



Impacts of Septic Tanks in Glenorchy

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Overview

- What are we worried about?
- Contaminants – Which ones?
- Transport - Where do they go?
- Fate - How are they transformed?
- Receptors -What impacts do they have?

Contaminants

Septic Tank Effluent

Parameter	Unit	Mean
pH		7.01
Dissolved Organic Carbon	mg/L	48
Total Phosphorous	mg/L	14.55
Total Nitrogen	mg/L	68
NH ₄ -N	mg/L	55
NO ₃ -N	mg/L	0.44
Sulfate	mg/L	6.21
Br	mg/L	0.02
Chloride	mg/L	51
<i>E. coli</i>	MPN/100 mL	1.3×10^6
Iron	<u>mg/L</u>	0.198

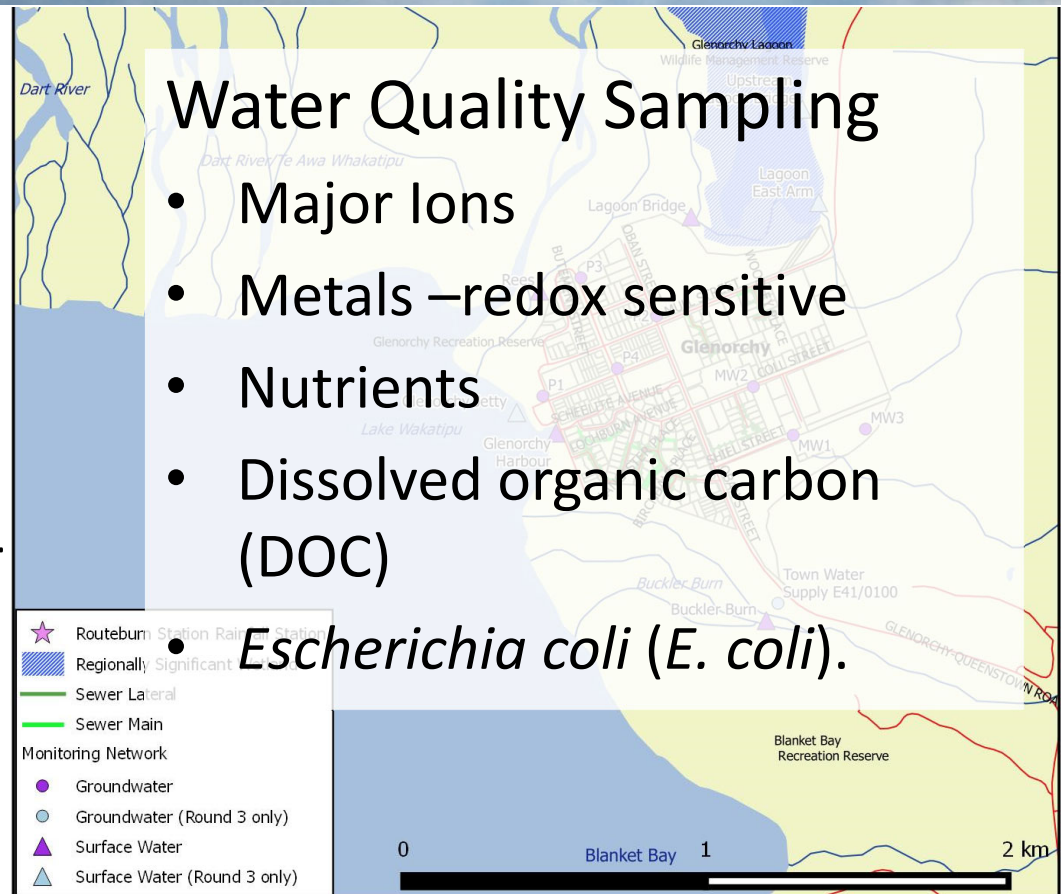
Source: (Richards, Withers, Paterson, McRoberts, & Stutter, 2016)

Our Approach

- Desktop Assessment
- Monitoring Network – Surface water, groundwater levels and quality
- Ecological Assessment - aquatic plants and animals Lake & Lagoon

