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Engineering Log - Borehole

Borehole ID.	***BH1024***
sheet:	1 of 3
project no.	***GEOTLCOV24443AA***
client: ***Roads and Maritime Services NSW***	date started: ***21 Jun 2012***
principal:	date completed: ***21 Jun 2012***
project: ***HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)***	logged by: ***JR***
location: ***Approximate Ch 41,420m***	checked by: ***MF***

position: E: 506113; N: 6708346 (MGA94 Zone 56) surface elevation : 11.80m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 6 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T CASING		Not Observed	SPT 3, 3, 5 N*=8	11	1		CH	**FILL: CLAYEY SAND**: fine to coarse, orange-brown, low plasticity fines, trace fine to medium grained sub-angular gravel.	M			**FILL**
								FILL: CLAYEY GRAVELLY SAND: fine to coarse, orange brown, medium plasticity fines, fine sub-angular gravel.	<Wp	H		**RESIDUAL SOIL**
								CLAY: high plasticity, pale grey to pale brown, mottled orange, trace of fine grained angular sandstone gravel.			>>	
			SPT 9, 16/12mm N*=R	10 9 8	2 3 4			**SANDSTONE**: pale orange brown, extremely weathered to highly weathered, recovered as sandy gravelly clay.				**WEATHERED ROCK**
			SPT 9/50mm N*=R	7 6 5 4	5 6 7			Borehole BH1024 continued as cored hole			>>	

CDF_0_9_04AD.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 08:59

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear peak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	***BH1024***
sheet:	2 of 3
project no.	***GEOTLCOV24443AA***
client: ***Roads and Maritime Services NSW***	date started: ***21 Jun 2012***
principal:	date completed: ***21 Jun 2012***
project: ***HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)***	logged by: ***JR***
location: ***Approximate Ch 41,420m***	checked by: ***MF***

position: E: 506113; N: 6708346 (MGA94 Zone 56) surface elevation : 11.80m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 6 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		11	1								
		10	2								
		9	3								
		8	4		start coring at 4.05m						
NQ3	Not Observed	7	5		**INTERLAMINATED SILTSTONE & SANDSTONE**: siltstone is pale brown, grey and orange, sandstone is fine to medium grained, pale brown to orange, thinly laminated at 0° with some extremely weathered seams (70% siltstone, 30% sandstone)	XW / HW		a=0.60 d=0.01 a=0.63 d=0.15	66%		SM, CL Clay, 80 mm JT closed, 65°, IR, CL Clay CO
		6	6		**SANDSTONE**: fine to medium grained, pale brown, indistinct bedding (0°-5°), trace irregular siltstone laminae	MW			47%		JT, 90°, PL, RO, Fe SN JT, 90°, IR, RO, Fe SN SM, 5°, PL, RO, Clay, 5 mm
		5			**NO CORE:** 0.09 m						
		4	7		**SANDSTONE**: fine to medium grained, pale brown to orange, becoming pale grey, indistinct bedding (0°-5°), trace irregular siltstone laminae	MW SW		a=1.06 d=0.44	35%		

Defects are: PT, 0 - 10°, PL, RO, Fe CN - SN, unless otherwise described

CDF_0_9_04AD.GLB Log COF BOREHOLE: CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 09:43

method & support

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
W	washbore
NMLC	NMLC core (51.9 mm)
NQ	wireline core (47.6mm)
HQ	wireline core (63.5mm)
PQ	wireline core (85.0mm)
SPT	standard penetration test

water

- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL: water pressure test result (lugeons) for depth interval shown

graphic log / core recovery

- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD

- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*

RS	residual soil
XW	extremely weathered
HW	highly weathered
DW	distinctly weathered
MW	moderately weathered
SW	slightly weathered
FR	fresh

*W replaced with A for alteration

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

PT	parting
JT	joint
SZ	shear zone
SS	shear surface
CS	crushed seam
SM	seam
DB	drilling break

roughness

SL	slickensided
POL	polished
SO	smooth
RO	rough
VR	very rough

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	Irregular

coating

CN	clean
SN	stain
VN	veneer
CO	coating

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Engineering Log - Cored Borehole

Borehole ID.	***BH1024***
sheet:	3 of 3
project no.	***GEOTLCOV24443AA***
client: ***Roads and Maritime Services NSW***	date started: ***21 Jun 2012***
principal:	date completed: ***21 Jun 2012***
project: ***HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)***	logged by: ***JR***
location: ***Approximate Ch 41,420m***	checked by: ***MF***

