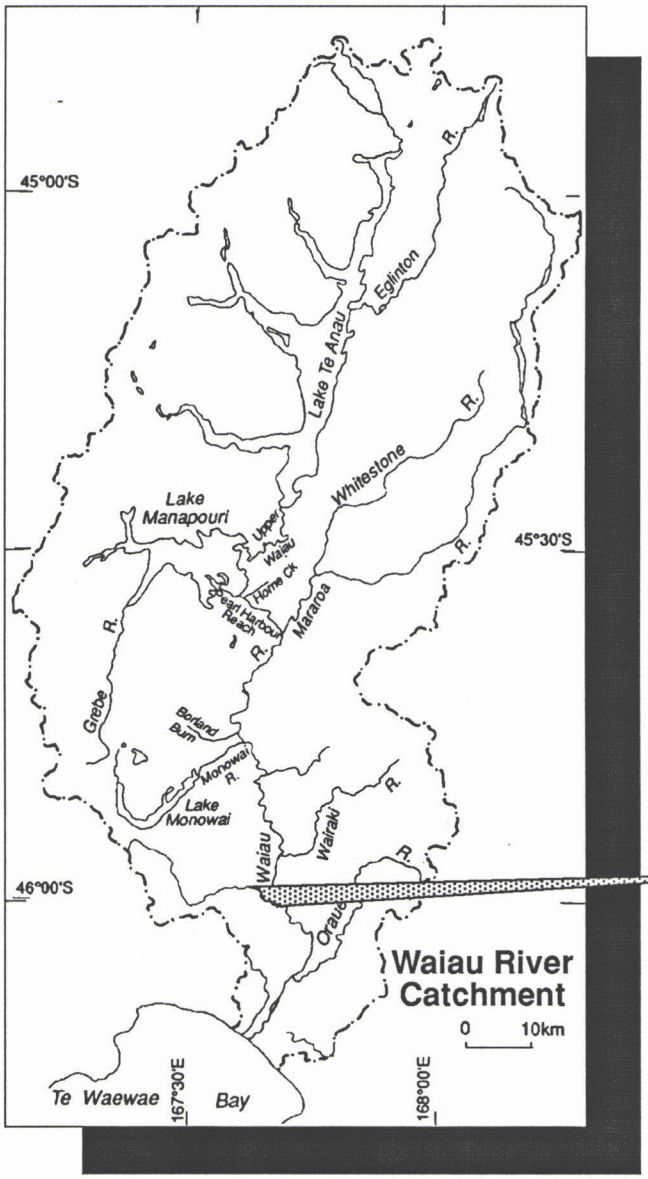
LILL BURN
Reach Analysis

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Lill Burn

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REACH NAME : LILL BURN

Geographic description of reach : Lill Burn is a right bank tributary that joins Waiau River 3.5 km upstream of Clifden. Other than the relatively narrow zone along the primary channels, Lill Burn catchment in largely forested, with Dean Forest to the north and Rowallan Forest to the south. Lill Burn is a relatively small stream, and it is only once a number of tributaries have joined the main valley that the river has a significant flow. However, these upstream valleys have a large number of meander scars, and terrace preservation is negligible, indicating that reworking of sediments and channel movement is very prevalent. Two subreaches are characterized along the lower course of Lill Burn. Bryce Burn subreach is a fairly incised section of channel that extends from Wairoto bridge down to the first reach in which significant within-channel sedimentation is evident, approximately six river kilometres downstream. This is a relatively stable subreach.

Lill Burn confluence subreach is much less stable than the upstream river section. This reach is characterized by a fairly sinuous, active channel that only locally abuts against bedrock or terrace constraints. The rate of lateral channel adjustment, and extent of active gravel surfaces, increases markedly down-reach, especially in the section when Lill Burn joins Waiau Valley.

Analysts : GB, AB, AH Date of Analysis : 27.01.93

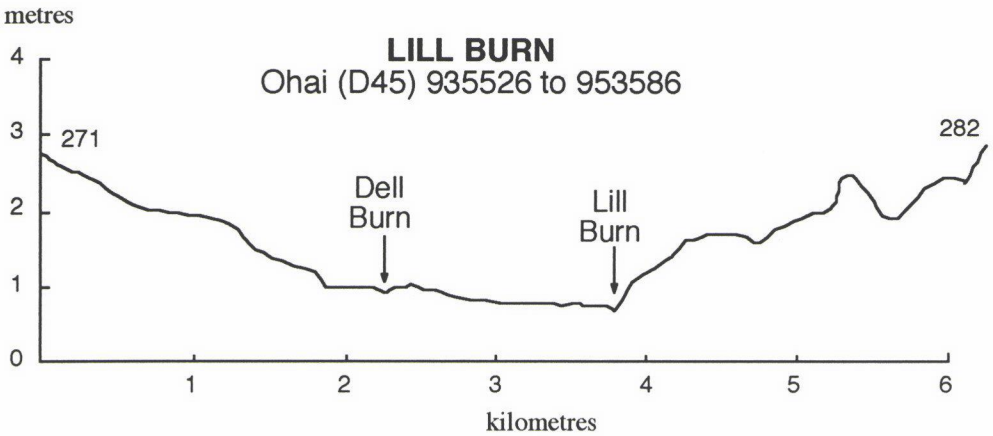
Grid co-ordinates of reach : Ohai (D45), 1:50,000, GR 916564 to 988534

