# SoE & measuring the effects of farm practices on water quality

John Threlfall

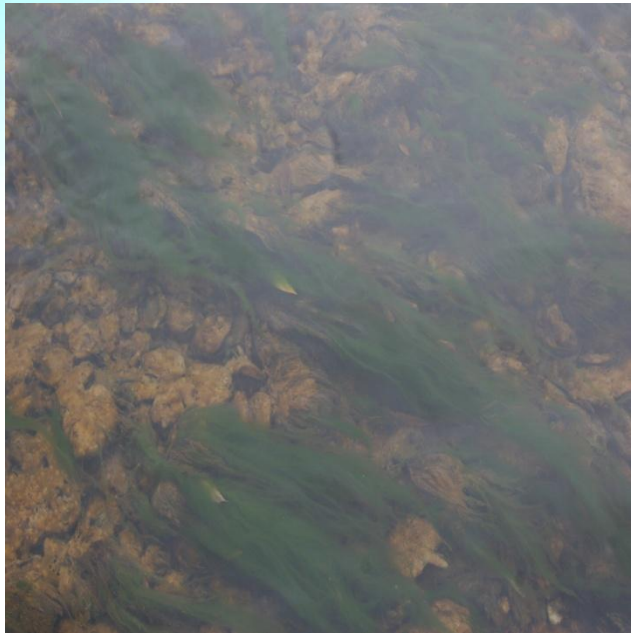
Director Environmental Information and Science

# Introduction

1. What is good water quality?
2. The science view – guidelines to describe and protect water quality
3. Trends in surface water quality
4. Groundwater quality
5. Pomahaka catchment study
   - Agresearch effluent contamination
6. Manuherikia catchment study

# What is good water quality?

| Characteristic | Description |
|---|---|
| **Clarity** | When standing in knee deep water, it should be possible to easily and clearly see your toes at non-event flows |
| **Colour** | Water should be colour-free, although naturally there are some tannin-stained rivers |
| **Algae** | Algae should not cover more than 30% of bed cobbles, with algae strands less than 2 cm in length at non-event flows. There should be no slime on the surface of the water. |



# What is good water quality?

| Characteristic | Description |
|---|---|
| **Sediment** | Riffles and runs should be free of obvious signs of sediment. Walking across a riffle or run should not produce an obvious sediment plume. |

# What is good water quality?

| Characteristic | Description |
|---|---|
| **Smell** | Water should be odourless, although water in wetlands may have a naturally earthy smell. |
| **River margin (bed/bank)** | On the bed or bank of a river, vegetation has not been stripped bare, there is no land disturbance resulting from land practices (including pugging) and there is no animal excrement. |

# Guidelines to protect water quality

- Which ones?
- ANZECC – national comparisons
- Trip point to start investigation/action
- Local effects need to be understood and local limits set

*Note* - monitoring water quality doesn't always show ecological health

# Guidelines

- Perception and science - defensible and agreed limits
- Catchment specific guidelines
- Effects based and designed to protect good water quality into the future and improve where necessary
- Based on SoE data/ANZECC and national values

# What and where

## What

1. Nutrients (nitrogen NNN and phosphorus DRP)
2. Ammoniacal nitrogen ($NH_4$)
3. Bacteria (E. *coli*)
4. Turbidity

## Where

1. Rivers & streams outside of the Lakes region
2. Rivers & streams in the Lakes region
3. Small lakes
4. Leachate (protecting groundwater)

# Nutrient guidelines for Otago rivers

| Analyte | Effects | Proposed limits |
|---|---|---|
| Nitrite/nitrate nitrogen (NNN) | Algal growth | Short Accrual 0.444 mg/l |
| | | Long Accrual 0.075 mg/l |
| Dissolved reactive phosphorus (DRP) | Algal growth | Short Accrual 0.026 mg/l |
| | | Long Accrual 0.006 mg/l |

# $NH_4$, E.coli, turbidity

| Analyte | Effects | Proposed limits |
|---|---|---|
| Ammoniacal nitrogen ($NH_4$) | Indicates effluent contamination | 0.1 mg/l |
| Escherichia coli (E. coli) | Contact recreation | 126 cfu/ 100 ml |
| Turbidity (TURB) | Clarity | 5 NTU |

