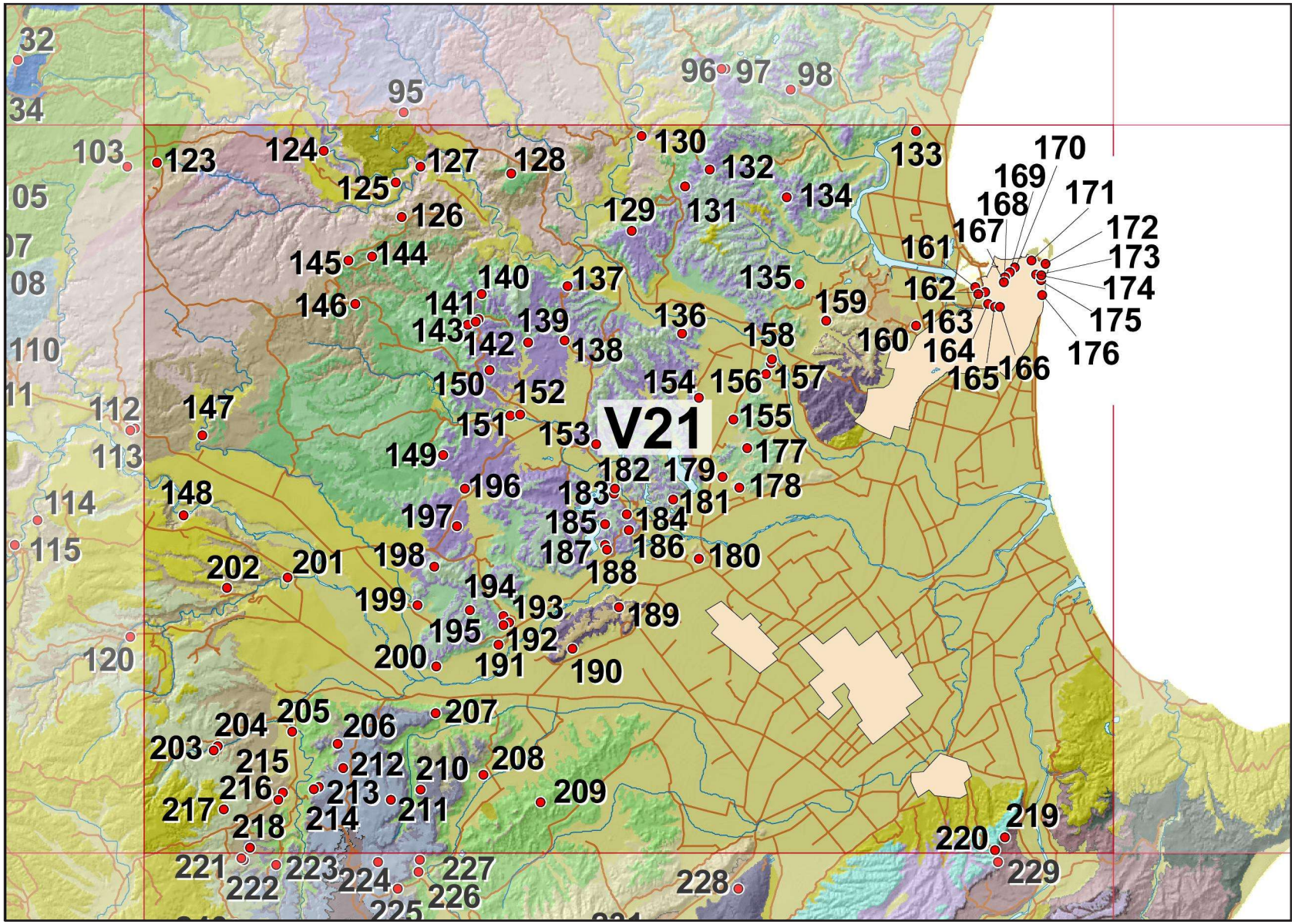

Fig. 10. Map showing location of stratigraphic columns within NZMS 260 Sheet V21.

Stratigraphic Column No: 123 | *Grid Reference:* | *Top* | *Bottom*

GPS Waypoint No(s): Wp 825-826 | *E:* | 2810746 | 2810532

Region: Otamauri | *N:* | 6188233 | 6188531

Location: Taihape Road near Waikonini Stream bridge | *Altitude:* | 280 m | 297 m

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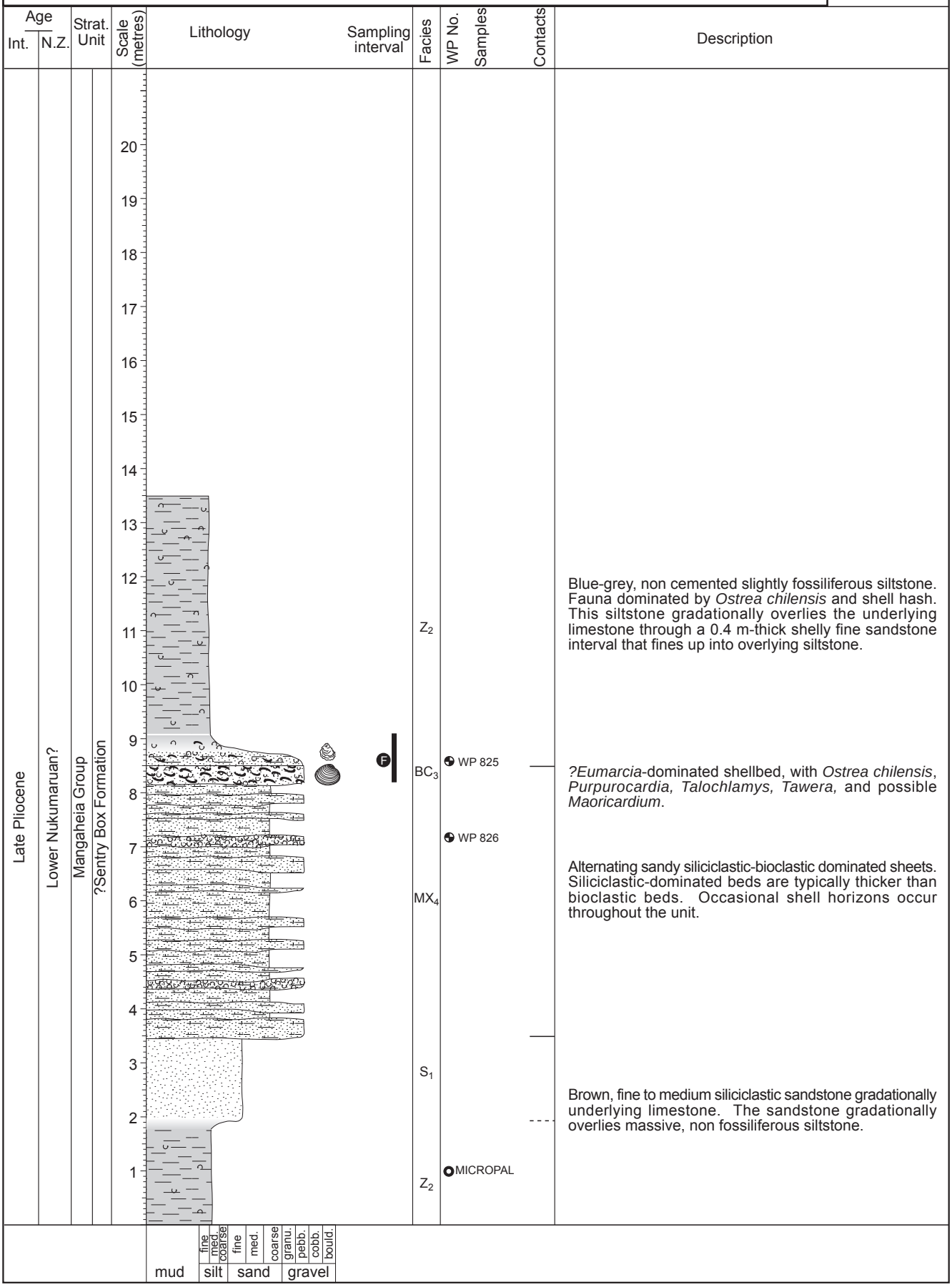

Stratigraphic Column No: 124 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 816 | **E:** 2817412 | -

Region: Waihau | **N:** 6189043 | -

Location: Tutaekuri River below Waldon Road ford, above Waikonini Stream | **Altitude:** 129 m | -

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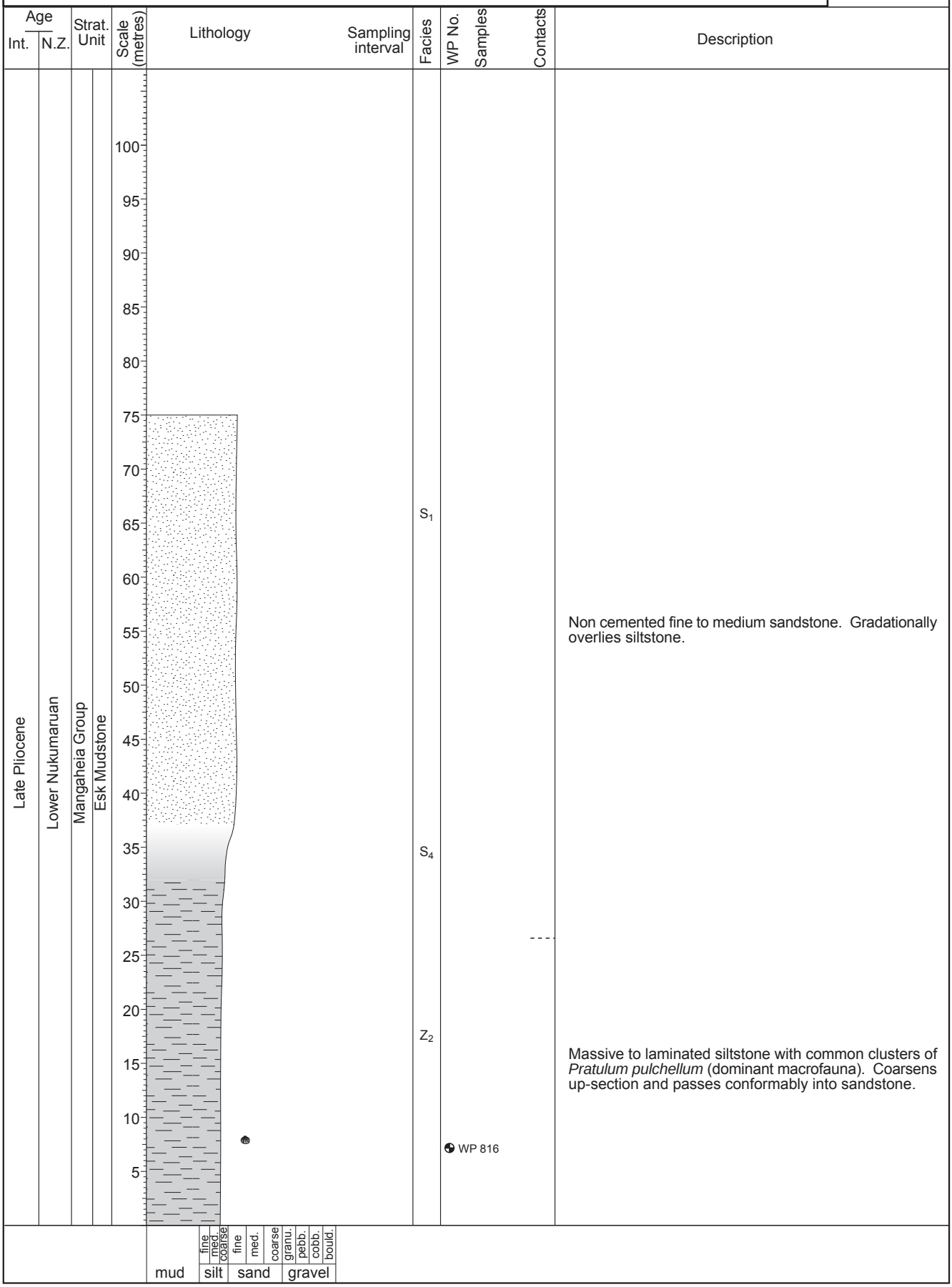

Stratigraphic Column No: 125 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 819 | **E:** - | 2820362

Region: Sherenden | **N:** - | 6187725

Location: Tutaekuri River below Waldon Road near Waikonini Stream confluence | **Altitude:** - | 102 m

