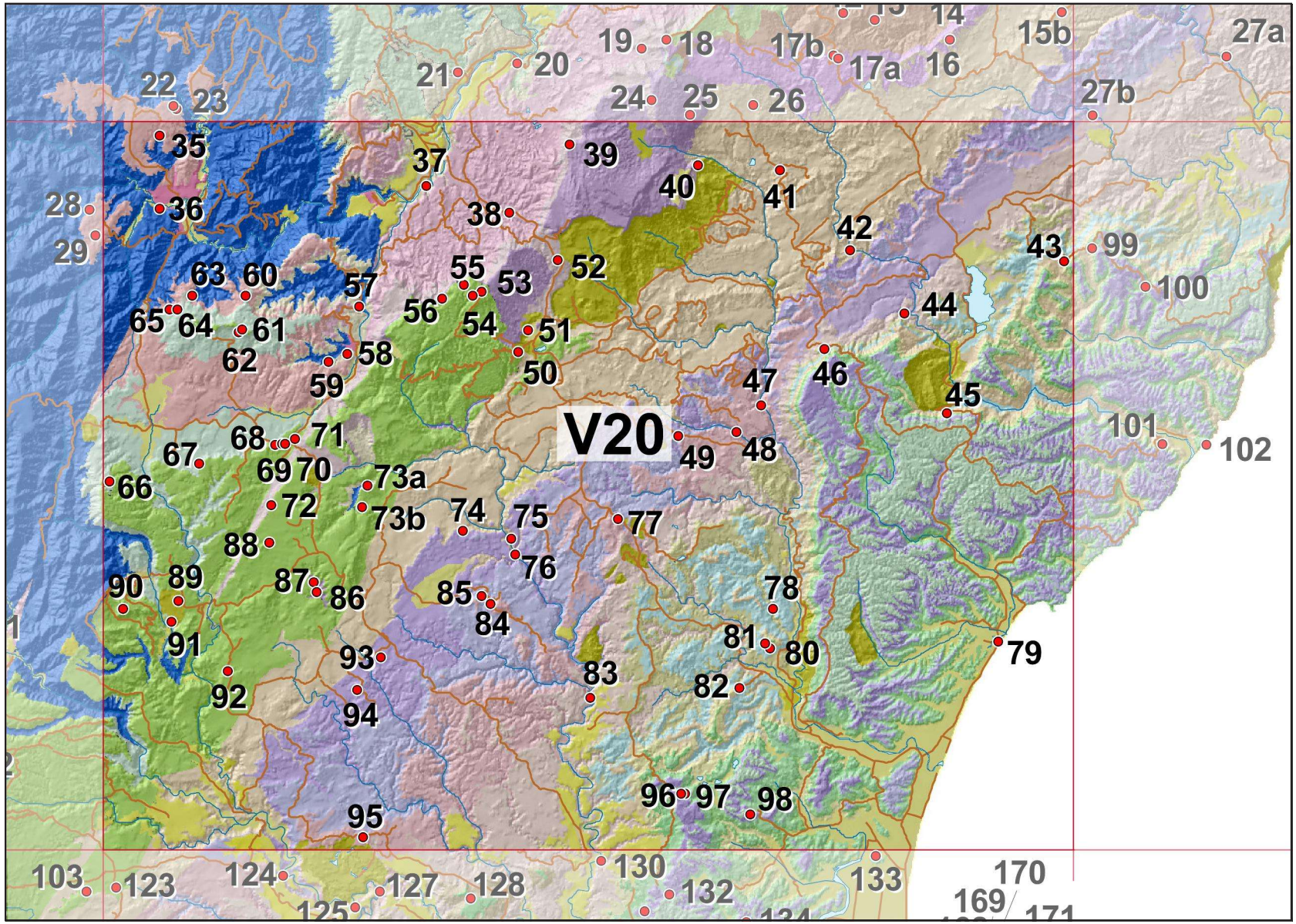

Fig. 7. Map showing location of stratigraphic columns within NZMS 260 Sheet V20.

Stratigraphic Column No: 91 | *Grid Reference:* | *Top* | *Bottom*

GPS Waypoint No(s): Wp 956 | *E:* 2812814 | -

Region: Hawkston | *N:* 6199510 | -

Location: Hawkston Lake, Hawkston Station | *Altitude:* 333 m | -

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Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No.	Samples	Contacts	Description
Pliocene	Mangapanian	Mangaheia Group / Te Waka Formation	1–10		A C; F; B D	BC_6	WP 956			Massive to weakly laminated, moderately to well cemented shellhash pebbly limestone with abundant whole shells. Barnacle plates are fragmented and abundant. Pebbles are of granule to fine pebble size, greywacke composition and well rounded, lensoidal to spheroidal shapes. Common *Crassostrea ingens*, *Phialopecten triphooki* and *Patro undatus* are present throughout the unit.
										Barnacles commonly attached to shells, and more rarely pebbles.
										Stacked 2-5 cm thick pebbly shellhash bodies arranged in cross-straified to laminated patterns. Some broad, low-angle trough cross-bedding is evident. Contains common *Phialopecten thomsoni*.

