1979/41. Site investigation for the proposed Cam River water treatment plant, Somerset.

R.C. Donaldson

Abstract

Investigation of two alternative water treatment plant sites has shown a variety of foundation conditions to exist. The foundation materials at Site A range from a weathered sandstone and siltstone bedrock with associated residual high plasticity, high shrinkage clay, to unconsolidated sandy gravel and alluvial deposits. There is potential for differential settlement, but gross foundation failure is unlikely. Site B is underlain by a slatey mudstone which will provide a suitable foundation for proposed structures. A narrow elongate superficial silcrete body cuts across the site and may present problems of costly excavation. A rearrangement of the plant layout could minimise these costs. Further investigation of both sites is recommended.

INTRODUCTION

The North West Regional Water Authority commissioned Gutteridge, Haskins and Davey, consulting engineers, to design a water treatment plant on the Cam River at Somerset. As part of preliminary site investigations, geological advice was sought on the conditions existing at the two alternative sites being considered. Concern was expressed that construction of a plant on Site A (fig. 1) would involve excavations into a steep slope above the river, whereas Site B may pose problems of costly excavation in a hard siliceous quartzite conglomerate.

The investigation, carried out on 5 and 6 July 1979, involved reconnaissance geological mapping and trenching by backhoe.

RESULTS OF INVESTIGATION

SITE A [DQ021542]

Geology

The published geological map of the area (Gee *et al.*, 1968) shows the site to be on the Precambrian Burnie Formation, a sequence of alternating slatey mudstone with siltstone and sandstone.

Reconnaissance geological mapping at the site has confirmed this to be the case. The trenching programme showed that within the limits of excavation, bedrock comprised an extremely weathered to moderately weathered sandstone and siltstone sequence on which residual clay derived from the *in situ* weathering of these sediments has developed. Overlying this, a discontinuous surficial unconsolidated sandy gravel horizon with a surface layer of sandy silt and clay was found to exist on the slopes above the river (Trenches 5A - 10A). Alluvial and possibly colluvial processes were active in the deposition of the silt, clay and gravel overlying bedrock on the river flats (Trenches 1A - 3A) and in the gully (Trench 4A).

Detailed descriptions of materials encountered during excavation are presented in Appendix 1. The results of the soil properties of the various materials are given in Table 1.

