Channel Form

Contemporary channel form and development varies along the length of the river. A high degree of channel confinement in the upper reaches provides for a confined and narrow valley resulting in erosion of the basement schist. The dominant characteristic of the river's central reaches is a relatively wide valley setting associated with a reduction in profile gradient.

Channel form within these reaches is influenced by sediment inputs derived from adjacent tributaries, such as the Branch Burn and Spotts Creek. In places, such as The Larches, geological and geomorphic controls dictate the river form by narrowing the valley floor considerably, in turn promoting a single thread sinuous channel conducive to sediment transportation.

Downstream of The Larches to the State Highway, a prevailing depositional zone in the river form exists, as the river loses transport potential beyond the confines of The Larches. Naturally, these reaches are dominated by a wide, braided channel margin subject to lateral migration however, over recent decades extensive modification of these areas, including commercial gravel extraction and river works, has removed the braided complexity of the channels (Figure.3).

Figure.3 Aerial photography of the Cardrona River between State Highway 6 and Ballantyne Road located between 3.0 and 5.1 km upstream of the Clutha River confluence.

Summary

Observed change in the Cardrona River's channel morphology and sedimentation characteristics indicates that sediment storage within the active channel margin has decreased considerably over surveyed periods. In addition, sediment replenishment within the river's main stem is primarily a function of large and/or recurrent flood events, which have sufficient energy to mobilise sediment deposits downstream.

Mean bed level and river profile analyses indicate that, while the river experienced an extraordinary sedimentation event in November 1999, the net trend over all surveyed periods has been one of net degradation. Should sediment replenishment rates along the Cardrona River main stem remain infrequent, it is anticipated that the river system will degrade further.

Further degradation may contribute to bank erosion and greater channel incision along the length of the river.

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Channel Morphology and Sedimentation in the Cardrona River

Summary Report February 2010

Otago Regional Council

Contents

Cardrona river

Introduction

Understanding the channel morphology and sedimentation characteristics of Otago's rivers enables their effective management. The Otago Regional Council (ORC) undertakes scheduled cross-section surveys of selected rivers as part of its river monitoring programme.

This information is used to understand the dynamic fluvial[1] processes of the river and to establish the general state of the river's channel morphology and gravel resource. The ORC has completed a study of the Cardrona River and the information contained in this report notes the main findings of the more comprehensive technical report *Channel Morphology and Sedimentation in the Cardrona River*.

Investigations into the channel morphology and sedimentation of the Cardrona River indicate that the river has experienced a significant net degradational trend over surveyed periods. Some cross-section locations exhibited net aggradation of mean bed levels and/or the channel thalweg which, in general, has been attributed to localised effects of adjacent tributaries and changes in channel morphology.

This study has noted that sediment storage within the active channel margin has decreased considerably over surveyed periods - with sediment replenishment of the river's main stem primarily a function of large and/or recurrent flood events.

Changes in the Cardrona River channel morphology are also apparent in aerial photography where imagery taken in 1966 exhibits a naturally braided, sediment-rich active channel margin. Subsequent photography, during the late 1990's and 2006, indicates that the braided complexity of the natural river form has been lost due to extensive modification of the active channel and a reduction in sediment replenishment rates.

1. Refer to glossary

Catchment Description

The Cardrona River catchment drains an area of 337km^2 and is bound by the Crown Range to the south and west and the Criffel and Pisa Ranges to the east. The river flows in a north-easterly direction from its headwaters, at the crest of the Crown Range, to its confluence with the Clutha River adjacent to Albert Town, a distance of approximately 40km.

The catchment is highly erodible. It is comprised of schist in the upper reaches dominated by alluvial gravel deposits in the lower valley. Sedimentation is largely related to recurring flood events which have sufficient energy to transport sediment downstream. An extraordinary example of this occurred during the flood of November 1999 where the river aggraded significantly causing migration of the channel and bank erosion.

Investigations

Channel form and development within the Cardrona River are representative of a very dynamic system that exhibits periodic reaches of braided to single thread channel planforms.

Analysis of cross-sections, aerial photographs and anecdotal records, supported by field inspections, indicate that the river is in a presiding degradational state due to extensive contemporary modification of the channel form and reduced sediment replenishment rates within the active channel margin.

