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Aerial Photographs and the Record of Agriculture and Engineering in Otago, New Zealand

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SUMMARY: *Otago has a wealth of engineering, goldmining and agricultural sites. Aerial photographs are essential to recognise and map sites and helpful in interpreting the meaning of patterns. The patterns may reflect a range of underlying variables such as the exploited resource, the facilities needed to exploit it, transport and social factors such as the supporting settlements, and also modern heritage management issues. Aerial photographs may also be used in illustrating and dramatising sites. Conventional wide-area aerial photographic coverage is useful but, for detail, custom-flown vertical aerials in medium format film and digital media are better. Historical aerial photographs (which date back to about 1945) also have applications, especially where there has been substantial landscape change. On the upper Shotover River, historical processes depended on settlement enclosure and mining capital investment all of which can be investigated using aerial photographs. In addition, examples of aerial photographs of a range of engineering subjects in Otago are shown.*

KEYWORDS: *engineering, goldmining, farming, historic landscapes, Bannockburn, Shotover, Waitaki Dam, Waianakarua bridges, Macraes, Criffel Range*

1. INTRODUCTION

New Zealand has been covered by vertical aerial photographs since mid World War II, flown by New Zealand Aerial Mapping Ltd for the Crown (1). The coverage was repeated up until the 1970s when the last national topographic mapping programme was set up. White's Aviation (2) took a number of large format oblique photographs, many in Central Otago, in the 1950s and 60s. These series comprise a uniquely valuable historical record of the New Zealand landscape which has undergone rapid change since the 1960s. White's Aviation photographs are now available at the National Library and the contact sheet runs of New Zealand Aerial Mapping (NZAM, comprising I estimate 5-10 tonnes of paper) are at the National Archives, both in Wellington.

Today Land Information New Zealand (LINZ) attempts to give national coverage in a programme of digital orthophotos at 1:25,000 scale (<http://www.linz.govt.nz/topography/aerial-images/index.aspx>). At best the orthophotos provide a simple layer for use in general Geographic Information Systems (GIS) applications. Many agencies particularly regional and district councils and large land managers commission their own aerial photographs. These photo runs appear to be the source of the better quality aerials on Google Earth.

The key sources for the history of goldmining in Otago are Parliamentary reports and the series of Geological Survey Bulletins (issued from 1890 to 1940) and G.J. Williams (3) *Economic Geology of New Zealand*. In the last few decades, important recorders of the archaeological landscape include Dr Jill Hamel (4), Dr Neville Ritchie (Clutha Valley Project) and Peter Petchey (see below).

2. AERIAL PHOTOGRAPHIC METHODS

2.1 Bannockburn landscape example

In the course of a recent (2004) landscape study, contracted by the Department of Conservation's Research Development and Improvement Division (RDID), Peter Petchey used older conventional photography to map the full extent of the Bannockburn (and Carricktown) landscapes (5). The photograph run was taken 7 March 1958 and is of small to medium original scale (1:16,500, the scale on the negative) sufficient to reveal much essential detail such as sluice faces, dam banks, mullock heaps and major races (Fig. 1). However, at this scale it is difficult to detect small features with low contrast such as the eroded bases of sod walls.

2.2 My aerial photographic methods

I have used medium format film cameras to take low level (below 3,000 feet) oblique photographs, occasionally vertical, and lately the digital equivalent of

35 mm SLR photographs. Because of the cost and lack of flexibility (printing, scanning) of film, I have reluctantly given away film.



Figure 1. Bannockburn NZAM vertical 2693/12 7 March 1958 at approximately original scale. Stewart Town is just left of centre.

Taking aerial photographs with the lens oriented at about 45 degrees below the horizontal exploits the many advantages of the elevated view. At the same time a fairly conventional view of the elevations of buildings is achieved. I also find that I can take, especially with the 35mm camera, wide angle views that scan from below the aerial viewpoint and up to the horizon, i.e. there is a low-angle (near vertical) oblique in the foreground, effectively looking down at the subject, but it is framed in a setting which recedes to the surrounding hills and the horizon. This type of photograph provides much needed context for particular sites and fits well with the landscape approach.

