MINERAL RESOURCES TASMANIA

Tasmania

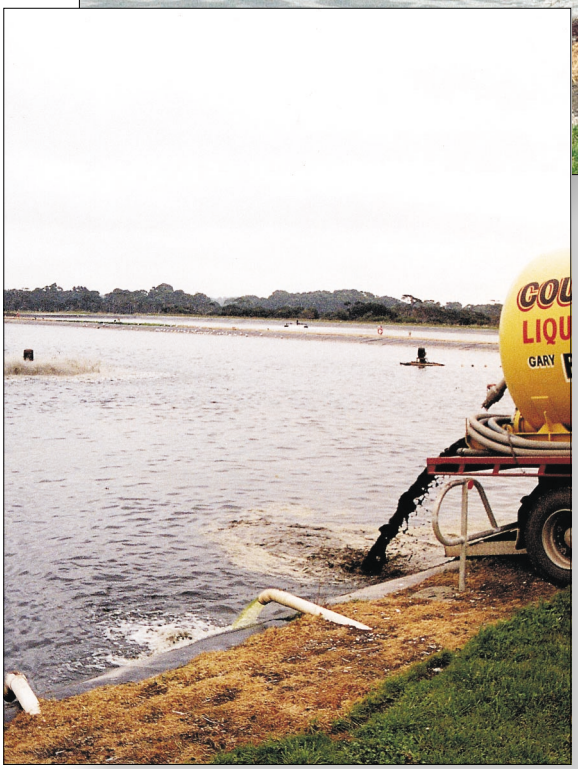
DEPARTMENT *of* INFRASTRUCTURE, ENERGY *and* RESOURCES

NHT Funded Project
NLP 13188

Natural Heritage Trust

Helping Communities Helping Australia

The effects of waste disposal on groundwater quality in Tasmania



Smithton sewage lagoons

Tasmanian Geological Survey Record 2002/05

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Mineral Resources Tasmania
Tasmanian Geological Survey
Record 2002/05

Groundwater quality investigations at the Smithton sewage lagoons

A. R. Ezzy

Abstract

Groundwater was investigated in the area of the Smithton sewage lagoons to determine if the lagoons were affecting groundwater quality. Significant nitrogen-based groundwater contamination was identified in excess of guideline limits. Natural attenuation processes appear to be occurring beneath adjacent farmland.

INTRODUCTION

Mineral Resources Tasmania (MRT) initiated a project to investigate the effects of waste disposal on groundwater quality in Tasmania. The project was funded by MRT and the Natural Heritage Trust (NHT) and included a number of sites for detailed study. The sewage lagoons at Smithton were one of these sites.

The objectives of the investigations at the Smithton sewage lagoons were to:

- Determine the geological nature of the host materials;
- Identify the depth of the water table;
- Examine the quality of the groundwater;
- Determine the permeability of the host materials; and
- Identify if a potential hydraulic connection exists between the lagoons and the local groundwater system.

SITE DESCRIPTION

The Smithton sewage lagoons are located approximately two kilometres northwest of Smithton (339 800 mE, 5 479 000 mN) (fig. 1). The (then) Department of Environment approved the initial lagoon construction and the facility is currently licensed by the Department of Primary Industries, Water and Environment (DPIWE). A major upgrade was undertaken between 1988 and 1990 to treat McCains Foods vegetable processing waste water under a joint agreement between the Circular Head Council, McCains Foods and the Tasmanian Government.

During the 1988–1990 upgrades, six lagoons were constructed in Quaternary sand deposits with HDPE liners installed on the lagoon bund walls (constructed from materials excavated on site). Because of the groundwater conditions encountered during the upgrade, no liners were installed in the base of the lagoons. As a result of this design, the lagoon bases are located in the unconfined water table, creating a migration pathway for waste water.

Geology

The Tasmania Department of Mines 1:50 000 scale Smithton geological map (Lennox *et al.*, 1982) indicates that the geology of the area is mainly comprised of

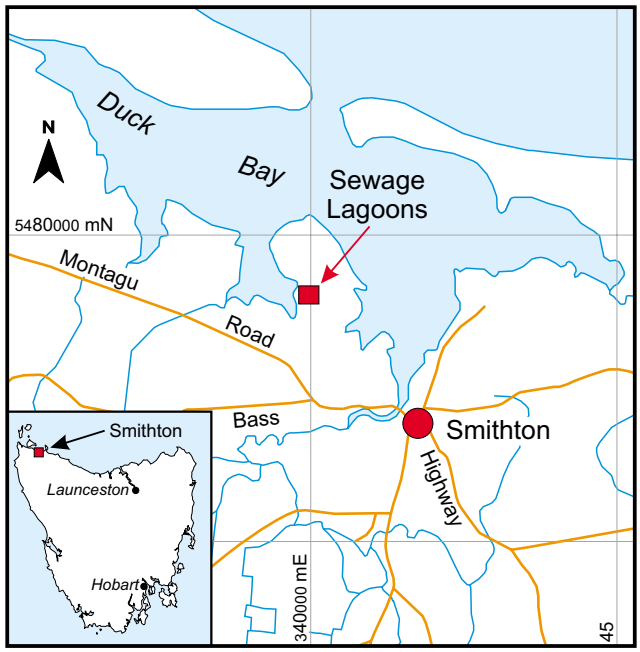


Figure 1. *Location of sewage lagoons, Smithton.*

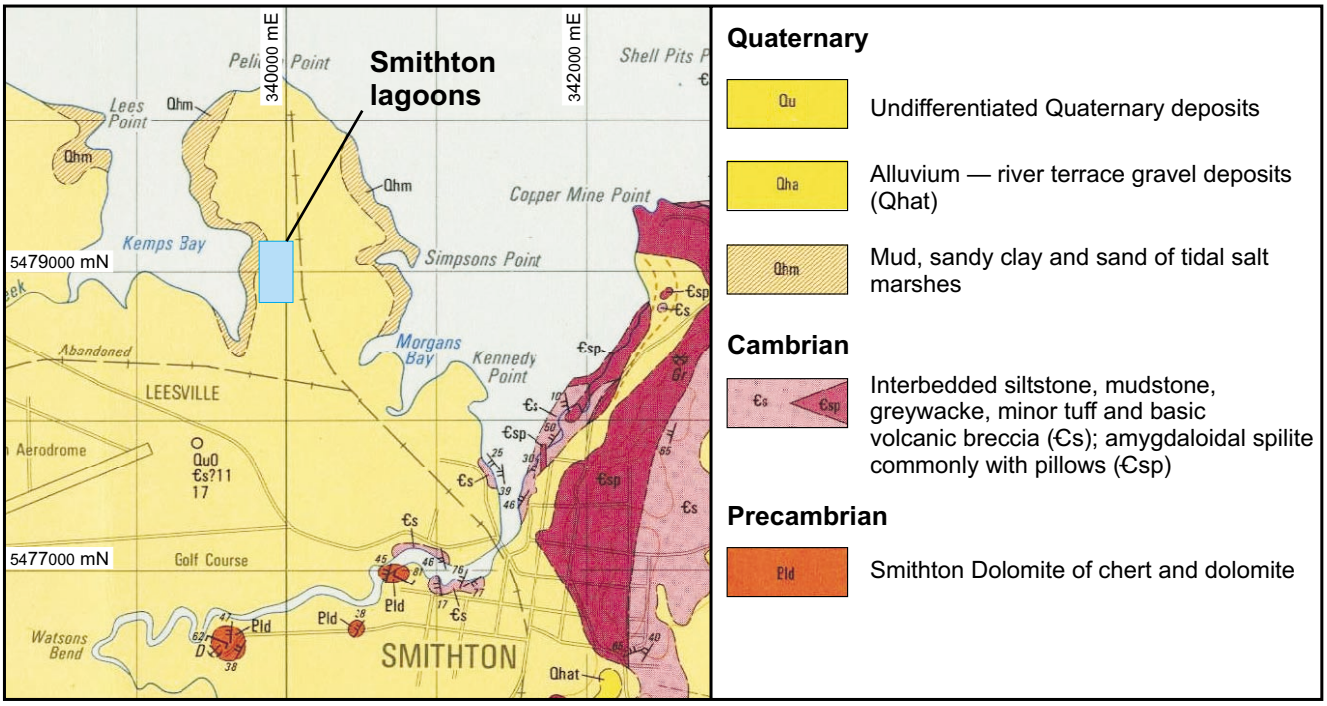


Figure 2

Extract from the Smithton geological map (Lennox et al., 1982) of the local area and related geology.

Quaternary windblown sand, with additional clay and sand tidal salt marsh deposits in the western part of the site. Figure 2 is a modified extract from the Smithton geological map.

Geological mapping during the present study showed that Quaternary sand deposits dominate the site. Marshes were observed in the western area of the site grading into tidal mud salt flats. The northwestern sludge drying lagoons are located on these tidal mud deposits (Plate 1), with the remainder of the lagoons and sludge stockpiles being located on sand deposits. Shell fragments encountered during drilling suggest that most of these sand deposits were formed in a beach environment.

Hydrology

The lagoons are located east of Kemps Bay on Pelican Point, a low lying peninsula approximately one kilometre wide that extends into Duck Bay. Australian Bureau of Meteorology rainfall station 091092 at Smithton (Grant Street) is the closest rainfall station to the site. The rainfall chart of average monthly recorded rainfall (fig. 3) shows a marked seasonality, with the highest rainfall in autumn/winter (April to October). The average annual rainfall for the station (1105.6 mm) is high for the region.

Plate 1. *Lagoons constructed on tidal marsh deposits in the northwest corner of the site.*

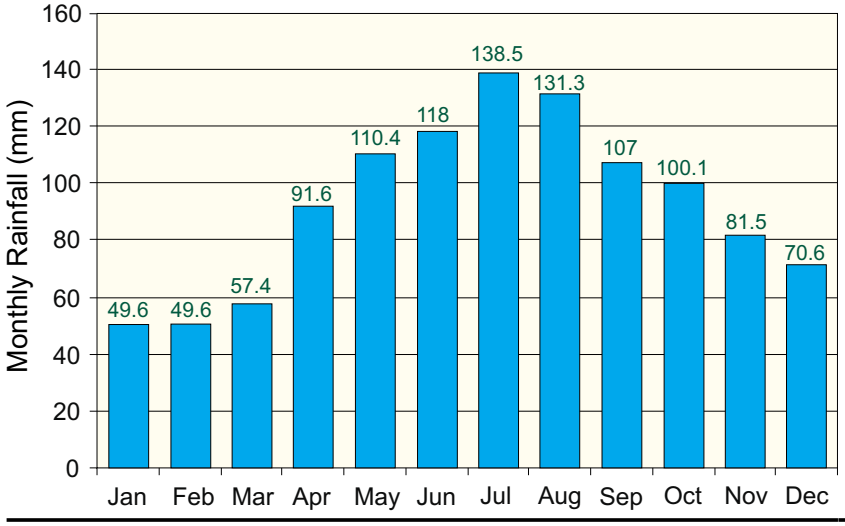


Figure 3

Average monthly rainfall for Australian Bureau of Meteorology rainfall station 091092, Smithton (Grant Street).

INVESTIGATION METHODS

Borehole drilling and installation

Fourteen 120 mm diameter monitoring bores were auger drilled to depths of between 4.0 and 7.5 metres between 30 August and 5 September 2000. Fifty millimetre PVC casing and slotted screens with bentonite seals were installed in each hole. The locations of the bores are shown on Figure 4, with engineering logs given in Appendix 1. All bores were logged in accordance with AS 1726-1993. Plate 2 shows the area where bores SLL2000/1, 4, 5 and 6 were drilled to assess any attenuation process occurring on adjoining farmland to the east of the lagoons. Bore SLL2000/14 was drilled and installed as a background hole.

Groundwater was encountered between 0.8 and 4.5 metres below ground level across the site. Flow during drilling indicated that the groundwater in all boreholes was unconfined. Recorded pumping yields of bores at the time of installation ranged between 0.01 to 0.21 litres/second. Lower yields occurred from bores installed in the clayey sand tidal marsh deposit.

Figure 5 shows a cross-section and related standing water levels on 13 August 2001 for bores SLL2000/1, 4, 5, 6, 7 and 8. Primary lagoons 1 and 2 and site investigation soil classifications are also superimposed on Figure 5.

Both the unsaturated and saturated zones consist of heterogenous layers of fine to coarse-grained sand. Shell fragments were intersected in bores SLL2000/10, SLL2000/12 and SLL2000/14 while mottled clay was intersected in bores SLL2000/3 and SLL2000/4. Waste fill was intersected in borehole SLL2000/9.

During the installation of SLL2000/8 on 31 August 2000, a significant volume of hydrogen sulphide gas vented from the borehole. The source of the gas may have been buried organic material in the tidal marsh deposits and/or biological activity in the deposits as a result of nutrients leached from the sewage sludge stockpiles. Plate 3 shows the location of SLL2000/8 with respect to stockpiles of sewage sludge in close proximity to the western-side tidal marsh deposits.

Plate 2

The area where bores SLL2000/1, 4, 5 and 6 were drilled to assess any attenuation process occurring on adjoining farmland to the east of the lagoons.

