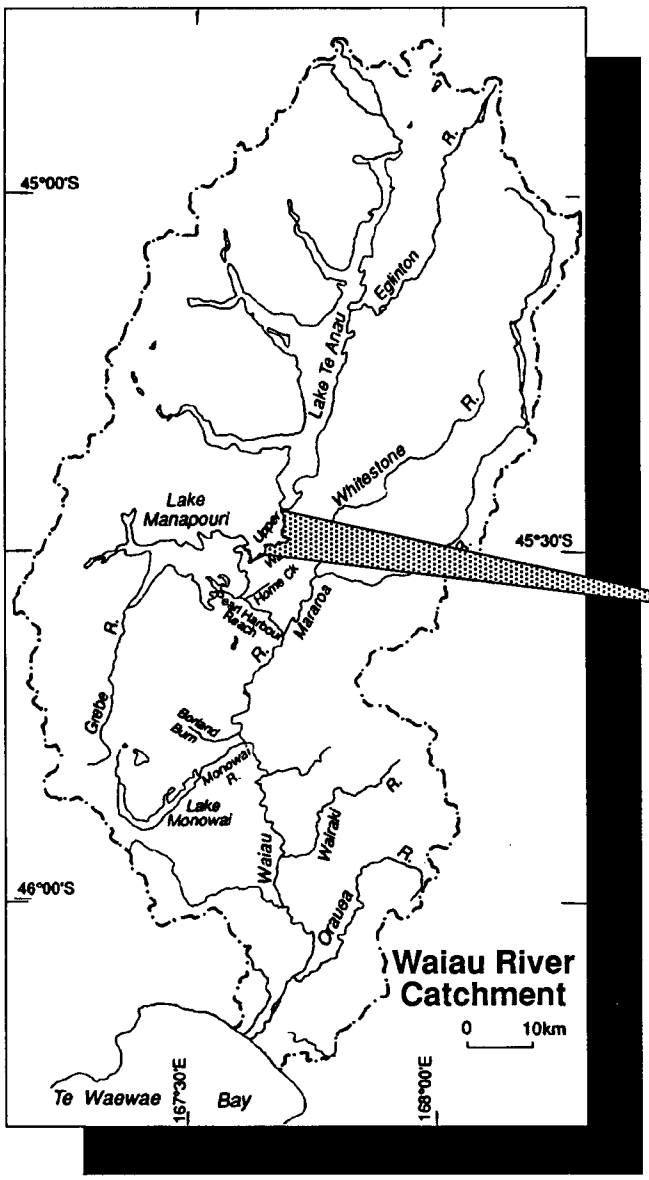
WAIRAU (UPPER WAIAU) Reach Analysis

Gary J. BRIERLEY
April, 1993



Upper Waiau (Wairau) River

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REACH NAME : UPPER WAIAU (WAIRAU) REACH

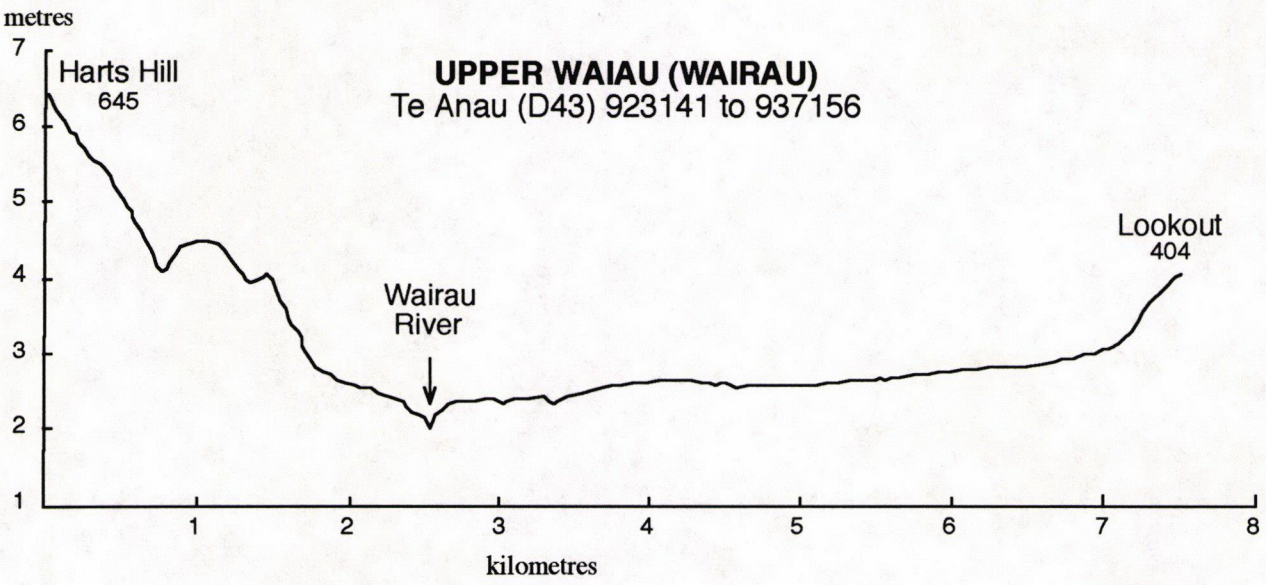
Geographic description of reach : Single-channelled, sinuous course of Waiau River between Lakes Te Anau and Manapouri. The river is deeply incised into former lake bed and glacial outwash deposits, and is accordingly laterally stable. Bank composition changes considerably down-reach, conditioned by differential preservation of glacially-derived materials. The flow regime in this reach is controlled by a control structure at the outlet of Lake Te Anau.