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

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Stratigraphic Column No: 92 | **Grid Reference:** | **Top** | **Bottom** | NZMS 260 V20

GPS Waypoint No(s): Wp 159-162 | **E:** 2815291 | 2815135

Region: Hawkeston | **N:** 6197221 | 6197454 | **92**

Location: Road cuttings up Price Cockburn Road at "The Incline" | **Altitude:** 394 m | 385 m

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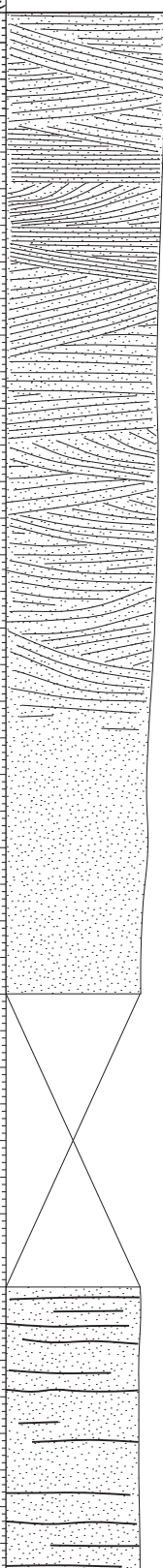
Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Mangapanian	Mangaheia Group / Te Waka Formation	10–1			S_2			Well sorted, cross-bedded fine sandstone. This unit is bioturbated and burrowed. Burrows are infilled by finer-grained sediment. Mudstone stringers are present capping some of the foresets.
						S_1	WP 160		Intensely bioturbated, clean, well sorted fine to medium sandstone. Burrows are filled by finer-grained siltstone.
						S_7	WP 159		Clean, well sorted, non cemented fine to medium sandstone with occasional thin mudstone stringers.

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

Stratigraphic Column No: 92 | **GPS Waypoint No(s):** Wp 159-162 | **Region:** Hawkeston | **Location:** Road cuttings up Price Cockburn road at "The Incline" | **NZMS 260 Sheet:** V20 Esk

Grid Reference:	Top	Bottom
E:	2815291	2815135
N:	6197221	6197454
Altitude:	394 m	385 m

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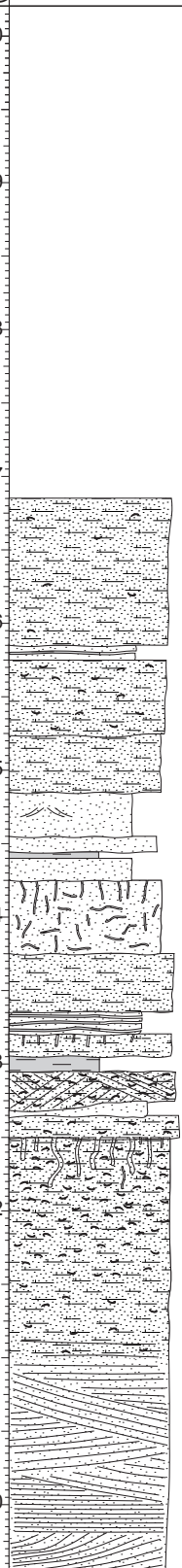
Age Int.	Age N.Z.	Strat. Unit	Scale (metres)	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Mangapanian	Mangaheia Group / Te Waka Formation	20–10			S_5/ MX_1			Slightly to moderately cemented shellhash-rich calcareous sandstone with few intact macrofossils visible
						MX_1	WP 162		
							WP 161		Strongly burowed, slightly to highly fossiliferous shellhash-rich sandstone. Many shallow-water faunas are present including *Zethalia ?coronata* (dominant in a highly fossiliferous shellbed), *Fellaster*, *Dosinia* sp. and other fragmented bivalves.
						S_3			

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

Stratigraphic Column No: 93 | **GPS Waypoint No(s):** Wp 202 | **Region:** Patoka | **Location:** Gravel pit off Waihau Road near Puketitiri Road. | **NZMS 260 Sheet:** V20 Esk

Grid Reference:	Top	Bottom
E:	2821431	-
N:	6198020	-
Altitude:	278	-

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Age Int.	Age N.Z.	Strat. Unit	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Upper Mangapanian	Mangaheia Group/Matahorua Formation — Papakiri Member		7	Cg_1/ Cg_3			Well sorted, massive to laminated, slightly cemented greywacke conglomerate. Clasts range from granule to fine pebble in size, and are well-rounded and spheriodal in shape.
		Trelinnoe Member		4	S_9	WP 202		Clean, well sorted fine to medium sandstone with common thin (<0.03 m thick) siltstone stringers and common greywacke conglomerate lenses. The conglomerate lenses are up to 0.5 m thick, and up to several metres in length, though average 15cm in thickness and <1.5 m in length. Gravel clasts are well sorted and well rounded, averaging 12 mm in diameter, though may be up to 40 mm across. Spherical shaped grains dominate, though oblate clasts are present. The sandstone commonly displays low-angle, small-scale trough cross-bedding, as well as laminations. Portions of the sandstone also contain common scattered greyewacke pebbles, and thin beds of mudstone rip-up clasts which are up to 70 mm in diameter.
				1	S_1			