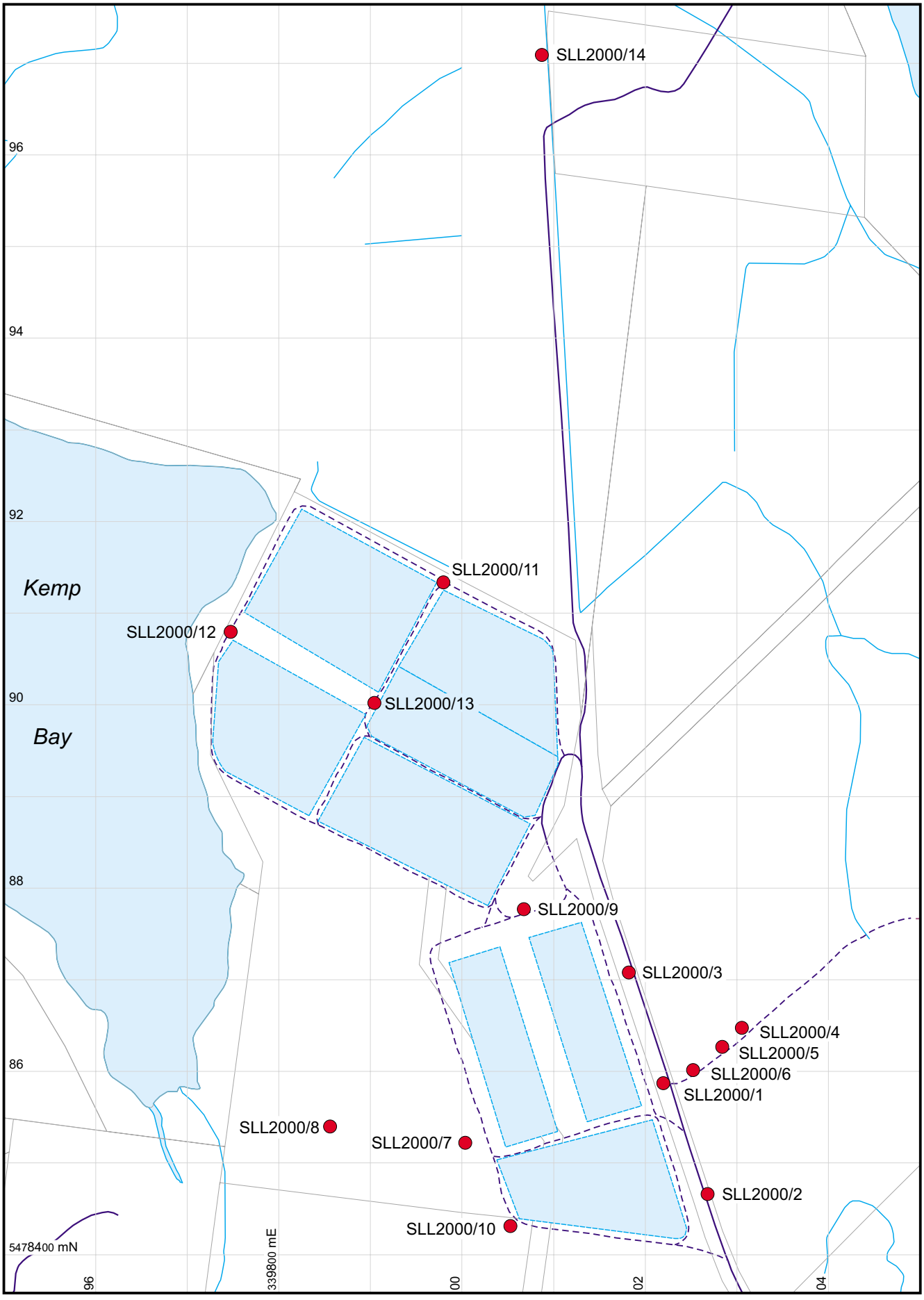


Figure 4

Locations of environmental monitoring bores installed at the Smithton sewage lagoons.

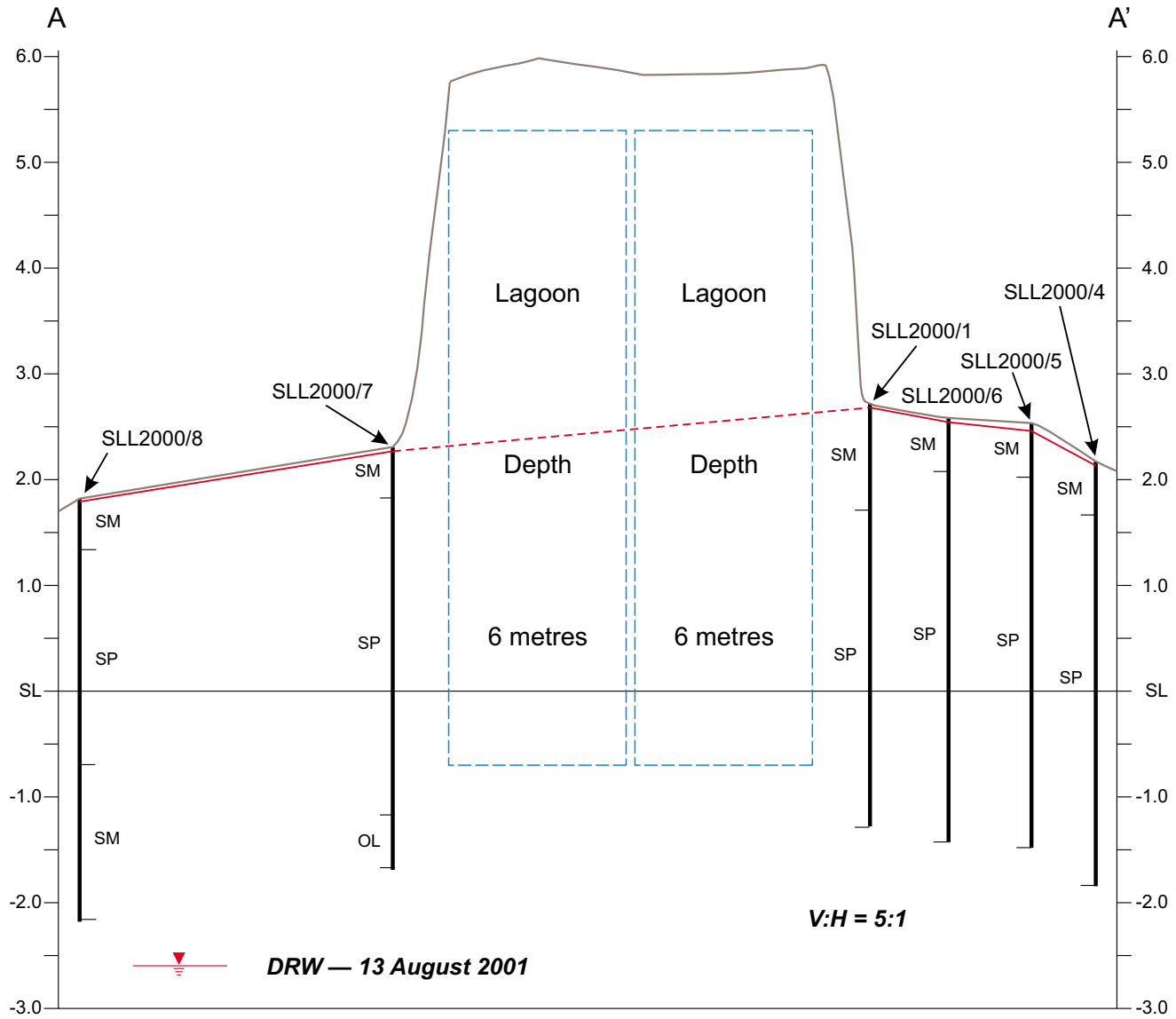


Figure 5. *Cross-section and related standing water levels on 13 August 2001 for bores SLL2000/1, 4, 5, 6, 7 ,and 8, with respect to the location of primary lagoons 1 and 2.*

Plate 3. *The location of SLL2000/8 with respect to stockpiles of sewage sludge in close proximity to the western-side marsh tidal deposits.*

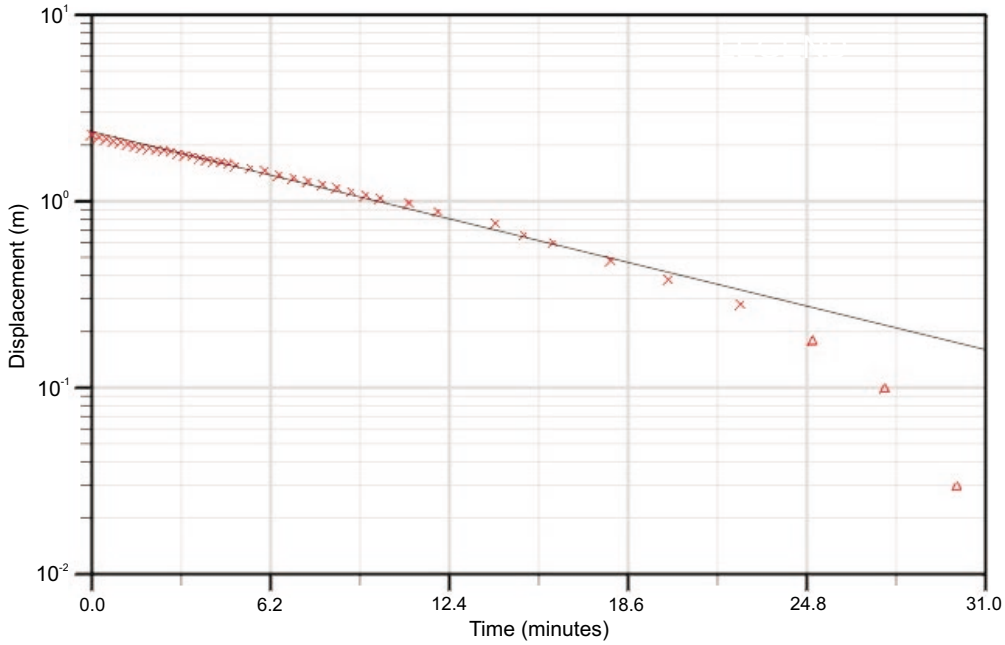
In situ permeability testing

Slug extraction tests were carried out on 14 August 2001 on bores SLL2000/7 and SLL2000/12. Data collected during the slug extraction tests are presented in Appendix 2.

Slug extraction tests were completed (30 to 120 litres) and levels monitored for 30 minutes (time for 95% plus recovery). Test data were analysed in the software package AquiferWin32 (Version 2.17, Environmental Simulations Inc.). The Bouwer and Rice (1976 Unconfined Aquifer) solution was used to calculate the hydraulic conductivities illustrated in Figure 6 (a) and (b) for holes SLL2000/7 and SLL2000/12 respectively. This method was selected as the most appropriate available within the software package.

These results imply that fines (silt) are clogging the sand. Both holes are on the western side of the lagoons, in the area of tidal marsh deposits. During construction excavated local sand was deposited at the location of SLL2000/12 and most likely also to some degree at SLL2000/7. Similar hydraulic conductivities are likely to exist in the beach sand deposits across the site, with lower permeability expected in the undisturbed tidal marsh deposits.

(a) SSL2000/7 (K = 0.14 m/d = 1.67 x 10^{-6} m/sec)



(b) SSL2000/12 (K = 0.21 m/d = 2.46 x 10^{-6} m/sec)

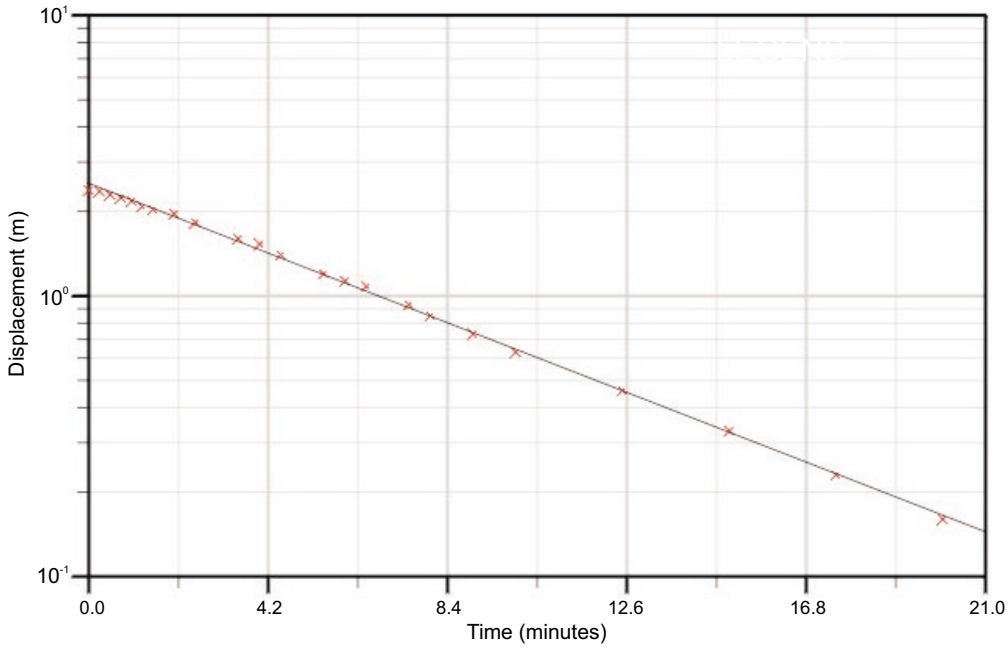


Figure 6

Hydraulic conductivity values calculated in AquiferWin32 Version 2.17, Environmental Simulations Inc., Bouwer and Rice (1976, Unconfined Aquifer) solution

HYDROLOGICAL MODEL

The cross section shown in Figure 5 indicates that the water table slopes towards the west and east. The cross section also suggests a direct hydraulic connection between the groundwater system and the infrastructure of primary lagoons 1 and 2. Because of the depth of water in all other bore holes, all lagoons at the site most likely directly recharge groundwater.

A groundwater mounding effect appears to be associated with the recharge of the unconsolidated Quaternary aquifer by the lagoons, with the mound probably occurring on all sides of the combined lagoon footprints. Plate 4 shows the discoloured water in the eastern area of the site perimeter drain (which could act as a discharge system to the groundwater mound). Groundwater mounding appears to be discharging via the perimeter drain and past monitoring undertaken by the Department of Primary Industries, Water and Environment has detected high ammonia concentrations along the total length of the perimeter drain. Tidal effects are also suspected and may be affecting the groundwater hydraulic regime at this site.

Figure 7 illustrates an interpretation of the piezometric surface based on surveyed heights and groundwater depths of the boreholes. Figure 8 shows a cross-sectional conceptual model of equipotential and related flow lines at Kemps Bay, the southwest sewage sludge stockpiles, the primary sewage lagoons, and farmland to the east. This model could be further defined once the extent and influence of the tidal marsh deposits was quantified.