Analysts : GB, AB, AH Date of Analysis : 13.01.93 and 16.01.93

Grid co-ordinates of reach : Manapouri (NZMS 1, S149), 1:63,360, 736170 (Te Anau (D43) 1:50,000, 945163) to Manapouri (NZMS 1, S149), 670102.

VALLEY CHARACTERISTICS

Valley cross section



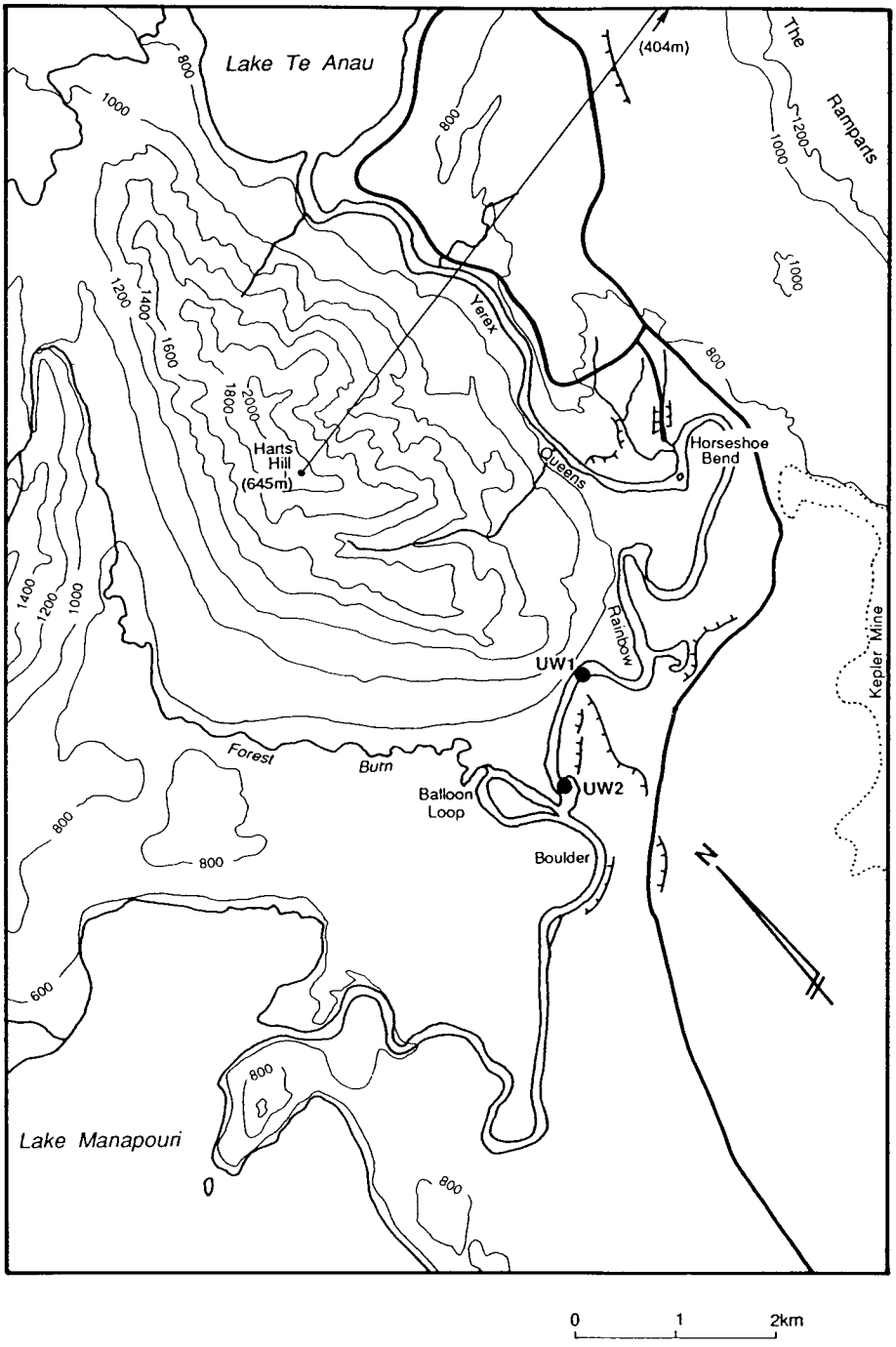
Valley setting

Steep hilly terrain between Lakes Te Anau and Manapouri, with extensive flat upper terrace surface of former lake bed. The upstream half of the reach has the steep-sided Harts Hill at its margin. Along most of this reach the right bank forms the margin of Fiordland National Park, and is covered by beech forest.

Extent of Valley flat

Upper Waiau (Wairau) Valley broadens down-reach. In the upstream half of the reach, the right bank abuts against Harts Hill. This moderate valley confinement extends downstream through Yerex and Queens reaches, where valley width is up to 2 km, but adjacent to Rainbow Downs (between Queens and Boulder reaches) the valley flat narrows to 1.5 km. Beyond this area the valley flats of the former lake bed are very extensive on both banks of the river. In the area adjacent to the swamps at the headwaters of Home Creek the valley flat is 5-6 km wide.

UPPER WAIAU (WAIRAU) Manapouri (S149) 1:63,360



LEGEND

- Road
- 500 — Contours (feet)
- Terrace riser
- Creeks / rivers
- Cross section
- UW — Sample location
- Reach margin
- Catchment margin

Terrace character

Terraces are highly variable down-reach. These are largely incisional features associated with river degradation through former lake bed deposits. Sedimentary sequences exposed in terraces are quite different to deposits observed elsewhere in the Waiau catchment, with a significantly greater proportion of sand. Braidplain deposits of outwash plains locally overlie these lacustrine sequences, but the Quaternary history of valley infilling is regionally complex.

Left Bank