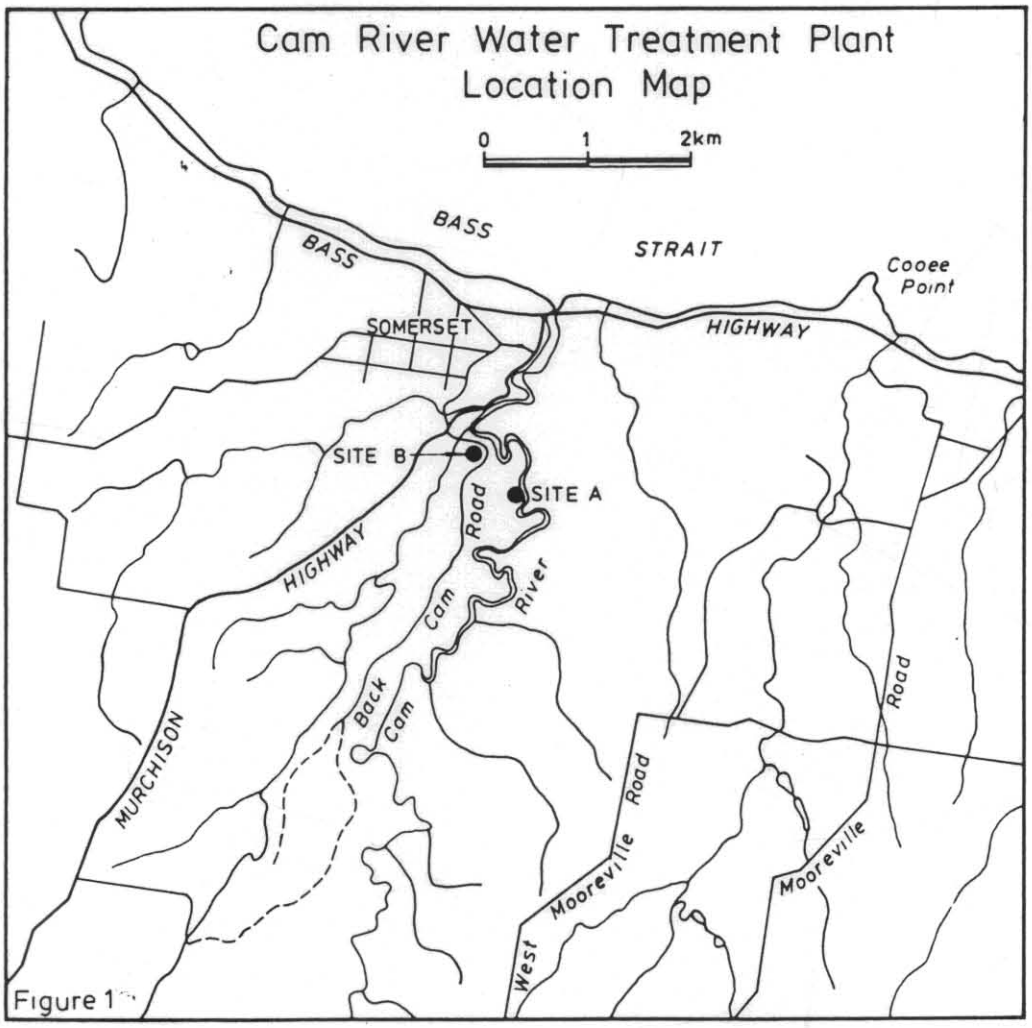

Cam River Water Treatment Plant
Location Map
0
1
2km
BASS
STRAIT
BASS
Cooee
Point
SOMERSET
HIGHWAY
SITE B
SITE A
Road
HIGHWAY
Cam
River
Back
Cam
MURCHISON
West
Mooreville
Road
Mooreville
Road

Figure 1

5 cm

Table 1. GENERAL SOIL PROPERTIES

Trench	Depth (mm)	Liquid limit	Plastic limit	Plasticity index	Linear Shrinkage	Unified Soil Classification
2A	300-3000	59.8	25.3	34.5	12	CH
4A	600-3000	32.4	20.6	10.8	6	ML - CL
	3000-3400	50.9	30.6	20.3	9	MH
5A	2700-3300	87.3	29.7	57.6	19	CH
6A	1600-2300	112.6	28.9	83.7	25	CH
8A	800-2800	101.5	22.8	98.7	22	CH
9A	900-2100	100.2	29.8	70.4	20	CH
1B	300-900	46.4	19.4	27.0	11	CL

Discussion

The investigation has shown a range of materials on which the various proposed structures are to be founded.

The soft high plasticity, organic, sandy and silty clay encountered in trenches 1A-3A inclusive show the greatest potential for settlement. However, it is understood that some settlement associated with the proposed sludge lagoons is not a significant problem. There is potential for leakage through the base of the lagoons to the water table at approximately three metres.

At the time of the investigation, the design called for the wash-water tank to be located in the bottom of the gully close to the site of trench 4A. Excavation revealed that the unconsolidated organic clay and gravel was prone to collapse, and with the presence of high water levels, this site was abandoned for the present site (fig. 2).

Having regard to the final layout and depths of excavation required, the foundations of the remaining proposed structures will be located either on the weathered bedrock or residual clay, or on the overlying unconsolidated sandy gravel horizon. The bedrock was found to be rippable and generally of low strength. Little is known of the extent and degree of weathering or the attitude of the bedding or other discontinuities beneath the structures. The residual clay is generally stiff to hard *in situ* but on remoulding with water, it becomes a high plasticity clay with high linear shrinkage characteristics. The implications drawn from this fact are twofold: moisture changes beneath proposed structures would have the potential to cause heave and shrinkage, and high plasticity clay has the ability to consolidate under load.

The prospect of differential settlement should not be discounted where foundations will be located partly on bedrock or residual clay, and partly on the unconsolidated sandy gravel horizon encountered in several trenches (Appendix 1).