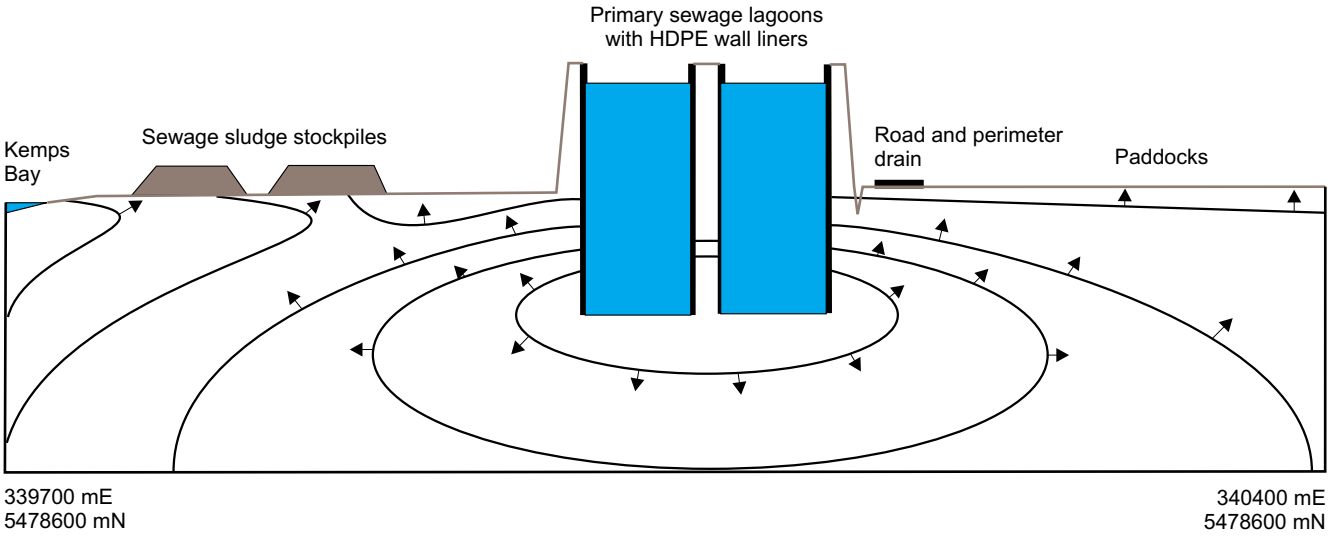


Figure 8

Cross sectional conceptual model of equipotential and related flow lines of Kemps Bay, the southwest sewage sludge stockpiles, the primary sewage lagoons and farmland to the east.

Plate 4

Discoloured water in the eastern area of the site perimeter drain.

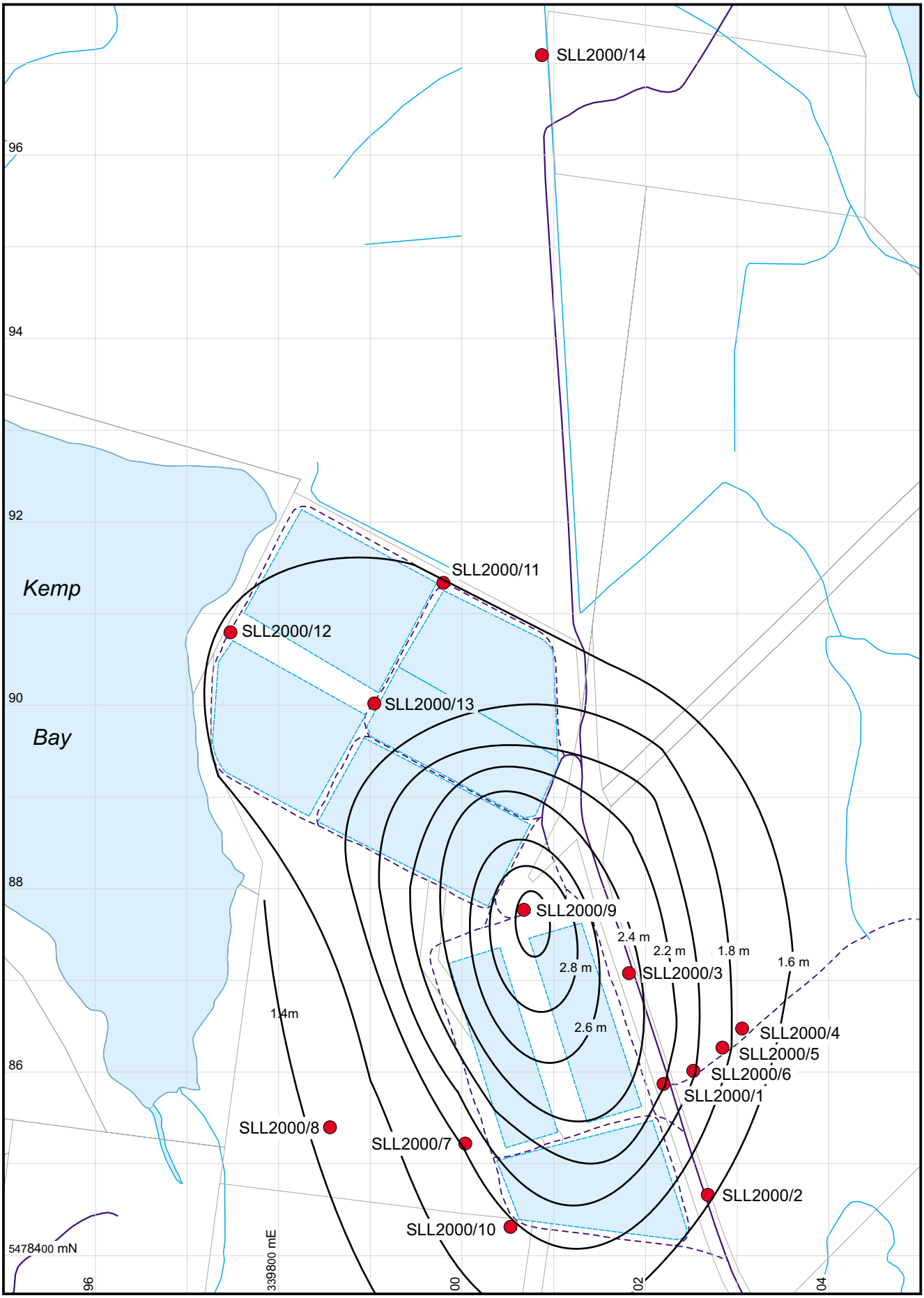


Figure 7

Interpretation of the piezometric surface (mound) based on surveyed heights and groundwater depths of the boreholes (RL metres).

GROUNDWATER CHEMISTRY

All bores were sampled on 1 November 2000 in accordance with Australian/New Zealand Standard AS/NZS 5667.11:1998. Analytical Services Tasmania, in accordance with relevant Australian and international standards, carried out laboratory testing of samples of groundwater extracted from the boreholes. The laboratory report from Analytical Services Tasmania is presented in Appendix 3. Values for pH ranged from 6.5 to 7.4, with conductivity values ranging between 747 and 12 900 µS/cm.

Analytical results are presented on site maps in Appendix 4. Figure 9 is a cation Ternary plot for the results of the groundwater samples, while Tables 1 and 2 are comparisons of the analytical results against international standards where a guideline/emission value is stated by the relevant standard.

Groundwater chemistry varies significantly between the background bore (SLL2000/14) and the thirteen other bores installed in the area of the sewage lagoons. Groundwater in the vicinity of the lagoons has elevated chemical results for selective water quality parameters, including ammonia (some results several orders of magnitude over the legal emission limit), chloride, ortho-phosphate and sulphate. Bores SLL2000/1, 4, 5 and 6 show decreasing ammonia values moving away from the eastern side of the lagoons, which may indicate a natural attenuation process.

The water chemistry on the anion Ternary plot for bores SLL2000/8 and 12 indicates a high proportion of chloride ions. Conductivity and TDS results for these two boreholes suggest that residual salinity most likely occurs within the tidal marsh deposits. The distinct water chemistry for bore SLL2000/9 on the anion Ternary plot is possibly the result of the bore being screened below buried decaying refuse fill material. This is also demonstrated by the highest recorded sulphate value (1400 mg/L) in the groundwater at the site.

CONTAMINATION ASSESSMENT

Significant contamination of groundwater by nitrogen-based ammonia has been identified but the degree and extent of the contamination has not been fully quantified. Natural attenuation appears to be an important process occurring within the contamination plume(s). This microbiological driven process is affecting the groundwater chemistry within the local hydrogeological system. Major groundwater cations and anions also appear to be diluted by leakage from the lagoons via the unconsolidated unconfined aquifer.

Unlined sewage sludge stockpiles may also be releasing some nutrients to the aquifer, although the main source of contamination is considered to be the lagoons themselves.

PRINCIPAL CONCLUSIONS

Major nutrient contamination of groundwater has been confirmed in the area of the Smithton sewage lagoons. The pond bases are below the unconfined water table, which is undesirable. Tidal marsh deposits have the potential to act as an aquitard. A process of natural attenuation appears to be occurring beneath adjacent farmland. Monitored natural attenuation (MNA) is considered the most appropriate action for this site.

FURTHER WORK

Pump tests are required on bores on the eastern side of the lagoons. Further work may quantify the southern and northern extent of the groundwater mound and associated contamination. The calculation of seepage estimates could be undertaken by measuring hydraulic gradients (and assuming a porosity of 0.35).

An electromagnetic (EM31/EM34, TEM) survey is recommended to identify zones of high and low ground conductivity. The survey could help to define the extent of variations in groundwater chemistry and potentially the extent of the groundwater mound associated with the lagoons. The extent and nature of the tidal marsh deposits (residual salinity) should be considered in the analysis of geophysical investigations at the site. This would require more detailed geological mapping of the tidal marsh deposits. Calibration of the mound and migrating plume(s) should also consider both water chemistry and conductivity of the sewage pond water.

Future monitoring of microbiological water quality parameters may help to confirm the extent of the degradation of groundwater quality in the local area and the processes associated with natural attenuation at the site. Monitoring of microbiological water quality parameters is considered to be a priority.

REFERENCES

LENNOX, P. G.; CORBETT, K. D.; BAILLIE, P. W.; CORBETT, E. B.; BROWN, A. V. 1982. *Geological Atlas 1:50 000 Series. Sheet 21 (7916S). Smithton*. Department of Mines Tasmania.

[30 May 2002]

Table 1

Comparison of analytical results against water quality standards (guideline value listed when stated by a relevant standard). Highlighted values exceed emission limits.

Parameter	*2000/1*	*2000/2*	*2000/3*	*2000/4*	*2000/5*	*2000/6*	*2000/7*	*2000/8*	*2000/9*	*2000/10*	*2000/11*	*2000/12*	*2000/13*	*2000/14*	*Emission limit*
pH	7.0	6.7	7.0	7.0	6.5	6.9	7.0	7.1	6.7	7.0	7.4	6.8	6.8	7.2	N/A
Conductivity (µS/cm)	1920	3700	2060	2180	1280	1630	2980	12900	3240	3740	1200	7770	1440	747	N/A: note average sea water value 36 000
TDS (mg/L)	752	1390	877	1260	851	960	2010	8750	2910	-	-	-	-	-	N/A
Alkalinity CO_3 (mg/L)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	N/A
Alkalinity HCO_3 (mg/L)	730	1410	779	672	455	697	761	429	740	1300	312	778	356	252	N/A
Chloride (mg/L)	120	110	140	**380**	110	130	**320**	**4000**	41	**380**	160	**1600**	200	26	250* (mg/L)
Fluoride (mg/L)	0.29	0.40	0.29	0.27	0.09	0.07	**1.5**	1.1	0.05	-	-	-	-	-	1.5* (mg/L)
Sulphate (mg/L)	1.4	**290**	2.7	11	4.8	1.0	**480**	**650**	**1400**	140	3.5	**300**	18	14	250* (mg/L)
Ammonia(mg/L)	**89.3**	**250**	**84.4**	**0.80**	**1.40**	**23.1**	**0.837**	0.406	**12.5**	**11.7**	**16.1**	**24.7**	**33.2**	0.295	0.5* (mg/L) nitrogen (as ammonia)
Nitrate + Nitrite (mg/L)	0.007	0.008	0.006	0.004	0.012	0.008	0.006	0.012	0.006	0.009	0.007	0.012	0.007	2.9	10.0* (mg/L) nitrogen (as nitrate or nitrite)
Nitrite (mg/L)	0.002	0.004	0.002	<0.002	0.007	0.003	<0.002	0.006	0.002	0.004	0.003	0.006	0.003	0.005	10.0* (mg/L) nitrogen (as nitrate or nitrite)
Ortho-P (mg/L)	0.132	1.33	**5.44**	0.004	0.006	0.003	0.007	0.013	0.004	0.012	**2.18**	0.005	0.031	0.01	2.0* as phosphorus

* *Environment Protection (Water Pollution) Regulations* 1974, Emission into inland water ** Australian Water Quality Guidelines for Fresh and Marine Waters, 1992
N/A – no emission limit available ND – not detected

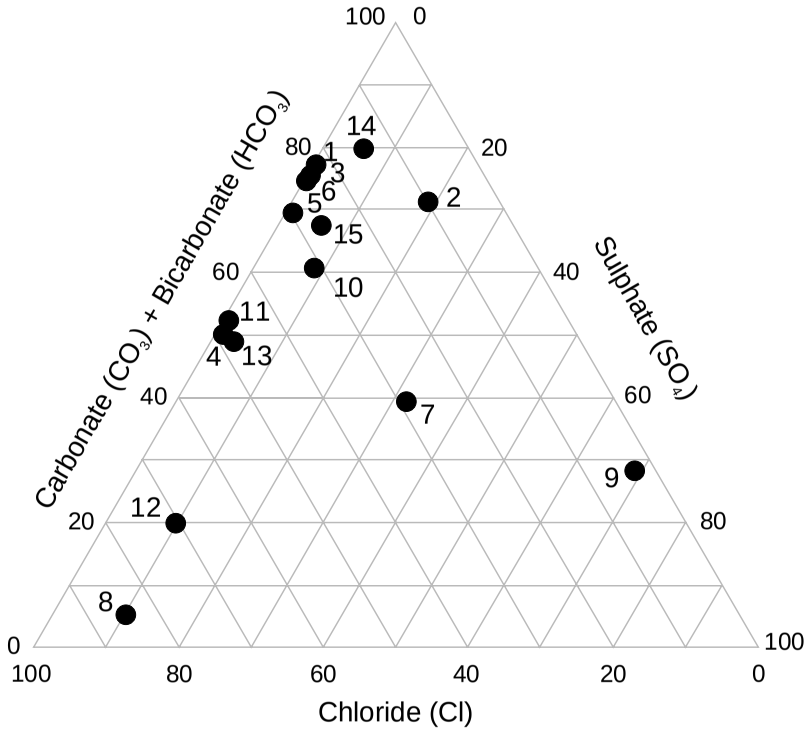


Figure 9

Anion Ternary plot for groundwater bores at the Smithton sewage lagoons.
1 - SLL2000/1; 2 – SLL2000/2; 3 – SLL2000/3; 4 – SLL2000/4; 5 – SLL2000/5;
6 – SLL2000/6; 7 – SLL2000/7; 8 - SLL2000/8; 9 - SLL2000/9;
10 – SLL2000/10; 11 – SLL2000/11; 12 – SLL2000/12; 13 - SLL2000/13; 14 – SLL2000/14;
15 – average of all MRT groundwater records for Quaternary coastal sands.

Table 2

Comparison of analytical results against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000.