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

Stratigraphic Column No: 94 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 205-207 **E:** 2820521 2820468

Region: Patoka **N:** 6196749 6196666

Location: Farm track below trig on Cascades Farm off Waihau Road **Altitude:** 355 m 311 m

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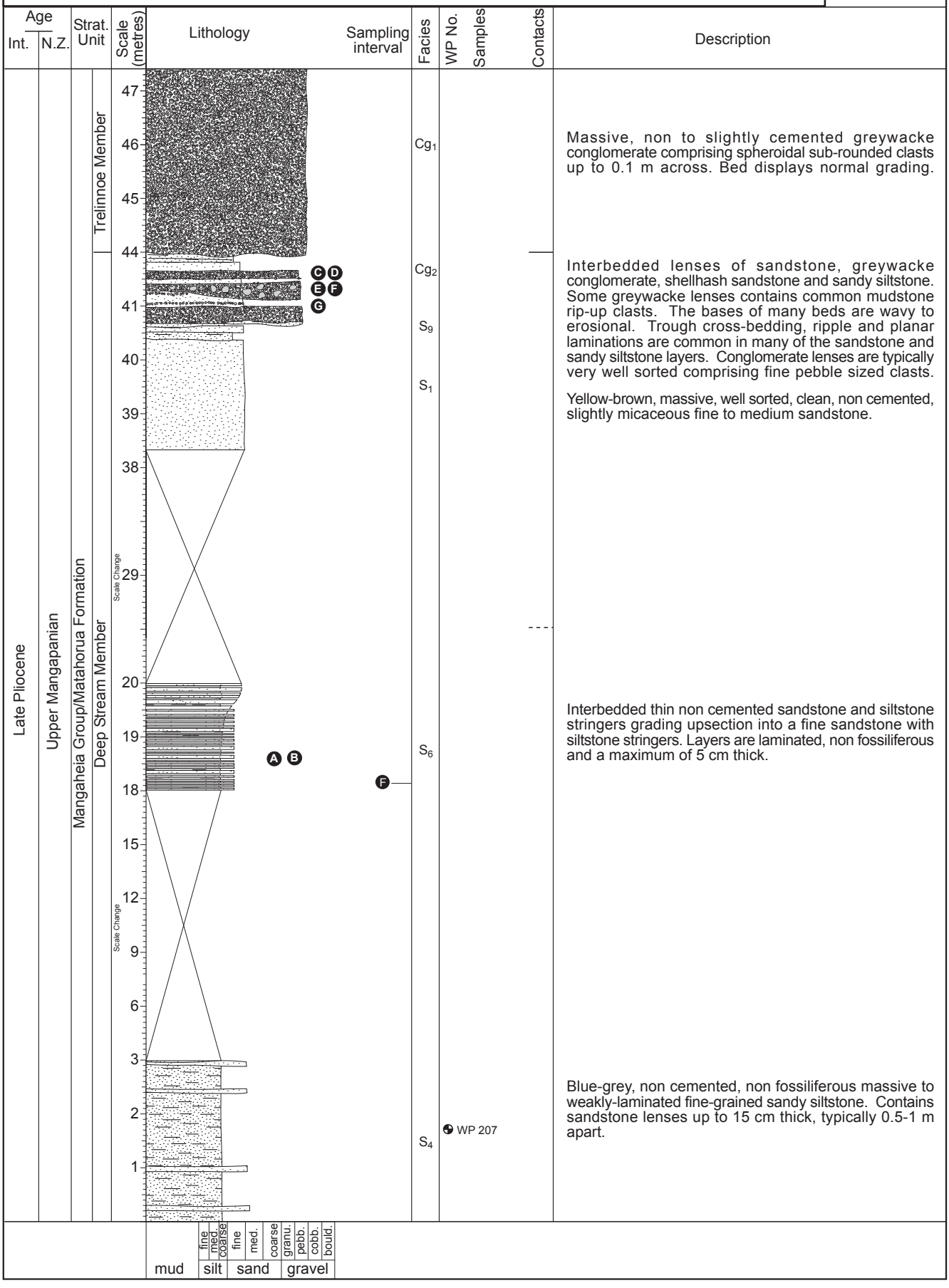

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Stratigraphic Column No: 95 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 21 **E:** 2813950

Region: Waihau **N:** 6205900

Location: Cutting on Waihau Road near Te Puna Farm **Altitude:** - -

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Age Int.	Age N.Z.	Strat. Unit	Lithology	Sampling interval	Facies	WP No. Samples	Contacts	Description
Late Pliocene	Lower Nukumaruan	Mangaheia Group	Esk Mudstone					
			Matahorua Formation/Grassy Knoll Conglomerate Member		S_4			Non cemented sandy siltstone.
					Cg_6			Slightly to highly fossiliferous greywacke conglomerate. Most of the bed is slightly to moderately fossiliferous, with 0.2 m thick highly fossiliferous beds at the interfaces between sandstone and conglomerate facies. *Ostrea chilensis* dominates the faunal content, with *Purpurocardia purpurata, Caryocorbula* sp. and *Lutraria* sp. also present. Some *Ostrea* valves were found to be encrusted with barnacles.
					Z_1			Blue-grey, non cemented, slightly weathered sandy siltstone.
					S_4			Moderately fossiliferous silty sandstone grading upward into slightly fossiliferous silty sandstone with rare scattered greywacke pebbles.
					S_9			
					Cg_6	WP 21 KJB 4		Non fossiliferous greywacke conglomerate bed passing upsection into a highly fossiliferous greywacke conglomerate. Metre-scale relief is present on the lower boundary of this unit.
					Cg_1			Tan, non cemented, clean, well sorted fine to medium siliciclastic sandstone. Base of the sandstone is not exposed.
					S_1			

