1983/71. Groundwater investigations at the St Helens golf course

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Abstract

The St Helens Golf Club is located in a small valley adjacent to Golden Fleece Rivulet at St Helens. Up to seven metres of saturated clayey gravel are beneath the valley floor. The water table is close to the surface and groundwater is of good quality. Yields of shallow spear bores are low and wells are considered to be the only suitable method of extracting the water. It is considered that an increase of water storage, either by extending the existing dam or by constructing a new dam, is the most efficient way of supplying the Golf Club requirements.

INTRODUCTION

The St Helens Golf Club initially requested an opinion and site inspection concerning the possibility of obtaining suitable quantities of groundwater beneath the golf course. Water is required for irrigation during the summer months. Present supplies are drawn from a small dam at the head of the valley in which the course is located. Groundwater supplies would be used to supplement the existing resources.

W.R. Moore (letter dated 12 May 1983) reported that the nature and extent of the superficial deposits covering the floor of the valley was uncertain. He considered that if a reasonable thickness of granite-derived gravel was present, then suitable quantities of water may be found. It was initially proposed to conduct three or four seismic spreads across the course. The Proline auger drill was eventually preferred as a more direct method of investigation, and also as it was in the vicinity on other investigations. Five auger holes were drilled to determine the nature and depth of the subsurface materials and the presence of groundwater. Two auger holes were pump tested to determine yield and water quality.

TOPOGRAPHY

The St Helens Golf Course is located in a small, flat-floored valley, draining to the south as a small tributary of the Golden Fleece Rivulet. The northern part of the course is flat and gently sloping to the south. Topographically this area may be an alluvial fan, composed of clay and gravel derived from the surrounding granite catchment area. The remainder of the golf course, including the area around the Club House, appears to be located on a gently undulating terrace remnant, related to the Golden Fleece Rivulet and accordant in height with the main terrace of the St Helens township area to the east. This terrace may also be composed of gravel, as is the case at the St Helens Refuse Disposal Area.

GEOLOGY

The valley floor of the Golf Club area has been geologically mapped by Groves *et al.* (1977) as undifferentiated Tertiary sediments with an irregular cover of Recent alluvium. The surrounding hills are mapped as Devonian granite. Inspection of the area indicates that this mapping is correct. Granite outcrop and boulders are evident on the valley sides and surface soils are typically granite-derived. A small granite outcrop is exposed in the valley floor to the north-east of the Club House. Topographically the valley floor and terrace sediments could be of reasonable thickness. A bore on the terrace at Le Fevres property to the north

indicates that at least 15 m of gravel and clayey gravel are present. Water bores sited in this area have been quite successful, the surrounding hills providing good recharge to the gravel deposits.

The purpose of auger drilling was to assess the nature of the valley floor sediments in the Golf Club area. It was considered that if the gravel was associated with the Thureau Deep Lead sediments, where bores had produced groundwater, then prospects were good. If the gravel was alluvially derived from the surrounding granite valley sides, then it was likely to have a high clay content and therefore unsuitable for groundwater extraction.

RESULTS OF INVESTIGATIONS

Geology

A tractor-mounted Proline auger drill was used to drill five shallow investigation holes. The logs of these holes are presented in Appendix 1. The first three holes were located along the centre of the valley floor, between the dam and the drain from the lowest part of the course area. All holes encountered saturated clayey gravel at shallow depth. The gravel has coarse angular quartz particles to 5 mm in diameter and is yellow-brown in colour. Minor clay layers were encountered and the clayey gravel is underlain by clay at about seven metres from the ground surface. Proline hole P5 on the eastern side of the golf course encountered yellow-brown and grey clay to a depth of at least four metres. Hole P4, located on the Club House terrace level, encountered yellow-brown gravelly clay to three metres, overlying 1.5 m of clayey gravel. An organic-rich brown gravelly clay extended from 4.5 m to at least six metres.

In summary, clayey saturated gravel approximately seven metres in thickness underlies the small valley floor. Granite, overlain by clay, occurs on the eastern side of the area, and gravelly clay and minor clayey gravel were encountered in a hole on the Club House terrace.

Hydrology

Valley floor Proline holes P1, P2, and P3 all encountered saturated clayey gravel. Clay content increased to the south, indicating that water yields could be low. The water table is close to the surface in holes P1, P2, and P3, with measurements from the ground surface of 0.3 m, 0.4 m, and 0.8 m respectively. Hole P4, on the higher Club House terrace, had a standing water level of 3.3 m.