	SMITHTON SEWAGE LAGOONS														ANZECC 2000	
Bore hole number (SLL2000/)	1	2	3	4	5	6	7	8	9	10	11	12	13	14 (back ground)	IRRIGATION	LIVESTOCK DRINKING
Analyte															STV (Short-term) / LTV (Long-term)	
Standing Water Level (m)	0.63	0.98	0.32	0.80	1.01	0.65	0.50	0.46	2.65	3.74	1.35	1.50	1.55	1.05		
pH - laboratory (pH Units)	7.0	6.7	7.0	7.0	6.5	6.9	7.0	7.1	6.7	7.0	7.4	6.8	6.8	7.2	**6.0-8.5	
Conductivity (µS/cm)	1920	3700	2060	2180	1280	1630	2980	12900	3240	3740	1200	7770	1440	747	(1) (Refer Tables 4.2.3 & 4.2.4)	
TDS (mg/L)	752	1390	877	1260	851	960	2010	8750	2910	-	-	-	-	-		(2) 2,000–10,000 (Refer Table 4.3.1)
Chloride (mg/L)	120	110	40	380	110	130	320	4000	41	380	160	1600	200	26	(3) MT (Refer Table 4.2.6) MR (Refer Table 4.2.7)	
Fluoride (mg/L)	0.29	0.4	0.29	0.27	0.09	0.07	1.5	1.1	0.05	-	-	-	-	-	4 / 1	
Sulphate (mg/L)	1.4	290	2.7	11	4.8	1.0	480	650	1400	140	3.5	300	18	14		
NH_3-N (mg/L)	89.3	250	84.4	0.8	1.44	23.1	0.837	0.406	12.5	117	16.1	24.7	33.2	0.295		
(NO_2 + NO_3)-N (mg/L)	0.007	0.008	0.006	0.004	0.012	0.008	0.006	0.012	0.006	0.009	0.007	0.012	0.007	2.9		
NO_2-N (mg/L)	0.002	0.004	0.002	<0.002	0.007	0.003	<0.002	0.006	0.002	0.004	0.003	0.006	0.003	0.005		
PO_4-P (mg/L)	0.321	1.33	5.44	0.004	0.006	0.003	0.007	0.013	0.004	0.012	2.18	0.005	0.031	0.01		

Shaded areas indicate values above relevant guideline levels

Notes: ** set to limit potential for corrosion and fouling of pumping, irrigation and stock watering systems

*** Chromium (VI)

(1) Suitability depends on salt tolerance of crop & calculation of ECse, the average root zone salinity. ECse depends on soil type & average root zone leaching fraction

(2) depending on animal type

(3) ES = Suits extremely sensitive crops
MT = Suits moderately tolerant crops
MR = Medium risk of increasing crop cadmium concentrations

STV — Short term trigger value for contaminant in irrigation water (<20 years) use

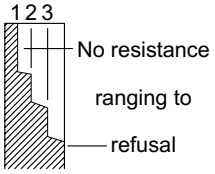
LTV — Long term trigger value for contaminant in irrigation water (100 years) use

Appendix 1

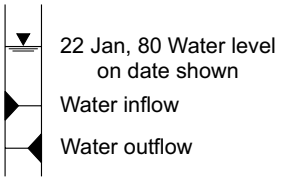
Engineering logs

EXPLANATION SHEET FOR ENGINEERING LOGS
Borehole and excavation log

Penetration



Water



Notes — samples and tests

U50	Undisturbed sample 50 mm diameter
D	Disturbed sample
N	Standard penetrometer blow count for 300 mm
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 feels 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

e.g. M>PL — Moist, moisture content greater than the plastic limit

Consistency

		: hand penetrometer
VS	Very soft	<25 (kPa)
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

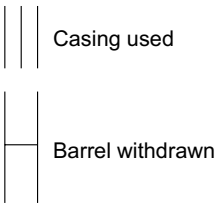
		%
VL	Very loose	0 – 15
L	Loose	15 – 35
MD	Medium dense	35 – 65
D	Dense	65 – 85
VD	Very dense	85 – 100

Fracture description

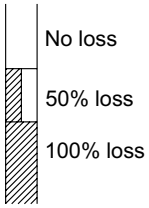
RP	Rough planar
RL	Rough irregular
SP	Smooth planar
SL	Smooth irregular

Cored borehole log

Case - lift



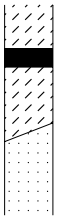
Fluid loss



Lugeons

Lugeon units (uL) are a measure of rock mass permeability. For a 46 to 74 mm 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 x 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

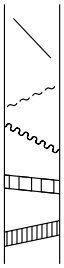
Strength

		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

Notes: X on log is test result.

Significant defects

Significant defects shown graphically



MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/1**
Sheet 1 of 1

Project	Smithton sewage lagoons			Location	Pelican Point, Smithton
Co-ordinates	55 340219 mE 5478587 mN	Drill type	Auger	Hole commenced	30 August 2000
		Drill method	Rotary	Hole completed	30 August 2000
R.L.		Drill fluid	Nil	Drilled by	Mr Shane Heawood
Inclination	Vertical			Logged by	Mr Andrew Ezzy
Bearing				Checked by	Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1	0.0		SM	SAND - fine, black	M	S L	Quaternary windblown sand
			D Sample ID 2	0.5						
		7 mm Gravel	D Sample ID 3	1.0		SP	SAND- medium, grey	W	VS VL	Quaternary beach sand
			D Sample ID 4	1.5						
	1.5 metre Screen - 4 x 150mm spaced 5mm holes		D Sample ID 5	2.0						
			D Sample ID 6	2.5						
		Back fill	D Sample ID 7	3.0						
	No Screen		D Sample ID 8	3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Hand bailed for 10 minutes At end of bailing, pH 7.2 and conductivity 1850 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/2**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340268 mE
5478466 mN

R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 30 August 2000
Hole completed 30 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SP	SAND - medium, dark grey, various rock chips	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - medium, grey, 10% clay mottled black	M	L S	Quaternary beach sand with decayed organics
			D Sample ID 3	1.0		SP	SAND - medium, grey, strong organic odour	W	L S	Quaternary sand zone enriched in organic gases
		7 mm Gravel	D Sample ID 4	1.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	1.5 metre slotted screen		D Sample ID 5	2.0						
			D Sample ID 6	2.5						
			D Sample ID 7	3.0						
	No Screen	Back fill	D Sample ID 8	3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 60 minutes at 3 L/m. At end of pumping, pH 6.7 and conductivity unstable.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/3**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340182 mE
5478708 mN

R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 30 August 2000
Hole completed 30 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
		Bentonite	D Sample ID 1			SP	SAND - medium, dark grey, quartzite fragments	M	S L	Reworked Quaternary material
	No Screen		D Sample ID 2	0.5		SP	SAND - medium, grey, 15% clay mottled black	M	VL VS	Quaternary sand with decayed organics
			D Sample ID 3	1.0		SP	SAND - medium, grey	W	VL S	Quaternary beach sand
			D Sample ID 4	1.5		SP	SAND -medium, grey	W	VS VL	Quaternary beach sand
	1.5 metre slotted screen	7 mm Gravel	D Sample ID 5	2.0						
			D Sample ID 6	2.5						
			D Sample ID 7	3.0						
	No Screen	Back fill	D Sample ID 8	3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 0.6 L/m. At end of pumping, pH 7.4 and conductivity 1810 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/4**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340306 mE
5478647 mN

R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 30 August 2000
Hole completed 30 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
		Bentonite	D Sample ID 1			SM	SAND -medium, mottled dark grey and light yellow	M	S L	Reworked Quaternary material
	No Screen		D Sample ID 2	0.5		SP	SAND - medium, grey, 5% sand mottled light red	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SP	SAND - medium, dark grey	M	VL VS	Quaternary beach sand
			D Sample ID 4	1.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	1.5 metre slotted screen	7 mm Gravel	D Sample ID 5	2.0						
			D Sample ID 6	2.5						
		Back fill	D Sample ID 7	3.0						
	No Screen		D Sample ID 8	3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 7 L/m. At end of pumping, pH 7.4 and conductivity 1840 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/5**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340284 mE
5478626 mN
R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 30 August 2000
Hole completed 30 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	structure, geology
	No Screen	Bentonite	D Sample ID 1				SM	SAND - medium, grey, 10% clay black mottles	M	S L	Reworked Quaternary material
			D Sample ID 2		0.5		SP	SAND - fine, black and brown	M	S L	Quaternary windblown sand
			D Sample ID 3		1.0		SP	SAND - fine, light grey, 5% sand black	W	S L	Quaternary windblown sand
			D Sample ID 4		1.5		SP	SAND - medium, light yellow-brown	W	VS VL	Quaternary dune sand
	1.5 metre Screen - 4 x 150mm spaced 5mm holes				2.0						
					2.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
					3.0						
					3.5						
	No Screen				4.0						
			Sample ID numbers refer to samples stored in MRT core shed					End of hole at 4.0 m Pumped for 30 minutes at 3 L/m. At end of pumping, pH 6.8 and conductivity 940 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/6**
Sheet 1 of 1

Project: Smithton sewage lagoons
Location: Pelican Point, Smithton

Co-ordinates: 55 340253 mE, 5478602 mN
R.L.
Inclination: Vertical
Bearing

Drill type: Auger
Drill method: Rotary
Drill fluid: Nil

Hole commenced: 31 August 2000
Hole completed: 31 August 2000
Drilled by: Mr Shane Heawood
Logged by: Mr Andrew Ezzy
Checked by: Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SM	SAND - medium, black, clayey	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - fine, light yellow, sand mottled grey	W	VS L	Quaternary windblown sand
			D Sample ID 3	1.0		SP	SAND - medium to coarse, light yellow-brown	W	VS VL	Quaternary dune sand
	1.5 metre slotted screen	7 mm Gravel	D Sample ID 4	1.5 / 2.0		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	No Screen	Back fill		2.5 / 3.0 / 3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 0.5 L/m. At end of pumping, pH 7.2 and conductivity 1480 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/7**
Sheet 1 of 1

Project: Smithton sewage lagoons
Location: Pelican Point, Smithton

Co-ordinates: 55 340003 mE, 5478522 mN
R.L.
Inclination: Vertical
Bearing

Drill type: Auger
Drill method: Rotary
Drill fluid: Nil

Hole commenced: 31 August 2000
Hole completed: 31 August 2000
Drilled by: Mr Shane Heawood
Logged by: Mr Andrew Ezzy
Checked by: Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SM	SAND - medium, black-grey, quartzite chips up to 100 mm x 30 mm	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - medium, black-grey, various rock fragments	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SP	SAND - fine, light yellow- brown	M	S L	Quaternary windblown sand
		7 mm Gravel	D Sample ID 4	1.5		SP	SAND - medium, light yellow-brown	W	VL VS	Quaternary dune sand
	1.5 metre slotted screen		D Sample ID 5	2.0						
			D Sample ID 6	2.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
				3.0						
	No Screen	Back fill	D Sample ID 7	3.5		OL	CLAY - dark grey	W	F	Quaternary tidal marsh deposit
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 0.3 L/m. At end of pumping, pH 6.8 and conductivity 1390 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/8**
Sheet 1 of 1

Project	Smithton sewage lagoons	Location	Pelican Point, Smithton
Co-ordinates	55 339856 mE 5478540 mN	Drill type	Auger
		Drill method	Rotary
		Drill fluid	Nil
R.L.		Hole commenced	31 August 2000
Inclination	Vertical	Hole completed	31 August 2000
Bearing		Drilled by	Mr Shane Heawood
		Logged by	Mr Andrew Ezzy
		Checked by	Mr Adrian Waite

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	structure, geology
		Bentonite	D Sample ID 1			SM	SAND - fine, dark grey, 30% orange	M	L	Quaternary windblown sand
	No Screen		D Sample ID 2	0.5		SP	SAND - fine, grey, white and light red	M	S L	Quaternary windblown sand
		7 mm Gravel	D Sample ID 3	1.0		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	1.5 metre slotted screen		D Sample ID 4	2.5		SM	SAND - fine to medium, dark grey and black, silty	W	VS VL	Quaternary tidal marsh deposit
	No Screen	Back fill	D Sample ID 5	3.5		SM	SAND - fine, dark brown, silty, strong organic odour	W	VL VS	Quaternary tidal marsh deposit
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 1.2 L/m. At end of pumping, pH 7.4 and conductivity 1660 µS/cm. **Extreme H_2S odour from bore while installing gravel pack and during pumping**. (Vapour gas masks worn) ***OH&S warning for future monitoring of this bore.***			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/9**
Sheet 1 of 2

Project	Smithton sewage lagoons			Location	Pelican Point, Smithton
Co-ordinates	55 340068 mE 5478777 mN	Drill type	Auger	Hole commenced	31 August 2000
		Drill method	Rotary	Hole completed	31 August 2000
R.L.		Drill fluid	Nil	Drilled by	Mr Shane Heawood
Inclination	Vertical			Logged by	Mr Andrew Ezzy
Bearing				Checked by	Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SP	SAND - fine to medium, light yellow-brown	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5			WASTE FILL - wood and plastic, sand, light yellow-brown	M		Domestic refuse
			D Sample ID 3	1.5			WASTE FILL - wood and plastic, sand, light red-grey	M		Domestic refuse
		7 mm Gravel	D Sample ID 4	2.0			WASTE FILL - wood and plastic, sand, light brown-grey	M		Domestic refuse
			D Sample ID 5	2.5		SP	SAND - fine to medium, light brown-grey	W	S L	Reworked Quaternary material
	2.0 metre slotted screen		D Sample ID 6	3.0		SP	SAND - medium, grey	W	VL VS	Quaternary beach sand
	No Screen	Back fill		3.5						
				4.0						
				4.5						

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/9**
Sheet 2 of 2

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340068 mE
5478777 mN

R.L.

Inclination Vertical

Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 31 August 2000
Hole completed 31 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	structure, geology
	Back fill							(As sheet 1)			
					5.5			End of hole at 5.5 m Pumped for 30 minutes at 0.7 L/m. At end of pumping, pH 7.5 and conductivity 1760 µS/cm. Note: Water samples had detergent foam on surface.			