It is anticipated that the bearing capacity of the residual clay and weathered bedrock in their undisturbed state will be adequate for the estimated loadings of the proposed structures. Nevertheless, the potential for gross foundation failure of the larger structures situated on the steeper slope segments, and in particular the 5 Ml clear water storage tank must be considered. The few exposures of rock cropping out downslope of the proposed tank site suggest that the sediments dip back into the slope at this locality. However, the Burnie Formation is well known to be

structurally complex at all scales, and in the absence of specific details relating to bedding and the nature of discontinuities beneath this proposed structure, the possibility of foundation failure cannot be entirely ruled out.

SITE B [DQ016547]

Geology

This site is also underlain by the Burnie Formation but investigations have shown that it differs markedly from the conditions found to exist at Site A.

The results of the geological mapping (fig. 3) show the presence of a narrow elongate north-west - south-east trending feature cutting across the site. The material, of uncertain origin, is essentially a silcrete, a siliceous cemented quartz conglomerate. Evidence suggests it lies unconformably on the Burnie Formation and occurs as a superficial deposit which is sporadic in occurrence, is discontinuous and of variable thickness. The remainder of the site is covered by scattered boulders and fragments of silcrete in an organic sandy and silty clay topsoil.

Excavations and road cut exposures showed the bedrock at this site to comprise a slightly to moderately weathered slatey mudstone. Overall, these rocks tend to have a north-westerly strike and dip towards the south-west.

Detailed descriptions of the materials encountered during trenching are given in Appendix 1.

Discussion

The results of the investigation at Site B have indicated that the area is underlain by a slatey mudstone sequence at depths of one metre or less. This rock is rippable and should provide a sound foundation with no settlement or bearing capacity problems for the proposed structures. A 10 m section exposed in the road cut along the Back Cam Road immediately to the west of the site confirmed the consistency and uniformity of this material at depth.

The silcrete is a hard dense rock and any excavation will require drilling and blasting where it occurs as massive unbroken sheets. The boundaries depicted on Figure 3 are the result of a pace and compass survey and are therefore only approximate. The dense bush in various places also hindered the accuracy of the mapping. It is anticipated the maximum depth of this material over the site should be in the order of about one metre; it is exposed in the Back Cam Road cutting to a depth of 600 mm. The thickest accumulation noted in the region is a 2 - 3 m exposure immediately to the north of the junction of the Murchison Highway and the Back Cam Road, where it lies unconformably on the Burnie Formation.

CONCLUSIONS

Foundation conditions at Site A will be variable. All structures sited on the slopes above the river will be located on a moderately to extremely weathered sandstone and siltstone sequence, their residual soils, or on the overlying unconsolidated sandy gravel horizon. Structures founded partly on bedrock and partly on the near-surface sandy gravel may

be subject to differential settlement. Remoulded, the residual soil overlying bedrock is high plasticity, high shrinkage clay; there is potential for heave and consolidation beneath proposed structures. Very little is known about the bedrock and the nature of the discontinuities at the site, and the possibility of gross foundation failure of the larger load bearing structures should be further investigated.

Site B is underlain by a slatey mudstone at shallow depth; it is rippable and is not expected to present problems as a foundation material. The narrow elongate surficial silcrete deposit that cuts across the site is considered to be in the order of one metre maximum thickness. The precise character of this silcrete deposit has not as yet been determined. Drilling and blasting may be required in the course of excavation.

RECOMMENDATIONS

Further investigations at Site A should concentrate on obtaining a more thorough knowledge of the foundation conditions beneath the larger structures. Additional trenching across their diameters would probably be sufficient, but a drill hole may be necessary if trenching does not provide adequate foundation information. In conjunction, consolidation tests are recommended, together with bearing capacity determinations to ensure against settlement or foundation failure.

At Site B, it is recommended that the nature and boundaries of the silcrete layer be determined more precisely. This would be best accomplished by the use of a backhoe for one day. The decision is then whether to relocate parts of the plant away from the silcrete or to excavate into it.

REFERENCE

GEE, R.D.; GULLINE, A.B.; BRAVO, A.P. 1968. Geological atlas 1 mile series. Zone 7 Sheet 28 (8015N). Burnie. *Department of Mines, Tasmania*.

