) the flooding was a blockage or maintenance problem **and not a lack of capacity in the system.** There were obviously some exceptions to this.

- The bottom retention basin on the Milns Estate subdivision was full of water while the upper two were empty. Flooding at the lower end of the basin occurred. The lower pond was overloaded and did not discharge at the desired rate.

- The flooding recorded in the southern and eastern parts of the city was generally much greater than that experienced in the north and western suburbs of the city.

Newspaper Reports

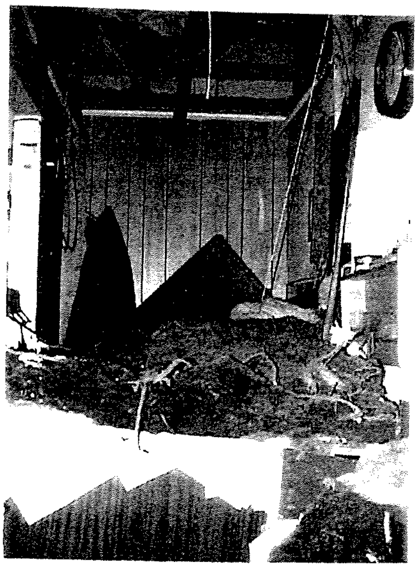
The Day The Rains Came Down

Continued from Page 18

'Divided We Fall'

A large stand of trees on the corner of Bridle Path and Port Hills Roads was decimated.

Luckiest guy around, Terry Papps, Security Manager of the Sumner RSA Club, walked out of his office into the club rooms three minutes before it was demolished by a landslide. Yes terry went out and bought a Lotto ticket; it wasn't a winner though!



MAGBAG

Continued from Page 4

Flooding

Sir Sumner residents experienced the effects of the southerly storm recently with water invading properties accompanied with damage to trees and to gardens. At no stage did we see people in boats around our streets as we have seen during past floods.

As a result of former floods some homes were flooded up to their windowsills. Such a situation did not occur during the recent flood. Perhaps residents may be interested to know why. After the former floods being so damaging the Sumner Residents' Association took up the issue, which resulted in having a pipe installed starting from behind Van Asch College and emptying into Bell's Baths beside the Sumner main drain outlet. This pipe is eighty inches in diameter and, I believe, was the largest pipe made at the time.

Without this eighty inch pipe Sumner would have had a flood of epic proportions recently. Let Sumner be thankful that we have this eighty inch pipe set in place.

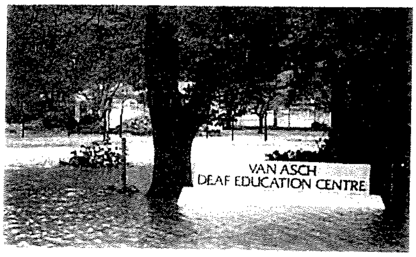
Another gain was that a partial civil emergency may be called in any area.

The Day The Rains Came Down

Shoreline's photographer threw caution to the winds and braved the elements to obtain a pictorial record of the October storm.

Continued onto Page 32

The Sumner Police Station became the Sumner Civil Defence H.Q.



'Lake Van Asch'

'How the Mighty are Fallen'

One of Truro Street's mighty oaks, probably approaching a century old, torn from the ground and brushing a house on the other side of the road.

Clean-up bill for storm tops $1m

The city council's clean-up bill for last month's storm is expected to climb to $1.1m.

New estimates for tree damage tipped the bill over last week's evaluation of about $800,000.

Director of operations Ken Lawn said the cost to the city has yet to be finalised but would exceed the original $800,000 "back of an envelope" estimate.

He said the cost of felling and clearing tree damage could amount to more than $500,000.

Some of the costs of damage to council plantations on the Port Hills would be recovered from milled timber. The timber would, however, be immature and storm damaged.

Mr Lawn said the main costs to the council were from storm damage to trees, pumping stations and stopbanks, cleaning operations on silted streets and repair work to a retaining wall at Evans Pass.

Silt and other debris had to be removed from streets in Sumner, Redcliffs and the Heathcote Valley.

Removing wind-blown branches and damaged trees continues at parks with areas still cordoned off at Hagley Park.

The last major natural event to put a dent in maintenance budgets was the Big Snow in 1992.