Sample ID numbers refer to samples stored in MRT core shed

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/10**
Sheet 1 of 2

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340053 mE 5478431 mN
R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 31 August 2000
Hole completed 31 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
		Bentonite	D Sample ID 1			SP	SAND - fine to medium, light grey	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - medium, dark grey and light yellow, metamorphic rock chips	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SP	SAND - fine to medium, light brown-grey, metamorphic rock chips	M	S L	Reworked Quaternary material
	No Screen	7 mm Gravel		1.5 2.0 2.5						
				3.0		SP	SAND - medium, brown-grey	W	L S	Reworked Quaternary material
			D Sample ID 4	3.5 4.0						
			D Sample ID 5	4.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/10**
Sheet 2 of 2

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340068 mE
5478777 mN

R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 31 August 2000
Hole completed 31 August 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
	1.5 metre slotted screen	7 mm Gravel		5.5			(As sheet 1)			
				6.0						
		Back fill		6.5						
	No Screen		D Sample ID 6			CL	CLAY - dark grey, shell fragments	W	L	Quaternary tidal marsh deposit
				7.0						
			Sample ID numbers refer to samples stored in MRT core shed				End of hole at 7.0 m Pumped for 30 minutes at 0.4 L/m. At end of pumping, pH 7.5 and conductivity 1860 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/11**
Sheet 1 of 1

Project: Smithton sewage lagoons — Location: Pelican Point, Smithton

Co-ordinates: 55 339980 mE, 5479134 mN
R.L.
Inclination: Vertical
Bearing

Drill type: Auger
Drill method: Rotary
Drill fluid: Nil

Hole commenced: 5 September 2000
Hole completed: 5 September 2000
Drilled by: Mr Shane Heawood
Logged by: Mr Andrew Ezzy
Checked by: Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SP	SAND - fine, light yellow, rock fragments	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - medium, light and dark grey	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SC	SAND - fine, black, clayey, sand light yellow	M	S L	Reworked Quaternary tidal marsh deposit
			D Sample ID 4	1.5		SP	SAND - fine, grey-brown	M	S L	Reworked Quaternary tidal marsh deposit
	1.5 metre slotted screen	7 mm Gravel	D Sample ID 5	2.0		SP	SAND - fine to medium, grey-brown	W	VL S	Reworked Quaternary tidal marsh deposit
		?	D Sample ID 6	2.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	No Screen	Back fill		3.0						
				3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 4 L/m. At end of pumping, pH 7.5 and conductivity 1180 µS/cm. Note: During pumping water had very strong H_2S odour.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/12**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 339748 mE
5479080 mN

R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 5 September 2000
Hole completed 5 September 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SP	SAND - fine, light yellow, rock fragments	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SP	SAND - medium, black, rock fragments	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SP	SAND - medium, brown-grey	M	S L	Reworked Quaternary tidal marsh deposit
		7 mm Gravel	D Sample ID 4	1.5		SC	SAND - fine, grey, clayey	M	S L	Reworked Quaternary tidal marsh deposit
	1.5 metre slotted screen		D Sample ID 5	2.0		SC	SAND - fine to medium, grey, clayey, shell fragments	M	S L	Reworked Quaternary tidal marsh deposit and beach sand
			D Sample ID 6	2.5		SM	SAND - fine to medium, grey, silty	W	VS VL	Reworked Quaternary tidal marsh deposit and beach sand
			D Sample ID 7	3.0		SP	SAND -medium, grey, quartzite rock fragments	W	VS VL	Reworked Quaternary beach sand including imported rock
	No Screen	Back fill		3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 0.4 L/m. At end of pumping, pH 7.6 and conductivity 1280 µS/cm. Note: During pumping water had strong detergent appearance and odour.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/13**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 339904 mE
5479002 mN
R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 5 September 2000
Hole completed 5 September 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

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	structure, geology
	No Screen	Bentonite	D Sample ID 1			SP	SAND - medium, dark grey, quartzite fragments	M	S L	Reworked Quaternary material
			D Sample ID 2	0.5		SM	SAND - fine to medium, mottled light yellow, light red, dark grey and black, silty	M	S L	Reworked Quaternary material
			D Sample ID 3	1.0		SM	SAND - fine to medium, mottled dark brown-grey and light yellow, silty	M	S L	Reworked Quaternary material
		7 mm Gravel	D Sample ID 4	1.5		SP	SAND - fine to medium, dark brown and light grey	M	S L	Reworked Quaternary tidal marsh deposit
	1.5 metre slotted screen		D Sample ID 5	2.0		SP	SAND - medium, dark and light grey	M	S L	Reworked Quaternary beach sand
			D Sample ID 6	2.5		SP	SAND - medium, grey	W	S L	Quaternary beach sand
		?	D Sample ID 7	3.0		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
	No Screen	Back fill	D Sample ID 8	3.5						
			Sample ID numbers refer to samples stored in MRT core shed	4.0			End of hole at 4.0 m Pumped for 30 minutes at 3.2 L/m. At end of pumping, pH 7.3 and conductivity 1560 µS/cm.			

MINERAL RESOURCES TASMANIA

ENGINEERING LOG - BOREHOLE

Borehole no. **SLL2000/14**
Sheet 1 of 1

Project Smithton sewage lagoons — Location Pelican Point, Smithton

Co-ordinates 55 340087 mE
5479709 mN
R.L.
Inclination Vertical
Bearing

Drill type Auger
Drill method Rotary
Drill fluid Nil

Hole commenced 5 September 2000
Hole completed 5 September 2000
Drilled by Mr Shane Heawood
Logged by Mr Andrew Ezzy
Checked by Mr Adrian Waite

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	structure, geology
	No Screen	Bentonite	D Sample ID 1				SP	SAND - fine to medium, dark brown and dark grey	M	S L	Reworked Quaternary material
			D Sample ID 2		0.5		SP	SAND - fine to medium, brown, light and dark grey	W	VS L	Reworked Quaternary material
	2.5 metre slotted screen	7 mm Gravel	D Sample ID 3 Major		1.0		SP	SAND - fine, light brown-grey	W	VS VL	Quaternary windblown sand
			D Sample ID 4		1.5		SP	SAND - fine, light yellow	W	VS VL	Quaternary windblown sand
			D Sample ID 5		2.0		SM	SAND - fine, grey, silty	W	VS VL	Quaternary windblown sand
			D Sample ID 6		2.5		SP	SAND - medium, grey	W	VS VL	Quaternary beach sand
			D Sample ID 7		3.0		SP	SAND - medium, grey, shell fragments	W	VS VL	Quaternary beach sand
	No Screen	Back fill	D Sample ID 8		3.5						
			Sample ID numbers refer to samples stored in MRT core shed		4.0			End of hole at 4.0 m Pumped for 45 minutes at 12 L/m. At end of pumping, pH 7.4 and conductivity 790 µS/cm.			

Appendix 2

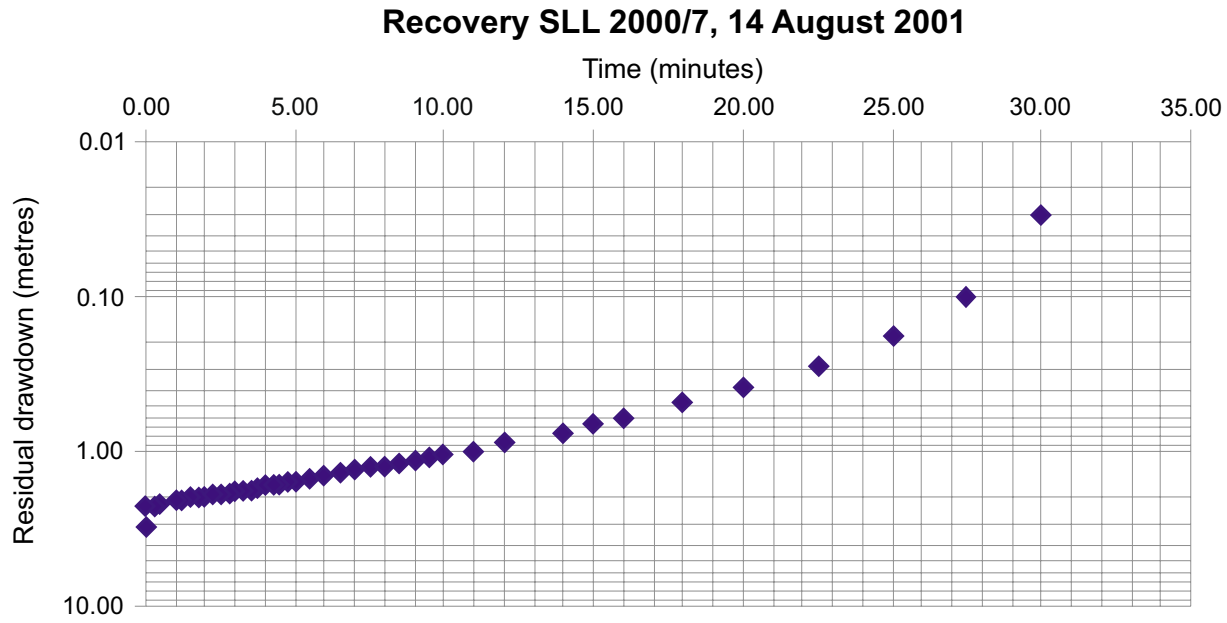
Raw data collected for slug extraction tests

Smithton lagoons pump tests — slug extraction recovery data

Date	14/08/2001
Bore	SLL 2000/7
TD	4.00 m
Flow	1.6 l/m
SWL	1.02 m

Recovery data

Time	*Residual drawdown*	*Measurement*	*Time*	*Residual drawdown*	*Measurement*
0.00	2.28	3.30	5.50	1.51	2.53
0.25	2.21	3.23	6.00	1.46	2.48
0.50	2.16	3.18	6.50	1.39	2.41
0.75	2.10	3.12	7.00	1.34	2.36
1.00	2.08	3.10	7.50	1.28	2.30
1.25	2.03	3.05	8.00	1.23	2.25
1.50	1.98	3.00	8.50	1.18	2.20
1.75	1.96	2.98	9.00	1.13	2.15
2.00	1.93	2.95	9.50	1.08	2.10
2.25	1.90	2.92	10.00	1.04	2.06
2.50	1.88	2.90	11.00	0.98	2.00
2.75	1.85	2.87	12.00	0.88	1.90
3.00	1.81	2.83	14.00	0.76	1.78
3.25	1.78	2.80	15.00	0.66	1.68
3.50	1.76	2.78	16.00	0.60	1.62
3.75	1.71	2.73	18.00	0.48	1.50
4.00	1.68	2.70	20.00	0.38	1.40
4.25	1.65	2.67	22.50	0.28	1.30
4.50	1.63	2.65	25.00	0.18	1.20
4.75	1.59	2.61	27.50	0.10	1.12
5.00	1.56	2.58	30.00	0.03	1.05

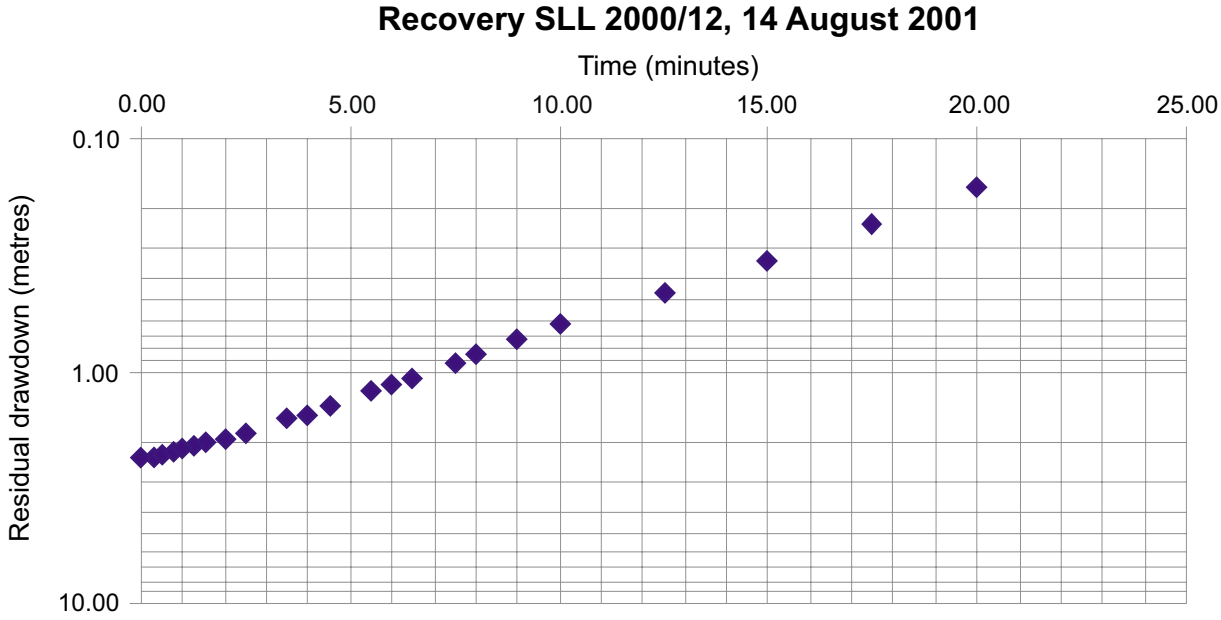


Smithton lagoons pump tests — slug extraction recovery data

Date	14/08/2001
Bore	SLL 2000/12
TD	4.00 m
Flow	4.0 l/m
SWL	1.62 m

Recovery data

Time	*Residual drawdown*	*Measurement*
0.00	2.38	4.00
0.25	2.36	3.98
0.50	2.30	3.92
0.75	2.24	3.86
1.00	2.18	3.80
1.25	2.08	3.70
1.50	2.03	3.65
2.00	1.96	3.58
2.50	1.83	3.45
3.50	1.60	3.22
4.00	1.53	3.15
4.50	1.40	3.02
5.50	1.20	2.82
6.00	1.13	2.75
6.50	1.08	2.70
7.50	0.93	2.55
8.00	0.85	2.47
9.00	0.73	2.35
10.00	0.63	2.25
12.50	0.46	2.08
15.00	0.33	1.95
17.50	0.23	1.85
20.00	0.16	1.78



Appendix 3

Analytical Services Tasmania — Laboratory reports

Tasmania

ANALYTICAL SERVICES TASMANIA
Sandy Bay Laboratory
c|- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005
Telephone: (03) 6226 7175 Fax: (03) 6226 7825
Email: ast.sandybay@dpiwe.tas.gov.au

NATA Accreditation Number: 5589

Laboratory Report

Report No:	13773	***Please quote this number when making enquiries about this report***	
Submitted By:	Andrew Ezzy		
Client:	Mineral Resources Tasmania		
Site Description:	Smithton Sewage Lagoons		
Received:	03-Nov-00	**Client Order No:**	
Report Date:	01-Dec-00		
Report To:	Andrew Ezzy		
Address:	Gordons Hill Rd Rosny TAS 7018		

Test Method(s) :

1001-Water:	pH in Water by APHA Method 4500-H
1002-Water:	Conductivity by APHA Method 2510
1004-Water:	Solids, Total Dissolved by APHA Method 2540C
1101-Water:	Alkalinity by APHA Method 2320/4500-CO2
1103-Water:	Anions by Ion Chromatography APHA Method 4110C
1201-Water:	Nutrients by APHA Method 4500

NATA endorsed test report.
This document shall not be reproduced, except in full.
Samples analysed as received.