A 600 mm long, 0.04 mm slot size, stainless steel screen was jetted in holes P1 and P2. Pump testing produced about 3.6 *l*/min (50 gallons per hour) of clean water. The water quality was good with conductivity meter readings of 150 mg/*l* from hole P1 and 240 mg/*l* from hole P2.

In summary, the valley floor gravel can produce 3.6 *l*/min of good quality ground water from shallow spear bores. The yield from these spears is not considered sufficient for the Club requirements. The low yield is a result of the clay content of the gravel, effectively reducing the permeability. Wells could be considered as a means of water extraction. The advantage of using wells in low permeability sediments is that the size enables a large volume of water to be stored. The water can be used for irrigation purposes and then allowed time for the level to recover, until a suitable quantity is available once more for pumping. A 1.3 m diameter well, four metres in depth is capable of storing about 4500 *l* of water.

The disadvantages are the recovery time required, cost, and labour intensive installation procedure. Wells work more effectively with a gravel pack around the outside, and French drains are sometimes used in conjunction as collectors and interceptors of groundwater.

CONCLUSIONS

The floor of the small valley is underlain by up to seven metres of saturated clayey gravel. Shallow spear bores produce a yield of about 3.6 *l*/min of good quality groundwater. This yield is low and therefore groundwater extraction by spear bores is not recommended. Wells could be used but cost and recovery time probably preclude their use when considering the amounts of water required by the Club. The use of underground water is therefore not recommended for irrigation purposes. Wells could be used for emergency purposes.

The logical alternative to underground water supplies is to increase dam storage, in order to provide more reliable volumes of irrigation water. The existing dam could be extended in length and height or a new dam considered. A suitable site occurs in the narrow valley adjacent to the car park. A considerable volume of water would be stored in this area and only a small part of the course could be flooded. The catchment area appears to be underlain by a reasonable thickness of clay which could also be used for dam building purposes. This proposal would need to be assessed and storage volume calculated. Further shallow auger holes would quickly confirm the areal extent, nature and thickness of the clay.

REFERENCE

GROVES, D.I.; COCKER, J.D.; JENNINGS, D.J. 1977. The Blue Tier Batholith. *Bull.geol.Surv.Tasm.* 55.

[20 December 1983]