[29 August 1979]

5 cm

6/19

pit no 1A

sheet 1 of 1

engineering log – excavation

file:

project: CAM RIVER WATER TREATMENT PLANT
pit location: see Figure 2

pit commenced: 5 July 1979
pit completed: ---
supervised by: R.C.D.
log checked by: A.T.M.

equipment type and model: Backhoe
excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 9 m approx
datum: Wynyard
operator: Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
					8 / 1		MH-OH	Organic sandy clayey *SILT*: high plasticity, grey-brown, sand fine to medium, roots up to 3 mm, slight organic smell	M <PL	S		TOPSOIL
							CH	Sandy *CLAY*: high plasticity, brown, sand fine to medium, trace organic material (charcoal fragments)	M ≈PL	S to F		ALLUVIUM
					7 / 2							
					6 / 3							
							CH	Sandy *CLAY*: high plasticity, brown, sand fine to medium, some organic material, (charcoal) with gravel and boulder fragments of shale and slate.	>PL	F		
					5 / 4							

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

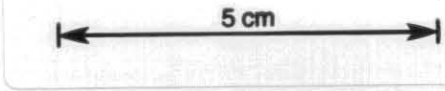
water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests
- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and 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 – moderately dense
- D – dense
- VD – very dense



7/19

pit no: 2A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 2

pit commenced: 5 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 8 m approx.

datum: Wynyard

operator: Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
					7 1		OH-MH	Organic sandy clayey *SILT*. high plasticity, grey-brown, sand fine to medium, root fibres, slight organic smell	M <PL	S		TOPSOIL
							CH		M ≈PL	S		ALLUVIUM
				D	6 2			Sandy *CLAY* high plasticity, brown, sand fine to medium, trace organic material (charcoal fragments).				
			▼		5 3			Similar to above, except some gravel size fragments which are dry and friable	W			Water flowing freely into trench
					4 4							

key

method: N natural exposure; E existing excavation; BH backhoe bucket; B bulldozer blade; R ripper

support: T timbering

penetration: 1 2 3 — no resistance ranging to refusal

water: ▽ 10 Oct, 73 water level on date shown; ▷ water inflow; ◁ water outflow

notes — samples and tests: U50 — undisturbed sample 50 mm diameter; D — disturbed sample; N — standard penetration test:figure = result; N* — SPT + sample; Nc — cone penetrometer

classification symbols and 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 — moderately dense; D — dense; VD — very dense

5 cm

pit no: 3A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT
pit location: see Figure 2

pit commenced: 5 July 1979
pit completed: ---
supervised by: R.C.D.
log checked by: A.T.M.

equipment type and model: Backhoe
excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 8 m approx. Wynyard
datum:
operator: Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
					7 / 1		MH-OH	Organic sandy clayey *SILT*. high plasticity, grey-brown, sand fine to medium, roots and root fibres, slight organic smell	M <PL	S		TOPSOIL
							CH	*CLAY*. high plasticity, mottled yellow brown and grey brown, some fine sand and charcoal	M ≈PL	S to F		COLLUVIUM Slow seepage of water into pit at 1.6 m. Water lying in pit at 3.4 m.
					6 / 2							
					5 / 3							
					4 / 4		CH	*CLAY*. high plasticity, mottled yellow-brown to olive green, some fine sand, trace mica.	M >PL	S to F		RESIDUAL CLAY

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
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- 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 — moderately dense
- D — dense
- VD — very dense

9/19

5 cm

pit no: 4A

sheet 1 of 1

engineering log — excavation

file:

pit commenced: 5 July 1979
pit completed: ---
project: CAM RIVER WATER TREATMENT PLANT
supervised by: R.C.D.
pit location: see Figure 2
log checked by: A.T.M.

equipment type and model: Backhoe
R.L. surface: 9 m approx.
excavation dimensions: 2.5 m long, 0.6 m wide
datum:
operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							OH-MH	Organic sandy clay *SILT:* high plasticity, black, sand fine to medium, some charcoal fragments, trace gravel fragments of shale. Roots and root fibres, strong organic smell	M >PL	S		TOPSOIL
					8 1		ML-CL		M >PL	L to MD		ALLUVIUM
				D	7 2			Gravelly, sandy silty *CLAY:* medium plasticity, grey-brown, sand fine to medium, gravel fine to coarse some boulders to 300 mm (mainly subrounded quartz) some charcoal fragments slight organic smell				Pit unstable (caving in) below 1.5 m water flowing freely into pit below 0.6 m.
				D	6 3		MH		M >PL	S to F		RESIDUAL CLAY
					5 4			Silty *CLAY:* high plasticity, mottled green-brown grey. Some sand fine to medium, Some mica and siliceous shale fragments.				