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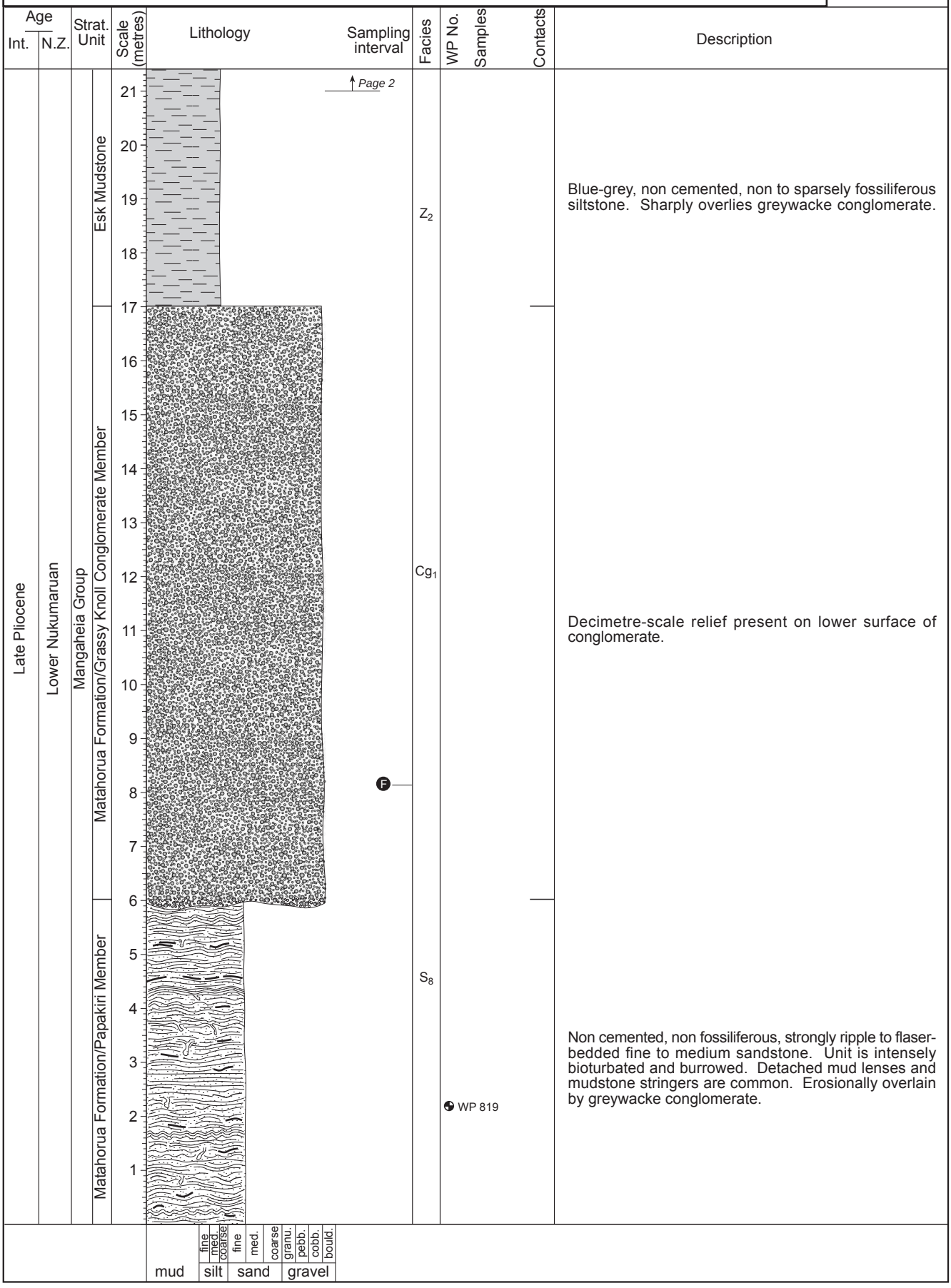

Stratigraphic Column No: 125 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 819 | **E:** - | 2820362

Region: Sherenden | **N:** - | 6187725

Location: Tutaekuri River below Waldon Road near Waikonini Stream confluence | **Altitude:** - | 102 m

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Quaternary	Haweran	Ripia Alluvium	42–32			Cg_1			Poorly sorted, non cemented Quaternary terrace gravels.
Late Pliocene	Lower Nukumaruan	Mangaheia Group / Esk Mudstone	32–22		F	Z_2	WP 149		Blue-grey, non cemented, non to sparsely fossiliferous siltstone.

Page 1

mud | silt (fine, med., coarse) | sand (fine, med., coarse) | gravel (granu., pebb., cobb., bould.)

Stratigraphic Column No: 126 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 729-734 **E:** 2820827 2820598

Region: Sherenden **N:** 6186043 6186291

Location: Section along driveway on Bilby's Block, east of Flag Range crest **Altitude:** 260 m 233 m

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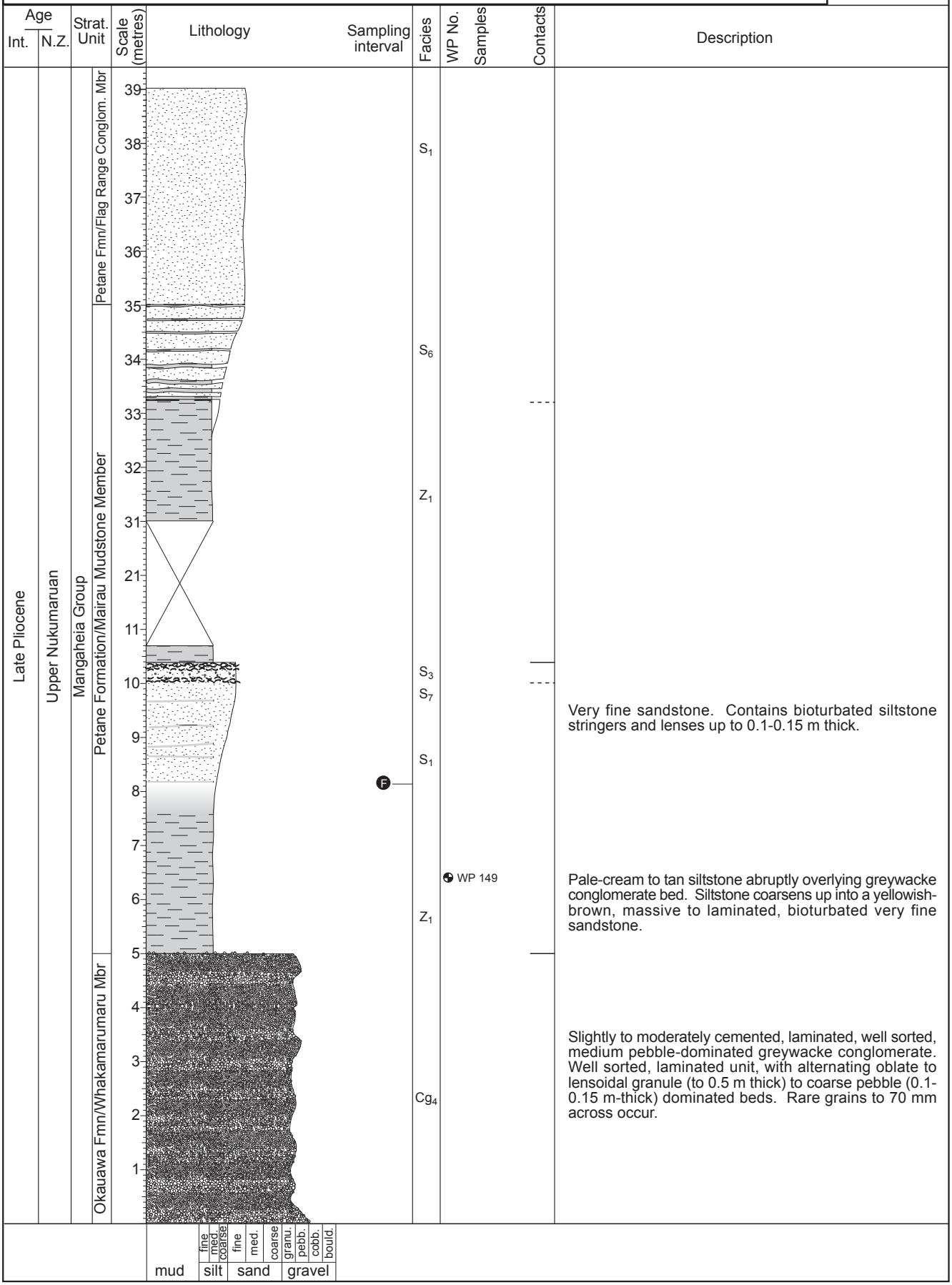

Stratigraphic Column No: 127 | **GPS Waypoint No(s):** Wp 736-745 | **Region:** Sherenden | **Location:** Waikonini Stream below Flag Range in to Tutaekuri River | **NZMS 260 Sheet:** V21 Napier

Grid Reference:	Top	Bottom
E:	2820739	2821392
N:	6186988	6188373
Altitude:	115 m	82 m

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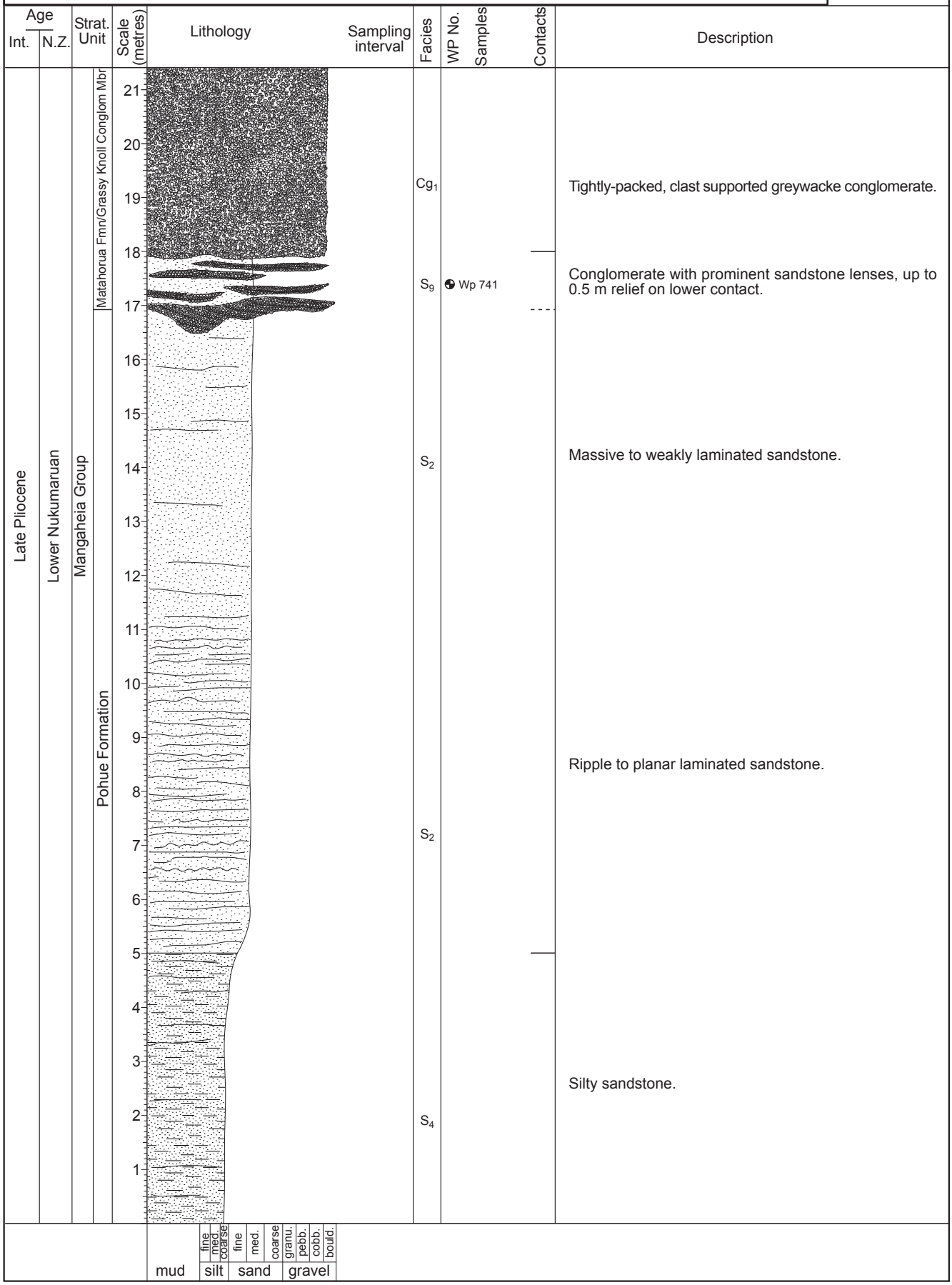

Stratigraphic Column No: 127 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 736-745 **E:** 2820739 2821392

Region: Sherenden **N:** 6186988 6188373

Location: Waikonini Stream below Flag Range in to Tutaekuri River **Altitude:** 115 m 82 m

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Lower Nukumaruan	Mangaheia Group	42				Wp 884		Siltstone continues to top of stream valley.
			41						
			40						
			39						
			38						
			37						
		Esk Mudsstone	36			Z_1			
			35						Massive, non to sparsely fossiliferous siltstone.
			34						
			33						
			32						
			31						
			30						
			29						
			28						
			27						
			26						
			25						
			24			Z_5 Cg_6			Transition into siltstone through pebbly siltstone.
		Grassy Knoll Cong. Mbr	23						Shellbed.
			22			Cg_1			Conglomerate.