Bryce Burn subreach	GR 916564 to 961543
Lill Burn Confluence subreach	GR 961543 to 988534

Air Photos used : NZ Aerial Mapping, SN 8317, 07.02.1984.

VALLEY CHARACTERISTICS

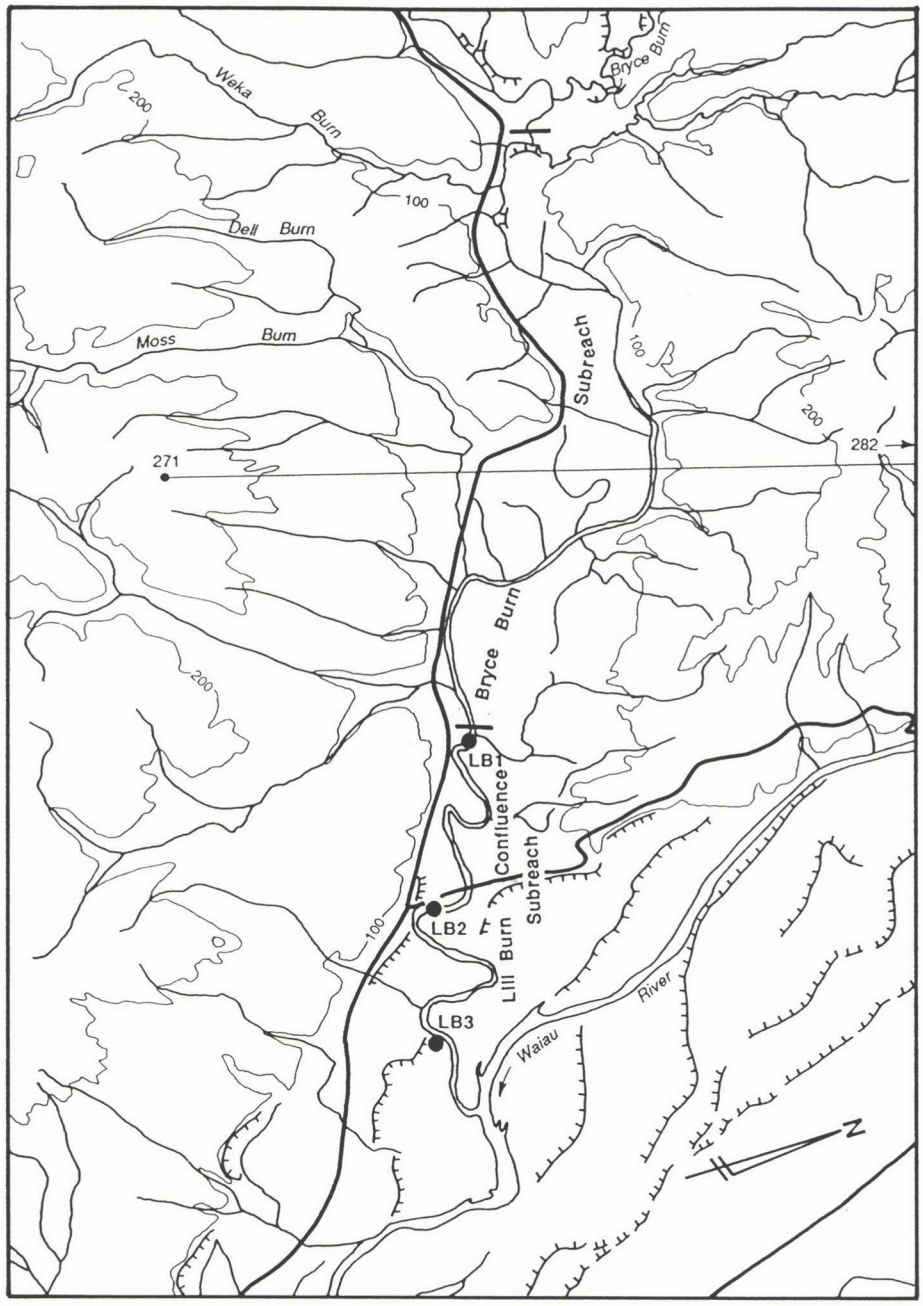
Valley cross section



Valley setting

Lill Burn lies among rolling foothills between Dean Forest/Motu Bush and Rowallan Forest. Upland terrain is steep, especially in Kaherekoua Mountains at the source of Lill Burn.