The former lake bed lies at between 30-40 m above the present channel. This continuous terrace surface has a range of discontinuous features beneath it. Between the Te Anau lake control structure and Yerex reach a 4-5 m terrace is noted. At the bend at GR 946150 a 20 m terrace surface is transitional downstream to a lower (10 m high) surface which may possibly represent an inset feature. An irregular shallow platform is observed 2-3 m above the channel in Yerex and Queen's reach. This lies in front of more extensive upper terraces. The bend at the head of Rainbow reach (GR 945106) has a 10 m high terrace at its outer margin, while the eroding outer bank at the end of Rainbow reach (GR 937102) is about 30 m high. Downstream of Balloon Loop, at the outer bank of Boulder reach, the upper (40 m high) terrace abuts directly against the channel. In the 1.5 km long straight channel section downstream of Boulder reach (GR 906080) the channel-marginal terrace is 15 m above the present channel. To this point the terraces are composed primarily of sand beds that are inclined downstream, typically with bedded gravel sequences atop. In the tight bend at the end of the straight section beyond Boulder reach (Manapouri Map sheet GR 680075) terrace composition changes abruptly to blue muddy sands. These are approximately 15 m high, with about 5 m of clean sands atop. This localized feature is transitional downstream to 8-10 m high terraces composed of variable proportions of sand/gravel. These surfaces extend virtually to Lake Manapouri, although this is not a continuous surface.

Right bank

Terraces are much less extensive than on the left bank. Three discontinuous terrace surfaces are evident, at 2-4 m, 8-10 m and around 20 m above the present channel. A small remnant of an upper terrace surface, 10 m or so above the level of the lake bed, is evident opposite Te Anau Aerodrome (GR 947136).