Mr Lawn said the funding of the repair bill would come from normal maintenance budgets and after the juggling of other budgets.

Current storm damage costs are up to $900,000.

Sumner-Redcliffs flooded

Firemen worked to unblock drains in Sumner as floodwaters rose during the afternoon yesterday. Flooding was worst towards the back of Sumner valley and throughout Redcliffs. PHOTO: GEOFF SLOAN

STAR 8/11/00

Storm bill reaches $11 million

The storm that ripped its way through Christchurch in mid-October has left a final bill of about $11 million.

New Zealand Insurance Council chief executive Chris Ryan said the storm claims had risen by about $1 million above the original estimate of $10 million as a result of damage that was not initially evident.

He said this caused the total of claims, including the damage to the Lyttelton marina and its vessels, to be about $11 million.

Mr Ryan said claims had now stopped coming in.

Christchurch had been pretty good at handling the storm and its aftermath, he said.

People had provided clear data on what had been lost and tried to protect property during the storm by covering things or moving possessions out of harm's way.

"Generally speaking, the claims that came in were very precise and pretty good."

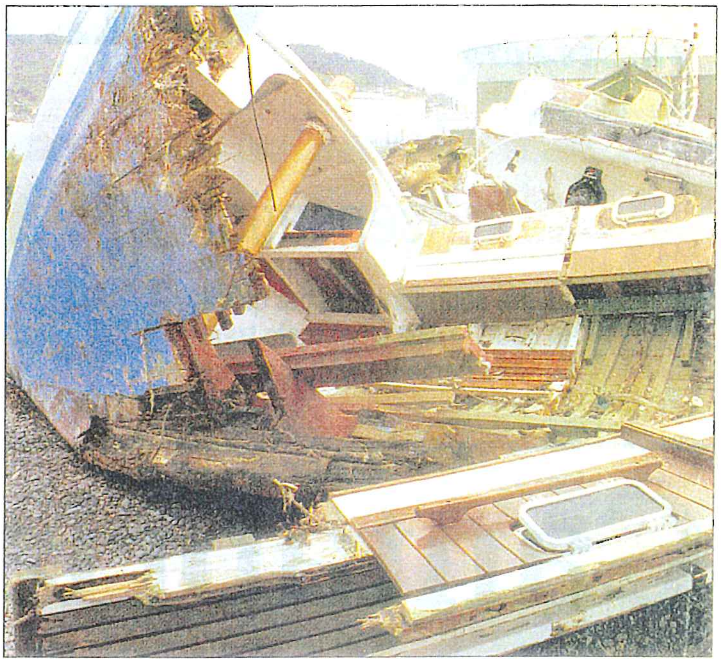
Mr Ryan said the damage was more than expected, but the storm was violent even though it was brief.

Most of the claims received were related to wind and water damage caused by the storm.

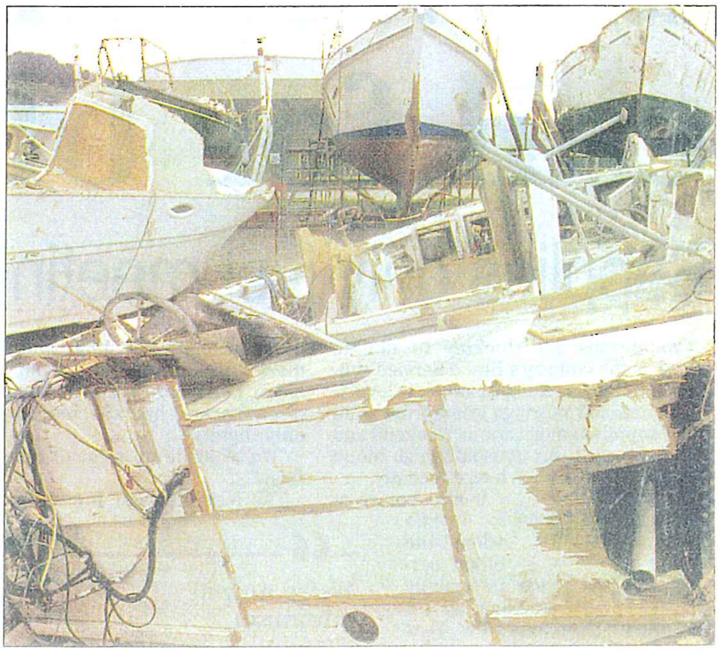
The insurance claim for the wrecked marina is $1.2 million.