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

Stratigraphic Column No: 128 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 644-646 **E:** 2825187 2825159

Region: Dartmoor **N:** 6188178 6188088

Location: Section up farm track on Waihau Road face of Mount Cameron **Altitude:** 289 m 338 m

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group / Petane Formation/ Mairau Mudstone Member	58–56			S_7			Pale yellow-brown, non cemented, bioturbated fine sandstone. Common siltstone stringers are present. The unit contains relatively common scattered *Ostrea* and *Patro* valves, typically concave-down. Lenses <30 cm thick of biomoulds resembling *Tawera* are common, interbedded with *Ostrea* valves.
			55–54		F	S_3	WP 646		Orange-brown, non cemented fine sandstone with common shell-rich layers and scattered macrofossils. Common *Zethalia zelandica* (typically in discrete monospecific beds), and some *Paphies australis*. Many other unidentified bivalves occur in this unit.
			53–43						
			42			Z_1			Pale-grey slightly micaceous siltstone.
		Okauawa Formation/Kikowhero Member	41–39			Cg_4			Fine to medium pebble-dominated greywacke conglomerate. The bed comprises of alternating granule - pebble beds 5-30 cm thick. Oblate shaped grains dominate.
			38		A				
			37				WP 645		
			36–35			Cg_1			Moderate to poorly sorted, greywacke conglomerate. The unit contains fine pebble to cobble-sized clasts, dominated by spheroidal to oblate-shaped clasts.
			27–19						
			11–3						
			2				WP 644		
			1			Z_3			Blue-grey to brownish-grey, massive, fine-grained slightly micaceous siltstone to sandy siltstone.

mud | silt (fine, med., coarse) | sand (fine, med., coarse) | gravel (granu., pebb., cobb., bould.)

Stratigraphic Column No: 128 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 644-646 | **E:** 2825187 | 2825159

Region: Dartmoor | **N:** 6188178 | 6188088

Location: Section up farm track on Waihau Road face of Mount Cameron | **Altitude:** 289 m | 338 m

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Age: Int. / N.Z. | Strat. Unit | Scale (metres) | Lithology | Sampling interval | Facies | WP No. | Samples | Contacts | Description

Late Pliocene

Upper Nukumaruan

Mangaheia Group

Petane Formation/Flag Range Conglomerate Member

Mairau Mst Mbr

65

64

63

62

61

60

59

58

57

A

B

F

Cg_6

S_1

Cg_6

Cg_6

S_9

S_7

C D

E F

WP 646

Clast-supported, well sorted slightly cemented greywacke conglomerate. Base of the conglomerate contains densely-packed beds of barnacles, the majority of which are attached to each other. *Ostrea* valves are common among the barnacles, with gastropod biomoulds.

Orange-brown to tan, slightly micaceous, non cemented fine sandstone.

Clast supported, well sorted pebble-dominated moderately fossiliferous greywacke conglomerate

Differentially cemented, shelly sandstone with *Ostrea, Tawera* and *barnacles*. Common biomould lenses to 30 cm thick.

Matrix-supported greywacke conglomerate passing up into clast supported greywacke conglomerate. Moderately to well sorted well rounded oblate to spheroidal clasts 20 -80 mm across. Basal parts contain common *Ostrea* valves, many are articulated, occasionaly encrusted with barnacles. Also *Oxyperas/Eucrassitella, Patro* and *Lutraria*.

Pale yellow-brown, non cemented, bioturbated, burrowed fine sandstone. Common siltstone stringers are present. The unit contains relatively common scattered *Ostrea* and *Patro* valves, typically concave-down. Lenses <30 cm thick of biomoulds resembling *Tawera* are common, interbedded with *Ostrea* valves.

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

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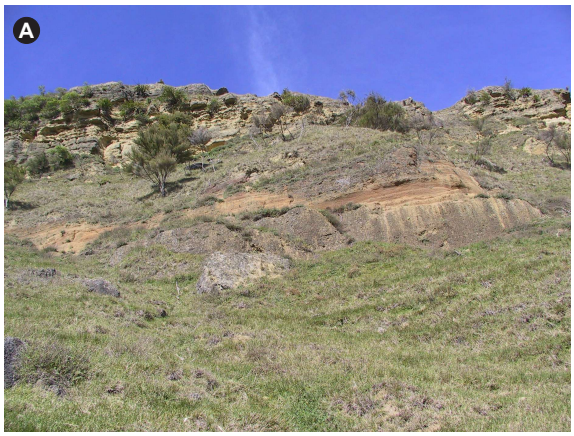

Stratigraphic Column No: 129 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 673 | **E:** 2830120 | -

Region: Dartmoor | **N:** 6185737 | -

Location: Ruawai Station overlooking Rissington | **Altitude:** 205 m | -

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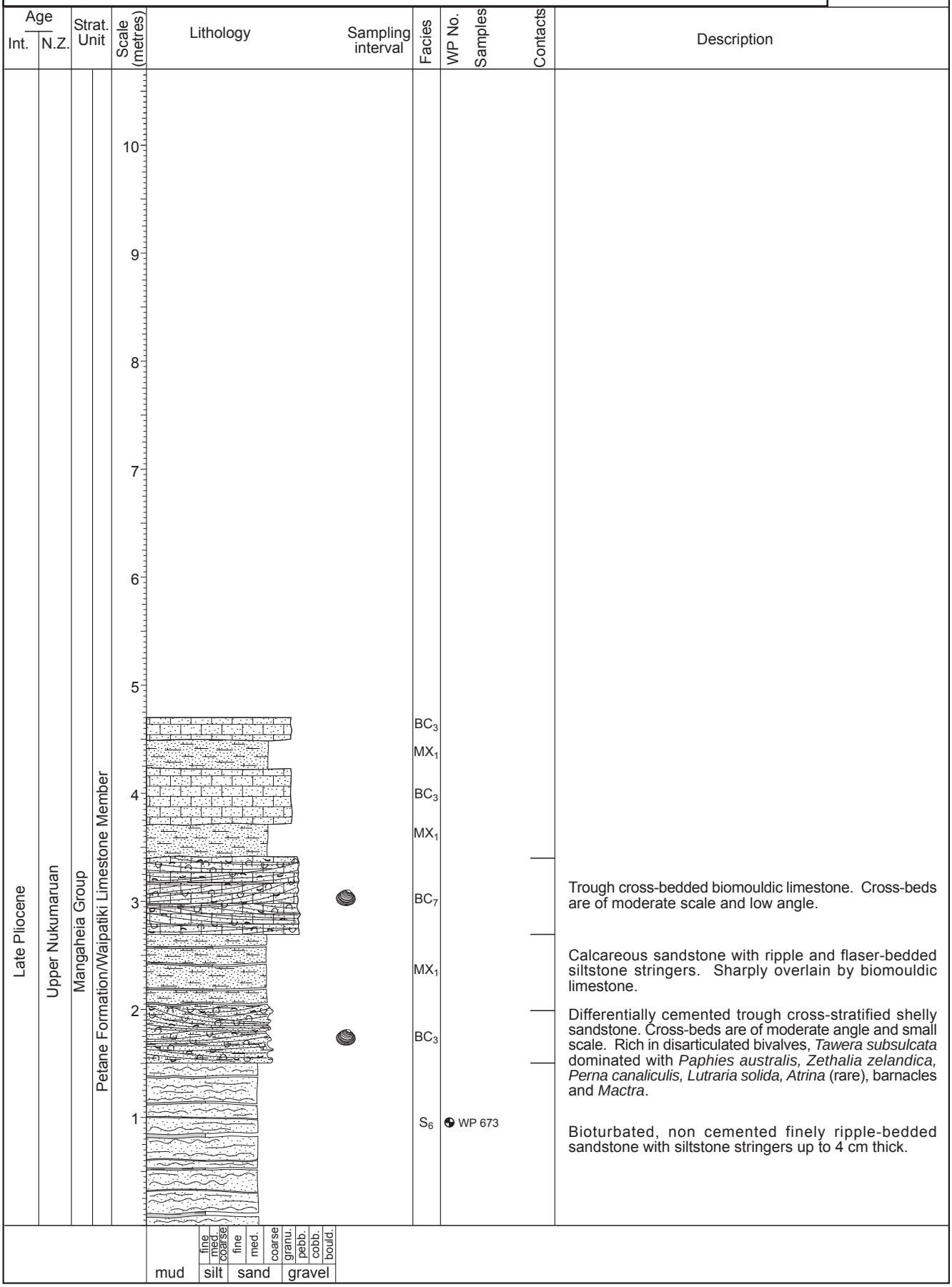

Stratigraphic Column No: 130 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 529 | **E:** 2830523 | -

Region: Rissington | **N:** 6189643 | -

Location: Mangaone River upstream of Rissington Bridge | **Altitude:** 68 m | -

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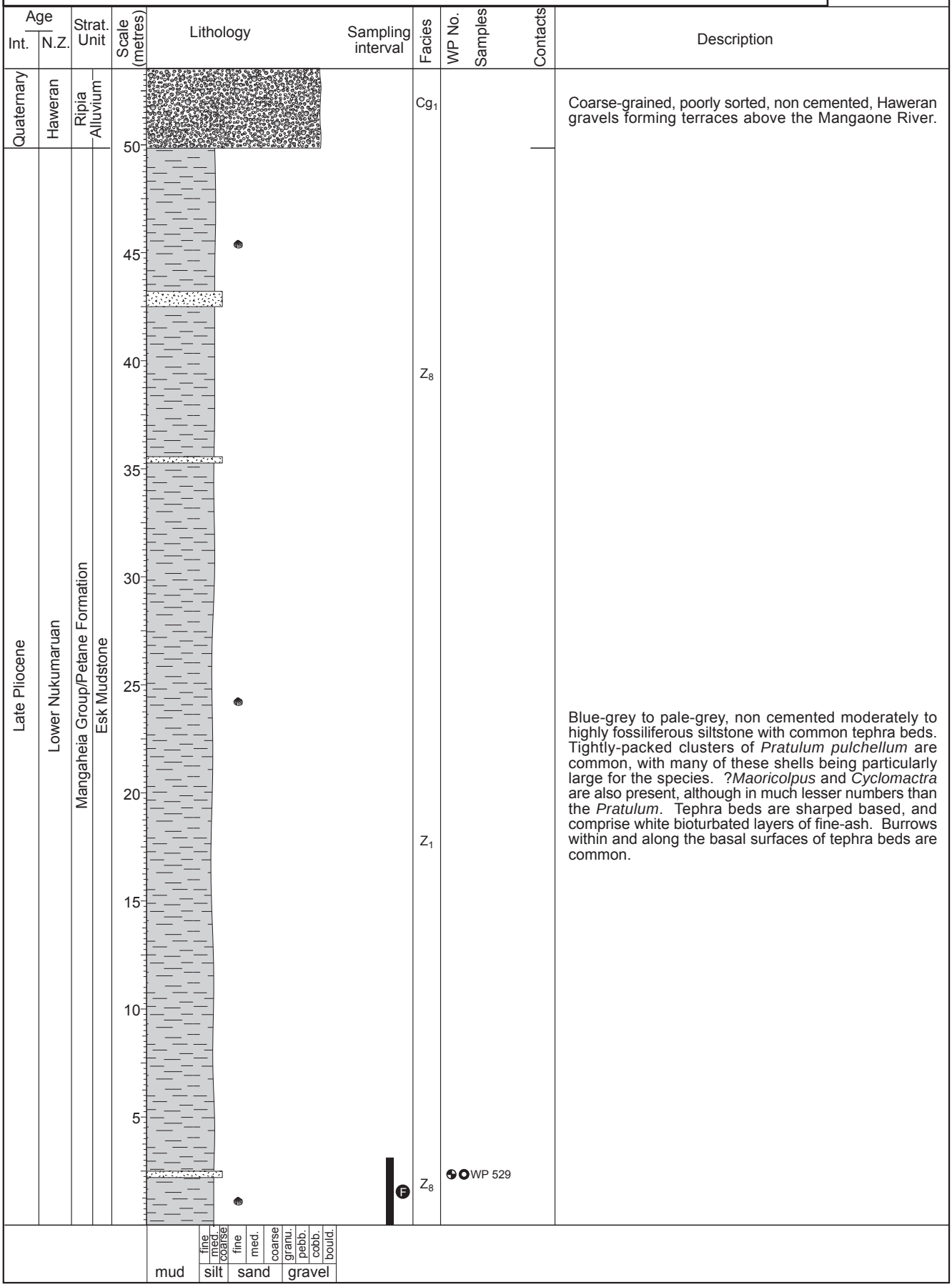