LILL BURN Ohai (D45) 1:50,000



LEGEND

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

Extent of Valley flat

Valley flats are discontinuous in Lill Burn Valley, conditioned primarily by the distribution of tributaries and their associated spurs. Around the confluence of Thicket Burn, Ardeer Burn and Lill Burn, valley flats extend up to 3 km wide, with a significant proportion of swampy terrain. Bedrock constraints 5 km upstream of Hindley Burn confines valley width to less than 1 km. Other than a short region adjacent to Hindley Burn confluence, this confinement extends downstream to 1 km beyond Bryce Burn confluence. Indeed, valley width is constrained to about 500 m wide at Wairoto bridge (GR 916561). Beyond GR 940560 the valley widens to 1.5 km, prior to opening out onto the Waiau Valley. Some parts of the valley flat are tussocky, others are swampy.

Terrace character

Terraces are quite discontinuous and irregular in upper Lill Burn Valley, although some quite spectacular perched meander scars are evident in the lower courses of tributary valleys. At the head of Bryce Burn subreach (GR 916564) there is a single, paired terrace, about 4-5 m above the channel. A perched remnant upper terrace is noted on the right bank downstream of Weka Burn. As the valley widens downstream the lower terrace becomes more laterally extensive and is up to 500 m wide. This now has a second terrace surface 4-5 m above it, and it is this surface that is the broadest terrace in the valley fill. By GR 942547 a distinct flight of three terraces is evident on the right bank, with the upper surface much more prominent than observed upstream. Terrace surfaces are locally quite hummocky.

At the head of Lill Burn Confluence subreach (GR 961542) there is a major lower terrace 2-3 m above the channel which extends to the left hand valley side. This has a discontinuous, remnant terrace about 15 m above it at the downstream margin of Motu Bush. Terraces are especially pronounced on the right bank adjacent to Waiau River confluence.

Extent of Alluvial flat

Although valley flats are locally quite extensive in the upstream sections of Lill Burn and its major tributaries, the active channel zone is very narrow, as flow is confined within an incised meandering course. Alluvial flats, as such, are scarcely evident. This is also the case in Bryce Burn subreach, where alluvial flats are typically restricted to narrow accumulation zones on the insides of bends.

At the head of Lill Burn Confluence subreach (GR 961542), alluvial flats are quite irregular, extending up to 100 m wide. The channelized zone is distinctly wider than upstream, and the channel itself is much less confined. Surfaces are locally quite hummocky. Beyond Lillburn-Monowai road bridge the alluvial flats form a relatively broad zone. This extends up to a few hundred metres wide, typically within-bends. Ridge and channel positions on alluvial flats at GR 974534 indicate that the channel has both shifted laterally and translated downstream in the past. Alluvial flats are still relatively constrained in this reach, and it is only when Lill Burn approaches the present position of Waiau River that the alluvial flats broaden appreciably. The section of river within 600-800 m of Waiau confluence has the appearance of a shallow fan, over which alluvial flats extend to greater than 1 km in width, with up to six active channels. Alluvial flats tend to become more gorse-covered down-reach.

Degree and character of channel constriction

Upstream sections of Lill Burn are confined either within incised meander bends or by valley-marginal bedrock constraints. Adjacent to Wairoto bridge, at the head of Bryce Burn subreach, Lill Burn channel appears to be incised within the valley flats with a low W:D. The channel almost appears as a groove at the head of this reach, and it is only when the valley broadens and alluvial flats become more extensive downstream that Lill Burn starts to erode the marginal low-terrace (e.g. at GR 961542). At this location the terrace is not a well-cemented unit, and has a 30 cm unit of fines at its surface.

As Lill Burn abuts against the right bank valley margin immediately downstream of Lillburn-Monowai road (GR 972535) it is constrained by bedrock. This forms a ledge on the bed of the river that extends downstream for several hundred metres (i.e. it is continuous to the bend at GR 974534). Moderately packed bank materials that form the banks in the downstream section of Lill Burn only constitute a minimal constraint on lateral expansion of bends.