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

Stratigraphic Column No: 96 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 222-230 **E:** 2834045 2833813

Region: Glengarry **N:** 6189871 6192389

Location: Matches farm above Glengarry Road and near "The Gums" **Altitude:** 319 m 308 m

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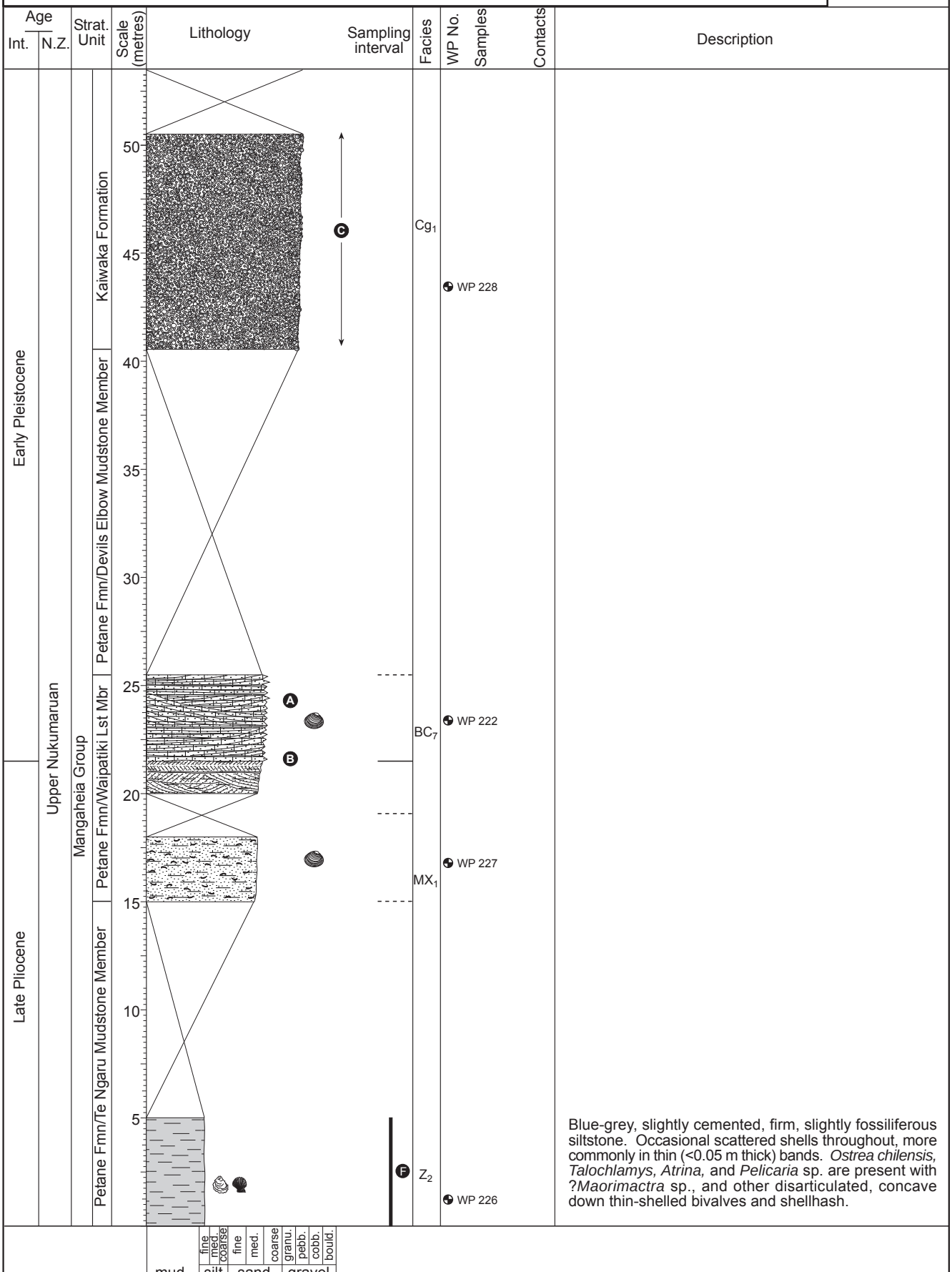

Blue-grey, slightly cemented, firm, slightly fossiliferous siltstone. Occasional scattered shells throughout, more commonly in thin (<0.05 m thick) bands. *Ostrea chilensis, Talochlamys, Atrina,* and *Pelicaria* sp. are present with ?*Maorimactra* sp., and other disarticulated, concave down thin-shelled bivalves and shellhash.

