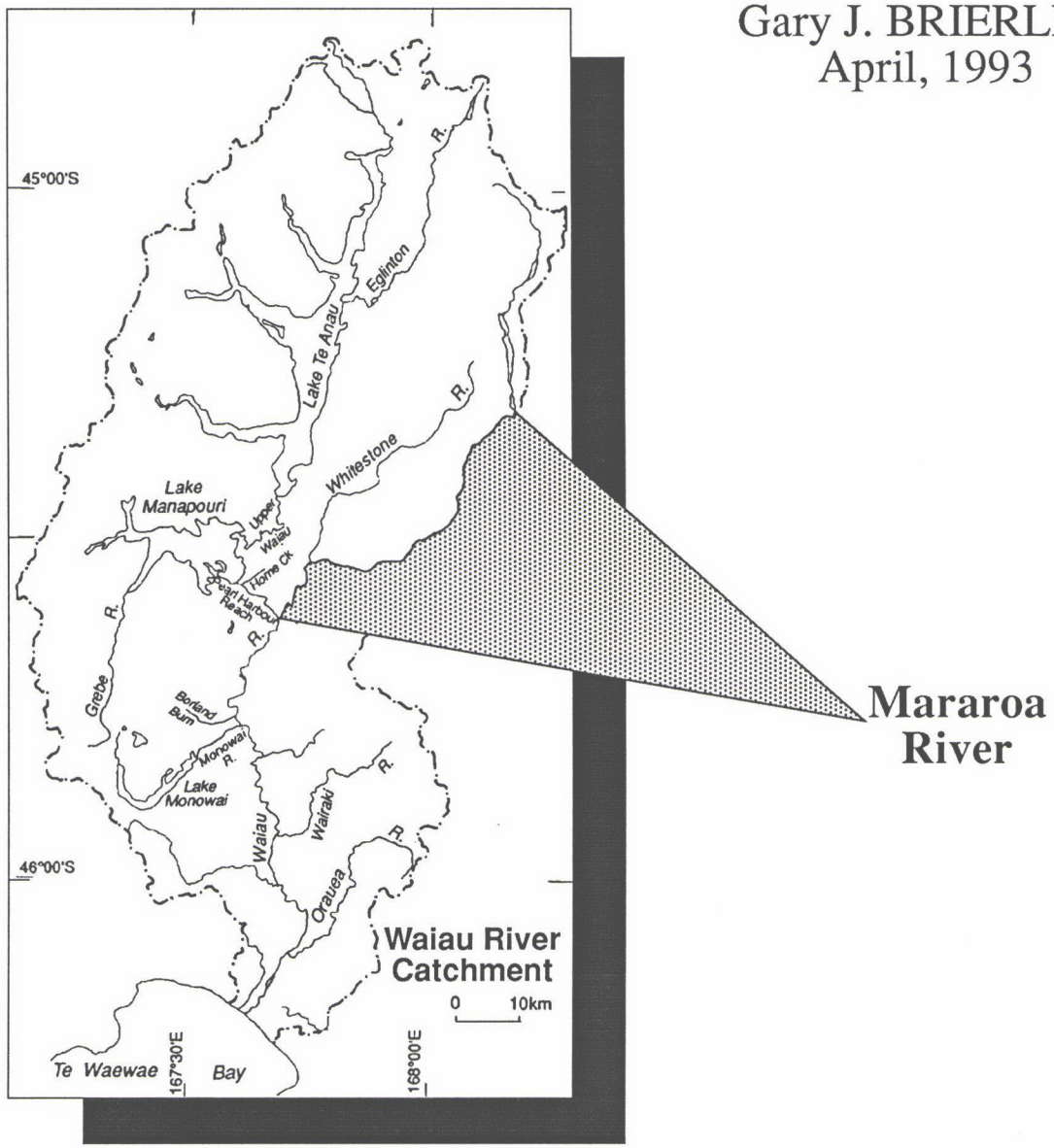
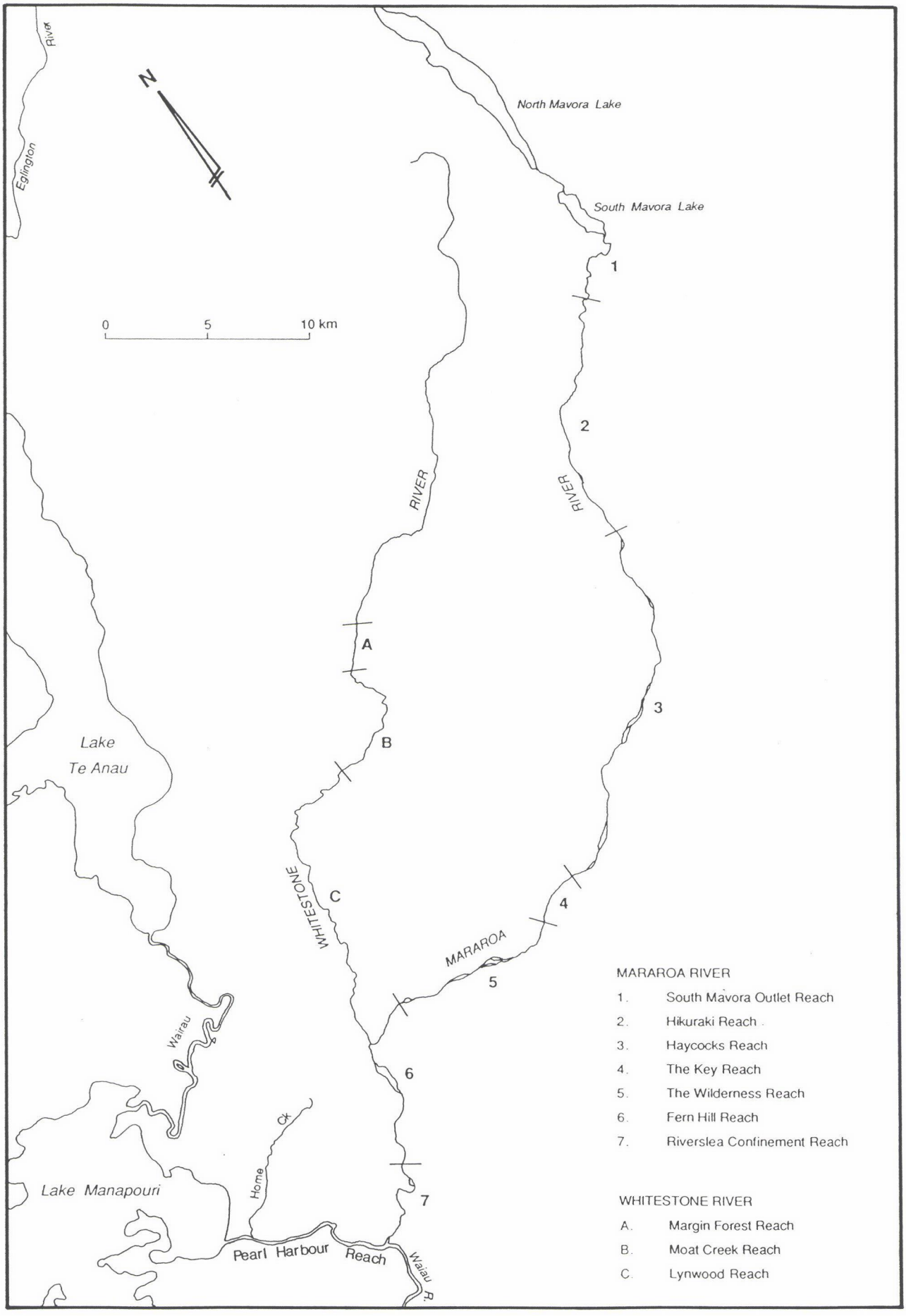
MARAROA RIVER
Reach Analysis

Gary J. BRIERLEY
April, 1993



Reach name	Page
1 South Mavora Outlet Reach	3
2 Hikuraki Reach	10
3 The Haycocks Reach	25
4 The Key Reach	44
5 The Wilderness Reach	51
6 Fern Hill	60
7 Riverslea Confinement Reach	71


River
Eglington
N
North Mavora Lake
South Mavora Lake
0
5
10 km
1
2
RIVER
RIVER
A
B
3
Lake
Te Anau
WHITESTONE
C
4
MARAROA
5
Wairau
6
Ck
Home
Lake Manapouri
7
Pearl Harbour Reach
Waiau R.
MARAROA RIVER
1. South Mavora Outlet Reach
2. Hikuraki Reach
3. Haycocks Reach
4. The Key Reach
5. The Wilderness Reach
6. Fern Hill Reach
7. Riverslea Confinement Reach
WHITESTONE RIVER
A. Margin Forest Reach
B. Moat Creek Reach
C. Lynwood Reach

REACH NAME : SOUTH MAVORA OUTLET REACH

Geographic description of reach : South Mavora Outlet reach extends from the footbridge at the outlet of South Mavora Lake down to the break in the beech forest cover, coincident with widening of the valley flats of Mararoa Valley. This river section is characterized by a very stable, incised single channel, with irregular sinuosity. Other than an abandoned meander loop, within-channel sedimentation is negligible, and alluvial flats are insubstantial.

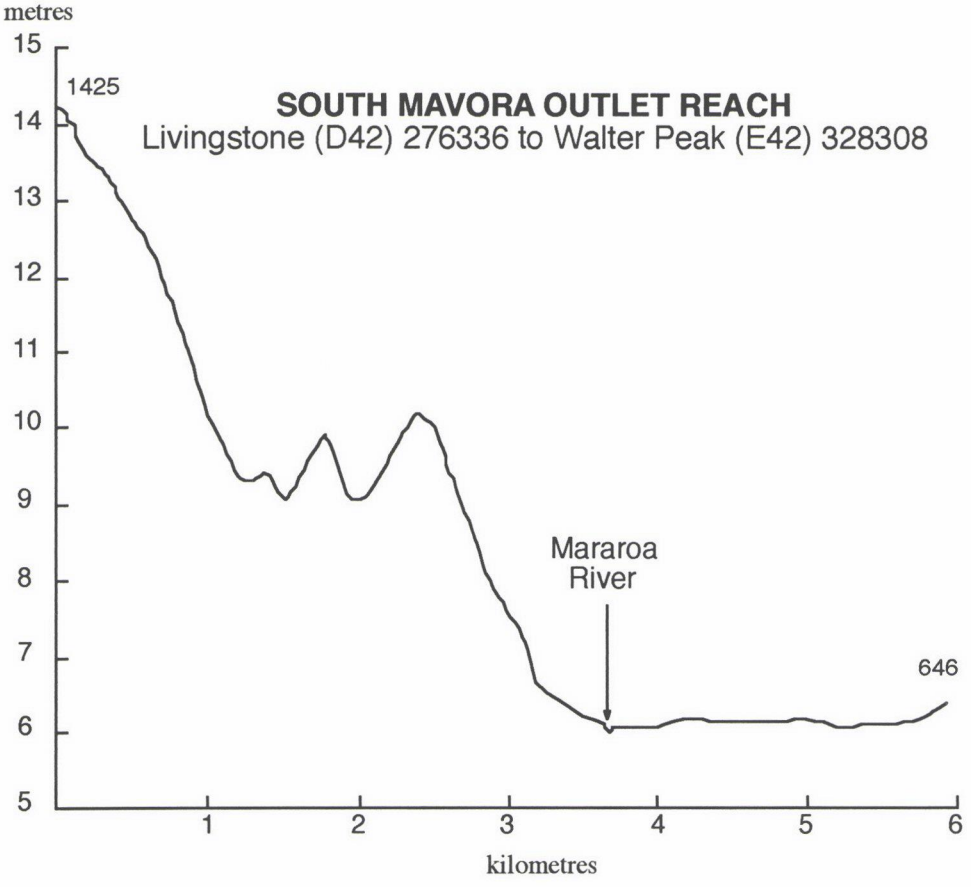
Analysts: GB, AB, AH Date of Analysis : 12.01.93

Grid co-ordinates of reach: Walter Peak (E42) 322325 to Livingstone (D42) 294304

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley cross section



Valley setting

Lake outlet in a glacially scoured U-shaped valley. Mararoa River abuts against a hill on left bank in mid-reach. This acts as a local sediment source for coarse subangular boulders.

Extent of Valley flat

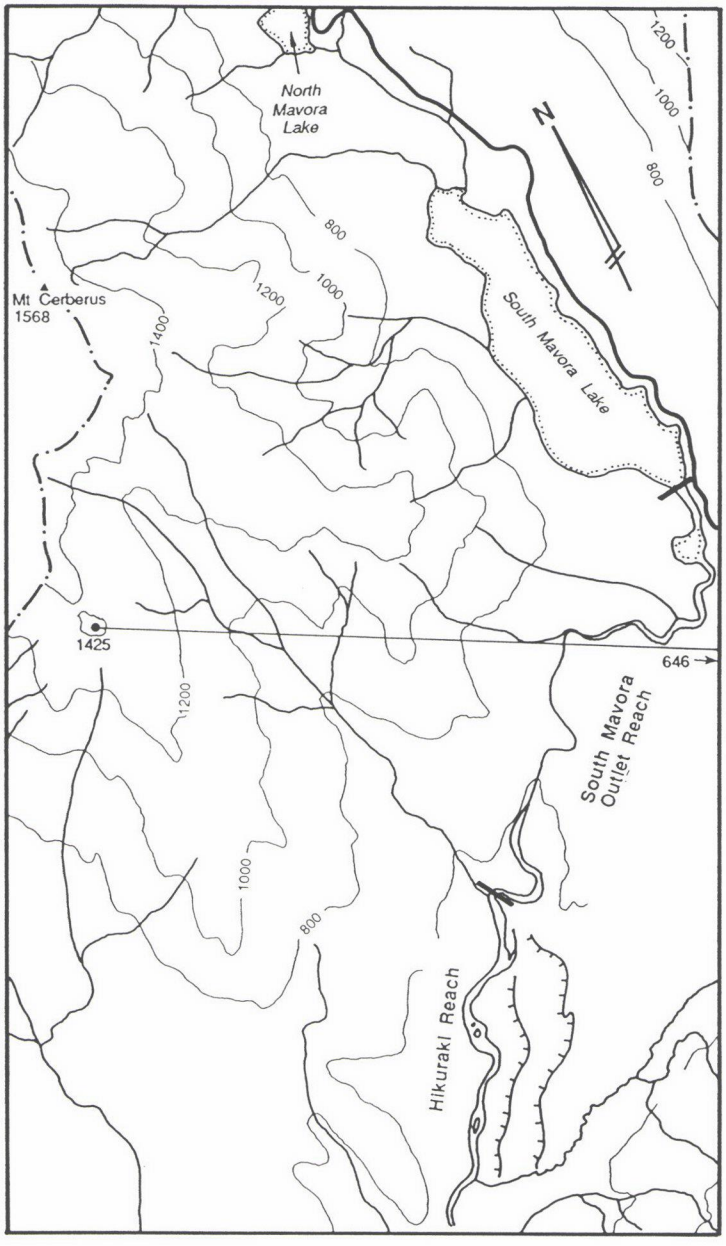
Up to 1 km wide. Valley floor has an irregular topography, with occasional steps and swamp. Flats become better-defined down-reach, with a less irregular topography.

SOUTH MAVORA OUTLET REACH

Walter Peak (E42) 1:50,000

Livingstone (D42) 1:50,000

Te Anau (D43) 1:50,000



LEGEND

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

Terrace character
Not-apparent at the reach head. In mid-reach there is an irregular single-terrace observed on right bank, about 10 m above the channel. Large subangular blocks up to 2-3 m wide were observed in a distinct cluster on the right bank terrace surface in mid-reach. The terrace itself becomes flatter and less hummocky downstream. A large swamp unit is observed on the right bank immediately downstream of South Mavora Lake.

Extent and character of Alluvial flats
Non-existent

Degree and character of channel constriction
Laterally confined reach, with some local variability (e.g. abandoned loop 500 m downstream of lake outlet).

Character and impact of tributary streams
Tributary streams are generally ephemeral and seemingly exert minimal impact on the main channel.

Surficial geology
Thomson Mountains, at the head of Mavora Lakes, are composed of Carboniferous/Permian greywacke and argillite, which are semi-schistose in places, with minor volcanics. Much of the landscape is draped by reworked glacially-derived (morainal?) material, well covered by mosses. Wakatipu glacier deposited moraine around the south end of Mavora Lakes (Mavora Formation). Downstream of this moraine there are a series of partly dissected terraces of sandy, roughly stratified gravel outwash that extends down to Waiau confluence (Mavora Outwash Member). Stream levels along Mararoa have incised up to 150 m into earlier Quaternary till sequences (McKellar, 1973).

Vegetation
Valley side/flats : Beech forest, with spongey ground cover.

Alluvial flats : Not evident

Bars/Bank : No bars evident. Beech forest with one-manuka-thick gallery downstream of the abandoned loop. Sedges, grasses, rushes, sporadic flax and aquatic vegetation noted along banks.

Land use
Undisturbed native forest other than walking track. A footbridge crosses Mararoa River at the lake outlet, and there is a dirt-track road along the left bank terrace.

CHANNEL CHARACTERISTICS

Number of channels : Single

Channel geometry : At the footbridge the channel has a uniform, rectangular cross-section (about 80 m wide, 1.5 m deep). In the bends and adjacent to an incised bench downstream, the channel has adopted an irregular cross-section. Channel width decreases to about 60 m wide downstream of the loop. Cross-sectional geometry is also locally variable, with distinct asymmetry in one bend, but irregular cross-sectional geometry in another bend. In a straight section at a point of inflexion, the channel is deeply incised in mid-channel with shallow channel-marginal benches (a cemented relict bed). At GR 318316 this bench had a fine-medium sand matrix. Downstream of the bench, flow divides around large basal boulders with rapids. The channel become more confined down-reach (from around 60 to 30-40 m), with subsequent increase in flow velocity and turbulence.

Sinuosity : Imposed moderately tight bends, with a laterally stable abandoned loop close to the reach head. In the lower half of the reach there are three large meander loops, separated by moderately straight reaches.

Lateral stability of channel(s) : Stable

Bar type and scale
No gravel bars are evident in South Mavora Outlet reach.

Bed/Bank character (extent and materials)
Small gravel beaches, bmax 50 mm, are evident at the lake outlet. Occasional boulders (up to 1m wide) are observed on the bed of the river beneath the footbridge. In the abandoned loop the bed has an organic-rich mud beneath a dense organic mat carpet. The first evidence of a gravel (up to 60 mm wide) lens on the bed of the river was observed at GR 318318, coincident with the first observed exposure of gravels in bank/terrace deposits. The bed of the river adjacent to this lens has a fine mossy cover, seemingly indicating that the bed is neither aggrading nor scouring at this point.

Beyond GR 318316 there is a bench of cemented sand/fines on the bed of the river. This has irregularly emplaced gravels within (i.e. this is a matrix-supported gravel unit). This incised former bed surface has distinct ledges adjacent to deep pools in the channel. The location of incision varies, and does not conform to predicted locations based on flow hydraulics/channel geometry.

At GR 314316 large subangular boulders (metre scale) are evident on a channel-marginal bench. These increase in abundance downstream. Local increase in slope at GR 308317 is reflected by a sequence of rapids. Bed slope appears to have a steeper grade than the channel-marginal terrace.

Steeply-inclined, extensive slopes form the banks for most of this reach, but adjacent to the abandoned loop and in occasional other locations the banks are more gently inclined.

Flow character
Steady, uniform flow, with occasional boils. Occasional logs obstruct flow. Water is crystal-clear, with no evident suspended sediment. Bedload transport appears to be incidental in the upstream half of this reach, driven by availability of materials, not flow competence. Flow in the lower half of the reach is characterized by rapid, shooting flow, with abundant whitewater.

SAMPLE SITE CHARACTERISTICS

No gravel bars are evident in South Mavora Outlet reach.

