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Inundation Design Performance Standards

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Flooding at Richardson Terrace, July 1977

The Press

20.1 Floodplain Management, Climate Change, and Risk

20.1.1 Floodplain Management

Christchurch City is located in close proximity to the coast and is also affected by a number of major river systems. This means that large sections of urban Christchurch are susceptible to inundation as a result of flooding, both from river systems (Figure 20-1) and the sea. To assess the most appropriate means to manage the effects associated with flooding for Christchurch, the Christchurch City Council and Environment Canterbury have developed floodplain management strategies for the major Christchurch rivers and their catchments.

A floodplain management approach to flooding focuses on reducing actual and potential flood damage through the adoption of a combination of physical, planning, and other measures. Inundation design performance standards are only one method of flood damage reduction.

The present planning methods that the Council use to avoid or mitigate natural hazards are contained in the Proposed Christchurch City Plan (Christchurch City Council 1999). These methods include zoning, waterway setbacks, restrictions on excavation and filling, and policies contained in Volume 2 of the Proposed City Plan. The Council is also required under the Building Act 1991 to ensure that floor levels are constructed so that habitable buildings do not become inundated in the 2% AEP (i.e. 1 in 50 year storm) event.

Further, in response to Environment Canterbury submissions to the City Plan, the Christchurch City Council has prepared a proposed variation which, if adopted, will require minimum floor levels above the Building Act 1991 standard based on the 0.5% AEP (i.e. 1 in 200 year storm) event in certain areas of the City. This Variation also proposes to add a map to Volume 2 of the Proposed City Plan, identifying those areas of the City that are predicted to be affected by climate change. For more information refer to the Proposed Variation to the City Plan, Variation 48 (Christchurch City Council 2000).

20.1.2 Climate Change

The Council has recently commissioned a study into likely effects of climate change on Christchurch. The results of this study indicate that as a consequence of climate change Christchurch will experience an increase in rainfall, increased severity of storms, and

Figure 20-1: Flooding during the 12th October 2000 storm caused water to overflow from Richmond Hill drain into the surrounding residential and commercial areas of Sumner.

higher tides. Increased levels of damage as a result of buildings being inundated with floodwaters are predicted for the future. An additional consequence of climate change is an anticipated rise in the sea level. See *Appendix 1: Definitions and Useful Numbers,* for the current best estimates on anticipated levels of sea level rise.

20.1.3 Level of Risk

Large areas of urban Christchurch are located on floodplains. Consequently there are significant assets at risk from flood damage. The levels of damage increase significantly once silt-laden floodwaters enter buildings. For instance, the average damage cost of floodwaters entering a dwelling is $50,000 (as at year 2000). This cost increases to $65,000 once the water exceeds 0.1 m in depth.

Physical damage can be measured in dollar terms, however this does not include the cost of distress and disruption to landowners and occupiers. These effects, while being difficult to quantify in monetary terms, are arguably at least as significant.

The level of risk associated with any particular event relates to a specific return period. People often assume if they have experienced a 1 in 100 year event last year, then it should be another 99 years until a similar event occurs. As Table 20-1 below illustrates, such an event has a probability of occurring in any given year.

For example, over a 30 year period, there is a:

- 25% chance of a 1% AEP (1 in 100 yr) flood
- 15% chance of a 0.5% AEP (1 in 200 yr) flood
- 6% chance of a 0.2% AEP (1 in 500 yr) flood.

Table 20-1: Probability of a flood event occurring in any given year.

Event	Probability Of Event Occurring In Any Given Year		
% AEP*	10 year period	30 year period	70 year period
5% (20 yr)	40%	80%	97%
2% (50 yr)	20%	50%	77%
1% (100 yr)	10%	25%	50%
0.5% (200 yr)	5%	15%	33%
0.2% (500 yr)	2%	6%	12%

* Annual Exceedance Probability

20.2 Inundation Design Philosophy

The inundation design performance standards that follow are minimum standards that apply to local sites, which must also be considered within the broader context of any floodplain management strategy for the overall catchment.

For any site the designer must also be aware of any issues raised by the Proposed Variation to the City Plan (Christchurch City Council 2000), and any floodplain management strategy for the overall catchment. For example, a floor level higher than the 2% AEP practical flood level Building Act standard is appropriate near the coast, tidal reaches of waterways, and on river floodplains.

Robust solutions that provide generous capacity and freeboard for maintenance activities, secondary flows, overflows in the event of blockage, and climate change are required. Inundation design performance standards set an absolute minimum standard and should be used as a guide only.

20.3 Secondary Flow Paths

Secondary flow paths can be defined as the course taken by excess flood waters when design capacity of the primary drainage system has been exceeded, or waterways/conduits are blocked. Secondary flow paths can include waterway overflows to and from large diameter pipe systems, sealed carriageways, and waterway flood plains.