Stratigraphic Column No: 131 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 412 **E:** 2832289 -

Region: Rissington **N:** 6187548 -

Location: Pukenoa Farm near Apley Road, farm track through forest block **Altitude:** 164 m -

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Early Pleistocene	Upper Nukumaruan	Mangaheia Group/Petane Formation / Waipatiki Limestone Member	10		H	BC_3	WP 412		Slightly cemented, highly fossiliferous shellbed. Scattered well rounded fine greywacke pebbles are present, as are occasional finely laminated siltstone stringers up to 0.03 m thick. A wide range of shallow-water bivalves are present including *Purpurocardia, Tawera, Tucetona, Lutraria, Gari, Ostrea, Anomia,* and *Talochlamys*, with the gastropod *Crepidula.* Also present are *Eumarcia* and a very fragmented *Sectipecten mariae.*
			9						
Late Pliocene			8		G				Medium-grained shelly sandstone with common siltstone lenses and stringers up to 0.15 m thick, and highly fossiliferous shell layers up to 0.45 m thick. Fauna in this bed include *Pelicaria convexa, Ostrea, Tucetona, Lutraria, Crepidula, Gari, Tawera* and *Purpurocardia.*
			7		F				
			6		E				
			5						
			4						Alternating siltstone and shellhash sandstone sheets 0.05-0.7 m thick. Siltstone beds are typically dirty-cream in colour, slightly to moderately fossiliferous, finely laminated and very fine-grained. Burrows infilled with shellhash are common through these beds. Shellhash sandstone beds are generally orange-brown in colour, of medium to coarse sand texture, non to slightly-cemented and moderately to highly fossiliferous. Fauna in the sand beds typically includes *Purpurocardia, Gari, Crepidula, Patro, Talochlamys* and barnacle plates.
			3		D	MX_1			
			2		C				
			1		B				
					A				

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

FAUNAL LIST

A- Shellhash-dominated sandstone with *Crepidula radiata* and *Talochlamys gemmulata*.

B - Non cemented shellhash sandstone withcommon *Gari* sp., barnacle plates, *Crepidula radiata, Anomia trigonopsis,* and *Patro undatus.*

C - Shellhash sandstone containing barnacle fragements and *Purpurocardia purpurata*.

D - Shellhash sandstone with common *Gari* sp., and *Talochlamys gemmulata*, with branching bryozoans, *Tawera* sp., and *Anomia trigonopsis*.

E - Shellhash sandstone containing *Purpurocardia purpurata*.

F - Coarsening-upwards shellhash sandstone bed with occasional thin siltstone stringers. Unit contains *Gari* sp., some of which are articulated, *Tawera* sp., *Alcithoe* sp., *Tucetona laticostata* and Gastropoda spp.

G - Shellhash sandstone-dominated unit with common siltstone lenses. Fauna includes *Pelicaria convexa, Ostrea chilensis, Lutraria, Crepidula radiata, Lamprodominea, Gari* sp., *Tawera* sp., *Taloclamys gemmulata,* and *Purpurocardia purpurata*.

H - Highly fossiliferous, slightly cemented limestone with scattered fine pebble, well rounded greywacke pebbles. Fauna includes *Purpurocardia purpurata*, *Tawera* sp., *Tucetona laticostata*, *Lutraria, Gari* sp., *Anomia trigonopsis, Talochlamys gemmulata,* and *Crepidula radiata*.

Stratigraphic Column No: 132 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 61 | **E:** 2833307

Region: Rissington | **N:** 6188260

Location: Puketitiri Road immediately south of Glengarry Road. | **Altitude:** 200m | -

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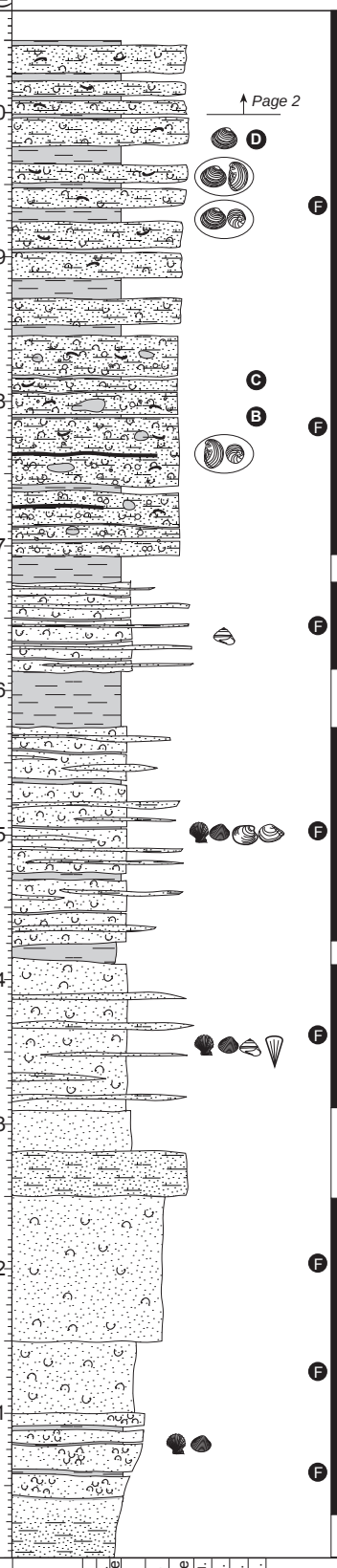
Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group / Waipatiki Limestone Member	10–1		H G F E D C B A	MX_4			Alternating siltstone and shellhash beds. Beds are very continuous, and moderately to highly fossiliferous, becoming more shellhash-rich before grading up into a shellhash-dominated sandstone. The faunal content of this zone is dominated by bivalves such as *Tawera subsulcata, Austrovenus stuchburyi, Gari stangeri* and *Glycymeris modesta.* Non to slightly cemented, moderately to highly fossiliferous, shellhash-dominated sandstone with prominent siltstone stringers. Siltstone rip-up clasts up to 12 cm diameter are present, averaging 5 cm across, as are a few scattered, well rounded greywacke pebbles. Low-angle, moderate-scale cross-bedding is visible, especially in the siltstone stringers. Shellhash rip-up clasts are also present. Non cemented, non fossiliferous siliciclastic siltstone. Non cemented, moderately to highly fossiliferous siliciclastic silty sandstone with laminated shellhash and siltstone stringers that show relief on their upper and lower contacts. Non cemented siliciclastic siltstone containing thin shellhash lenses. Non to slightly cemented silty sandstone with common siltstone stringers up to 10 cm thick, and shellhash lenses up to 5 cm thick. Moderately to highly fossiliferous with an estuarine-dominated fauna including *Austrovenus stutchburyi* and *Barytellina crassidens.* Non cemented siltstone lens that pinches out over 10 m. Non cemented silty sandstone with a bioclastc sandstone content. The unit is moderately fossiliferous. Shellhash lenses are common in this unit. Non cemented silty sandstone with a bioclastc sandstone content. Bioclastc medium sandstone. Non to slightly cemented, moderately fossiliferous shelly medium sandstone. Non to slightly cemented, moderately fossiliferous fine siliciclastic sandstone. Unfossiliferous blue-grey sandy siltstone grading up into medium sandstone with pockets of shellhash-rich in bivalve fossils. This sandstone contains mudstone stringers up to 0.1 m thick which are frequently laminated. The unit as a whole is intensely bioturbated and burrowed. The base of this section is not exposed.

mud | silt (fine, med., coarse) | sand (fine, med., coarse) | gravel (granu., pebb., cobb., bould.)

Stratigraphic Column No: 132 ***Grid Reference:*** ***Top*** ***Bottom***

GPS Waypoint No(s): Wp 61 ***E:*** 2833307

Region: Rissington ***N:*** 6188260

Location: Puketitiri Road immediately south of Glengarry Road. ***Altitude:*** 200m -

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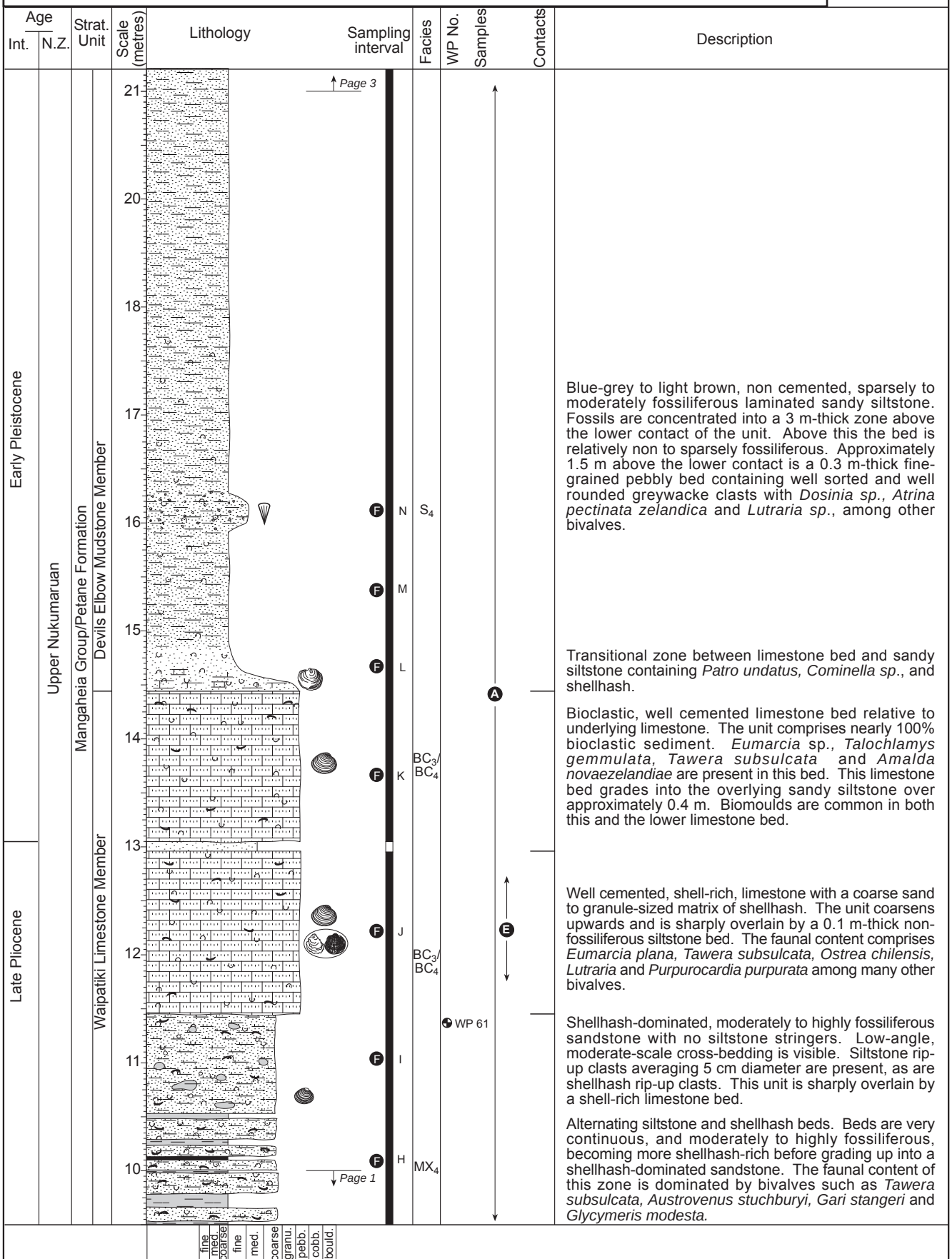

Blue-grey to light brown, non cemented, sparsely to moderately fossiliferous laminated sandy siltstone. Fossils are concentrated into a 3 m-thick zone above the lower contact of the unit. Above this the bed is relatively non to sparsely fossiliferous. Approximately 1.5 m above the lower contact is a 0.3 m-thick fine-grained pebbly bed containing well sorted and well rounded greywacke clasts with *Dosinia sp., Atrina pectinata zelandica* and *Lutraria sp.*, among other bivalves.