Mararoa River Photo 1, South Mavora Outlet Reach
North Mavora Lake looking upstream. Note the U-shaped, glacially-scoured valley.
16.01.93 AHF 1/3



Mararoa River Photo 2, South Mavora Outlet Reach
South Mavora Lake. Outlet of Mararoa River is in the background.
16.01.93 GBF 1/20



Mararoa River Photo 3, South Mavora Outlet Reach
Mavora Lakes looking upstream, with South Mavora Outlet reach of mid-photo. Note the abandoned meander loop just downstream of the lake outlet, and the imposed meandering outline of the river.
16.01.93 GBF 1/23



Mararoa River Photo 4, South Mavora Outlet Reach
View downstream of South Mavora Outlet reach. Note the abandoned meander loop in mid-photo, and the abrupt break in beech forest cover.
16.01.93 GBF 1/22



Mararoa River Photo 5, South Mavora Outlet Reach
South Mavora Outlet reach, viewed from the footbridge. Note the regular, stable channel geometry and densely vegetated banks.
12.01.93 1-31 Walter Peak (E42) 1:50,000, GR 322325



REACH NAME : HIKURAKI REACH

Geographic description of reach : Reach extends from the downstream limit of beech forest on the valley flats downstream of South Mavora Outlet reach to a less constrained channel section adjacent to Little Hill. Hikuraki reach is characterized by a relatively stable channel which locally divides to two or three channels around islands of differing magnitude. This is not a truly alluvial reach, and appears to be incisional or degradational rather than aggradational.

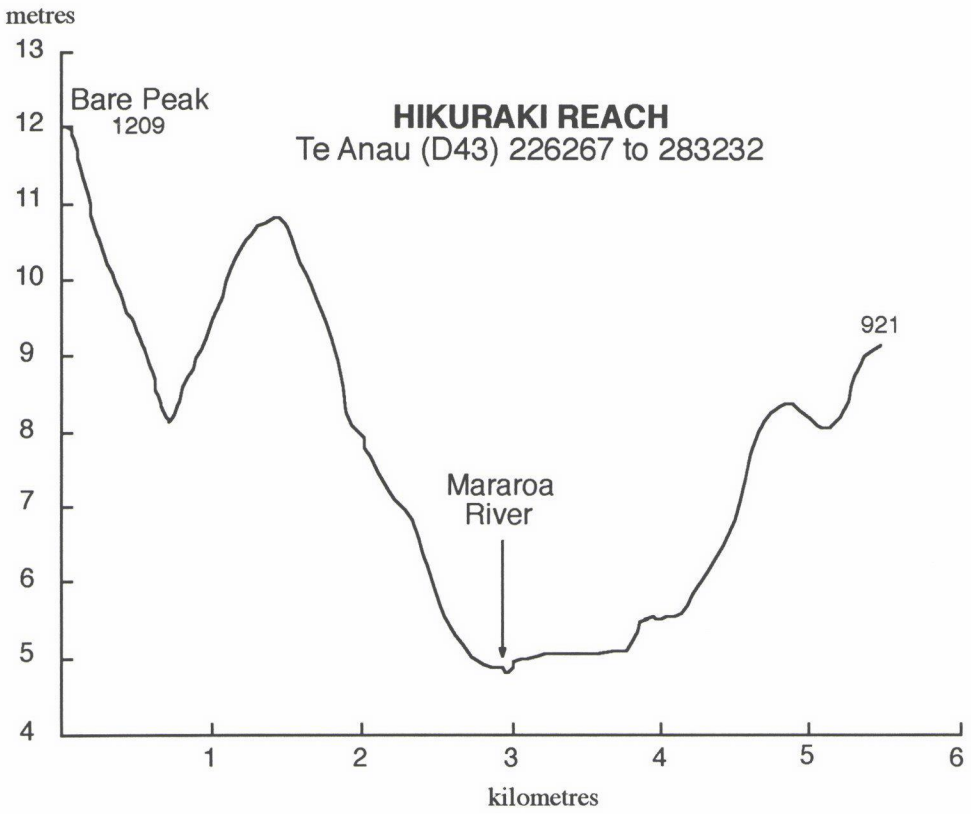
Analysts: GB, AB, AH Date of Analysis : 12.01.93 and 15.01.93

Grid co-ordinates of reach : Livingstone (D42) 294304 to Te Anau (D43) 246209

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

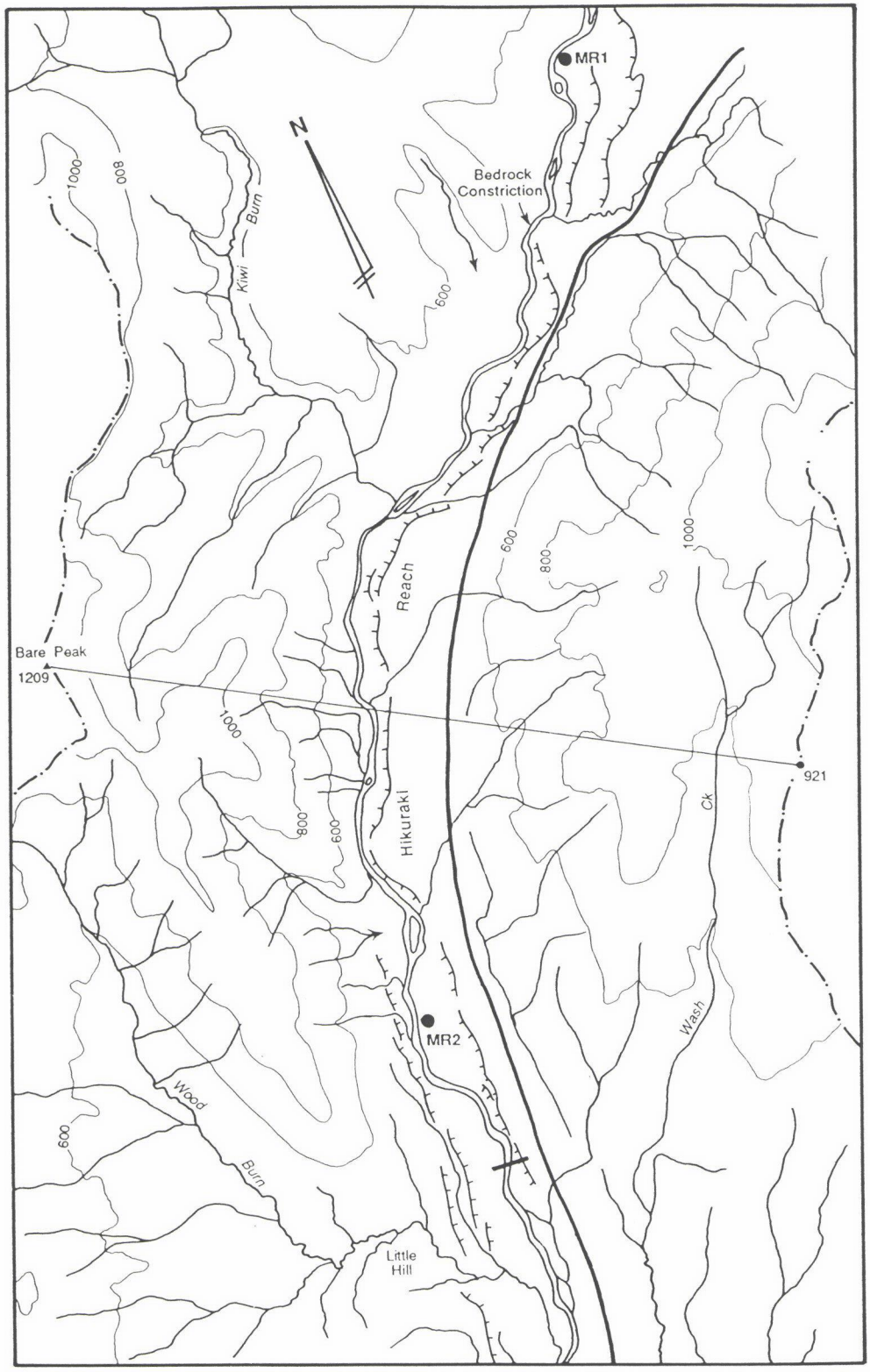
VALLEY CHARACTERISTICS

Valley cross section



Valley setting
Broad terraced valley, with steep left side and dissected ridge on right side. In the downstream section of the reach (at GR 255266) the right bank of Mararoa River abuts against the valley slope which is characterized by steep fans with active scars at their heads.

Extent of Valley flat
Relatively uniform valley width of about 1 km is maintained throughout Hikuraki reach.



0 1 2km

LEGEND

- Road
- 500 Contours (metres)
- Terrace riser
- Creeks / rivers
- Cross section
- MR Sample location
- Reach margin
- Catchment margin

Terrace character

Unpaired features, associated with differential reworking of fluvioglacial outwash. Terraces become more prominent in the downstream half of the reach, where all but the upper and lower terraces are discontinuous features.

Left Bank

At the head of the reach there is a flight of five terraces extending up to 30 m high. In the confined bedrock section in mid-reach there are two continuous left bank terraces, 10 m above the river, perched on bedrock, and about 10 m higher. In the downstream half of the reach there are six or more terraces :

#1 2-3 m, discontinuous, crescent-shaped terrace
#2 1-2 m above terrace 1, discontinuous, crescent-shaped terrace
#3 c 5 m above terrace 2, discontinuous remnant terrace that has been reworked by the channel that scoured terraces 1 and 2.
#4 2-3 m above terrace 3, discontinuous remnant terrace that has been reworked by the channel that scoured terraces 1 and 2.
#5 4-5 m above terrace 4, discontinuous remnant terrace that has been reworked by the channel that scoured terraces 1 and 2.
#6 Much larger, continuous upper terrace about 5 m above terrace 5.

Downstream of a channel bend at GR 274275 the valley flat is composed solely of terraces #2 and #6. In the lower stretch of this reach, terrace 6 has a very steep terrace riser that is 25-30 m high. This upper terrace is especially prominent and undissected adjacent to the airstrip (GR 250230).

Right bank

30 m high terrace is dominant, with a discontinuous lower terrace (approximately 4 m high). In the confined bedrock section in mid-reach there is a discontinuous, beech-covered terrace about 10 m above the channel. In the downstream half of the reach, right bank terraces are significantly smaller features than those observed on the left bank The prominent surface is equivalent to terrace #2 on the left bank. This beech covered, continuous feature is about 3-4 m above the present channel.

Just downstream of the airstrip (GR 245239), the river no longer abuts against the right bank and a discontinuous 'perched' terrace is evident (at GR 243236). A magnificant fan sequence is evident at GR 242226. The toe of this fan has been removed by the Mararoa River, and a 7 m high scarp remains. Basal erosion is no longer active, and the present Mararoa channel is now separated from the toe of the fan by a side channel and alluvial flat/island. At its downstream limit the fan channel abuts against a 12 m high outwash terrace.

Extent and character of Alluvial flat

Extent and character of alluvial flats is locally variable. Upstream of the bedrock constriction at GR 283285, Mararoa River is largely unconstrained. It appears to be partially incised and only occasionally abuts against terraces. The ratio of alluvial flat width to channel width ranges between 1:15 to 1:5. Alluvial flats appear to be relatively stable, with little evidence of active gravel sheets, although up to four channels were observed on alluvial flat surfaces. At this point alluvial flats extend up to 200 m wide.

No flats are evident adjacent to the bedrock constriction in mid-reach. Downstream of this point the alluvial flats have a markedly discontinuous surface, constrained by the available space between terraces. Flats are much narrower features, typically up to 30-40 m wide, and are generally restricted to the inside of large sweeping bends. A large number of irregular flood channels is evident on the alluvial flats. Flats become much more extensive towards Kiwi Burn, where they extend up to 100 m wide. A large pond is evident on the flats at GR 274277. Island formation and channel abandonment appears to be the primary mechanism of alluvial flat formation. Hikuraki reach appears to be degradational rather than aggradational. The relationship between lateral and vertical stability of the channel is unclear.

Degree and character of channel constriction

Although the river only abuts against 2-3 m high alluvial flats throughout most of this reach, the channel appears to be relatively stable in most sections. There is a distinct lack of active gravel surfaces in the upstream half of the reach. In mid-reach the channel is confined within a bedrock gorge at GR 283285, with channel width about 15 m. Beyond this point the channel remains moderately constrained, with little alluvial flats and limited evidence for active lateral erosion. Gravels flushed through the confined bedrock subreach are not being liberally spread atop bars and alluvial flat surfaces. Even in less constrained areas the alluvial flats are not very active, and there is negligible evidence for active fluvial processes on the 2 m terrace surface. Grasses, along with matagary and manuka on these lower surfaces attest to their relative stability. The channel appears to be acting as a flume for any gravels supplied, with little evidence for sediment build up.

Character and impact of tributary streams
A prominent right bank tributary defines the upstream margin of this reach. A large (unnamed) left-bank tributary enters the Mararoa immediately upstream of the bedrock confinement in mid-reach. This tributary has a largely jumbled bed, with a number of active erosion sites. Marginal terraces in this tributary are about 4 m high. Bank exposures are composed of a roughly equal proportion of sand and clasts (bmax 150-200 mm). Although eroded materials are being actively supplied to the Mararoa, the configuration of the Mararoa itself is scarcely affected and there is no sediment build-up at the confluence. Indeed, at the confluence the channel divides around a small mid-channel bar, and the Mararoa appears to be reworking and expanding laterally towards the confluence bar.

Adjacent to the bedrock confinement in mid-reach there is a steep ephemeral waterfall on the right bank. This exerts minimal impact on the Mararoa channel, as high energy flows in the confined bedrock reach simply remove materials supplied by this tributary.

Left bank tributary at GR 268270 is a deeply incised terraced system, but this is not presently supplying much material to the Mararoa. Kiwi Burn (GR 260267) is a muddy, right-bank tributary. At the confluence, Mararoa River is divided around a grassed island, but no gravel aggradation is evident, and there is no deflection of the Mararoa. A further left bank tributary is noted at GR 260266, but once more this does not appear to exert much impact on the Mararoa. As the Mararoa shifts towards the right bank down-reach, tributary streams have been deflected down-valley (e.g. fan stream at GR 242226). While such systems have exerted an influence on the Mararoa in the past (during fan build-up phase), these fans appear to be only marginally active at present and their toes are not presently eroding.

Surficial geology
Stream levels along Mararoa have incised up to 150 m into earlier Quaternary till sequences (McKellar, 1973). In Hikuraki reach the most prominent features of the glaciated landscape is the high terrace divided between Mararoa and Oreti Valleys. This narrow divide testifies to post-glacial realignment of major valleys. Fluvioglacial outwash terraces with observed bmax boulders 2-3 m wide. Regional bedrock comprises Permian limestone, laminated fine sandstone and siltstone and tuffaceous sandstones, along with basaltic units. Papa mudstone evident on left bank of the present channel down-reach (adjacent to airstrip).

Vegetation
Valley side/flats : At the reach head there is beech forest on the valley sides, with pasture on terrace surfaces. Moving down-reach tussock grass grades downslope to discontinuous beech forest along fluves on the right valley side, while the left valley side has continuous beech forest cover. Manuka and matagary become more evident on the lower terraces down-reach.

Alluvial flats : Predominantly grass, with occasional tussock, matagary, rosehip, flax and cutty grass.

Bars/Banks : Predominantly grass, with occasional tussock, matagary, rosehip, flax and cutty grass. Occasional trees (beech/willow).

Land use
Pasture, forest, walking tracks.

CHANNEL CHARACTERISTICS

Number of channels : Predominantly 1 or 2 channels, with occasional division to three channels around islands of widely differing magnitude. Side channels are long, windy features.

Channel geometry : Locally variable within reach as flow divides and rejoins around bars. Width-depth ratios range from approximately 20:1 in single-channelled stretches to 10:1 in divided channels. This variability is accounted for by changes in flow depth, as channel geometry adjusts in association with the pool-riffle sequence. Channel width ranges from approximately 20-40 m. Channel is constrained to about 15 m wide by the bedrock constriction in mid-reach. In this subreach the channel has a low width:depth and an irregular geometry. A series of bedrock steps act as local base levels.

Sinuosity : The upstream half of the reach has a low sinuosity. The bedrock constrained subreach is virtually straight, with a distinct right-angle bend at its entrance. In the downstream half of the reach the channel appears to be low sinuosity on the map sheet, but the channel is actually moderately sinuous. This may indicate that sinuosity has recently increased. Moving downstream, bends become more sweeping, broader features, and then are quite irregular. In the subreach upstream of Kiwi Burn the channel has very low sinuosity.

Lateral stability of channel(s) : Moderately laterally stable, with very limited evidence of either erosion at the outside of bends or gravel accumulation on the inside of bends. In the upstream half of the reach bank erosion is only evident adjacent to the complex bar assemblage at GR 287294. Channel is incised into bedrock in mid-reach. The downstream half of the reach certainly appears to be less stable than upstream, but even in the downstream half it is clear that lateral expansion of channels was much more prevalent in the past. Areas of active erosion are localised and shallow channel banks are generally well-vegetated by shrubs and grasses (e.g. matagary, rosehip, thistles and exotic weeds). An eroding terrace is evident at GR 243220.

Bar type and scale
Variable down-reach. Mid-channel bar at the reach head is about 30 m wide, with a prominent side channel (< 15 m wide). At GR 287296 a complex bar assemblage is evident. Bar surfaces are much more complex than indicated on the 1989 map. The complex pattern is largely the result of dissection of a major mid-channel compound bar, with an excellent example of a diagonal bar evident. Downstream of this complex bar assemblage the flow is primarily contained within a single channel, other than adjacent to two extensive bank-attached compound bars (GR 289297 and 285288) which have partially infilled chute channels. Secondary channels were evident on these bars and also adjacent to terrace risers.

No bars are evident in the bedrock-constained section in mid-reach. A few kilometres downstream, however, there is the first evidence of active within-channel sedimentation along the course of the Mararoa, with channel multiplicity around small vegetated islands. However, this is yet to become a truly aggradational system, with little evidence of lateral expansion of channels. Bars in the lower part of the reach do not reflect distinctive bar types, but appear as extensions of riffles which may act as precursors to island extension. Within-channel sedimentation appears to be mid-channel rather than channel-marginal.

Bed/Bank character (extent and materials)
Locally variable contingent on channel position relative to alluvial flats and terraces. Basal materials are seemingly flushed through the bedrock constriction in mid-reach, although some coarse clasts are evident above the waterline. Beyond the bedrock subreach, banks are largely non-eroding, 1-2 m high and grassed. Occasional large boulders are evident on the river bed. Bed has a stepped cross-section. The bed itself appears to be a mobile, active gravel sheet, with no evidence of aquatic vegetation.

Flow character
Pool-riffle sequence dictates both local bed geometry and grain size distribution. Riffles at stream confluences reflect local bed oversteepening. Large number of standing waves. The very steep grade in the bedrock subreach results in rapid flow, with continuous whitecaps. Beyond the bedrock constriction there is still significant white water, but riffle spacing is indistinct, associated with the pattern of bars. As channels are overfilled, there is clear evidence of a lateral component to flow over channel-marginal riffles. This is only apparent in the lower half of the reach, associated with increased channel width. Water is very clear, with little or no suspended load.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR1** Grid reference : Te Anau, 1:50,000, 289297

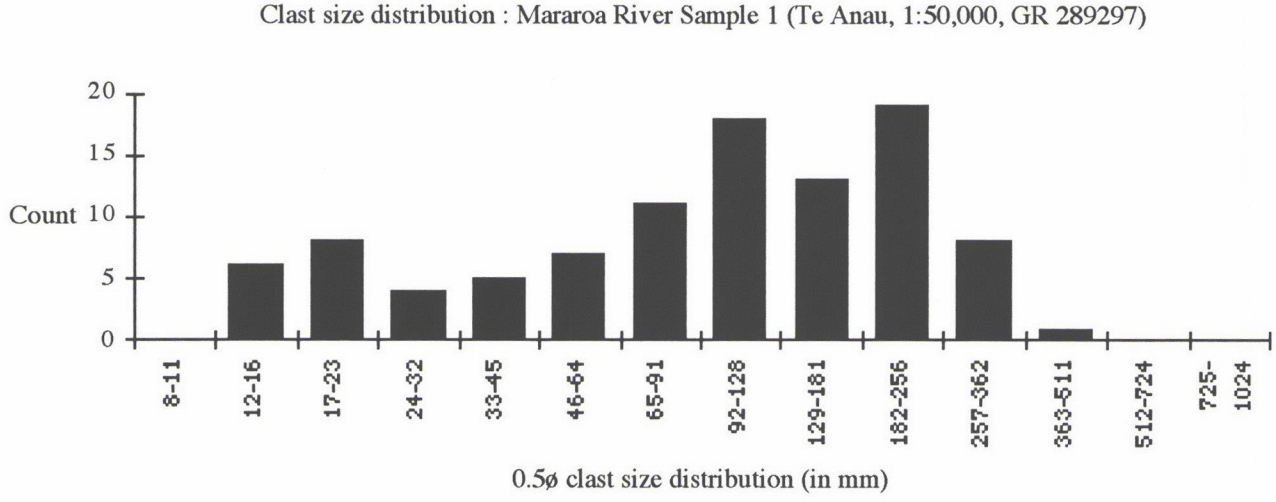
Sample type : 2 x 25 m transects @ 0.5 m interval

Bar type : Sample collected in the chute channel on alluvial flats a few tens of metres from the present channel. Few other sites are available for sampling given the high discharge stage. Flats may be part of a former bank-attached bar.

