Rotorua Protection and Restoration Programme

Overview for Land TAG

8 October 2014

ROTORUA TE ARAWA LAKES PROGRAMME

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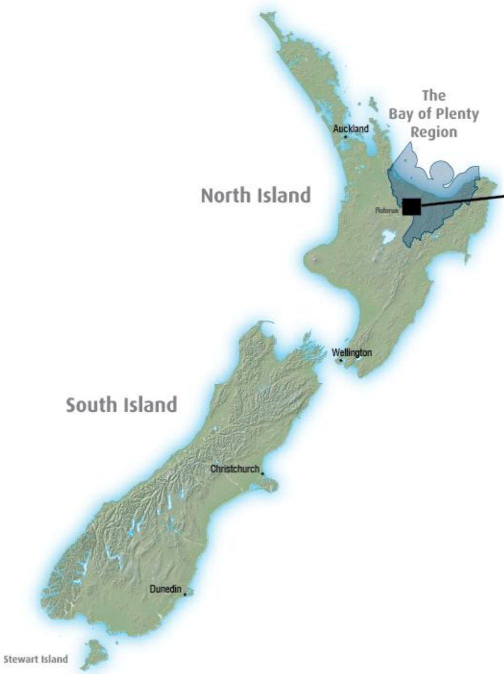
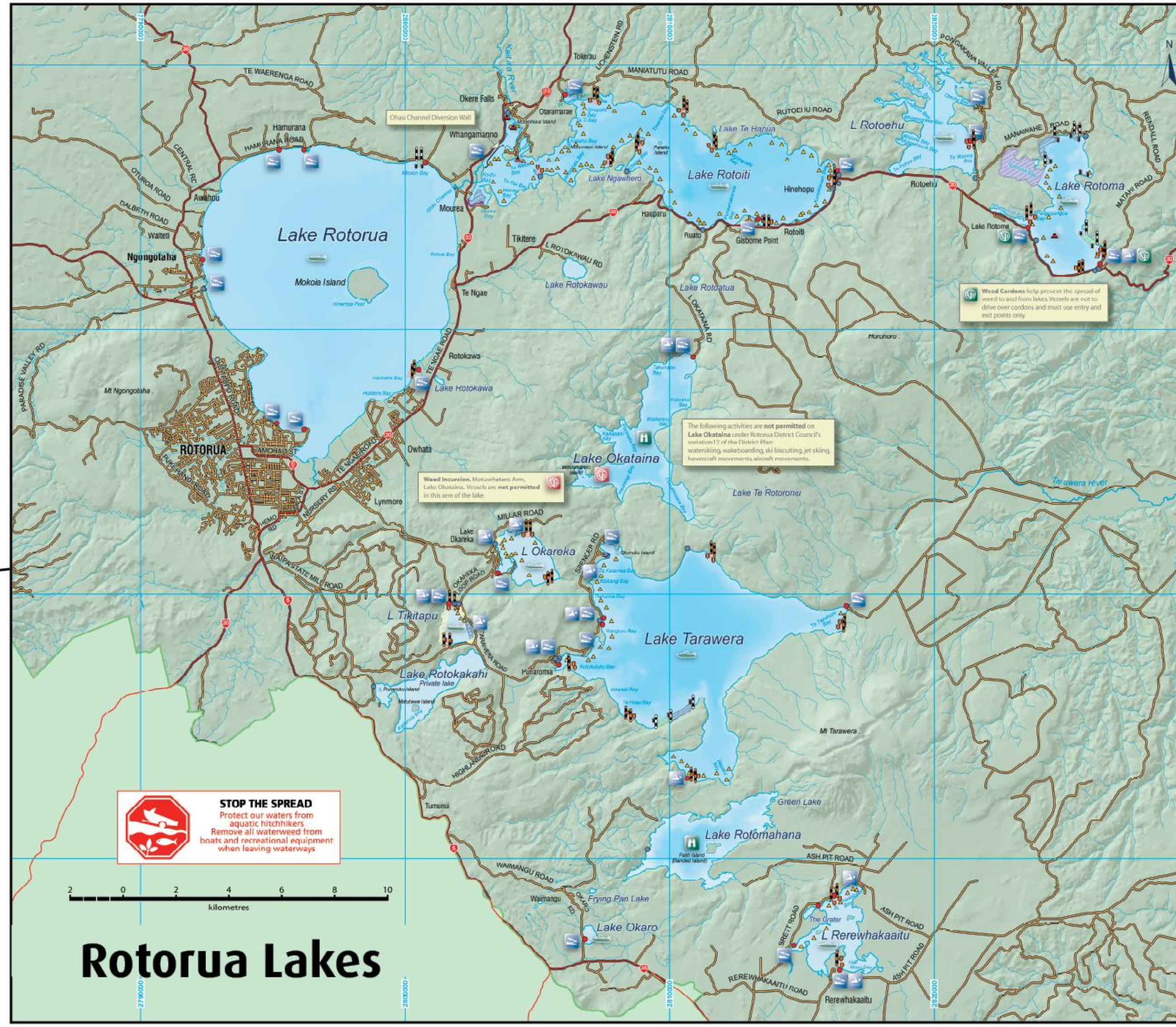


The Bay of Plenty Region
North Island
South Island
Auckland
Rotorua
Wellington
Christchurch
Dunedin
Stewart Island

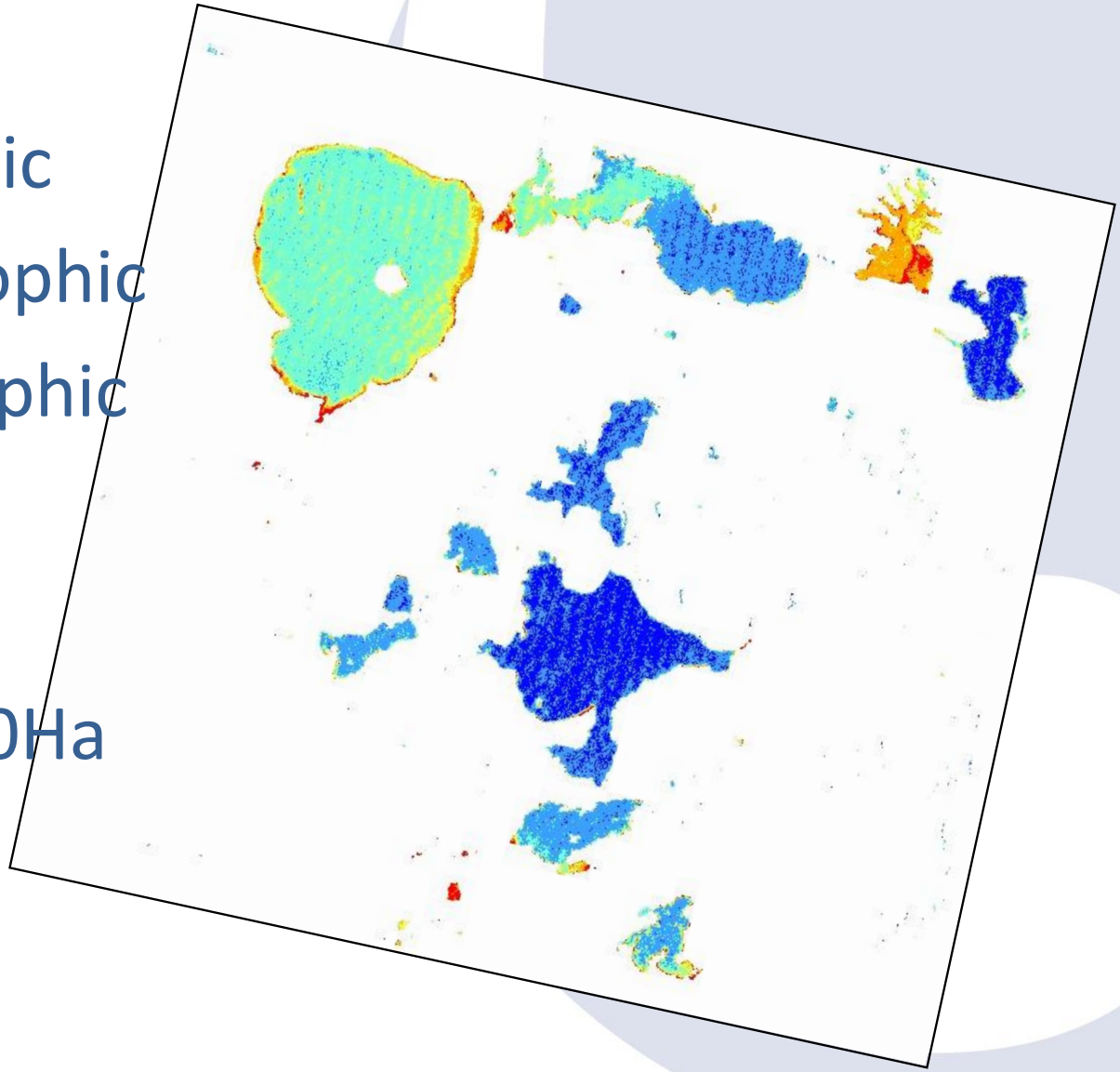


Rotorua Lakes
Lake Rotorua
Mokoia Island
ROTORUA
Ngongotaha
Hamurana
Awahou
Okere Falls
Ohau Channel Diversion Wall
Lake Rotoiti
Lake Te Hapua
L Rotoehu
Lake Rotoma
Lake Rotokawau
Lake Rotoatua
Lake Rotokawa
Lake Okataina
Lake Te Rotoroniu
L Okareka
L Tikitapu
Lake Rotokakahi
Private lake
Lake Tarawera
Mt Tarawera
Green Lake
Lake Rotomahana
Frying Pan Lake
Lake Okaro
L Rerewhakaaitu
Mt Ngongotaha
Tarawera River
STOP THE SPREAD
Protect our waters from aquatic hitchhikers
Remove all waterweed from boats and recreational equipment when leaving waterways
kilometres

12 Lakes

- 4 eutrophic
- 4 mesotrophic
- 4 oligotrophic

- 30 – 8,000Ha



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ROTORU
TE ARAV
LAKES
PROGRAMME

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ROTORUA
TE ARAWA
LAKES
PROGRAMME

The Problem

Deteriorating WQ

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Lake Rotomā 12 m water clarity

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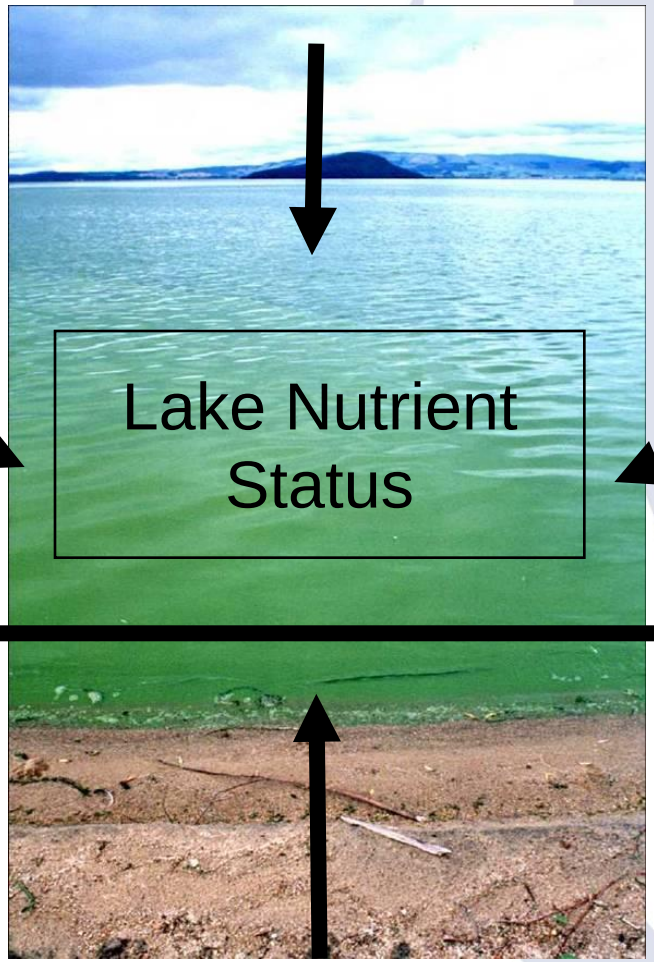

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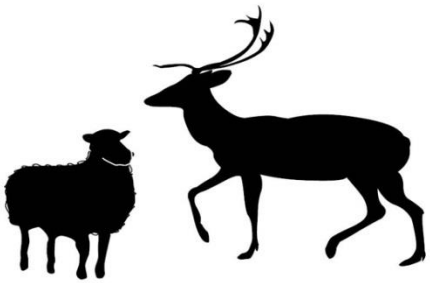
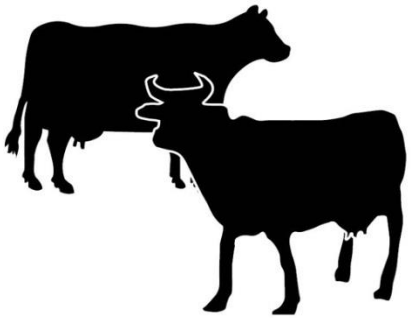
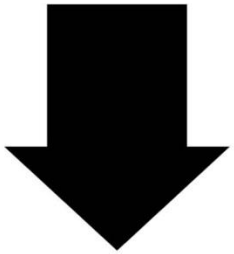
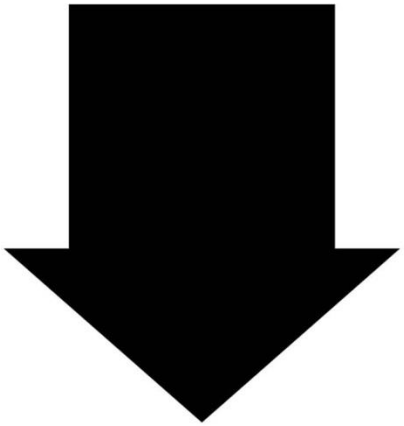
Nitrate leaching rates from various land uses

Bush/Forestry	Sheep/Deer	Dairy
		
2 - 4 kg N/ha/yr	8 - 15 kg N/ha/yr	28 -100 kg N/ha/yr
 N	 N	 N
Ratios: 1	: 5	: 25
	1	: 5

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LAKE ROTORUA INPUTS

	Nitrogen inputs t/yr*	% of nitrogen inputs	Phosphorus input t/yr**	% of phosphorus input
Forest and bush	75.4	10	2.26	6
Pasture	526	70	17.49	44
Lifestyle and urban	93.4	12	4.32	11
Springs and geothermal input	30	4	14.4	36
Rainfall	29.2	4	1.33	3
Sediment releases	360	NA	36	NA

Source: * ROTAN 2011 report NIWA

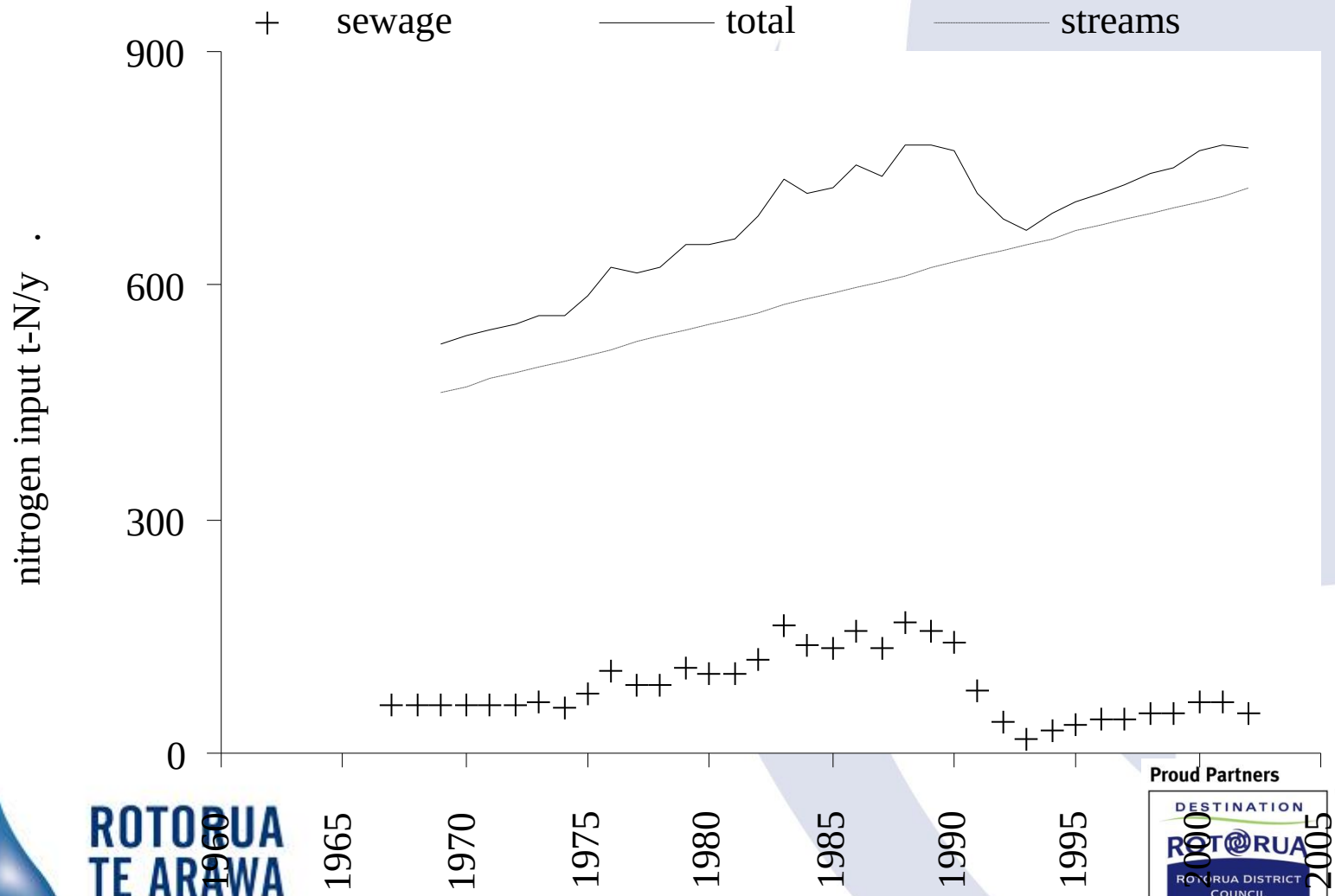
**Rotorua Rotoiti Draft Action Plan November 2007