Transitional zone between limestone bed and sandy siltstone containing *Patro undatus, Cominella sp.*, and shellhash.

Bioclastic, well cemented limestone bed relative to underlying limestone. The unit comprises nearly 100% bioclastic sediment. *Eumarcia* sp., *Talochlamys gemmulata, Tawera subsulcata* and *Amalda novaezelandiae* are present in this bed. This limestone bed grades into the overlying sandy siltstone over approximately 0.4 m. Biomoulds are common in both this and the lower limestone bed.

Well cemented, shell-rich, limestone with a coarse sand to granule-sized matrix of shellhash. The unit coarsens upwards and is sharply overlain by a 0.1 m-thick non-fossiliferous siltstone bed. The faunal content comprises *Eumarcia plana, Tawera subsulcata, Ostrea chilensis, Lutraria* and *Purpurocardia purpurata* among many other bivalves.

Shellhash-dominated, moderately to highly fossiliferous sandstone with no siltstone stringers. Low-angle, moderate-scale cross-bedding is visible. Siltstone rip-up clasts averaging 5 cm diameter are present, as are shellhash rip-up clasts. This unit is sharply overlain by a shell-rich limestone bed.

Alternating siltstone and shellhash beds. Beds are very continuous, and moderately to highly fossiliferous, becoming more shellhash-rich before grading up into a shellhash-dominated sandstone. The faunal content of this zone is dominated by bivalves such as *Tawera subsulcata, Austrovenus stuchburyi, Gari stangeri* and *Glycymeris modesta.*

Stratigraphic Column No: 132 ***Grid Reference:*** ***Top*** ***Bottom***

GPS Waypoint No(s): Wp 61 ***E:*** 2833307

Region: Rissington ***N:*** 6188260

Location: Puketitiri Road immediately south of Glengarry Road. ***Altitude:*** 200m -

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Early Pleistocene	Upper Nukumaruan	Mangaheia Group/Petane Formation / Devils Elbow Mudstone Member	23 / 22 / 21			S_4	A		Blue-grey, to light-brown, non cemented, non to sparsely fossiliferous sandy siltstone.

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A- Medium sandstone with pockets of shellhash containing *Sigapetella novaezelandiae, Crepidula radiata, Austrovenus stuchburyi, Tawera spissa, Notocallista sp., Talochlamys gemmulata*, *Tellinota edgari,* and in situ *Panopea* sp.

B- Moderately fossiliferous fine siliciclastic sandstone containing *Sigapetella novaezelandiae.*

C- Non to slightly cemented medium shelly sandstone dominated by *Maoriomactra ordinaria.*

D- Fine siliciclastic sandstone with a bioclastic component, containing *Callisotoma pellucidum*, *Talochlamys gemmulata, Tawera subsulcata, Patro undatus, Zenatia acinaces, Zethalia zelandica, Tellinota edgari, Glycymeris modesta,* and *Atrina pectinata zelandica.*

E- Non to slightly cemented sandstone with siltstone and shellhash lenses containing *Pelicaria convexa*, in situ *Panopea* sp., *Talochlamys gemmulata, Maoriomactra ordinaria, Bassina yatei, Crepidula radaiata, Barnea simmilis, Glycymeris ordinaria, Sigapetella novaezelandiae, Barytellina crassidens, Tawera subsulcata,* and *Austrovenus stutchburyi.*

F- Non cemented, moderately to highly fossiliferous siliciclastic silty sandstone with siltstone and shellhash lenses containing *Barnea simmilis, Cirrsotrema, Maoriomactra ordinaria, Sigapetella novaezelandiae, Crepidula radiata, Gari stangeri, Zethalia zelandica, Gari lineolata,* and *Lutraria* sp.

G- Non to slightly cemented shellhash-dominated sandstone with *Gari lineolata, Glycymeris modesta, Panopea* sp., *Gari stangeri, Tawera subsulcata, Sigapetella novaezelandiae, Crepidula radiata*, and *Austrovenus stutchburyi.*

H- Alternating siltstone and shellhash lenses containing *Tawera subsulcata, Austrovenus stutchburyi, Gari stangeri, Sigapetella novaezelandiae, Panopea* sp., *Crepidula radiata, Glycymeris modesta, Lutraria* sp., *Glycymeris* sp., *Ostrea chilensis, Barytellina crassidens, Atrina pectinata zelandica, Purpurocardia purpurata, Zethalia zelandica,* and *Stiracolpus* sp.

I- Shellhash-dominated, moderately to highly fossiliferous sandstone with siltstone and shellhash rip-up clasts. The faunal content comprises *Purpurocardia purpurata, Stiracolpus, Austrovenus stutchburyi, Dosinia nukumaruensis, Gari stangeri, Zethalia zelandica, Glycymeris modesta, Tawera subsulcata, Caryocorbula, Eumarcia plana, Gari lineolata, Lamprodominea* sp., *Dosina* sp., and *Sigapatella novaezelandiae.*

J- Well cemented, shell-rich limestone bed with a matrix of coarse sand-sized shellhash. *Eumarcia plana, Tawera subsulcata, Ostrea chilensis, Gari stangeri, Dosinia nukumaruensis, Dosina* sp., *Purpurocardia purpurata, Lutraria* sp., and barnacle plates are present in the unit.

K- Bioclastic-dominated, well cemented limestone containing virtually no siliciclastic sediment. Fauna present include *Eumarcia plana, Talochlamys gemmulata, Tawera subsulcata,* and *Amalda novaezelandiae.*

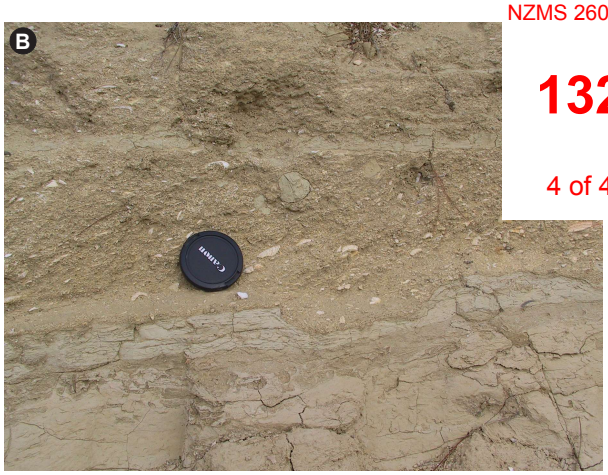
L- Transitional zone between limestone bed and overlying sandy siltstone that contains *Patro undatus* and *Cominella* sp.

M- Non cemented sandy siltstone containing *Pelicaria convexa*, *Lutraria* sp., *Notocallista multistriata,* and *Stiracolpus* sp.

N- Fine-grained pebble bed containing *Dosina* sp., *Atrina pectinata zelandica, Lutraria* sp., *Notiris* sp., *Trachycardium* sp., *Tellinota edgari, Tawera subsulcata,* and *Tucetona laticostata.*

mud	silt			sand			gravel			
	fine	med.	coarse	fine	med.	coarse	granu.	pebb.	cobb.	bould.


A
TOYOTA


B


C


D


E

Stratigraphic Column No: 133 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 496 | **E:** 2841846 | -

Region: Bayview | **N:** 6189837 | -

Location: Rorookiwa Hill off Onehunga Road Bayview | **Altitude:** -4m | -

NZMS 260 Sheet: V21 Napier | *Page* 1 *of* 1 | **Author:** K. Bland

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Pliocene	Nukumaruan	Mangaheia Group/Petane Formation, Mairau Mudstone Member	12 11 10 9 8 7 6 5 4 3 2 1	mud; silt (fine, med., coarse); sand (fine, med., coarse); gravel (granu., pebb., cobb., bould.)	A B C D E F	S_3 MX_1 S_3 S_1	WP 496		Highly fossiliferous shellbed. The lower 0.15 m contains packed beds of stacked *Talochlamys* of large size, with many large *Mesopeplum convexum* valves and scattered gastropods. A 0.25-0.30 m thick zone above this contains smaller although equally abundant *Talochlamys* with common *Ostrea*, some in situ *Atrina* and many gastropods. Barnacles are also common, many attached to bivalve shells. This bed is overlain by laminated sandy siltstone with scattered shells. This unit contains much less shellhash than the lower sandstone. The contact with the underlying shellbed is gradational. Yellow-brown, non cemented non to slightly fossiliferous fine sandstone.Small clusters of shells are present, dominated by *Ostrea* and *Talochlamys* with some *Eumarcia* sp. and gastropods. Shell clusters are more common towards the top of the bed. This unit contains a prominent shellhash component and is intensely bioturbated and burrowed. Burrows underneath the overlying shellbed are commonly filled with shellhash.

133

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Stratigraphic Column No: 134 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 371-373 | **E:** | 2836553 | 2836357

Region: Puketapu | **N:** | 6187257 | 6187021

Location: Farm track at Bayliss Bros. drilling depot above Puketitiri Road. | **Altitude:** | 143m | 126m

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NZMS 260 V21

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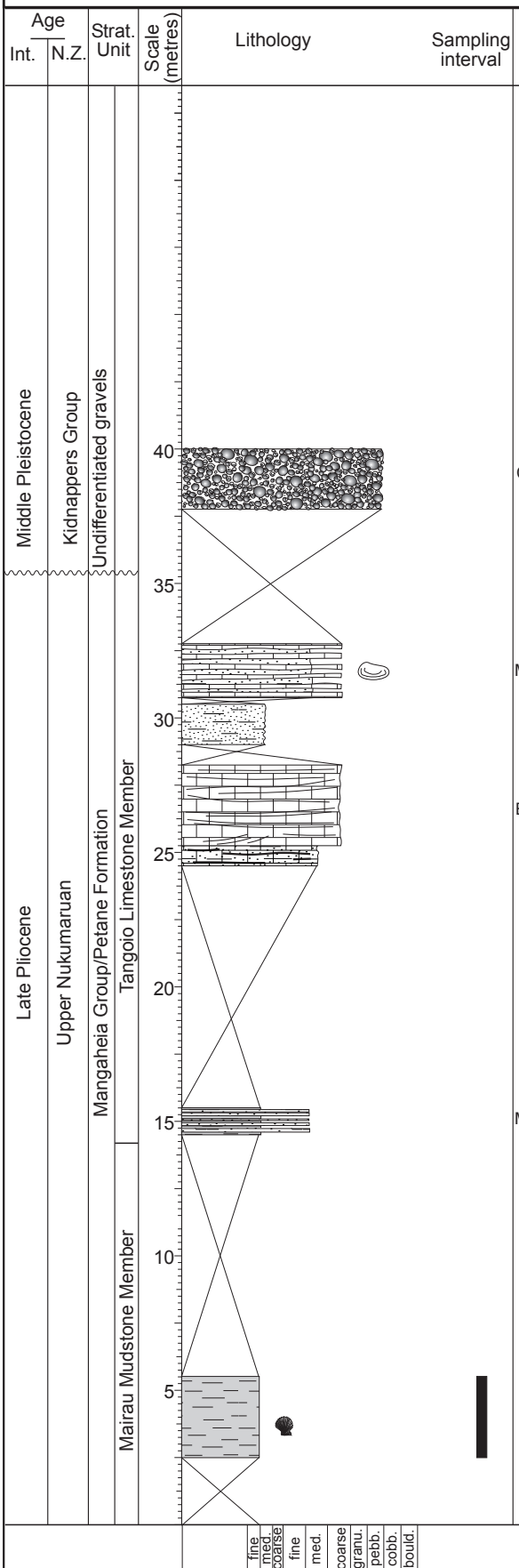

Very poorly sorted, non cemented greywacke conglomerate. Clasts are sub-rounded, spheroid to lensoidal in shape, up to 120 mm across, averaging 20-60 mm. Unit appears to be unconformable with respect to underlying strata.