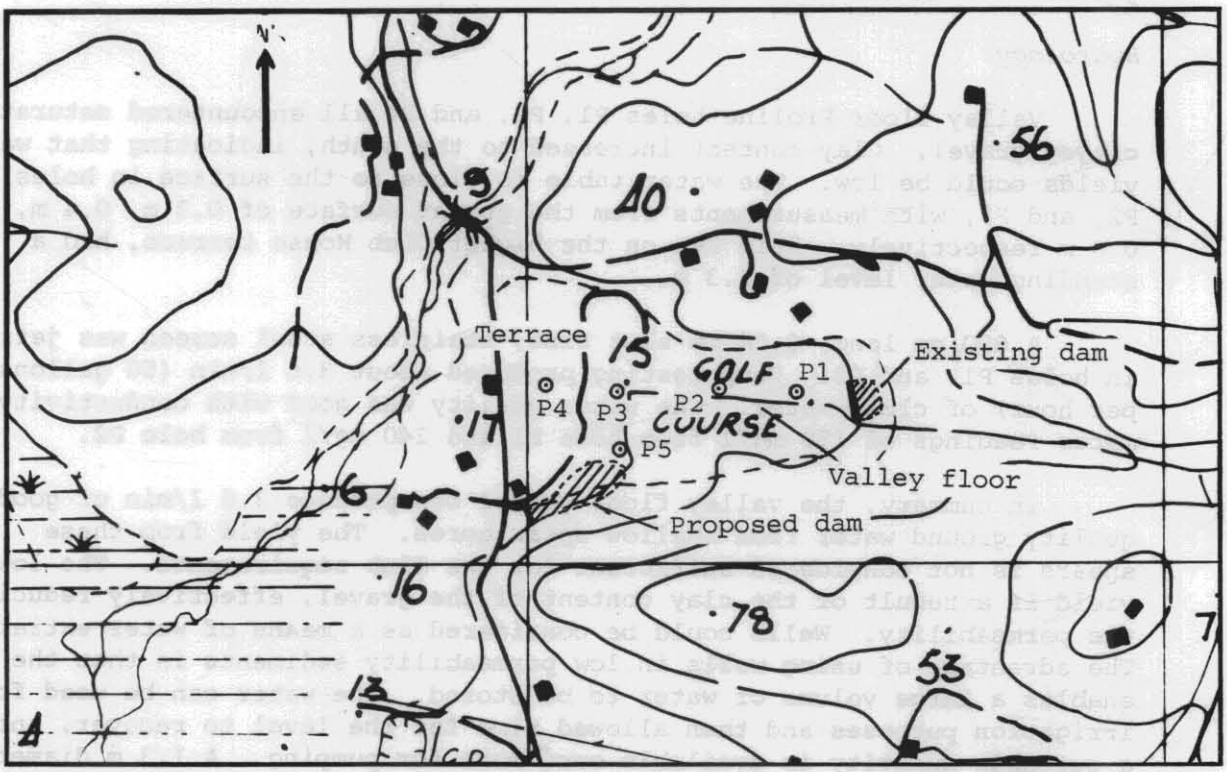

Figure 1. *Location of auger holes and dam sites*

5 cm

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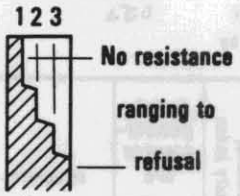
EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water

22 Jan, 80 Water level on date shown.

Water inflow.

Water outflow.

Notes - samples and tests

U50	Undistributed sample 50mm diameter.
D	Disturbed sample.
N	Standard penetrometer blow count for 300mm.
N*	SPT + sample.

Material classification

Based on Unified Soil Classification System.

In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

D	Dry, looks and feel dry.
M	Moist, no free water on hand when remoulding.
W	Wet, free water on hand when remoulding.
LL	Liquid limit.
PL	Plastic limit.
PI	Plasticity Index.

eg. M > PL – Moist, moisture content greater than the plastic limit.

Consistency

		hand penetrometer (kPa)
VS	Very soft.	< 25
S	Soft.	25 - 50
F	Firm.	50 - 100
St	Stiff.	100 - 200
VSt	Very stiff.	200 - 400
H	Hard.	> 400
Fb	Friable.	

Notes: X on log is test result

— is range of results.

Density index

		%
VL	Very loose.	0 - 15
L	Loose.	15 - 35
MD	Medium dense.	35 - 65
D	Dense.	65 - 85
VD	Very Dense	85 - 100

Cored borehole log

Case - lift

Casing used.

Barrel withdrawn.

Fluid loss

No loss

50% loss

100% loss.

Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log

No core.

Rock substances represented by clear, contrasting symbols consistent for each project.

Weathering

Fr	Fresh.
SW	Slightly weathered.
HW	Highly weathered.
EW	Extremely weathered.

Strength

		point load strength index $I_{s\,(50)}$ (MPa)
EL	Extremely low.	< 0·03
VL	Very low.	0·03 - 0·1
L	Low.	0·1 - 0·3
M	Medium.	0·3 - 1
H	High	1 - 3
VH	Very high.	3 - 10
EH	Extremely high.	>10

Note: X on log is test result.

Significant defects

Significant defects shown graphically.

Joint.

Sheared zone.

Crushed seam.

Infill seam.

Extremely weathered seam.

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ENGINEERING LOG – BOREHOLE

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borehole no. P1
sheet 1 of 1

project GOLF CLUB location ST. HELENS

co-ordinates 6017 54254
R.L. ≃ 15m
inclination 90°
bearing

drill type PROLINE
drill method AUGER SCREW
drill fluid

hole commenced 19/7/'83
hole completed 19/7/'83
drilled by BC
logged by DJS
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
			S.W.L. 19/7	0		SM	SILTY SAND: Fine to medium quartz sand. Greyish yellow brown. Approx 30% silt.	D	L		A1 soil horizon
				1		GC	CLAYEY GRAVEL: Coarse quartz particles to 5mm dia. Low rounding and sphericity. Some clay. Yellow brown. Approx 20% plastic clay.	W	L		
				2		GC	CLAYEY GRAVEL: Coarse grained, angular particles to 7mm diameter. Approx 40% high plasticity clay. Yellow brown.	W	VS		
				3		GC	GRAVEL: Coarse grained, low sphericity and roundness. Trace clay and fine sand. Particles to 5mm. Median grainsize approx 3mm	W	L		
		SWAMP	150ppm 3.6 l/min	4							
			END	5							
				6							