Water Quality Sampling

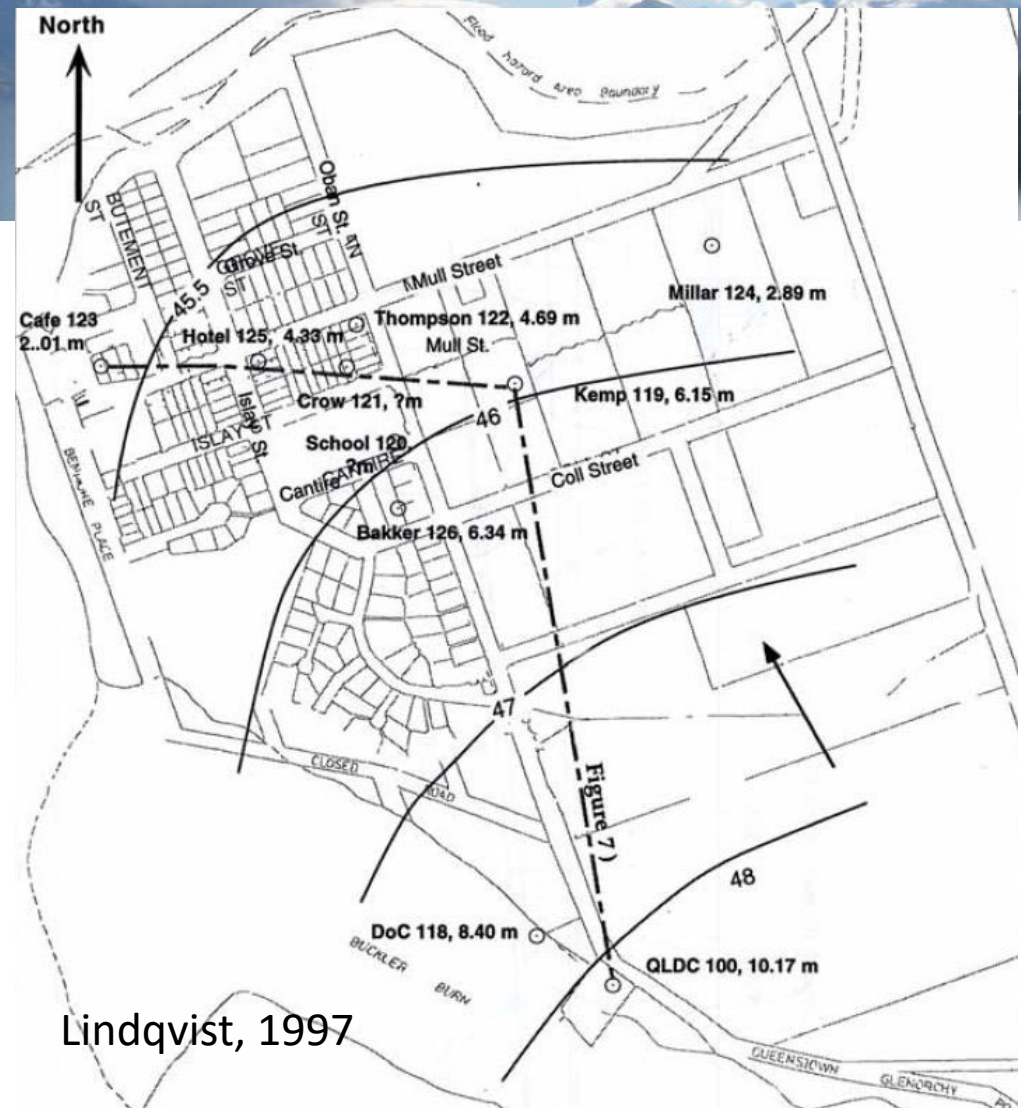
- Major Ions
- Metals –redox sensitive
- Nutrients
- Dissolved organic carbon (DOC)
- *Escherichia coli* (*E. coli*).



Where does it go?