Alternating siliciclastic - biomould-rich layers 0.1-0.5 m thick. Very large dissolution moulds and beds are common. The upper 0.6 m of this unit consists of moderately weathered, biomould-rich partially recrystallised limestone.

Creamy-brown, moderately fossiliferous, weathered sandy siltstone. Fauna is dominated by *Paphies australis* with gastropoda sp. The outcrop is moderately flaggy, flags are 0.1-0.2 m thick.

Coarse-grained, moderately weathered limestone with abundant biomoulds, occasional *Ostrea* valve and fragments. Massive to laminated to moderate-scale cross-bedded.

Medium to coarse sand shellhash-dominated limestone with siltstone stringers and lenses up to 0.15 m thick.

Alternating siliciclastic siltstone-bioclastic shelly sandstone sheets of up to 0.3 m thick. Poorly to moderately cemented, the units are moderately fossiliferous.

Blue-grey, firm, moderately fossilifeous siltstone. The unit is gastropod dominated; *Antalis nana* is very abundant, with common *Stiracolpus*, *Amalda*, and *Talochlamys*. Some disarticulated *Ostrea* valves are *Alcithoe*, *Austrofusus glans*, ?*Cominella* sp. and *Pelicaria* sp. are also present. Other unidentified bivalves, both articulated and disarticulated are present. Upper and lower contacts are not exposed but upper surface is probably gradational.

Stratigraphic Column No: 135 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 392 **E:** 2837029 -

Region: Puketapu **N:** 6183535 -

Location: Springvale Station at Puketapu Road end **Altitude:** 37m -

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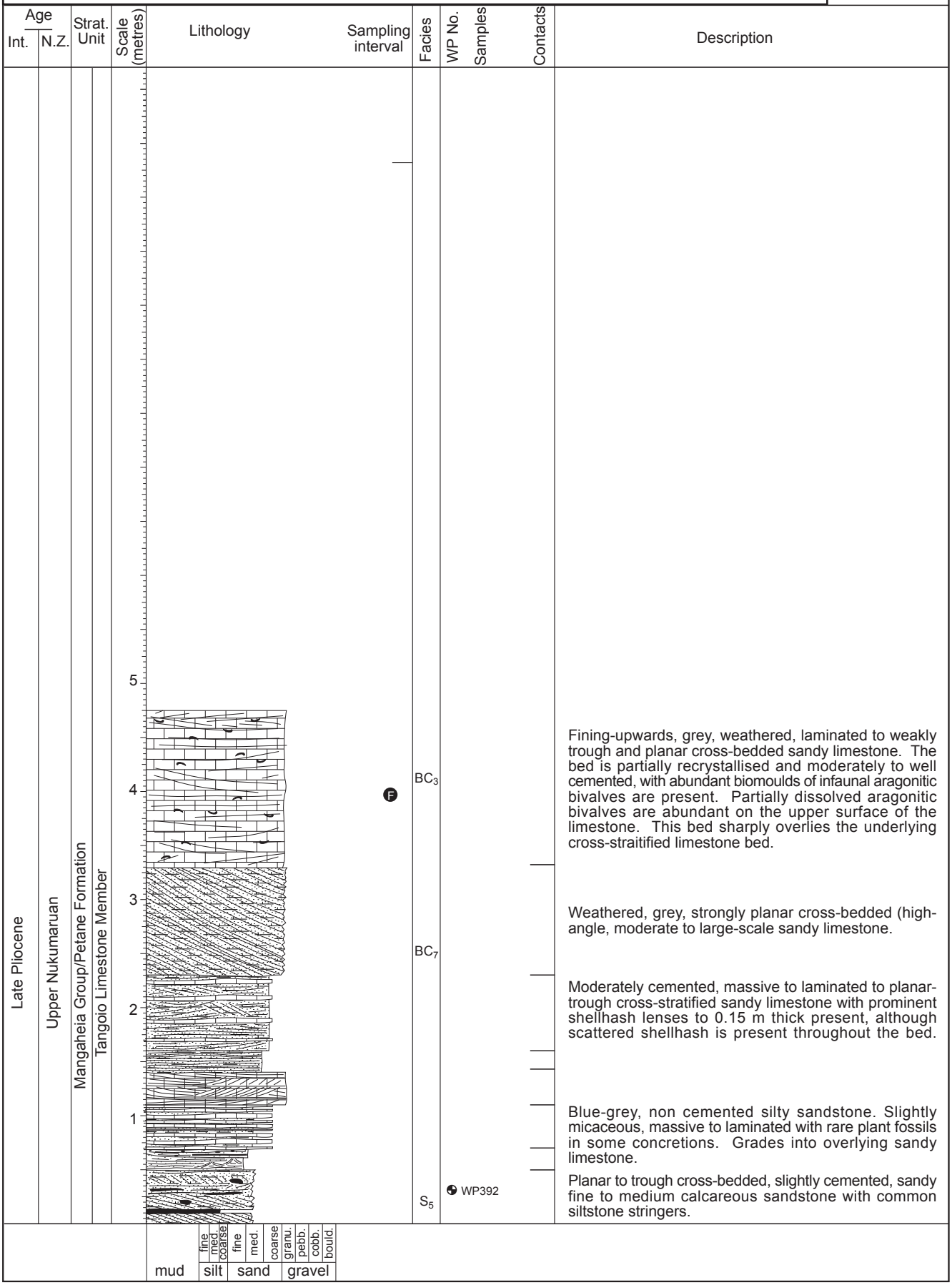

Stratigraphic Column No: 136
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Ebetts farm, on hills beside Tutaekuri River (12 Feb. 2003)
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2832205 -
N: 6181470 -
Altitude: 49m -

Author: R. Baggs

NZMS 260 V21

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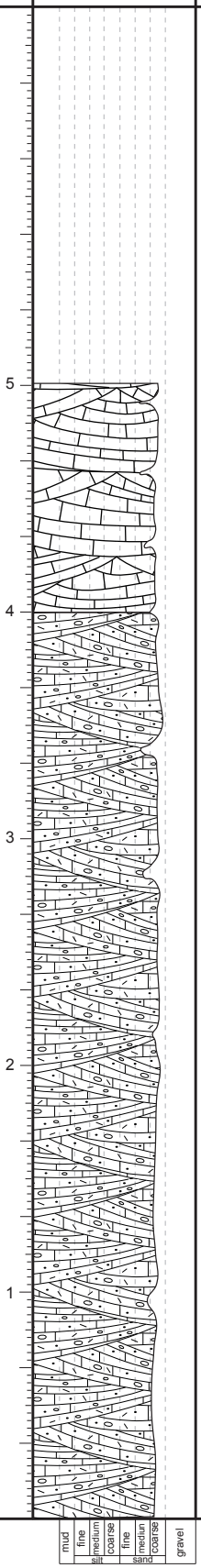
Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petnae Formation / Waipatiki Limestone Member	5		?		C2	Tabular cross-bedded pebbly limestone. *Tawera* sp. dominates.
	3				C2	Beige, moderately cemented , bidirectionally cross-bedded pebbly sandy limestone.
	2					
	1					

Stratigraphic Column No: 137
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Ngamahanga Station, overlooking the Tutaekuri River (31 Mar. 2003)
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2827444 -
N: 6183451 -
Altitude: 152m -

Author: R. Baggs

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Waipatiki Limestone Member	7		≠		C2	Well cemented, massive, pebbly sandy limestone. *Tawera* sp. and *Stiracolpus* sp.
						Cross-bedded pebbly limestone.
					M1	Weakly cemented trough cross-bedded, shelly pebbly sand.
	6					Well cemented, grey pebbly limestone
	5				C2	Very well cemented pebbly limestone.
	4					
	3				M1	Cross-bedded, shelly pebbly sand, moderately cemented.
					C2	
	2					Weakly cemented, cross-bedded, shelly sandstone with greywacke pebbles and some mud stringers.
	1				S5	Pebbly tabular bedded limestone.
					C2	Pebbly tabular bedded limestone.

mud | fine | medium | coarse | fine | medium | coarse | gravel
silt | sand

Stratigraphic Column No: 138 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 381 **E:** 2827357 -

Region: Okawa **N:** 6181193 -

Location: Ngamahanga Station along Kawera Road **Altitude:** 69m -

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group/Petane Formation, Waipatiki Limestone Member	10		G	BC_7			Grey, weathered, moderately cemented pebbly shelly limestone. Strongly cross-bedded, moderate scale, low to high-angle. Herringbone and bi-directional cross-stratification are visible. The bed becomes sandier upsection and upper parts comprise well cemented, shelly sandy limestone with aragonitic bivalves and biomoulds throughout. Greywacke granules to fine pebble-sized clasts are scattered through this bed.
			9						Massive, weathered, greywacke granule and pebble-rich partially recrystallised, moderately well cemented shelly limestone. Pebbles are sub-rounded to well-rounded. The bed contains abundant shell moulds of infaunal aragonitic bivalves such as *Tawera*. Underlying this unit is a bed comprising moderately well cemented fine-grained partially recrystallised sandy limestone displaying bi-directional cross-bedding with scattered, well rounded greywacke granules. Cross-beds are small to moderate-scale, moderate angle and dominated by tabular bedforms, with minor trough cross-beds. Small biomoulds are common.
			8		F	BC_3			
			7		E				Moderately cemented, flaggy, slightly-pebbly, coarse-grained partially recrystallised limestone. Shell fragments and disarticulated bivalve shells are common, as are biomoulds and *Ostrea* valves. Weakly cross-bedded in places
			6		D				Yellowish-brown, slightly to moderately cemented well sorted calcareous sandstone with abundant shell hash. Thin discrete shell layers are present containing *Tawera* and *Purpurocardia.* Tabular to trough cross-bedding is present.
			5						Poorly exposed interval containing yellow-brown, massive to cross-bedded, fine to medium sandstone with shell lenses.
			4						
			3		C	BC_7			Coarsening-upwards highly fossiliferous medium calcareous sandstone with closely packed bivalves and abundant gastropods. Fine greywacke pebbles become more common in the upper 0.5 m of the bed, with large *Ostrea* valves common in the upper 0.3 m. The unit is *Tawera* dominated with articulated *Tawera* valves common in the upper 1 m. Very large-scale, low-angle trough cross-bedding is present through the unit. Thin (<0.02 m thick) laminated siltstone stringers are present. Other common faunas include *Amalda, Talochlamys*, large *Zethalia, Purpurocardia*, *Crepidula* and *Sigapetella*. Over 0.15 m this bed is abruptly diluted by siliciclastic sediments and passes in to a yellowish-brown, well-sorted, fine calcareous sandstone with a shell hash content.
			2		B	MX_4			Alternating medium-grained siliciclastic/bioclastic sandstone-dominated sheets to 0.1 m thick. Greywacke granules and fine pebbles are concentrated in shellhash lenses. Low-angle, moderate-scale cross-bedding is present through the bed. Abundant disarticulated bivalves and gastropods present. *Tawera* common, as is *Sigapetella* and *Crepidula*. Many valves have been bored. Passes abruptly into overlying bed.
			1		A		WP381		Light-brown, highly fossiliferous, shelly medium sandstone rich in shellhash and intact, disarticulated bivalves. Approx. 5% well rounded and well sorted greywacke granules in unit. The bed is laminated and shell debris have been reworked. Fauna dominated by *Tawera, Crepidula* and *Sigapetella*.

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

Stratigraphic Column No: 138 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 381 | **E:** 2827357 | -

Region: Okawa | **N:** 6181193 | -

Location: Ngamahanga Station along Kawera Road | **Altitude:** 69m | -

NZMS 260 Sheet: V21 Napier | *Page 2 of 2* | **Author:** K Bland

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description

A- Shellhash-rich medium sandstone, dominated by *Tawera,* with common *Crepidula radiata and Sigapetella novaezelandiae.* Also present are *Zethalia zelandica, Purpurocardia purpurata, Eumarcia ?plana* and *Zenatia ?acinaces.*

B- Alternating medium-grained siliciclastic/bioclastic sandstone dominated sheets. Fauna is dominated by *Tawera*, with *Crepidula radiata* and *Sigapetella novaezelandiae* also common. *Maoricolpus roseus*, *Patro undatus*, juvenille *Pupurocardia purpurata, Amalda mucronata, Atrina pectinata zelandica* (in transported alignment), *Ostrea chilensis* and *Anomia trigonopsis* are also present. Valves of *Talochlamys gemmulata* were found in a wide range of sizes.