position: E: 506113; N: 6708346 (MGA94 Zone 56) surface elevation : 11.80m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 6 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ3	Not Observed	3	9		**INTERLAMINATED SILTSTONE & SANDSTONE**: sandstone is fine grained, pale grey, siltstone is dark grey, distinct bedding (0°-5°), thinly laminated (60% sandstone, 40% siltstone) *(continued)*	SW		a=0.72 d=0.32	35%		JT sub-vertical, PL, RO, Fe VN - SN, mineral JT, 70°, IR, RO, Mineral VN
						FR		a=0.85 d=1.10			
		2	10								JT sub-vertical, 85°, PL, RO, Mineral VN
		1	11		**SANDSTONE**: fine to medium grained, pale grey, indistinct bedding (0°-5°), trace highly weathered lamination			a=0.35 d=0.04	64%		
						HW					
					SILTSTONE: dark grey, indistinct bedding (0°-5°)	FR					JT, 45°, PL, RO, Mineral VN JT, 45°, PL, RO, Mineral VN
		0	12					a=1.01 d=0.79			
					INTERLAMINATED SILTSTONE & SANDSTONE: siltstone is dark grey, sandstone is fine grained, pale grey, distinct bedding (0°-5°), thinly laminated (70% sandstone, 30% siltstone)			a=1.21 d=1.10			JT, 80°, IR, RO, Mineral VN JT, 75°, PL, RO, Mineral VN
		-1	13					a=1.31 d=1.14			JT, 40°, PL, RO, Mineral VN JT, 60°, PL, RO, Mineral VN JT, 55°, PL, RO, CN
		-2	14						95%		JT, 55°, IR, RO, CN
		-3	15					a=0.95 d=1.10			
					SILTSTONE: dark grey, indistinct bedding			a=1.35 d=1.34			
		-4			Borehole BH1024 terminated at 15.15 m Target depth Grouted upon completion						

Defects are:PT, 0 - 10°, PL, RO, Fe CN - SN, unless otherwise described

CDF_0_9_04AD.GLB Log COF BOREHOLE: CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 09:43

method & support

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
W	washbore
NMLC	NMLC core (51.9 mm)
NQ	wireline core (47.6mm)
HQ	wireline core (63.5mm)
PQ	wireline core (85.0mm)
SPT	standard penetration test

water

10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery

core recovered (graphic symbols indicate material)
no core recovered

core run & RQD

barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*

RS	residual soil
XW	extremely weathered
HW	highly weathered
DW	distinctly weathered
MW	moderately weathered
SW	slightly weathered
FR	fresh

*W replaced with A for alteration

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

PT	parting
JT	joint
SZ	shear zone
SS	shear surface
CS	crushed seam
SM	seam
DB	drilling break

roughness

SL	slickensided
POL	polished
SO	smooth
RO	rough
VR	very rough

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	Irregular

coating

CN	clean
SN	stain
VN	veneer
CO	coating

PointID : BH1024 Depth Range: 4.05 - 13.00 m

drawn	
approved	
date	**25/10/2012**
scale	**N.T.S.**
original size	**A4**

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SPECIALISTS MANAGING THE EARTH

client: Roads and Maritime Services NSW

project: HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)

title: **CORE PHOTOGRAPH BH1024**

project no: GEOTLCOV24443AA | fig no: **FIGURE 1** | rev:

PointID : BH1024 Depth Range: 13.00 - 15.15 m

drawn	
approved	
date	**25/10/2012**
scale	**N.T.S.**
original size	**A4**

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geotechnics
SPECIALISTS MANAGING
THE EARTH

client: Roads and Maritime Services NSW

project: HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)

title: **CORE PHOTOGRAPH BH1024**

project no: GEOTLCOV24443AA | fig no: **FIGURE 2** | rev:

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Engineering Log - Borehole

Borehole ID.	***BH1025***
sheet:	1 of 3
project no.	***GEOTLCOV24443AA***
client: ***Roads and Maritime Services NSW***	date started: ***19 Jun 2012***
principal:	date completed: ***20 Jun 2012***
project: ***HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)***	logged by: ***JR***
location: ***Approximate Ch 41,422m***	checked by: ***MF***

position: E: 506115; N: 6708378 (MGA94 Zone 56) surface elevation : 11.37m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 76 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T CASING				11			CH	**CLAY**: high plasticity, pale brown, trace fine grained sand, trace fine sub-angular gravel.	<Wp	St / VSt		**RESIDUAL SOIL**
									=Wp			
			SPT 1, 2, 3 N*=5	10	1			0.90m - colour change to pale brown, mottled orange				
				9	2							
			SPT 16/110mm N*=R					**SANDSTONE**: extremely to highly weathered, very low strength, recovered as clayey sand, fine to medium grained.			>>	**WEATHERED ROCK**
				8	3							
			SPT 16/50mm N*=R		4			Borehole BH1025 continued as cored hole				
				7	5							
				6	6							
				5								
				4	7							

CDF_0_9_04AD.GLB Log COF BOREHOLE: NON CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 08:59