Extent and character of Alluvial flat

Alluvial flats are non-existent other than shallow zones on the insides of bends where discontinuous surfaces are 1-2 m above the present channel position (e.g. area by the boat launch in Queens reach).

Degree and character of channel constriction

The channel has an imposed condition throughout this reach, as channel margins abut directly against fairly high terraces for most of the reach.

Character and impact of tributary streams

Other than small, localized impacts, such as the input of gravels from the small stream immediately downstream of the boat launch in Queens reach, tributary impacts appear to be negligible in Wairau Reach. The downstream half of Balloon Loop is murky as it infills with fines from Forest Burn. The upstream half of the loop has already largely infilled. Most other tributaries are marked by small fans that barely extend into the Waiau.

Surficial geology

Waiau channel is incised into sand-dominated fluvio-lacustrine sequences, the composition of which is locally variable. In some exposures gravels are dominant. The vertical arrangement of sands/gravels is interchangeable from exposure to exposure. These units are mapped as Manapouri Sand (McKellar, 1973). Blue muddy fine-sands are observed in a 15-20 m high exposure at the outside of the bend at GR 680075 (Manapouri Sheet). Prospect Formation sequences, of late Miocene to basal Quaternary age, outcrop on the west bank of Waiau River at GR 736134 (Manapouri Sheet). These thick sequences of greywacke gravel set in a lightly cemented sandy matrix, with discontinuous sand lenses and some beds of sand and silt, are probably extensive beneath the forest cover in Fiordland National Park (McKellar, 1973). Harts Hill is composed of quartzose feldspathic sandstone and mudstone of early Tertiary age. Fiordland complex plutonics lie behind Harts Hill and terraces on the right bank. Fiordland Plutonics in this area consist primarily of gneisses, granites and schists of Palaeozoic age.

Vegetation

Valley side/flats : Beech with some podocarps (e.g. Rimu). Some right-bank areas were cleared for agricultural purposes earlier this century. These area now have secondary manuka forests. Bracken is prevalent.

Alluvial flats : Barely evident.

Bars/Banks: Small shrubs and grasses, e.g. lupins are observed on bar surfaces. The banks are dominated by a manuka gallery forest, with grasses, flax, rushes, ferns, lancewood, and pepper-tree.

Land use
Pasture on the left bank; right bank is primarily forest with walking tracks through Fiordland National Park. Kepler track follows the river bank for some distance.

Direct human impacts
The primary human impact on Wairau reach is the flow control structure at the outlet of Lake Te Anau. At the time of construction the channel immediately downstream of this structure was deeply scoured. Other impacts which have affected the local sediment and erosional regime of Upper Waiau River include development of the boat launch and realignment of the tributary stream in Queens Reach, gravel extraction on the large gravel bar at Balloon Loop, and the reported dynamiting of the gooseneck of Balloon Loop in 1965.

CHANNEL CHARACTERISTICS

Number of channels : The reach is single channelled along its course, other than localized disruptions associated with discrete sediment inputs to the channel. These occur in divided channel sections around dissected point bars, adjacent to the large bank-attached compound bar opposite Balloon Loop, and in gravel accumulations immediately downstream of eroding terraces.

Channel geometry : A relatively uniform channel width of 80-100 m is maintained throughout the reach, other than broader areas among dissected bars. Several deep pools are evident, but they do not appear to be regularly spaced. Some shallow benches are evident in the outsides of bends (e.g. the large bend at the upstream end of Rainbow reach at GR736114 (Manapouri sheet)).

Sinuosity : Upper Waiau channel has an imposed alignment of highly variable sinuosity. The reach from the Outlet, through Yerex to Queens Reach has low sinuosity. A series of tight confined bends extend from Horseshoe Bend through Rainbow Reach to Balloon Loop. There are two broad bends in Boulder Reach, prior to a more open pattern of bends in the stretch through to Lake Manapouri.

Lateral stability of channel(s) : The channel is laterally constrained throughout the reach, and is therefore stable. Occasional terraces at the outside of bends are being actively trimmed.

Bar type and scale
Bars are spatially discontinuous, associated with the downstream variation in channel alignment. Most bars are restricted to the insides of bends. These point and compound point bars have varying degrees of dissection. In several instances mid-channel and diagonal bars have formed just downstream of eroding terraces. Opposite Balloon Loop a large bank-attached compound bar has developed. This has been dissected adjacent to the main channel, and a series of small riffles and mid-channel bars have formed. This large bar complex reflects local imbalance in the sedimentation regime of Upper Waiau River.