C- Medium-grained calcareous sandstone with closely-packed bivalves and abundant gastropods. *Tawera* is the dominant faunal type, with common *Ostrea chilensis*, particularly towards the top of the bed. Also present are *Amalda mucronata, Purpurocardia purpurata, Patro undatus, Crepidula radiata,* large *Zethalia zelandica, Sigapetella novaezelandiae, Alcithoe* sp., *Anomia trigonopsis, Maoricolpus roseus, Austrofusus sp., Talochlamys gemmulata, Stiracolpus, Atrina pectinata zelandica,* fragmented *Pelicaria* sp., and branching bryozoans. Articulated *Tawera* valves are common in the upper 1 m of this bed.

D- Well sorted calcareous sandstone with abundant shellhash. Discrete shell lenses are present containing *Tawera* and *Purpurocardia purpurata*. *Ostrea chilensis* valves are also present through the unit.

E- Slightly pebbly, coarse-grained partially recrystallised limestone rich in shell fragments and disarticulated bivalve shells. Abundant biomoulds occur through the bed with some *Ostrea chilensis* valves present.

F- Massive greywacke granule to pebble-rich, partially recystallised well cemented shelly limestone. Abundant biomoulds are present with scattered, partially dissolved infaunal aragonitic bivalves such as *Tawera.*

G- Strongly cross-bedded pebbly shelly limestone rich in biomoulds of aragonitic infaunal bivalves.

mud	silt			sand			gravel			
	fine	med.	coarse	fine	med.	coarse	granu.	pebb.	cobb.	bould.

Stratigraphic Column No: 139
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Oreka Station, beside track at back of farm, near stock yards (31 Jan. 2003)
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2825819 -
N: 6181113 -
Altitude: 91m -

Author: R. Baggs

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Waipatiki Limestone Member	6				C2	Cross-bedded pebbly limestone, well cemented with common biomoulds.
	5					
					M1	Trough cross-bedded shelly sand with liquifaction structures and greywacke pebbles.
	4				C2	Pebbly limestone with common biomoulds, very well cemented.
					M1	Cross-bedded shelly sand.
	3				C2	Coarse grained, grey/beige pebbly limestone, cross-bedded with common biomoulds.
	2				C1	Tawera sp. dominated pebbly shell bed, becoming more cemented up the unit.
	1				M1 C2	Well sorted fine shelly sand, laminated.

mud | silt: fine, medium, coarse | sand: fine, medium, coarse | gravel

Stratigraphic Column No: 140
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Castlehill forest track cutting at cross roads in forest
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2823933 -
N: 6183137 -
Altitude: 239m -

Author: R. Baggs

NZMS 260 V21

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Devils Elbow Mudstone Member	9		≠		S4	Non fossiliferous, massive silty sand.
Petane Formation / Waipatiki Limestone Member	8		≠		C1	Grey, well cemented, pebbly limestone. Articulated *Paphies sp.*? *Tawera* sp. dominated, some *Ostrea*
	7		≠		M1	Massive fine grained sand, articulated *Tawera* sp. and *Tisostrea*.
	6		=			Fine well cemented laminated mud.
	5				C1	*Tawera* sp. dominated shell bed in shell hash matrix.
					M1	Shelly , cemented fine grained cross-bedded sand.
	4				M1	Cemented shelly sand, fine grained with very low angle cross-bedding and burrows.
			≠		C1	*Tawera* sp. dominated pebbly shellbeds and *Tisostrea* with well cemented shelly sand between shell beds. concentrations
	3				C2	Grey biomoulded limestone, bidirectional cross-bedding becomes low angle down section. *Tawera* sp. dominant with some *Crepidula radiata* and *Tisostrea.*
	2				C2	
	1		≠		M1	Very fine, shelly non cemented massive sand with thin white mud layer.

mud | fine | medium | coarse silt | fine | medium | coarse sand | gravel

Stratigraphic Column No: 141
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Forest on Puketautahi Hill, on track leading to Oreka (07 Feb. 2003)
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2823655 -
N: 6181987 -
Altitude: 193m -

Author: R. Baggs

NZMS 260 V21

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Devils Elbow Mudstone Member	2				S5	Grey weakly calcareous mud.
Petane Formation / Waipatiki Limestone Member					M1	Gastropod rich shell bed. *Zethalia zelandica* dominates.
					S2	Interbedded fossiliferous well sorted laminated sand and grey weakly calcareous mud.
	1				M1	
					S3	
					S2	
					S2	Interbedded calcareous mud and greywacke gravel
					S3	
					M1	Gastropod rich shell bed. *Zethalia zelandica* dominates, some bivalves, barnacle plates and rare *Stiracolpus* sp.
					S4	Well sorted, non calcareous massive sand, laterally grading into gravel.
					S1	Gravel with a non calcareous sandy matrix.

mud | fine | medium | coarse (silt) | fine | medium | coarse (sand) | gravel

Stratigraphic Column No: 142

Section:

GPS Waypoint No(s):

Region: Central Hawkes Bay

Location: Forest on Puketautahi Hill, track leading to Oreka, 2m from 65a (07 Feb. 2003)

NZMS 260 Sheet: V21

Grid Reference:	Top	Bottom
E:	2823621	-
N:	6181960	-
Altitude:	185m	-

Author: R. Baggs

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Waipatiki Limestone Member	1				S3	Interbedded non calcareous laminated sand with very calcareous mud.
					M2	Calcareous silt with *Zethalia zelandica* dominated shell concentrations and some bivalves.
					M2	
					S3	

mud | fine | medium | coarse (silt) | fine | medium | coarse (sand) | gravel

Stratigraphic Column No: 143
Section:
GPS Waypoint No(s):
Region: Central Hawkes Bay
Location: Castlehill Forest
NZMS 260 Sheet: V21

Grid Reference: Top Bottom
E: 2823365 -
N: 6181839 -
Altitude: 220m -

Author: R. Baggs

NZMS 260 V21

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Stratigraphic Unit	Thickness (m)	Lithology	Structures	Fossils	Facies code	Description
Petane Formation / Waipatiki Limestone Member	3				C2	Cross-bedded sandy limestone.
	2		=		M1	Weakly cemented, well sorted shelly sand with mud stringers.
					C2	Moderately cemented, pebbly sandy limestone.
						Trough cross bedded, weakly cemented pebbly sand.
					M1	Well sorted, cross-bedded shelly sand with, mud stingers.
	1		=		M1	Laminated sand with mud stringers.
					M1	Cross-bedded shelly sand.
					M1	Well sorted, cross-bedded shelly sand. *Tawera* sp., *Crepidula radiata*, *Amalda* sp. *Sigapettela.*

mud | fine | medium | coarse (silt) | fine | medium | coarse (sand) | gravel

Stratigraphic Column No: 144 **Grid Reference:**

	Top	Bottom
E:	2819493	2819387
N:	6184873	6184658
Altitude:	318 m	269 m

GPS Waypoint No(s): Wp 700 and 702

Region: Sherenden

Location: Tunanui Station on southeastern face of Flag Range near poplars

NZMS 260 Sheet: V21 Napier

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Author: K. Bland

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group / Petane Formation/Flag Range Conglomerate Member	30		B	MX_3			Bed of tightly-packed oyster valves in a pebbly sandy matrix. Pebble content and size increases dramatically up-section. Large bryozoan clusters up to 0.07-0.08 m-across are present in places.
			29		C				Differentially cemented beds 0.02-0.1 m thick, stacked in planar to cross-bedded pattern. Larger greywacke pebbles to 25 mm present, more common than below. Abundant biomoulds, *Ostrea* valves present.
			28		F		WP 700		Massive to trough cross-bedded sandy limestone. Very abundant biomoulds, scattered greywacke granules. Burrows present between layers. "Wedges" of limestone up to 0.2 m-thick present.
			27			BC_7			
			26						Massive to trough cross-bedded sandy limestone. Very abundant biomoulds, scattered greywacke granules.
			25			BC_6			Trough cross-bedded sandy limestone. Moderately well cemented, coarse grained pebbly limestone with abundant greywacke granules.
		Petane Formation/Mairau Mudstone Member	24						
			22						
			18						
			16		A				
			14						
			12						
			11						
			10						
			8						
			6						
			4						
			2			S_4			Orange-brown, finely laminated, non cemented sandy siltstone. Abruptly overlies conglomerate.
		Okauawa Fmn	1				WP 702		
						Cg_1			Massive, moderately well sorted fining-upwards grewacke conglomerate. Clasts granule to cobble size (up to 0.08 m across). Becomes more pebble-dominated in upper parts.

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

A

B

C

D

Stratigraphic Column No: 145	Grid Reference:	Top	Bottom
Section: F1	E:	2818400	-
GPS Waypoint No(s):	N:	6184500	-
Region: Central Hawkes Bay	Altitude:		-
Location: Flag Range			
NZMS 260 Sheet: V21		**Author:** V.Caron	

NZMS 260 V21

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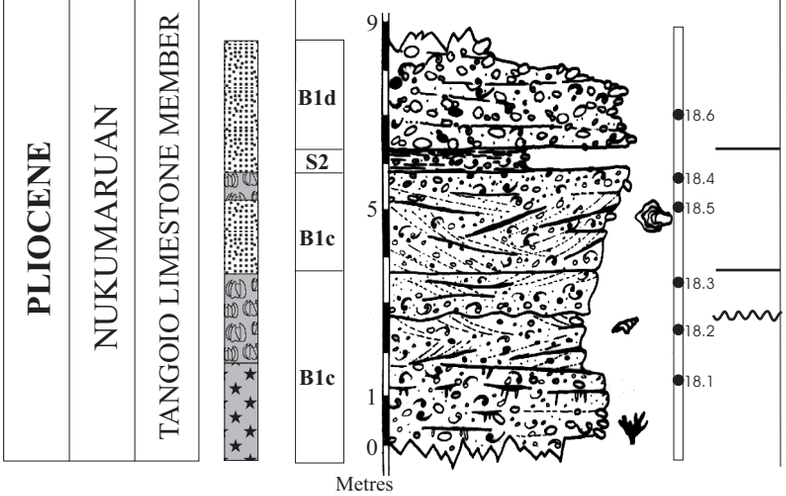
Section: F1 (45)
Locality: Flag Range
Grid reference: V21/184845



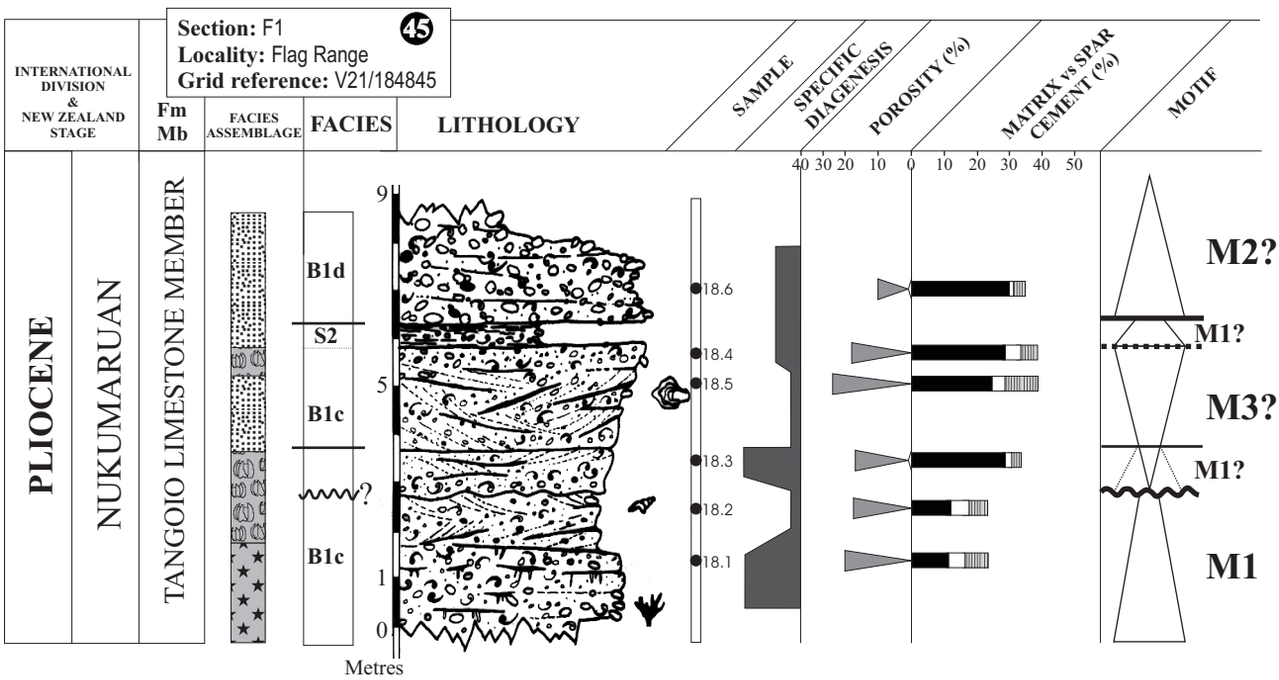
Conglomeratic bed consisting of oysters and Torlesse pebbles up to 10 cm across, encrusted by multilaminar bryozoans, and drowned within a muddy carbonate matrix.