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test:figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and 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 — moderately dense
- D — dense
- VD — very dense

5 cm

10/19

pit no: 5A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT
pit location: see Figure 2

pit commenced: 5 July 1979
pit completed: ---
supervised by: R.C.D.
log checked by: A.T.M.

equipment type and model: Backhoe
excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 18 m approx.
datum:
operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 200 300 400 kPa	structure and additional observations
					17 1		ML-OL GM	Sandy *SILT:* low plasticity, grey black, sand fine to medium, some gravel (quartz) roots and fibres. Organic smell.	M<PL	S		TOPSOIL
							GM	Sandy silty *GRAVEL:* sub-angular to subrounded quartz gravel in a matrix of grey sandy silt [ML]	M<PL	L to MD		
					16 2			Sandy silty *GRAVEL:* fine to coarse, subangular to sub-rounded quartz, some boulders to 300 mm. Some rock fragments to 100 mm (siltstone, shale). Matrix low plasticity, yellow-brown, medium dilatancy, sand fine to medium. Some clay [SM].	D	L to MD		GRAVEL BED
				D	15 3		SM and CH		M <PL	St to V.St.		E.W. LITHIC SANDSTONE
					14 4			E.W. *ROCK:* remolds to silty *SAND* [SM] medium dilatancy, yellow brown sand fine to coarse, trace mica. Alternating layers of clay (CH), high plasticity, mottled grey brown, some sand fine to medium.				

key

method
N natural exposure
E existing excavation
BH backhoe bucket
B bulldozer blade
R ripper

support
T timbering

penetration
1 2 3 no resistance ranging to refusal

water
10 Oct, 73 water level on date shown
water inflow
water outflow

notes — samples and tests
U50 — undisturbed sample 50 mm diameter
D — disturbed sample
N — standard penetration test: figure = result
N* — SPT + sample
Nc — cone penetrometer

classification symbols and 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 — moderately dense
D — dense
VD — very dense

5 cm

pit no: 6A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 2

pit commenced: 5 July 1979

pit completed: ----

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 16 m approx.

datum: Wynyard

operator: Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							ML-OL	Sandy *SILT:* low plasticity, medium dilatancy, grey-black, sand and some gravel-quartz. Roots, organic smell	M<PL	S		TOPSOIL
							GM		M<PL	L to MD		
					15	1	GM	Sandy silty *GRAVEL:* sub-angular to subrounded gravel in a matrix of grey sandy silt. Similar to above (ML).	D	L to MD		GRAVEL BED
				D	14	2	CH	Sandy silty *GRAVEL:* sub-angular to subrounded quartz some to 300 m. Matrix yellow brown, medium dilatancy, sand fine to medium, some clay [ML].	M <PL	F/ V.St		RESIDUAL CLAY
								CLAY: high plasticity mottled grey brown, some fine sand.				

key

method: N natural exposure; E existing excavation; BH backhoe bucket; B bulldozer blade; R ripper

support: T timbering

penetration: 1 2 3 no resistance ranging to refusal

water: 10 Oct, 73 water level on date shown; water inflow; water outflow

notes — samples and tests: U50 undisturbed sample 50 mm diameter; D disturbed sample; N standard penetration test:figure = result; N* SPT + sample; Nc cone penetrometer

classification symbols and 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 moderately dense; D dense; VD very dense

12/19

5 cm

engineering log — excavation

pit no: 7A

sheet 1 of 1

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 2

pit commenced: 5 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 13 m approx.