Bed/Bank character (extent and materials)
Bank height and sedimentologic character is locally variable, dependent largely on the nature of the channel-marginal terrace materials. Shallow banks are generally restricted to the insides of major bends (e.g. opposite boat launch in Queens Reach). The channel bed is composed of coarse-gravels throughout the reach, with numerous boulders evident.

Flow character
Flow character is locally variable, with sections of uniform flow interspersed with rapid flow around large dissected compound bars. This pattern, along with numerous log obstructions, results in a series of upwellings or boils. The water is generally very clean throughout the reach, indicating the limited suspended load, but the flow becomes murky downstream of the blue muddy cliffs (Manapouri Map sheet GR 680075).

SAMPLE SITE CHARACTERISTICS

Sample number : **UW1** Grid reference : Te Anau (D43) 1:50,000, 933106
Manapouri (S149) 1:63,360, 722108

Sample type : 2 x 25 m @ 0.5 m interval.

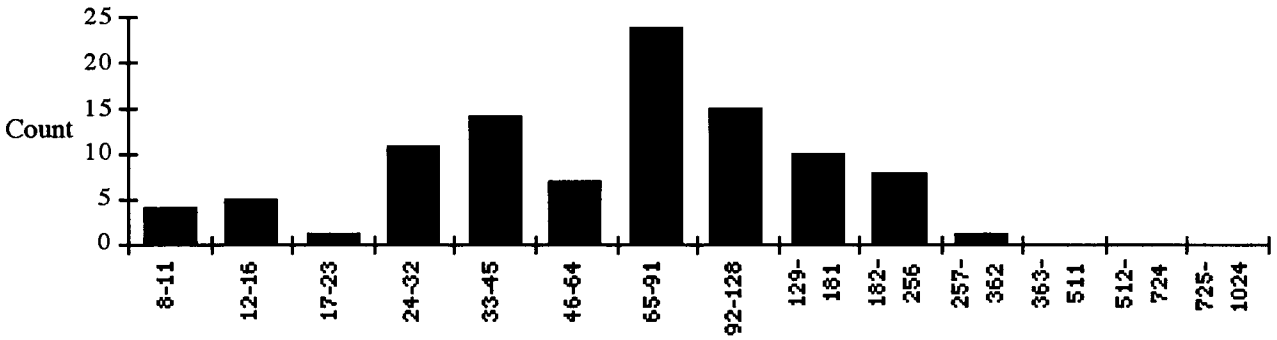
Bar type : Point bar in a moderately tight bend. The bar has a distinct platform at the water's edge, with a finer-grained supraplatform adjacent to it. This is dissected by a scoured chute-channel adjacent to the bank. A recent sand sheet has accumulated at the tail of the bar. A riffle is observed at the bar head. This is transitional to a mid-channel bar at the upstream end of the bend.

Sample position on bar : Water's edge sample at the head of the bar. Transect was located in the coarsest gravel locale in the bar platform unit.

'Particle characteristics'

0.5ø Clast size frequency Histogram

Clast size distribution : Upper Waiau (Wairau) River Sample 1 (Te Anau, 1:50,000, GR 933106)



D95 215 mm; D84 140 mm; D50 75 mm; D16 25 mm; D5 15 mm

Mean 84.65 mm; Sorting 61.56 mm

Sorting : Poor. Note the irregular clast size distribution indicated in the histogram above.

Packing arrangement : Quite well imbricated at the bar head, transitional to a jumbled surface within the 25 m transect. Although the surface is well-winnowed of fine gravels, the most recent flow event has left a discontinuous sand veneer over parts of the bar. The surface is not well-packed, with little evidence of paving other than trapping of some coarse sands. Many clasts are relatively loose.

Shape : Blocky; subrounded.

Lithology : Largely plutonic (Fiordland Complex)

Other characteristics : This is a texturally well-segregated bar surface, with discrete lobes of material and lenses over the bar surface. Distinct down-bar fining is evident, with relatively thick sand sheets at the bar tail. The bar supralatform is a loose, largely unsorted, relatively flat surface. A layer of clasts one to two grains thick, with observed b max of 85 mm, protects a thick fine gravel/coarse sand matrix beneath the surface. The thin gravel surface is not densely packed, however, and the subrounded clasts are unwinnowed with no evidence of paving or imbrication. The surface layer may represent the remnant from a well sorted thicker gravel mix on the channel bed, in which the surface is sorted down to 85 mm,with a finer drape atop). The bank-marginal chute channel has a log jam at its head. Downstream of the logs are a series of discontinuous gravel lenses and scour pools, with marginal sand sheets. Gravels are moderately packed and imbricated at the bar head (b max 130 mm) but are transitional down-chute to a loose, largely unpacked surface, similar in character to the supraplatform.