Planar to trough cross-bedded, coarsening-upwards, shelly and pebbly mixed carbonate-siliciclastic facies.

Micropebbly skeletal packstone/grainstone displaying internal bi-directional cross-stratifications.

Conglomeratic massive bed containing abundant Torlesse pebbles up to 5 cm across, clumps of oysters, unidentified bivalves and robust branching bryozoans.

Stratigraphic Column No: 145	Grid Reference:	Top	Bottom	NZMS 260 V21
Section: F1	E:	2818400	-	**145**
GPS Waypoint No(s):	N:	6184500	-	
Region: Central Hawkes Bay	Altitude:		-	2 of 2
Location: Flag Range				
NZMS 260 Sheet: V21			**Author:** V.Caron	



Stratigraphic Column No: 146 | **Grid Reference:** | **Top** | **Bottom** | NZMS 260 V21

GPS Waypoint No(s): Wp 5b | **E:** 2818700

Region: Sherenden | **N:** 6282700

Location: Taihape Road immediately south of Flag Range Road intersection. | **Altitude:** - | -

NZMS 260 Sheet: V21 Napier | *Page* 1 *of* 1 | **Author:** K. Bland

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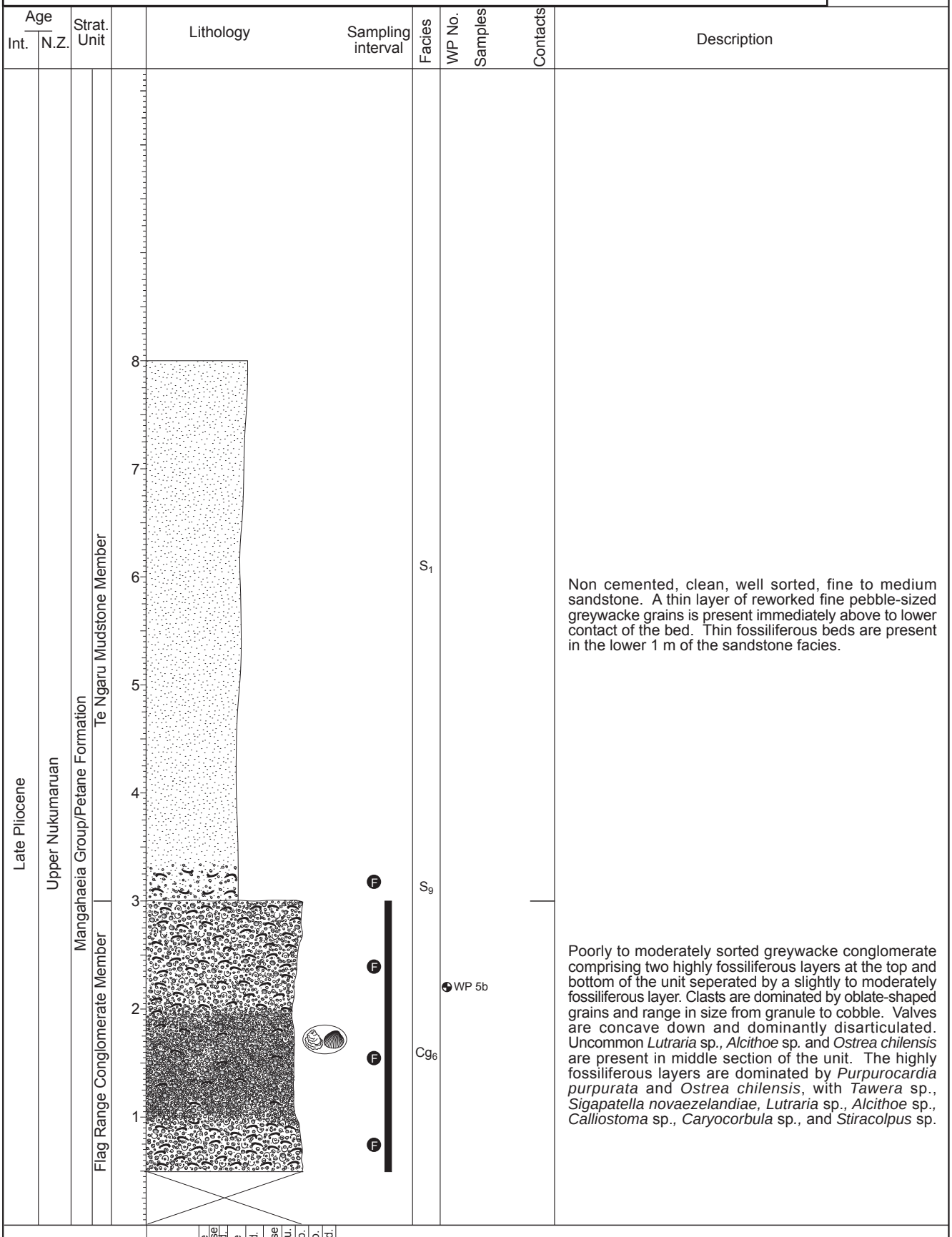

Non cemented, clean, well sorted, fine to medium sandstone. A thin layer of reworked fine pebble-sized greywacke grains is present immediately above to lower contact of the bed. Thin fossiliferous beds are present in the lower 1 m of the sandstone facies.

Poorly to moderately sorted greywacke conglomerate comprising two highly fossiliferous layers at the top and bottom of the unit seperated by a slightly to moderately fossiliferous layer. Clasts are dominated by oblate-shaped grains and range in size from granule to cobble. Valves are concave down and dominantly disarticulated. Uncommon *Lutraria* sp., *Alcithoe* sp. and *Ostrea chilensis* are present in middle section of the unit. The highly fossiliferous layers are dominated by *Purpurocardia purpurata* and *Ostrea chilensis*, with *Tawera* sp., *Sigapatella novaezelandiae, Lutraria* sp., *Alcithoe* sp., *Calliostoma* sp., *Caryocorbula* sp., and *Stiracolpus* sp.

Stratigraphic Column No: 147 ***Grid Reference:*** ***Top*** ***Bottom***

GPS Waypoint No(s): Wp 838 ***E:*** 2812410 -

Region: Whanawhana ***N:*** 6177310 -

Location: Kikowhero Stream, Whakamarumaru Station ***Altitude:*** 180 m -

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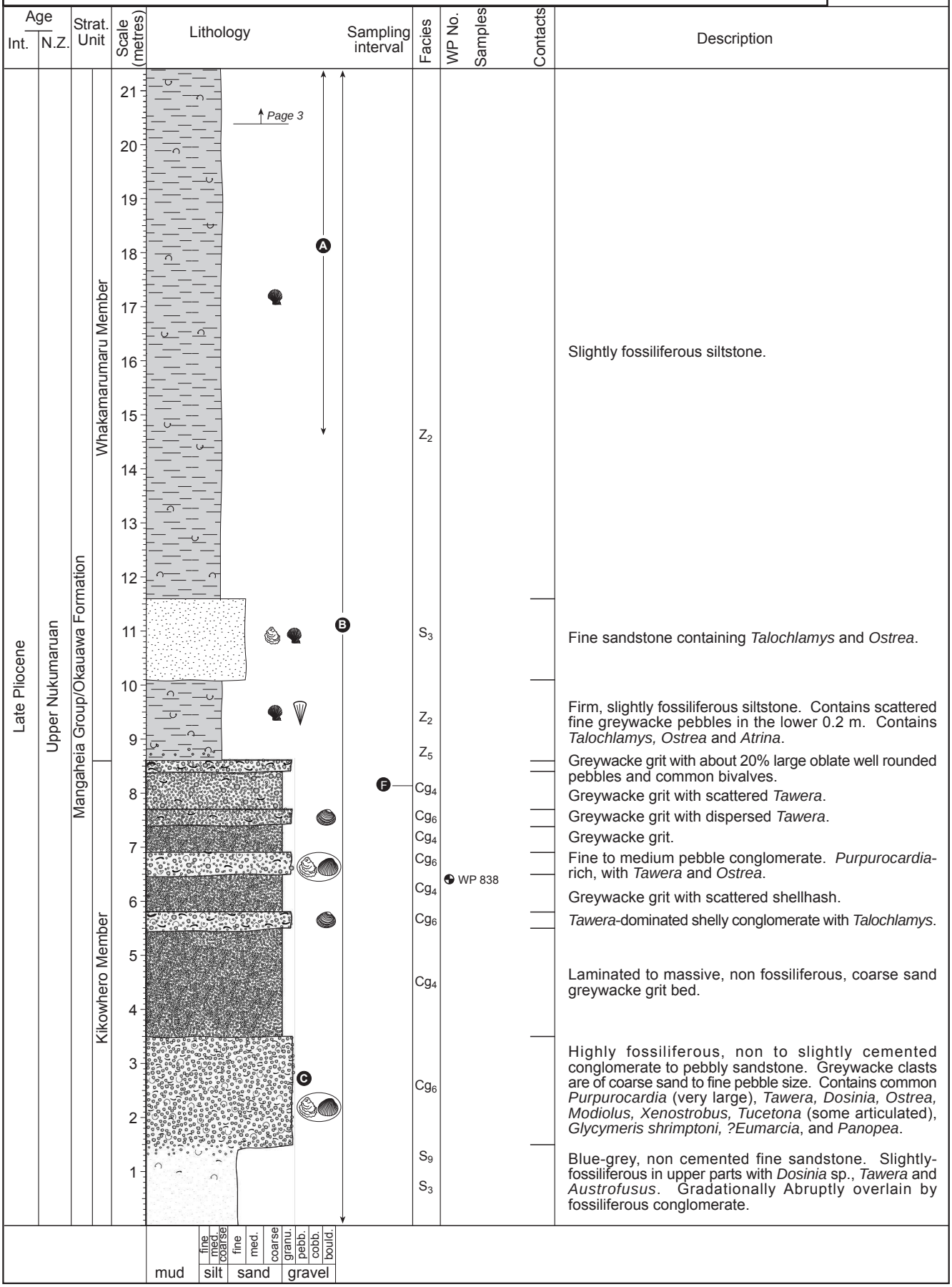

Stratigraphic Column No: 147 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 838 | **E:** 2812410 | -

Region: Whanawhana | **N:** 6177310 | -

Location: Kikowhero Stream, Whakamarumaru Station | **Altitude:** 180 m | -

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group/Okauawa Formation / Whakamarumaru Member	41–21		Page 3	Cg_1			Non fossiliferous greywacke conglomerate.
									Non fossiliferous fine to medium sandstone.
						S_1			Non fossiliferous fine to medium sandstone.
							WP 149		
						S_6			
						Z_9			Siltstone grades into overlying sandstone through about 3 m of alternating siltstone-sandstone beds.
						Z_2			Slightly fossiliferous siltstone.

mud | silt: fine, med., coarse | sand: fine, med., coarse | gravel: granu., pebb., cobb., bould.

Stratigraphic Column No: 147 | **Grid Reference:** | **Top** | **Bottom**

GPS Waypoint No(s): Wp 838 | **E:** 2812410 | -

Region: Whanawhana | **N:** 6177310 | -

Location: Kikowhero Stream, Whakamarumaru Station | **Altitude:** 180 m | -

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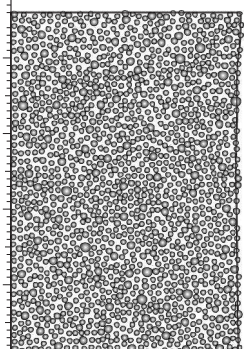
Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Nukumaruan	Mangaheia Group/Okauawa Fmn, Whakamarumaru Member	48–41	Page 3 	A	Cg_1			Non fossiliferous greywacke conglomerate.

mud | silt (fine, med., coarse) | sand (fine, med., coarse) | gravel (granu., pebb., cobb., bould.)


A


B


C