Sample position on bar : Close to head of side/chute channel at margin of terrace riser. Sample collected in a grassed area with remnant gravels left exposed in the deepest part of the channel. Numerous other channels are evident on the flats. Flats surface is largely vegetated, with grasses and rosehip prominent. Sample site represents either a deeper channel position or a within-channel scour feature on the flats.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 225 mm; D84 155 mm; D50 80 mm; D16 20 mm; D5 11 mm

Mean 89.96 mm; Sorting 64.4 mm

Sorting : Poor

Packing arrangement : Moderately tightly packed with occasional imbrication. This is generally a jumbled surface, with a large number of loose individual clasts.

Shape : Subrounded with occasional discs/blades.

Lithology : Very mixed, with schists, greywacke and some plutonics.

Other characteristics : Many clasts are lichen-covered. This sample reflects sediment availability in this area as indicated by the record of deposition on the alluvial flats. Whether this sampled material reflects eroded terrace deposits or materials derived from actively reworked gravel bars and islands incorporated into alluvial flats is unknown. Some very large clasts clearly indicate minimal movement of materials from their 'recent' source (i.e. outwash terraces as opposed to their ultimate pre-glacial source). Interspersed among these large boulders are smaller clasts up to 250 mm wide which would seemingly be carried with relative ease by a flood-stage Mararoa channel. As such, this sample records both sediment availability and actual bedload transport.

Sample number : **MR2** Grid reference : Te Anau, 1:50,000, 244226

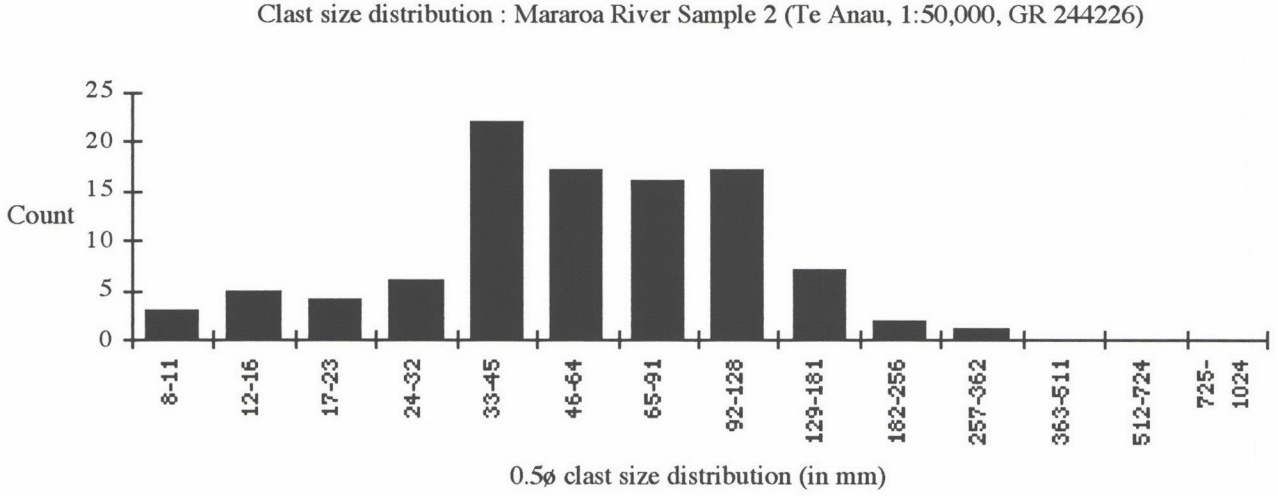
Sample type : 2 x 50 m @ 1 m interval down-riffle

Bar type : Left-bank channel-marginal riffle which extends 10 m into channel.

Sample position on bar : Sample extends down-riffle, which becomes bank-attached at its downstream end.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 150 mm; D84 110 mm; D50 55 mm; D16 30 mm; D5 15 mm

Mean 68.9 mm; Sorting 47.4 mm

Sorting : Moderate

Packing arrangement : Little evidence of imbrication - this may relate to mechanism of deposition on a bench/riffle rather than on the bed itself. Surface has been effectively winnowed to 10 mm. Early stages of algae on larger clasts. Fine gravels (< 8 mm) and coarse sands are evident beneath the moderately packed surface.

Shape : Subangular to subrounded; blocky with very few discs or blades.

Lithology : Extremely mixed

Other characteristics : 'Typical' flow level indicated by band of velvety-feel algae on clasts. Discrete lobes of material are evident. Mean clast size fines down-riffle.

Mararoa River Photo 6, Hikuraki Reach
Head of Hikuraki reach. Note the imposed sinuous outline of the Mararoa River and the chaotic pattern of interconnected channels (a former braidplain) on the terrace surface in the foreground. Flow is to the left.
16.01.93 GBF 1/24



Mararoa River Photo 7, Hikuraki Reach
Head of Hikuraki reach. Mararoa River is divided around a mid-channel bar in mid-photo, with a large side channel in the foreground. Flow is to the left.
12.01.93 1-35 Te Anau (D43) 1:50,000, GR 294298



Mararoa River Photo 8, Hikuraki Reach
Head of Hikuraki reach, looking downstream. Note the irregular surface of the alluvial flats.
12.01.93 1-36 Te Anau (D43) 1:50,000, GR 294298



Mararoa River Photo 9, Hikuraki Reach
Sample site MR1, located in a side channel at GR 289297. The right bank of Mararoa River flows against beech forest.
12.01.93 3-6



Mararoa River Photo 10, Hikuraki Reach
Hikuraki reach upstream of the bedrock constriction. Note the irregular channel geometry, as flow dissects islands and alluvial flats. Sample site MR1 is located in a side channel at the upstream end of the bend in mid-photo.
16.01.93 GBF 1/25



Mararoa River Photo 11, Hikuraki Reach
Diagonal bar which forms part of the dissected bar complex in the middle of the upper photo.
12.01.93 3-7 Te Anau (D43) 1:50,000, GR 287295



Mararoa River Photo 12, Hikuraki Reach
White water flowing over a large riffle downstream of an eroding bank in Hikuraki reach.
12.01.93 3-4 Te Anau (D43) 1:50,000, GR 286295



Mararoa River Photo 13, Hikuraki Reach
View upstream from the left-bank bedrock buttress in mid-Hikuraki reach. Note the low to moderate sinuosity of single channelled Mararoa River, and the flight of terraces on the left bank (right hand side of photo).
15.01.93 2-27 Te Anau (D43) 1:50,000, GR 283285



Mararoa River Photo 14, Hikuraki Reach
Unnamed left-bank tributary that joins Mararoa River immediately upstream of the bedrock buttress in the middle of Hikuraki reach. Note the much greater sinuosity of the tributary compared to Mararoa River, and the presence of numerous erosion scars at the outside of bends.
16.01.93 GBF 1/26 Te Anau (D43) 1:50,000, GR 283285



Mararoa River Photo 15, Hikuraki Reach
Bedrock constriction in the middle of Hikuraki reach.
12.01.93 3-9 Te Anau (D43) 1:50,000, GR 282285



Mararoa River Photo 16, Hikuraki Reach
View immediately beyond bedrock constriction in Hikuraki reach.
15.01.93 2-30 Te Anau (D43) 1:50,000, GR 281281



Mararoa River Photo 17, Hikuraki Reach
View upstream in the downstream half of Hikuraki reach. Alluvial flats are much broader in this subreach than upstream.
15.01.93 2-36 Te Anau (D43) 1:50,000, GR 263265



Mararoa River Photo 18, Hikuraki Reach
Alluvial fan viewed from sample site MR2
15.01.93 4-2 Te Anau (D43) 1:50,000, GR 244226



Mararoa River Photo 19, Hikuraki Reach
Sample site MR2 located on a large riffle in Hikuraki reach. Note the eroding right bank terrace downstream.
15.01.93 4-4 Te Anau (D43) 1:50,000, GR 244226



Mararoa River Photo 20, Hikuraki Reach
Low sinuosity, single channelled Mararoa River at the downstream end of Hikuraki reach. Note the active gravels on the fan on the left hand side in mid-photo.
16.01.93 1/27 Te Anau (D43) 1:50,000, GR 250250



Mararoa River Photo 21, Hikuraki Reach
Dissected island at the downstream end of Hikuraki reach. This photo and the upper photo are contiguous, and clearly reflect the local variability in channel configuration in this reach.
16.01.93 GBF 1/28 Te Anau (D43) 1:50,000, GR 245233



REACH NAME : HAYCOCKS REACH

Geographic description of reach : Haycocks reach extends from Little Hill down to the right bank bedrock constriction between Burwood and The Key. In this reach the valley widens considerably from the upstream reaches, and the channel becomes more multichannelled with more extensive alluvial flats.

Analysts : GB, AB, AH Date of Analysis : 15.01.93, 17.01.93 and 18.01.93

Grid co-ordinates of reach : Te Anau (D43) 1:50,000 246209 to 137072

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley setting
Broad valley with extensive alluvial flats. Tilted sedimentary strata form the left bank valley margin along The Haycocks.

Extent of Valley flat
The valley flat is notably wider than upstream. Upstream of Wash Creek confluence the valley is about 2 km wide. Bedrock confinement immediately downstream of Wash Creek restricts valley width to just over 1 km. Downstream of this bedrock the valley maintains a fairly uniform width of about 1.2 km down to Mararoa Station. Valley flats widen to beyond 2 km adjacent to Burwood Station at the downstream end of the reach. This progressive down-valley widening is evident on the three valley cross-sections drawn for Haycocks reach (see next page).

Terrace character
Highly variable down-reach. The prominent upper terrace described in Hikuraki reach is no longer evident. At the upstream end of the reach the lower terrace is much more extensive than upstream and may act as an alluvial flat, indicating a possible downstream change in the aggradation/degradation balance of the river.

Left Bank
A massive, 50-60 m high discontinuous terrace at the reach head separates the Mararoa and Oreti catchments. Opposite Little Hill there is an extensive terrace 10-15 m above the present channel. No other lower terraces are evident prior to bedrock constriction downstream of Wash Creek. About 500 m downstream of Wash Creek an 8-10 m high discontinuous terrace is observed. This feature is composed of clast-supported gravels with occasional boulders up to 500 mm wide. Few sand lenses are evident within the terrace, and a loess cap up to 2 m thick is observed atop.

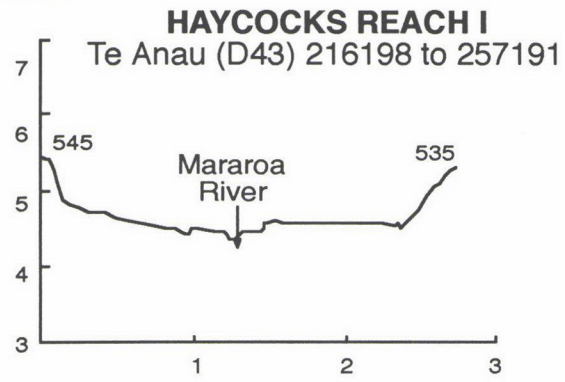
2 km upstream of Mararoa Station bridge, a 2-3 m terrace forms the left bank of the channelized zone. This is being locally eroded. Beyond this point a flight of four or more terraces is maintained. The lower 4-5 m high terrace is a significant distance from the channel adjacent to Burwood Station, separated by extensive alluvial flats. A highly discontinuous, much higher upper terrace is fragmentarily preserved in the foothills of the Takitimu's.

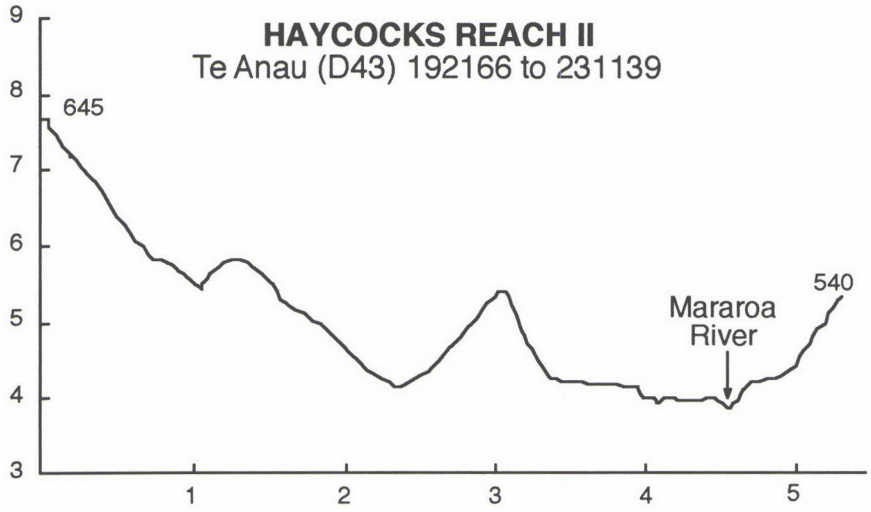
Right bank
Opposite Wood Burn, there is a flight of three terraces, the upper of which is 10-15 m above the present channel. The two lower terraces are discontinuous. The 10-15 m high terrace pinches out 1.5 km upstream of Wash Creek. The major right bank terrace is about 10 m above the channel. This is a continuous surface, which locally has a small terrace (1-2 m high) atop. Downstream of Wash Creek the lowest terrace forms a fairly continuous surface a few metres above the present channel.

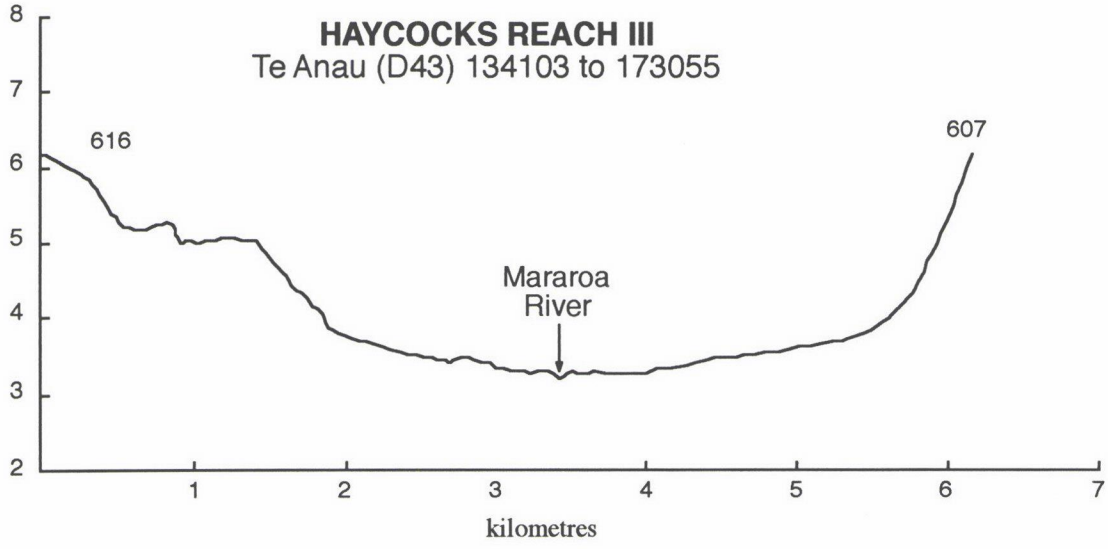
Just downstream of Mararoa Station bridge the Mararoa abuts against the 8-10 m high terrace. This surface is continuous down-valley until the Mararoa abuts against bedrock at GR 145075. Between Mararoa Station bridge and this bedrock buttress the 4-5m high lower terrace is markedly discontinuous and is being actively eroded at various locations.

Valley cross sections

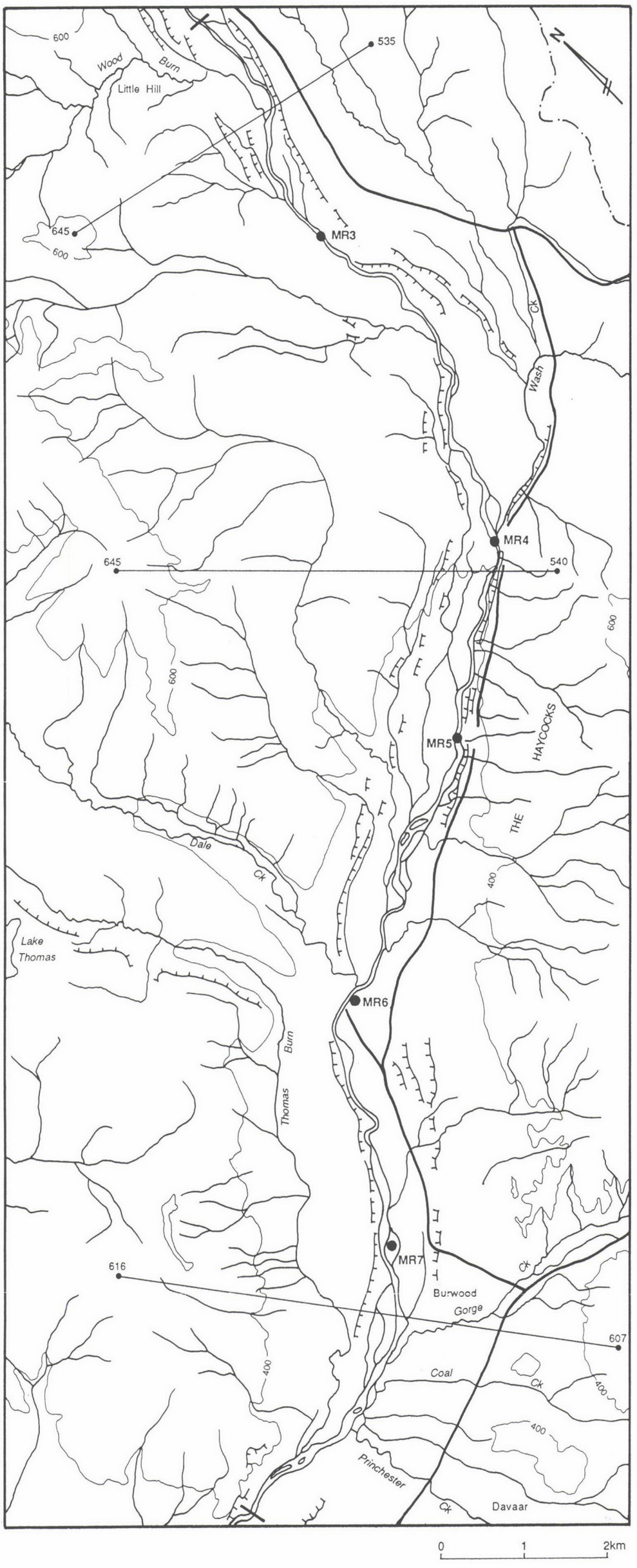
metres







HAYCOCKS REACH Te Anau (D43) 1:50,000



LEGEND

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

Extent of Alluvial flat

The extent of alluval flats is locally variable, ranging from 500-600 m wide at the head of the reach to up to 800 m wide down-reach, but the flats are locally much narrower (e.g. in bedrock-constrained subreaches and immediately upstream of Mararoa Station bridge). Flats are highly dissected by secondary channels, some of which are presently active. These are generally small channels and frequently have tortuous paths. The flats have a hummocky microtopography, with significant surfaces of exposed gravels. Channels on the alluvial flats form a series of topographic levels, as indicated by the variable extent and character of vegetative cover.