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud N nil
C casing

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear peak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH1025**
sheet:	2 of 3
project no.	**GEOTLCOV24443AA**
client:	**Roads and Maritime Services NSW**
date started:	**19 Jun 2012**
principal:	
date completed:	**20 Jun 2012**
project:	**HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)**
logged by:	**JR**
location:	**Approximate Ch 41,422m**
checked by:	**MF**

position: E: 506115; N: 6708378 (MGA94 Zone 56) surface elevation : 11.37m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		11	0								
		10	1								
		9	2								
		8	3								
			4		start coring at 4.05m						
NQ3		7			**NO CORE:** 0.28 m						
			5		**SANDSTONE**: fine to medium grained, pale brown to orange, indistinct bedding (0°-5°), trace siltstone laminae	XW MW					SM, Sandy clay, 15 mm SM, Sandy clay, 4 mm
		6			**SILTSTONE**: pale brown to grey, some orange, indistinct bedding (0°-5°), trace of fine grained sandstone laminae				27%		
			6		**INTERLAMINATED SILTSTONE & SANDSTONE**: siltstone is grey to orange, sandstone is fine to medium grained, pale brown to orange (80% siltstone, 20% sandstone)	XW MW					SM, Clayey sand, 60 mm JT x2, 50°, PL, RO, Fe SN, 10 mm JT, 35°, IR, RO, Fe SN, fractured
		5			**SANDSTONE**: fine to medium grained, pale grey, with some pale orange, indistinct bedding (0°-5°)						JT, 75°, PL, RO, Fe SN fractured JT, 15°, PL, RO, CN
			7						86%		50 mm, highly fractured zone JT, 45 - 80°, IR, RO, CN JT, 45°, PL, RO, Fe SN JT, 45°, PL, RO, Fe SN
		4			7.60m - some irregular siltstone laminae, dark grey	SW					Defects are:PT, 0 - 10°, PL, RO, Fe CN - SN, unless otherwise described

CDF_0_9_04AD.GLB Log COF BOREHOLE: CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 09:43

method & support

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
W	washbore
NMLC	NMLC core (51.9 mm)
NQ	wireline core (47.6mm)
HQ	wireline core (63.5mm)
PQ	wireline core (85.0mm)
SPT	standard penetration test

water

- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL — water pressure test result (lugeons) for depth interval shown

graphic log / core recovery

- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD

- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*

RS	residual soil
XW	extremely weathered
HW	highly weathered
DW	distinctly weathered
MW	moderately weathered
SW	slightly weathered
FR	fresh

*W replaced with A for alteration

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

PT	parting
JT	joint
SZ	shear zone
SS	shear surface
CS	crushed seam
SM	seam
DB	drilling break

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	Irregular

roughness

SL	slickensided
POL	polished
SO	smooth
RO	rough
VR	very rough

coating

CN	clean
SN	stain
VN	veneer
CO	coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH1025**
sheet:	3 of 3
project no.	**GEOTLCOV24443AA**
client:	**Roads and Maritime Services NSW**
date started:	**19 Jun 2012**
principal:	
date completed:	**20 Jun 2012**
project:	**HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)**
logged by:	**JR**
location:	**Approximate Ch 41,422m**
checked by:	**MF**

position: E: 506115; N: 6708378 (MGA94 Zone 56) surface elevation : 11.37m (AHD) angle from horizontal: 90°

drill model: Intertech 450 mounting: Truck hole diameter : 76 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NQ3		3				SW					
					INTERLAMINATED SILTSTONE & SANDSTONE: dark grey and pale grey, sandstone is fine grained, distinctly interlaminated at 0°-5° (60% siltstone, 40% sandstone)	FR			86%		JT sub-vertical, 75 - 90°, IR, RO, Calcite VN, 180 mm JT, 80°, PL, RO, CN
		2	9								
			10								
		1							78%		
			11		**SILTSTONE**: dark grey, indistinct bedding, some thin pale grey fine grained sandstone laminae						JT, 45°, PL, RO, CN JT closed, 85°, PL
		0									JT, 15°, PL, RO, CN JT, 60°, PL, RO, CN
			12								JT, 10°, PL, RO, CN JT, 10°, PL, RO, CN
		-1									JT, 80°, PL, RO, Mineral VN
			13					a=1.47 d=1.18	85%		JT, 50°, PL, RO, Mineral VN JT, 80°, PL, RO, Mineral VN
		-2									
			14								
		-3			**INTERLAMINATED SILTSTONE & SANDSTONE**: dark grey and pale grey, sandstone is fine grained, distinctly interlaminated at 0°-5° (80% siltstone, 20% sandstone)			a=1.14 d=0.66			JT, 30°, IR, RO, CN
			15		Borehole BH1025 terminated at 15.00 m Target depth						Defects are:PT, 0 - 10°, PL, RO, Fe CN - SN, unless otherwise described
		-4			Grouted upon completion						

CDF_0_9_04AD.GLB Log COF BOREHOLE: CORED GEOTLCOV24443AA SECTION 3.GPJ <<DrawingFile>> 31/01/2013 09:43

method & support

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
W	washbore
NMLC	NMLC core (51.9 mm)
NQ	wireline core (47.6mm)
HQ	wireline core (63.5mm)
PQ	wireline core (85.0mm)
SPT	standard penetration test

water

10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery

core recovered (graphic symbols indicate material)
no core recovered

core run & RQD

barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*

RS	residual soil
XW	extremely weathered
HW	highly weathered
DW	distinctly weathered
MW	moderately weathered
SW	slightly weathered
FR	fresh