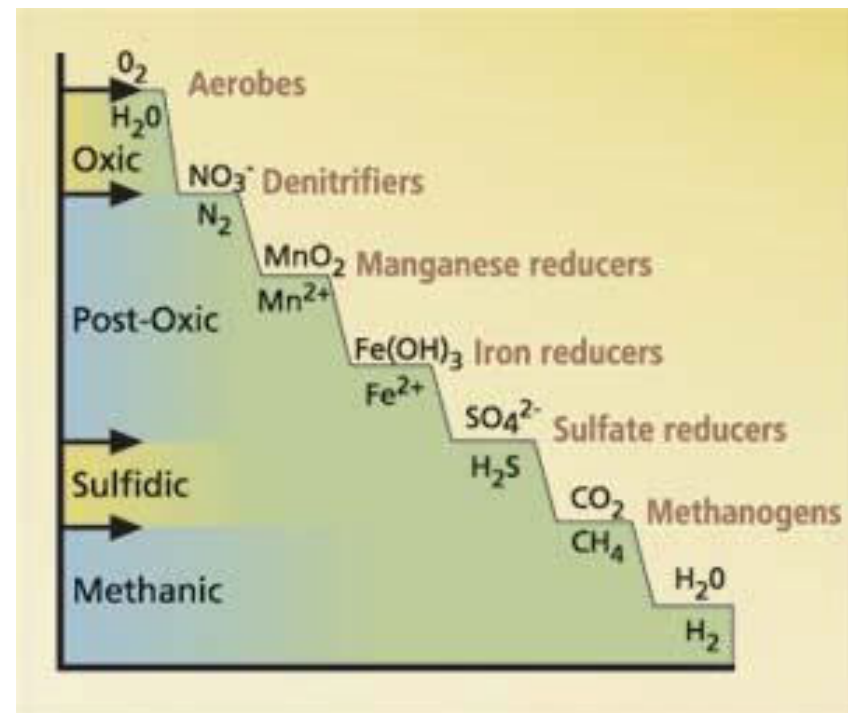
- Water levels
- Surveys

Location	Water Level (m below ground)
	30/11/2017
P1	1.33
P2	3.87
P3	1.07
P4	4.00
MW1 [#]	8.71
MW2	6.37
MW3	13.6



Some background chemistry - redox

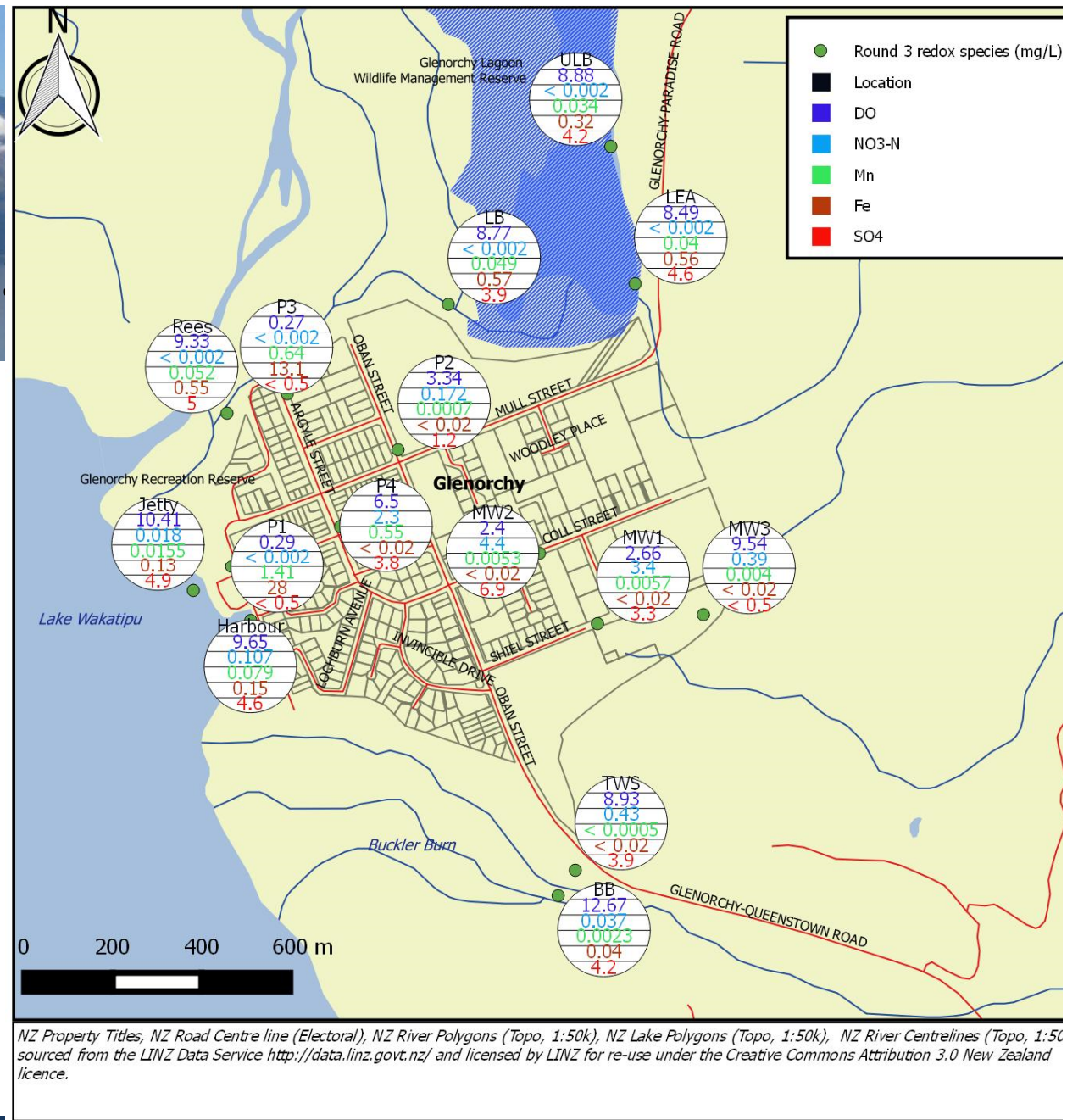
- Dissolved organic matter leaching from soils can change the chemistry of the groundwater