SoE median results short accrual catchments

| Site Name | NNN | NH4 | DRP | *E.coli* | TURB |
|---|---|---|---|---|---|
| **Proposed ORC limits** | **0.444** | **0.1** | **0.026** | **126** | **5** |
| Catlins at Houipapa | 0.377 | 0.01 | 0.0165 | 110 | 3.1 |
| Kaikorai Stream at Brighton Rd | 0.34 | 0.02 | 0.0135 | 355 | 3.4 |
| Leith at Dundas Street Bridge | 0.394 | 0.01 | 0.026 | 210 | 2.4 |
| Kakanui at McCones | 0.145 | 0.01 | 0.005 | 30 | 0.5 |
| Waiareka Creek at Taipo Road | 0.062 | 0.02 | 0.124 | 87 | 1.1 |
| Kauru at Ewings | 0.019 | 0.01 | 0.006 | 36 | 0.3 |
| Kakanui at Clifton Falls Bridge | 0.017 | 0.01 | 0.005 | 72 | 0.3 |
| Pomahaka at Burkes Ford | 0.4895 | 0.01 | 0.013 | 88 | 3.3 |
| Waipahi at Waipahi | 0.814 | 0.01 | 0.018 | 120 | 3.0 |
| Waipahi at Cairns Peak | 0.616 | 0.02 | 0.021 | 250 | 8.8 |
| Heriot Burn at Park Hill Road | 1.19 | 0.03 | 0.024 | 440 | 4.6 |
| Pomahaka at Glenken | 0.0385 | 0.01 | 0.009 | 130 | 2.1 |
| Shotover at Bowens Peak | 0.015 | 0.003 | 0.001 | 16 | 2.8 |
| Waiwera at Maws Farm | 0.781 | 0.02 | 0.027 | 210 | 3.6 |

# SoE median results long accrual catchments (1)

| Site Name | NNN | NH4 | DRP | *E.coli* | TURB |
|---|---|---|---|---|---|
| **ORC proposed limits** | **0.075** | **0.1** | **0.006** | **126** | **5** |
| Cardrona at Mt Barker | 0.055 | 0.009 | 0.005 | 20 | 1.1 |
| Clutha at Balclutha | 0.049 | 0.003 | 0.002 | 7 | 1.7 |
| Clutha at Millers Flat | 0.025 | 0.002 | 0.001 | 2 | 1.3 |
| Fraser at Marshall Road | 0.028 | 0.009 | 0.005 | 19 | 1.2 |
| Lindis at Ardgour Road | 0.072 | 0.009 | 0.005 | 34 | 1.3 |
| Lindis at Lindis Peak | 0.022 | 0.009 | 0.006 | 28 | 1.3 |
| Luggate Creek at SH6 Bridge | 0.0045 | 0.009 | 0.011 | 19 | 0.6 |
| Manuherikia at Galloway | 0.021 | 0.009 | 0.014 | 42 | 2.1 |
| Manuherikia at Ophir | 0.026 | 0.009 | 0.016 | 80 | 2.8 |
| Dunstan Creek at Beattie Road | 0.0305 | 0.009 | 0.007 | 16 | 1.0 |
| Mill Creek at Fish Trap | 0.3485 | 0.009 | 0.0065 | 79 | 3.1 |
| Shag at Goodwood Pump | 0.279 | 0.009 | 0.008 | 43 | 0.6 |
| Shag at Craig Road | 0.0215 | 0.009 | 0.006 | 38 | 0.6 |