There is enormous scope for lateral expansion of channels throughout this reach. Wide expanses of active channel gravels are locally observed to extend up to 150 m wide atop adjacent alluvial flats, associated with the differing pattern of secondary channels. Unlike reaches upstream, these channels appear to remain active for a much wider range of flow conditions.

Degree and character of channel constriction

Compared to upstream reaches, Mararoa River is notably less constrained in Haycocks reach. This is evidenced by shallower banks, greater preponderance of active bar surfaces, and greater inundation of channel-marginal flats by secondary channels. The channel itself is wider and shallower than upstream. Channel width is highly variable dependent on local channel configuration and geometry, but is typically 50-70 m wide. The ratio of width of alluvial flats to channel width is approximately 10:1.

At GR 237178 the river is incised into bedrock (Papa mudstone) which acts to constrain the river against the right hand side of the valley. Downstream of this bedrock constraint the river is virtually unconfined through the remainder of the reach. There is, however, a further marginal bedrock constraint on the left bank downstream of Wash Creek and the terraces are locally eroded downstream.

Character and impact of tributary streams

Wood Burn, which drains a relatively large subcatchment on the left bank, exerts negigible impact on the Mararoa. There is no evidence of a shallow fan as Wood Burn wanders across the flats prior to the confluence. Indeed, a number of small right-bank tributaries from Snowdon Forest have sinuous outlines in their lower course and are aligned down-valley prior to joining the Mararoa. These tributaries appear to contribute little sediment to the Mararoa.

A large number of left bank tributaries join the Mararoa from The Haycocks range. These are relatively short systems and appear to contribute only small volumes of poorly-competent material to the main channel. These channels have, however, locally eroded through outwash terraces. Large volumes of sediment have been released from the terraces themselves.

Moving downstream, several right bank tributaries join the Mararoa opposite The Haycocks (e.g. Dale Creek, Thomas Burn). While these are longer rivers draining more extensive subcatchments, their lower courses are sinuous and these are not high-energy systems. These channels flow along relatively straight (glacially or meltwater-scoured) valleys from which most readily available sediment appears to have been already removed.

Left bank tributaries at the downstream end of Haycocks reach constitute much more substantive sediment sources. Gorge Creek, Coal Creek and Princhester Creek all drain moderate-sized catchments in the relatively friable volcanic Takitimu's. These channels have also scoured through the extensive upper left-bank terrace, supplying vast volumes of material to the Mararoa in the past. These short, steep catchments, with high relief ratios, are seemingly active gravel sources.

Surficial geology

The steeply inclined sedimentary strata of The Haycocks range represent a text-book example of differing lithologic resistance to erosion. These Tertiary deposits are predominantly composed of sandstone and siltstone beds, with occasional quartzose coal measures. On the right bank, sandstone sequences at Little Hill are transitional downstream to Pliocene-Pleistocene warped and locally faulted blue-grey gravels.

Fluvioglacial outwash terraces are prominent in Haycocks reach. These grey sandy roughly stratified deposits are termed the Mavora Outwash Member (McKellar, 1973). Originally these sediments were laid down as an outwash plain (or sandur) in front of Wakatipu Glacier, which seemingly terminated around the southern end of Mavora Lakes.

Vegetation
Valley side/flats : Beech cover becomes patchy down-reach. Valley sides are primarily covered by scrub tussock, matagary and grasses, with occasional ferns and bracken. Valley flats are primarily pasture.

Alluvial flats : Predominantly scrubby grasses with some tussocks and patchy matagary.

Bars/Banks: Sparsely grassed. Occasional shrubs, exotic weeds, matagary, lupins, water cress, rosehip and thistles. Banks are locally undercut.

Land use
Scrubby pasture, forest.

Direct human impacts
Direct human impacts on Mararoa River are minimal, but there has been some ditch-clearance along secondary channels. No stop banks are evident along the Mararoa itself, but there has been some channelization of tributaries. Crude stop banks have been constructed immediately upstream of Mararoa Station bridge. These comprise gravel boulder berms bulldozed to 2 m high, constraining the flow to its present channel position.

Other notes
This is truly a landscape fashioned by the regional glacial and paraglacial history. Dry valleys, massive lake fills and the vast glaciofluvial outwash terraces all attest to the glacial history. Catchments have been realigned, and drainage networks refashioned (e.g. narrow neck that separates upper Mararoa/Oreti systems). Such events need to be placed in context of the regional events that have fashioned river development in Southland, with infilling of the lowland plains, structural (tectonic?) control on channel alignment, and possible diversion history (from crudely NNW-ESE to roughly N-S).

CHANNEL CHARACTERISTICS

Number of channels : Multichannelled, with up to 4 active channels, at the head of the reach. Locally becomes single-channelled with occasional side channels adjacent to bedrock confinements. Beyond this bedrock constriction there are typically two and occasionally three channels. While this number of channels is maintained throughout most of the reach, there are occasional short, single-channelled stretches that appear to be more stable. In contrast, some of the larger highly-dissected compound bars have 5 or 6 active channels (e.g. compound bar at GR 208122). Just upstream of Mararoa Station bridge, the main channel is well defined, with few active secondary channels.

Channel geometry : The channel in this reach has a much higher width:depth than upstream. However, flow width is locally constrained adjacent to bedrock confinement (where width is about 25 m). At the bedrock constriction the channel is clearly asymmetrical, with a well defined thalweg. Channels become less well-defined down-reach, with higher width:depth. A large number of riffles are evident, and channels are clearly asymmetrical in bends. Most channels have irregular cross-sectional geometries, and thalweg definition is locally variable.

Sinuosity : Sinuosity is generally low, with occasional sweeping bends. Secondary channels have variable sinuosity.

Lateral stability of channel(s) : Throughout most of the reach the channels are laterally unstable, with erosion on the outside of bends, poorly defined banks, and a larger proportion of active gravel surfaces than upstream. Local variability in bank stability depends on whether the channel is locally of low sinuosity and relatively stable, or a series of channels which flow around dissected within-channel compound bars. Adjacent to the compound bar at GR 208122 the outwash terrace has been recently eroded, with three fence-posts hanging over the cliff edge, and a telegraph pole in mid-channel. This attests to the laterally shifting nature of the channel in this reach.

Local subreaches are moderately stable due to bedrock confinement (Papa mudstone; e.g. at GR 237176 and immediately downstream of Wash Creek confluence). At the head of the reach the right bank is generally well vegetated, although there are localized erosion sites. On the left bank upstream of Mararoa Station bridge, the channel is incising into the 2-3 m high terrace. Crude stop banks have been constructed constraining the channel at this point.

Bar type and scale

A large mid-channel compound bar has formed at the head of Haycocks reach. This is dissected by a small secondary channel, while the bar tail is undergoing active trimming. This bar is largely vegetated. Immediately downstream there are two small active gravel surfaces on a broad bend. These are gravel sheets of indistinct morphology, and are not lateral bars or parts of a dissected point bar. This attests to the partially-alluvial nature of this reach, with evidence of smaller gravel sheets which are scaled smaller than channel width. Downstream of this broad bend is a large bank-attached compound bar, the tail of which is dissected into a mid-channel compound bar (adjacent to confluence of Wood Burn). Numerous mid-channel bars are evident beyond this point.

Immediately upstream of GR 237178, where the river is incised into bedrock (Papa mudstone), a mid-channel bar is transitional downstream to a bank-attached bar. Beyond the bedrock constriction there is down-reach variability in channel configuration, with alternating zones of active and less active channel activity associated with complex bar assemblages and single-channelled sections respectively. These zones may be time-transgressive, reflecting downstream translation of 'sedimentation' zones. Complex bar assemblages are characterized by dissected mid-channel and bank-attached compound bars, with bank-attached features predominant. Active gravel surfaces are extensive. Such sections are not truly braided, as lateral movement of channels prevails. For example, the confluence bar at Wash Creek confluence does not exhibit clearly aligned morphostratigraphic units. Just upstream of Mararoa Station bridge, there is a large bank-attached compound bar, which is clearly dissected by numerous channels at high flow stages.

Adjacent to Burwood Station there is a mixed assemblage of compound bars of differing scales, the specific pattern of which appears to reflect the degree of bar dissection at differing flow stages. Bar dissection is locally variable. The lower end of Haycocks reach appears to be transitional with respect to the downstream sequence of degradation/aggradation, with a greater preponderance of mid-channel bars and more active alluvial flat formation. This implies a more alluvial channel condition. Alluvial flats are being reworked by flood flows oriented diagonally over the bar at GR 162084. This may be indicative of within-channel aggradation, as the main channel no longer has the capacity to transport all gravels available to it and spreads finer clasts over adjacent flats. Clasts certainly appear to be active and mobile over these surfaces, and flows do not appear to be scouring or incisional events.

Bed/Bank character (extent and materials)

Other than in areas of local bedrock constriction, banks are typically very shallow, only occasionally extending up to a few metres in height. Active undercutting is common. Slimy algae is evident on the bed of secondary channels.

Bar surfaces are highly irregular and very poorly sorted, reflecting local reworking of deposits. Several large boulders are evident on the channel bed and on bar surfaces. These represent reworked outwash deposits. At the downstream end of the reach there are numerous sand drapes over bank/bar surfaces.

Flow character

Distinct pool/riffle sequence with less white water than upstream. Subreaches of confined flow have standing waves. Flow locally backs up against bedrock banks, with a series of secondary circulation cells and boils adjacent to local erosion points. Beyond the bedrock constriction, riffles are fairly regularly spaced. This attests to the alluvial character of Haycocks reach. Standing waves alternate with stretches of uniform flow, but the overall flow character is quite irregular. Adjacent to Burwood Station flow is rapid, but there is less white water than upstream. Bar gravels adjacent to the main channel are well imbricated, indicating the non-dissipative flow in this zone.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR3** Grid reference : 237178

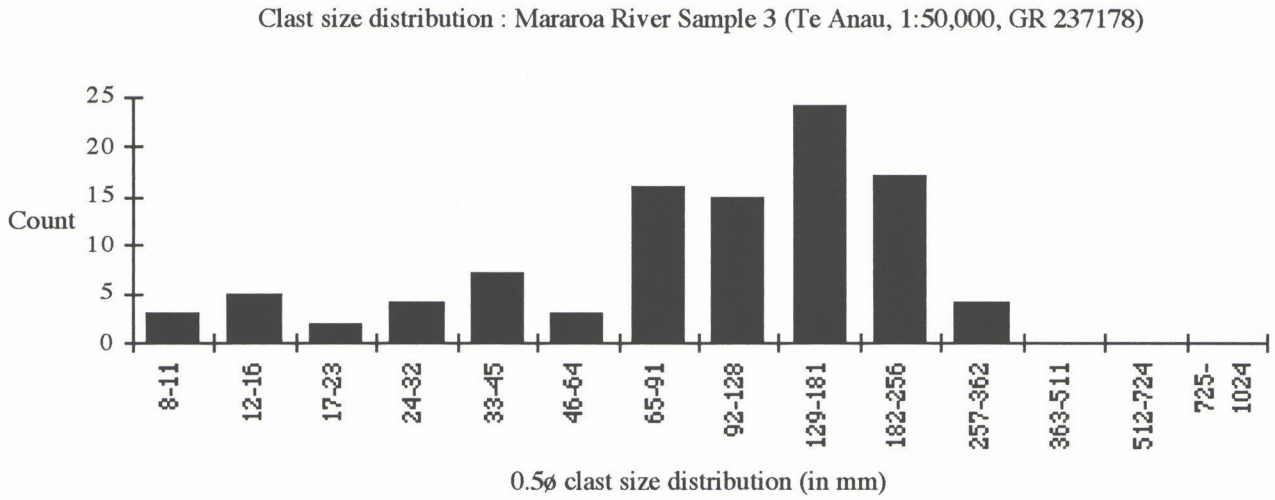
Sample type : 2 x 33 m, 1 x 34 m @ 1 m interval

Bar type : Partially developed point bar that forms part of a well-defined riffle at the entrance to a bend.

Sample position on bar : Channel margin at the bar head.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 245 mm; D84 195 mm; D50 105 mm; D16 33 mm; D5 12 mm

Mean 120.8 mm; Sorting 75.4 mm

Sorting : Poor, with a distinct tail to the clast size distribution.

Packing arrangement : Not imbricated, jumbled. Flow on the inside of the bend has not effectively winnowed away fine gravels and distinct sand lenses are evident.

Shape : Subrounded, generally blocky with some discs/blades.

Lithology : Highly variable

Other characteristics : Mixed gravel population. The outside of the bend is a much more efficient conveyor of gravels. Occasional algae-covered boulders are evident at the channel margin.

Sample number : **MR4** Grid reference : 228137

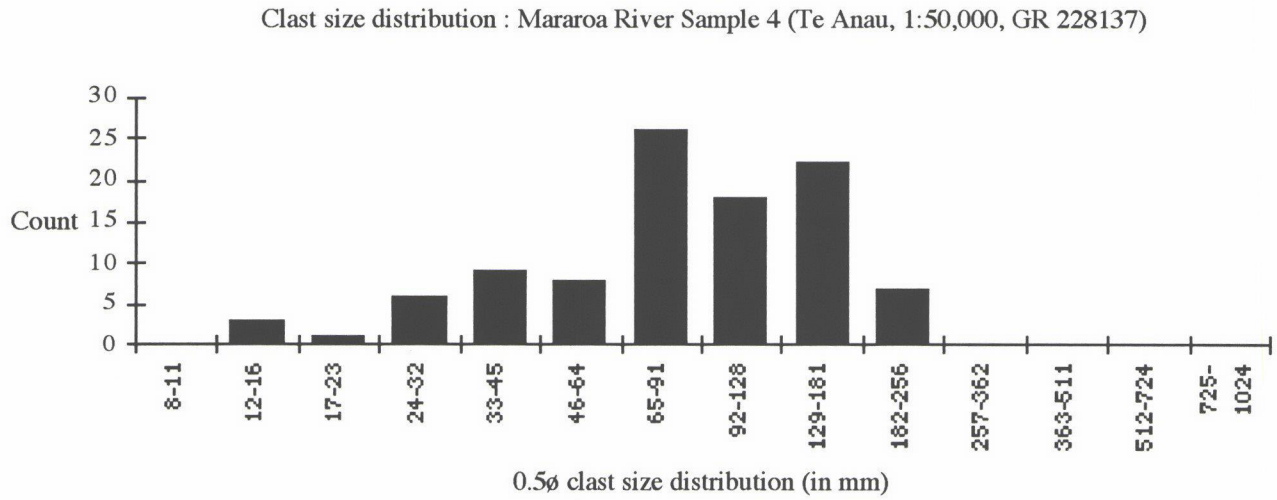
Sample type : 2 x 25 m @ 0.5 m interval.

Bar type : Confluence bar immediately downstream of Wash Creek. Sediment accumulation has built up upstream of a left-bank channel bedrock constriction. Secondary channel crossed to gain access to bar. Chute channel has adjacent supraplatform composed of finer, looser gravels. A riffle has formed at the bar head and also within the secondary channel.

Sample position on bar : Down chute channel that diagonally cuts bar.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 190 mm; D84 160 mm; D50 90 mm; D16 40 mm; D5 25 mm

Mean 99.45 mm; Sorting 54.15 mm

Sorting : Poor, ranging from large boulders up to 350 mm wide down to fine sands/muds draped around vegetation on bar surface.

Packing arrangement : Clasts are imbricated and moderately tightly packed at the head of the chute channel. Elsewhere the surface is moderately imbricated and packed, with occasional loose clasts. Surface is winnowed to about 20 mm. One-clast thick surface protects finer grained material beneath.

Shape : Blocky, with occasional discs and blades; subrounded to subangular

Lithology : Mixed

Other characteristics : Fairly regular surface, with distinct depositional units over bar surface. Bar is partially covered by low-lying ground cover with pioneer grasses, clover, dandelions and other weeds. Much debris is caught between rocks. Moss-like groundcover partially covers come rocks. Slimy algae observed on bed of secondary channel.

Sample number : **MR5** Grid reference : 208122

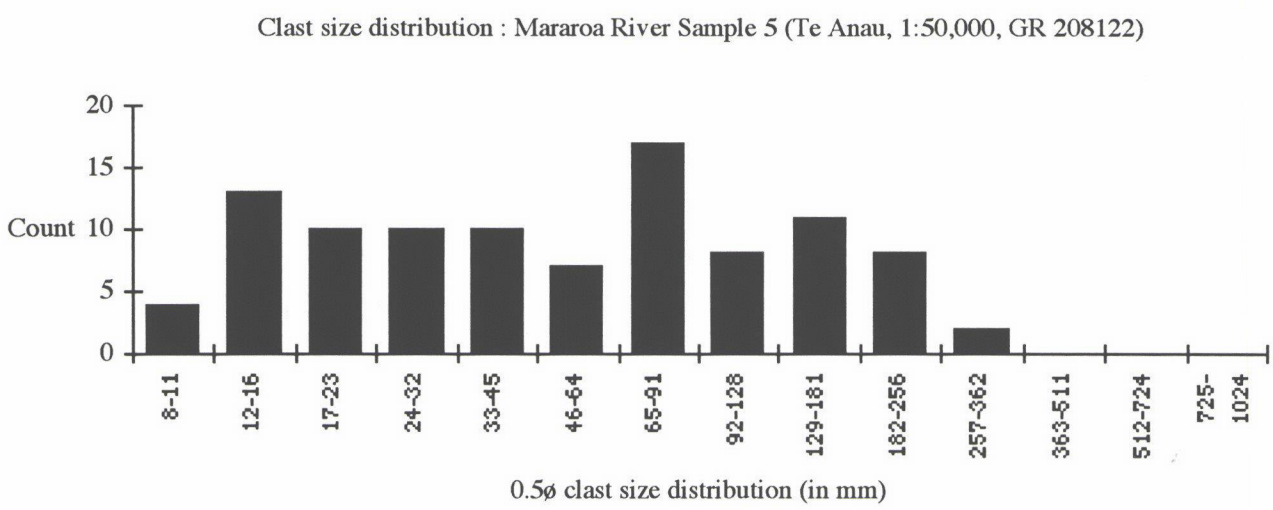
Sample type : 1 x 50 m @ 0.5 m interval

Bar type : Large, dissected bank-attached compound bar, with extensive active gravel surface. This surface is irregular, with a large number of dissecting channels.

Sample position on bar : Water's edge transect at head of bar. Transect cuts across abandoned channel gravels.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 230 mm; D84 150 mm; D50 50 mm; D16 15 mm; D5 15 mm

Mean 76.75 mm; Sorting 68.13 mm

Sorting : Very poor. Many large boulders are seemingly derived from the adjacent eroding terrace. Note the wide spread in the histogram above.

Packing arrangement : Jumbled surface, with a large number of relatively loose clasts. These may reflect recent influxes of finer clasts onto a coarser pavement.

Shape : Subrounded; blocky with occasional discs.

Lithology : Mixed lithology, with competent plutonic and metamorphics (including schists), but less competent and readily friable sedimentary clasts (typically sandstones).

Other characteristics : Abandoned channel at the left bank margin has eroded outwash terrace. This horizontally banded, clast-supported terrace typically has clasts up to 60-70 mm, but occasional clasts are up to 500 mm wide. The 1990 topographic map shows the channel at the left bank margin. Evidence for recent channel shifting is provided by a telegraph pole located within the present channel. This behaviour is typical of a laterally shifting channel in a truly alluvial reach. Uprooted matagary on the gravel pavement seemingly reflect erosion of the terrace immediately upstream. The matagary commonly has fine-grained deposits (loess?) attached in their roots. Pioneer grasses and exotic weeds are irregularly patched over the bar surface.