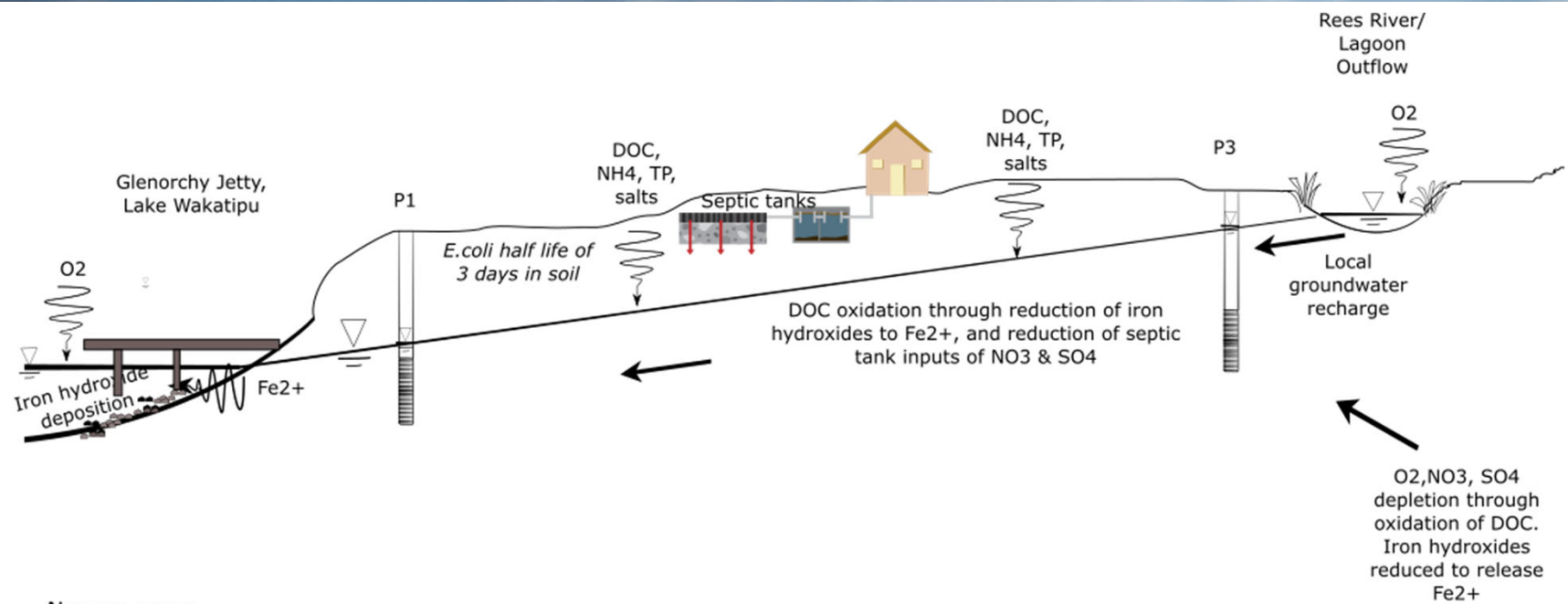
Source: Duke University (2012)
<https://sites.duke.edu/microbialecolgy/files/2012/01/fig5702p56athumb.jpg>