*W replaced with A for alteration

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

PT	parting
JT	joint
SZ	shear zone
SS	shear surface
CS	crushed seam
SM	seam
DB	drilling break

roughness

SL	slickensided
POL	polished
SO	smooth
RO	rough
VR	very rough

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	Irregular

coating

CN	clean
SN	stain
VN	veneer
CO	coating

PointID : BH1025 Depth Range: 4.05 - 13.00 m

drawn	
approved	
date	**25/10/2012**
scale	**N.T.S.**
original size	**A4**

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: Roads and Maritime Services NSW

project: HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)

title: **CORE PHOTOGRAPH BH1025**

project no: GEOTLCOV24443AA | fig no: **FIGURE 1** | rev:

PointID : BH1025 Depth Range: 13.00 - 15.00 m

drawn	
approved	
date	**25/10/2012**
scale	**N.T.S.**
original size	**A4**

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geotechnics
SPECIALISTS MANAGING
THE EARTH

client: Roads and Maritime Services NSW

project: HW10 Pacific Highway Upgrade - Section 3 (Glenugie to Tyndale)

title: **CORE PHOTOGRAPH BH1025**

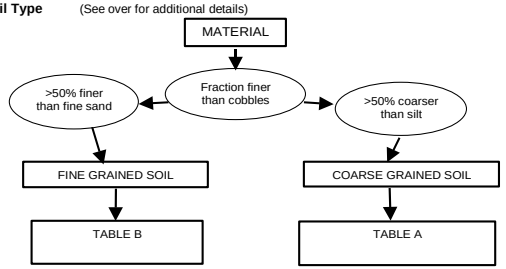
project no: GEOTLCOV24443AA | fig no: **FIGURE 2** | rev:

Appendix B. Test pit logs

ORDER OF DESCRIPTION

Soils are described as follows:
A) MAIN SOIL TYPE & UNIFIED CLASSIFICATION SYMBOL (BLOCK LETTERS)
B) Plasticity if fine grained **or Particle Size Distribution and Grading** if coarse grained
C) Particle Shape
D) Colour.
E) Secondary and Minor component(s); name, estimated proportion, plasticity, particle size, colour.
F) Moisture condition.
G) Consistency or density.
H) Geological Origin (FILL, ALLUVIUM, COLLUVIUM, RESIDUAL etc.).
e.g. Silty SAND (SM); medium grained, poorly graded, rounded, yellow-brown, with a trace of fine grained subangular gravel, dry, loose. *Quaternary Alluvium*

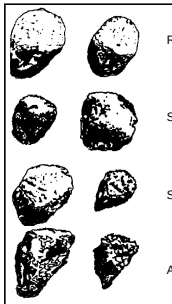
A) Main Soil Type (See over for additional details)



B) Plasticity (fine grained soils) **OR** **Grading** (coarse grained soils)

DESCRIPTIVE TERM	LIQUID LIMIT (%)
Of low plasticity	<35
Of medium plasticity	>35; <50
Of high plasticity	>50

DESCRIPTIVE TERM	DEFINITION
Well graded	good representation of all particle size from largest to the smallest
Poorly graded	one or more intermediate size poorly represented
Gap Graded	one or more intermediate sizes absent
Uniform	Essentially one size



C) Particle Shape

D) Colour

Described in the moist condition, using simple terms (eg black, white, grey, red, brown, yellow etc, modified as necessary by 'pale', 'dark' or 'mottled'. Borderline colours may be described as a combination of these colours. (eg dark grey, red-brown)

E) Proportion of Secondary & Minor Components

COARSE GRAINED SOILS		FINE GRAINED SOILS	
% fines	Modifier	% coarse	Modifier
<5	"with a trace of"	<15	"with a trace of"
>5 <15	"with some"	>15 <30	"with some"
>15	prefix soil with "silty, clayey, sandy, or gravelly"	>30	prefix soil with "sandy, gravelly silty, or clayey"

F) Moisture Content

CONDITION	CRITERIA
Dry	Cohesive soils hard and friable, granular sands free running
Moist	Soils feel cool, darkened in colour. Cohesive soils can be moulded. Granular soils cohere
Wet	Soil feels cool, darkened in colour. Free water forms on hands when handling

TABLE A: COARSE GRAINED SOILS: more than half of the material less than 60mm is larger than 0.06mm

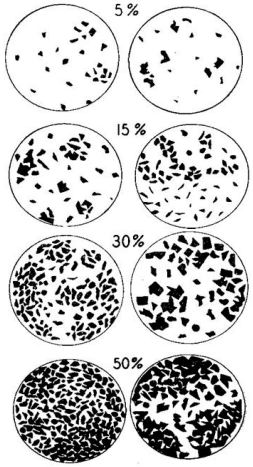
		GRADATIONS	NATURE OF FINES	DRY STRENGTH	SYMBOL	TYPICAL NAME
>50% coarser than coarse sand	*Gravels*	Good	Wide range in grain size	None	GW	Well graded gravels and sand - gravel mixtures, little or no fines
		Poor	Predominantly one size or range of sizes		GP	Poorly graded gravels and gravel - sand mixtures little or no fines
		Good to Fair	"Dirty" Materials (excess of Fines)	Fines are non-plastic	None to med	GM	Silty Gravels, gravel - sand - silt mixtures
				Fines are plastic	Med to high	GC	Clayey Gravels, gravel - sand - clay mixtures
>50% finer than fine gravel	*Sands*	Good	Wide range in grain size	None	SW	Well graded sands and gravelly sands, little or no fines
		Poor	Predominantly one size or range of sizes		SP	Poorly graded sands and gravelly sands, little or no fines
		Good to Fair	"Dirty" Materials (excess of Fines)	Fines are non-plastic	None to med	SM	Silty Sand, sand-silt mixtures
				Fines are plastic	Med to high	SC	Clayey Sand, sand-clay mixtures