Character and impact of tributary streams
Upstream tributaries of Lill Burn, especially Ardeer Burn, Hindley Burn and Bryce Burn are all incised, meandering streams which presently supply relatively small volumes of material to Lill Burn. Downstream of Bryce Burn confluence, Weka Burn is incised into bedrock, and exerts no real impact on Lill Burn itself. Beyond this, Dell and Moss Burns are right bank tributaries which flow with sinuous lower courses over the flats prior to joining Lill Burn. Local erosion is evident on their banks. Tributaries in the lower section of Lill Burn are very few in number, and are extensively ditched on the valley and alluvial flats.

Surficial geology
Kaherekoau Mountains at the head of Lill Burn are composed primarily of metamorphic and igneous rocks of Princess Formation, and consist of schists and granite. These rocks only constitute a small proportion of the headwaters of Lill Burn. Most of the catchment is composed of Tertiary sedimentary strata which become younger to the east. Moving from west to east this sequence is transitional from quartzo-feldspathic sandstone and mudstone through interbedded calcareous sandstone and limestone, to marine siltstones and mudstones. The latter, marine units are the primary rock types in Lill Burn catchment, and lie beneath Motu Bush and Rowallan Forest. Quaternary outwash terraces are generally restricted to remnant features, and it is only at Waiau confluence that terraces become extensive.

Vegetation
Valley side/flats : Grasses, tussock, manuka, flax, coprosma, gorse, ferns and other shrubs.

Alluvial flats/Bank/Bars : Grasses, exotic weeds. Poplars have been planted and willows locally line the channel.

Land use
Pastoral.

Direct human impacts
Willows and poplars line channels, especially downstream. These are occasionally tiered and cut. Rip-rap has been placed at the outside of some bends. In one instance (at GR 982533) coarse clasts and boulders have been dumped as a series of groynes. Most tributaries along the flats have been ditched. Some channel realignment by bulldozers has also taken place at Waiau confluence.

Other comments
A local landowner commented that Lill Burn channel has undergone considerable incision adjacent to Lillburn-Monowai road bridge. It was also indicated that greenstone bedrock boulders were emplaced as rip-rap in a bend at the lower end of Lill Burn. This bend was subsequently undercut, and the boulders ended up in the channel.

BRYCE BURN SUBREACH (Ohai, GR 916564 to 961543)

CHANNEL CHARACTERISTICS

Number of channels : Single channelled.

Channel geometry : Confined channel, with low W:D. Channel width is typically 15-30 m.

Sinuosity : Wairoto bridge (GR 916561) is located within an imposed moderately tight meander loop. Downstream of this point, until GR 962541, the channel comprises a series of low sinuousity/straight subreaches.

Lateral stability of channel(s) : Adjacent to Wairoto bridge, Lill Burn is a constrained, incised channel which appears to be laterally stable.

Bar type and scale
No gravel bars are evident in Bryce Burn subreach.

Bed/Bank character (extent and materials)
Banks are generally 3-4 m high. These are gravel-based, with a sand cap. The channel bed has pockets of fine gravels, with sand drapes prominent.

Flow character
Flow is generally uniform, with occasional small boils. These are generally associated with local flow constrictions around abundant organics and trees which disrupt flow. Water is generally quite murky.

Other comments
Adjacent to Wairoto bridge and in the reach immediately downstream, the channel of Lill Burn appears to be relatively stable within willow-protected banks. The sinuous thread of a former channel is evident over the flats. This former course has poplars and eucalypts at its margins.

SAMPLE SITE CHARACTERISTICS

There are no gravel bars in Bryce Burn reach.

Lill Burn Photo 1
Confluence of Ardeer Burn (in foreground) and Thicket Burn (on right hand side in mid-photo) in the headwaters of Lill Burn. Note the sinuous, single-channelled courses, with a large number of meander cut-offs and scars. Rowallan Forest is in the background. Flow is from right to left.
16.01.93 GBF 3/7 Tuatapere (S167) 1:63,360, GR 594474



Lill Burn Photo 2
Confluence of Hindley Burn (in foreground) with Lill Burn. Flow is from right to left. Both rivers are single channelled, and have adopted highly sinuous courses.
16.01.93 GBF 3/9 Tuatapere (S167) 1:63,360, GR 638493



Lill Burn Photo 3
Irregular sinuosity of Lill Burn upstream of Bryce Burn confluence. Flow is from right to left.
16.01.93 AHF 2/9 Tuatapere (S167) 1:63,360, GR 675505



Lill Burn Photo 4, Bryce Burn subreach
Well vegetated banks of the single channelled Lill Burn, viewed looking downstream from Deer Forest road bridge. The channel is laterally constrained by terraces in this reach. Note the brown coloured water and abundant logs within channel and perched on banks.
27.01.93 9/7 Ohai (D45) 1:50,000, GR 916564



LILL BURN CONFLUENCE SUBREACH (Ohai, GR 961543 to 988534)

CHANNEL CHARACTERISTICS

Number of channels : At the reach head, Lill Burn Confluence subreach is single channelled. Downstream of Lillburn-Monowai road bridge, Lill Burn retains its single channelled configuration, other than local dissection of flow over riffles at the entrance to bends. Beyond the large bend at GR 983534, flow becomes much more divided around dissected mid-channel compound bars. In the 600-800 m section upstream of Waiau confluence, up to six active channels are evident on this shallow fan-like surface.