Water Quality Result

- Redox sensitive species



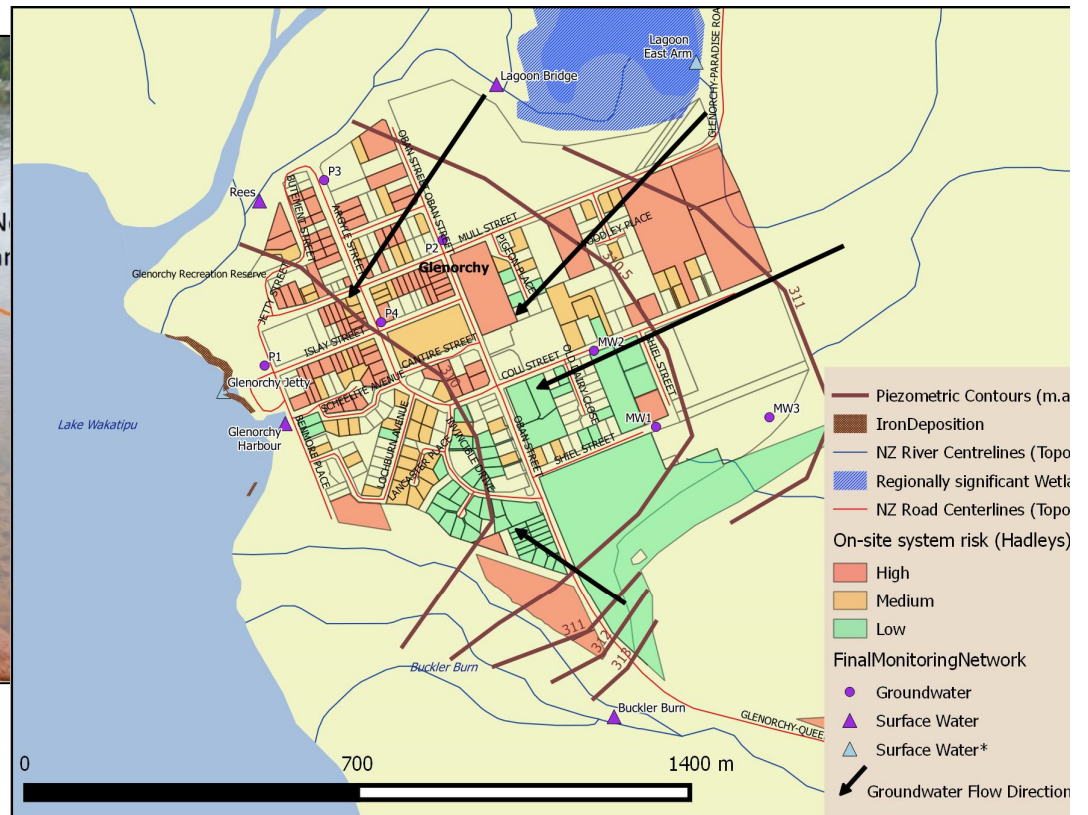
Iron Deposition



NOT TO SCALE

Septic tank image source: Jane Thomas
(<http://ian.umces.edu/imagelibrary/displayimage-6130.html>)

Iron Deposition



NZ Property Titles, NZ Road Centre line (Electoral), NZ River Polygons (Topo, 1:50k), NZ Lake Polygons (Topo, 1:50k), NZ River Centrelines (Topo, 1:50k) sourced from the LINZ Data Service (<http://data.linz.govt.nz/>) and licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence. Aerial Imagery sourced from the the LINZ Data Service (insert URL) and licensed by (insert Licensee) for re-use under the Creative Commons Attribution 3.0 New Zealand licence.