Stratigraphic Column No: 96 | **GPS Waypoint No(s):** Wp 222-230 | **Region:** Glengarry | **Location:** Matches farm above Glengarry Road and near "The Gums" | **NZMS 260 Sheet:** V20 Esk, V21 Napier

Grid Reference:	Top	Bottom
E:	2834045	2833813
N:	6189871	6192389
Altitude:	319 m	308 m

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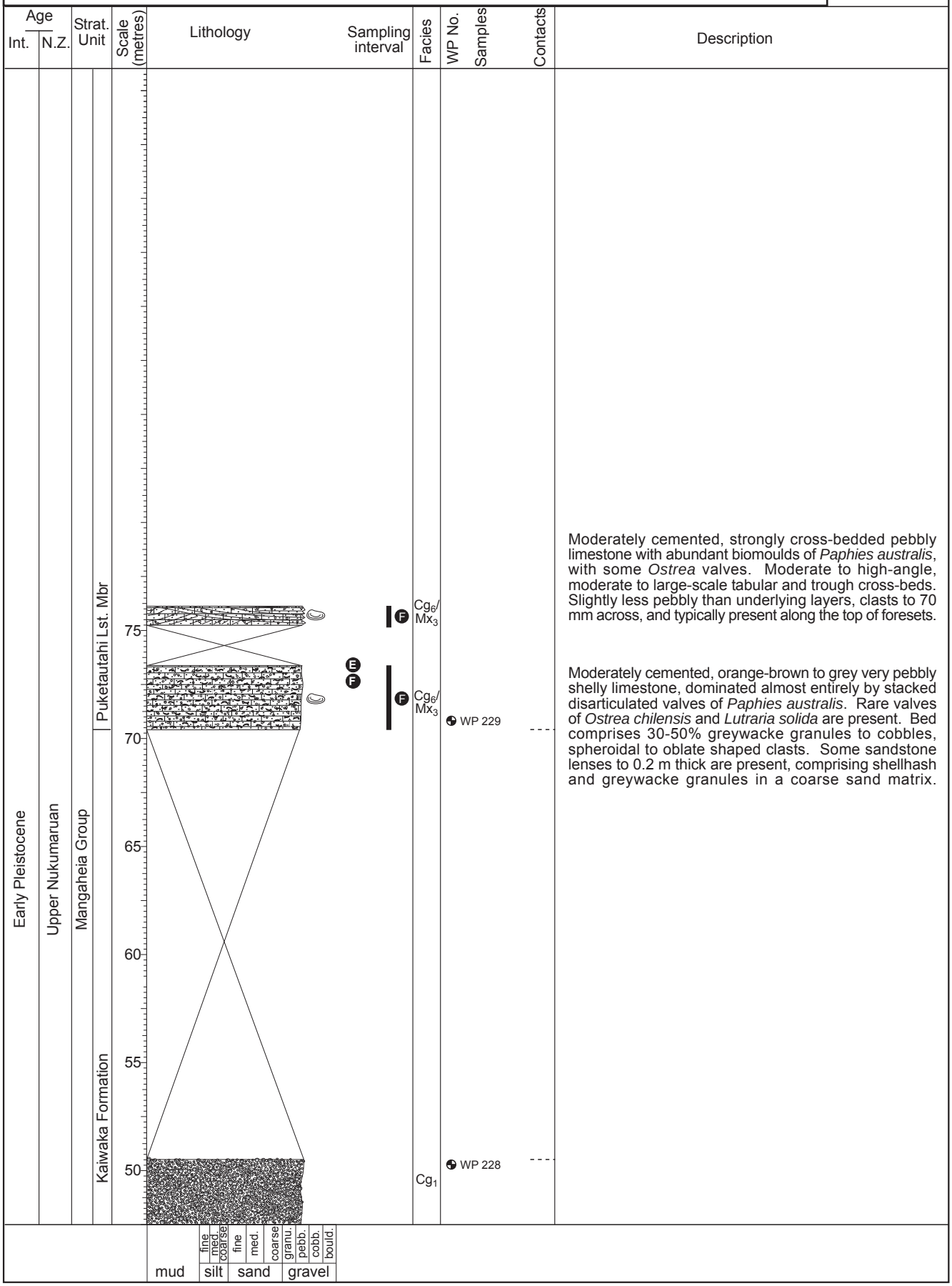

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Stratigraphic Column No: 97 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 222 and 226 **E:** 2833813 2833980

Region: Glengarry **N:** 6192389 6192389

Location: Awanui Farm off Glengarry Road, cuttings in farm track and hillsides **Altitude:** 308m 278m