And insurance assessors say the bill for yachts lost or facing repair is between $1.5 and $2 million.

Several uninsured yachts were also lost.



What remains of boats damaged in last month's storm lie in the Lyttelton marina. The insurance bill for boats that were lost or needing repair is between $1.5 million and $2 million. PHOTOS: MARTIN WOODHALL



Photographs

Typical hill waterway pipeline inlet conditions during the storm

Stret flooding, Kennedy Place, Opawa

Heathcote River (foreground) and Heathvote Valley ponding (middle foreground)

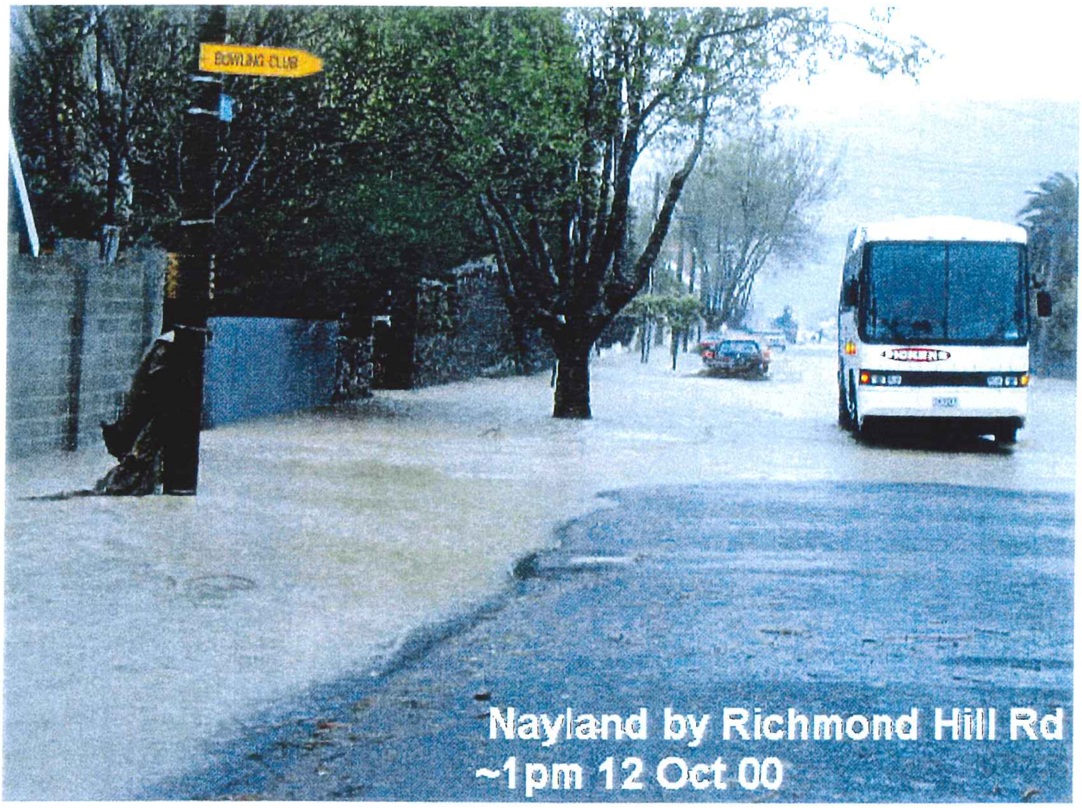
Ponding between Heathcote River and Tunnel Road,
Heathcote Valley, 11am 13 October 2000