Consideration of secondary flow paths is an integral part of the design of any drainage system. There are several factors to be considered regarding secondary flow paths including the following:

- Secondary flow paths must be clearly identified.
- They must be of sufficient capacity to ensure that levels of service are maintained along their length.
- They shall be located to ensure that they remain unobstructed.
- In the interests of a safe, predictable system operation during storms, secondary flow paths should always follow the primary flow path (unless this is not feasible).
- Where the secondary flow path deviates from the primary flow path, then protection by a legal instrument is especially important. Roads should be used for this purpose where appropriate.
- If the flow path is over private property, its purpose should be made obvious to the property owner, and the flow path should be protected with an easement in favour of the Council to ensure legal

protection. The easement document should be worded to prevent any activity over the flow path that could reduce its effectiveness.

- Other mechanisms such as a Section 221 Resource Management Act (RMA) title notice is another method of protecting the secondary flow path.

20.3.1 New Zealand Building Act

The designer is referred to the New Zealand Building Act, Surface Water Clause E1 (Building Industry Authority 2002), as follows:

Section E1.3.1:

- Except as otherwise required under the RMA 1991 for the protection of other property, the following applies. Any surface water resulting from a storm having a 10% probability of occurring annually, and which is collected or concentrated by buildings or site work, shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property.

Section E1.3.2:

- Surface water resulting from a storm having a 2% probability of occurring annually, shall not enter any buildings.

In addition, surface water shall not enter buildings during a more frequent storm event due to blockage of the drainage system.

20.3.2 Hill Catchments

For hill catchments, special care is required when assessing both primary and secondary flow paths:

- All existing gully areas should always be retained and treated as primary and/or secondary drainage paths. Where any of the existing gullies are to be abandoned or altered, then the designer shall clearly demonstrate that all environmental impacts can be mitigated.
- Easements shall be granted over the gully floor to allow for both piped and surface flow, as well as to provide for future maintenance and possible modification. Easements shall generally not be less than five metres, but may need to be greater.
- All stormwater interception and inlet systems situated in valley positions shall be designed to continue to pass design flows, even with up to 50% blockage.
- No valley position shall be created without a formalised (recognised legally as an easement over private property) secondary flow path immediately downstream, which will direct full design flow stormwater away from buildings or land that is susceptible to erosion.
- Information on hillside interception channels is given in *Chapter 5.2.2: Hillside Interception Channels.*

20.3.3 Waterways

Floodplains act as secondary flow paths, therefore building and filling should not encroach into the floodplain area. The Proposed City Plan setback rule (Volume 3, Part 9, Section 5.2.4; Christchurch City Council 1999) provides partial protection of floodplains.

Open waterways are likely to carry more debris than piped systems. Therefore the designer should consider the following:

- Possibly leaving the culvert or pipeline entry points unobstructed by grills.
- Where small entry size, or safety considerations require grills, dual entry systems (i.e. side and top entry) can be considered as secondary flow paths.
- Debris racks or grills placed upstream of inlets with clear secondary flow paths between may also be acceptable.
- Where such arrangements are impractical, then consideration should be given to a greater level of service in the design of the inlet system.
- At all times the designer should consider the unusual; abandoned washing machines and dead animals are some of the objects that have blocked inlets in the past.

Refer to *Chapter 13.2: Bridges and Culverts,* and *Chapter 13.4: Grills in Waterways.*

20.3.4 Small Catchments

Where it can be demonstrated that peak flows and total volume of stormwater is small, and therefore potential for damage is negligible for design storm events, it may not be critical to identify a secondary flow path.

20.4 Specific Design Criteria

The following minimum criteria for different land types and land use should be applied. Early consultation with Council staff is advisable for up-to-date advice on drainage design standards, as the minimum criteria is likely to change over time.

20.4.1 Public Roads and Road Reserves

Concentrated or collected surface water from a storm event having a 20% probability of occurring annually (five year return period) must not cause damage or nuisance to the road or other land.

Explanatory Notes

a) Stormwater should not encroach into the traffic lane on significant vehicular traffic routes. The encroachable width may require further discussion with the Council's City Streets Unit. Road type and duration of encroachment may determine the acceptability of stormwater encroachment. For example, short-term ponding in cul-de-sacs is often acceptable.

b) It is otherwise permissible to have the:

   i) 10% (ten year) design flow up to the back of the footpath level/private boundary

   ii) 20% (five year) design flow up to the top of the kerb level.

20.4.2 Public Reserves

Public Reserves should not be subject to deliberate inundation without the Christchurch City Council's approval. In most situations Council will agree to concentrated or collected surface water from a storm event having a 20% probability of occurring annually (a five year return period). Consideration can be given to more frequent events subject to flooding depth and duration. In all situations the flooding should not cause damage or nuisance to the reserve or other land.