NATA Accreditation Number: 5589

Mike Johnson
Manager

Tasmania

ANALYTICAL SERVICES TASMANIA
Sandy Bay Laboratory
c|- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005

NATA Accreditation Number: 5589

Report No: 13773 **Report Date:** 01-Dec-00

		Lab.No.:	13089	13090	13091	13092	13093
		Sample Id.:	SLL 2000/1	SLL 2000/2	SLL 2000/3	SLL 2000/4	SLL 2000/5
Method	**Analyte**	**Units / Sampled On :**	01/11/00 14:25	01/11/00 13:50	01/11/00 16:00	01/11/00 15:45	01/11/00 15:20
1001-Water	pH		7.0	6.7	7.0	7.0	6.5
1002-Water	Conductivity	µS/cm	1920	3700	2060	2180	1280
1004-Water	TDS	mg/L	752	1390	877	1260	851
1101-Water	Alkalinity CO3	mg/L CaCO3	<1	<1	<1	<1	<1
	Alkalinity HCO3	mg/L CaCO3	730	1410	779	672	455
1103-Water	Chloride	mg/L	120	110	140	380	110
	Fluoride	mg/L	0.29	0.40	0.29	0.27	0.09
	Sulphate	mg/L	1.4	290	2.7	11	4.8
1201-Water	Ammonia	µg-N/L	89300	250000	84400	800	1440
	Nitrate+Nitrite	µg-N/L	7	8	6	4	12
	Nitrite	µg-N/L	2	4	2	<2	7
	Ortho-P	µg-P/L	132	1330	5440	4	6

Tasmania

ANALYTICAL SERVICES TASMANIA
Sandy Bay Laboratory
c|- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005

NATA Accreditation Number: 5589

Report No: 13773 **Report Date:** 01-Dec-00

		Lab.No.:	13094	13095	13096	13097	13098
		Sample Id.:	SLL 2000/6	SLL 2000/7	SLL 2000/8	SLL 2000/9	SLL 2000/10
Method	**Analyte**	**Units / Sampled On :**	01/11/00 14:50	01/11/00 10:40	01/11/00 11:25	01/11/00 09:10	01/11/00 10:05
1001-Water	pH		6.9	7.0	7.1	6.7	7.0
1002-Water	Conductivity	µS/cm	1630	2980	12900	3240	3740
1004-Water	TDS	mg/L	960	2010	8750	2910	
1101-Water	Alkalinity CO3	mg/L CaCO3	<1	<1	<1	<1	<1
	Alkalinity HCO3	mg/L CaCO3	697	761	429	740	1300
1103-Water	Chloride	mg/L	130	320	4000	41	380
	Fluoride	mg/L	0.07	1.5	1.1	0.05	
	Sulphate	mg/L	1.0	480	650	1400	140
1201-Water	Ammonia	µg-N/L	23100	837	406	12500	117000
	Nitrate+Nitrite	µg-N/L	8	6	12	6	9
	Nitrite	µg-N/L	3	<2	6	2	4
	Ortho-P	µg-P/L	3	7	13	4	12

Tasmania

ANALYTICAL SERVICES TASMANIA
Sandy Bay Laboratory
c|- Chemistry Department University of Tasmania
Sandy Bay Tasmania 7005

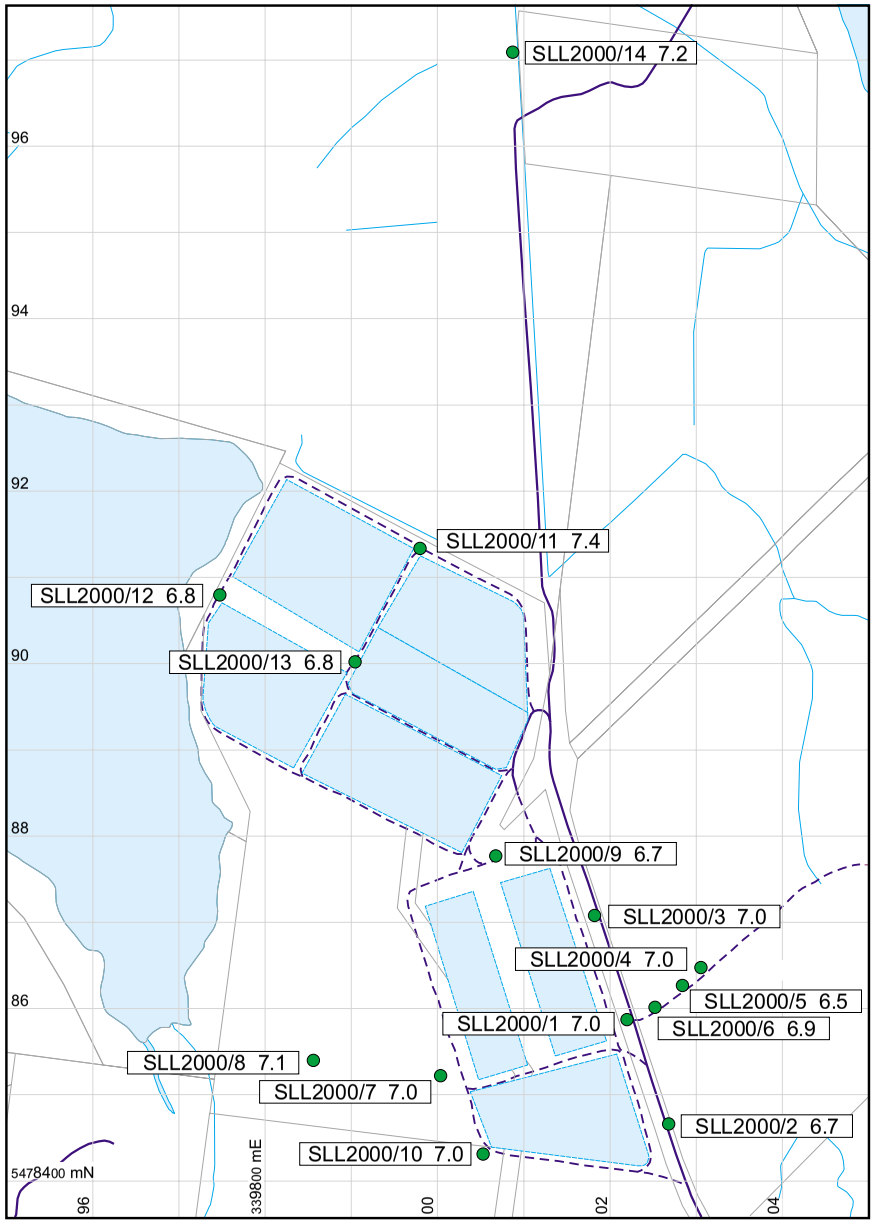
NATA Accreditation Number: 5589

Report No: 13773 **Report Date:** 01-Dec-00

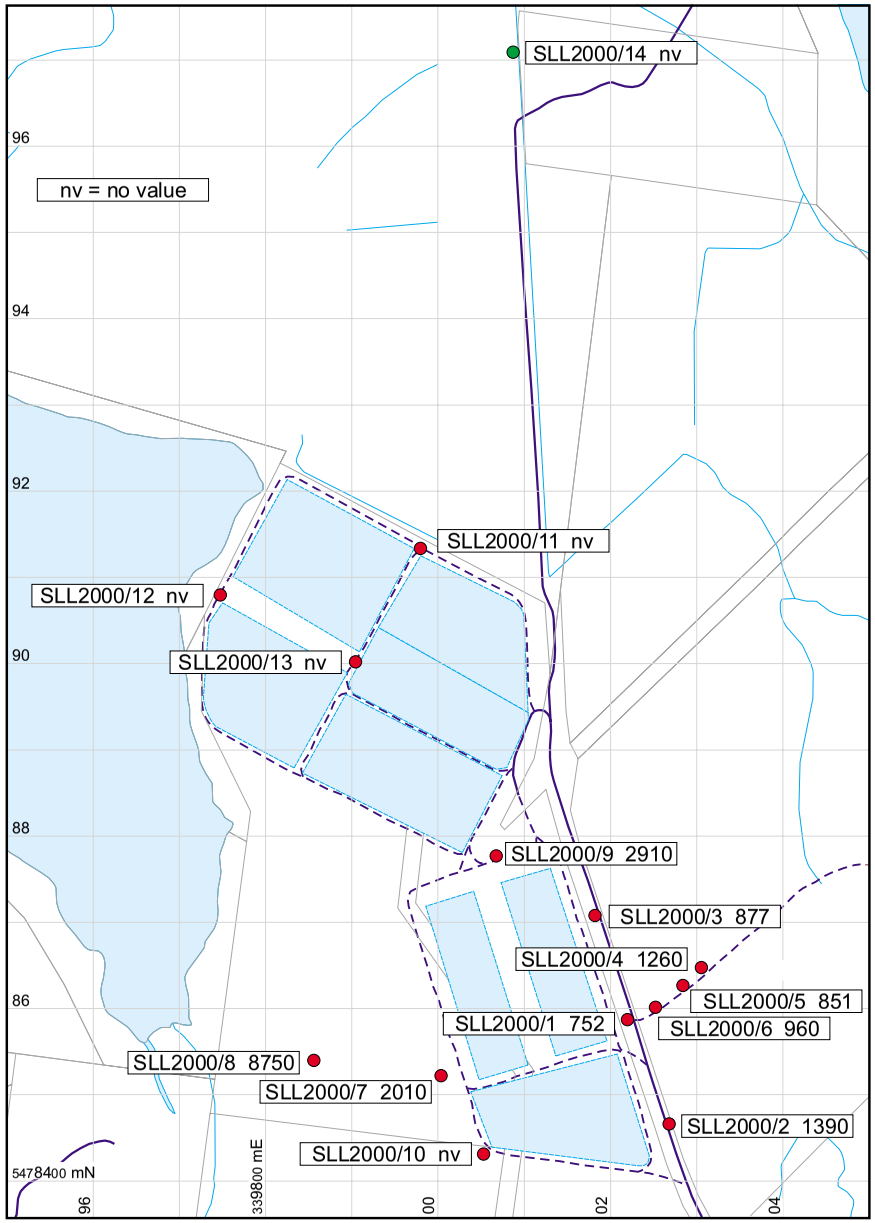
		Lab.No.:	13099	13100	13101	13102
		Sample Id.:	SLL 2000/11	SLL 2000/12	SLL 2000/13	SLL 2000/14
Method	**Analyte**	**Units / Sampled On :**	01/11/00 12:10	01/11/00 12:40	01/11/00 13:25	01/11/00 16:30
1001-Water	pH		7.4	6.8	6.8	7.2
1002-Water	Conductivity	µS/cm	1200	7770	1440	747
1101-Water	Alkalinity CO3	mg/L CaCO3	<1	<1	<1	<1
	Alkalinity HCO3	mg/L CaCO3	312	778	356	252
1103-Water	Chloride	mg/L	160	1600	200	26
	Sulphate	mg/L	3.5	300	18	14
1201-Water	Ammonia	µg-N/L	16100	24700	33200	295
	Nitrate+Nitrite	µg-N/L	7	12	7	2900
	Nitrite	µg-N/L	3	6	3	5
	Ortho-P	µg-P/L	2180	5	31	10

Appendix 4
Analytical results on site maps

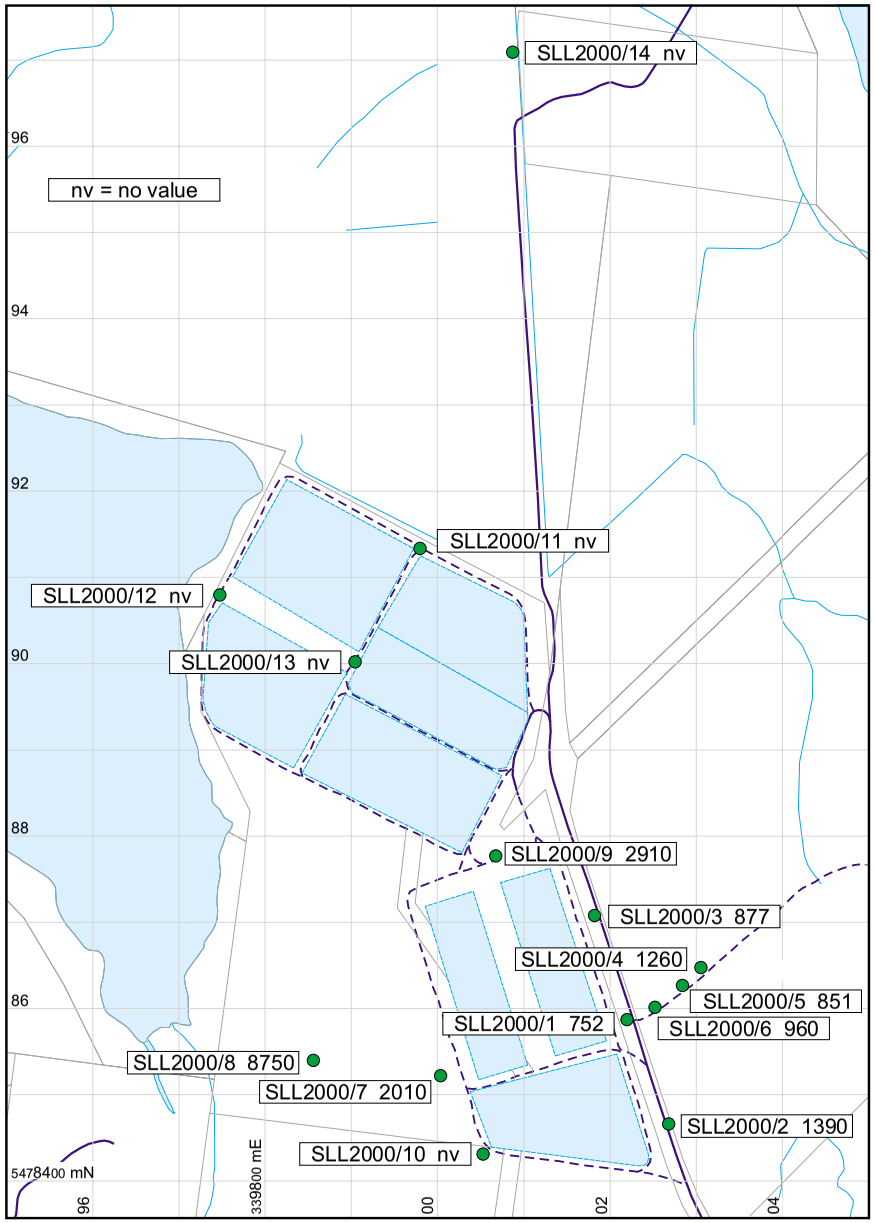
Smithton sewage lagoons — November 2000
pH