Secondary flow down Bowenvale Avenue, Sibleys Drain catchment
12 October 2000

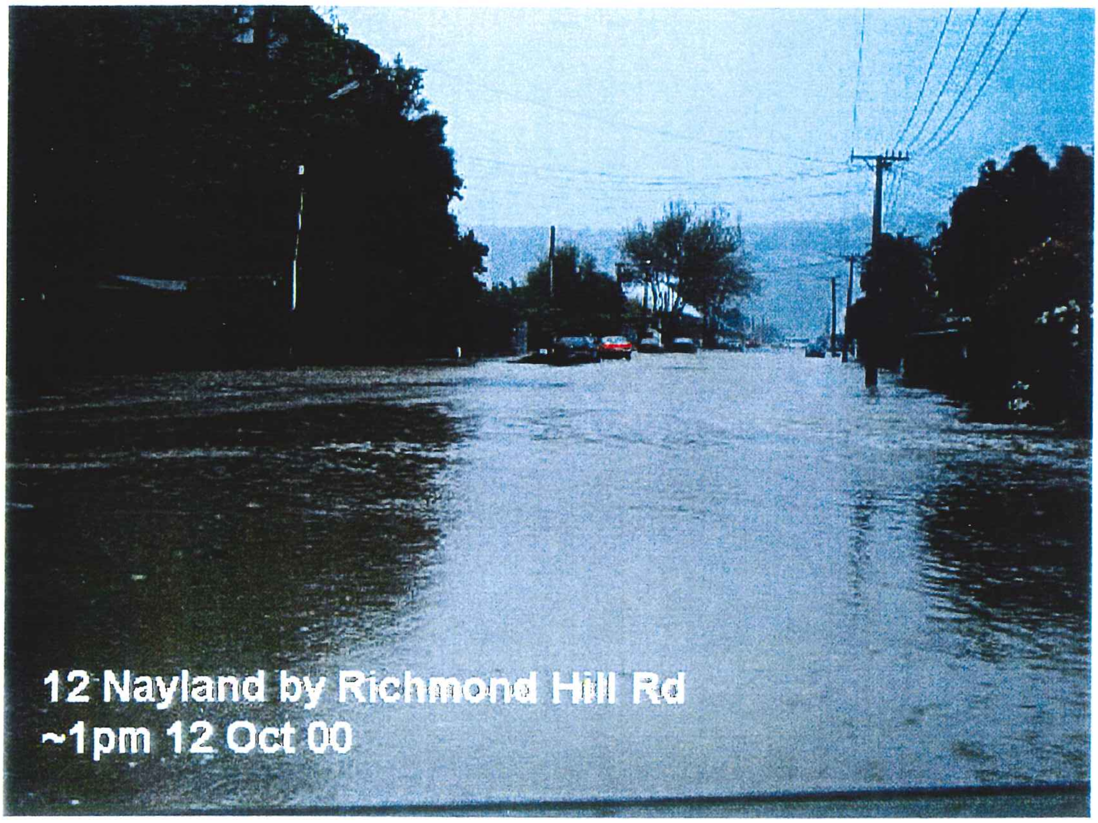
Sibleys Dr ain,, Bowenvale Avenue below flume
12 October 2000