TABLE B: FINE GRAINED SOILS: more than half of the material less than 60mm is smaller than 0.06mm

DRY STRENGTH	DILATANCY	TOUGHNESS	SYMBOL	TYPICAL NAME
None to Low	Quick to Slow	None	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
Medium to high	None to Very Slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays etc
Low to medium	Slow	Low	OL	Organic silts and organic silt clays of low plasticity
Low to medium	Slow to none	Low to Medium	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
High to very high	None	High	CH	Inorganic clays of high plasticity
Medium to high	None to very slow	Low to Medium	OH	Organic clays of medium to high plasticity
Readily identified by colour, odour, spongy feel and generally by fibrous texture			Pt	Peat muck and other highly organic soils

Organic and Artificial Materials

PREFERRED TERMS	TYPE
Fibrous Peat Charcoal Wood Fragments Roots (greater than 2mm dia) Root fibres (less than 2mm dia)	Organic Matter
Oil, Bitumen Domestic Refuse Brickbats Concrete Rubble Fibrous Plaster Wood pieces, shavings, sawdust Iron filings, drums, steel scrap Bottles, broken glass Leather	Waste Fill



Particle Size	0.002	0.06	0.2	0.6	2.0	6	20	60	200	Size (mm)
	Clay	Silt	Sand			Gravel			Cobbles	Boulders
			fine	medium	coarse	fine	medium	coarse		

G) Consistency or Density

GRAVEL/SAND (GW, GP, GM, GC)

DESCRIPTION	FIELD TEST
Loosely Packed	Can be removed from exposure by hand or easily removed by shovel
Tightly Packed	Requires pick for removal, either as lumps or as disaggregated material

SAND (SW, SP, SM, SC)

DENSITY	FIELD TEST	PSP Blows/150mm	SPT(N-value)	RELATIVE DENSITY (%)	CPT q_c (Mpa)
Very Loose	Easily penetrated with 13mm reinforcing rod pushed by hand Can be excavated with a spade; 50mm wooden peg can be driven easily	0 - 1	<4	<15	0-2
Loose	Easily penetrated with 13mm reinforcing rod pushed by hand Can be excavated with a spade; 50mm wooden peg can be driven easily	1 - 3	4- 10	15 - 35	2 - 5
Medium Dense	Penetrated with 13mm reinforcing rod driven with 2kg hammer - hard shovelling	3 - 8	10 - 30	35 - 65	5 - 15
Dense	Penetrated 300mm with 13mm reinforcing rod driven with 2kg hammer, requires pick for excavation; 50mm wooden peg hard to drive	8 - 15	30 - 50	65 - 85	15 - 25
Very Dense	Penetrated only 25 - 50mm with 13mm reinforcing rod driven with 2kg hammer	>15	>50	>85	>25

SILT AND CLAY (ML, CL, OL, MH, CH, PH, Pt)

CONSISTENCY	FIELD TEST	DCP (blows/ 150mm)	SPT (N)	UNDRAINED SHEAR STRENGTH (kPa)	UCS (pocket penetrom.) (kPa)	CPT q_c (kPa)
Very Soft	Easily penetrated 40mm by thumb. Exudes between thumb and fingers when squeezed	<1	<2	<12	<25	0 - 180
Soft	Easily penetrated 10mm by thumb. Can be moulded by light finger pressure	1 - 1.5	2- 4	12 - 25	25 - 50	180 - 375
Firm	Impression made by thumb with moderate effort. Can be moulded by strong finger pressure	1.5 - 3	4 - 8	25 - 50	50 - 100	375 - 750
Stiff	Slight impression made by thumb, cannot be moulded by fingers	4 - 6	8 - 16	50 - 100	100 - 200	750 - 1500
Very Stiff	Very tough. Readily indented by thumbnail	7 - 12	16 - 32	100 - 200	200 - 400	1500 - 3000
Hard	Brittle. Indented with difficulty by thumbnail	>12	>32	>200	>400	>3000

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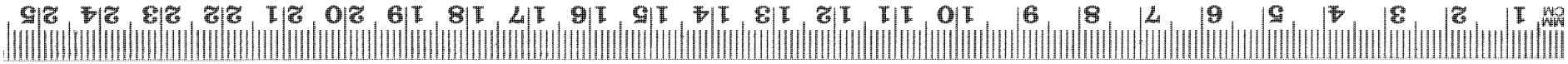


Determination of Dry Strength, Dilatency, Toughness and Plasticity

1. Dry Strength (Crushing Characteristics)
After removing particles larger than 0.4mm sieve size, mould a pat of soil to the consistency of putty, adding of water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. The strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

2. Dilatancy (Reaction to Shaking)
After removing particles larger than 0.4mm sieve size, prepare a pat of moist soil with a volume of about 8cm crumbled. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbs. The rapidity of appearance of water during shaking and of its disappearance during the squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

3. Toughness (Consistency near Plastic Limit)
After removing particles larger than the 0.4mm sieve size a specimen of soil about 12mm cube in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached. After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles. The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicates either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line. Highly organic clays have a very weak and spongy feel at the plastic limit.