datum:

operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							ML-OH	Organic sandy *SILT:* low plasticity, black, sand fine to medium. Roots and root fragments. Distinct organic smell.	M	S		TOPSOIL
							CH		D	F to St		SUBSOIL
					12 1		GM	Sandy *CLAY:* high plasticity, slight dilatancy, red brown, sand fine to medium, some coarse. Some gravel up to 50 mm [subrounded subangular quartz and rock fragments]. Trace charcoal, roots to 3 mm. Slight organic smell.	D	L to MD		GRAVEL BED
					11 2		ML		D			E.W. LITHIC SANDSTONE
					10 3			Sandy silty *GRAVEL:* fine-coarse quartz (subangular to subrounded) in a matrix of low plasticity sandy silt with some clay [ML]. E.W. *ROCK:* remolds to low plasticity, med. dilatancy, mottled brown grey green, sand fine to coarse (quartz and E.W. clastic grains). Trace mica.				

key

method

- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support

- T timbering

penetration

- 1 2 3 no resistance ranging to refusal

water

- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes – samples and tests

- U50 – undisturbed sample 50 mm diameter
- D – disturbed sample
- N – standard penetration test: figure = result
- N* – SPT + sample
- Nc – cone penetrometer

classification symbols and 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 – moderately dense
- D – dense
- VD – very dense

13/19

5 cm

pit no: 8A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: See Figure 2

pit commenced: 5 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 17 m approx.

datum:

operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							ML-OL	Sandy *SILT:* low plasticity, slow to medium dilatancy, grey to black, sand fine-medium, some coarse. Some charcoal. Roots and fibres. Organic smell	D	S		TOPSOIL
							CH		D	F to St.		SUBSOIL
							CH-OH		M ≮PL	St		
				D	16 / 1		CH	Sandy *CLAY:* high plasticity, red brown, sand fine to medium, some coarse. Trace gravel. Roots and root fibres.	M ≮PL	St / V.St.		RESIDUAL CLAY
					15 / 2			Organic *CLAY:* high plasticity, mottled brown-black. Some fine sand. Charcoal fragments and root remains.				
					14 / 3			Sandy *CLAY:* high plasticity, slight dilatancy, mottled grey brown, sand fine to medium, trace mica.				

key

method: N natural exposure; E existing excavation; BH backhoe bucket; B bulldozer blade; R ripper

support: T timbering

penetration: 1 2 3 — no resistance ranging to refusal

water: 10 Oct, 73 water level on date shown; water inflow; water outflow

notes — samples and tests: U50 — undisturbed sample 50 mm diameter; D — disturbed sample; N — standard penetration test: figure = result; N* — SPT + sample; Nc — cone penetrometer

classification symbols and 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 — moderately dense; D — dense; VD — very dense

14/19

5 cm

pit no: 9A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 2

pit commenced: 6 July 1979

pit completed: ----

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 21 m approx.

datum:

operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							ML-OL	Sandy *SILT:* low plasticity, grey to black, sand fine to medium, some coarse. Some charcoal and root fibres. Organic smell.	D	S		TOPSOIL
							CH		M <PL	F/ St.		
				D	20 1		CH	Sandy *CLAY:* high plasticity, slight dilatancy, red-brown, sand fine to medium some coarse. Trace charcoal. Fine roots and root fibres.	M <PL	St/ H		RESIDUAL CLAY
					19 2		ML	Sandy *CLAY:* high plasticity, slight dilatancy, mottled grey brown, sand fine to medium, some coarse.				M.W. COARSE SILTSTONE
					18 3		CH	E.W. *ROCK:* remolds to sandy *SILT:* low plasticity, medium dilatancy, light green brown, sand fine to medium. Some clay. Trace mica.	M <PL	St.		RESIDUAL CLAY
					17 4			Similar to material exposed from 900-2100 mm.				

key

method

- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support

- T timbering

penetration

1 2 3 — no resistance ranging to refusal

water

- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests

- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test:figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and 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 — moderately dense
- D — dense
- VD — very dense

15/19

5 cm

pit no. 10A

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 2

pit commenced: 6 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 21 m approx.