Iron Deposition Ecological Effects

*Myriophyllum
triphyllum*



Inside iron deposition area



Outside iron deposition area

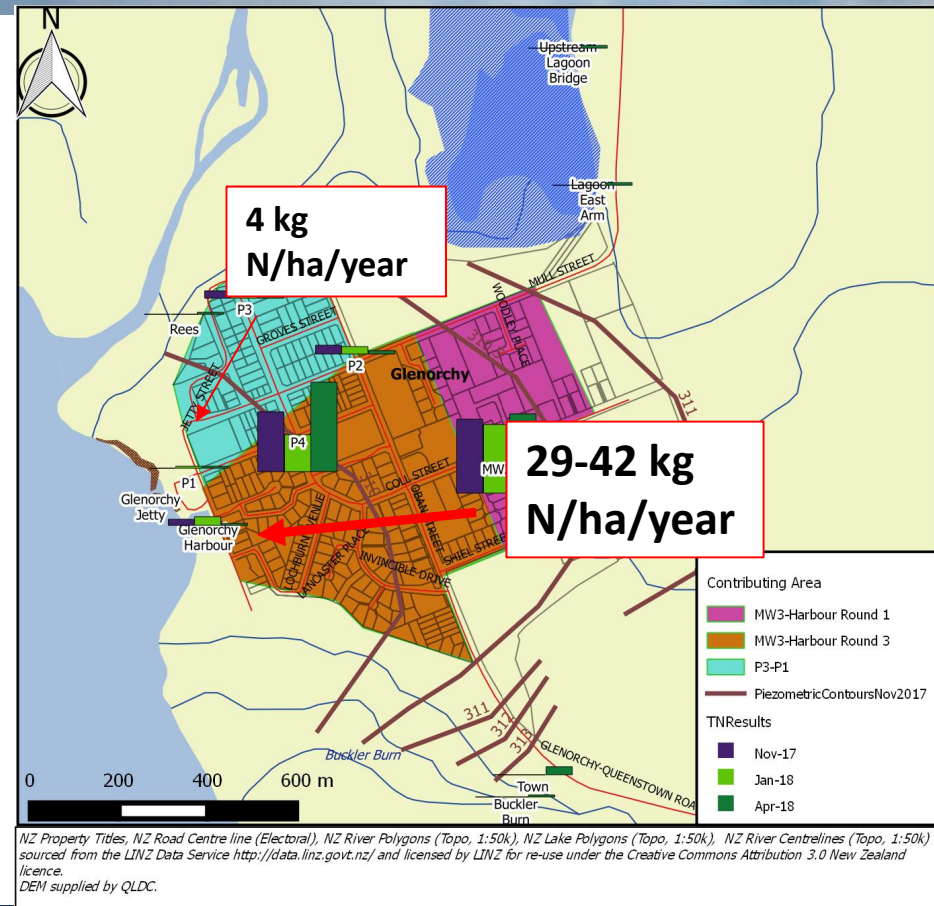
*Potamogeton
crispus*



- Only one type of snail
- No large adult fish

Nitrogen Loadings

- Otago Regional Council:
areas where nitrogen
loading exceeds 30
kg/ha/year = high priority
for change.



Overall Impacts

Location	Hydrology	Water Quality	Ecology
Glenorchy Harbour	Receives groundwater discharge poorly mixed	Total Nitrogen, NH ₄ -N and E.coli. > ORC (2016) Schedule 15 good water quality targets for Lake Wakatipu Manganese and iron concentrations elevated.	Seasonal surface water quality degradation within the harbour May be declining annually.
Glenorchy Jetty	Receives groundwater discharge well mixed	Iron deposition.	Macroinvertebrates diversity and abundance is decreased Longevity of benthic dwelling fish may be limited in this area. Macrophyte communities suffered morphological iron toxicity symptoms.

Risks to Human Health?

- Recreational use of Lake
- E.coli and health risk...viruses
- For gravel aquifers, the ESR indicative groundwater quality 10 m is required for the satisfactory removal of viruses within 300 m of the disposal field (McIntyre, 2017)
- Efficacy of soil treatment of wastewater reduces “as septic tank density increases, as systems age, or if they are sited too close to groundwater or within saturated or otherwise unsuitable soils” (Lusk, et al., 2017)

Groundwater

1 – 4 m

below ground surface



More information available on QLDC website....

- e3Scientific (2018) Ecological Assessment of Glenorchy Freshwater Habitats: Lake Wakatipu Margins and Glenorchy Lagoon
- e3Scientific (2018) Environmental Effects of On-Site Sewage Management in Glenorchy Stage 2: Investigations