Ground water age

60 years

ROTORUA TE ARAWA LAKES PROGRAMME

Total nitrogen loads to Lake Rotorua



Source: Rotorua Rotoiti Draft Action Plan November 2007

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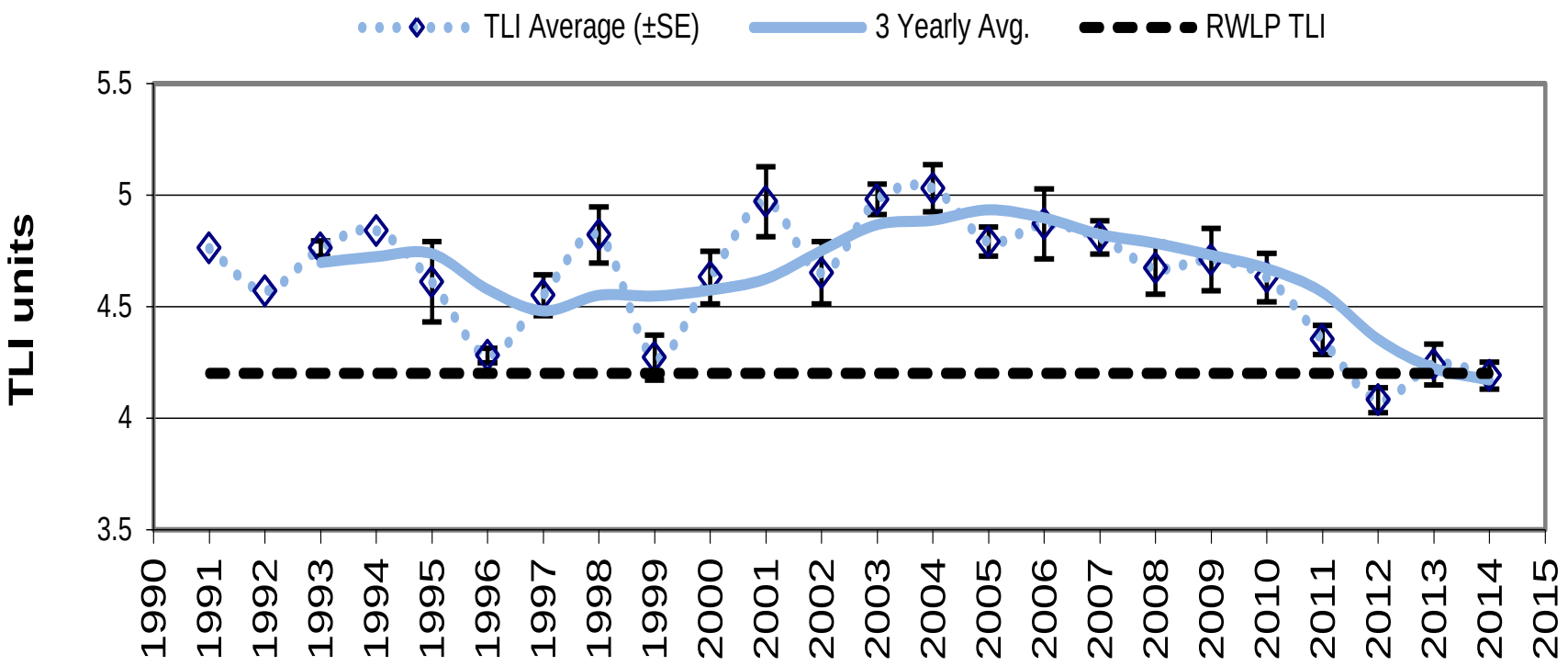
TLI objectives

Lake Regional Water & Land Plan Objective TLI units	3-yearly average TLI to 2011 TLI units	3-yearly average TLI to 2012 TLI units	3-yearly average TLI to 2013 TLI units	3-yearly average TLI to 2014 TLI units	2012/13 Annual TLI TLI units	2013/14 Annual TLI TLI units	Lake Type based on Trophic Status	LakeSPI Condition 2013/2014
Ōkaro 5.0	5.1	5.1	5.4	5.1	5.4	4.5	Supertrophic	Moderate
Rotorua 4.2	4.6	4.4	4.2	4.2	4.2	4.2	Eutrophic	Moderate
Rotoehu 3.9	4.4	4.3	4.1	4.0	4.0	4.0	Eutrophic	Poor
Rotomahana 3.9	4.0	4.0	4.0	3.9	3.9	3.8	Mesotrophic	Moderate
Rotoiti 3.5	3.9	3.8	3.7	3.5	3.4	3.4	Mesotrophic	Moderate
Rerewhakaaitu 3.6	3.8	3.8	3.6	3.5	3.5	3.4	Mesotrophic	Moderate
Okareka 3.0	3.3	3.3	3.2	3.3	3.1	3.3	Mesotrophic	Moderate
Tikitapu 2.7	3.0	2.9	2.8	2.8	2.8	2.8	Oligotrophic	Moderate
Ōkataina 2.6	2.8	2.9	2.9	2.8	2.8	2.7	Oligotrophic	Moderate
Tarawera 2.6	2.8	2.9	3.0	3.0	2.9	3.0	Oligotrophic	Moderate
Rotoma 2.3	2.3	2.3	2.4	2.4	2.4	2.3	Oligotrophic	High
Rotokakahi* 3.1	4.2	4.2	3.8	3.7	3.7	3.6	Mesotrophic	Moderate

Lake Rotorua



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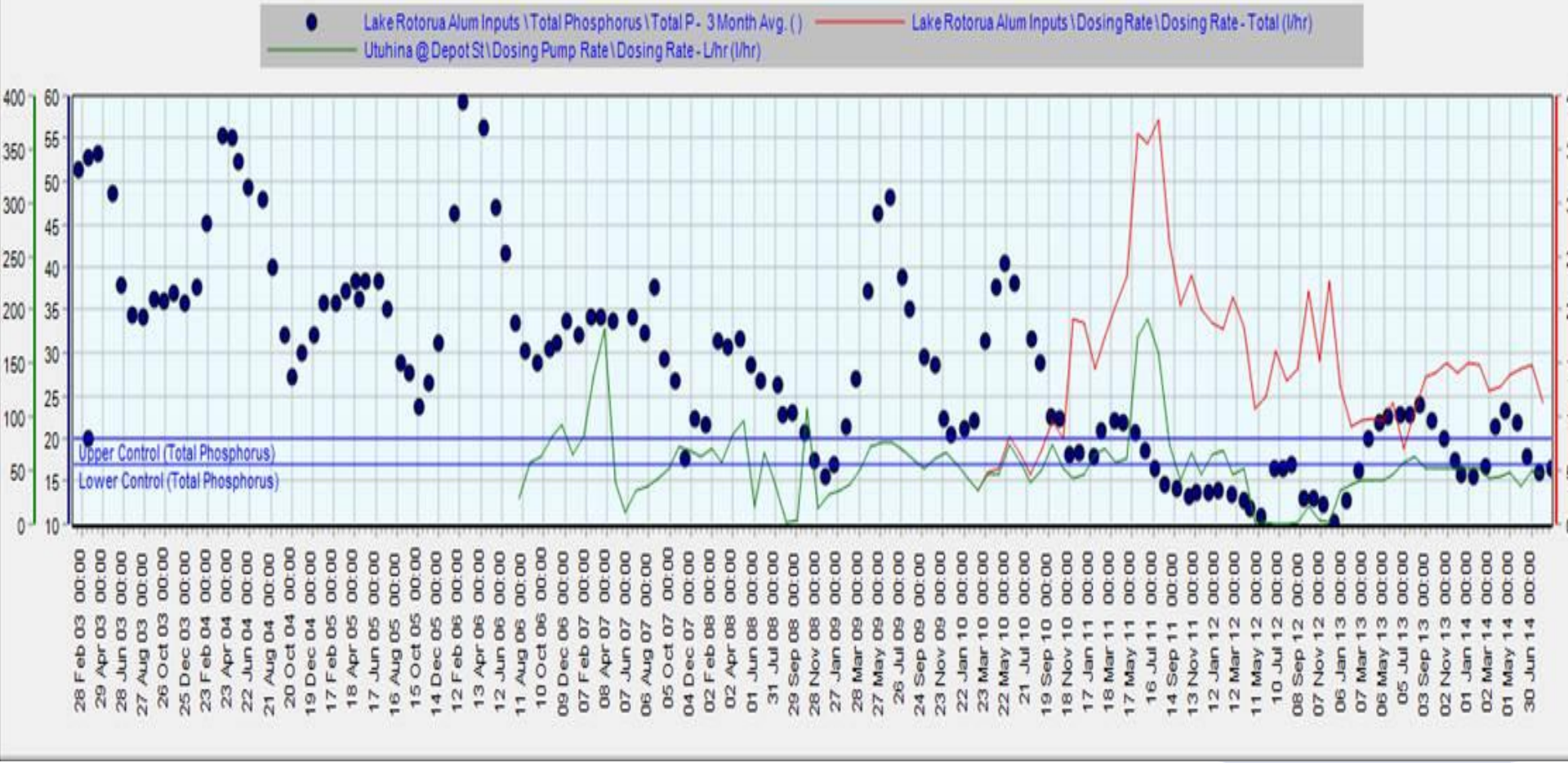
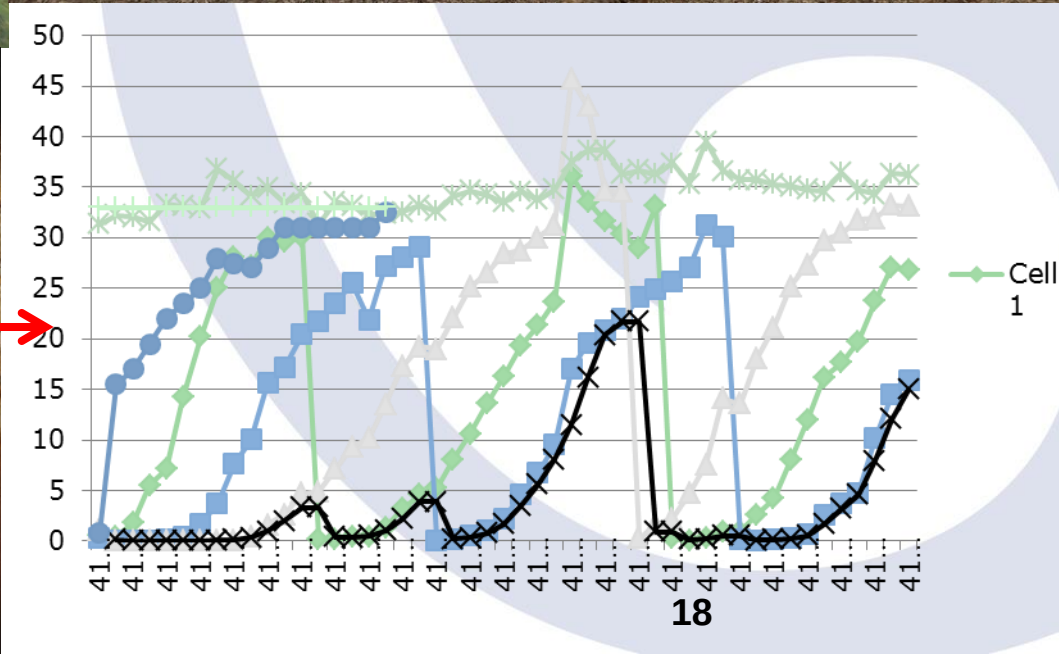
P locking plants



LAKES
PROGRAMME

Point sources



Hi frequency monitoring buoys

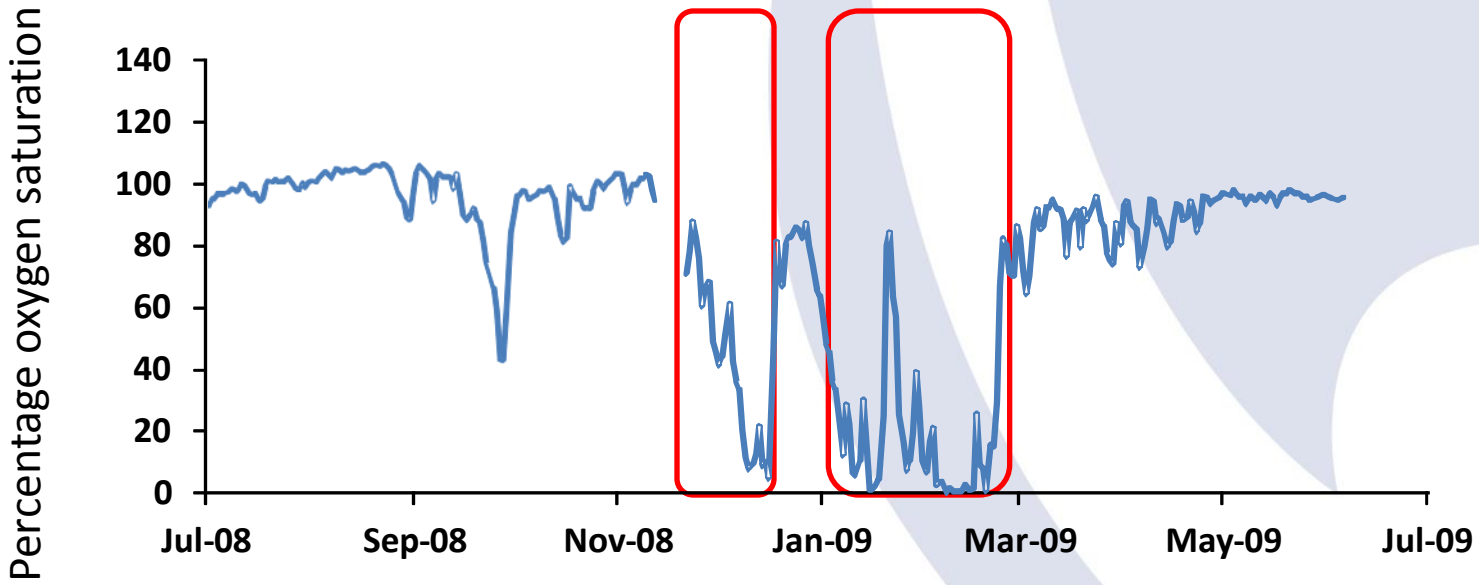
- climate and water quality 15 mins
- online web interface in real-time.