If the subject warrants it, instead of making a broad circuit around the subject and pointing the camera at about 45 degrees, I fly straight above the subject, keeping an eye on it as it approaches. Once above the site, I instruct the pilot to make a steep bank and I can point the camera more or less vertically on to the subject. This gives a good plan view similar to that achieved in a map. It allows instant recognition of the pattern of features on the ground but is not so good at revealing the setting, or how the setting might feel if visited on the ground.

The original scale of the photographs is between 1:3,000 and 1:15,000 and allows for the observation and mapping of good detail. This and the subject matter mean that I have tailored a niche that conventional aerial photography does not cover, e.g. in the area of Menzies Dam and Stewart Town, Bannockburn (Fig. 2). Many other examples can be found in my two books (6, 7).



Figure 2. Near vertical oblique of Stewart Town (compare Fig. 1).

3. GOLDMINING, DAMS AND EARLY FARMING ON THE SHOTOVER

I have photographed the Shotover on a number of occasions using both oblique and medium format vertical aerial photography (Appendix A). Gold was discovered there in November 1862 both alluvial, and later, the major source lodes in the Mt Aurum area (3). By the 1890s it had settled to a steady pattern of terrace exploitation using California sluice monitors and becoming steadily more capital intensive with larger dams and investment in races. The area was abandoned during WW I and re-worked in the 1930s using dredges with large investments in river diversion through cuts in the river bed (Sandhill Cut) and through elevated sheet-metal fluming (at Maori Point).

In 2003 I took systematic medium format coverage of all areas with alluvial mining and in 2006 I led a small Department of Conservation team to make ground records and to observe controls using Geographic Positioning System (GPS) grid points on pinpoint features that could be seen in the aerial photographs such as the intersection of races or the tops of fence posts. I was also able to record and calculate the depths and area of dams/reservoirs, the section and gradient of supply and head races and the nature of the small miners' settlements that are associated with the fields. Following the fieldwork I mapped to scale all the alluvial areas in detail. The results were reported in Jones (8).

The volume of dams fell into two intuitive classes: small less than 1500 m³ and medium 5,000 – 15,000 m³ (Fig. 3). The small dams are scattered throughout the Shotover and represent earlier efforts by small teams of informally organised men. The medium dams were company dams built on the large heavily exploited

terraces below the Skippers Creek which rises in the main lode areas at Mt Aurum. All dams and head races were informal affairs, did not comply with the guidance in Gordon's (9) *Mining and Engineering; and Miners' Guide* and the dams were much smaller than the late nineteenth-century government dams described by Offer (10) in his *Walls for Water: Pioneer Dam Building in New Zealand*. For point of comparison with Offer, the total volume of the 60 or so dams on the upper and middle Shotover was 94,000 m³.

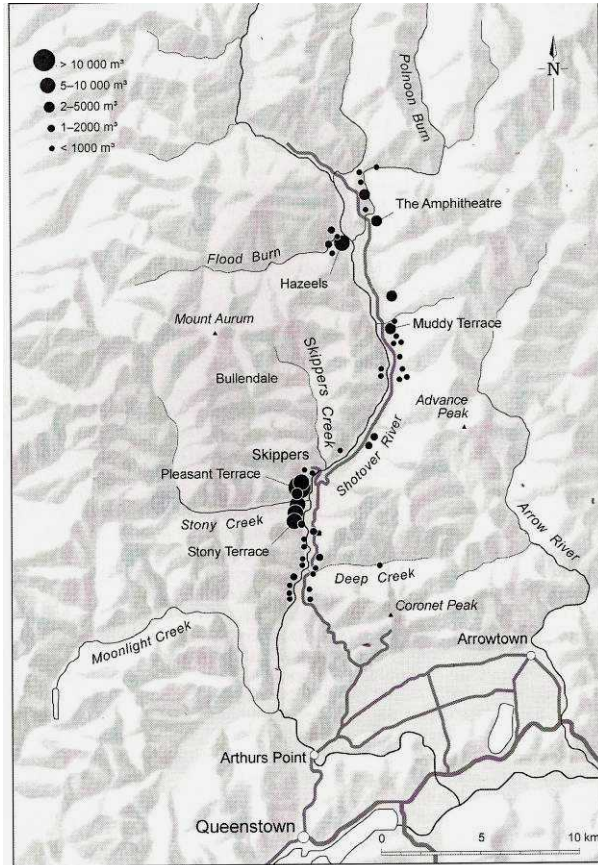


Figure 3. Volume of dams on the Shotover. Courtesy *New Zealand Journal of Archaeology*.