5 cm

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ENGINEERING LOG – BOREHOLE

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borehole no. P2
sheet 1 of 1

project GOLF CLUB location ST. HELENS

co-ordinates 6017 54253
R.L. ≈15m
inclination 90°
bearing

drill type PROLINE
drill method AUGER SCREW
drill fluid

hole commenced 19/7/'83
hole completed 19/7/'83
drilled by BC
logged by DJS
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0		SM	SILTY SAND: Fine–medium grained. Greyish yellow brown. Quartz particles. Approx 20% silt	D	L		A1 soil horizon
		SWL 19/7		1		GC	CLAYEY GRAVEL: Yellow brown. Coarse quartz particles to 5mm. Plastic clay fines, approx 30% – 40%. Trace fine sand	W	VS		
				2							
				3			GRAVEL: Coarse grained. Quartz particles to 6mm. Median dia. approx 3mm. Low sphericity and roundness. Some 10% clay. Some medium sand.				
				4				W	VS		
	SCREEN		0·04mm 240ppm 3·6l/min	5		GC					
				6							
						OH	CLAY: Dark brown, high plasticity, organic rich.	M	St		
			END	7							

5 cm

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ENGINEERING LOG – BOREHOLE

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borehole no. P3
sheet 1 of 1

project GOLF CLUB location ST. HELENS

co-ordinates 6027 54252
R.L. ≃ 15m
inclination 90°
bearing

drill type PROLINE
drill method AUGER SCREW
drill fluid

hole commenced 19/7/'83
hole completed 19/7/'83
drilled by BC
logged by DJS
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0		SM	SILTY SAND: Fine - medium grainsize. Greyish yellow brown. Approx 25% silt. Quartz sand	D	L		A1 soil Horizon
		▼	SWL 19/7	1		GC	CLAYEY GRAVEL: Coarse quartz gravel. Yellow brown. Low sphericity and roundness Partides to 8mm. Median size 4mm. Approx 30% plastic clay	M / W	VS		
				2			GRAVEL: Coarse quartz to 6mm dia. Median approx 4mm. Some fine-medium sand. Approx 10% - 20% clay.	W	VS		
				3							
				4		GC					
				5							
				6							
			END	7							

5 cm

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ENGINEERING LOG – BOREHOLE

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borehole no. P4
sheet 1 of 1

project GOLF CLUB location ST. HELENS

co-ordinates 6017 54251
R.L. ≃ 15m
inclination 90°
bearing

drill type PROBE
drill method AUGER SCREW
drill fluid

hole commenced 19/7/83
hole completed 19/7/83
drilled by BC
logged by DJS
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0		SM	SILTY SAND: Fine-medium grained qtz. Approx 25% silt. Greyish yellow brown	D	L		A1 Soil horizon
				1		CL	GRAVELLY CLAY: Moderate plasticity. Yellow brown. Approx 30% gravel and medium quartz sand. Quartz particles to 5mm dia.	M	St		
				2							
				3		GC	CLAYEY GRAVEL: Coarse grained quartz gravel. Particles to 7mm dia. Median dia 3mm. Some mod. plasticity clay and medium-fine sand. Yellow brown.	M	S		
		▶	SWL 19/7 140ppm	4							
				5		CL	GRAVELLY CLAY: Moderate plasticity clay. Grey brown-organic rich. Approx 20% gravel quartz particles to 5 mm diameter.	M	St		
			END	6							

5 cm

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ENGINEERING LOG – BOREHOLE

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borehole no. P5
sheet 1 of 1

project GOLF CLUB location ST. HELENS

co-ordinates 6018 54253
R.L. ≥ 15m
inclination 90°
bearing

drill type PROLINE
drill method AUGER SCREW
drill fluid

hole commenced 19/7/83
hole completed 19/7/83
drilled by BC
logged by DJS
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0		SM	SILTY SAND: Medium - fine grained quartz sand. 20% silt. Greyish yellow brown	D	L		A1 Soil horizon
				1			CLAY: Moderate - high plasticity. Mottled Yellow brown - grey. Occasional sand and gravel lenses.	M	ST		
		SWL		2		CH					
				3							
			END	4							

5 cm