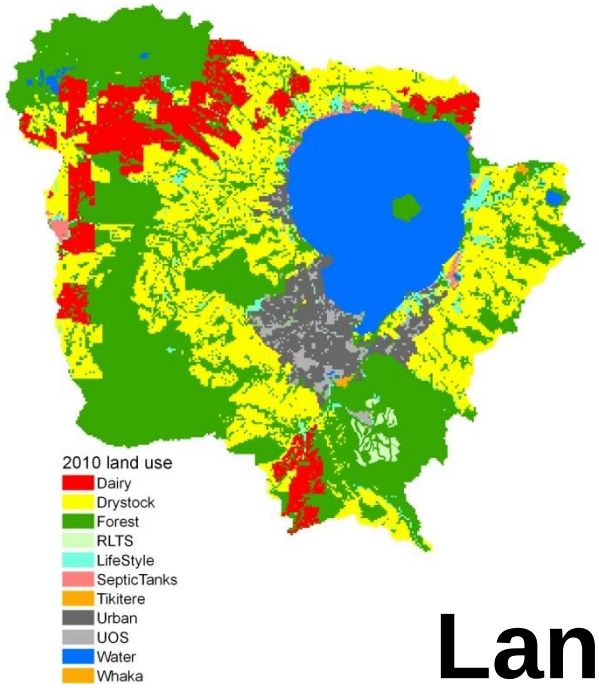
Meteorology:
- wind speed/direction
- air temperature
- etc

Water quality:
- dissolved oxygen
- chlorophyll
- phycocyanin
- water temperature profile

High frequency monitoring buoys

de-oxygenation of bottom waters





Land use

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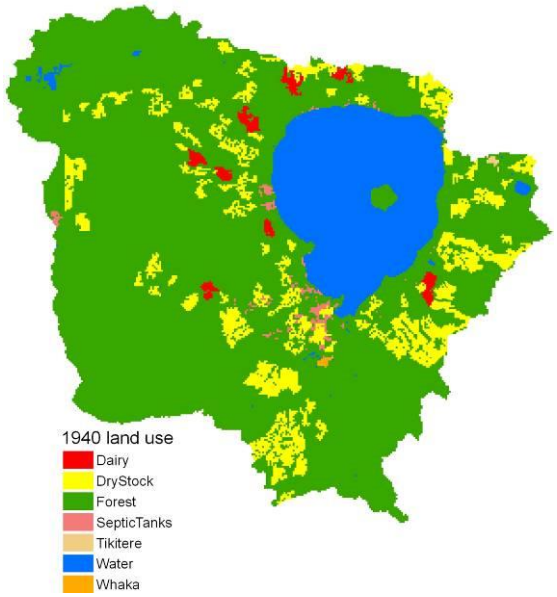

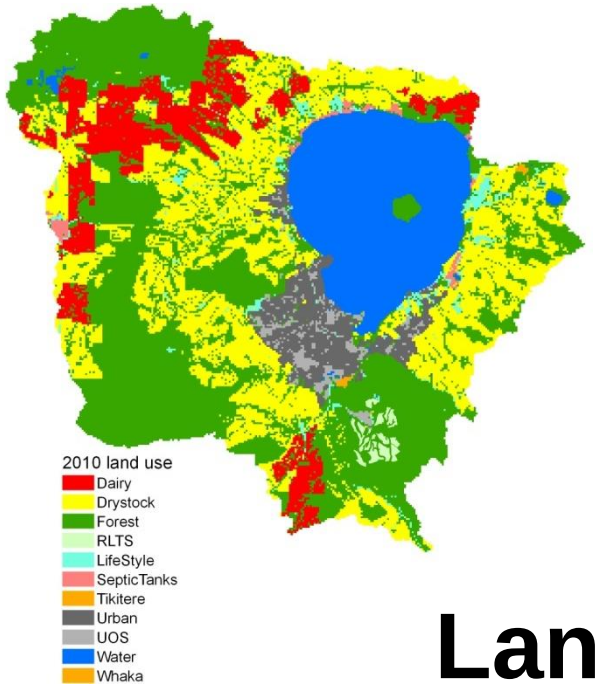

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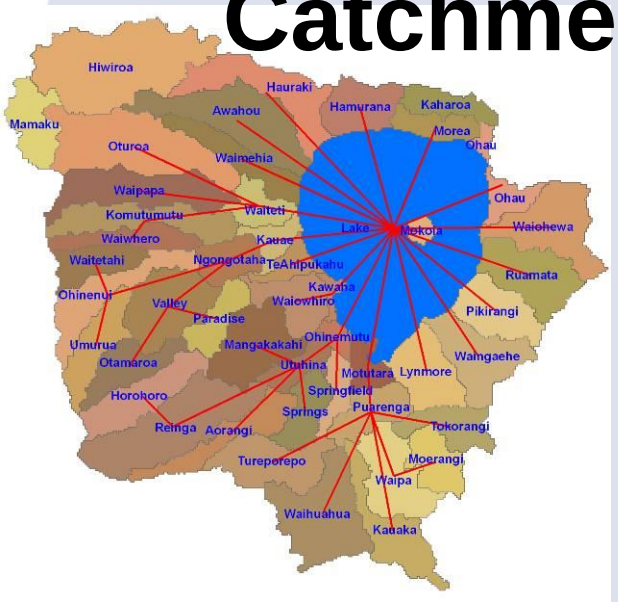
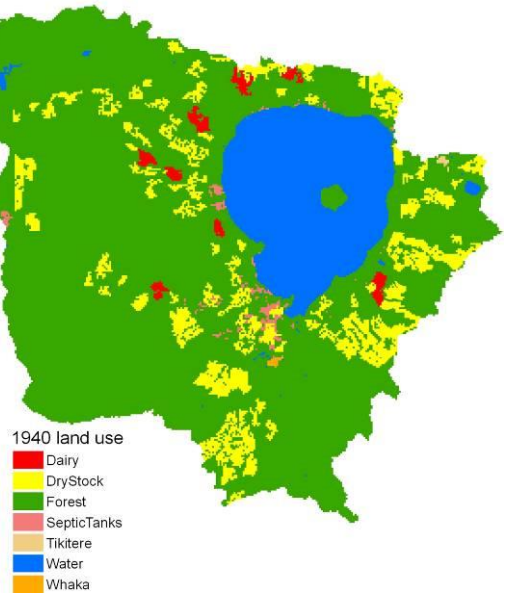
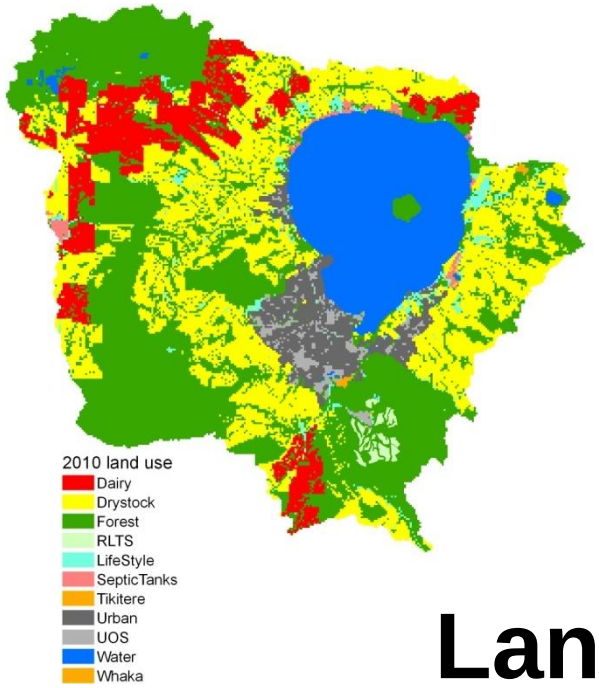
Catchments







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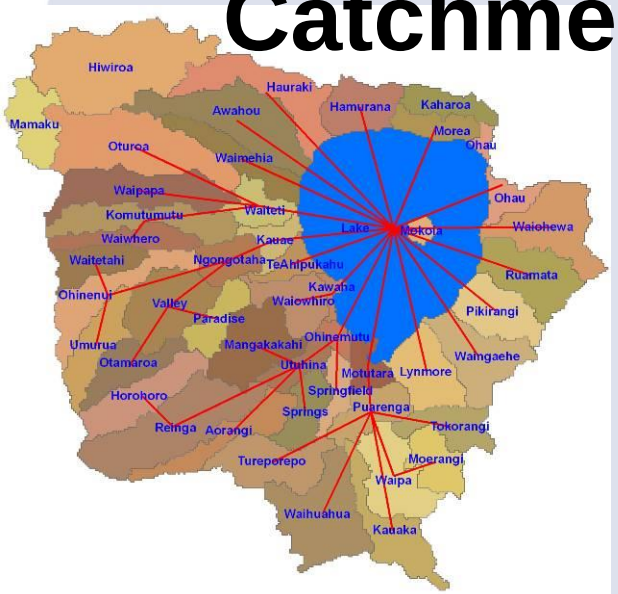
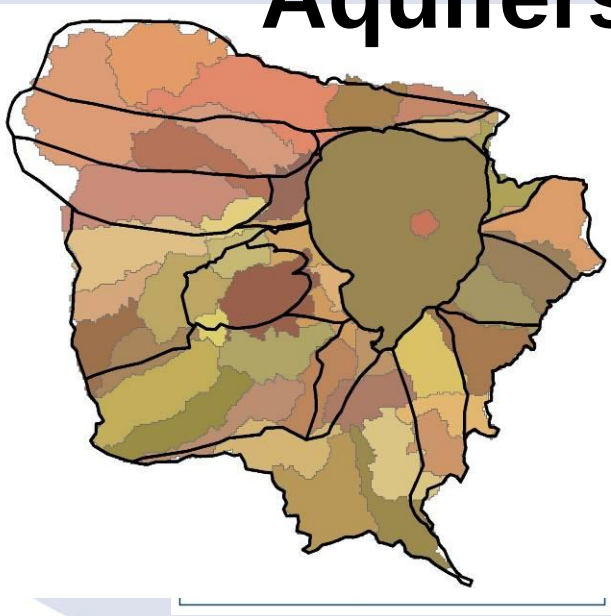
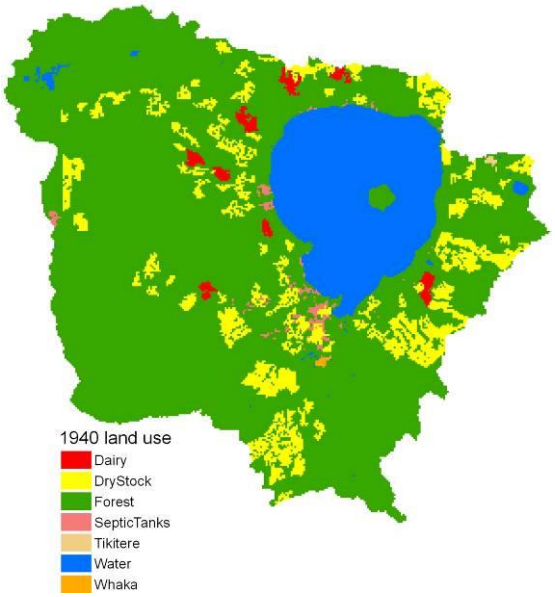
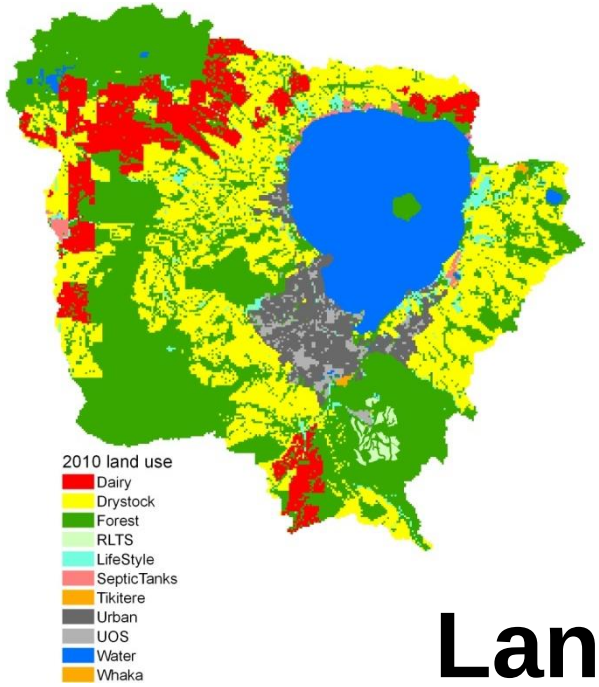