The gradients of head races were seriously steeper and at variance with the gradients of 16 feet per mile (1:300) recommended by Gordon. Again, I suggest that what we are seeing for the most part are early (pre-1880) informally engineered investments that were dictated by the need to get water to the sluice face with the least possible short-term effort. Gordon's recommendations apply to carefully engineered and costly supply races from a later, more capital-intensive period after 1880.

Finally, most of the large areas of alluvial mining were associated with small settlements marked by sod house ruins and ditch and bank enclosures. The enclosures were to keep stock out and to provide yards and gardens for the miners. The largest was just over the proverbial one acre of the miner's right, most were smaller because they had to fit on narrow terraces. This suggests that the

earliest miners (1862-1880) brought in horses and their own stock of sheep. It also suggests that there would be conflict with pastoral licence holders in the valley, not simply because of the stock but because of the miners' lawful right to cut races and to fill valleys and river courses with waste gravel.

I found only one site that seemed to be solely of pastoral licensee origin. This was at The Neck between the Polnoon and the Shiel Burn where there is a ditch and bank fence some 120 m long across the high ground between the two streams (Fig. 4). The fence will date to the period before the 1880s (when galvanised wire came into use). In autumn it would have held the sheep up in the high tussock country of Snowy Peak, to be let back down to the easy 'lowland' pastures of The Island just before the snows came.



Figure 4. The Neck, Polnoon at left, Shiel Burn right. The ditch and bank fence runs across the narrowest point at top. The tunnel runs from the prominent bend at top centre to the bright area of water at right.

Here are some further impressions of my aerial photographic observations on the Shotover.

The remarkable features of Muddy Terrace were in a yellow brown tussock cover with the dams and races defined by the shadows of the afternoon light (Fig. 5). Here and there were sporadic traces of races, dams and sluiced terrace edges. The actual amount of mining seemed low, compared with the extent and invasiveness of the mining further down the river by Skippers. Perhaps these terraces, upstream from what is regarded today as the main lode areas such as Bullendale, had little to offer the miners. Certainly they were not as heavily exploited as the terraces below Skippers.

The downstream end of the Polnoon Burn, above its confluence with the Shotover, is perched above the main valley. About 4 km up it was diverted through a tunnel into the nearby Shiel Burn which allowed the lower part of the Polnoon to be exploited for gold (see Fig. 4 above). I was able to photograph the stream of

water which flows with some force out of the tunnel and down a rocky slope into the burn.

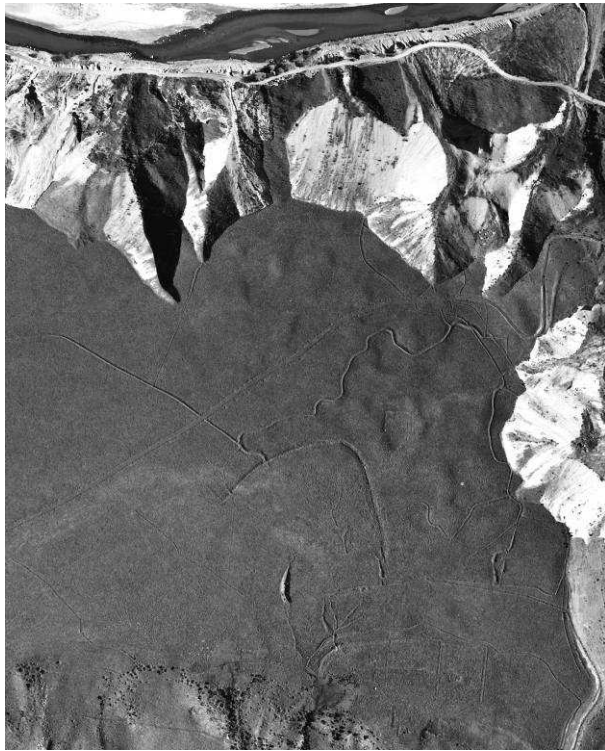


Figure 5. Medium format vertical of Muddy Terrace, dams at centre and bottom (total volume 5,200m³), sluice faces and the Shotover River at top.