Sample number : **MR6** Grid reference : 178108

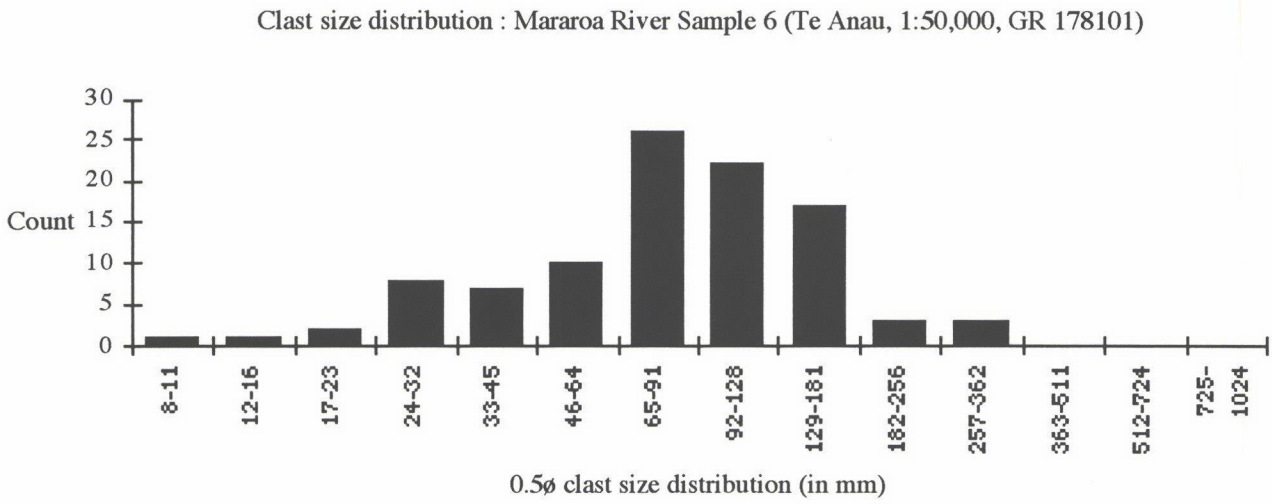
Sample type : 1 x 50 m @ 0.5 m interval

Bar type : Bank-attached compound bar dissected by artificially dug chute/secondary channel. Riffle evident at bar head.

Sample position on bar : Bar head, water's edge sample.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 205 mm; D84 145 mm; D50 85 mm; D16 45 mm; D5 24 mm

Mean 97.39 mm; Sorting 60.53 mm

Sorting : Moderately poor.

Packing arrangement : Extremely jumbled, loose gravel surface, with lots of locally reworked coarse clasts. Occasional patches are imbricated, but these appear to be basal pavement units which have had finer gravels emplaced atop.

Shape : Subrounded; blocky with occasional blades (very few discs).

Lithology : Mixed.

Other characteristics : Lenses of washed-up fine gravels/sands at bar margin. Large boulder evident in adjacent main channel.

Sample number : **MR7** Grid reference : 162084

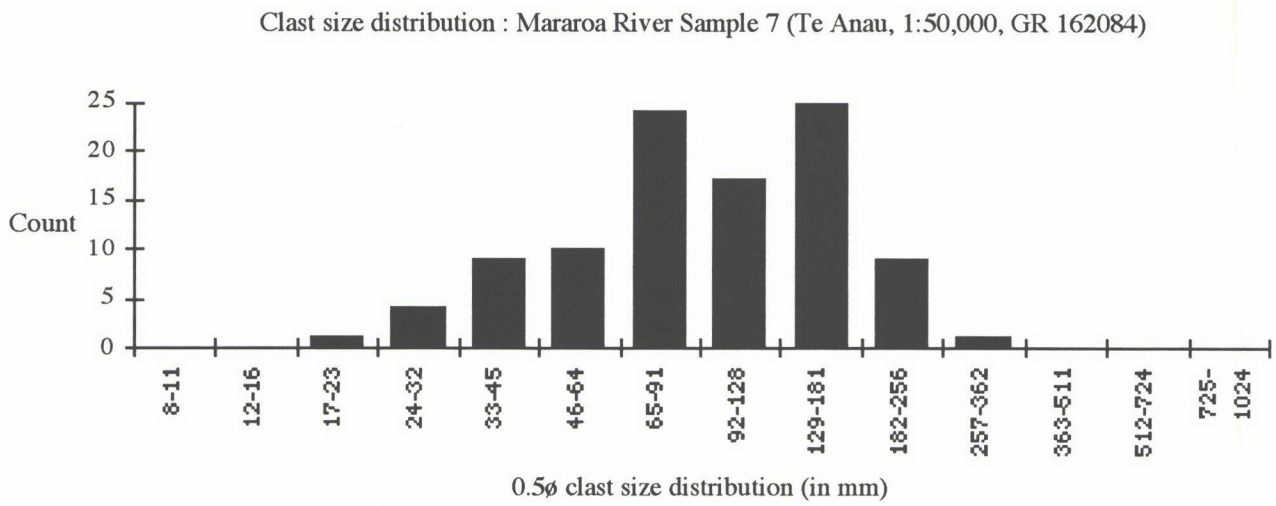
Sample type : 1 x 50 m @ 0.5 m interval

Bar type : Bank-attached compound bar separated from alluvial flats by at least two discontinuous chute/side channels.

Sample position on bar : Bar head, water's edge sample.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 220 mm; D84 165 mm; D50 95 mm; D16 50 mm; D5 30 mm

Mean 108.1 mm; Sorting 57.36 mm

Sorting : Moderate to poor.

Packing arrangement : Well-imbricated surface, with occasional looser clasts atop. Bar surface is quite well winnowed, other than a sand drape from recent higher flow levels. Gravels seem to rest upon a well-packed basal pavement.

Shape : Subrounded; blocky. Clasts appear to be more rounded downstream, but at the same time there also appears to be a larger proportion of blades (possibly associated with the greater proportion of plutonics).

Lithology : Although mixed, fine-grained plutonics appear to be more abundant than upstream.

Other characteristics : Occasional organic debris on the bar surface. Early stage gorse, lupins and other weeds.

Mararoa River Photo 22, Haycocks Reach
Upstream end of Haycocks reach. Note the low sinuosity, divided channels. Alluvial flats are dissected by long threads of side channels.
16.01.93 AMF 1/16 Te Anau (D43) 1:50,000, GR 245207



Mararoa River Photo 23, Haycocks Reach
View downstream at the upper limit of Haycock's reach. Note the well defined margin of the alluvial flats as they abut against a major terrace river, and the high sinuosity tributary channel (Wash Creek) on the terrace surface.
16.01.93 AMF 1/5 Te Anau (D43) 1:50,000, GR 245207



Mararoa River Photo 24, Haycocks Reach
View upstream at the upstream end of Haycock's reach. Note the extensive alluvial flats and poorly defined channel banks.
15.01.93 4-5 Te Anau (D43) 1:50,000, GR 246195



Mararoa River Photo 25, Haycocks Reach
View looking downstream, a few kilometres downstream of Little Hill. Mararoa River abuts against bedrock marginal to the beech forest. Sample site MR3 is located on the inside of the bend downstream of the first windbreak.
16.01.93 AMF 1/7 Te Anau (D43) 1:50,000, GR 237288



Mararoa River Photo 26, Haycocks Reach
Sample site MR3, located on a shallow platform on the inside of a bend at GR 237178. Mararoa River locally abuts against bedrock in this subreach,
15.01.93 4-10 Te Anau (D43) 1:50,000, GR 237178



Mararoa River Photo 27, Haycocks Reach
View upstream of upper Haycocks reach from Wash Creek confluence.
17.01.93 5-27 Te Anau (D43) 1:50,000, GR 228137



Mararoa River Photo 28, Haycocks Reach
Mararoa-Wash Creek confluence. Sample site MR4 was located in the chute channel on the mid-channel bar at the confluence. Photograph is taken from a bedrock buttress on the left bank.
17.01.93 5-33 Te Anau (D43) 1:50,000, GR 225134



Mararoa River Photo 29, Haycocks Reach
Expansive, dissected alluvial flats just downstream of Wash Creek confluence. The river is much more active over these flats compared to upstream, and gravel surfaces are considerably more extensive.
17.01.93 5-34 Te Anau (D43) 1:50,000, GR 225134



Mararoa River Photo 30, Haycocks Reach
View downstream from bedrock buttress close to Wash Creek confluence.
17.01.93 5-35 Te Anau (D43) 1:50,000, GR 225134



Mararoa River Photo 31, Haycocks Reach
View upstream at sample site MR5. This is a dissected compound point bar. Note the erosion of the left bank terrace (right hand side of photo).
17.01.93 5-37 Te Anau (D43) 1:50,000, GR 206120



Mararoa River Photo 32, Haycocks Reach
Sample site MR5. Note the extensive, shallow, active gravel surfaces, indicating that this is a laterally unstable reach prone to channel adjustment. This is testified by the position of the telegraph pole within the channel in mid-photo.
17.01.93 6-00 Te Anau (D43) 1:50,000, GR 208122



Mararoa River Photo 33, Haycocks Reach
View downstream from eroding terrace bank immediately downstream from sample site MR5. Note the increase in channel multiplicity compared to upstream, and the eroding fence posts on the left bank.
17.01.93 5-38 Te Anau (D43) 1:50,000, GR 206120



Mararoa River Photo 34, Haycocks Reach
The lower course of Dale Creek winds its way towards the Mararoa in Haycocks reach. Mararoa River itself is less multi-channelled than upstream, and has a low sinuosity course.
16.01.93 1-10



Mararoa River Photo 35, Haycocks Reach
Sample site MR6, located on the platform of a compound point bar immediately upstream of the road bridge to Mararoa Station.
18.01.93 6-2 Te Anau (D43) 1:50,000, GR 178108



Mararoa River Photo 36, Haycocks Reach
Prominent riffle at the head of the bar where sample MR7 was collected (near Burwood Station).
18.01.93 6-3 Te Anau (D43) 1:50,000, GR 162084



Mararoa River Photo 37, Haycocks Reach
Sample site MR7, located on a bank attached compound bar near Burwood Station.
18.01.93 6-5 Te Anau (D43) 1:50,000, GR 162084



REACH NAME : THE KEY REACH

Geographic description of reach : The Key reach extends from midway between Burwood Station and The Key down to Te Anau-Mossburn road bridge. This reach is less multi-channelled and has a lower sinuosity than upstream, with a much better-defined thalweg. The Key reach is less alluvial than Haycocks reach, with fewer active gravel surfaces. Bars are generally restricted to bank-attached features in a well-defined, relatively narrow channelized zone. Mararoa River abuts against bedrock on its right bank.

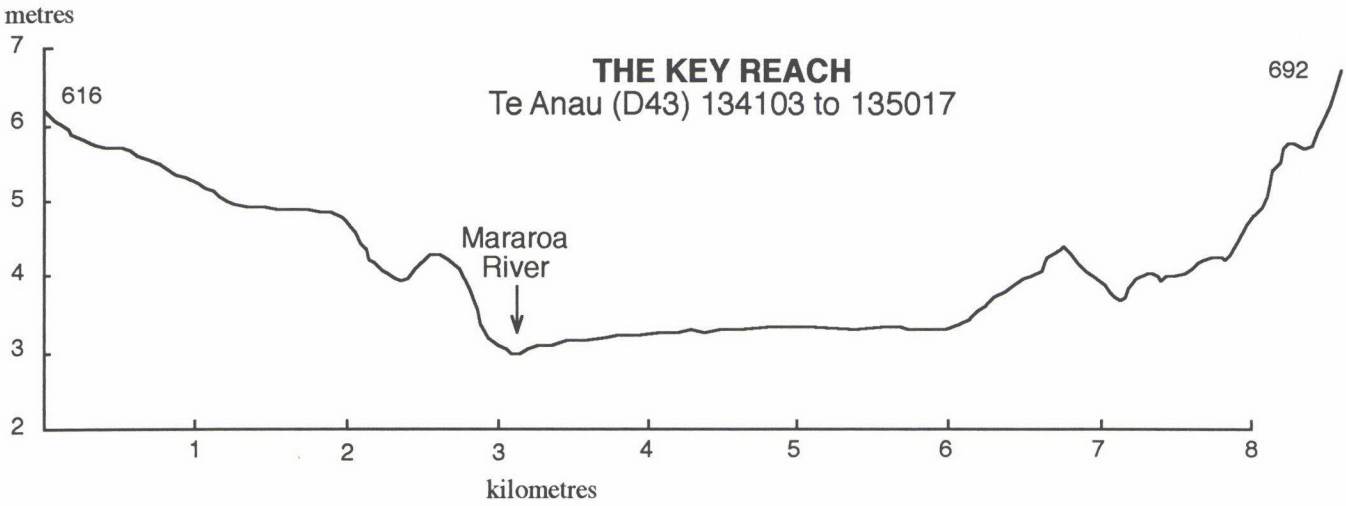
Analysts : GB, AB, AH Date of Analysis : 18.01.93

Grid co-ordinates of reach : Te Anau (D43), 1:50,000, 137072 to 108060

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley cross section



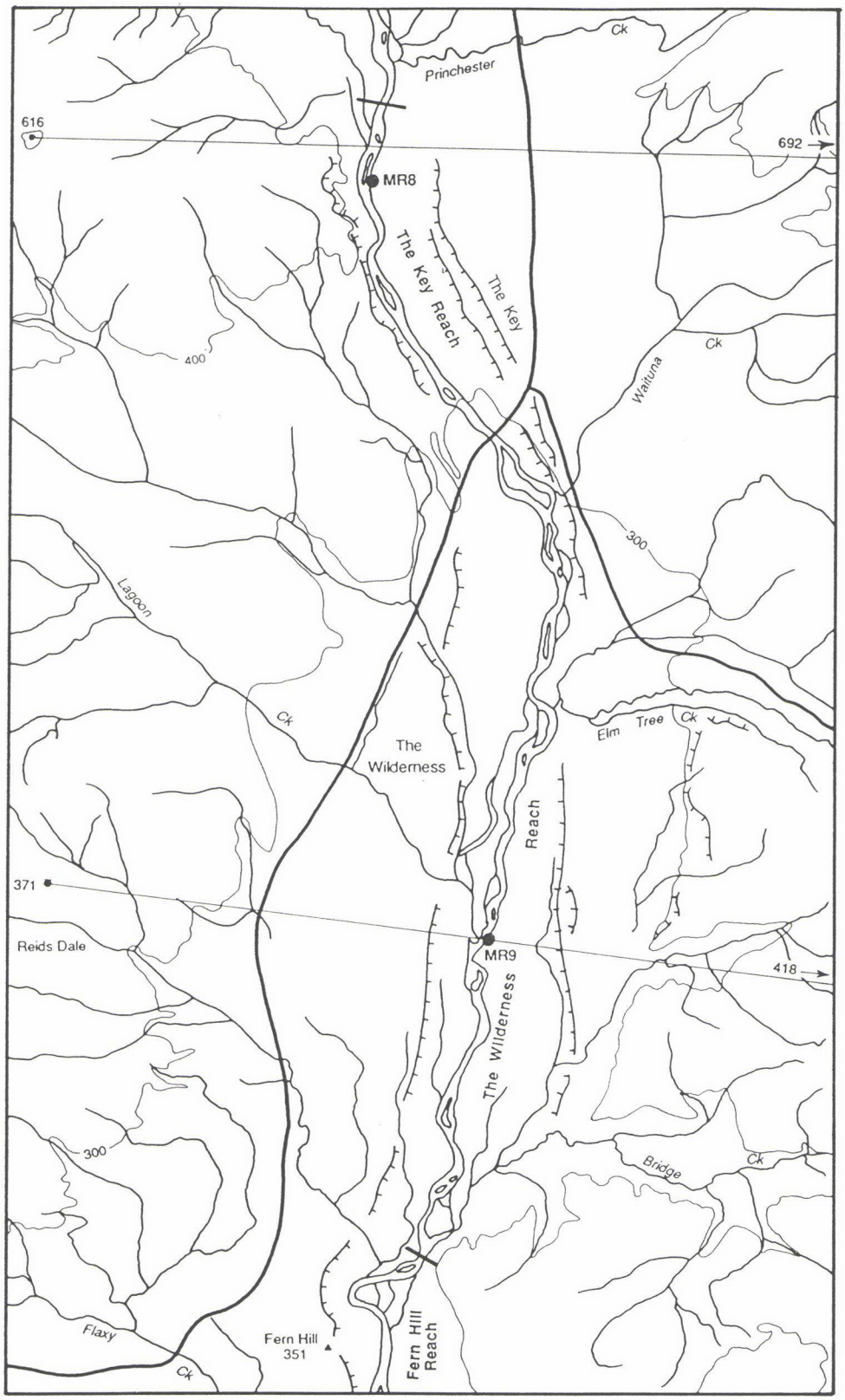
Valley setting
Broad valley with extensive alluvial flats, constrained on right bank by bedrock cliffs composed of tilted sedimentary strata.

Extent of Valley flat
The valley maintains a relatively uniform width of almost 3 km.

Terrace character
No terraces are evident on the right bank as the river abuts against bedrock. On the left bank there is a flight of three or more regularly spaced terraces, with a remnant perched very high terrace at the margins of the Takitimu's.

Extent of Alluvial flat
Roughly up to 500 m wide. Flats are generally restricted to the left bank, with occasional abandoned islands on the right. Surface of the alluvial flats is highly dissected by side/chute channels of varying size and orientation. Some channels are irregularly scoured. Flats/islands are covered by gorse/broom/matagary and exotic weeds, along vegetated strips within fences in this fairly straight and uniform 'channelized' reach. This is the first reach downstream in which a distinct river corridor is evident.

THE KEY AND THE WILDERNESS REACHES Te Anau (D43) 1:50,000



LEGEND

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

Degree and character of channel constriction
Bedrock cliffs on the right bank are actively eroding, but the channel is only moderately constrained on the left bank. The dense vegetation in the channelized section of the alluvial zone suggests that the channel is relatively stable in this reach. Lateral adjustments appear to be restricted to bar movements within the channelized zone, with relatively little channel shifting onto adjacent flats.

Character and impact of tributary streams
Immediately upstream of the head of the reach, Thomas Burn forms a right bank tributary. The relatively sinuous nature of Thomas Burn and the fact that it flows for almost 5 km over the relatively flat upper terrace surface, suggests that this tributary has relatively little impact on the Mararoa itself. No left bank tributaries join the Mararoa in this reach, but three major left bank tributaries immediately upstream may supply considerable volumes of material. At the very least, these tributaries have supplied a considerable volume of sediment in the past.

Surficial geology
Bedrock exposures along the right bank of The Key reach are composed of tilted sedimentary strata of Pliocene-Pleistocene age. This sequence, referred to as the Prospect Formation (McKellar, 1973), consists of thick units of greywacke gravel set in a lightly cemented sandy matrix, with discontinuous sand lenses and some beds of sand and silt.

Fluvioglacial outwash terraces are less prominent than upstream. Behind the extensive low-lying outwash terraces on the left bank, there are remnant upper terraces adjacent to the Takitimu's. These perched terraces attest to extensive sediment reworking in the past. The northern margins of the volcanic Takitimu's (of Permian-Carboniferous age) are composed of early Tertiary sandstones and conglomerates. The Takitimu Mountains are composed of grey, red and green tuffaceous sandstone and tuff, volcanic breccia, pillow lavas, and andesitic flows and sills.

Vegetation
Valley side/flats : Left-bank valley flats are covered by pasture grasses.

Alluvial flats : Dense gorse, broom and matagary are dominant along the channelized zone, with willows abundant along channel margins.

Bars/Bank : Sparsely vegetated in the channelized zone itself, although gorse, broom, matagary and exotic weeds are evident. Willows, broom and gorse are dominant along banks.

Land use
Pasture.

Direct Human Impacts
Gravel extraction for stockpiles adjacent to the bridge at the downstream limit of the bridge. Ditches are evident over alluvial flats adjacent to the bridge.

Other comments
Why is the bedrock cliff eroding if the reach is seen to be relatively stable? Has vegetation resulted in the channel being constrained against the right bank through most of this reach, or is this merely a response to excessive volumes of sediment supplied from the Takitimu's?

CHANNEL CHARACTERISTICS

Number of channels : Typically two and occasionally three channels, but the flow is locally restricted to one channel within a well-defined channelized zone.