# SoE median results long accrual catchments (2)

| Site Name | NNN | NH4 | DRP | *E.coli* | TURB |
|---|---|---|---|---|---|
| **ORC proposed limits** | **0.075** | **0.1** | **0.006** | **126** | **5** |
| Silverstream at Taieri Depot | 0.259 | 0.009 | 0.007 | 77 | 1.6 |
| Taieri at Outram | 0.035 | 0.006 | 0.008 | 71 | 2.2 |
| Sutton at SH87 | 0.007 | 0.006 | 0.005 | 25 | 2.2 |
| Taieri at Sutton | 0.019 | 0.009 | 0.01 | 66 | 3.6 |
| Taieri at Tiroiti | 0.0205 | 0.004 | 0.0135 | 122 | 2.8 |
| Kye Burn at SH85 Bridge | 0.033 | 0.009 | 0.008 | 26 | 1.4 |
| Taieri at Waipiata | 0.0175 | 0.009 | 0.019 | 58 | 3.0 |
| Taieri at Stonehenge (Waipiata recorder) | 0.0045 | 0.009 | 0.006 | 33 | 1.5 |
| Taieri at Linnburn (Canadian Flat recorder) | 0.0045 | 0.009 | 0.0045 | 36 | 1.2 |
| Tokomairiro at West Branch Bridge | 0.1535 | 0.01 | 0.011 | 178 | 2.6 |
| Trotters Creek at Mathesons | 0.1245 | 0.01 | 0.005 | 43 | 1.6 |
| Waianakarua at Browns | 0.1485 | 0.009 | 0.007 | 14 | 0.3 |
| Waikouaiti at Orbells Crossing | 0.026 | 0.009 | 0.005 | 30 | 0.8 |
| Waitahuna at Tweeds Bridge | 0.106 | 0.01 | 0.012 | 138 | 3.7 |
| Waipori at Waipori Falls Reserve | 0.054 | 0.009 | 0.0048 | 6 | 2.5 |