Alderson Avenue
2pm 12 October 2000

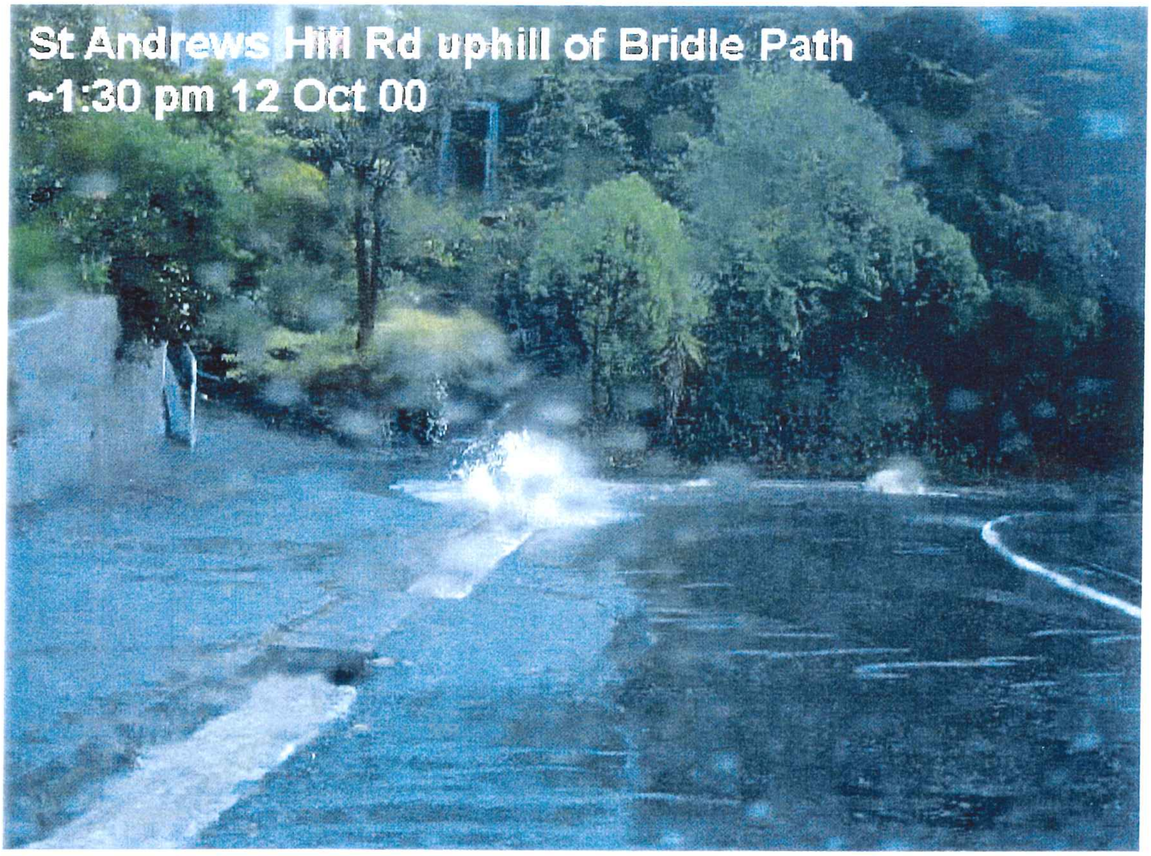
Cashmere and Worsleys Valleys ponding area
10.45am 13 October 2000