Aquifers

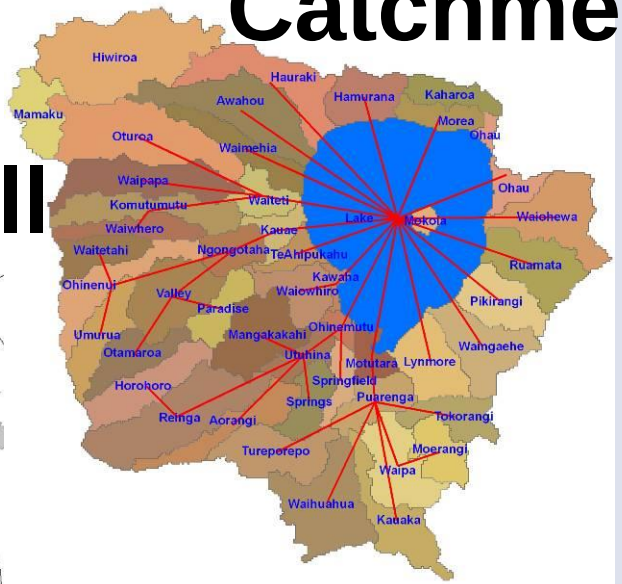




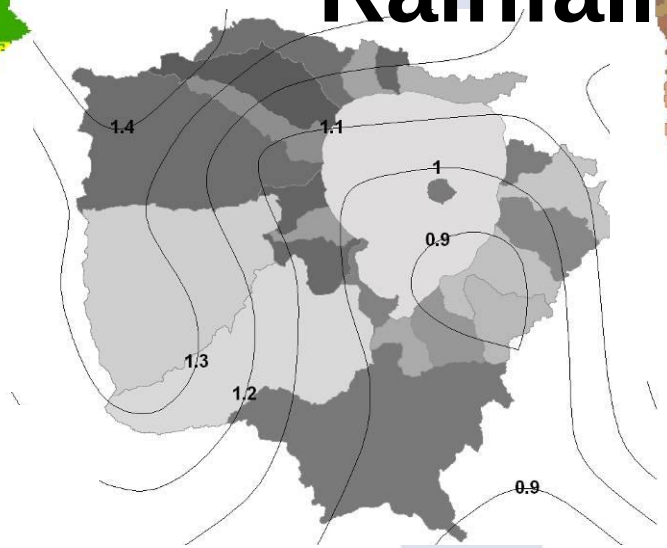


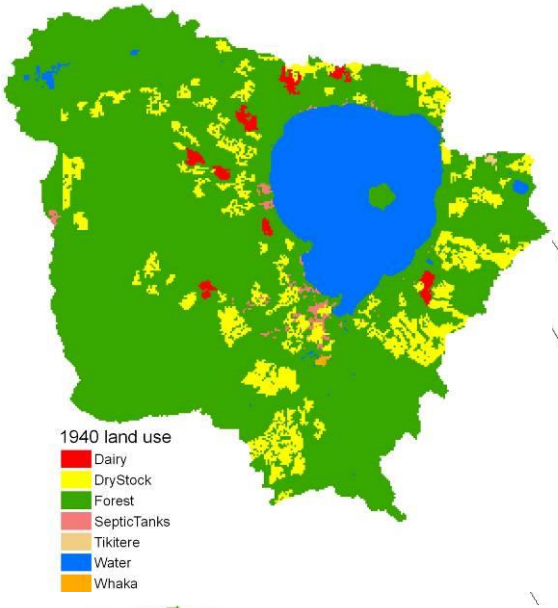
Land use

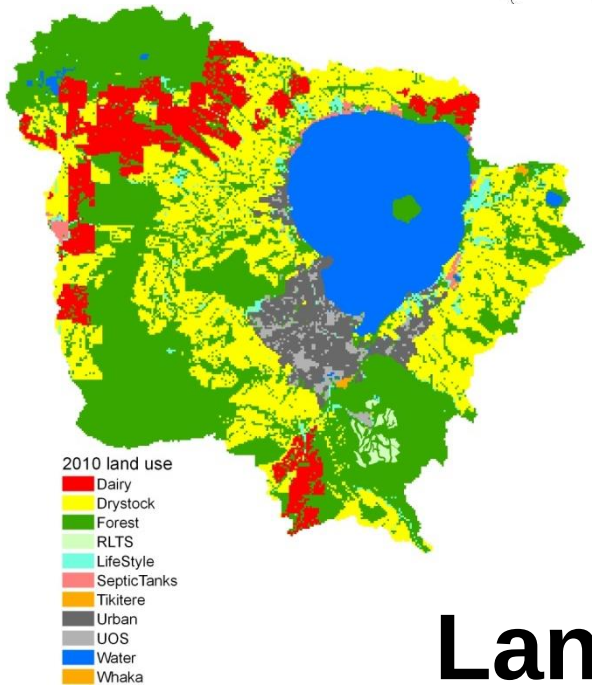
Catchments



Rainfall

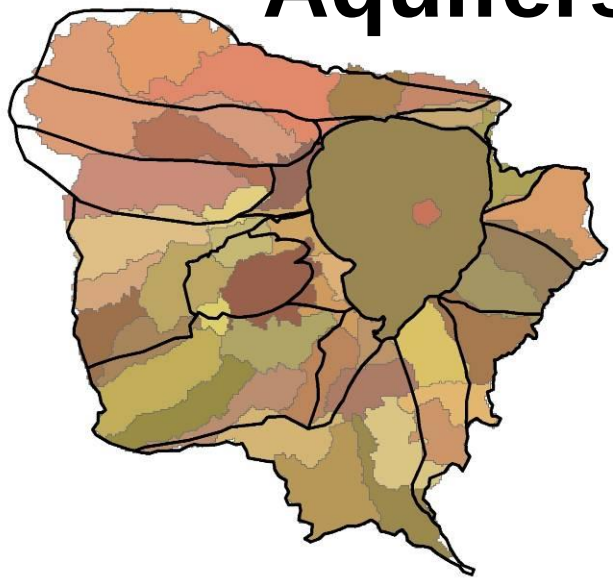




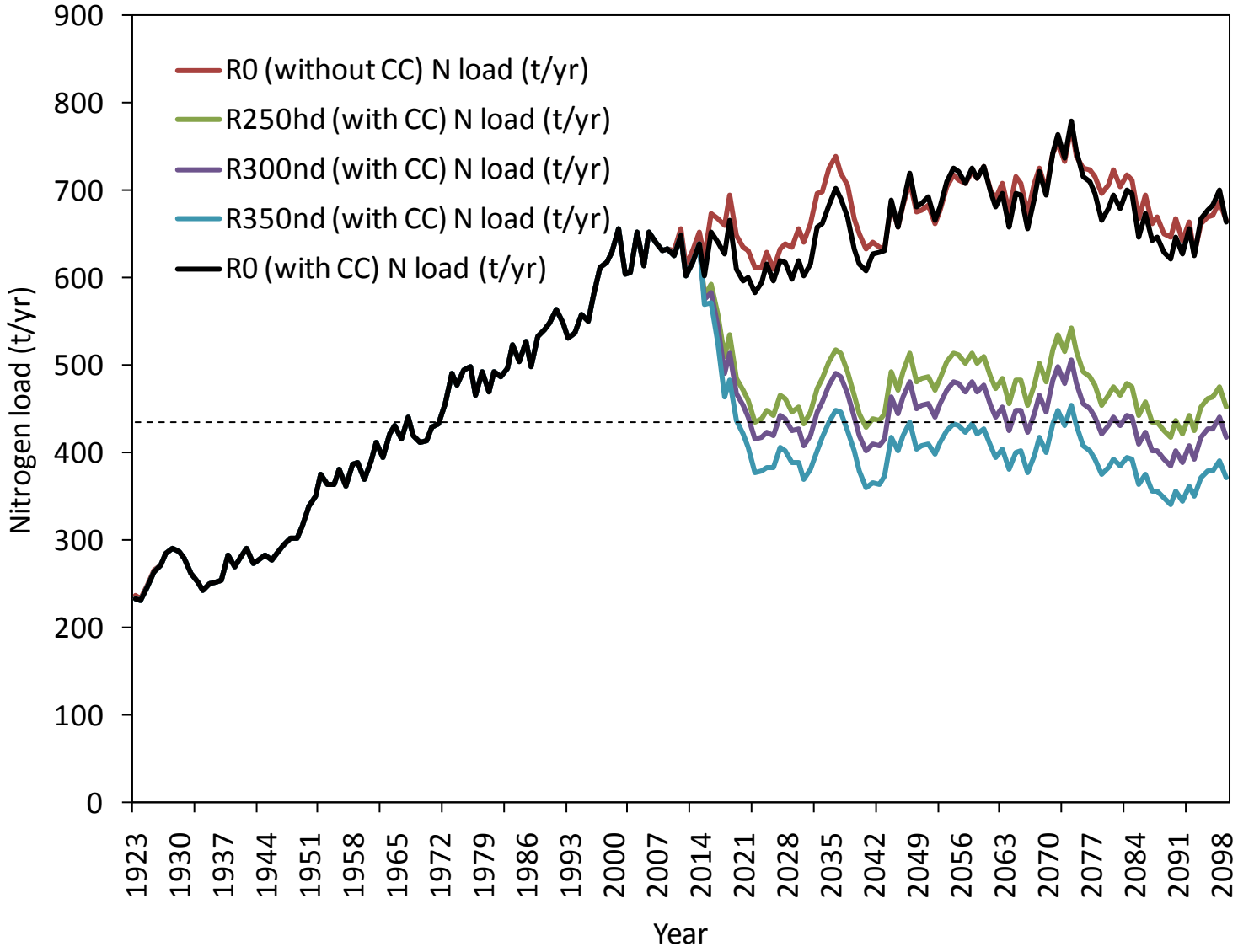


Land use

Aquifers

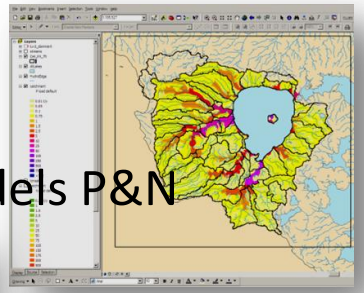


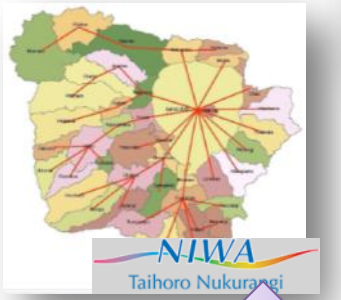
Land use change scenarios



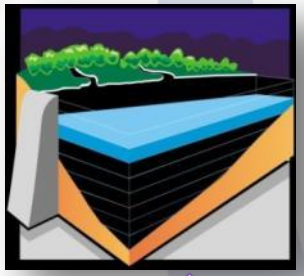
Lake Rotorua modelling as a decision support tool

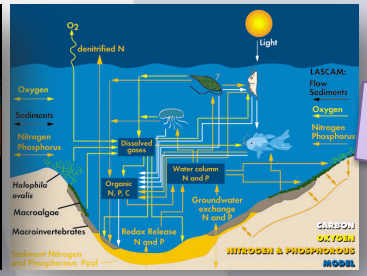
Catchment models P&N



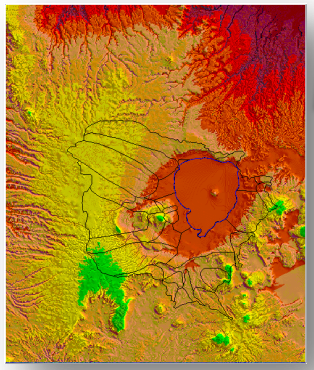


Lake model



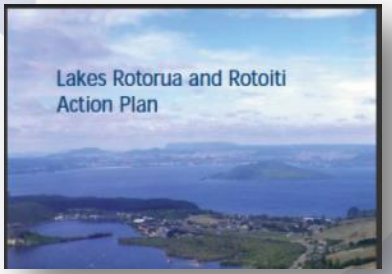


Climate model



High frequency monitoring

Inform



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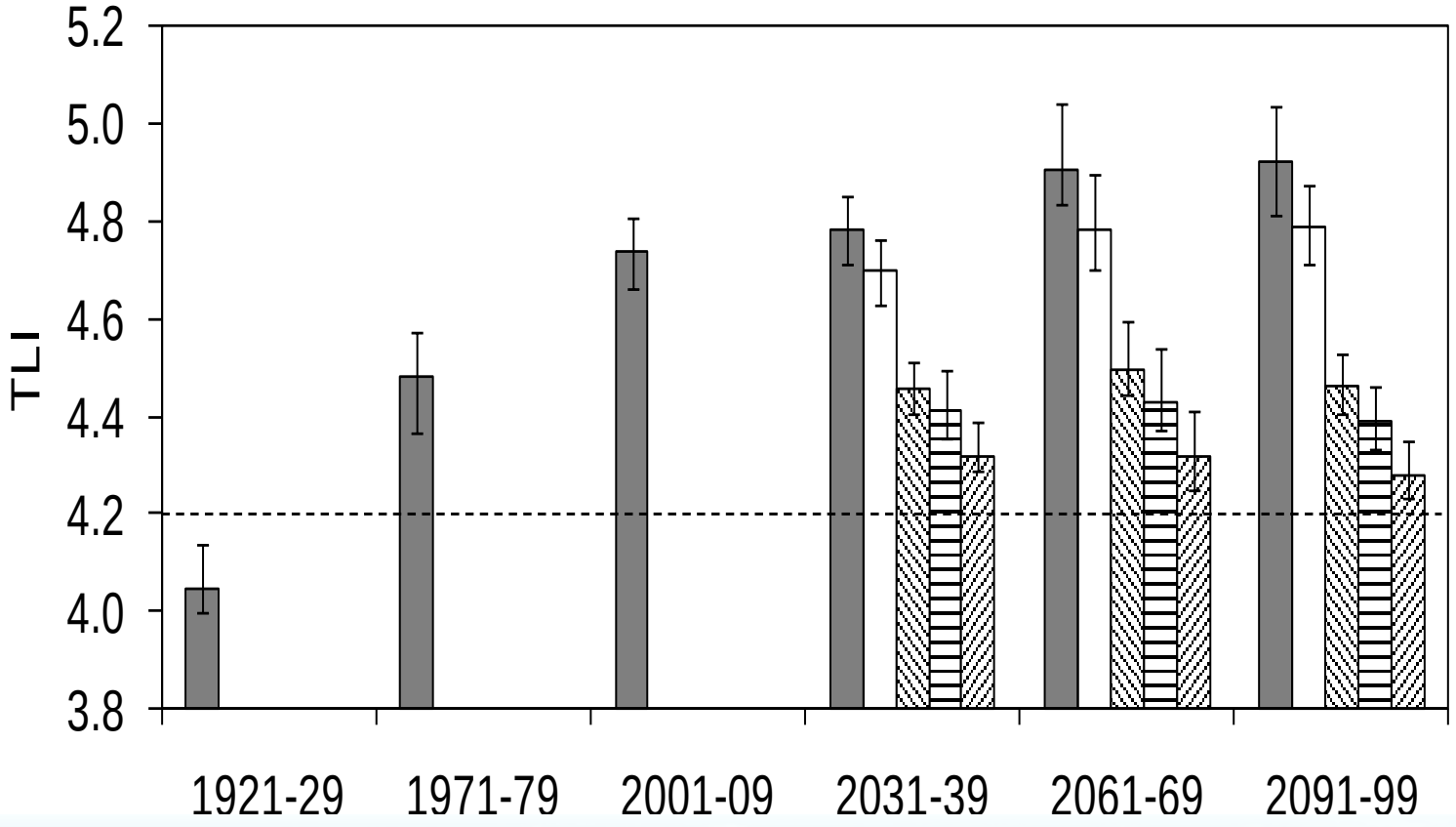
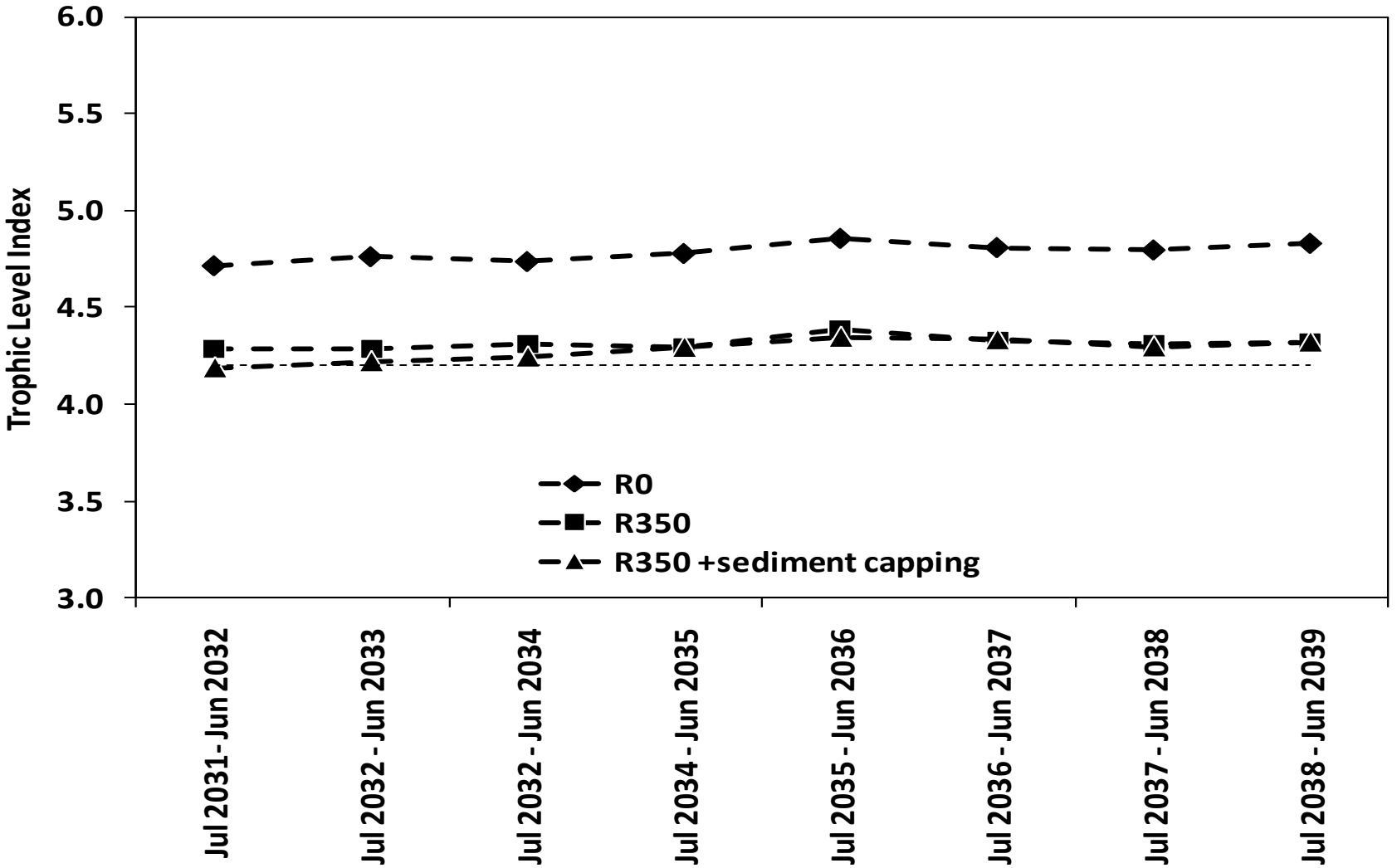
LAKE MODEL: Effects of land use change and inflow diversion