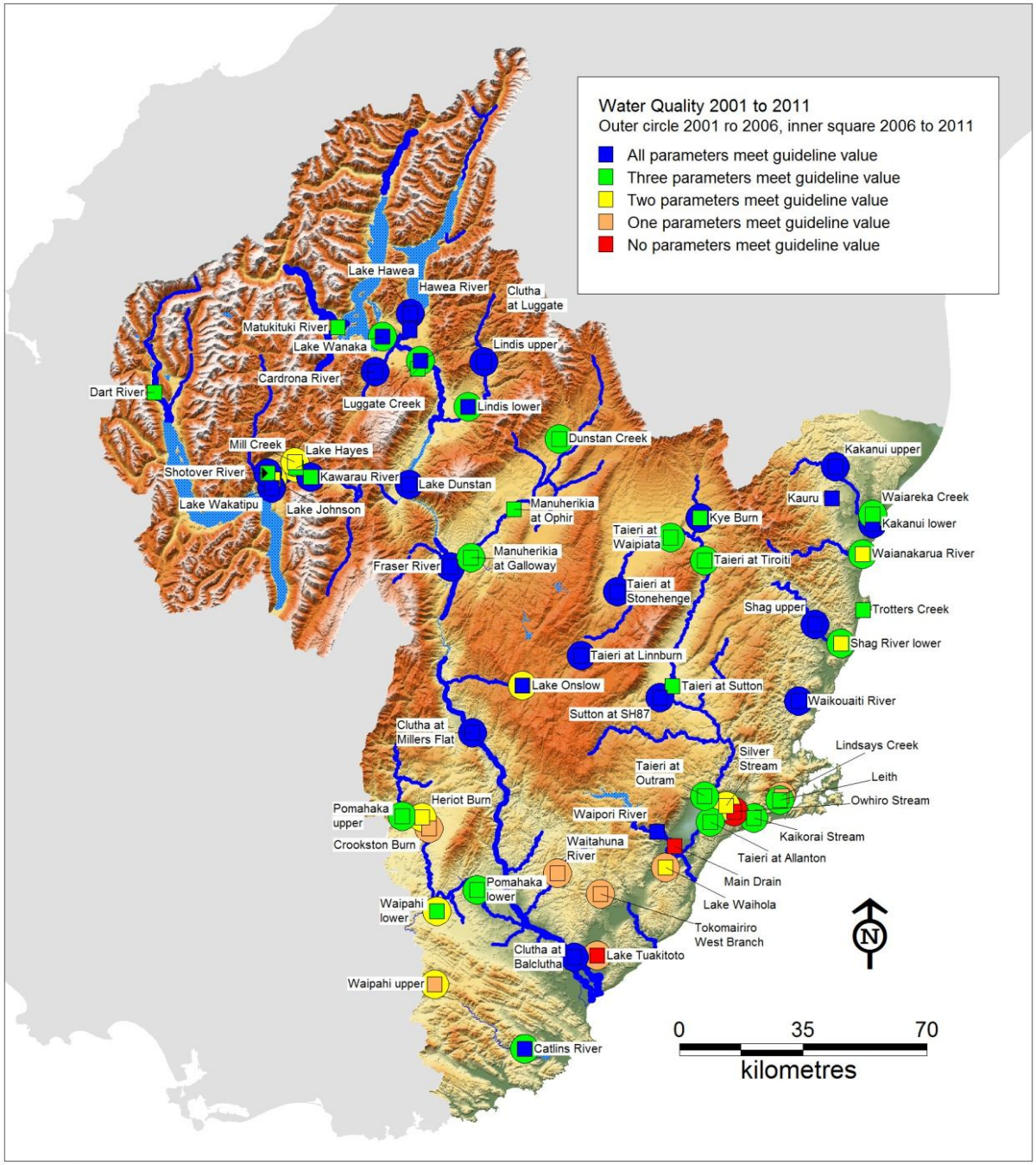
# Lakes region

| Site Name | NNN | NH4 | DRP | *E.coli* | TURB |
|---|---|---|---|---|---|
| **ORC proposed limits** | **0.03** | **0.01** | **0.005** | ***10*** | **3** |
| Clutha at Luggate Br. | 0.027 | 0.002 | 0.001 | 3 | 2.4 |
| Dart at The Hillocks | 0.018 | 0.009 | 0.0045 | 4 | 19 |
| Kawarau at Chards | 0.022 | 0.009 | 0.001 | 15 | 2.5 |
| Lake Hawea Outflow at Dam | 0.008 | 0.009 | 0.0045 | 1 | 0.4 |
| Lake Wakatipu at Outflow | 0.023 | 0.009 | 0.0045 | 1 | 0.4 |
| Lake Wanaka at Outlet | 0.027 | 0.009 | 0.0045 | 1 | 0.4 |
| Matukituki at West Wanaka | 0.047 | 0.009 | 0.0045 | 9 | 2.0 |

| | Chlorophyll a | TN | NH4 | TP | EC | TURB |
|---|---|---|---|---|---|---|
| **ORC Proposed limits** | **12** | **0.725** | **0.1** | **0.043** | **126** | **5** |
| Lake Tuakitoto at Outlet | 7.5 | 0.07 | 0.02 | 0.007 | 130 | 6.5 |
| Lake Waihola at end of jetty | 5.3 | 0.38 | 0.009 | 0.046 | 30 | 7.8 |
| Lake Hayes at Mid Lake - Surface | 10.5 | 0.25 | 0.009 | 0.033 | 1 | 1.2 |
| Lake Johnson at Surface | 8.9 | 1 | 0.009 | 0.1 | 1 | 1.6 |
| Lake Onslow at Boat Ramp | 2.9 | 0.49 | 0.009 | 0.046 | 1 | 4.8 |