Nayland by Richmond Hill Rd
~1pm 12 Oct 00

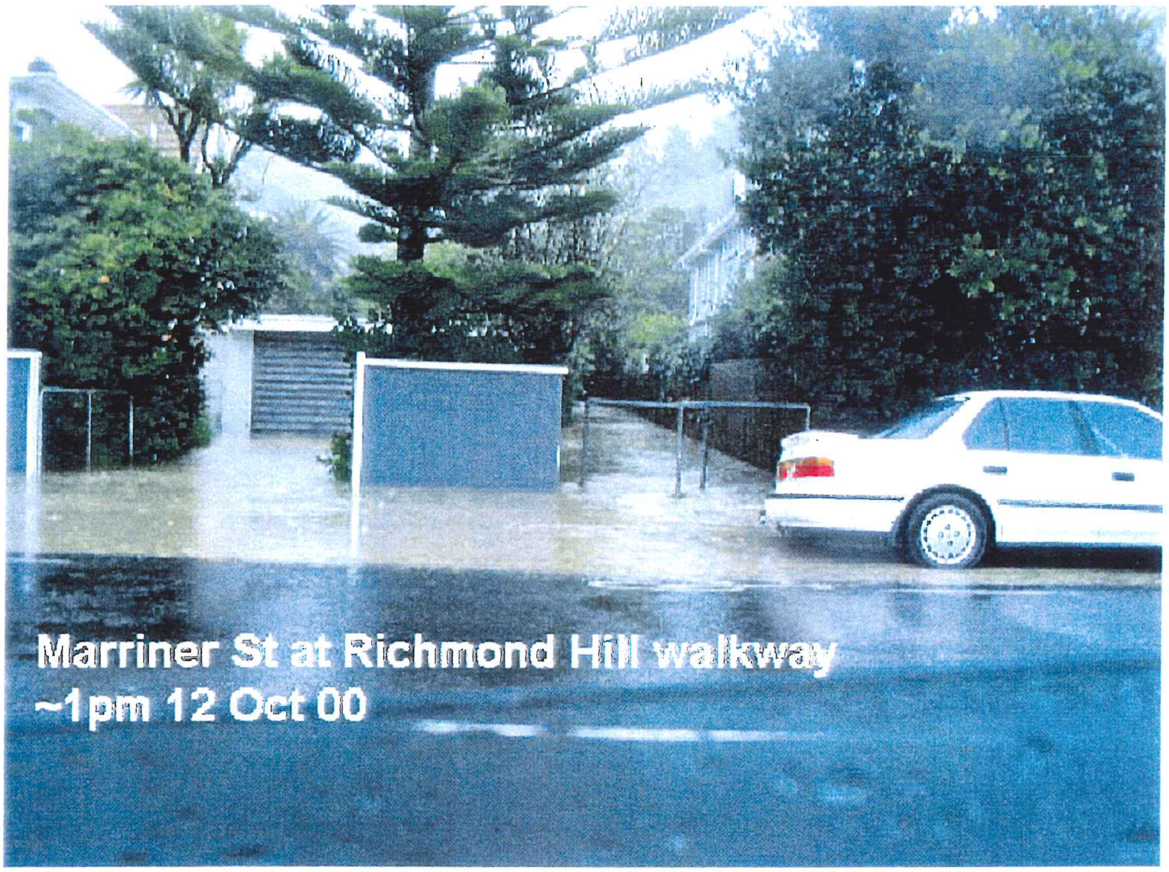


12 Nayland by Richmond Hill Rd
~1pm 12 Oct 00

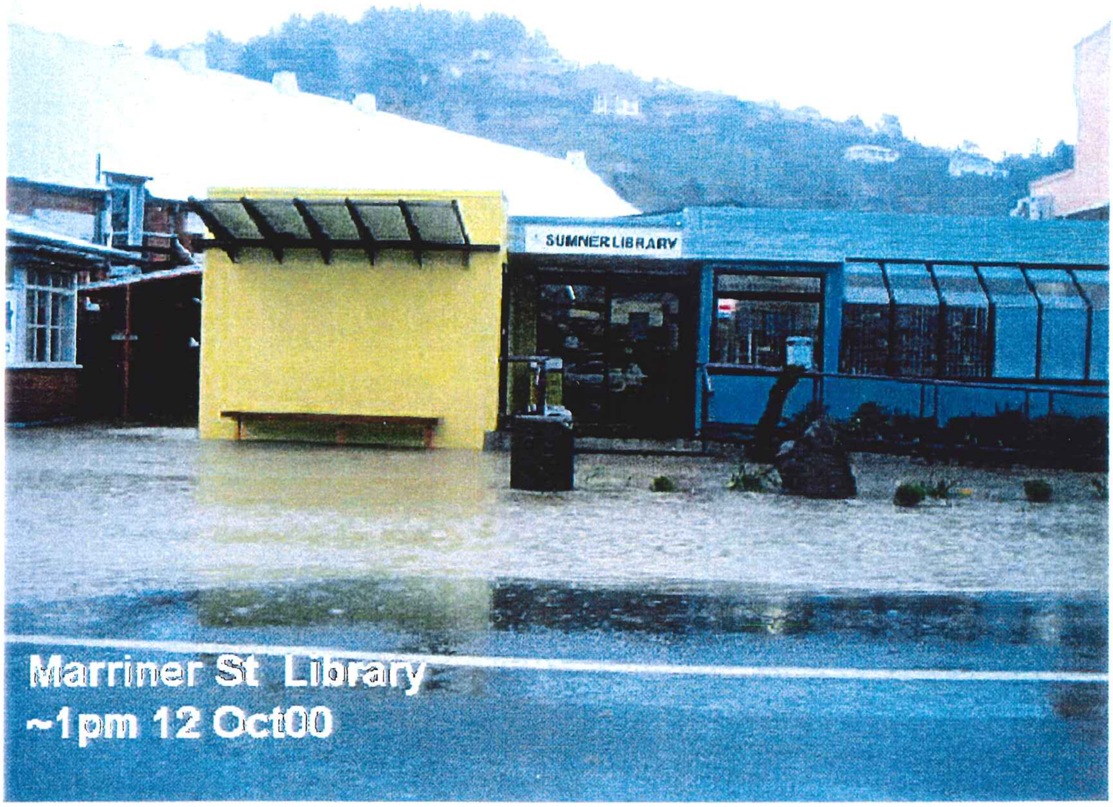


St Andrews Hill Rd uphill of Bridle Path
~1:30 pm 12 Oct 00

Port Hills Rd west of Horotane/Tunnel Rd
~1:30pm 12 Oct 00



Marriner St at Richmond Hill walkway
~1pm 12 Oct 00



Marriner St Library
~1pm 12 Oct00