datum: Wynyard

operator: Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
					20 1		ML-OL	Sandy *SILT:* low plasticity, grey-black, sand fine to medium, some coarse, some charcoal, roots and fibres.	M	S		TOPSOIL
							GM		M	MD to D		GRAVEL BED
					19 2		ML-OL	Sandy silty *GRAVEL:* fine to coarse, subangular to sub-rounded quartz, in a matrix of moderate-high dilatancy, grey, sandy silt [ML]	D	1		BURIED SOIL HORIZON
							SM and CH					E.W. LITHIC SANDSTONE
							CH	Organic sandy *SILT:* rapid dilatancy, black, fine sand, root remains, organic smell.	M <PL	St / H		RESIDUAL CLAY
					18 3			E.W. *ROCK:* remolds to silty *SAND* [SM] medium dilatancy, yellow brown, sand fine-medium (quartz and weathered mineral grains) Alternating layers of [CH] *CLAY:* high plasticity, mottled grey brown, some sand fine-medium. *CLAY:* high plasticity, yellow brown, some fine sand.				

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
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classification symbols and 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 — moderately dense
- D — dense
- VD — very dense

16/19

5 cm

pit no: 1B

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 3

pit commenced: 6 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 23 m approx.

datum:

operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. / depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
							MH	Silty *CLAY*: high plasticity, slow dilatancy; red brown, some sand fine-medium. Trace charcoal, roots and fibres.	M <PL	F		TOPSOIL
				D			CL		M <PL	F		RESIDUAL CLAY
					22 1			*CLAY*: medium plasticity, slow dilatancy, mottled grey yellow brown, some sand, fine-medium. Some fragments weathered rock (MW-EW).				SLATEY MUDSTONE
					21 2			*ROCK* - green grey thinly laminated, slatey mudstone, SW-MW				
					20 3							

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes — samples and tests
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test:figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and 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 — moderately dense
- D — dense
- VD — very dense

17/19

5 cm

pit no: 2B

sheet 1 of 1

engineering log — excavation

file:

project: CAM RIVER WATER TREATMENT PLANT

pit location: see Figure 3.

pit commenced: 6 July 1979

pit completed: ---

supervised by: R.C.D.

log checked by: A.T.M.

equipment type and model: Backhoe

excavation dimensions: 2.5 m long, 0.6 m wide

R.L. surface: 19 m approx.

datum:

operator: Wynyard Council

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency, rel. density	hand penetrometer 100 kPa 200 300 400	structure and additional observations
					18 1		OH	Organic sandy silty *CLAY*: medium to high plasticity, medium dilatancy, black sandy fine to medium, some gravel. Many roots, root fibres, bark Strong organic smell.	M <PL	F		TOPSOIL
					17 2			*ROCK* - green grey SW-MW slatey mudstone.				SLATEY MUDSTONE

key

method
- N natural exposure
- E existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper

support
- T timbering

penetration 1 2 3 — no resistance ranging to refusal

water
- 10 Oct, 73 water level on date shown
- water inflow
- water outflow

notes
- U50 — undisturbed sample 50 mm diameter
- D — disturbed sample
- N — standard penetration test: figure = result
- N* — SPT + sample
- Nc — cone penetrometer

classification symbols and soil description — based on unified classification system

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consistency/relative density
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- VL — very loose
- L — loose
- MD — moderately dense
- D — dense
- VD — very dense

CAM RIVER WATER TREATMENT PLANT

GEOLOGICAL PLAN - SITE A

R.C. Donaldson August 1979

LEGEND

- Alluvium - sandy silt
- Topsoil - sandy silt
- Residual clay
- Sandstone, siltstone and slaty mudstone rock fragments
- Bedrock - sandstone
- 4A Trench