Trophic Level Index for sediment capping



Detainment bunds

- Research: holding back storm flows
- Contain sediment Phosphorus

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ROTOITI

- Ohau Channel
- Reticulation/OSET
- Sediment assessment

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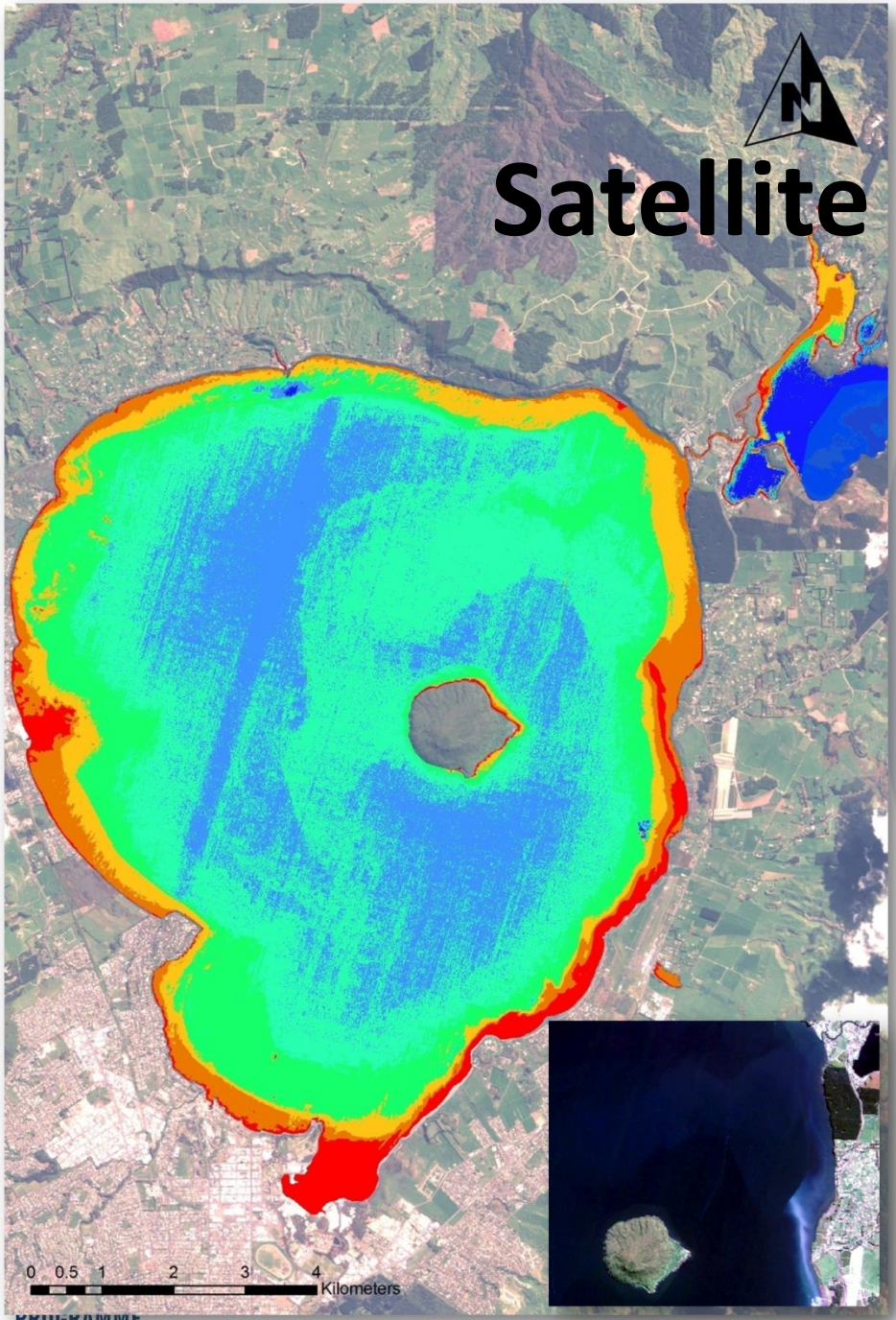
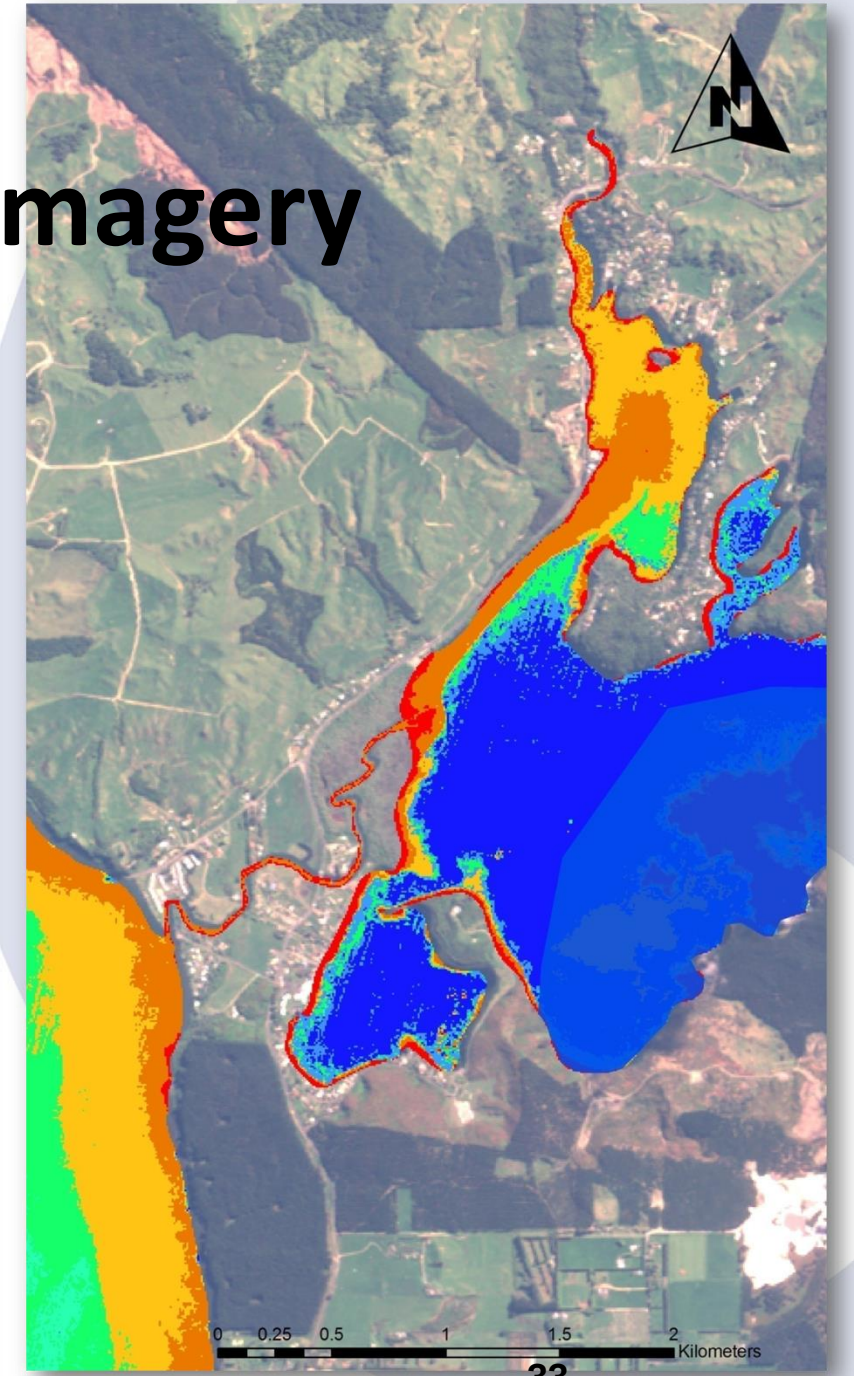
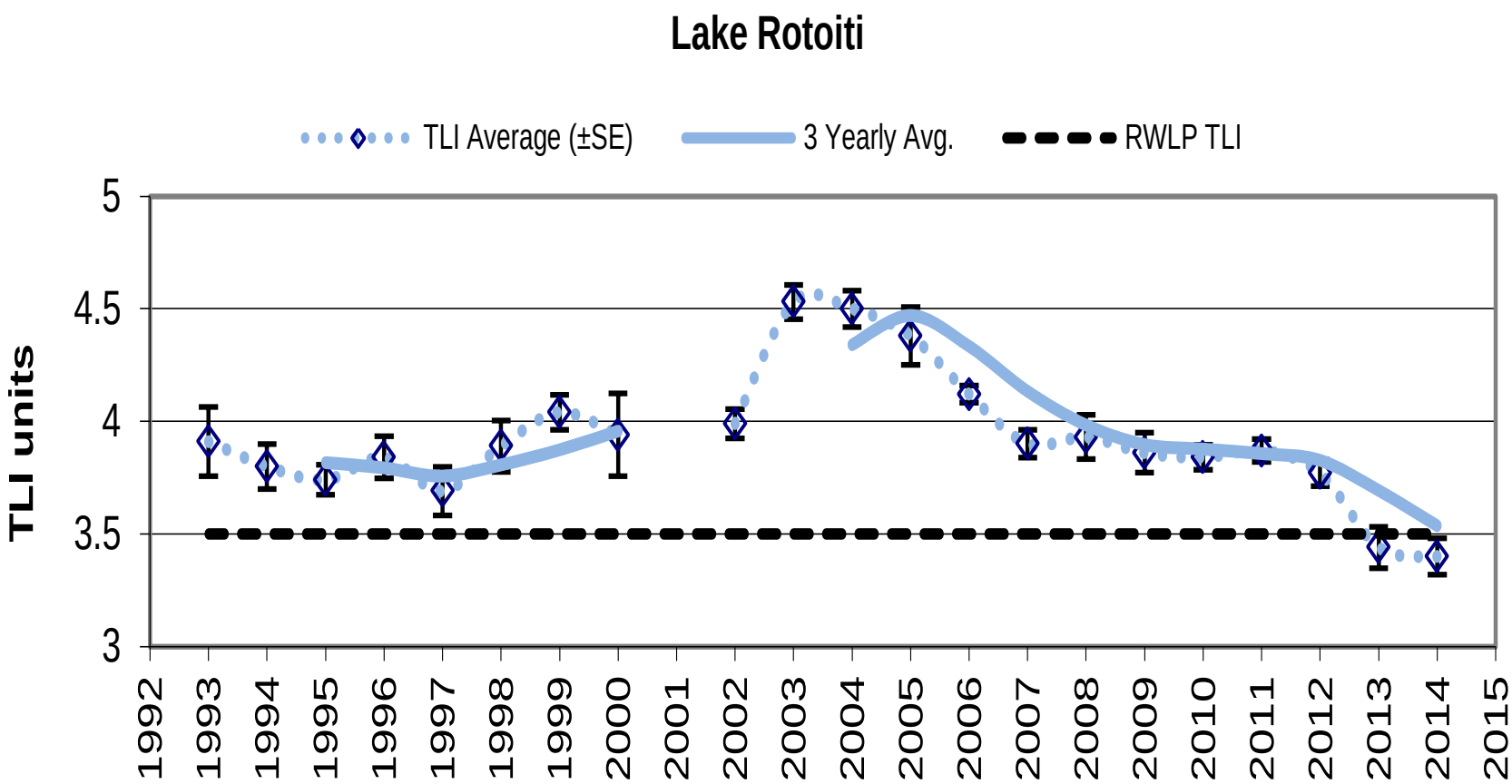
Satellite imagery





Rotoiti



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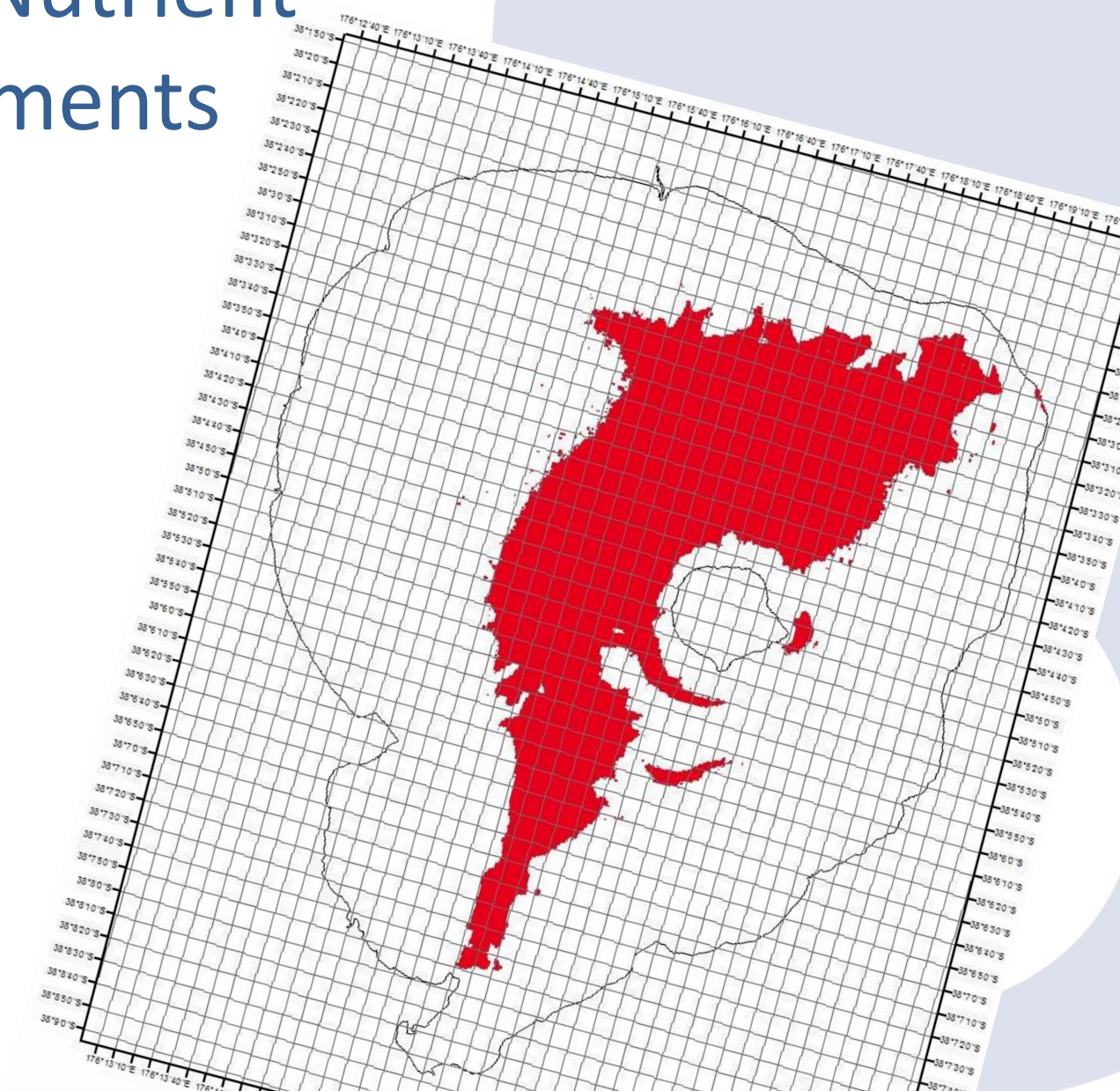
Re-setting: Nutrient from sediments

- Capping
- Aeration
- Dredging



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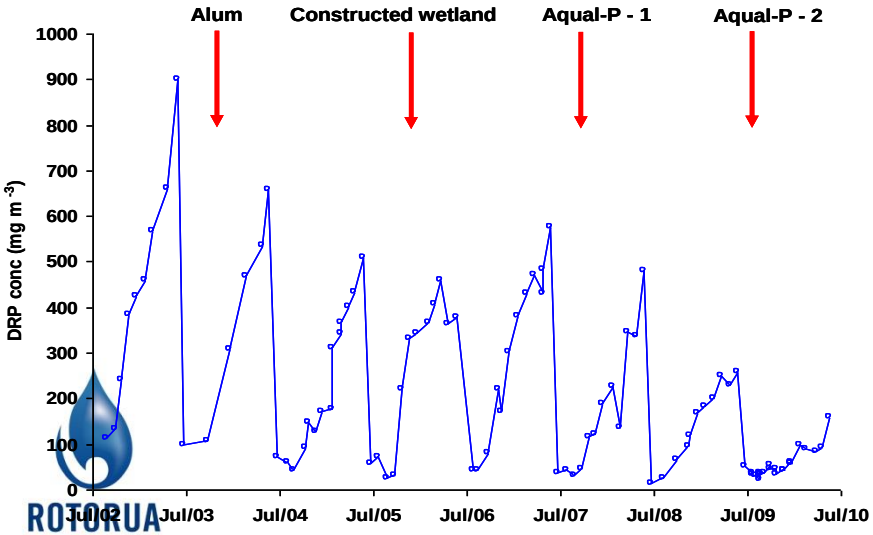
Capping



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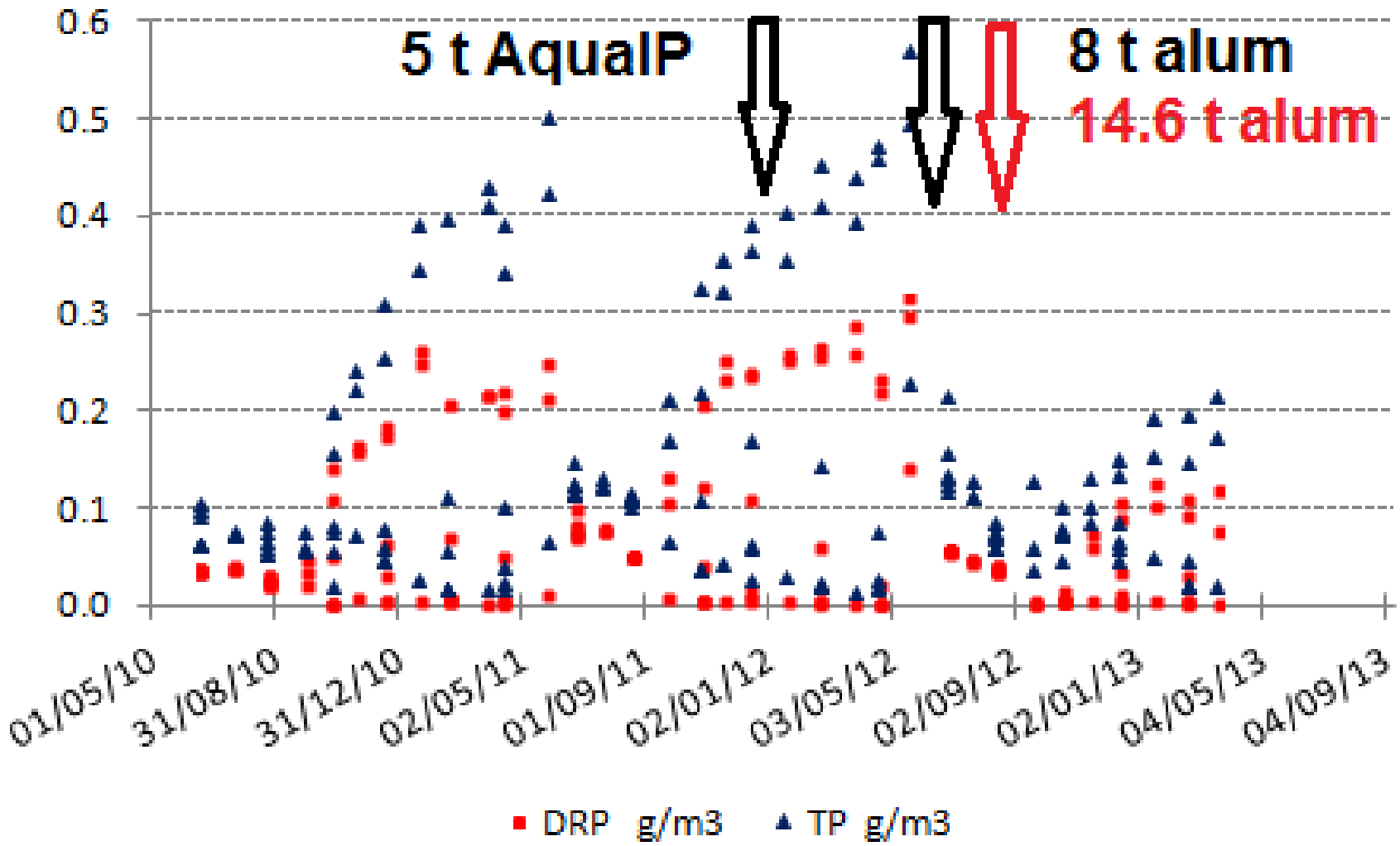
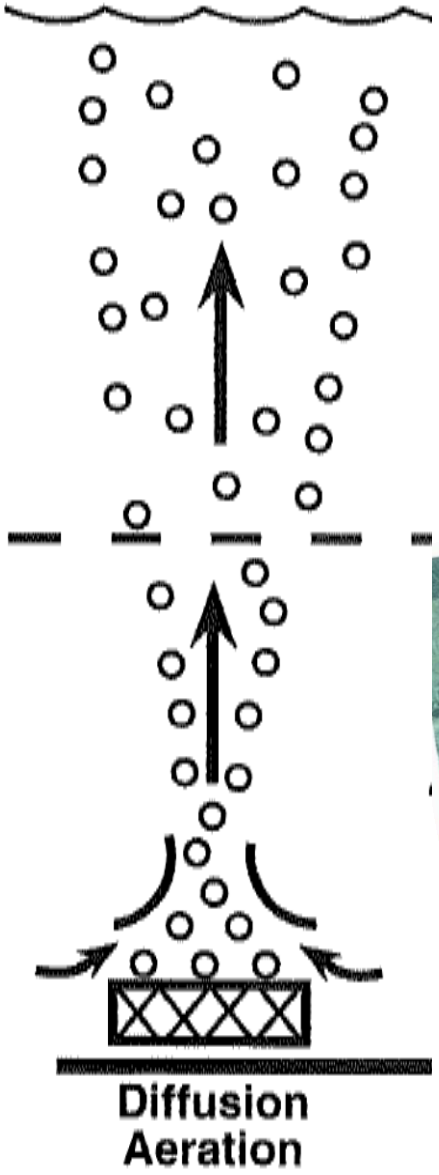
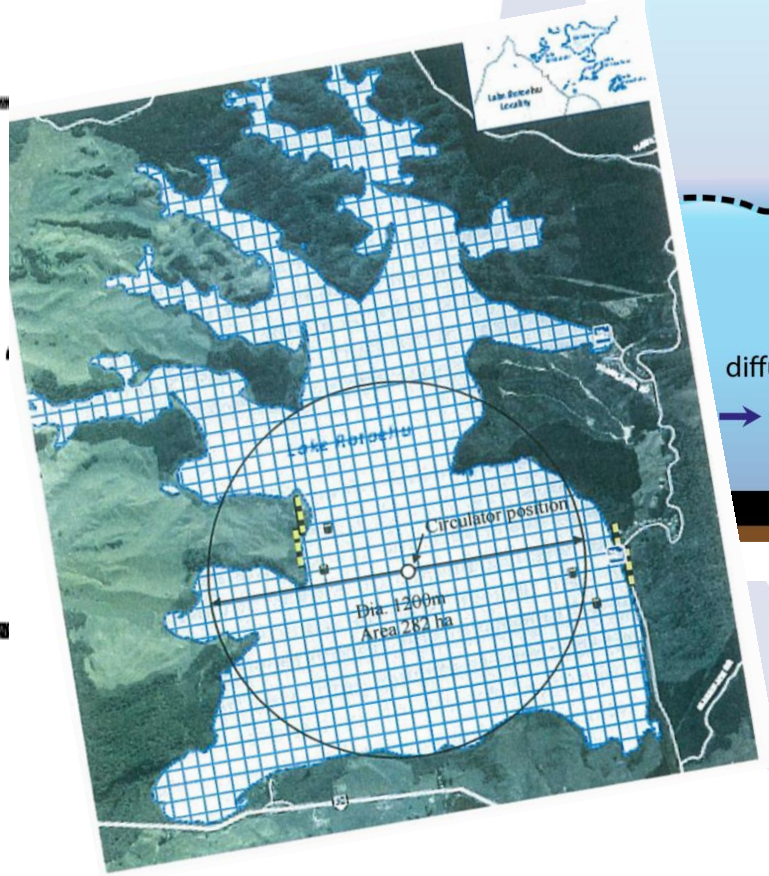
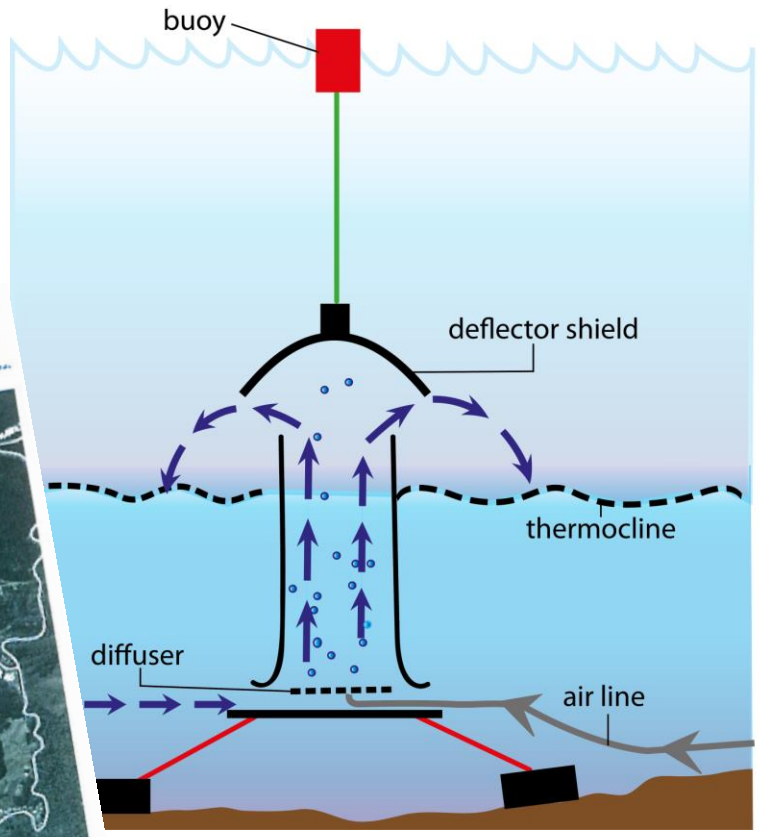
Lake Okaro treatments