Channel geometry : At the reach head, Lill Burn Confluence subreach is characterized by a regular cross-section, with well-defined asymmetry in bends. The channel is about 20-25 m wide. Beyond Lillburn-Monowai road bridge the channel adopts an irregular bed geometry and bed configuration as the channel locally abuts against bedrock. In the fairly tight bend at GR 973536 a major riffle extends across-channel to a concave-bank lateral bar. The thalweg is less well-defined than upstream. Immediately upstream of Waiau confluence, there are a sequence or riffles at the head of broad compound point bars. In this lower section, flow is generally quite shallow (< 1 m deep), while the channel is up to 30 m wide.

Sinuosity : At the upstream end of Lill Burn Confluence subreach, channel sinuosity is quite variable from bend to bend. An abandoned channel on the lower terrace flats in this upstream section has a large number of meander cut-offs. Meander amplitude increases downstream towards Waiau confluence. Many bends are quite tortuous. Although the channel follows a sinuous course, low-stage flow regime is irregular, and is not in-phase with the broader channel geometry. The section immediately upstream of Waiau confluence is a well-developed, freely meandering zone.

Lateral stability of channel(s) : Lill Burn is laterally unstable throughout Lill Burn Confluence subreach, other than the bedrock-pinned and human-modified sections downstream of Lillburn-Monowai road bridge. Eroding banks and extensive areas of active gravel surfaces are prevalent, especially in the section immediately upstream of Waiau confluence. Within-channel sedimentation is increasingly prominent down-reach, with concomitant lateral erosion of shallow banks. An entire fence line has been taken out on the outside of a bend at GR 982533.

Bar type and scale

Lill Burn Confluence subreach is characterized by a distinct downstream transition in bar type. At the reach head there are moderately stable point bars. Bedrock constraints at the outside of the bend at GR 973536 have resulted in a complex local pattern of bars, with a cross-channel riffle at the entrance to the bend connecting to a lateral bar at the outside of the bend. The point bar that has developed on the inside of this bend is very small, and is not scaled to the channel. A coarse gravel lateral bar has developed downstream of this bend (at GR 974536). Upstream of the highly dissected complex assemblage of bars on the fan surface at Waiau confluence there is a sequence of freely meandering point bars. These point bars demonstrate characteristic around-the-bend trends in clast-size distribution. Downstream of the compound point bar at GR 983534, flow dissects around a much larger active gravel surface.

Bed/Bank character (extent and materials)

At the head of Lill Burn Confluence subreach the bed of the channel and adjacent bare surfaces are characterized by extremely loose small gravels and sands, with a distinct sand sheet spread over the adjacent alluvial flats. Most of the gravels on the bar surface are exceedingly competent white-coloured plutonic rocks from the Fiordland Complex. Most clasts are 20-50 mm wide, with only very occasional clasts up to 150 mm. A series of discrete fine gravel sheets have washed over the bar tail. The locally eroding banks in this section have a sand sheet up to 1 m thick at their surface.

Once Lill Burn enters Waiau Valley the calibre of bed and bank materials becomes significantly coarser. Reworked outwash gravels from Waiau Valley terraces are up to 300 mm wide, and are much more platey than locally-derived clasts. Lithologically there is a greater proportion of metamorphic and fine-grained volcanic/plutonic rocks than observed upstream in Lill Burn. Many of these clasts act as a lag deposit on the bed of the channel. The bed is commonly very poorly sorted and unwinnowed, with abundant coarse sands. Many willows have fallen or been collapsed into the channel. Clasts on the river bed commonly have a coating of algal slime.

The eroding concave bank opposite a compound point bar 800 m upstream of Waiau River confluence is composed of well-rounded, moderately bedded, gravels. These deposits are clast-supported and are quite well cemented. Banks are gorse covered. Bar surfaces are well imbricated but poorly sorted, with finer gravels (up to 100 mm) resting upon

larger, imbricated clasts. The latter are often disc-shaped. Downstream of the compound point bar at GR 983534, the proportion of fine gravels on the river bed notably increases, with coarser gravels restricted to the narrow thalweg zone. Many logs are washed over bar surfaces.