Channel geometry : Well defined thalweg, indicating a regular channel cross-section. Channel-marginal riffles are occasionally evident, giving a stepped cross-sectional profile. Channels are often perched (*sensu* Williams and Rust, 1969).

Sinuosity : Irregular, but typically very low sinuosity channels within a virtually straight, bedrock constrained channelized zone. The channel itself alternates from side to side within this channelized zone, but very few bends are even moderately sinuous.

Lateral stability of channel(s) : Constrained on the right bank by bedrock, the channel has much greater propensity to shift laterally on the left bank. Even the left bank, however, appears to be stable, with dense vegetation at the margin of the channelized zone. Several islands within the channelized zone indicate that flats are forming by island formation and channel abandonment, but channel movement beyond the channelized zone appears to be minimal. This may relate to the altered channel condition with less active gravel bar surfaces, but may also relate to stabilization by dense gorse/broom.

Bar type and scale
The extent of active gravel surfaces is significantly less than observed adjacent to Burwood Station at the lower end of Haycocks reach. Bars are a mix of bank-attached and mid-channel compound features, although the latter are generally divided around a distinct primary channel with a much smaller secondary channel. Lateral riffles are attached at their downstream margins to bars, but these riffles do not extend very far across the main channel (i.e. they may form across former chute/secondary channels).

Bed/Bank character (extent and materials)
Although banks are commonly shallow on the left bank, there is little evidence of active channel expansion into the densely vegetated flats. These left banks have a mixed gravel population with dense gorse cover. A bedrock cliff forms the right bank.

Flow character
Generally uniform other than white water around boulders eroded from the adjacent bedrock cliff.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR8** Grid reference : 132072

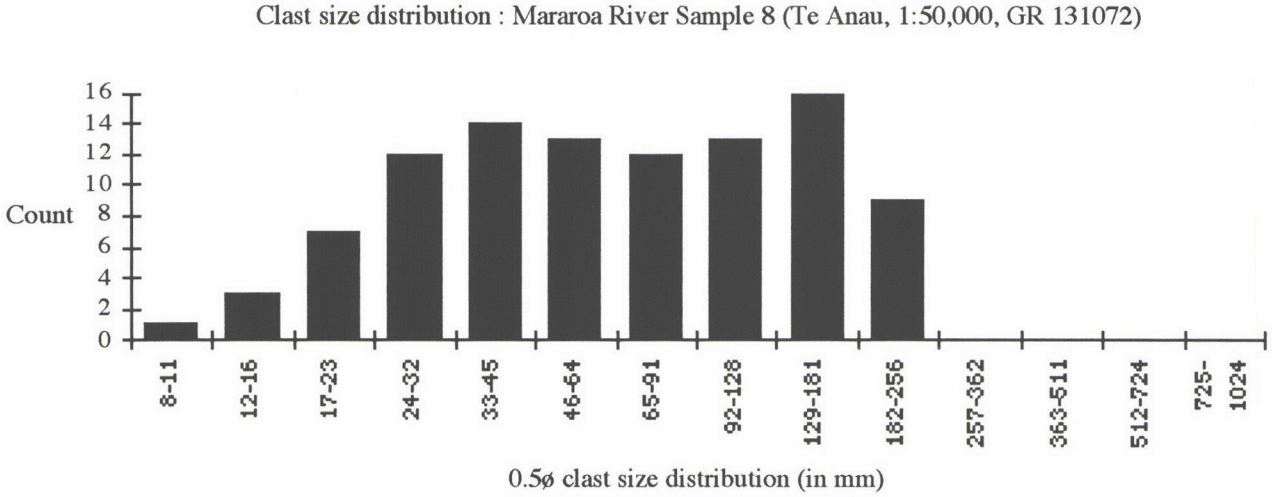
Sample type : 1 x 50 m sample at 0.5 m interval

Bar type : Down-riffle across a connecting channel of a bank-attached compound bar. Riffle is attached at its downstream end.

Sample position on bar : Two 25 m transects were sampled along the water's edge. The upper 25 m is part of the bar itself, while the lower 25 m sample is actually part of a riffle.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 215 mm; D84 155 mm; D50 60 mm; D16 25 mm; D5 20 mm

Mean 85.76 mm; Sorting 62.35 mm

Sorting : Very poor, as indicated by the broad spread in the histogram above.

Packing arrangement : Upstream sample site is unwinnowed, with fine gravels and sands observed between clasts and occasionally draped over the bar surface. Several fine gravel/sand lenses observed. These rest atop a coarser, well-packed pavement, within which clasts are imbricated. The lower 25 m transect on the riffle surface is effectively winnowed down to 20 mm, as flows appear to be more effective over the riffle surface than they are on the upper bar section.

Shape : Subrounded, with a greater proportion of blades/discs compared to upstream sites.

Lithology : Mixed.

Other characteristics : The bar surface is regular, with no vegetation other than small willows which have established in accumulations of fines entrained behind large fallen willows at the head of the bar.

Mararoa River Photo 38, The Key Reach
The Key reach. Note the low sinuosity channel threads in a relatively narrow channelized zone which abuts against bedrock on the right bank. Note also the dense gorse infestation.
16.01.93 AHF 1/15



Mararoa River Photo 39, The Key Reach
Downstream end of the Key reach, with the Te Anau-Mossburn Road bridge on the right hand side in mid-photo.
16.01.93 AHF 1/14



Mararoa River Photo 40, The Key Reach
View upstream at sample site MR8. Note the bedrock constriction on the right bank (left hand side of photo) with some large boulders within channel.
18.01.93 6-9 Te Anau (D43) 1:50,000, GR 131072



Mararoa River Photo 41, The Key Reach
View downstream at sample site MR8. Note the prominent riffle at the head of the bar, the well defined thalweg in the main channel, the bedrock constriction on the right bank, and the gorse infestation at the margin of the channelized zone.
18.01.93 6-7 Te Anau (D43) 1:50,000, GR 131072



REACH NAME : THE WILDERNESS REACH

Geographic description of reach : The Wilderness reach extends from Te Anau-Mossburn road bridge to Fern Hill. This reach has a greater number of active channels than The Key reach immediately upstream. A prominent channelized zone is evident, within which the channel divides around complex, dissected bars within a series of broad, sweeping bends. The channels themselves are less stable than in The Key reach. The main channel and its thalweg are less well defined, and much recent within-channel sedimentation is evident. This may be coincident with incursion of large numbers of willows onto bar surfaces. Despite this, active gravel surfaces are less abundant than in Haycocks reach.

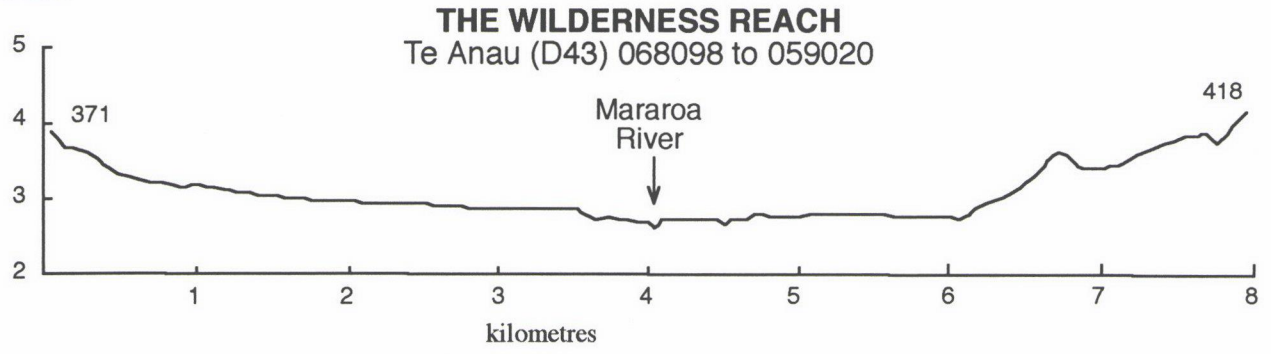
Analysts : GB, AB, AH Date of Analysis : 18.01.93

Grid co-ordinates of reach : Te Anau (D43), 1:50,000, 108060 to 034064

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley cross section



Valley setting
Broad valley with extensive alluvial flats. The reach is located marginal to the northern foothills of the Takitimu's.

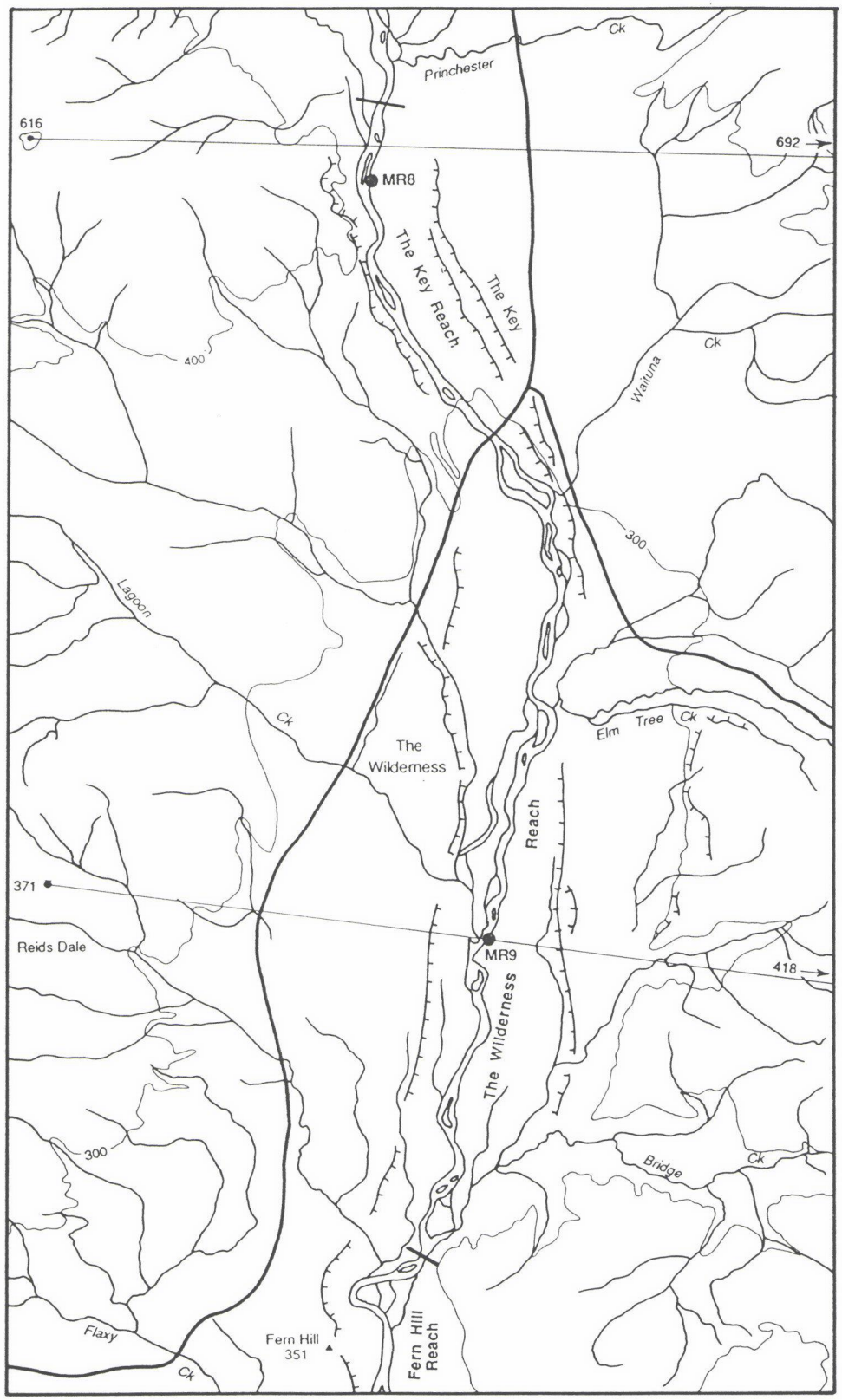
Extent of Valley flat
Valley flats are notably wider than upstream. Adjacent to The Wilderness, associated with Lagoon Creek and Reids Dale, flats extend to almost 3 km wide. At the downstream limit of the reach the valley becomes much narrower associated with bedrock constraints marginal to Fern Hill.

Terrace character
Highly variable down-reach. Terraces are certainly less prevalent than upstream, with no distinct flights of terraces evident.

Left Bank
Dominated by an extremely prominent surface several metres above the channel. This has occasional discontinuous lower surfaces, and upper features at the margins of the Takitimu's. The latter are extremely perched, highly reworked features. Bedrock-based terraces are evident on the left bank at the downstream end of the reach.

Right bank
Major terrace surface is about 300 m back from the channelized zone. This is roughly 8-10 m above the present channel.

THE KEY AND THE WILDERNESS REACHES Te Anau (D43) 1:50,000



LEGEND

- Road
- 500 Contours (metres)
- Terrace riser
- Creeks / rivers
- Cross section
- MR Sample location
- Reach margin
- Catchment margin

Extent and character of Alluvial flat
Retains a fairly uniform width of roughly 600-800 m down-reach. The flats themselves are highly dissected, with a series of stringers of older channel positions demarcated by willows.

Degree and character of channel constriction
Bedrock constraints are evident upstream of the bridge at the head of the reach and marginal to Fern Hill at the downstream limit of the reach. Channel movement within the channelized zone is unconstrained, but it appears that channels move by avulsion rather than migration mechanisms. The channellized zone only locally abuts against terrace margins.

Character and impact of tributary streams
Left bank terraces drain the Takitimu's. Waituna Creek, Elm Tree Creek and Bridge Creek are all highly sediment charged, but they do not appear to be especially active at present, and do not deflect the Mararoa channel. Right bank tributaries, such as Lagoon Creek, are effectively artificial drains. Most tributaries flow for some distance downstream on valley and alluvial flats prior to joining the Mararoa.

Surficial geology
Bedrock exposures on the right bank at the head and tail of The Wilderness reach are composed of tilted sedimentary strata of Pliocene-Pleistocene age. These units are part of the Prospect Formation, which is much more extensive on the south bank between Elm Tree Creek and Mount York. Prospect Formation consists of thick sequences of greywacke gravel set in a lightly cemented sandy matrix, with discontinuous sand lenses and some beds of sands and silt. This unit always occurs beneath the oldest Quaternary till (McKellar, 1973). Behind the extensive low-lying outwash terraces on the left bank, there are remnant upper terraces adjacent to the Takitimu's which attest to extensive sediment reworking in the past.

Cheviot Hills, in the northern margins of the volcanic Takitimu's, are composed of early Tertiary sandstones and conglomerates. The Takitimu Mountains are composed of sub-vertical sediments and intercalated lavas of Permian age (McKellar, 1973). Among the rock types found are :grey, red and green tuffaceous sandstone and tuff, volcanic breccia, pillow lavas, and andesitic flows and sills.

Vegetation
Valley side/flats : Valley flats are covered by pasture grasses. Upland margins of the Takitimu's are forested.

Alluvial flats : Dense gorse, broom and willows are dominant along the channelized zone.

Bars/Bank : Willows and broom are dominant along banks. Many incipient, pioneer weeds are evident on bar surfaces. These bars are generally not well defined, and appear as dynamic, transient features. Many willows are observed in mid-channel.

Land use
Pasture is dominant.

Direct Human Impacts
Gravel extraction for stockpiles is evident adjacent to bridge. Large drainage ditches are evident on the valley flats. Introduced willows are dominant along river banks and on the flats of the channelized zone.

Other comments
Build-up of gravels behind the constriction at Fern Hill may have resulted in modification and reduction of the channel slope, such that channels locally aggrade. Within-channel sedimentation and abundant incursions of willows onto within-channel bars indicate that channel definition is less pronounded than in The Key reach. However, active gravel surfaces are not abundant in this reach, and floodplain inundation was evident along left bank channels.

CHANNEL CHARACTERISTICS

Number of channels : Typically 2-4 channels are evident. In general the primary channel is not well-defined. Distinct topographic levels are common for differing channels.

Channel geometry : Channel geometry is locally variable, but in general there are less active gravel surfaces than upstream. Many channels appear to have an irregular cross-sectional geometry, as they are infilled with gravels. The thalweg is not well-defined.

Sinuosity : Relatively low. In some sections channels are virtually straight, with flow alternating from side to side within the channel zone.

Lateral stability of channel(s) : Although multichannelled, with erosional scours evident as banks are undercut by channels at the left margins of the alluvial flats, this reach is characterized by well-vegetated bars/islands with substantial, mature willows. Gravel surfaces are less abundant than in some reaches upstream, indicating relative channel stability.

Bar type and scale
Mid-channel bars/islands at the head of the reach appear to have formed as much by channel division associated with incision as they have by aggradational processes. Alternate bars have formed in low sinuosity reaches. These are typically dissected bank-attached compound bars.

Bed/Bank character (extent and materials)
Secondary channels at the reach head have partially inundated the adjacent flats. Fines/sands have accumulated on banks behind willows. In some instances in mid-reach, willows are observed in mid-channel.

Pavement, framework gravels are observed in mid-reach. How does this relate to the gradational condition of the reach. Are surface gravels being removed, and local channel incision taking place? How does this relate to eroding willows in mid-channel? Active gravel surfaces are certainly less abundant than upstream.

Flow character
More uniform than upstream. Although riffles are less prevalent than upstream, flow is still very rapid through this reach, possibly indicating a uniform, pronounced bed surface slope.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR9** Grid reference : 064059

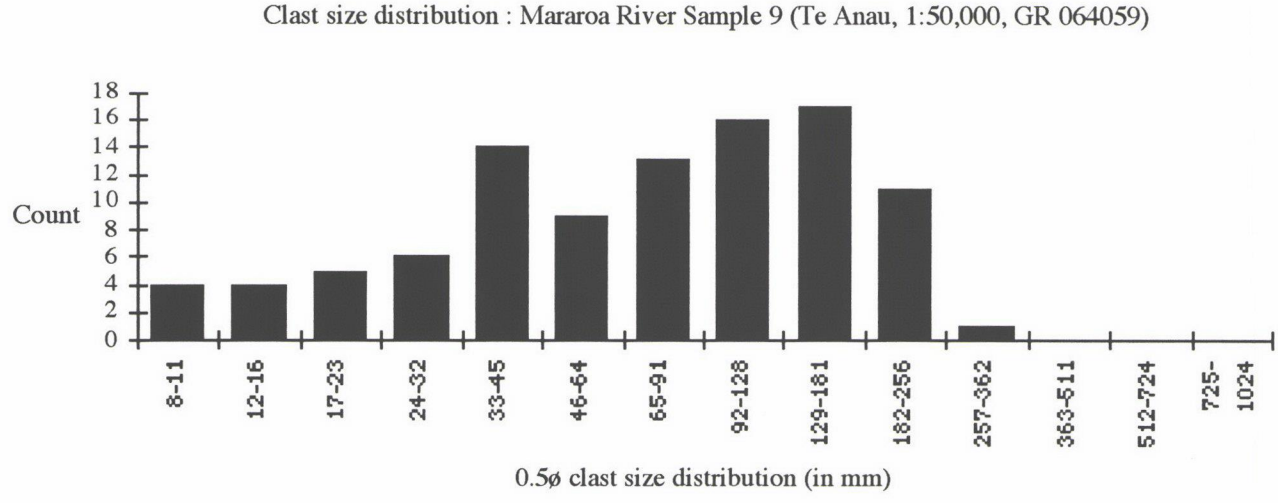
Sample type : 1 x 50 m @ 0.5 m interval

Bar type : Dissected bank-attached compound bar. Lobes of finer grained materials have been washed onto the bar surface.

Sample position on bar : At bar head, extending down a major chute channel that dissects the bar.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 215 mm; D84 165 mm; D50 80 mm; D16 25 mm; D5 15 mm

Mean 96.00 mm; Sorting 72.8 mm

Sorting : Very poor

Packing arrangement : Locally imbricated. Jumbled, unwinnowed clasts rest upon a distinct basement of framework gravels.

Shape : Subrounded; blocky

Lithology : Mixed, with plutonics/volcanics dominant and only a small proportion of sedimentary/metamorphics.

Other characteristics : A couple of large trees have been washed onto the bar head. The bar surface is sparsely vegetated, with exotic weeds and lupins dominant.