Below Skippers township and the bridge, the terraces have been very heavily exploited by sluicing with California sluice monitors. As much as half to two

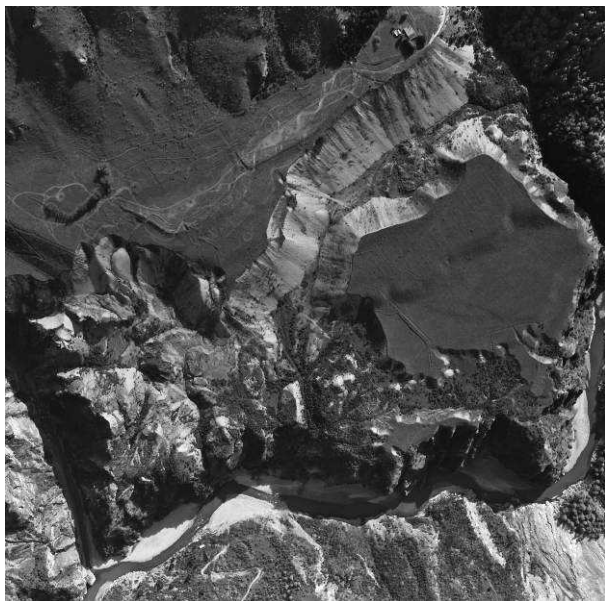


Figure 6. Medium format vertical of Pleasant Terrace, Shotover at bottom.

thirds the volume of some blocks of terrace has been removed as at Pleasant Terrace (Fig. 6). The terrace remnants have shallow dams fed by supply races. In some cases the races have entered the main valley by crossing cliffs where only fragmentary wooden supports and light gauge steel pipes remain of the fluming and pipes which carried the water the final few hundred metres to the dam.

4. ENGINEERING SUBJECTS IN OTAGO, SOME EXAMPLES

4.1 The Waianakarua bridges

About 10 minutes flying to the south of Oamaru are the branches of the Waianakarua River and the SH 1 and rail crossing. The river is in two courses. The southern Waianakarua bridge was completed in 1869 and the northern in 1874. Built in Oamaru limestone, the engineer was J.T. Thomson (from 1876 the Surveyor General). They are the oldest bridges on S.H. 1 and have very elegant flat arches in elevation (side view) while the northern one is skewed from the line of the river and has a distinct humpback profile, well captured in an aerial photograph (Fig. 7).



Figure 7. The northern Waianakarua bridge.

The southern one was widened in 1962, losing the parapets (11), and giving it a modern form superstructure, driven by the demands of the roadway. This wonderful pair of bridges later had further modifications with the re-alignment of the approaches to the northern one. It was widened symmetrically with a new concrete superstructure, then the stone parapets (damaged by trucks) reconstructed on the deck cantilevers (Jill Hamel, Lloyd Smith pers. comm.). The aerial photograph shows the relationship with the corresponding rail bridge crossing about 20 metres downstream.

4.2 The Waitaki Dam (1936)

The dam became fully operational in 1936 (*New Zealand Historical Atlas*, plate 88). The dam does not have a conventional spillway gate and over-flow race. Instead surplus water flows over the long (more than 500 m) curved sill which forms the full length of the dam (Fig. 8). The power house on the southern flank is a well known piece of late Art Deco but the curve of the face of the dam and the thickness of it seeming to

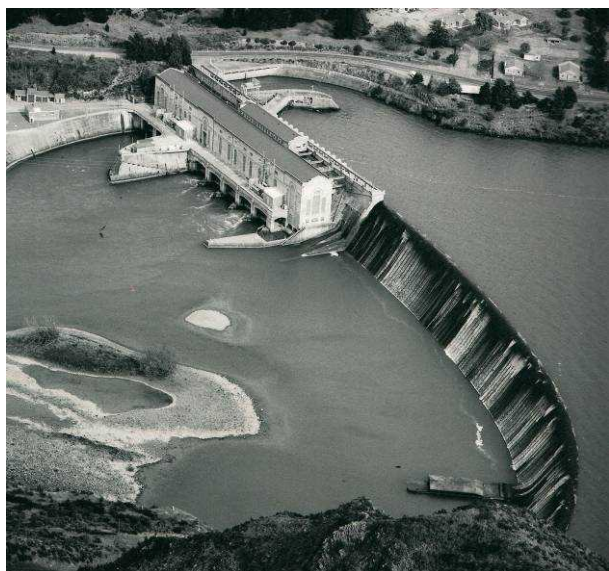


Figure 8. *The Waitaki Dam (1936).*

vanish as it reaches the level of the lake seems to be both elegantly Deco and miraculous in its engineering.