Surface Water Results

	Parameters	Buckler Burn			Glenorchy Harbour			Glenorchy Jetty	Lagoon Halfway Bridge	Lagoon East Arm	Lagoon bridge			Rees			Guideline Values
		30/11/2017	22/01/2018	18/04/2018	30/11/2017	22/01/2018	18/04/2018	18/04/2018	18/04/2018	18/04/2018	30/11/2017	22/01/2018	18/04/2018	30/11/2017	22/01/2018	18/04/2018	
Field Measurements	pH	7.26	7.94	7.45	6.45	6.21	7.02	7.54	6.85	7.12	7.27	7.35	6.93	7.27	7.33	7	5.0 - 9.0 ¹
	EC	76.2	103	80	121	133.6	83.2	64.4	87.1	92.7	101	105.6	85.1	94.4	105.7	85.4	n/a
	Temp C	13.9	13.6	5.4	15.4	15.5	12	12.1	7.6	7.9	19.1	21.6	7.8	17.9	20.9	7.8	n/a
	Eh (mV)	104.1	136	136.1	27	32.2	17.3	2.6	57.8	46	-2.5	-10.4	29.1	-35	-16	44.4	n/a
	DO (mg/L)	11.23	9.88	12.67	6.22	3.99	9.65	10.41	8.88	8.49	8.24	8.48	8.77	9.18	8.56	9.33	<4 ²
Major ions (mg/L)	Calcium	13.6	17.8	13.7	17.9	19.4	11.4	9.4	13.4	14.3	17.5	17.7	12.7	16.2	17.2	12.8	n/a
	Magnesium	0.47	0.66	0.57	1.8	1.96	0.84	0.58	0.79	0.86	0.8	0.8	0.76	0.73	0.76	0.72	n/a
	Potassium	0.36	0.5	0.42	1.09	1.29	0.58	0.41	1.45	1.39	0.36	0.48	1.45	0.38	0.48	1.35	n/a
	Sodium	0.89	1.24	0.99	2.6	2.8	1.42	1.15	1.49	1.56	1.36	1.38	1.45	1.25	1.38	1.41	n/a
	Chloride	0.6	<0.5	<0.5	1.5	1.8	0.7	<0.5	0.9	0.9	0.7	0.7	0.8	0.6	0.7	0.8	120 ³
	Bicarbonate (mg/L at 25°C)	41	55	40	69	76	38	29	42	45	55	55	40	51	58	43	n/a
	Sulphate	4.5	6.5	4.2	3.4	2.5	4.6	4.9	4.2	4.6	4.5	4.1	3.9	4.6	4.1	5	n/a
	Bromide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	n/a
	TDS	61	82	60	99	107	58	46	65	69	81	81	62	75	83	66	1000 ⁴
Metals (mg/L)	Iron	0.03	<0.02	0.04	0.56	0.43	0.15	0.13	0.32	0.56	0.79	0.34	0.57	0.64	0.52	0.55	0.3 ³
	Manganese	0.002	0.0021	0.0023	0.4	0.75	0.079	0.0155	0.034	0.04	0.126	0.142	0.049	0.084	0.123	0.052	1.2 ⁵
	Boron	<0.0053	<0.005	<0.005	0.0073	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0053	<0.005	<0.005	<0.0053	<0.005	<0.005	0.09 ⁵
Nutrients & Organics (mg/L)	Total Nitrogen	<0.11	<0.11	0.13	0.38	0.5	0.14	<0.11	0.19	0.19	0.12	<0.11	0.18	<0.11	<0.11	0.14	0.1 ^{6b}
	Total NH ₄ -N	0.012	<0.010	<0.010	0.036	0.036	<0.010	<0.010	<0.010	<0.010	<0.010	0.014	<0.010	<0.010	<0.010	<0.010	0.01 ^{6a,b}
	Nitrite-N	<0.002	<0.002	<0.002	0.004	0.008	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.075 ^{6a,c}
	Nitrate-N	0.002	<0.002	0.037	0.28	0.37	0.107	0.018	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.075 ^{6a,c}
	Total Kjeldahl Nitrogen (TKN)	<0.10	<0.10	<0.10	<0.10	0.13	<0.10	<0.10	0.19	0.19	0.12	<0.10	0.18	<0.10	<0.10	0.14	n/a
	Dissolved Reactive Phosphorus	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.005 ^{6a}
	Total Phosphorus	<0.004	<0.004	0.059	<0.004	0.004	<0.004	<0.004	0.012	0.016	<0.004	0.009	0.011	<0.004	0.008	0.022	Oligotrophic 0.004 – 0.01 ³ / 0.005 ^{6b}
	DOC	<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	2.6	2.6	1.2	<0.5	2.1	0.6	<0.5	1.5	n/a
	E.coli (cfu/100ml)	<1 [#]	46	7 [#]	4 [#]	25	14 [#]	170 [#]	900 [#]	130 [#]	150 [#]	380	1,100 [#]	110 [#]	200	650 [#]	50 ^{6a} /10 ^{6b}