0 10 20 30m

5 cm

EXISTING SHED

EXISTING SHED

FUTURE CLARIFIER

CLARIFIER
TWL 23.8
BL 13.0

CLEARWATER STORAGE (5 ML)
TWL 19.5
BL 13.0

5A

6A

10A

9A

8A

7A

F.F.L. 20.0
SERVICES
CHEMICAL STORE
CONTROL
G.F.L. 19.0

DELAY TANK

FILTERS
TWL 22.5
BL 16.8

FUTURE FILTERS

WASHWATER TANK

HIGHLIFT STATION
BLOWERS

TRANSFORMER

TEMPORARY BALANCE TANK

EXISTING ROAD

EXISTING RISING MAIN

EXISTING PUMP STATION F.L. 9.5

CAM RIVER

3A

4A

No.2
2A

SLUDGE LAGOON No.1

1A
No.3

HEC EASEMENT

N

5 cm

Figure 2

CAM RIVER WATER TREATMENT PLANT

GEOLOGICAL PLAN - SITE B

R.C.Donaldson August 1979

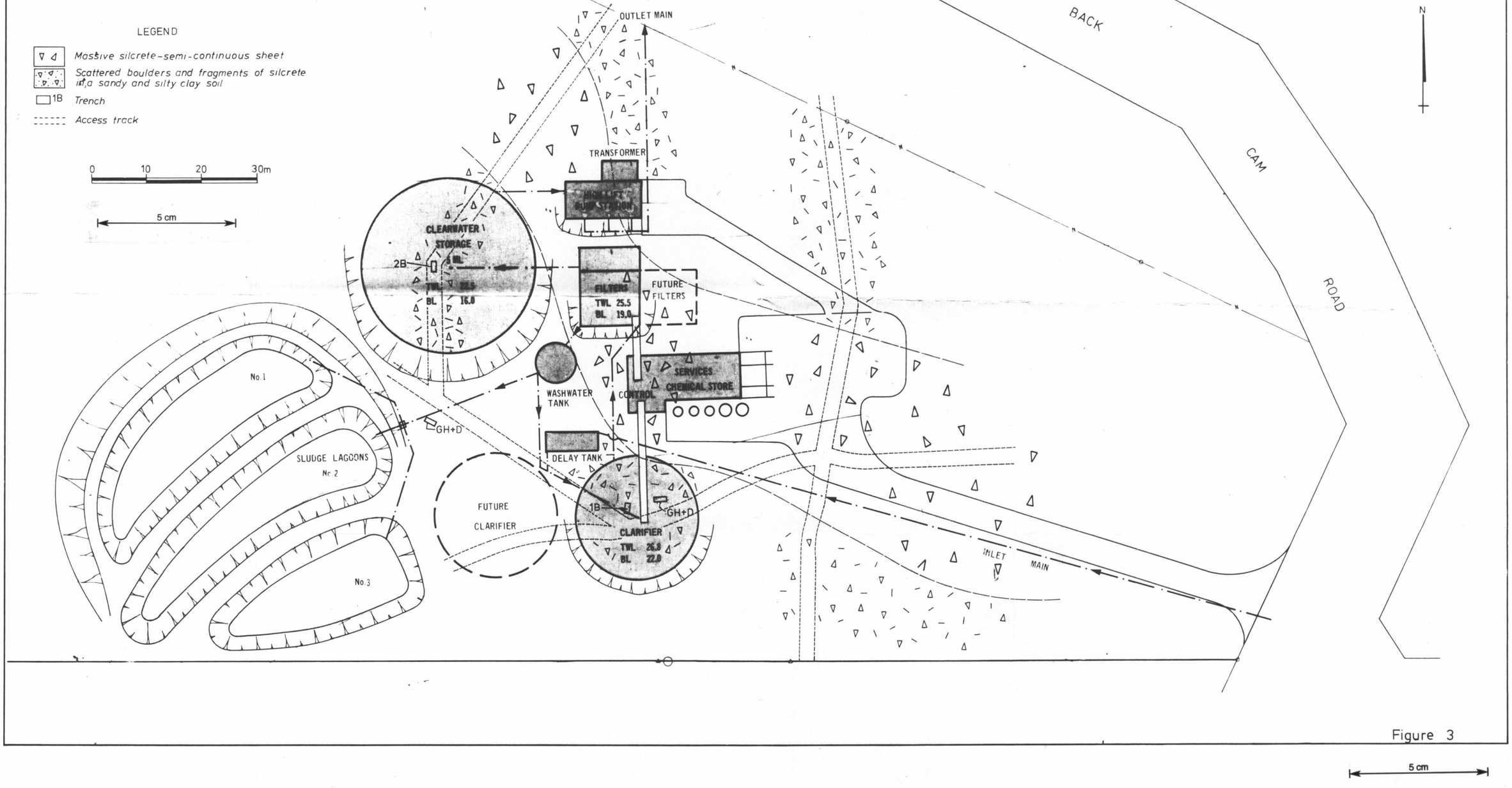

Figure 3

5 cm