The broad-footed gorge across which the dam is built seems to be one of those areas where wind and turbulence concentrate. There was an irregular tilting of the aeroplane as we tracked over the hills to photograph the dam. At lake level 2000 feet below, every now and then a small gust would stop and then lift the water trickling over the sill, raising a sheet of spray and blowing it back into the lake.

4.3 The Mt Buster Diggings

The Mount Buster diggings are on a basement of old quartz sand (geologically an old lake bed), as are the deposits in the Nevis valley, the Pisa Range, the Manuherikia valley, at St Bathans and at Kyeburn (3, 11).



Figure 9. *The Buster Diggings.*

The miners removed the topsoil and overburden to get at the gold-bearing deposits, the base of the deposit presents the white or greyish-white surface of the quartz sand. On Mount Buster or Clarkes Diggings, the oval area of quartz sand left after the sluicing are seamed by the dendritic (branch-like) form of the tail races (Fig. 9). Filled with peat, they stood out in a dark colour, each of the sluiced areas like a section of a kidney with the veins showing. Tiers of dams, filled with a slow accumulation of peat, occupy shallow gullies above the sluiced areas. Races lead from them to the work face but the relief of the land is difficult to determine in the flat light from the overcast sky.

4.4 Golden Point Historic Reserve and Macraes open cast

The modern Macraes opencast mine has worked out the general area of the old adits and drives on the lodes which fed the batteries at Golden Point, now an Historic Reserve. From 1888-89 through to 1944, the miners exploited the main economic lodes here (12), conducting deep, branching drives at many levels into the reefs. Golden Point Historic Reserve itself is an important assemblage of batteries, other buildings, hut terraces, and a series of dams from which water was taken via races to drive the battery and to exploit the small area of alluvial gold on the narrow valley floor (Fig. 10).



Figure 10. Golden Point Historic Reserve. Callery's Battery at centre, old mullock, adit entries and the boundary of the Macraes open cast at top right.

From the air, the significance of the reserve may seem reduced by the area of the open cast, but they both reflect the same economic imperative – gold extraction – and the one is partly the reflection of the other. But the technology has changed along with community attitudes.

4.5 The Criffel Range diggings

These were a cluster of short-lived, high-altitude (1300 m a.s.l.) fields that had a continuing shortage of water. At its peak (1880s) it was served by a series of very long races (some 15 km long) from the upper reaches of the Luggate Creek and a pack track from the Wanaka area. I mapped this field from 35 mm format positive film (slides) at original scales of 1:18,000 enlarged for mapping to scales between 1:2,800 and 1:5,000 (see Fig. 11).

In this challenging environment, a lot of effort was put into exploratory shafts and into securing a supply of water that was suitable for only a short summer season of effort. The water races as recorded are in fact three narrow benches on which pipes probably of a thin gauge of steel were laid.



Figure 11. Medium format vertical of Western Criffel Diggings showing pipe route top left and exploratory shafts top right.

5. CONCLUSIONS

In this paper I have reviewed the value of older vertical aerial photography for historical analysis. It is critical that these resources are retained and kept well curated for use at the National Archives, Wellington. The current circumstances of aerial photography in New Zealand are that national programmes are weak (for the large scales needed for archaeological work) and there are many niche areas of aerial and remote sensing all looking for a market. My own practice is large-scale (low-level, below 3,000 feet) oblique and vertical aerial photographs of sites, structures and buildings, using the advantage of the aerial view: identification, analysis of pattern and persuasive imagery for advocacy of heritage. These methods all have application to the remarkable heritage of engineering in Otago.

6. ACKNOWLEDGMENTS

The conventional New Zealand Aerial Mapping vertical photographs are Crown copyright. My photographs were taken in the course of employment by the Department of Conservation. My original paper on the Shotover was published in the *New Zealand Journal of Archaeology*. Parts of this paper were developed in the course of seminars on 'Writing the Land' at the International Institute of Modern Letters, Victoria University of Wellington. I thank Dr Jill Hamel for comments on the draft.