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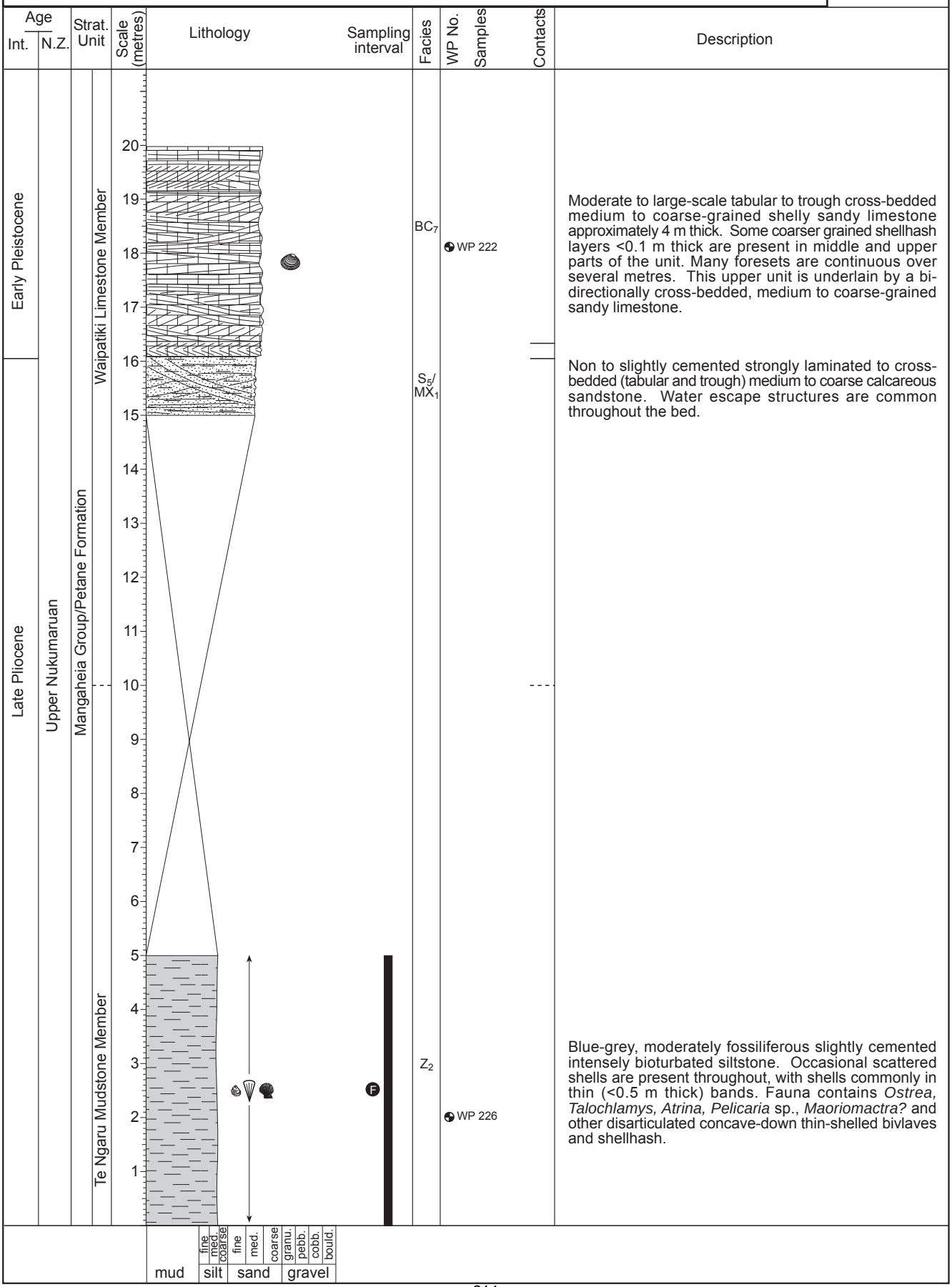