# Lake sites

Trends in water quality: $NH_4$, NNN, DRP, E.coli



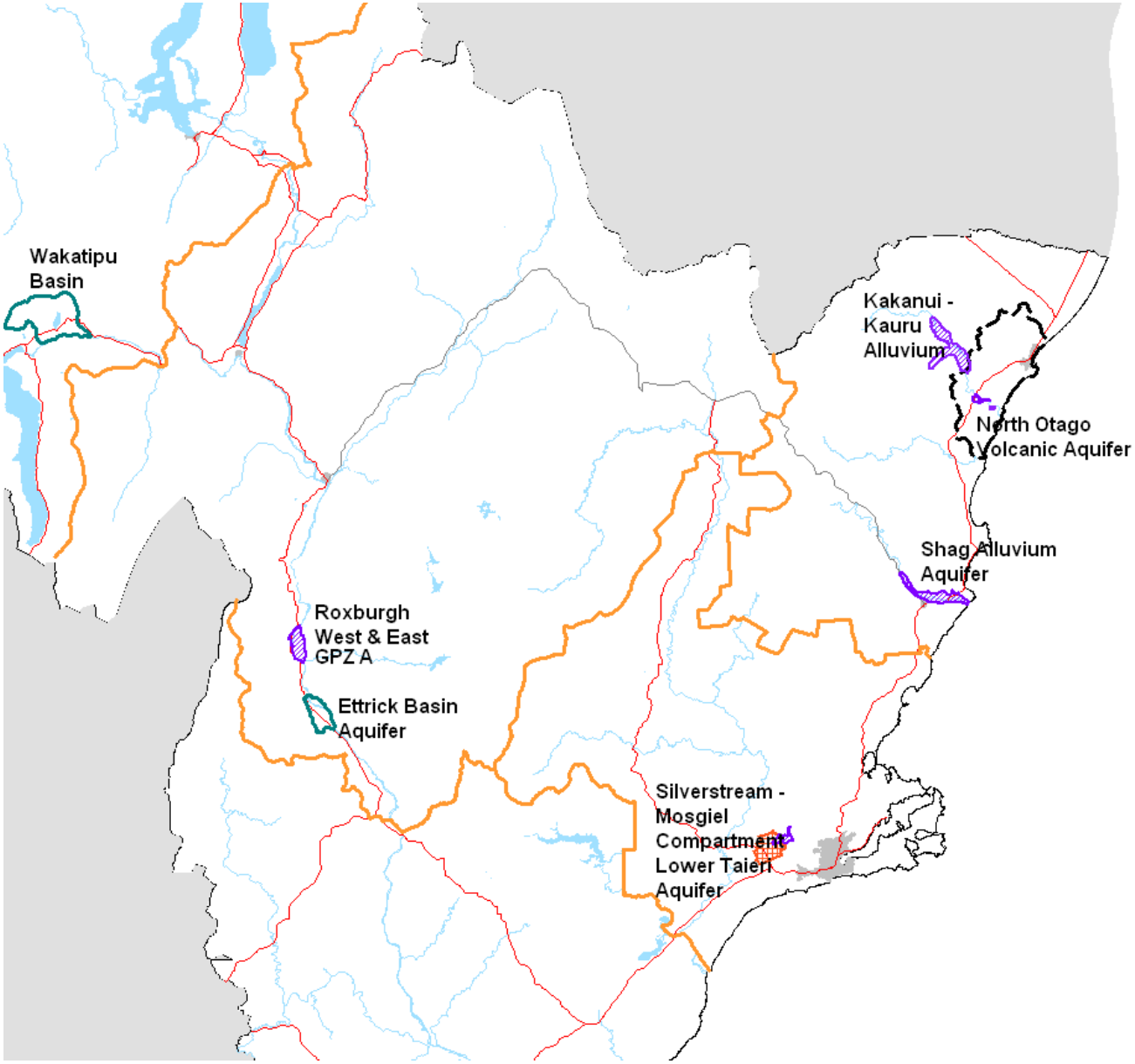
# Groundwater quality: nitrates

- Indicator of non-point source pollution from land-use, especially in shallow aquifers
- It's a natural component of N cycle in soil and water –but also shows impact from septic tanks, fertilisers, intensive agriculture and organic wastewater
- Drinking water standard in NZ (MoH 2005) is 11.3 $g/m^3$

*Leachate*

- water leaving the root zone heading for groundwater
- Leachate control to protect groundwater