7. REFERENCES

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8. APPENDIX A

Aerial photographic flights carried out in Otago. Negatives and originals are held at the Head Office Department of Conservation and should be accessed through kljarchaeologist@paradise.net.nz. A search fee is charged. National coverage is listed at: <http://www.nzarchaeology.org/elecpublications/aerial%20photo%20index%20.htm>

Sites covered	Date
Kawarau, Cromwell, Northburn, Bendigo, Arrowtown, Chinatown	Aug 1991
Earnslceugh, Kawarau Gorge, Macetown, Branches Station, Shotover River, Skippers, Moonlight Creek	5 Sept 1995
Macetown, Heyes Creek, Branches, Mt Aurum Station (verticals with 35 mm camera)	23 June 1996
Gibbston, Coalpit Saddle, Nevis, Alexandra, Manuherikia R, Otago Central Railway (Raggedy Range), Poolburn Viaduct, Cambrians, Bendigo, Kawarau Goldmining Centre/Gees Flat	24 July 1997
Arrow River (verticals), Macetown, Brackens gully, Heyes Creek, Soho Homestead, Rich Burn, North Branch Arrow, Scanlans Gully, Sylvia Creek, Advance Peak	24 May 1999
Cargill's Castle, Donaghy's ropeworks, Larnach's Castle, peninsula fields, Quarantine Island, Carey's Bay hulks, Otakou umu ti, Harrington Pt, Taiaroa Head, Long Beach, Mapoutahi, Seacliff rail cuttings, Puketeraki, Huriawa, Cornish Pt, Matanaka buildings, Pleasant River, Shag River, Katiki Point, Moeraki wharf, Dunback lime quarry, Macraes, Golden Point, Murphy's Flat, Nenthorn, the Great Sod Fence, Barewood, Lake Mahinarangi, OPQ Battery, Gabriel's Gully, Blue Spur	22 July 1999
Timaru, Waitaki River mouth, Pukeuri, St Kevin's College, Waitaki Boy's High School, Railway Station, Catholic Cathedral, Masonic Hall, Whitestone area/Harbour and Tyne St, Waitaki District Council Chambers, banks, gardens, Cape Wanbrow, Kaka Point, Totara Estate, Waianakarua bridges, Shag Valley Station, Golden Point, Deepdell Station, Longburn, Kyeburn, Mt Buster, Otekaike	18 April 2002
Timaru, Waitaki River panoramas, Maerewhenua, Waitaki Dam, Otekaike, Mt Buster diggings, Kyeburn diggings, Longburn Station, Taieri Lakes Station, Cottessbrook Station Garthmyl Station, "Stonehenge" on the Rock and Pillar Range, Puketoi Station, Taieri meander belt, Rough Range, North Rough Range, Oturehua, silcrete quarry, Hayes Engineering Works, Blackstone Hill Station, St Bathans, Blue Lake, 'Grey' Lake, Lauder Creek and Thomsons Creek goldmining, Bendigo, Kawarau Gorge, Roaring Meg hydroelectricity station, Kawarau suspension bridge.	21 April 2002
Olveston, Royal Tce, Botanical Gardens, Knox Church, Otago Museum, Benhar, township, Hoffman Kiln, industry Milton, limestone quarry near Milton, Taieri Mouth, Taieri Island, Brighton, Clutha mouth, Watson's Beach, Myre's Homestead, Balclutha rail bridge, Balclutha road bridge, chicory kiln, Waitepeka, Telford Inst, Clutha mouth, The Glen, Romahapa, flax mill, mill pond, Nuggets, Lighthouse, Pt Molyneux cemetery, Murikauhaka, Port Molyneux township, Wharf shed, Flax mill (Flax Mill Road), Dunedin Southern Cemetery, Otago University quadrangle, Northern Cemetery, Botanical Gardens, Octagon, St Clair, Black Head, Otago Boys HS, Otago Polytech, Railway Station, Dominican Priory, First Church, Octagon, Quarantine Island, Goat Is, Scott Memorial, hulks (Carey's Bay), Victoria Channel, Harbour Basin, Port Chalmers.	3 July 2002