Sample number : **UW2** Grid reference : Te Anau (D43), 1:50,000, 923099
Manapouri (S149), 1:63,360, 713100

Sample type : 1 x 50 m @ 0.5 m interval

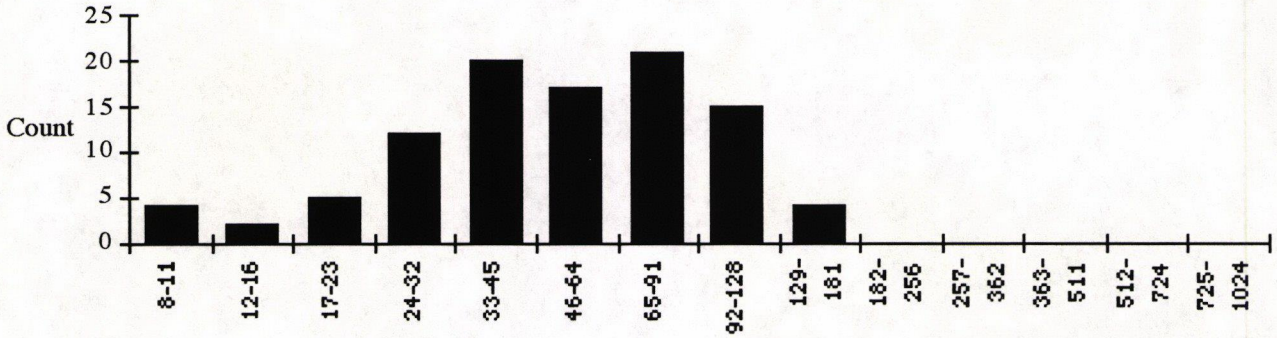
Bar type : Large, dissected bank-attached compound bar opposite Balloon Loop. This is an area of active channel reworking following the collapse of Balloon Loop and associated channel realignment. The bar has an extensive active gravel surface. This surface is irregular, with a number of dissecting channels and a bank-marginal chute/secondary channel. The bar surface has been extensively modified by a gravel extraction operation.

Sample position on bar : Water's edge transect in a coarse triangular-shaped gravel locale at the bar head.

'Particle characteristics'

0.5ø Clast size frequency Histogram

Clast size distribution : Upper Waiau (Wairau) River Sample 2 (Te Anau, 1:50,000, GR 923099)



D95 125 mm; D84 100 mm; D50 54 mm; D16 25 mm; D5 15 mm

Mean 60.26 mm; Sorting 34.92 mm

Sorting : Poor. Surface materials appear to have been 'dumped'.

Packing arrangement : Relatively loose jumbled and irregular surface. Barely winnowed, with little evidence of either paving or packing.

Shape : Subrounded; largely blocky.

Lithology : Largely Fiordland Complex plutonics.

Other characteristics : Logs are trapped at the bar head and over the bar surface. The bar has occasional patches of pioneer vegetation. Cusps of varying dimension were observed at the bar margin. The chute/secondary channel at the bank-margin drains a small swamp in adjacent flats. The marginal terrace is typically 4-5 m wide. The bar has an extensive supraplatform composed of fine gravels (b max 60 mm) and loose sands. This supraplatform has a steep face at the channel margin, and appears to be actively reworked. Terrace exposures are evident on the right bank upstream of the sampled bar and on the left bank downstream of the sampled bar, but in both cases these banks appear to be stabilizing with small vegetation.