4. Smear Test
A fragment of soil smeared between the thumb and forefinger or drawn across the thumbnail will, by the smoothness and sheen of the smear surface, indicate the plasticity of the soil. A soil of low plasticity will exhibit a rough textured, dull smear while a soil of high plasticity will exhibit a slick, waxy smear surface.

Derivation of Soil Name

Soils are generally made up of more than one component. The soil name depends on the proportion of each component.

The soil name is based on the presence of more than 50% of either fine grained (silt, clay) or coarse grained (sand, gravel) components in the soil. When more than one component exists the smaller amount is placed first.

Example 1: 60% clay
35% sand
5% gravel

is Sandy CLAY, with a trace of Gravel

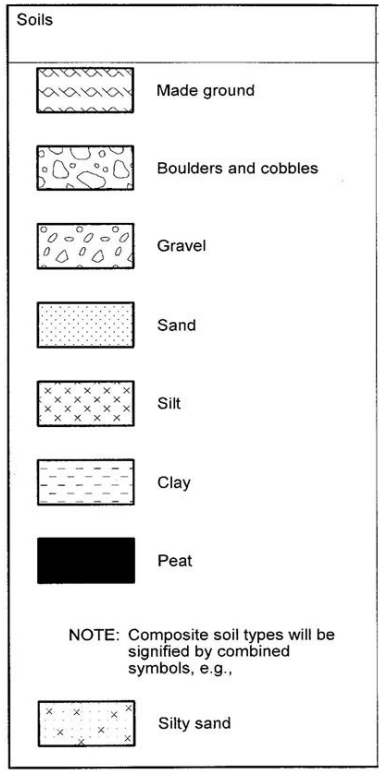
Example 2: 40% gravel
14% sand
46% silt
} >50% coarse grained :

is Silty GRAVEL with some sand

The soil name can therefore be split into three fractions:
1. Secondary, 2 .Major, and 3. Minor

e.g. Silty GRAVEL with some sand

Graphic Symbols



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DATA FOR DECRIPTION AND CLASSIFICATION OF SOILS

ORDER OF DESCRIPTION

Rock Material is described as follows:
A) MAIN ROCK TYPE (BLOCK LETTERS)
B) Strength
C) Weathering
D) Colour e.g. black, white, grey, red, brown, orange, yellow, green, or blue - using pale, dark or mottled.
E) Fabric (spacing and development)
F) Particle Size (if coarse grained)
G) Inclusions or minor components
H) Degree of Fracturing (drill core) or Defect spacing (outcrop)
Geological Name (optional)
eg. GRANODIORITE, very high strength, slightly weathered, light pink-grey, massive, coarse sand sized. Jointing widely spaced. *Mowamba Granodiorite*

A) Main Rock Type ***SEE OVER PAGE***

B) Strength

Rock Strength is defined by the Point Load Strength Index (Is50) and refers to the strength of the rock substance in the direction normal to the fabric

STRENGTH	SYM--BOL	Is(50) (MPa)	UCS (approx)	FIELD GUIDE
Extremely Low	EL	<0.03	>0.7	Easily remoulded by hand to a material with soil properties
Very Low	VL	0.03 - 0.1	0.7 - 2.4	Material crumbles under firm blows with sharp end of pick; can be peeled by a knife. Pieces up to 30mm thick can be broken by finger pressure.
Low	L	>0.1 - 0.3	2.4 - 7	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long and 50mm diameter may be broken by hand.
Medium	M	>0.3 - 1.0	7 - 24	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty
High	H	>1 - 3	24 - 70	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken in one blow by a geological hammer
Very High	VH	>3 - 10	70 - 240	Hand specimen breaks with geological hammer after more than one blow; rock rings under hammer
Extremely High	EH	>10	>240	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

C) Weathering

TERM	SYM--BOL	DEFINITION
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties ie it can be remoulded and can be classified according to the Unified Soil Classification System, but the texture of the rock is still evident
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the fresh rock are no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock and the original colour of the rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by Limonite, has taken place. The colour and textrue of the fresh rock is recognisable; strength proporties are essentially those of the fresh rock substance
Fresh	FR	Rock substance unaffected by weathering

E) Fabric

Typical rock fabrics include but are not limited to:
- bedding, cross bedding (sedimentary)
- flow banding (igneous)
- schistosity or foliation (metamorphic)