De-stratification







TE ARAWA LAKES PROGRAMME

LAKES
PROGRAMME

ROTORUA TE ARAWA LAKES PROGRAMME

Rotoehu Trial

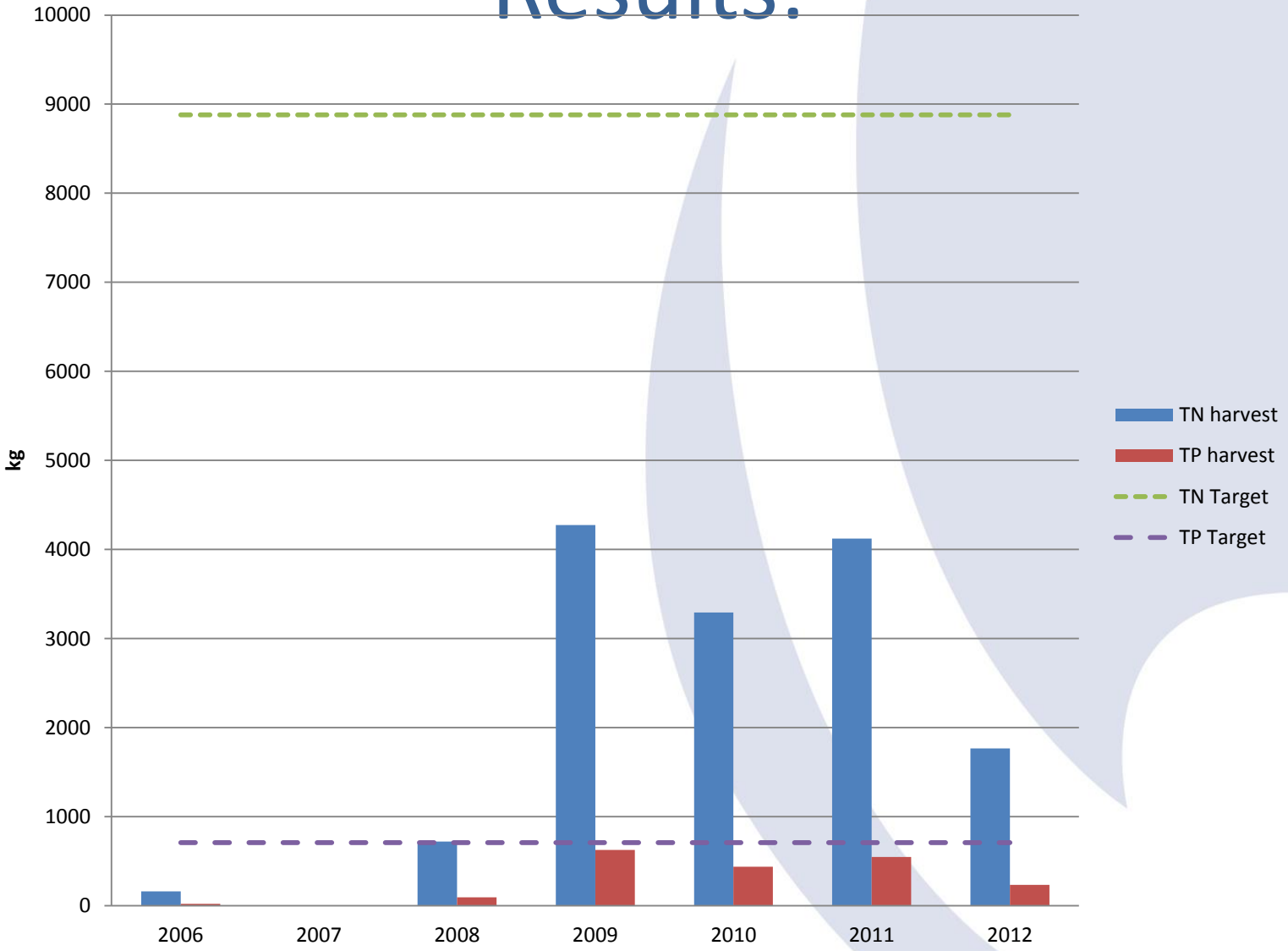
ROTORUA TE ARAWA LAKES PROGRAMME

ROTORUA
TE ARAWA
LAKES
PROGRAMME

TE ARAWA LAKES PROGRAMME

Harvester

Results:



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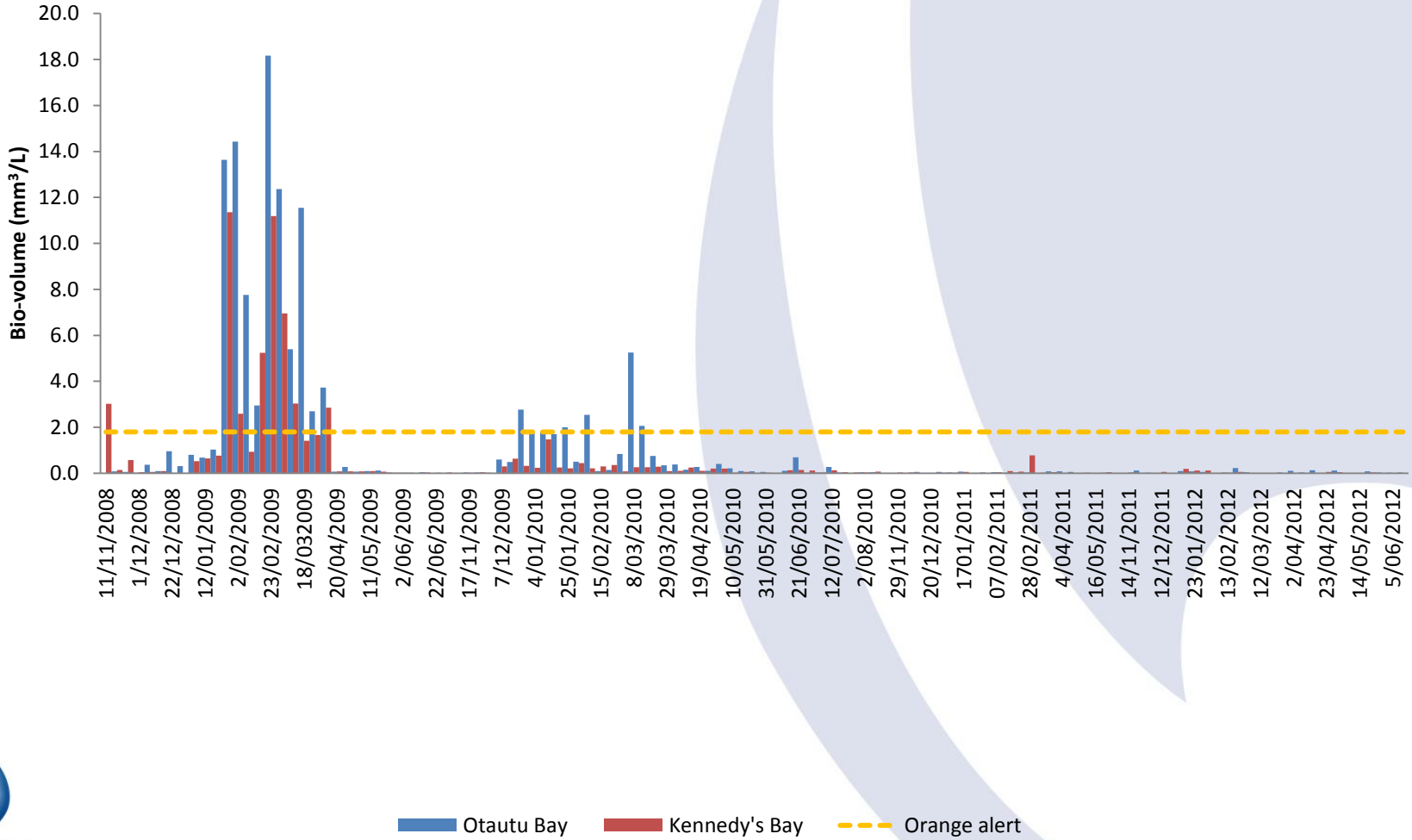
Cyano-bacteria



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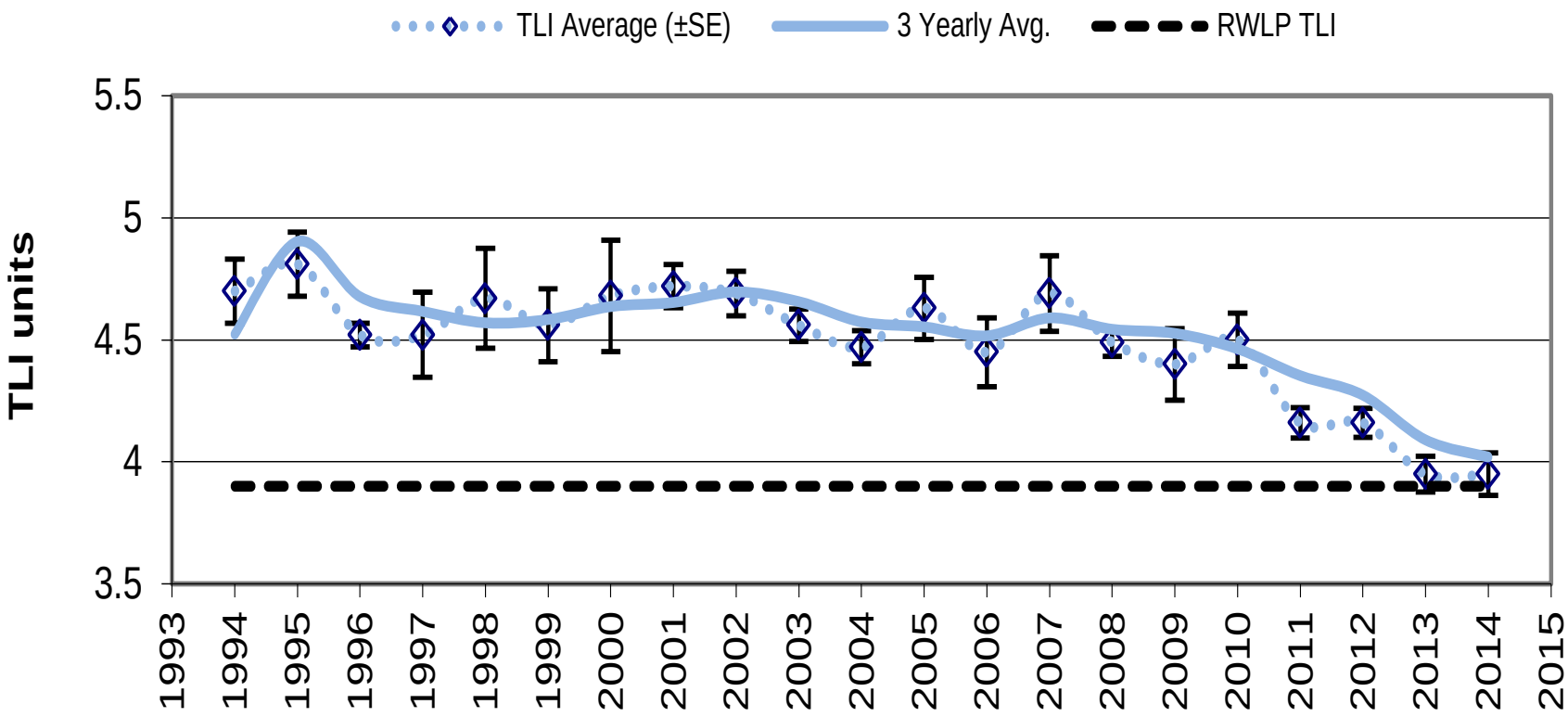
Lake Rotoehu



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Key points

- Land use also complicated by GW age,
- Short term and long term interventions
- TLI monitoring shows progress/ but complex
- Intervention response/ site specific
- Sediment treatment? Alum dosing success
- LUC/LMC combination = Future
- Monitoring what is achieved
- Models for decision making but rely on monitoring data.