Refer also to deliberate flooding criteria of Reserves/Sportsfields in *Chapter 6.6.2: Design Considerations (Detention Basins within Parks and Reserves).*

20.4.3 Private Flat Land

Concentrated or collected surface water from a storm event having a 10% probability of occurring annually (10 year return period) must not be likely to cause damage or significant nuisance to other land.

Explanatory Notes

a) A nuisance is not considered to have occurred if the design storm secondary flow path width is protected by an easement or suitably worded RMA Section 221 notice.

b) At the upper end of catchments discharging into the Council's main waterway/drainage system the Council encourages the temporary detention of stormwater. For large industrial or commercial carparks, swales, basins, constructed wetlands, and peak flow restriction devices are encouraged. This provides some water quality control and may reduce the size of structures needed downstream.

c) Refer also to *Section 20.4.5: Structures on Private Property* below.

20.4.4 Private Hill Land

Concentrated or collected surface water from a storm event having a 5% probability of occurring annually (20 year return period) must not be likely to cause damage or nuisance to the land or surrounding land.

Explanatory Notes

a) A higher standard is necessary on hill areas as the potential for high velocity water to cause damage is far greater.

b) A nuisance is not considered to have occurred if the design storm secondary flow path width is protected by an easement or suitably worded RMA Section 221 notice.

c) Refer to *Section 20.4.5: Structures on Private Property*, explanatory notes (c) and (d).

20.4.5 Structures on Private Property

Concentrated or collected surface water from a storm event having a 2% probability of occurring annually (e.g. a 50 year return period, or a higher nominated protection figure), must not be likely to cause any nuisance or minor damage to structures on private property. In addition refer to *Section 20.4.6: Essential Public Services.*

Explanatory Notes

a) In order to establish Minimum Floor Level for residential property, typically 300–400 mm above the estimated design flood level needs to be provided to take account of wave run up, survey inaccuracy, velocity head, etc.

b) Non-residential property, garages, basements, commercial property, etc, may have their floor level entrance at the 2% design level or, in some instances, lower. However, depending on the circumstances, Council may approve Building Consents for these structures subject to a Section (36)2 Building Act notice on the title. Note that this notice may have insurance and valuation implications for the landowner.

c) Council expects designers to ensure that new hill developments and dwellings will be safe from significant damage from storm generated debris slides. A such, a detailed geotechnical investigation is warranted.

To satisfy the Council that the Building Consent is able to be released without a Section (36)2 Building Act erosion title notice with respect to debris slide risks and inundation risks, the investigating/certifying Geotechnical Engineer must confirm that, in his/her professional opinion, the new structure/dwelling is unlikely to be damaged in either of the following two design events:

i) A debris slide generated by a low intensity long duration storm event, up to and including a 50 year return period storm (i.e. a constant rainfall of average intensity of 2.7 mm/hr for four days or 260 mm in four days), which may or may not be followed within the next four days by another short duration high intensity rainfall event, up to and including a 10 year 10 minute return period storm event of 11 mm of rain falling in 10 minutes.

ii) Stormwater entering the dwelling/garage from a short duration, high intensity rainfall event up to and including a 50 year return period storm of 15 minutes duration (i.e. 19 mm of rain falling in 15 minutes).

Council places strong emphasis on protection from overland stormwater flow. On most hillsides, a stormwater interception channel with an impervious base (e.g. concrete, or preferably an appropriate aesthetic equivalent) is expected to be installed above any development or excavation that has a significant uncontrolled catchment uphill. Individual interception and cutoff drainage paths for each lot are required (see *Chapter 5.2.2: Hillside Interception Channels*).

These certifications are required both before the Building Consent is able to be released and after completion of the construction works, before the Council will release the Code Compliance Certificate. This standard, clarified February 1998, is to apply until altered by 'Case Law' or 'Christchurch City Council Building Control Policy'. These criteria will influence the design of slope stabilisation measures and subsequent certifications.

d) Council encourages (within legal parameters of the Building Code, Environment Canterbury rules, etc), consideration of creative innovative measures that enable the beneficial treatment, use, or disposal of stormwater.

20.4.6 Essential Public Services

Concentrated or collected surface water from a storm event having a 1% probability of occurring annually (e.g. a 100 year return period, or even lower probability at the Parks and Waterways Unit's discretion) must not be likely to cause damage or nuisance to essential public services, including those related to Public Health, Civil Defence, and facilities involved in the disposal of sewage or the supply of power, water, and telecommunications.

20.5 References

Building Industry Authority (BIA) 2002. *Approved Document for the New Zealand Building Code, Surface Water Clause E1*. Scenario Communications Ltd. (on behalf of the Building Industry Authority), Wellington.

Christchurch City Council 1999. *City of Christchurch City Plan. The Proposed District Plan for the City of Christchurch*. Christchurch City Council, Christchurch.

Christchurch City Council 2000. *Proposed Variation to the City Plan, Variation 48: Flooding Issues in Christchurch. Draft Discussion Document*. Christchurch City Council, Christchurch.