FABRIC SPACING

TERM		SEPARATION OF STRATIFICATION PLANES
Sedimentary	Igneous/Metamorphic	
Thinly laminated	Thinly foliated	< 6mm
Laminated	Foliated	6mm to 20mm
Very thinly bedded	Very thinly layered	20 to 60mm
Thinly bedded	Thinly layered	60mm to 0.2m
Medium bedded	Medium layered	0.2m to 0.6m
Thickly bedded	Thickly layered	0.6m to 2m
Very thickly bedded	Very thickly layered	>2m

FABRIC DEVELOPMENT

Massive	No obvious fabric - rock appears homogenous
Poorly developed	Fabric is barely obvious as faint mineralogical layering or grain size banding.
Well developed	Fabric is apparent as distinct layers or lines marked by mineralogical or grain size layering.
Very well developed	Fabric is often marked by a distinct colour banding as well as by mineralogical or grain size layering.

F) Particle Size

0.2	0.6	2.0	6	20	60	200	Size (mm)
fine	medium	coarse	fine	medium	coarse		
Sand			Gravel			Cobbles	Boulders

Sedimentary rocks:

Sandstone - Use sand terms
Conglomerate - Use gravel terms
Shale, Siltstone
Claystone - No description of grain size is necessary

Metamorphic and Igneous Rocks:

Either record the grain size in millimetres **or** use appropriate sedimentary term, for example, "fine sand sized crystals", medium gravel sized crystals"

G) Inclusions or Minor Components

Any isolated minor components within the rock material may be described using the appropriate terms. Some examples are given in the table below.

Sedimentary Rocks	Igneous Rocks
Concretions	Vesicles
Ironstone Band	Xenoliths
'Tea leaf' structure	Phenocrysts

H) Degree of Fracturing or Defect Spacing

Degree of Fracturing (borehole core)

TERM	DESCRIPTION
Fragmented	The core is composed primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
Highly Fractured	Core lengths are generally less than 20mm - 40mm with occasional fragments
Fractured	Core lengths are mainly 30 - 100mm with occasional shorter and longer sections
Slightly Fractured	Core lengths are generally 300 - 1000mm with occasional longer sections and occasional sections between 100 to 300mm
Unbroken	The core does not contain any fractures

Defect Spacing (Outcrop)

TERM	SPACING (mm)
Extremely closely spaced	<20
Very closely spaced	20 - 60mm
Closely spaced	60 - 200m
Moderately spaced	200 - 600mm
Widely spaced	600mm - 2m

Rock Mass Defects Order of Description: Type; inclination, shape, roughness, infill type, infill thickness

1. Defect Type

Abbreviation	Map Symbol	Description
FL		Fault - fracture along which displacement is recognisable.
SH		Shear - a fracture along which movement has taken place but no displacement is recognisable. Evidence for movement may be slickensides, polishing and/or clay gouge.
SZ		Sheared Zone - zone of multiple closely spaced fracture planes with roughly parallel planar boundaries usually forming blocks of lenticular or wedge shaped intact material. Fractures are typically smooth, polished or slickensided; and curved.
BG		Bedding parting - arrangement in layers of mineral grains or crystals parallel to surface of deposition along which a continuous observable parting occurs.
BSH		Bedding plane shear - a shear formed along a bedding plane
JN		Joint - a single fracture across which rock has little or no tensile strength and is not obviously related to rock fabric.
CN		Contact - surface between two lithologies.
FO		Foliation ï a planar arrangement of textural or structural features in any type of rock, especially the planar orientation of platy minerals.
CV		Cleavage - plane of mechanical fracture in a rock normally sufficiently closely spaced to form parallel-sided slices.
CZ		Crushed Zone - zone with roughly parallel, planar boundaries (commonly slickensided) containing disoriented usually angular rock fragments of variable size often in a soil matrix.
VN		Vein - fracture in which a tabular or sheet-like body of minerals have been intruded.
DZ		Decomposed Zone - zone of any shape but commonly with parallel boundaries containing moderately to extremely weathered rock, typically with gradational boundaries into fresher rock.
FZ		Fractured Zone - a zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised of core lengths in the order of 50mm or less.

2. Defect Inclination
measured as dip/dipdirection in exposure
measured in degrees from core normal in boreholes (90Âis vertical)

3. Defect Shape

Symbol	Term	Description
Pl	Planar	Forms a continuous plane without variation in orientation
Cu	Curved	Has a gradual change in orientation
Wa	Wavy	Has a wavy surface shape
St	Stepped	Has one or more well defined ridges
Ir	Irregular	Many changes of orientation

4. Defect Roughness

Sym-bol	Term	Description
Slk	Slickensided /polished	Visual evidence of striations or a smooth glassy finish
S	Smooth	Surface appears smooth and feels so to the touch
Sr	Slightly Rough	Asperities on the defect are distinguishable and can be felt
R	Rough	Some ridges and angle steps are evident; asperities are clearly visible and surface feels very abrasive
Vr	Very Rough	Near right angle steps and ridges occur on the surface