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Rotorua: THE CHALLENGE

- Rotorua
  - Target 320 TN – 10 TP
- Farming 270 TN – 10 TP
  - Significant interventions & LUC
- Total cost $96M

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Other Projects

- Okaro
  - Sediment capping
  - Wetland
  - Best management practice
- Okareka
  - Sewage
  - Land use change
  - Phoslock
- Rotoehu
  - Weed harvest
  - P locking
  - Land use change
  - Floating wetlands

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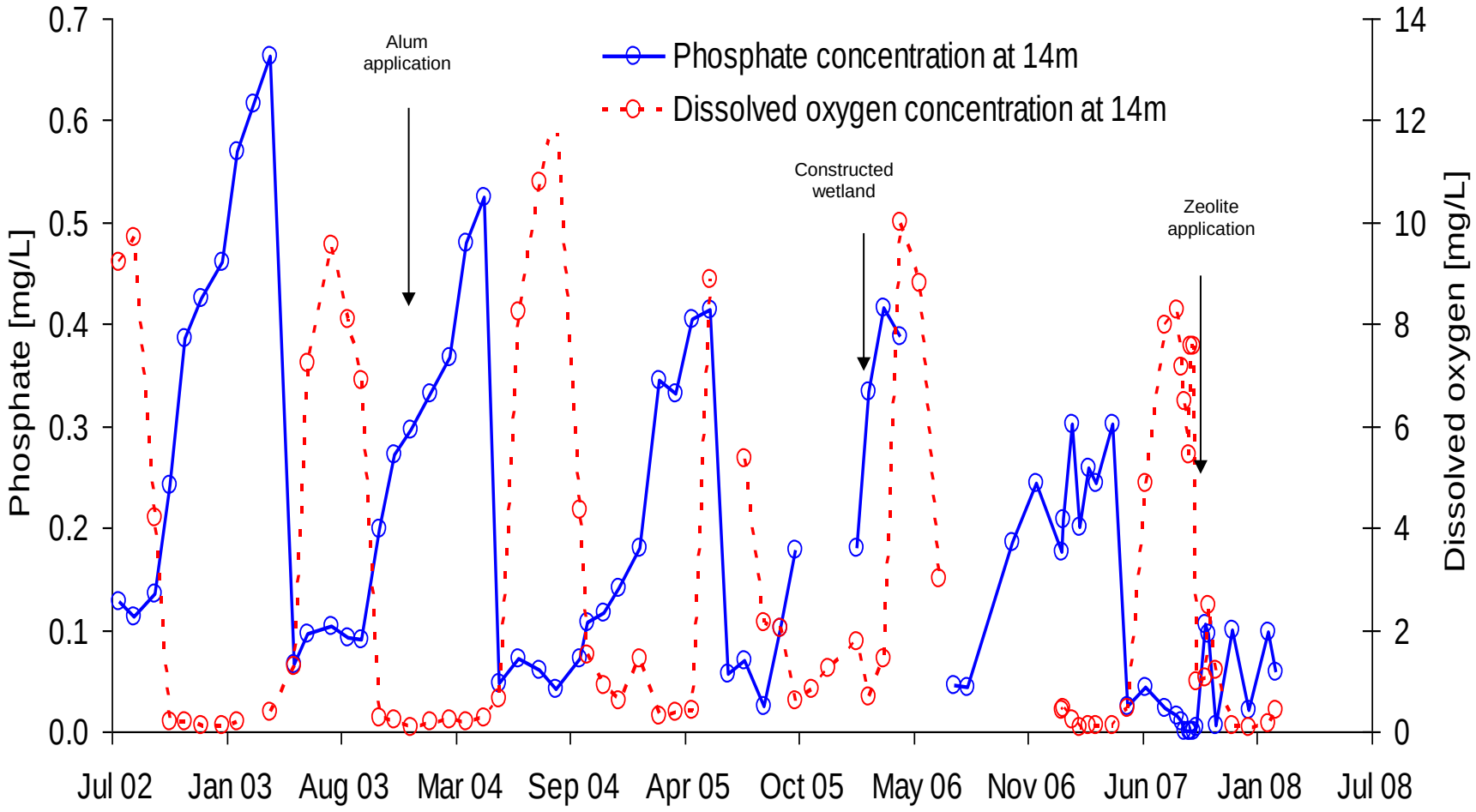
- Info from Prof D Hamilton UoW.



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The Main Challenges

- Community support
- Consultation and relationships
- Interventions on private land
- Land management change
- Land use change

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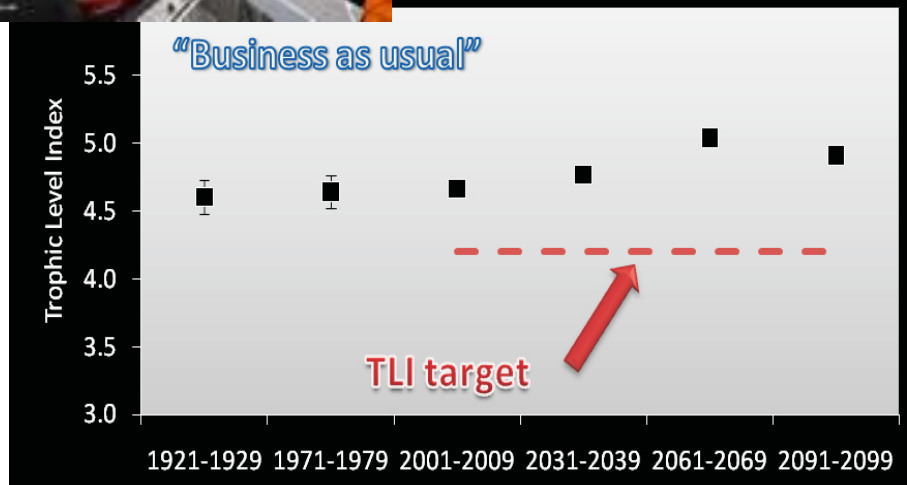
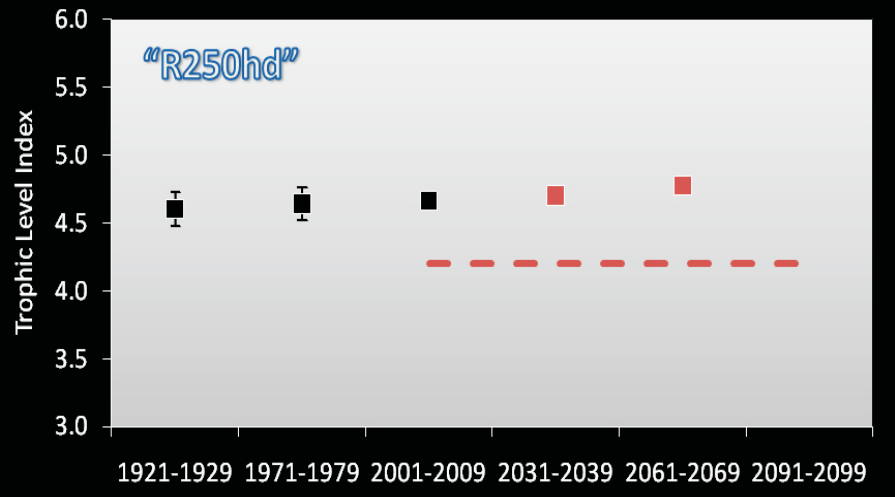
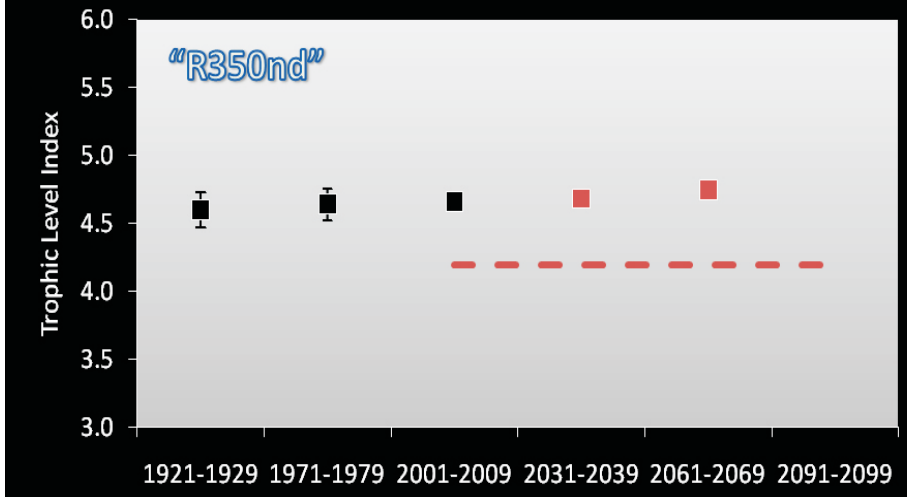
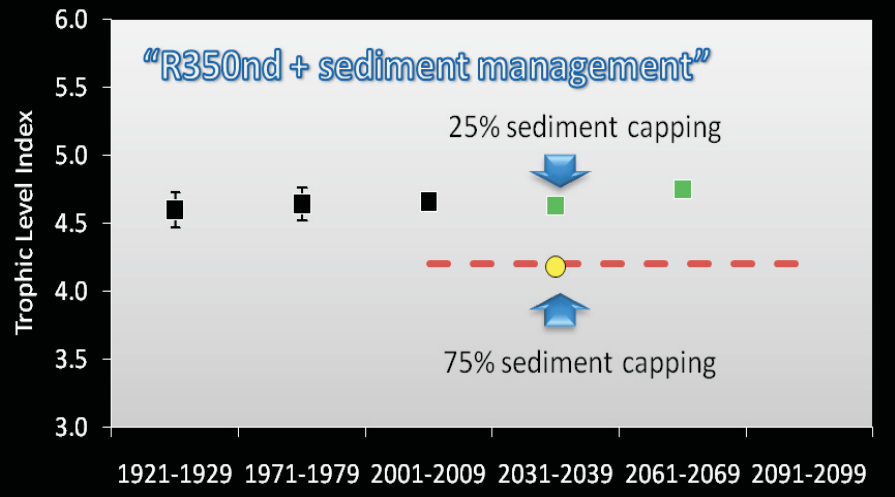
High frequency monitoring coupled with predictive models



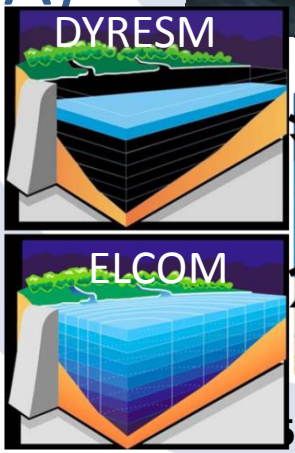


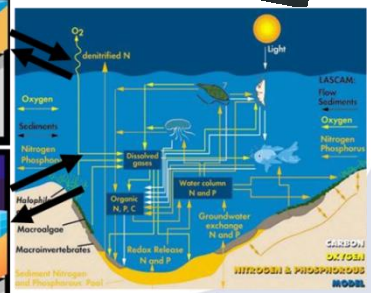




Science support TAG
University and Crown Research

- University of Waikato,
  Prof David Hamilton
- National Institute of Water and
  Atmospheric Research (NIWA)
- GNS Science
- SCION





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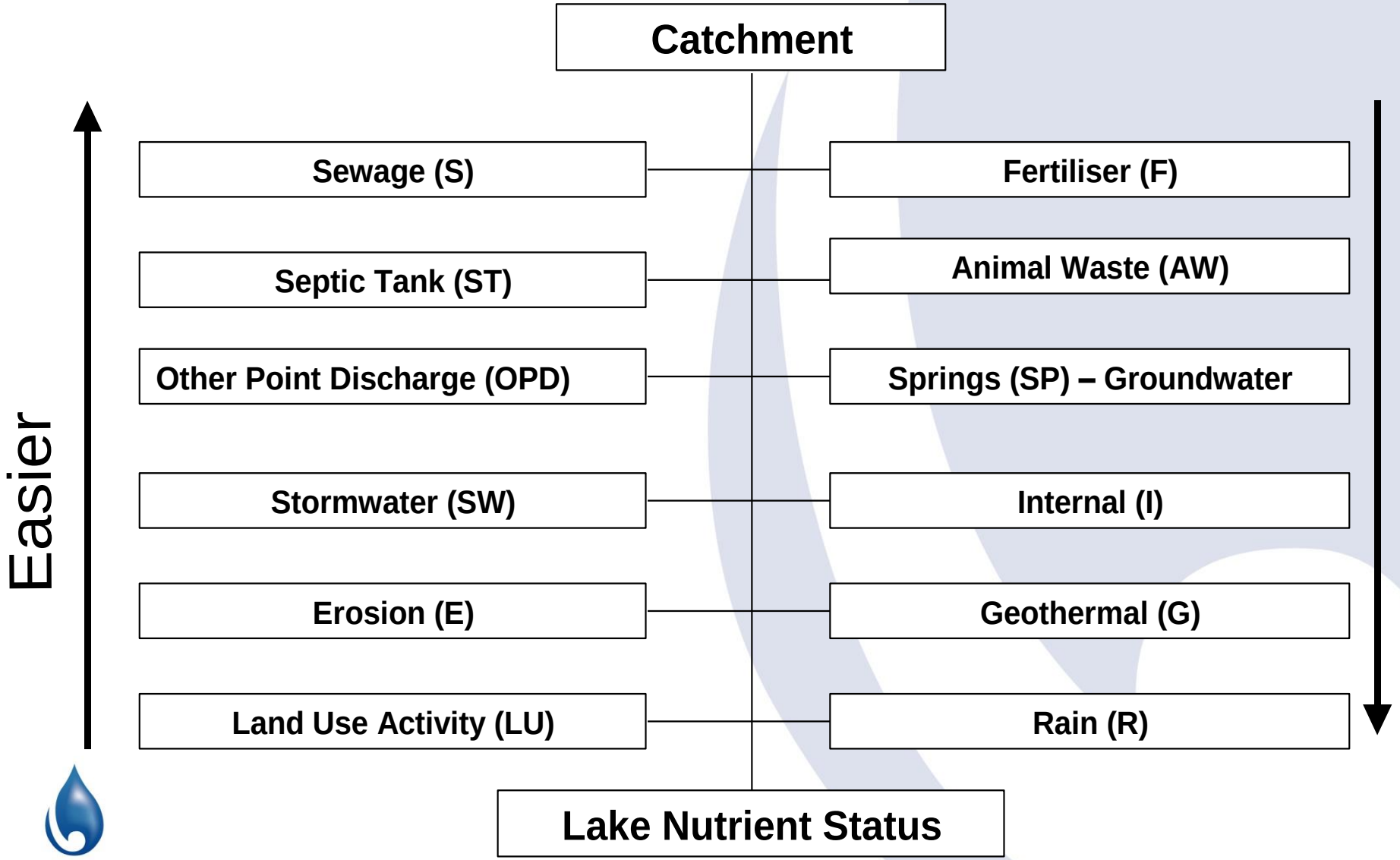
The Cause – too much nutrient



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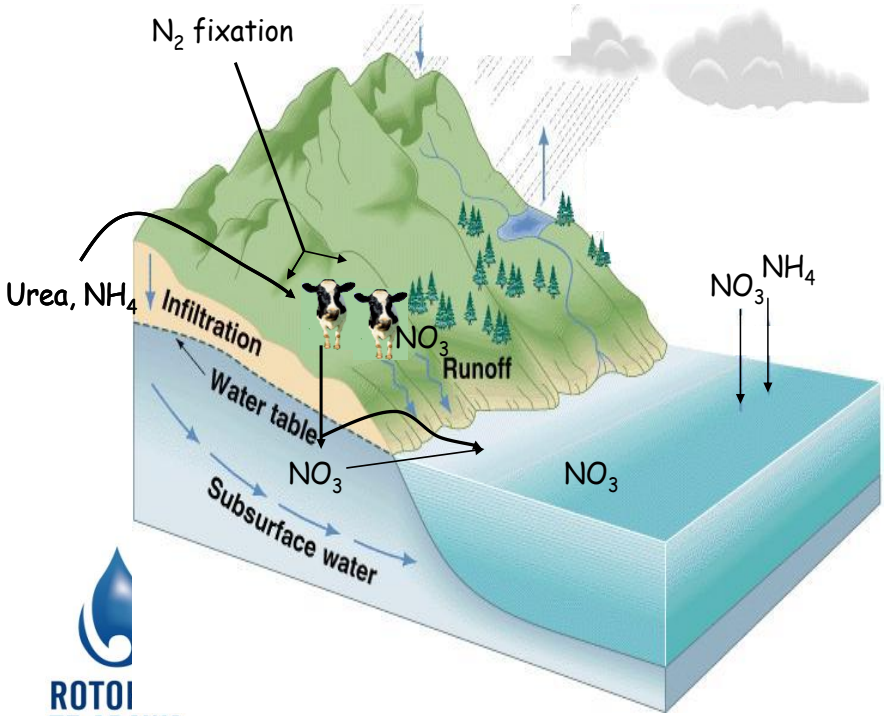
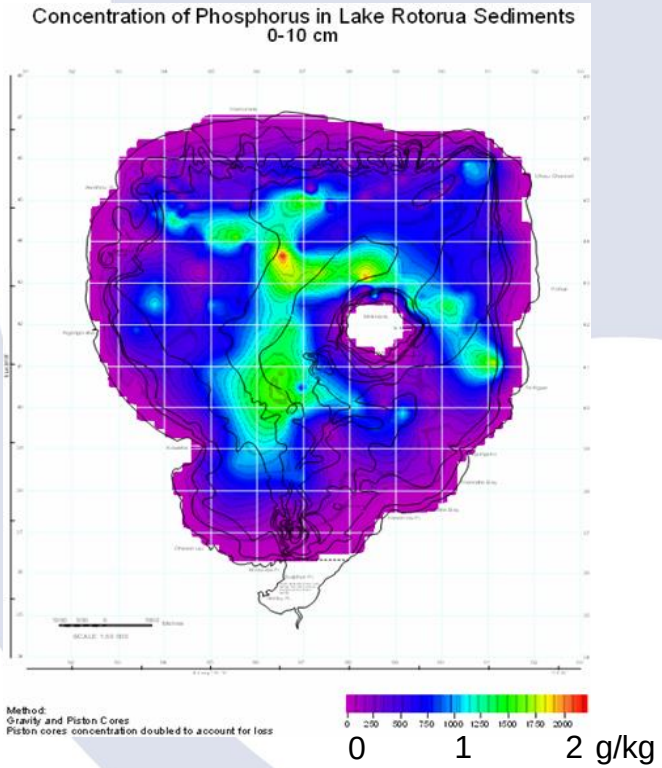
Where do the nutrients come from?