Mararoa River Photo 42, The Wilderness Reach
Upstream end of the Wilderness reach, with Te Anau-Mossburn road bridge on the left hand side in mid photo. Mid channel bars and islands are more abundant than in the Key reach, with a less pronounced thalweg.
16.01.93 AHF 1/17



Mararoa River Photo 43, The Wilderness Reach
The confluence of Elm Tree Creek with the Mararoa. Note the alternating patterns of flow division in the channelized zone of the Mararoa, within an irregular sequence of broad, sweeping bends. Vegetative encroachment in the channelized zone is also evident.
16.01.93 AHF 1/18 Te Anau (D43) 1:50,000, GR 084054



Mararoa River Photo 44, The Wilderness Reach
Encroachment of willows in the channelized zone, immediately upstream of sample site MR9
18.01.93 6-18 Te Anau (D43) 1:50,000, GR 065058



Mararoa River Photo 45, The Wilderness Reach
Dissected broadly sinuous bends of the Wilderness reach. Sample site MR9 is located in the highly dissected bar complex on the left hand side in mid photo. Flow is to the left.
16.01.93 GBF 1/35



Mararoa River Photo 46, The Wilderness Reach
Sample site MR9, located on a highly dissected bar complex. Note the uprooted trees on the bar surface and in the adjacent channel.
18.01.93 6-19 Te Anau (D43) 1:50,000, GR 064059



Mararoa River Photo 47, The Wilderness Reach
The downstream half of the Wilderness reach, with Fern Hill on the right hand side at the top of the photo. Note the chaotic pattern of abandoned sinuous channels picked out by willows on the alluvial flats.
16.01.93 GBF 1/32



Mararoa River Photo 48, The Wilderness Reach
The downstream half of the Wilderness reach with Fern Hill, the Whitestone River, and Lake Manapouri in the background.
16.01.93 GBF 1/31



Mararoa River Photo 49, The Wilderness Reach
View upstream at the downstream limit of the Wilderness reach. Photo taken from Fern Hill. Note the large abandoned meander loop in mid-photo.
18.02.93 MR6-00 Te Anau (D43) 1:50,000, GR 025073



REACH NAME : FERN HILL REACH

Geographic description of reach : Fern Hill reach extends from bedrock constriction on the right bank at Fern Hill to the downstream margin of Mount York. In this reach the Mararoa is joined by Whitestone River. Although laterally confined at the head and tail of the reach, Fern Hill reach is characterized by fairly extensive active gravel surfaces, contained within a well-defined channel zone. This reach is differentiated from The Wilderness reach by a better-defined primary channel and the greater abundance of active gravel surfaces.

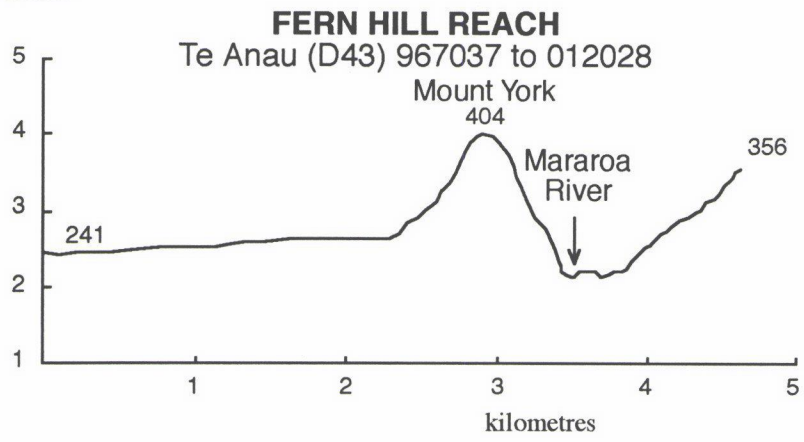
Analysts : GB, AB, AH Date of Analysis : 18.01.93

Grid co-ordinates of reach : Te Anau (D43), 1:50,000, 034067 to 983002

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley cross section



Valley setting
Broad valley constrained by eroded bedrock ridges at its upstream and downstream margins.

Extent of Valley flat
Valley flats are limited to about 1 km in width at the upstream end of Fern Hill reach, where both banks of Mararoa River are constrained by bedrock. A few kilometres downstream from Fern Hill, adjacent to Whitestone confluence, the valley widens considerably to 1.5-2.0 km. The right bank is set against a series of terraces which lie at the base of extensive flats of former lake beds extending across to the Waiau River at the margins of Fiordland National Park. Kepler Mire lies among these extensive lake-bed flats. At the downstream margin of Fern Hill reach the right bank of the river abuts against Mount York, while the left bank abuts aginst ridged bedrock and ancient outwash materials.

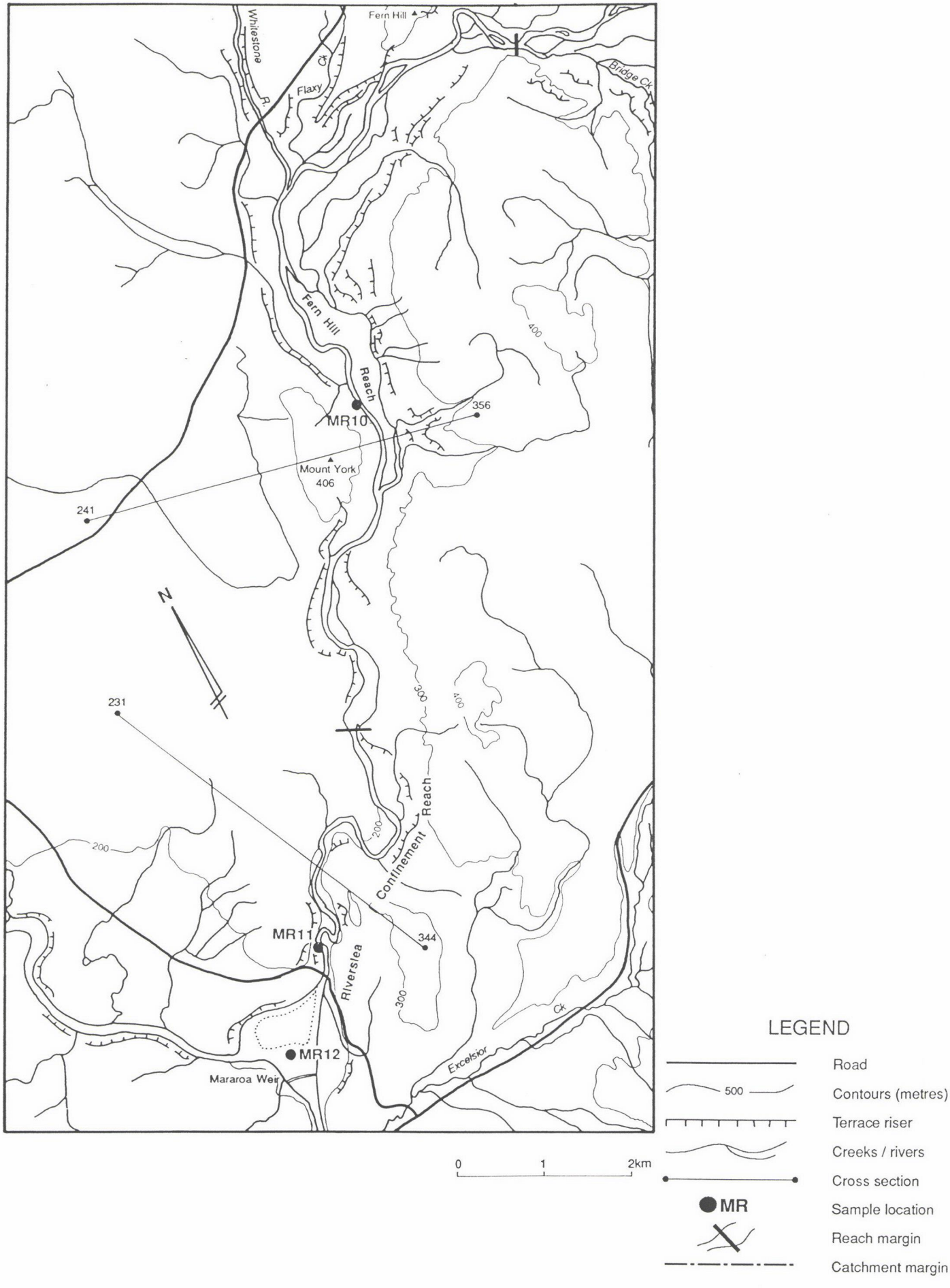
Terrace character
Upper terraces on Mararoa River are less well-preserved in Fern Hill reach than upstream.

Left Bank
Up to 6 extremely discontinuous, valley-marginal remnant terraces. These terraces are never observed in a continuous sequence, and the characteristic pattern is transitional from the lowest terrace to a remnant upper terrace.

Right bank
Much more characteristic flight of three terraces, of which the lowest is by far the most expansive.

FERN HILL AND RIVERSLEA CONFINEMENT REACHES

Te Anau (043) and Takitimu (D44) 1:50,000



Extent of Alluvial flat
Generally about 800 m wide. In mid-reach the active channel zone is about 150 m wide, with large expanses of mobile gravels. Numerous secondary channels are evident.

Degree and character of channel constriction
Channel is laterally confined at the upstream and downstream limits of the reach. The middle section, coincident with the Whitestone confluence, is considerably wider and hence less constrained. The channel presently flows along the centre of the alluvial flats, with large areas of within-channel sedimentation.

Character and impact of tributary streams
Whitestone River seemingly contributes large volumes of fine-gravels. A series of very short tributaries flow down the steep ridged terrain of the left bank, but these exert negligible impact on the Mararoa.

Surficial geology
Fern Hill and Mount York are composed of tilted sedimentary strata of Pliocene-Pleistocene age. These units form part of the Prospect Formation, and are dominated by greywacke gravels in a light cemented sandy matrix, with discontinuous sand lenses. This unit always underlies the earliest Quaternary till unit (McKellar, 1973). Referring to the latter, Quaternary till units, old outwash gravels of the Athol Formation are abundant on the left bank of Mararoa River, while outwash gravels, moraines, and tills of the more recent Marakura Formation are dominant on the right bank. Both of these formations are Pleistocene in age.

The left bank valley margin is composed of relatively thin sedimentary sequences at the foothills of the volcanic Takitimu's. The Cheviot Hills are composed of greywacke-type rocks and conglomerate. The dissected Takitimu Mountains behind Cheviot Hills are composed of sub-vertical sediments and intercalated lavas of Permian age (McKellar, 1973). Among the rock types found in the Takitimu's are : grey, red and green tuffaceous sandstones and tuffs, volcanic breccia, pillow lavas, and andesitic flows and sills.

Vegetation
Valley side/flats : Predominantly grassland pasture, often quite scrubby.

Alluvial flats : Thickly covered by gorse, broom, willow and lupins.

Bank/bars: Sparsely grassed, with occasional willows and other primary colonizers (especially lupin).

Land use
Pasture.

Direct Human Impacts
Valley flats are largely ditched. Many willows extend along the channelized zone.

Other comments
The subreach immediately downstream of Fern Hill is much less constrained than adjacent to Fern Hill itself. This less-confined condition, in association with the input of gravels from the Whitestone, has resulted in more active gravel surfaces than observed in The Wilderness reach upstream. Abundant fine gravels are accumulating on bar surfaces. Beyond the confinement at Mount York, fine gravels are seemingly flushed through Riverslea Confinement reach and are accumulating upstream of Mararoa Weir.

CHANNEL CHARACTERISTICS

Number of channels : Channel confinement at the upstream and downstream limits of the reach constrain flow to a single channel. In mid-reach, flow is divided around bar surfaces into two or three active channels.

Channel geometry : Thalweg definition is locally variable. At the head and tail of the reach the thalweg is quite well-defined. However, in mid-reach the thalweg is poorly defined, as flow divides around dissected bars. These active gravel surfaces are more abundant than in The Wilderness reach,

Sinuosity : While the overall channel sinousity is low, individual channels in the channelized zone are moderately windy. The channelized zone itself is less regular than upstream, and switches from valley side to side in an alternating sequence, largely associated with the pattern of bedrock constraints.

Lateral stability of channel(s) : The channel is laterally constrained at the upstream and downstream limits of the reach, but in mid-reach the channel is laterally unstable within a distinct channelized zone.

Bar type and scale
Dissected bank-attached and mid-channel compound bars prevail with extensive active gravel surfaces. The extent of active gravel surfaces, composed of finer gravels, indicate that this is probably an aggadational reach.

Bed/Bank character (extent and materials)
Although the channel is laterally unstable in the active channel belt, the margins of the channelized zone appear to be quite stable and are well vegetated. Conditions on the channel bed are locally variable, and many fine gravel sheets are washed over bar surfaces.

Flow character
In mid-reach flow switches from side to side around alternating dissected bank-attached compound bars. A distinct lateral component of the flow is evidenced over laterally-attached riffles. These riffles are quite regularly spaced.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR10** Grid reference : 999034

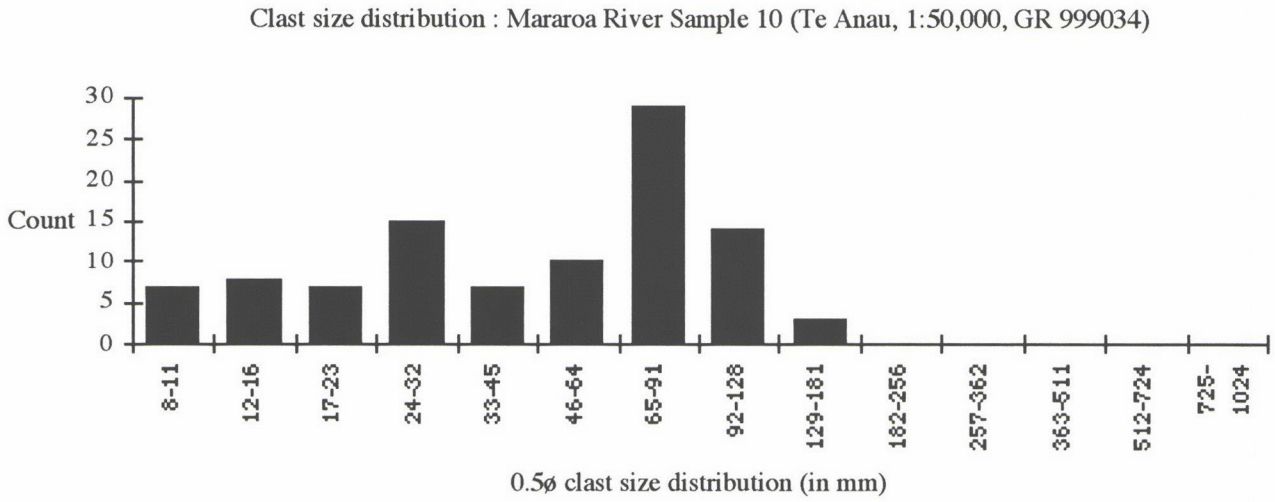
Sample type : 2 x 25 m @ 0.5 m interval

Bar type : Lateral bar.

Sample position on bar : Coarse gravel locale at bar apex. Water's edge sample.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 120 mm; D84 95 mm; D50 55 mm; D16 20 mm; D5 10 mm

Mean 57.9 mm; Sorting 36.58 mm

Sorting : Very poorly sorted overall, with discrete well-sorted lenses or lobes. The clast-size distribution is virtually bimodal, with peaks at 24-32 and 65-91 mm.

Packing arrangement: Loose, jumbled surface over a packed pavement. Lots of finer gravel sheets are evident over the bar surface. Surface is winnowed of all sand, but fine gravels are abundant.

Shape : Subrounded to rounded; notably less blocky than upstream.

Lithology : Mixed.

Other characteristics : Exposed bedrock on right bank downstream of sample bar. Clasts are notably finer than upstream, probably due to extensive incursions of finer gravels over a coarser base.

Mararoa River Photo 50, Fern Hill Reach
The upstream end of Fern Hill reach. Whitestone River confluence with Mararoa River is in mid-photo.
16.01.93 GBF-1/34



Mararoa River Photo 51, Fern Hill Reach
One of the Mararoa channels at the base of Fern Hill. Note the prolific willow and broom.
19.02.93 MR6-12 Te Anau (D43) 1:50,000, GR 021069



Mararoa River Photo 52, Fern Hill Reach
View upstream of Mararoa River from the flank of Fern Hill.
19.02.93 MR6-13 Te Anau (D43) 1:50,000, GR 021069



Mararoa River Photo 53, Fern Hill Reach
View downstream of Mararoa River from the flank of Fern Hill.
19.02.93 MR6-14 Te Anau (D43) 1:50,000, GR 021069



Mararoa River Photo 54, Fern Hill Reach
View downstream of Mararoa River from Fern Hill. Note the extensive alluvial flats.
18.02.93 MR6-3 Te Anau (D43) 1:50,000, GR 023071



Mararoa River Photo 55, Fern Hill Reach
View downstream of Mararoa River at the base of Fern Hill. Note the extensive active gravel surface and the poor channel definition, with a very high width:depth. Flow is dissected over a major riffle in mid-photo.
18.02.93 MR6-11 Te Anau (D43) 1:50,000, GR 028067



Mararoa River Photo 56, Fern Hill Reach
View upstream with Whitestone/Mararoa River confluence in mid photo.
16.01.93 GBF 1/36



Mararoa River Photo 57, Fern Hill Reach
The Whitestone/Mararoa confluence. View upstream of Mararoa River, with Whitestone River on the left hand margin of the photo.
19.02.93 MR7-12 Te Anau (D43) 1:50,000, GR 003061



Mararoa River Photo 58, Fern Hill Reach
Mararoa River about 0.5 km downstream from Whitestone River confluence. Mt. York is in the background.
19.02.93 MR7-15 Te Anau (D43) 1:50,000, GR 999055



Mararoa River Photo 59, Fern Hill Reach
View upstream of Fern Hill reach from the flanks of Mount York.
18.01.93 6-25 Te Anau (D43) 1:50,000, GR 995041



Mararoa River Photo 60, Fern Hill Reach
Lateral constriction placed on the Mararoa River by Mount York. Sample site MR10 was located on the small bank attached compound bar immediately upstream of Mount York (in mid-photo).
16.01.93 GBF 1/37



Mararoa River Photo 61, Fern Hill Reach
Sample site MR10, a bank attached compound bar adjacent to Mount York. This bar has a number of discrete lobes of fine gravels washed over its surface.
18.01.93 6-27 Te Anau (D43) 1:50,000, GR 999034



REACH NAME : RIVERSLEA CONFINEMENT REACH

Geographic description of reach : Riverslea Confinement reach is a single-channelled reach that extends from 2 km downstream of Mount York to Mararoa Weir. This reach is characterized by a series of tight, confined bends that flow within cemented outwash deposits and bedrock. As Mararoa River enters Waiau Valley lateral constraints are removed. Adjacent to Waiau River confluence, the Mararoa channel has shifted position on various occasions, prior to a straight channel configuration being imposed between coarse boulder constraints in the section immediately upstream of Mararoa Weir.

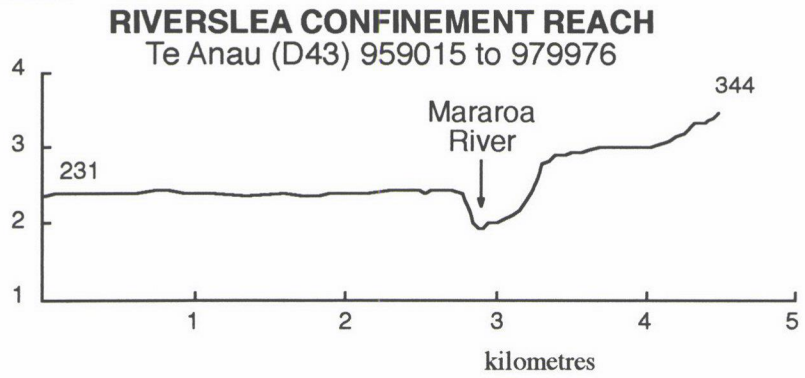
Analysts : GB, AH Date of Analysis : 19.01.93

Grid co-ordinates of reach : 1:50,000, Te Anau (D43) 983002 to Takitimu (D44) 960969

Air Photos used : Southland Regional Council Survey # 0962, 18.12.91

VALLEY CHARACTERISTICS

Valley cross section



Valley setting

Channel is incised within confined cemented outwash terraces. Beyond and behind the upper terrace on the right bank are extensive former lake-bed flats. As the Mararoa approaches the Waiau the valley widens considerably.