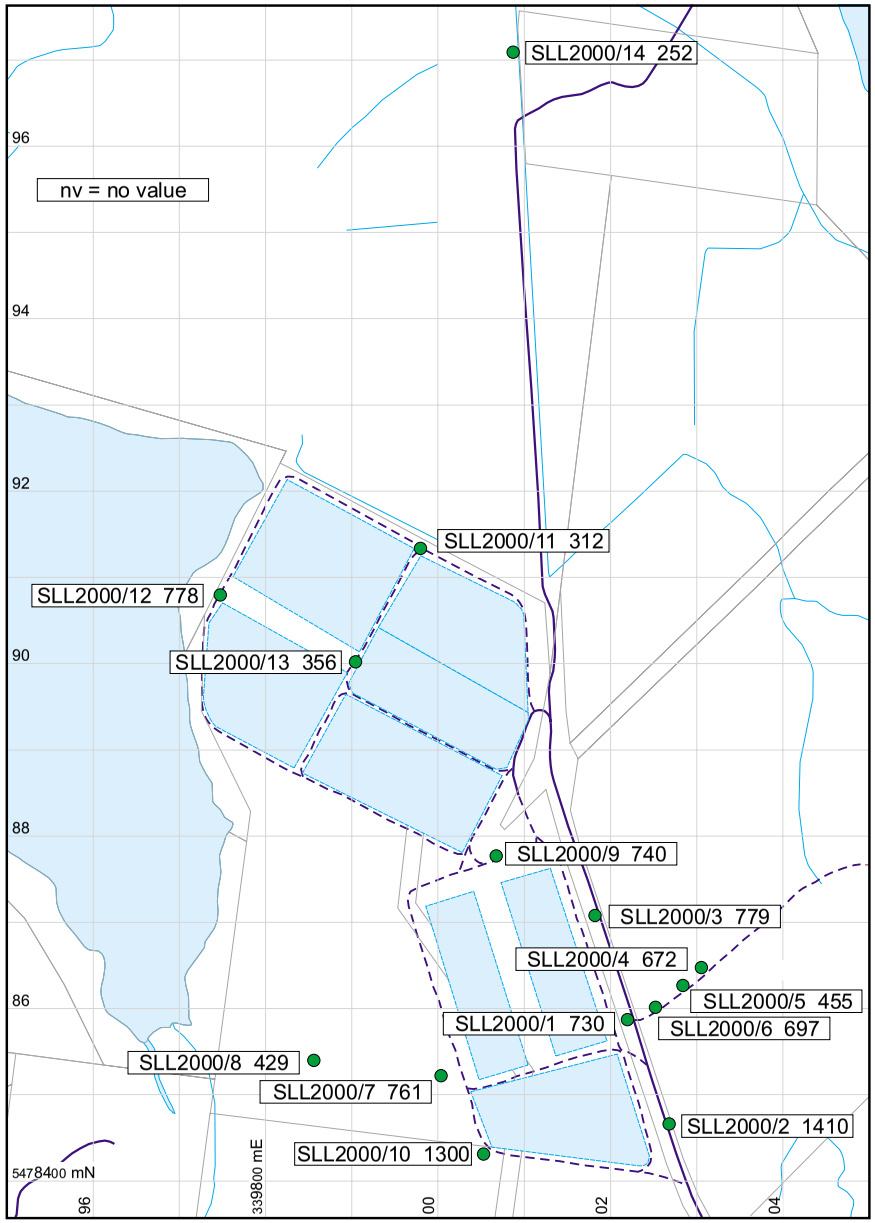
Smithton sewage lagoons — November 2000
Conductivity (mg/L)



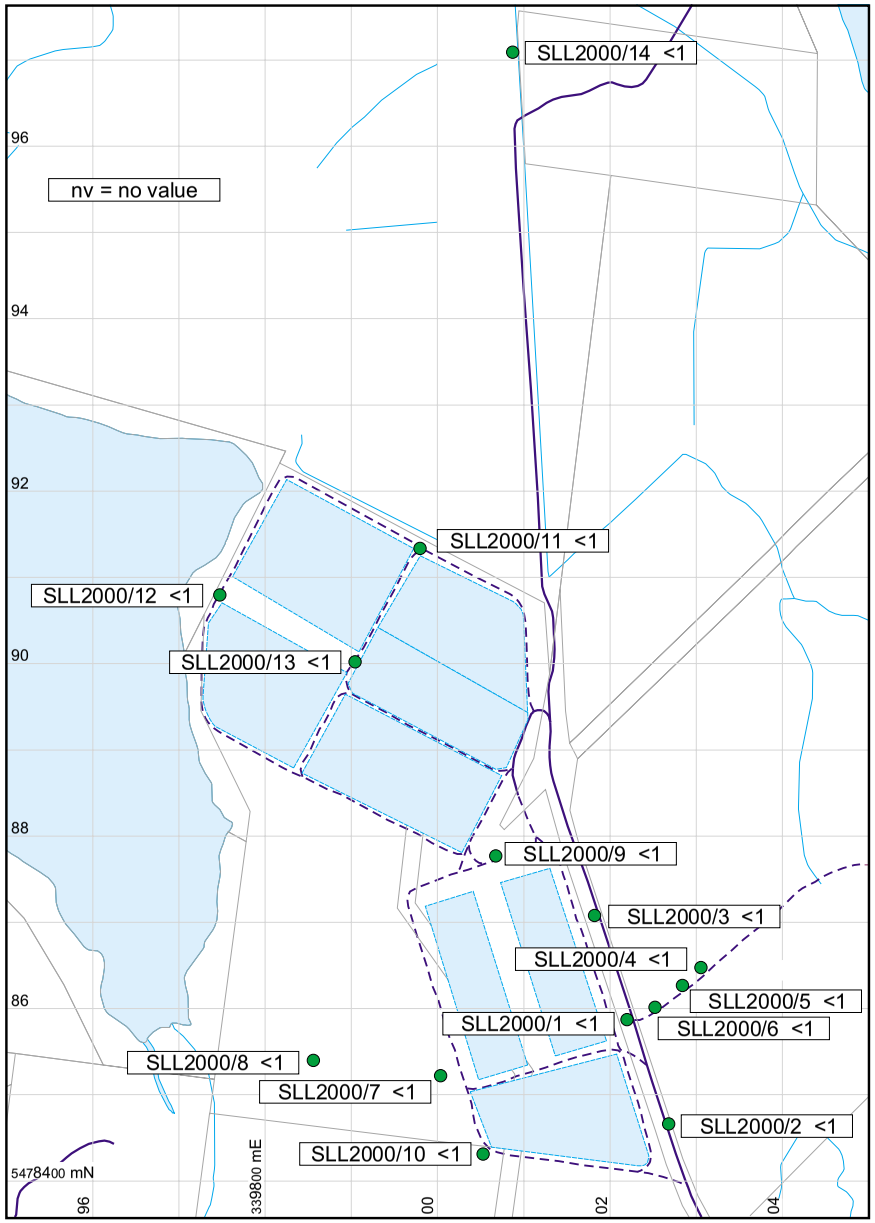
Smithton sewage lagoons — November 2000
TDS (mg/L)



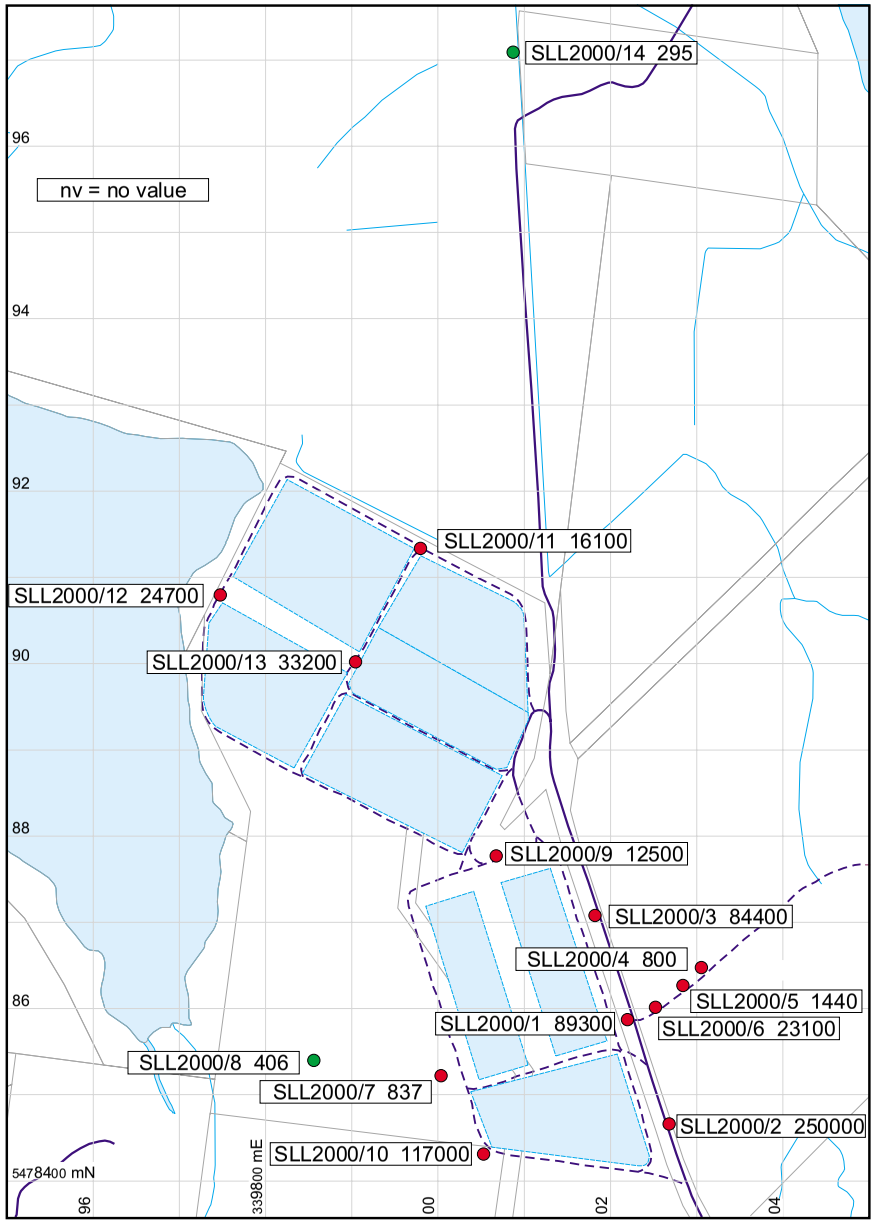
Smithton sewage lagoons — November 2000
Alkalinity HCO_3 (mg/L $CaCO_3$)



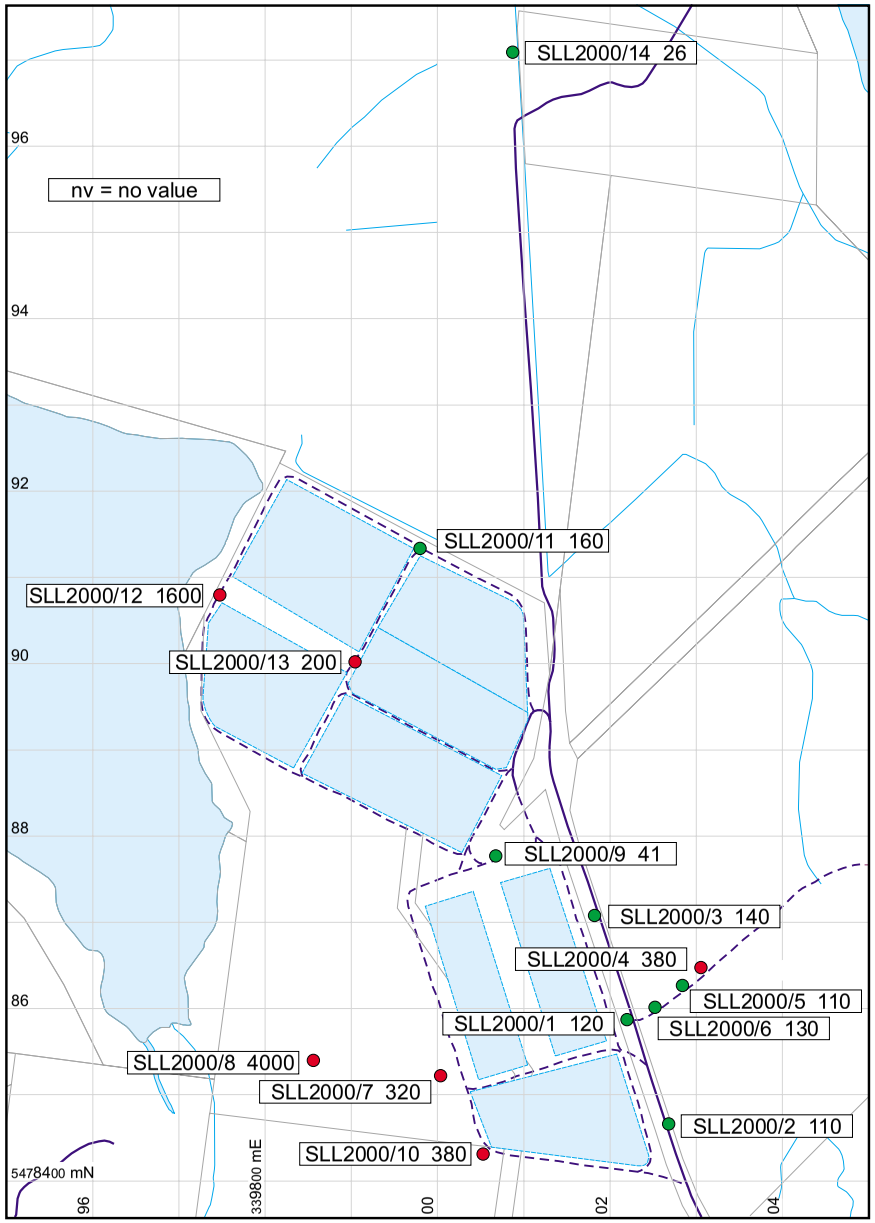
Smithton sewage lagoons — November 2000
Alkalinity Co_3 (mg/L $CaCO_3$)