# Sensitive groundwater to nitrate nitrogen contamination



## Sensitive Aquifers

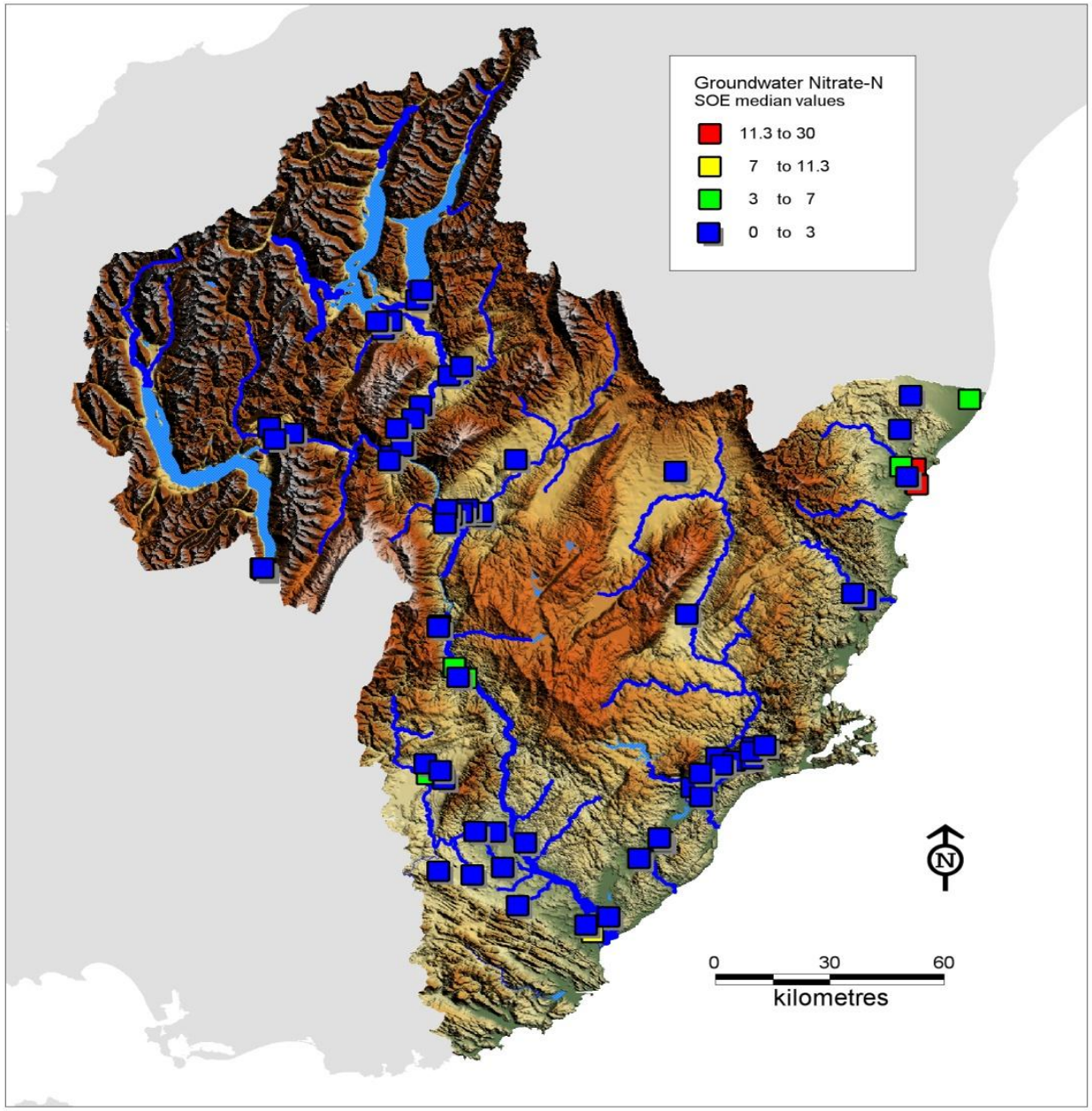
| ORC proposed limit | 10 g/m³ | Median NNN g/m³ |
|---|---|---|
| Wakatipu | | 0.6 |
| Roxburgh | | 2.6 |
| Ettrick | | 3.6 |
| Silverstream-Mosgiel | | 3.0 |
| Shag Alluvium | | 0.8 |
| Kakanui-Kauru | | N/D |
| North Otago Volcanic | | 11.7 |

## Additional Aquifers

| ORC proposed limit | 25 g/m³ | Median NNN g/m³ |
|---|---|---|
| Kuriwao | | 0.01 |
| Pomahaka | | 0.01 |
| Clydevale | | 0.05 |
| Tokomairiro | | 0.02 |
| L Waitaki | | 3.6 |
| Manuherikia | | 1.9 |
| Cromwell | | 1.8 |
| Ida Valley | | N/D |
| Inch Clutha | | 0.2 |
| Maniototo | | 0.05 |
| Strath | | 1.4 |