Wairau (Upper Waiau) River Photo 1
Lake Te Anau control gates viewed from downstream. At the time of construction the bed of Waiau River was physically excavated at this location.
13.01.93 3-12 Manapouri (S149) 1:63,360, GR 736170
Te Anau (D43) 1:50,000, GR 944163



Wairau (Upper Waiau) River Photo 2
Old erosion site on the left bank downstream of the control gates. The vegetative pattern on the talus slope indicates that erosion is not presently active.
13.01.93 3-13 Manapouri (S149) 1:63,360, GR 738161
Te Anau (D43) 1:50,000, GR 946156



Wairau (Upper Waiau) River Photo 3
The stable channel of the Waiau (upper Waiau) in Yerex reach.
13.01.93 3-16 Manapouri (S149) 1:63,360, GR 742147
Te Anau (D43) 1:50,000, GR 948142



Wairau (Upper Waiau) River Photo 4
Aerial view of Rainbow Reach, looking downstream towards Lake Manapouri. Note the stable, confined, sinuous course of Wairau (Upper Waiau) River. Sample site UW1 was located on the inside of the right bend on the right hand side in mid-photo.
16.01.93 GBF 1/3



Wairau (Upper Waiau) River Photo 5
Small point bar on the inside of a tight bend in Rainbow Reach that served as the Sample Site for transect UW1. Note the irregular surface of the point bar with a distinct gravel platform and bank-marginal chute channel. Note also the large clumps of organic debris washed onto the bar surface.
16.01.93 4-16 Manapouri (S149) 1:63,360, GR 734115
Te Anau (D43) 1:50,000, GR 933106



Wairau (Upper Waiau) River Photo 6
Sample site UW1 looking downstream. Sample was collected as a water's edge transect at the bar head.
16.01.93 4-15 Manapouri (S149) 1:63,360, GR 734115
Te Anau (D43) 1:50,000, GR 933106



Wairau (Upper Waiau) River Photo 7
Complex assemblage of depositional units at the tail end of the small point bar on which sample site UW1 was located. Note the gravel platform, a series of sand sheets, and the scoured chute channel. The bar surface in the foreground is extremely poorly sorted.
16.01.93 4-14 Manapouri (S149) 1:63,360, GR 734115
Te Anau (D43) 1:50,000, GR 933106



Wairau (Upper Waiau) River Photo 8
View upstream from Kepler Track footbridge. Sample site UW1 was located on the point bar in mid-photo.
07.01.93 A-19 Manapouri (S149) 1:63,360, GR 719108
Te Anau (D43) 1:50,000, GR 930106



Wairau (Upper Waiau) River Photo 9
Right bank erosion site immeditely upstream of Balloon Loop. Oblique air photographs from 1965 show this site virtually unchanged from its present position (i.e. although the terrace face appears active, rates of erosion are slow).
16.01.93 4-17 Manapouri (S149) 1:63,360, GR 712102
Te Anau (D43) 1:50,000, GR 924102



Wairau (Upper Waiau) River Photo 10
Sample site UW2. This is a large bank-attached compound bar, with a number of discrete depositional units. For example, a side channel and remnant sand sheet can be seen in this photograph. The eroding bank seen in the photograph is evident in the background.
16.01.93 4-24 Manapouri (S149) 1:63,360, GR 713101
Te Anau (D43) 1:50,000, GR 923099



Wairau (Upper Waiau) River Photo 11
View downstream at the head of the large bank-attached compound bar on which sample site UW2 was located. Note the distinct platform on the bar surface, and the logs in the channel (adjacent to Balloon Loop).
16.01.93 4-18 Manapouri (S149) 1:63,360, GR 713101
Te Anau (D43) 1:50,000, GR 923099



Wairau (Upper Waiau) River Photo 12
Large bank-attached compound bar, opposite Balloon Loop, on which sample site UW2 was located. Bar gravels has been used for a gravel extraction operation.
16.01.93 4-22 Manapouri (S149) 1:63,360, GR 713098
Te Anau (D43) 1:50,000, GR 923096



Wairau (Upper Waiau) River Photo 13
Mouth of Balloon Loop viewed from left bank of Waiau River. Note the dissected riffle in the middle of Waiau channel.
16.01.93 4-21 Manapouri (S149) 1:63,360, GR 713098
Te Anau (D43) 1:50,000, GR 923096



Wairau (Upper Waiau) River Photo 14
View downstream from large bank-attached compound bar opposite Balloon Loop. Note the large erosion face on the concave bank downstream (in Boulder Reach) and the significant number of logs pinned in the channel.
16.01.93 4-20 Manapouri (S149) 1:63,360, GR 71098
Te Anau (D43) 1:50,000, GR 923096