5. Defect Infill

Symbol	Description	Symbol	Description
KL	Clean	g	gravelly -
Ca	Calcite	s	sandy -
Cb	Carbonaceous material	z	silty -
Ch	Chlorite	c	clayey -
Lm	Limonite	G	Gravel
Qz	Quartz	S	Sand
Su	Sulphides	Z	Silt
Rf	Rock fragments	C	Clay
RC	Rock/Clay mixture	hp	high plasticity
		lp	low plasticity

6. Infill Thickness measured in mm or use "Sl" (stain) - Limonite or "vn" (veneer) - other infill types

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A) Main Rock Type

Igneous Rocks

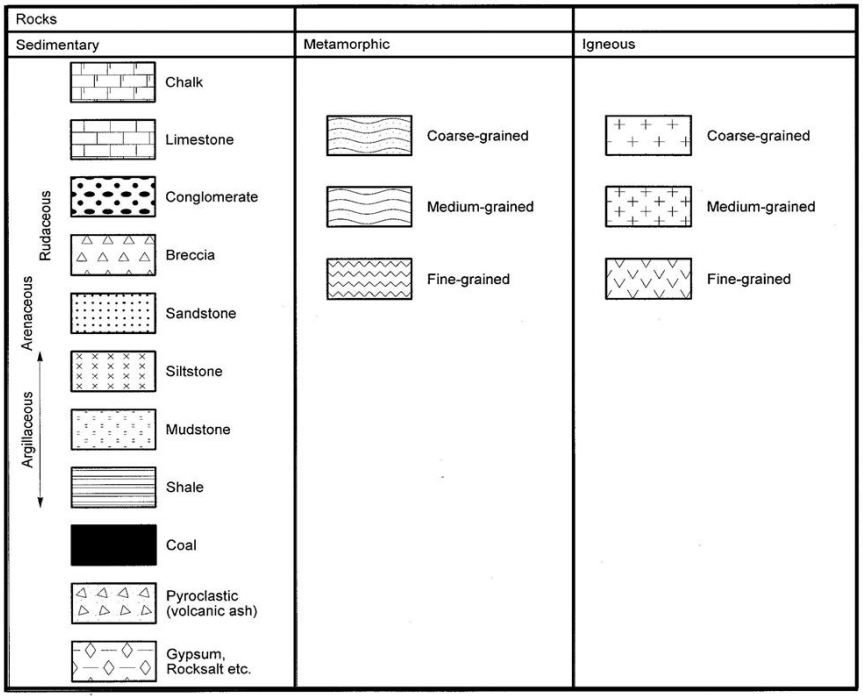
Pyroclastic	Igneous				Composition		
At least 50% of grains are of igneous rock	Quartz, feldspars, micas dark minerals		Feldspar, dark minerals	Dark minerals			
	Acid	Intermediate	Basic	Ultrabasic			
Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	PEGMATITE			Pyroxenite	Very Coarse Grained	60	Predominant Grain Size (mm)
	GRANITE	DIORITE	GABBRO	Peridotite	Coarse Grained	2	
TUFF			DOLERITE	Serpentinite	Medium Grained	0.06	
Fine grained TUFF	RHYOLITE	ANDESITE	BASALT		Fine Grained	0.002	
Very Fine Grained TUFF					Very Fine Grained		
	VOLCANIC GLASS (OBSIDIAN)				Glassy Amorphous		

Sedimentary Rocks

Detrital Sedimentary					Chemical/ Organic	Composition		
Grains of rock, quartz, feldspar and clay minerals			At least 50% of the grains are of carbonate		Salts, carbonates silica, carbonaceous			
Rudaceous	Grains are typically rock fragments		LIMESTONE (undifferentiated)		*Saline Rocks* HALITE ANHYDRITE GYPSUM	Very Coarse Grained	60	Predominant Grain Size (mm)
	Rounded grains: CONGLOMERATE Angular grains: BRECCIA			CALCI- -RUDITE	*Calcareous Rocks* LIMESTONE DOLOMITE	Coarse Grained	2	
Arenaceous	Grains are typically mineral fragments					Medium Grained	0.06	
	SANDSTONE			CALC- -ARENITE	*Siliceous Rocks* CHERT FLINT			
Argillaceous	MUDSTONE SHALE (fissile mudstone)	SILTSTONE: 50% fine grained particles		CALCI- -SILTITE	*Carbonaceous Rocks* LIGNITE COAL	Fine Grained	0.002	
		CLAYSTONE: 50% very fine grained particles		CALCI- -LUTITE		Very Fine Grained		

Metamorphic Rocks

Foliated		Massive	Composition		
Quartz, feldspars, micas dark minerals		Quartz, feldspars, micas dark minerals, carbonates			
MIGMATITE	TECTONIC BRECCIA	HORNFELS MARBLE GRANULITE QUARTZITE AMPHIBOLITE	Very Coarse Grained	60	Predominant Grain Size (mm)
GNEISS			Coarse Grained	2	
SCHIST	MYLONITE		Medium Grained	0.06	
PHYLLITE			Fine Grained	0.002	
SLATE			Very Fine Grained		



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