Flow character

Flow in the lower course of Lill Burn is generally uniform, although riffle spacing around the series of bends is not regular. This probably relates to the local presence of bedrock (and associated scour pools) and the irregular distribution of bed material clast sizes. Occasional bank-collapse and cut willows add further irregularities to flow. In general the water is relatively murky.

Other comments

The left bank of Waiau River opposite the shallow fan surface at Lill Burn confluence is presently being undercut. As the erosive potential of Waiau River has diminished following flow regulation, and sediment accumulation at Lill Burn confluence has increased, Waiau River is increasingly constrained to the channel that abuts its left bank, with an associated acceleration in erosion.

SAMPLE SITE CHARACTERISTICS

Sample number : **LB1** Analysts : GB, AB, AH

Grid reference : Ohai (D45) 1:50,000; 961542

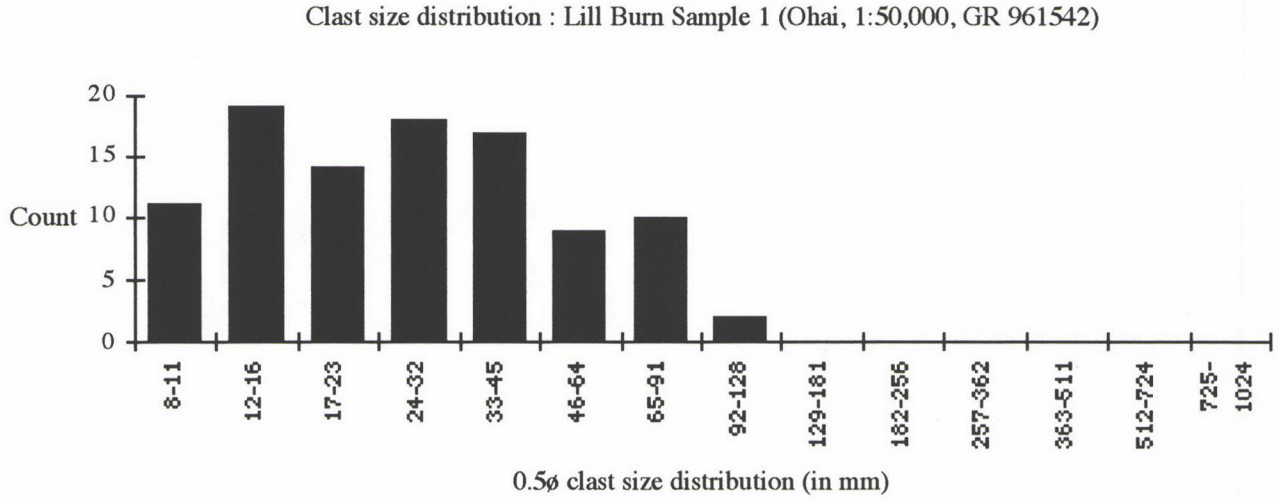
Sample type : 1 x 50 @ 0.5 m interval

Bar type : Bank-attached compound bar with a prominent bar platform. The left bank opposite the bar has willow protection. Some coarse gravel clusters and sand drapes are evident on the bar surface.

Sample position on bar : Head of bar at water's edge.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 75 mm; D84 55 mm; D50 25 mm; D16 15 mm; D5 10 mm

Mean 33.45 mm; Sorting 23.66 mm

Sorting : Moderately poor, with an equal spread in the 0.5ø clast size distribution.

Packing arrangement : No pavement. Loose, jumbled clasts at head of transect, transitional down-transect to a moderately imbricated unit. No winnowing evident.

Shape : Subangular; blocky.

Lithology : Mixed lithology, with Fiordland Plutonics and fossiliferous sandstone.

Other characteristics : Unvegetated, cow-trampled bar surface; some organic debris and bricks.