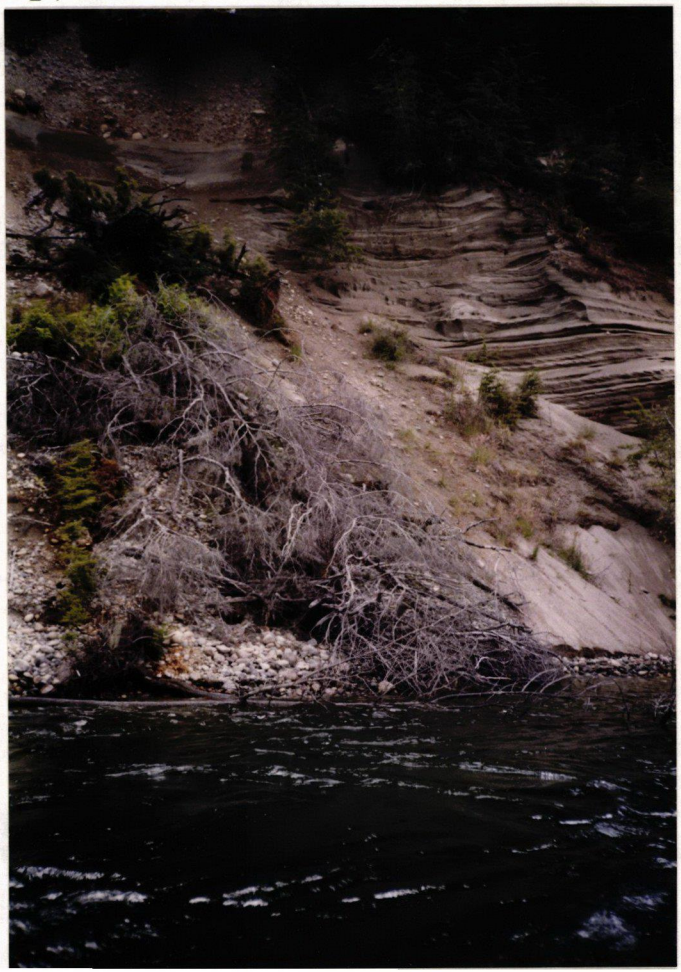
Wairau (Upper Waiau) River Photos 15 and 16
Extensive eroding concave bank in Boulder Reach, downstream of Balloon Loop.
13.01.93 2-2 and 2-3 Manapouri (S149) 1:63,360, GR 712092
Te Anau (D43) 1:50,000, GR 923092



Wairau (Upper Waiau) River Photo 17
Localized bank erosion beyond Boulder Reach. Note the cross bedded nature of the outwash gravels in mid-exposure.
13.01.93 2-6



Wairau (Upper Waiau) River Photo 18
Close up of sediments in the basal section of an eroding bank beyond Boulder Reach. Note the horizontally bedded sands with ripple cross-laminated sequences. This unit is capped by a finer unit, with outwash gravels atop.
13.01.93 2-7



Wairau (Upper Waiau) River Photo 19
The sub reach of Wairau (Upper Waiau) River beyond Boulder Reach has densely vegetated, stable banks.
13.01.93 2-20



Wairau (Upper Waiau) River Photo 20
In this subreach, beyond Boulder Reach, erosion sites are limited both in number and extent, and outwash gravel sequences are often quite well cemented.
13.01.93 2-9



Wairau (Upper Waiau) River Photo 21
In the fairly tight bend at GR 680076 (Manapouri (S149) 1:63,360) the sedimentologic composition of bank exposures changes abruptly, and the basal section of the bank is composed of finely laminated grey clays. These deposits, interpreted as a glacio-lacustrine sequence, are more erodible than cemented gravel and sand deposits upstream, and the outside of this bend has expanded considerably.
13.01.93 2-11 Manapouri (S149) 1:63,360, GR 680076



Wairau (Upper Waiau) River Photo 22
Close up photograph of basal grey glaciolacustrine deposits in the concave bank at GR 680076.
13.01.93 2-13 Manapouri (S149) 1:63,360, GR 680076



Wairau (Upper Waiau) River Photo 23
The grey basal clay deposits are only locally preserved, and banks downstream of the concave bank at GR 680076 are once more dominated by sand and gravel sequences. In the example shown below, lenses of gravel are inclined quite steeply downstream.
13.01.93 2-15 Manapouri (S149) 1:63,360, GR 68608



Wairau (Upper Waiau) River Photo 24
Build up of a large sand and fine gravel delta at the mouth of Wairau (Upper Waiau) River as it enters Lake Manapouri.
13.01.93 2-16 Manapouri (S149) 1:63,360, GR 668103