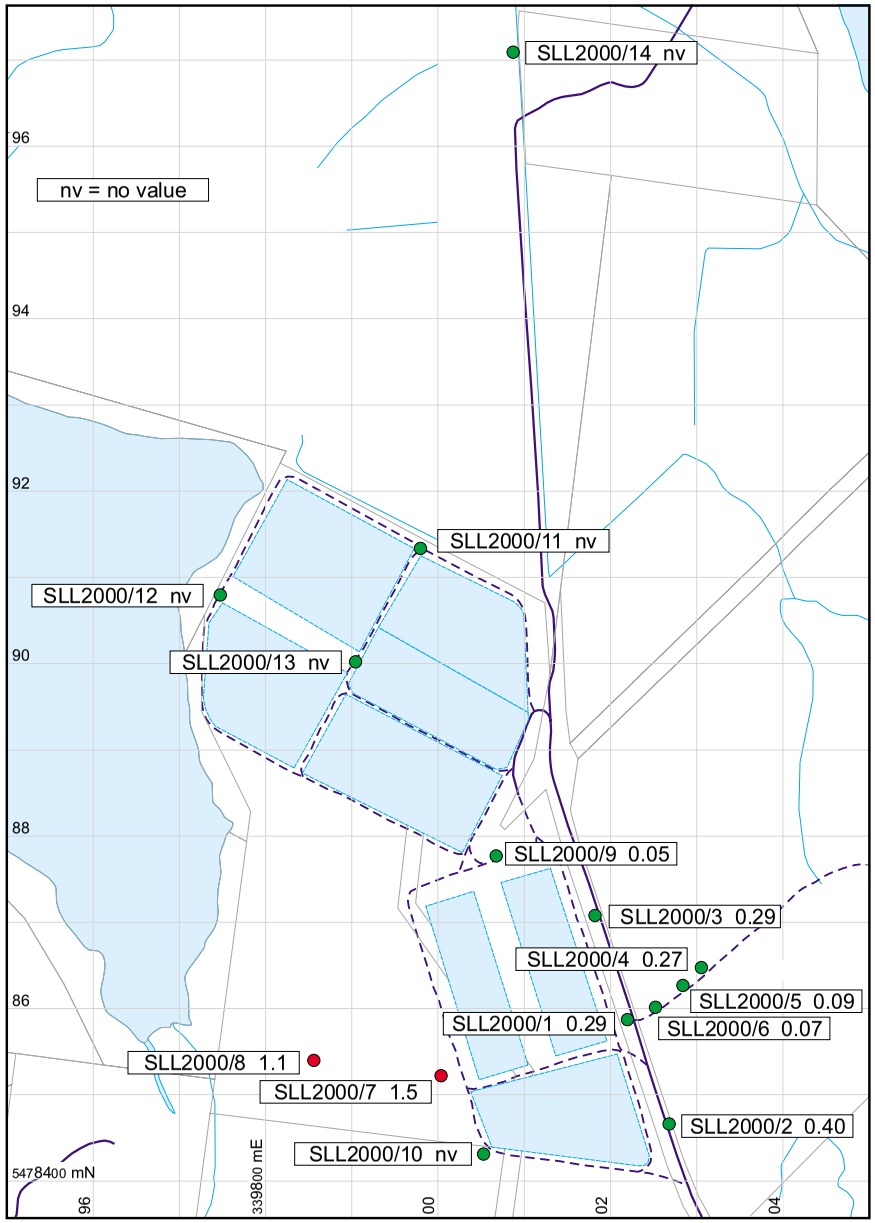
Smithton sewage lagoons — November 2000
Ammonia (μg-N/L)



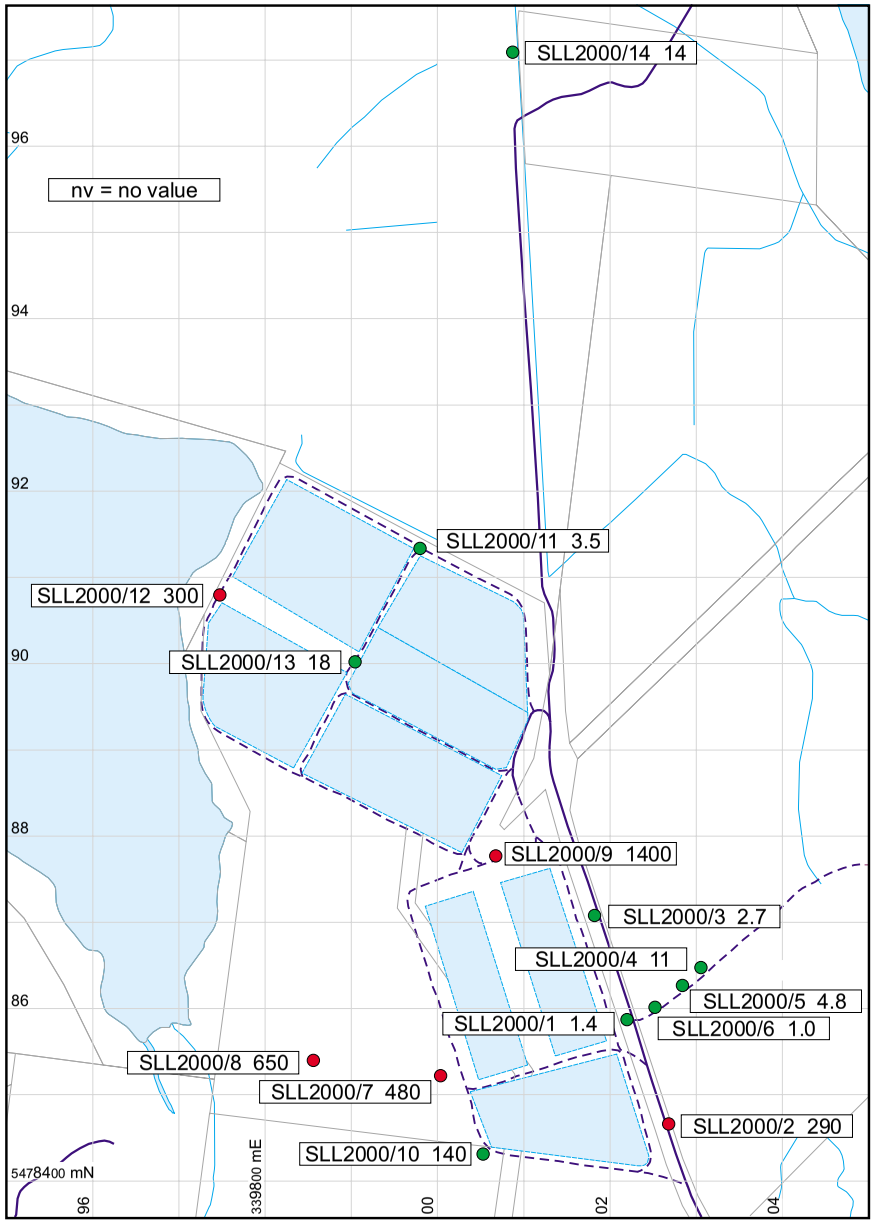
Smithton sewage lagoons — November 2000
Chloride (mg/L)



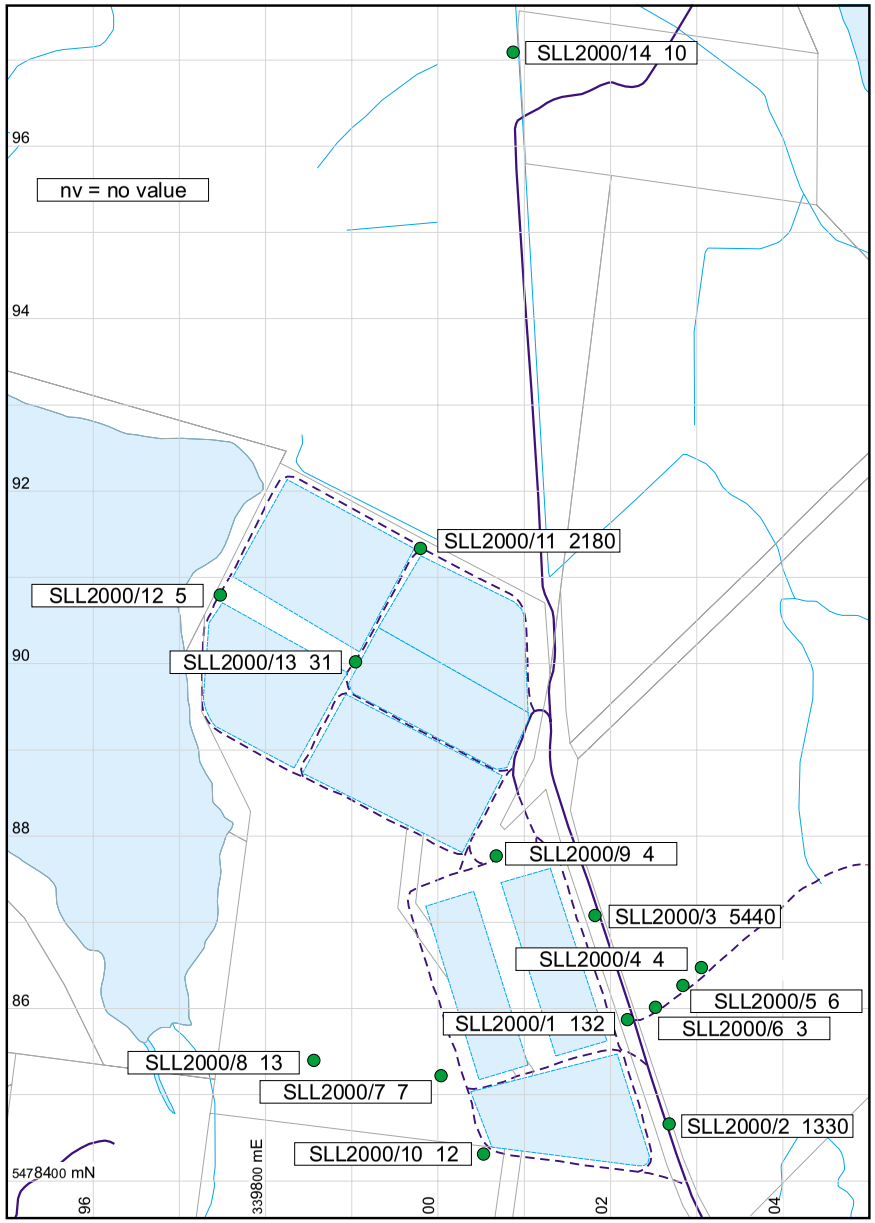
Smithton sewage lagoons — November 2000
Fluoride (mg/L)



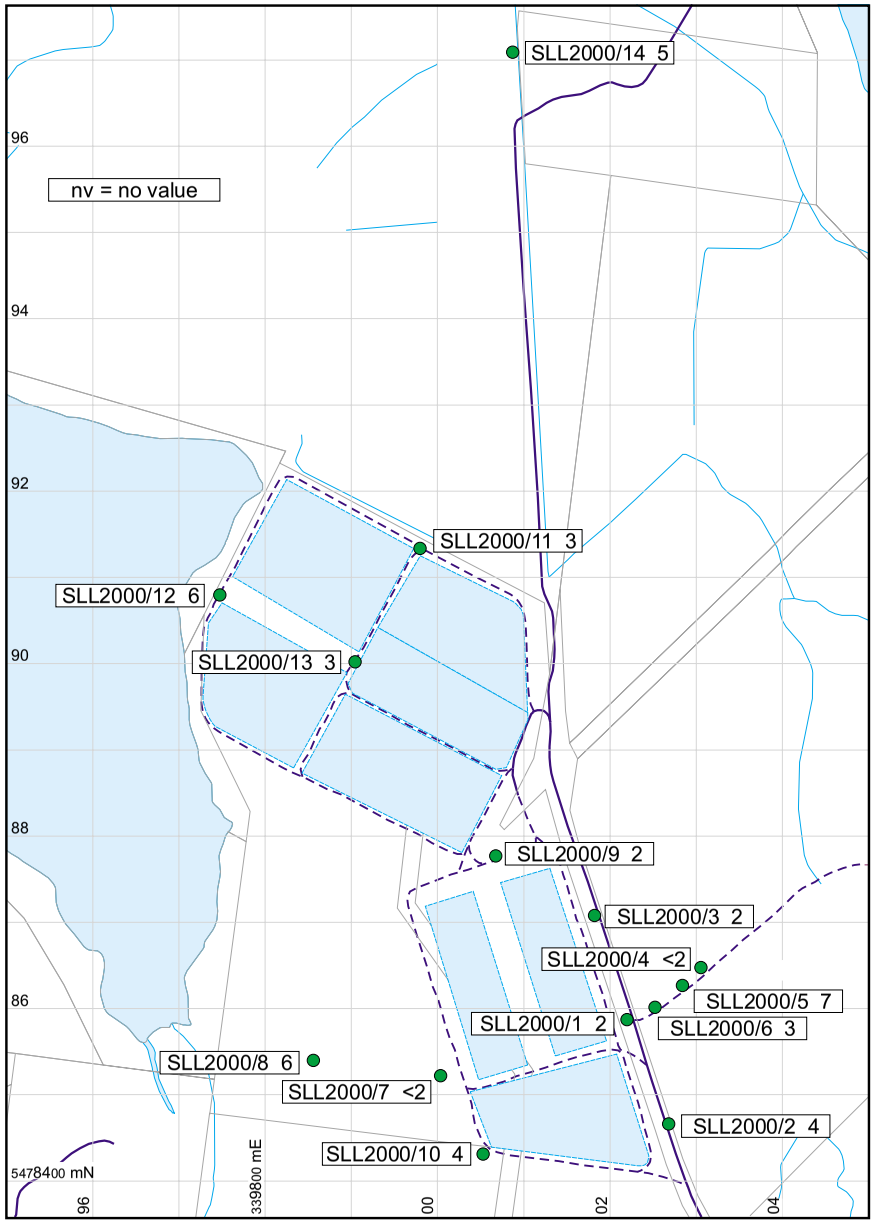
Smithton sewage lagoons — November 2000
Sulphate (mg/L)



Smithton sewage lagoons — November 2000
Ortho-P (μg-P/L)



Smithton sewage lagoons — November 2000
Nitrite (μg-N/L)



Smithton sewage lagoons — November 2000
Nitrate + Nitrite (μg-N/L)