Sample number : **LB2** Analysts : GB, AB, AH

Grid reference : Ohai (D45) 1:50,000; 973536

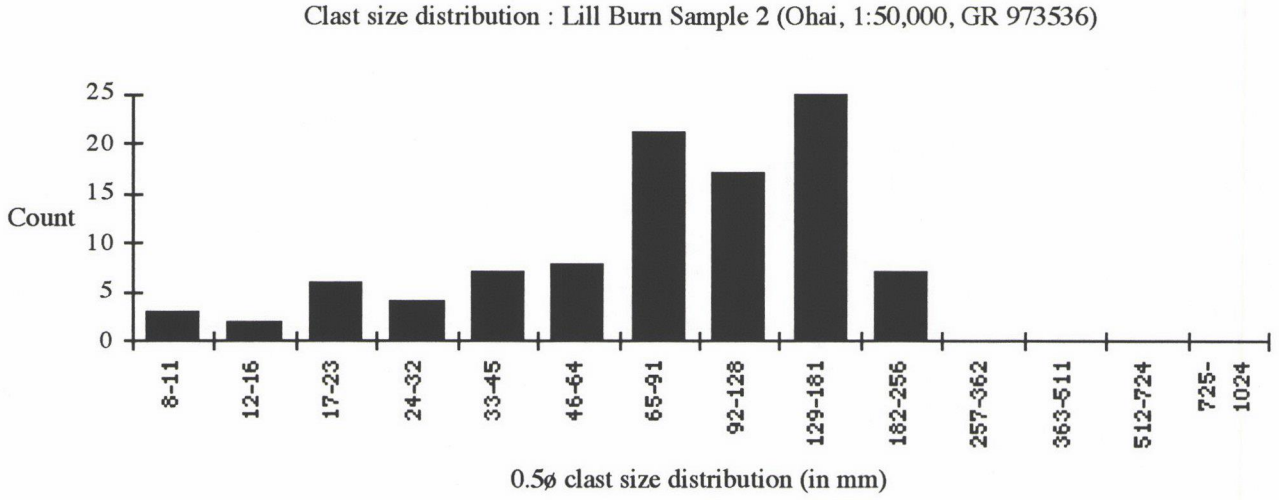
Sample type : 1 x 50 m @ 0.5 m interval

Bar type : Lateral bar at the concave bank of a tight bend. This is a unit bar with a small chute channel at its margin.

Sample position on bar : Water's edge sample close to the bar head.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 195 mm; D84 165 mm; D50 90 mm; D16 35 mm; D5 15 mm

Mean 100.8 mm; Sorting 58.6 mm

Sorting : Moderately poor, with no distinct clustering evident over the bar surface.

Packing arrangement : Moderately imbricated; partially packed with some loose clasts. Unwinnowed surface.

Shape : Subrounded; blocky with a large proportion of discs (especially the fine-grained volcanics).

Lithology : Mixed lithology, with a higher proportion of fine-grained volcanics and occasional metamorphics, along with Fiordland Plutonics.

Other characteristics : Sample fines down-bar. Unvegetated surface, with debris washed atop and collapsed willows at the bar margin.

Sample number : **LB3** Analysts : GB, AB, AH

Grid reference : Ohai (D45) 1:50,000; 983534

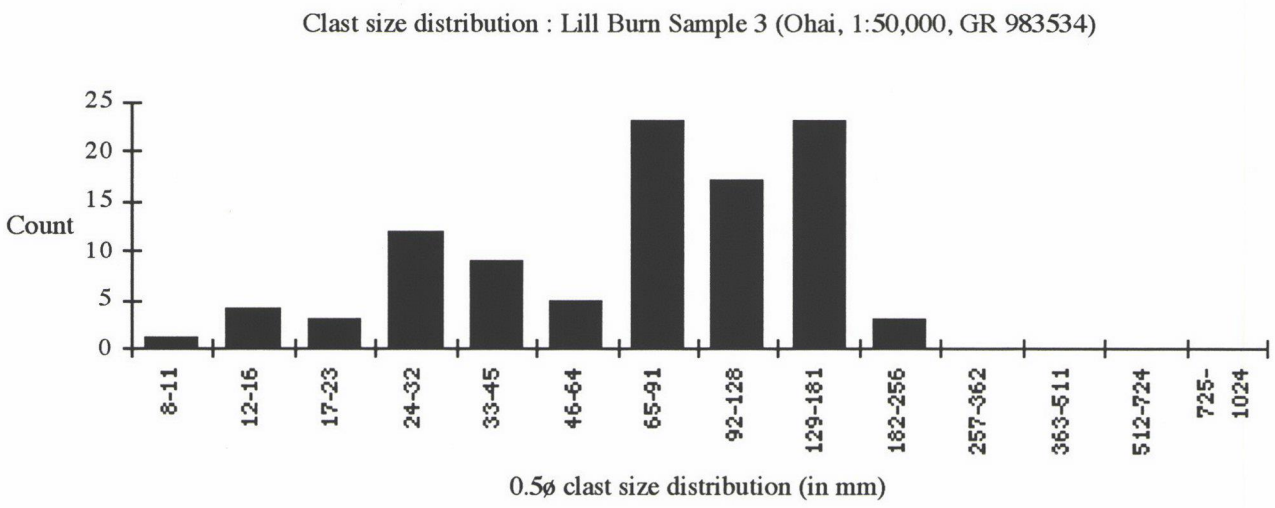
Sample type : 1 x 50 m @ 0.5 m

Bar type : Large point bar with an across-channel riffle at its head. Riffle has been dissected at three places. Distinct slope on the bar surface down to the platform.