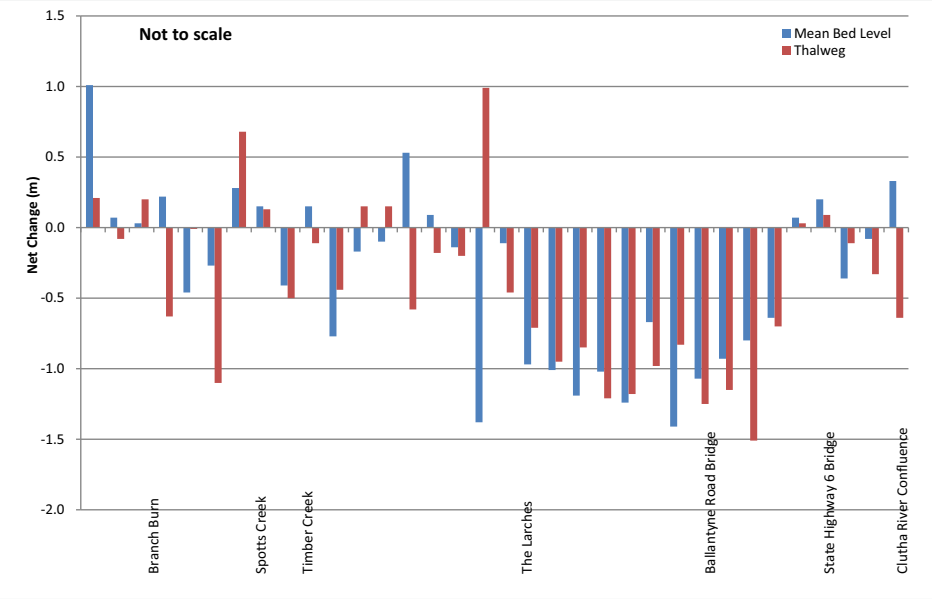

Figure.1 Graph showing net change in mean bed level and thalweg level across all survey periods for each cross-section.

Mean Bed Levels

Figure.1 shows the net change in mean bed and thalweg levels calculated for each cross-section over each respective survey period. Of the 34 comparable surveyed cross-sections, the mean bed level experienced net degradation at 22 locations with 12 cross-sections experiencing net aggradation. Two cross-sections experienced net aggradation greater than 0.5m over surveyed periods.

Comparatively, 13 cross-sections experienced net degradation greater than 0.5m, 12 of which are located between The Larches and the State Highway 6 Bridge (a distance of 6.9km). The greatest change in mean bed level, at cross-section 41 just upstream of Ballantyne Rd, occurred during the period 1988 and 2007 with degradation of 1.41m. Notably, cross-section 54-2, in the vicinity of The Larches, experienced net degradation of 1.38m over the nine year survey period 1998 to 2007.

Longitudinal Profile

Observations of the longitudinal profile indicate that the Cardrona River form has, in general, been subject to a presiding degradational trend from 1988 to 2007. The shape of the 2007 profile indicates that active channel sediment storage, particularly in the 6.9km reach downstream of The Larches (Figure 2), has significantly decreased.

Of the 34 surveyed locations, two cross-sections had thalweg levels that increased by greater than 0.5m, a phenomenon largely attributed to a significant change in channel form. In comparison, 16 cross-section locations experienced lowering, or degradation, of the channel thalweg by 0.5m or greater over each respective survey period.

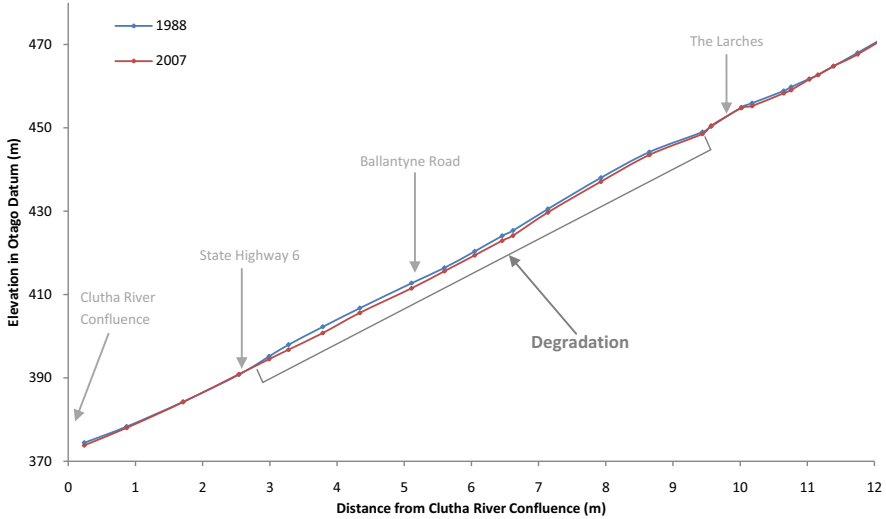

Figure.2 Longitudinal profile of the Cardrona River lower to mid reaches channel thalweg for 1988 and 2007. Otago Datum lies 100m below mean sea level therefore, subtract 100m to relate values to mean sea level.

Glossary

Aggradation
To raise the grade or level of the river bed primarily by depositing sediment accumulations.

Channel Planform
The shape or outline of the river generally defined by morphometric characteristics such as channel width, length and depth.

Degradation
To lower the grade or level of the river bed primarily through the removal of sediment.

Fluvial
Relating to or formed by river processes.

Longitudinal Profile
The shape of the river profile along its length, determined from the channel thalweg.

Mean Bed Level
The mean level of the river bed as calculated at a particular location or cross section.

Thalweg
The lowest point of the cross-section i.e. the lowest part of the channel

Channel Morphology and Sedimentation in the Cardrona River **Feb 2010**