Stratigraphic Column No: 98 **Grid Reference:** **Top** **Bottom**

GPS Waypoint No(s): Wp 351-352 **E:** 2836612 2836660

Region: Eskdale **N:** 6191521 6191555

Location: Quarry in forest above Hedgely Station **Altitude:** 283m 243m

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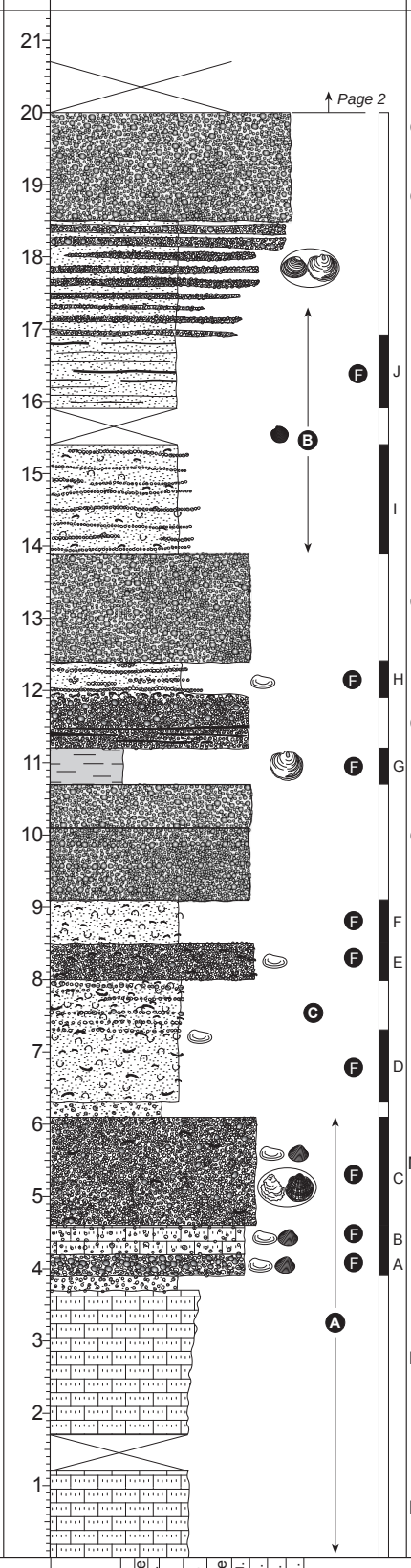
Age Int.	Age N.Z.	Strat. Unit	Description
Early Pleistocene	Upper Nukumaruan	Mangaheia Group / Kaiwaka Formation	
			Laminted sandstone as below, with abundant siltstone stringers to 0.3 m thick, averaging 0.05-0.1 m. This unit passes upward into a more laminated and cross-bedded unit, with sharp-based conglomerate stringers (generally 0.15-0.3 m thick) and pebbles on cross-bed foresets. Valves of *Patro undatus* are present in this pebbly zone. Above this conglomerate beds become more poorly-sorted before passing into a massive pebble to cobble greywacke conglomerate bed with clasts up to 0.2 m across (rare). This unit displays a coarsening upwards trend throughout.
			Well sorted, non cemented fine to medium sandstone with common thin greywacke pebble bands and specimens of *Sigapetella novazelandiae* and *Dosinia* (*subrosea?*).
			Fine-grained greywacke conglomerate bed with a muddy matrix. sharply overlying sandstone pebbly sandstone bed. Parallel bedded to low-angle, moderate-scale trough cross-bedded.
			Very well sorted greywacke conglomerate bed containing common siltstone lenses and stringers. Rapidly overlain by well sorted, fine to medium sandstone with common pebble lenses and stringers, and *P. australis* valves.
			Finely laminated siltstone containing valves of *Patro undatus*. Sharply overlies underlying conglomerate bed.
			Well sorted, laminated graunle to fine pebble slightly shelly greywacke conglomerate bed. Overlain by slightly shelly non cemented greywacke conglomerate with large-scale, moderate angle cross-bedding.
			Moderately cemented sandy siltstone containing abundant well rounded coarse sand to medium pebble-sized greywacke clasts. Overlain by poorly cemented rock fragment-dominated olive-brown, highly fossiliferous fine to medium sandstone. Faunal content is dominated by *P. australis, T. subsulcata, X. huttoni* and *S. novaezelandiae*. In turn overlain by granule to fine pebble-sized greywacke conglomerate bed. Common *Sigapetella novaezelandiae* and *P. australis*.
			Moderately cemented pebbly limestone containing well sorted, well-rounded fine pebble-sized greywacke clasts. Abundant *P. australis*, with *T. subsulcata* and shell hash. Overlain by non cemented laminated moderately fossiliferous greywacke conglomerate, well-rounded granule to coarse pebble-sized clasts averageing 20 mm across. Macrofauna are *P. australis* dominated.
			Non cemented shelly greywacke conglomerate containing well rounded, well sorted oblate to lensoidal clasts averaging 5-10 mm across, rarely to 40 mm across. Shell hash dominated, with common intact *P. australis, T. subsulcata* and *Cominella* sp.
			Well cemented, hard, recrystallised orange-brown sandy limestone with abundant biomoulds. The unit coarsens up through the section into a more shelly limestone. This bed is sharply overlain by a 0.2 m thick moderately cemented highly pebbly sandstone. Clasts are moderately sorted and well rounded.
			Moderately cemented, case hardened, orange-brown, fine-grained sandy limestone dominated by shelly sandstone. Massive to weakly laminated with visible reprecipitated calcite.



Stratigraphic Column No: 98 | **Grid Reference:** | **Top** | **Bottom** | NZMS 260 V20