Extent of Valley flat

The channel-marginal valley flats are extremely constrained, and generally extend for just a few hundred metres, generally atop terraces 15-20 m high. Beyond the upper terrace, however, the valley opens up considerably, with an extensive former lake bed on the right bank which extends to Fiordland National Park.

Terrace character

Terraces are generally unpaired, discontinuous features, the pattern of which is locally determined by the manner of bedrock constraint and associated channel configuration. Some terraces may represent inset (aggradational) features.

Left Bank

Immediately upstream of Weir road bridge the following terrace sequence is evident :

(i) Discontinuous inset terrace about 4 m high, composed of loose gravels with large sand lenses.

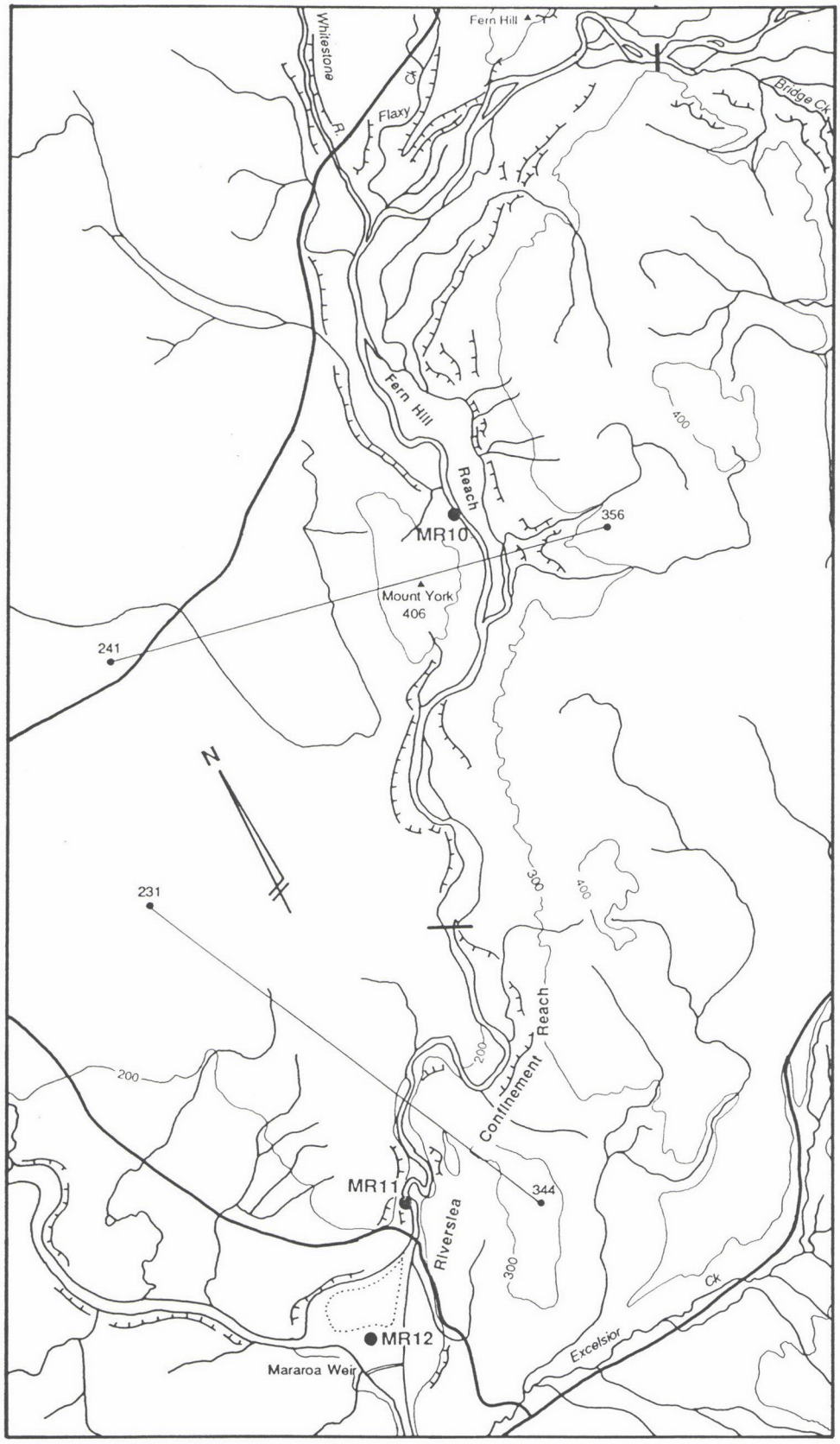
(ii) 15-20 m high cemented well-banded outwash terrace, with finer-grained channel fills.

(iii) 40 m high cemented well-banded outwash terrace, with finer-grained channel fills. This has a sandy unit which is several metres thick atop.

Downstream of Weir road bridge, the middle terrace is dominant.

FERN HILL AND RIVERSLEA CONFINEMENT REACHES

Te Anau (043) and Takitimu (D44) 1:50,000



LEGEND

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

Right bank
Small discontinuous 2-3 m high terrace a few hundred metres upstream of Weir road bridge. In general the right bank is steeply inclined along a 25-30 m high cemented well-banded outwash terrace that appears to be pinned onto a bedrock ridge. Downstream of Weir road bridge, Mararoa River has reworked channel-marginal terraces, and only remnant features remain adjacent to the most upstream of the diversion channels at Waiau River confluence.

Extent of Alluvial flat
Scarcely evident other than isolated patches on the inside of some bends and immediately upstream of Mararoa Weir. At the confluence zone these flats and reworked islands extend for 800-1000 m.

Degree and character of channel constriction
Upstream of Weir Road bridge, Riverslea Confinement reach has an extremely confined channel which flows within cemented outwash terraces. The channel has a sharply sinuous outline, as the tortuous configuration of the channel has been superimposed within the outwash deposits. The channel is especially confined between GR 983996 and 968978.

Character and impact of tributary streams
Tributaries in this reach are very small and have negligible impact on the main channel. Right bank tributaries are very few in number, and are generally ephemeral features that drain small swamps on the perched lake bed flats. Left bank tributaries are very short channels that drain small catchments among the ridged terrain.

Surficial geology
Prospect Formation occurs on both banks of Mararoa River south of Mount York, and extends virtually to Waiau confluence. This Pliocene-Pleistocene unit consits of a thick sequence of greywacke gravel set in a lightly cemented sandy matrix, with discontinuous sand lenses (McKellar, 1973). This unit always underlies the oldest Quaternary Till. A 15 m section of Prospect Formation adjacent to Mount York is described by McKellar (1973, p4) as follows :

Pebbly buff-coloured, cross-bedded sand with weathered quartz and lenses of pebble conglomerate is underlain by 10 m of thinner bedded, uncemented gravelly sand. Individual beds are 0.3-2.5 m thick and include 150-600 mm beds of very fine, well-sorted blue-grey sand. These sequences overlie brown-weathered cemented gravel, with subrounded greywacke pebbles 10-100 mm in diameter and boulders of granite up to 1 m.

On the 1:250,000 Geology sheet, however, the sequences immediately upstream of Weir Road bridge along the lower Mararoa River are mapped as cemented outwash terraces of the late Pleistocene Marakura Formation.

On the right bank the Prospect Formation lies in front of a series of glacially-derived units that are spread over the low-lying flats that extend to Fiordland National Park. These units include a series of morainal sequences (e.g The Ramparts), meltwater channels, and extensive fluvio-lacustrine units of Manapouri Sand. On the left bank, the valley marginal Cheviot Hills are composed of greywacke-type rocks and conglomerates, while the Takitimu Moutnains are composed of sub-vertical sediments and lavas of Permian age (McKellar, 1973).

Vegetation
Valley side/alluvial flats : Dominated by dense assemblages of gorse, broom, cabbage tree, ferns and toe toe.

Bank/Bars: Willows, gorse, broom on banks, with pioneer willows and exotic weeds on bars.

Land use
Pasture behind terraces. Gauging station immediately upstream of bridge.

Direct human impacts
Pronounced impacts on the channel at the lower end of the reach, with complete realignment and straightening of the channel immediately upstream of Mararoa Weir. The channel is protected by coarse angular rip-rap boulders from the stretch upstream of Weir road bridge down to the weir section.

CHANNEL CHARACTERISTICS

Number of channels : Other than occasional channel division and side channels in wider alluvial sections close to the reach head, this confined reach is single channelled.

Channel geometry : This is an imposed, non-alluvial reach. Channel geometry is highly irregular, with distinct asymmetry in channel bends.

Sinuosity : Highly variable, with tortuous bends (e.g. GR 969983) and straight reaches.

Lateral stability of channel(s) : Confined, laterally stable reach. In the past the short section downstream of Weir road bridge has shifted the position of the Waiau confluence, but this subreach has now been constrained by a straight diversion channel.

Bar type and scale
Occasional tight point and lateral bars with riffles attached to their head.

Bed/Bank character (extent and materials)
Cemented outwash terraces or large boulder banks. These are being actively reworked at various points. The stream bed and bar surfaces are dominated by locally-derived outwash boulders, resulting in extremely jumbled bar surfaces. Finer clasts are seemingly flushed through this constrained reach.

Flow character
Rapid flow with irregular riffles at oversteepened sections. Amazing superelevation and flow separation cells are evident at the outside of laterally confined tight bends. One circulation cell even extends across-channel to the inside of the bend. The velocity of flow within this cell may well lead to upstream-oriented imbrication of fine gravels!

Other comments
Reach appears to be an effective conveyor of fine gravels which accumulate at the weir.

SAMPLE SITE CHARACTERISTICS

Sample number : **MR11** Grid reference : Takitimu Sheet (D44), 1:50,000, 968982

Sample type : Water's edge and 2 m inshore; 2 x 50 m @ 1.0 m interval.

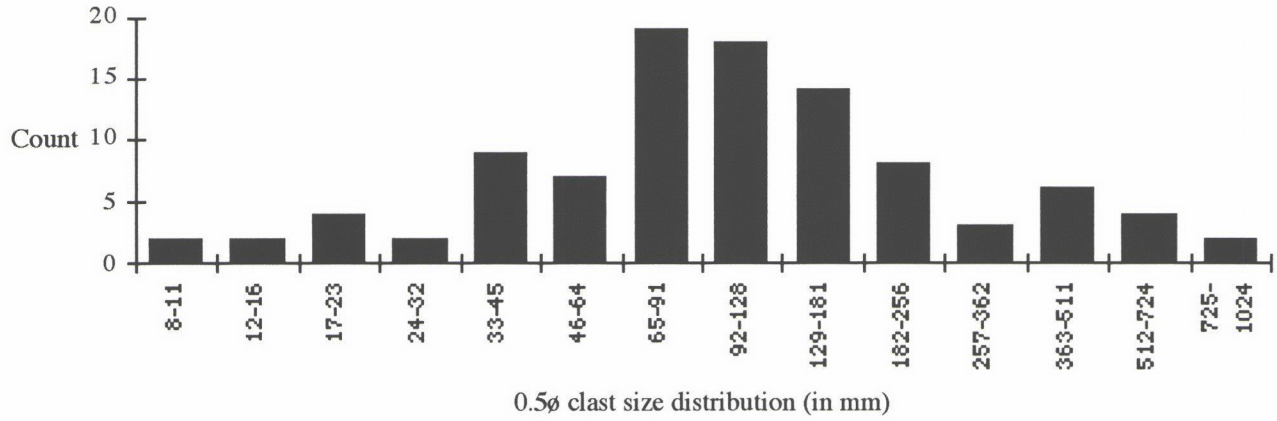
Bar type : Lateral bar with riffle at head extending across the channel. Chute channel evident at the bar margin.

Sample position on bar : Down-bar at the water's edge, approximately at the apex of the bar in the most confined river stretch. This is the coarsest gravel locale, and comprises coarse gravels and boulders.

'Particle characteristics'

0.5ø Clast size frequency Histogram

Clast size distribution : Mararoa River Sample 11 (Te Anau, 1:50,000, GR 968982)



D95 520 mm; D84 250 mm; D50 103 mm; D16 40 mm; D5 20 mm

Mean 158.6 mm; Sorting 168.7 mm

Sorting : Extremely poor, with large numbers of boulders derived locally from outwash terraces and many finer-sized clasts, but little inbetween (i.e. distinctly spread, diverse gravel population).

Packing arrangement : Surface is only locally imbricated, and is generally jumbled. Clasts are moderately loose atop a dense, well-packed pavement. This reflects mobilization and through-put of clasts up to 150 mm wide. Surface is typically winnowed down to 40 mm, but occasional fine gravels have been washed atop. These do not take the form of discrete lenses; rather they reflect individual gravels possibly deposited from secondary cells.

Shape : Boulders are subrounded and blocky, while smaller clasts are less blocky with a large number of discs.

Lithology : Mixed population - many boulders are plutonic, with occasional limestone chunks.

Other characteristics : Pioneer juvenile willows and exotic weeds extend over the bar surface.

Sample number : **MR12** Grid reference : Takitimu (D44) 1:50,000, 958973

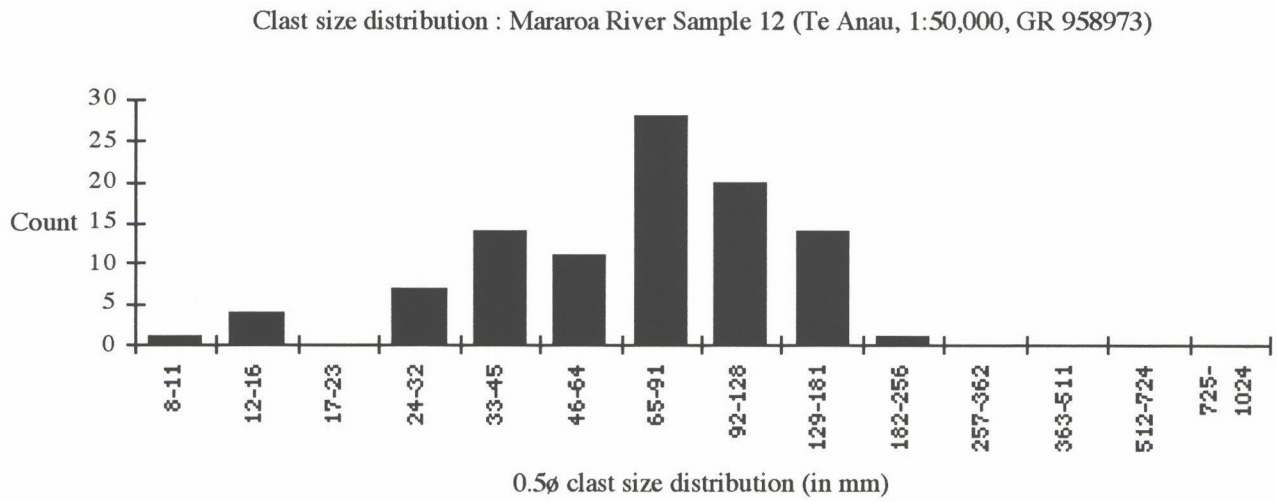
Sample type : 1 x 50m @ 0.5 m interval.

Bar type : Mid-channel confluence bar at the mouth of the second Mararoa diversion channel and Waiau River. This bar platform has a distinct cluster of coarser, jumbled clasts at its head, and a finer-grained lobe at its tail.

Sample position on bar : Down the centre of the coarsest gravel locale in the bar platform at the head of the bar.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 160 mm; D84 125 mm; D50 75 mm; D16 40 mm; D5 15 mm

Mean 81.35 mm; Sorting 42.44 mm

Sorting : Poor. Sorting is locally variable over the bar surface, and reflects the variability between framework pavement and sheet gravels deposited at differing positions over the bar. Distinct clusters are evident.

Packing arrangement : Clasts are locally moderately packed, but the surface is generally mixed and jumbled. Many clasts are fairly loose, but appear to have finer clasts deposited between them. A distinct zone on the right side of the bar at the bar head is clearly imbricated down-Waiau (i.e. diagonally towards the weir). The bar surface is winnowed down to 20 mm, but a discontinuous mud drape is evident atop. Removal of the surface clasts generally reveals coarse sands and granules beneath the surface.

Shape : Subangular to subrounded; Predominantly blocky or discs (few skimmers).

Lithology : Mixed, with a high percentage of fine-grained volcanics.

Other characteristics : Very little vegetation on the bar surface, other than one willow (Salix fragilis) in the adjacent channel and clustered weeds on the highest section of the bar (including dock, plantain, lupins and dandelion). The bar history at this site relates directly to the sequence of diversion channels and gravel sediment supply events at the Mararoa confluence. The coarse fraction at the bar head is imbricated down-Waiau. Gravels appear to represent a mixed population, with a bimodal clast-size distribution. Coarser fractions (up to 350 mm) seemingly reflect a basal framework gravel pavement which is now locally reworked and jumbled. Clast size within this fraction appears to diminish down-bar to about 150-200 mm. Atop this pavement are loose, more recently reworked gravels that appear to be moving as discrete sheets over the basal pavement. This fraction also decreases in grain size down-bar, with clasts up to 150 mm at the bar head diminishing in mean size down to about 50-80 mm at the bar tail.

Mararoa River Photo 62, Riverslea Confinement Reach
Riverslea Confinement Reach. Note the deeply incised, tortuous course of single channelled Mararoa River. Pearl Harbour is in the background.
16.01.93 AHF 1/19



Mararoa River Photo 63, Riverslea Confinement Reach
The tight confined bends of Riverslea Confinement reach.
16.01.93 GBF 2/3



Mararoa River Photo 64, Riverslea Confinement Reach
Sample site MR11, located at the apex of a point bar feature a few hundred metres upstream of Weir Road bridge in Riverslea Confinement Reach.
19.01.93 6-34 Te Anau (D43) 1:50,000, GR 968982



Mararoa River Photo 65, Riverslea Confinement Reach
Riverslea Confinement reach viewed from Weir Road Bridge.
19.01.93 6-30 Te Anau (D43) 1:50,000, GR 969978



Mararoa River Photo 66, Riverslea Confinement Reach
Mararoa diversion channel, immediately upstream of Mararoa Weir.
19.01.93 6-29 Takitimu (D44) 1:50,000, GR 968978



Mararoa River Photo 67, Riverslea Confinement Reach
Mararoa diversion channel viewed from Mararoa Weir. Note the extensive accumulation of gravels, which have adopted the form of a delta at the end of the diversion channel.
22.01.93 AO 1/31 Takitimu (D44) 1:50,000, GR 960969



Mararoa River Photo 68, Riverslea Confinement Reach
Sequence of diversion channels of the Mararoa River immediately upstream of Mararoa Weir. Note the complex assemblage of gravel bars that has accumulated in this zone.
16.01.93 GBF 2/7



Mararoa River Photo 69, Riverslea Confinement Reach
Aerial overview of the lower section of Riverslea Confinement reach and Pearl Harbour reach.
16.01.93 AHF 1/21



Mararoa River Photo 70, Riverslea Confinement Reach
Sample site MR12, a mid-channel bar formed at the mouth of a diversion channel upstream of Mararoa Weir.
22.01.93 AO 1/23 Takitimu (D44) 1:50,000, GR 958973



Mararoa River Photo 71, Riverslea Confinement Reach
Tape transect laid out at the head of sample site MR12.
22.01.93 AO 1/26 Takitimu (D44) 1:50,000, GR 958973



Mararoa River Photo 72, Riverslea Confinement Reach
Mixed gravel population at the head of sample site MR12.
22.01.93 AO 1/27 Takitimu (D44) 1:50,000, GR 958973



Mararoa River Photo 73, Riverslea Confinement Reach
Mixed gravel population at the tail of sample site MR12.
22.01.93 AO 1/28 Takitimu (D44) 1:50,000, GR 958973