Groundwater Results

	Parameters	MW1			MW2			MW3			P1			P2			P3			P4			Town	Guideline
		Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Nov-17	Jan-18	Apr-18	Apr-18	Values
Field Measurements	pH	5.5	5.3	5.3	5.4	4.9	5.2	5.3	4.9	5.5	7.1	6.8	7.1	6.1	5.4	6.0	6.8	6.4	6.7	6.1	5.8	6.0	7.7	n/a
	EC	86	94	96	101	97.8	113.7	28	29.7	28.3	230	230.8	233.9	80.4	83.3	83.8	183	176.7	172.1	172	180	242.7	162.7	n/a
	Temp C	15.2	11.3	11.2	10.9	11.4	11.6	11.3	11.6	11.1	10.5	12.6	11.1	10.8	12.2	12.2	9.5	11.4	11.2	10.4	12.7	12.6	9.3	n/a
	Eh (mV)	139	130	-120	181	233	150	169	120	-60	-151	123	-119	78	88	68	-59	-51	-62	96	84	101	690	n/a
	DO (mg/L)	3.8	4.3	2.66	6.7	4.13	2.4	11.1	10	9.54	0.32	0.26	0.29	7.51	3.34	3.34	0.19	0.3	0.27	1.67	1.19	6.5	8.93	n/a
Major ions (mg/L)	Calcium	8.4	8	9.5	8	7.8	8.7	1.96	2.1	1.96	25	25	25	12.1	12.1	12	24	23	22	22	23	27	30	n/a
	Magnesium	1.48	1.45	1.79	1.39	1.28	1.54	0.48	0.54	0.55	1.03	1.05	1.15	1.03	1.01	1.1	1.03	0.97	0.98	1.92	2.1	2.3	1.12	n/a
	Potassium	1.66	1.88	1.82	6	5.8	6.2	0.64	0.75	0.64	1.71	1.79	1.77	1.35	1.45	1.42	0.9	1.01	1.03	3.6	3.1	5.2	0.65	n/a
	Sodium	4.3	7.4	4.4	4.8	4	5	2.1	2.3	2.2	2	2.1	2.1	1.65	1.87	1.84	1.65	1.69	1.69	4.4	7	9.2	1.54	n/a
	Chloride	4.3	4.5	4.1	2.1	2.6	3.7	1.8	2.4	1.8	0.6	0.7	0.6	0.7	1	0.9	0.6	0.8	<0.5	5	6	9.4	0.9	120 ³
	Bicarbonate (mg/L at 25°C)	25	29	27	25	23	26	12.6	11	12.1	94	97	103	46	47	45	90	87	88	84	94	102	88	n/a
	Sulphate	2.8	2.4	3.3	6.6	5.1	6.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1	0.8	1.2	<0.5	<0.5	<0.5	3.5	2.9	3.8	3.9	n/a
	Bromide	0.06	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	n/a
	TDS	51	57	55	58	53	63	20	20	20	157	157	163	64	66	64	135	129	128	128	141	165	127	1000 ⁴
Metals (mg/L)	Iron	0.073	<0.02	<0.02	<0.021	<0.02	<0.02	0.029	<0.02	<0.02	31	28	28	<0.021	<0.02	<0.02	15.7	13.8	13.1	0.037	<0.02	<0.02	<0.02	n/a
	Manganese	0.0044	0.0035	0.0057	0.0042	0.0046	0.0053	0.0025	0.0066	0.004	1.43	1.38	1.41	0.004	0.0035	0.0007	0.68	0.65	0.64	0.56	0.51	0.55	<0.0005	1.2 ⁵
	Boron	0.0058	<0.005	0.008	0.022	0.009	0.016	<0.0053	<0.005	<0.005	0.0058	<0.005	<0.005	<0.0053	<0.005	<0.005	<0.0053	<0.005	<0.005	0.0111	<0.005	0.01	<0.005	0.09 ⁵
Nutrients & Organics (mg/L)	Total Nitrogen	2.6	2.5	3.5	4.2	3.9	4.5	0.33	0.51	0.51	<0.11	0.12	0.15	0.51	0.42	0.22	0.45	0.53	0.48	3.4	2.1	5.1	0.47	
	Total NH ₄ -N	0.017	<0.010	0.01	0.013	<0.010	<0.010	0.011	<0.010	0.011	0.1	0.101	0.117	<0.010	<0.010	<0.010	0.46	0.46	0.45	1.93	1	2.6	<0.010	0.01 ^{6a}
	Nitrite-N	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.009	0.003	<0.002	0.075 ^{6a*}
	Nitrate-N	2.5	2.4	3.4	4.1	3.8	4.4	0.27	0.38	0.39	<0.002	<0.002	<0.002	0.39	0.35	0.172	<0.002	<0.002	<0.002	1.44	0.98	2.3	0.43	0.075 ^{6a*}
	Total Kjeldahl Nitrogen (TKN)	0.12	<0.10	0.14	0.12	0.1	0.14	<0.10	0.13	0.12	<0.10	0.12	0.14	0.12	<0.10	<0.10	0.45	0.53	0.48	1.98	1.1	2.8	<0.10	n/a
	Dissolved Reactive Phosphorus	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.029	0.028	0.035	<0.004	0.005 ^{6a}
	Total Phosphorus	<0.004	0.006	0.011	<0.004	<0.004	0.015	<0.004	0.013	0.046	<0.004	0.013	0.027	<0.004	0.014	0.006	0.007	0.062	0.06	0.025 ^{#3}	0.04	0.047	0.004	
	DOC	<0.5	<0.5	0.8	0.8	<0.5	0.8	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	n/a
	E.coli (cfu/100mL)	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	20	<1 [#]	38	<1 [#]	<10 [#]	<10 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	<1 [#]	50 ^{6a}