GPS Waypoint No(s): Wp 351-352 | **E:** 2836612 | 2836660 | **98**

Region: Eskdale | **N:** 6191521 | 6191555

Location: Quarry in forest above Hedgely Station | **Altitude:** 283m | 243m

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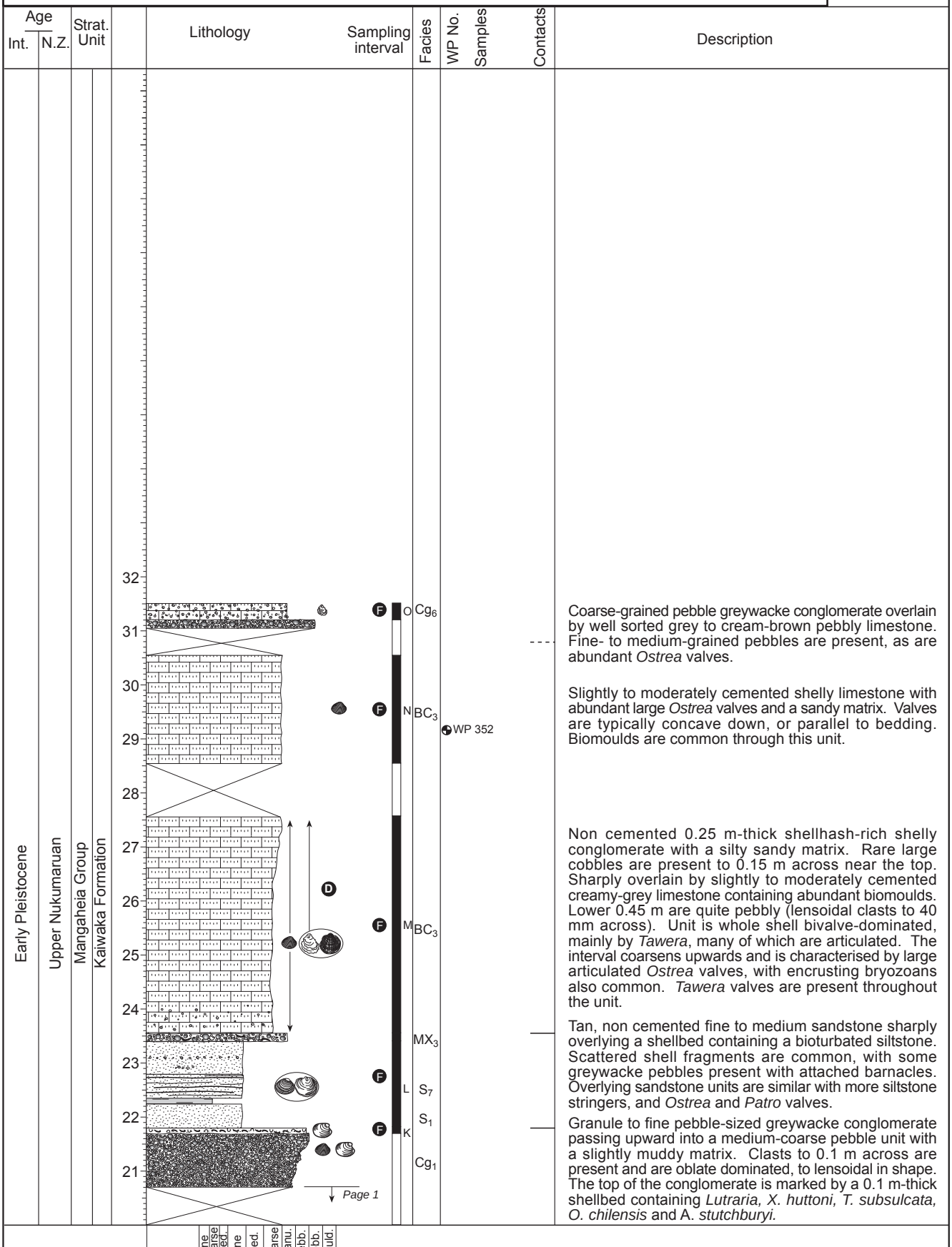

A- Very pebbly sandstone dominated by shellhash with some intact *Paphies australis, Tawera subsulcata, Cominella* sp., and *?Dosinia*.

B- Pebbly limestone containing abundant *Paphies australis*, with *Tawera subsulcata* and shellhash.

C- Moderately fossiliferous greywacke conglomerate containing *Paphies australis, Sigapetella novaezelandiae, Amalda* sp., *Tucetona laticostata, Tawera subsulcata* and gastropoda spp.

D- Highly fossiliferous fine to medium sandstone with common *Paphies australis, Tawera subsulcata, Sigapetella novaezelandiae* and some *Xenostrobus huttoni, Tucetona laticostata* and *Dosinia subrosea*.

E- Fine-grained greywacke conglomerate containing common *Sigapetella novaezelandiae* and some *Paphies australis*.

F- Fine to medium sandstone containing common *Sigapetella novaezelandiae*, with some *Crepidula radiata* and *Maorimactra* sp.?

G- Strongly laminated siltstone containing valves of *Patro undatus*.

H- Siliciclastic-dominated sandstone with a high calcareous fraction containing common *Paphies australis.*

I- Fine to medium sandstone with *Sigapetella novaezelandiae* and *Dosina* sp.

J- Laminated to cross-bedded sandstone with common siltstone and conglomerate stringers containing valves of *Patro undatus*.

K- 0.1 m-thick shellbed capping greywacke conglomerate bed. *Lutraria solida, Xeonstrobus huttoni, Tawera subsulcata, Ostrea chilensis* and *Austroveus stuchburyi* are present in this shellbed.

L- Fine to medium sandstone with common siltstone and greywacke pebble stringers. Articulated and disarticulated *Patro undatus* and *Ostrea chilensis* are present, as are common intact barnacles, some of which are attached to greywacke pebbles and oyster valves. Rare *Paphies australis* are also present, and the upper part of this unit is shellhash dominated.

M- Biomouldic, whole bivalve shell-dominated limestone. *Tawera subsulcata*, some of which may be articulated, dominates the faunal content. Upper parts of the unit contain common, very large articulated and disarticulated *Ostrea chilensis*. Encrusting bryozoans are also present.

N- Whole-shell dominated limestone, biomould rich, with abundant large *Ostrea chilensis* valves that are both disarticulated and articulated.

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O- Well cemented pebbly limestone containing abundant *Ostrea chilensis* valves.

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