# Leachate limits compared with groundwater SoE

# Groundwater Quality



# Pomahaka catchment

- Lower Pomahaka water quality been decreasing for number of years
- Poor  draining pallic soils with tile and mole drainage
- Increased intensification
- ORC 12 month study looking at effects of land use
- Compared dairy with sheep/beef sub-catchments
- Tile discharges and surface flows were analysed
- Focus on nutrients (DRP and NNN),  sediment and bacteria

# Ecosystem health

| Site | % Dairy | Chemical and Bacteria | Physical Habitat | MCI | Trout density/ condition |
|---|---|---|---|---|---|
| Leithen Burn | 0 | Excellent | Excellent | Excellent | Excellent |
| Black Gully (Upper) | 0 | Good | Excellent | Excellent | Good |
| Spylaw Burn | 1 | Fair | Good | Fair | Excellent |
| Flodden @ SH90 | 26 | Good | Good | Good | Good |
| Crookston Burn @ Walker | 44 | Poor | Good | Good | Good |
| Heriot Burn (Upper) | 12 | Fair | Poor | Good | Good |

# Findings from the Pomahaka study

- Degraded water quality, habitat and ecological values attributed to land management
- Tiles draining dairy farms had more DRP, SS, TN and NNN
- Bacteria are a factor in all farming
- Sediment, E.coli and DRP were main concerns to river health
  - Sediment, E.coli and DRP can be controlled by good land management
- Agresearch further investigation…

# Effluent application to land under bad practice

agresearch

- Used NH4, E. coli and TP to give a combined variable
- Greater than this ‘combination value’ indicates contamination with effluent
- Useful as performance monitoring tool
- 9% of samples from Wairuna Stream and Heriot Burn catchments found to be contaminated

# Effluent application to land under bad practice

agresearch

| Parameter Loads | Existing | Without contamination | % decrease |
|---|---|---|---|
| $NH_4$ ($g/s^{-1}$) | 9 | 5 | **42** |
| DRP ($g/s^{-1}$) | 4 | 3 | **17** |
| E. *coli* ($cfu/s^{-1}$) | 1150376 | 487994 | **58** |
| NNN ($g/s^{-1}$) | 354 | 344 | **3** |
| SS ($g/s^{-1}$) | 1890 | 1456 | **23** |

# Manuherikia catchment

- Manuherikia catchment dry catchment (long accrual time) and irrigation essential
- New efficient irrigation and Intensification likely to progress into the future
- Pressure on water quality and ecological values
- 12 month study to determine water quality, ecological health and sensitivity to change

# Ecosystem health

| Site | Water quality | Habitat | MCI | Trout | Native fish |
|---|---|---|---|---|---|
| Manuherikia at Loop Road | Excellent | Excellent | Poor | N/A | N/A |
| Ida Burn upper | Excellent | Excellent | Fair | Excellent | Poor |
| Ida Burn lower | Fair | Good | Poor | Fair | Excellent |
| Pool Burn upper | Fair | Poor | Poor | Poor | Poor |
| Pool Burn lower | Fair | Good | Poor | Good | Excellent |
| Lauder Creek | Fair | Fair | Poor | Poor | Excellent |
| Manuherikia at Omakau | Good | Excellent | Fair | N/A | N/A |
| Thomsons Creek upper | Good | Excellent | Good | Excellent | Poor |
| Thomsons Creek lower | Poor | Good | Good | N/A | N/A |
| Manuherikia at Ophir | Fair | Excellent | Poor | N/A | N/A |
| Chatto Creek | Fair | Good | Good | N/A | N/A |
| Manuherikia US Chatto Creek | Good | Excellent | Fair | N/A | N/A |
| Manuherikia at Galloway | Good | Excellent | Poor | N/A | N/A |
| Dovedale at Rocks Bluff | Good | Fair | Poor | Poor | Excellent |

# Manuherikia study conclusions

– Better riparian management