Sample position on bar : Bar head transect at the water's edge.

'Particle characteristics'

0.5ø Clast size frequency Histogram



D95 170 mm; D84 145 mm; D50 80 mm; D16 30 mm; D5 15 mm

Mean 86.9 mm; Sorting 50.8 mm

Sorting : Poorly sorted, associated with the large number of smaller clasts washed atop the bar surface. However, the coarser imbricated clasts are of relatively uniform size..

Packing arrangement : Surface is quite well imbricated and moderately packed, with loose clasts (< 100 mm wide) atop. Gravels are not well winnowed, with occasional sand at the lee of larger clasts.

Shape : Subrounded; blocky with a large number of discs.

Lithology : Mixed, with a large proportion of Fiordland Plutonics and fine grained volcanics.

Other characteristics : Distinct round-the-bend fining trend evident. Bar is located downstream of an eroding bank, with lots of gorse on the adjacent alluvial flats.

Lill Burn Photo 5, Lill Burn Confluence subreach
View upstream at Sample site LB1. This is a bar head site of a linear lateral bar.
27.01.93 9/10 Ohai (D45) 1:50,000, GR 962543



Lill Burn Photo 6, Lill Burn Confluence subreach
View downstream of lateral bar on which Sample site LB1 was located.
27.01.93 9/9 Ohai (D45) 1:50,000, GR 962542



Lill Burn Photo 7, Lill Burn Confluence subreach
View downstream of Sample site LB2, located on a lateral bar a few hundred metres downstream of Lill Burn-Monawai road bridge. Note the substantial willows on banks. Gravels are considerably coarser than at sample site LB 1, associated with local reworking of Waiau Valley terraces.
27.01.93 9/11 Ohai (D45) 1:50,000, GR 973536



Lill Burn Photo 8, Lill Burn Confluence subreach
View upstream of Lill Burn, 1 km upstream of Waiau confluence. Note the single channelled, sinuous course, with extensive lateral and point bars. The concave bank is protected by coarse, angular rip-rap and willow planting.
27.01.93 9/12 Ohai (D45) 1:50,000, GR 981533



Lill Burn Photo 9, Lill Burn Confluence subreach
View downstream of Lill Burn, 1 km upstream from Waiau confluence. A large point bar, with a riffle at its head, is evident on the left bank, while the right, concave bank is actively eroding. Bank protection measures include tiered and cut willows (in the foreground) and coarse boulder-pile groynes (in mid-photo).
27.01.93 9/14 Ohai (D45) 1:50,000, GR 982533



Lill Burn Photo 10, Lill Burn Confluence subreach
Sample site LB3, located at the head of a compound point bar with a major riffle at the bar head. The eroding bank described in the upper photograph is evident in mid-photo.
27.01.93 9/15 Ohai (D45) 1:50,000, GR 983534



Lill Burn Photo 11, Lill Burn Confluence subreach
Lill Burn-Waiau confluence. Note the highly sinuous course of lower Lill Burn, with numerous abandoned meander scars evident. Sample site LB3 was located on the large compound point bar in mid-photo.
16.01.93 GBF 2/32



Lill Burn Photo 12, Lill Burn Confluence subreach
View downstream of the shallow-angle fan at Lill Burn-Waiau confluence. This is a highly dissected fan surface. Channel alignment on the fan surface has been modified by direct human action in management schemes. Note the poorly sorted fan surface, with abundant logs and organic debris.
27.01.93 9/16 Ohai (D45) 1:50,000, GR 988535



Lill Burn Photo 13, Lill Burn Confluence subreach
Lill Burn-Waiau confluence, looking upstream along Waiau River. Note the differing clast sizes in various depositional units over the bar surface.
27.01.93 9/18 Ohai (D45) 1:50,000, GR 988534



Lill Burn Photo 14, Lill Burn Confluence subreach
Lill Burn-Waiau confluence, looking downstream along Waiau River. Note the extensive active gravel surfaces and alluvial flats downstream.
27.01.93 9/18 Ohai (D45) 1:50,000, GR 988534



Lill Burn Photo 14, Lill Burn Confluence subreach
Aerial overview of Waiau-Lill Burn confluence. Waiau River flows from right to left. Note the differing scales of the two rivers and their associated pattern of bars. The shallow fan surface at the confluence is quite prominent, and the downstream change in bar types along Waiau River is quite dramatic. Alluvial flats and lower terrace surfaces are abundant in this reach. Note the interconnected channel network (a former braidplain) on the terrace surface in the foreground.
16.01.93 AHF 1/33