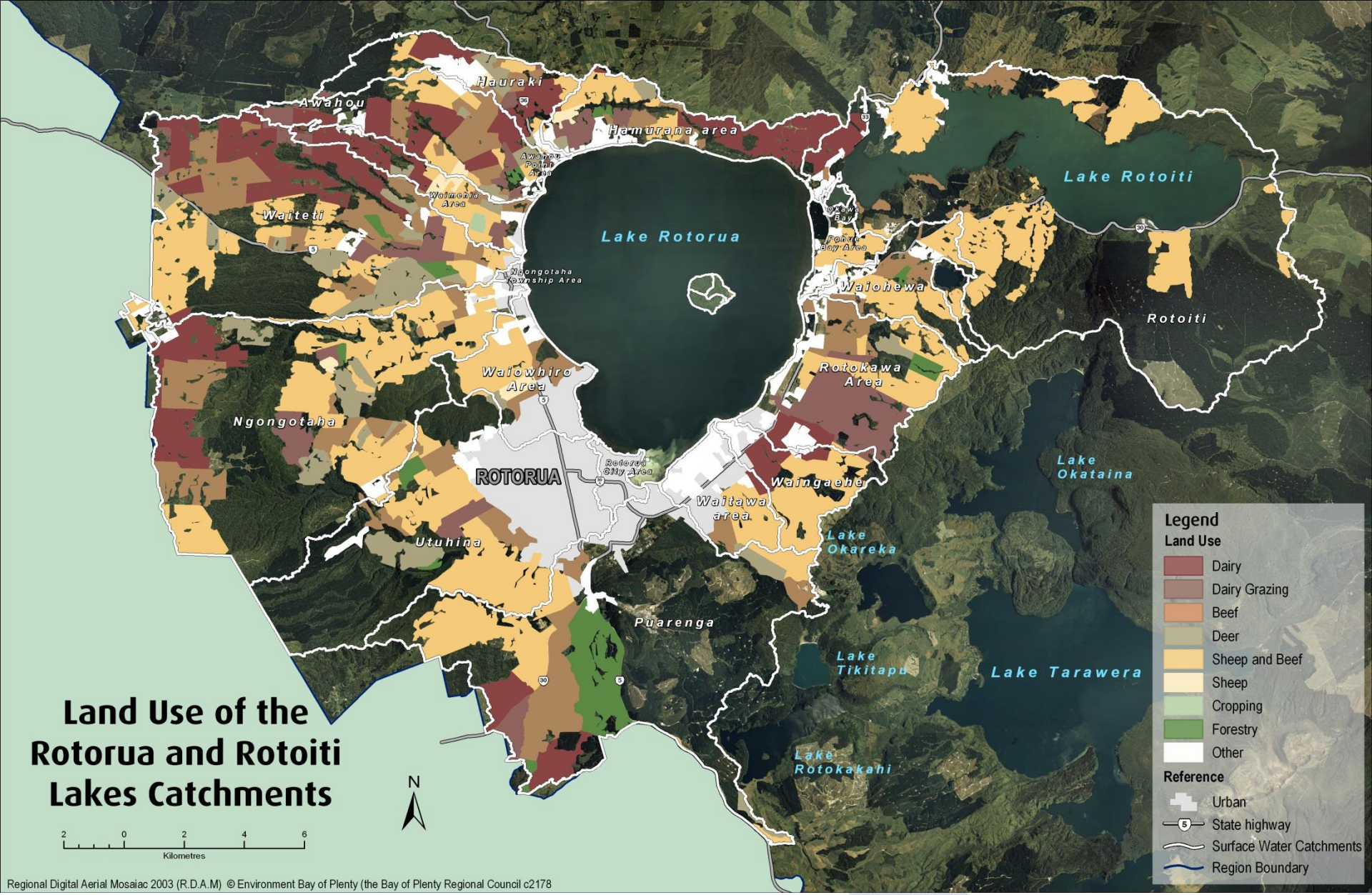
1. External catchment (farming)
2. Internal recycling from sediments

Need to address both





ROTOI TE ARAWA LAKES PROGRAMME



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Rule 11

- Cap nutrient outputs
- N & P
- 5 lakes
- Benchmark 2001-04
- Model outputs

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Science Support

- Council monitoring network
- Rotorua Lakes TAG
- University of Waikato Chair in Lake
  - Post grad and post doc
- CRI's and Consultants

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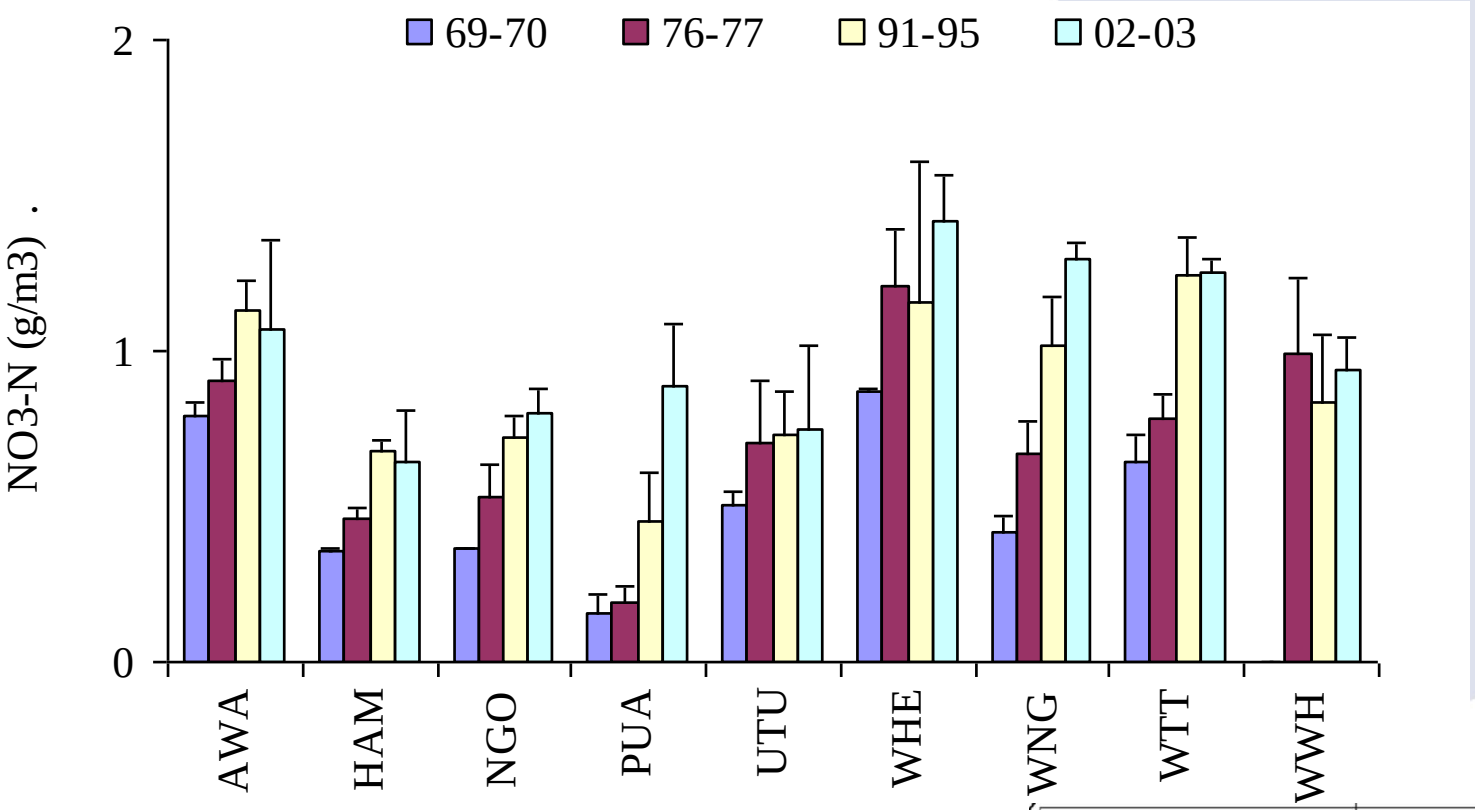
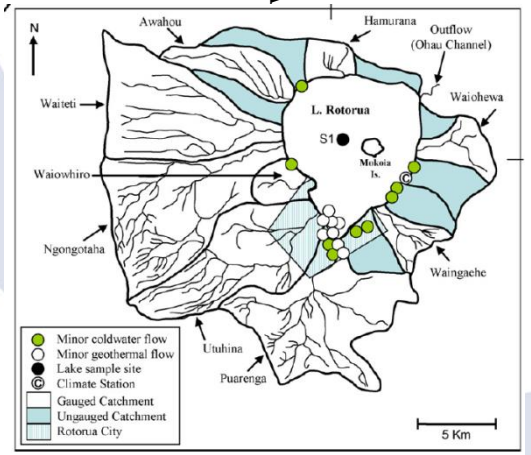
Nutrient loads to Lake Rotorua: Major tributaries





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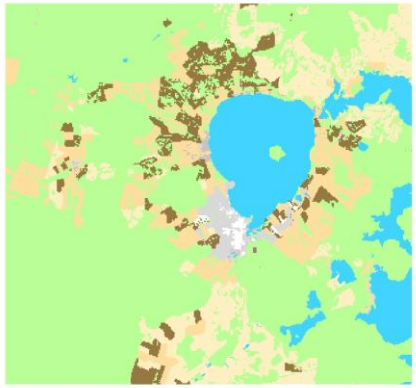
Numerical modeling of Lake Rotorua catchment

1) Understand effects of historic land use change
2) Predict effects of recent land use intensification
3) Assess effectiveness of proposed mitigations
4) Predict nutrient inputs→lake models



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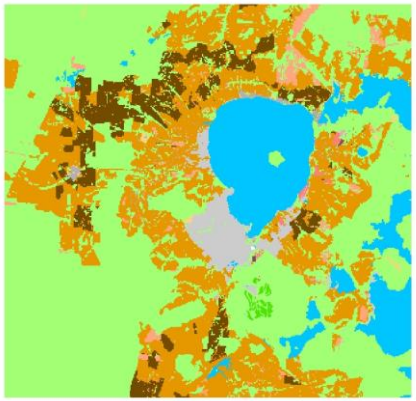


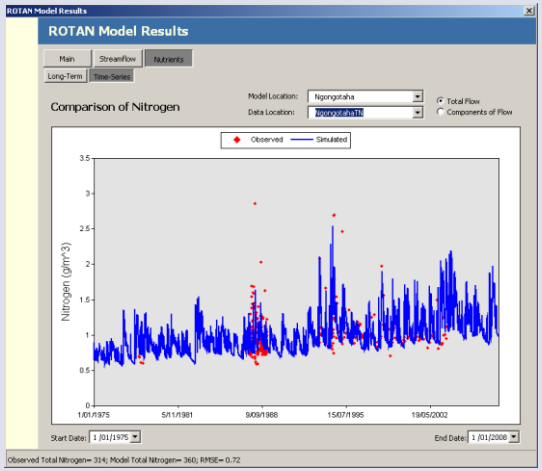
2001

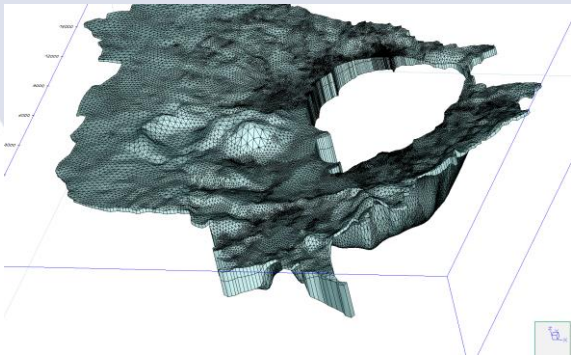
PROGRAMME

Aquifers

Groundwater dominates flow and 'lags' nitrate delivery

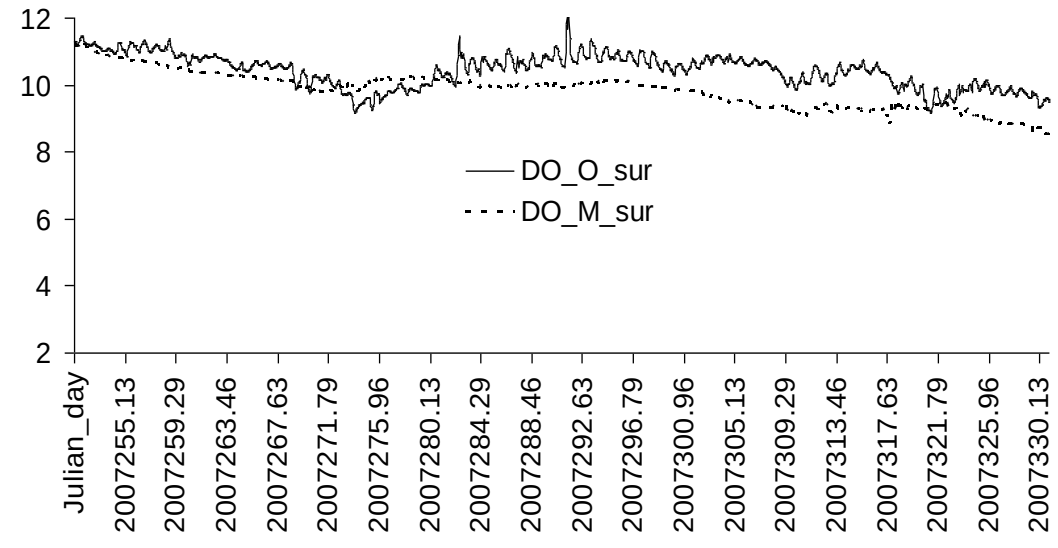
ROTAN Modelling - Calibration: daily flow and TN, major streams

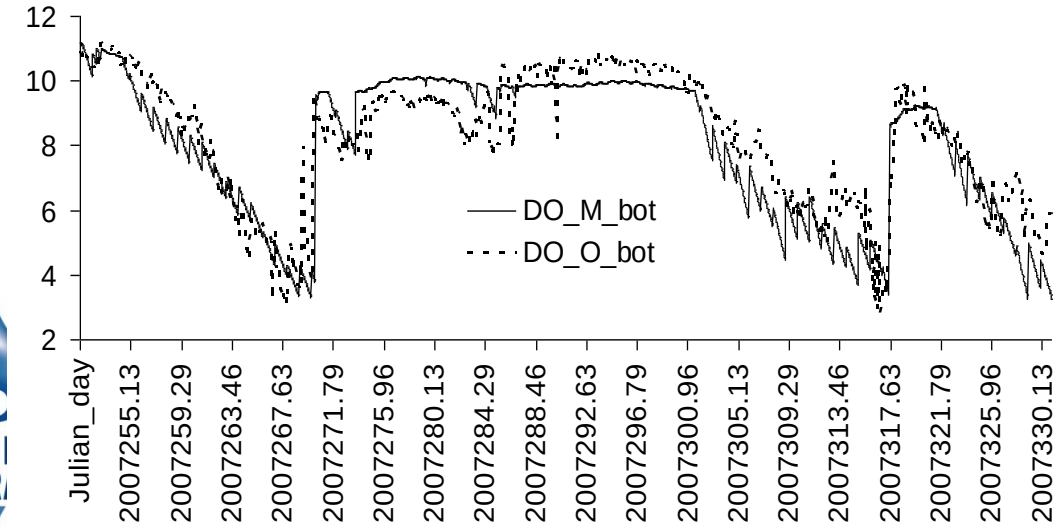




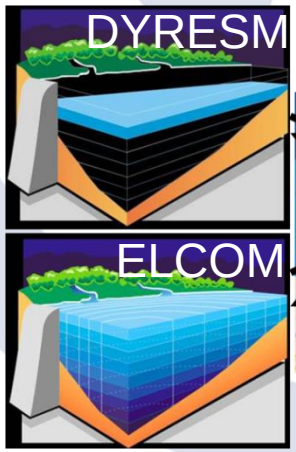
MODFLOW

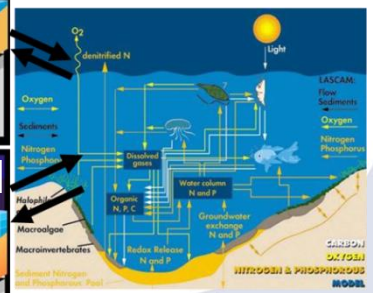
Oxygen data and model comparison, Lake Rotorua





Dissolved oxygen (mg L^{-1})





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Interventions

Rotorua Major Projects

Sewage Treatment/Reticulation
Tikitere Treatment
P Locking
Sediment Remediation
Land Use Management/Change
Hamurana Diversion

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P locking plants

- **Alum dosing**
- **In-stream**
- **2 T per year P removal**
- **$250K capital**
- **Puarenga/ Utuhina**

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Tikitere

- Geothermal N input
- 30 T N per year
- Pilot plant
- Off-stream de-nitrification
- Long term treatment design
- Zeolite testing

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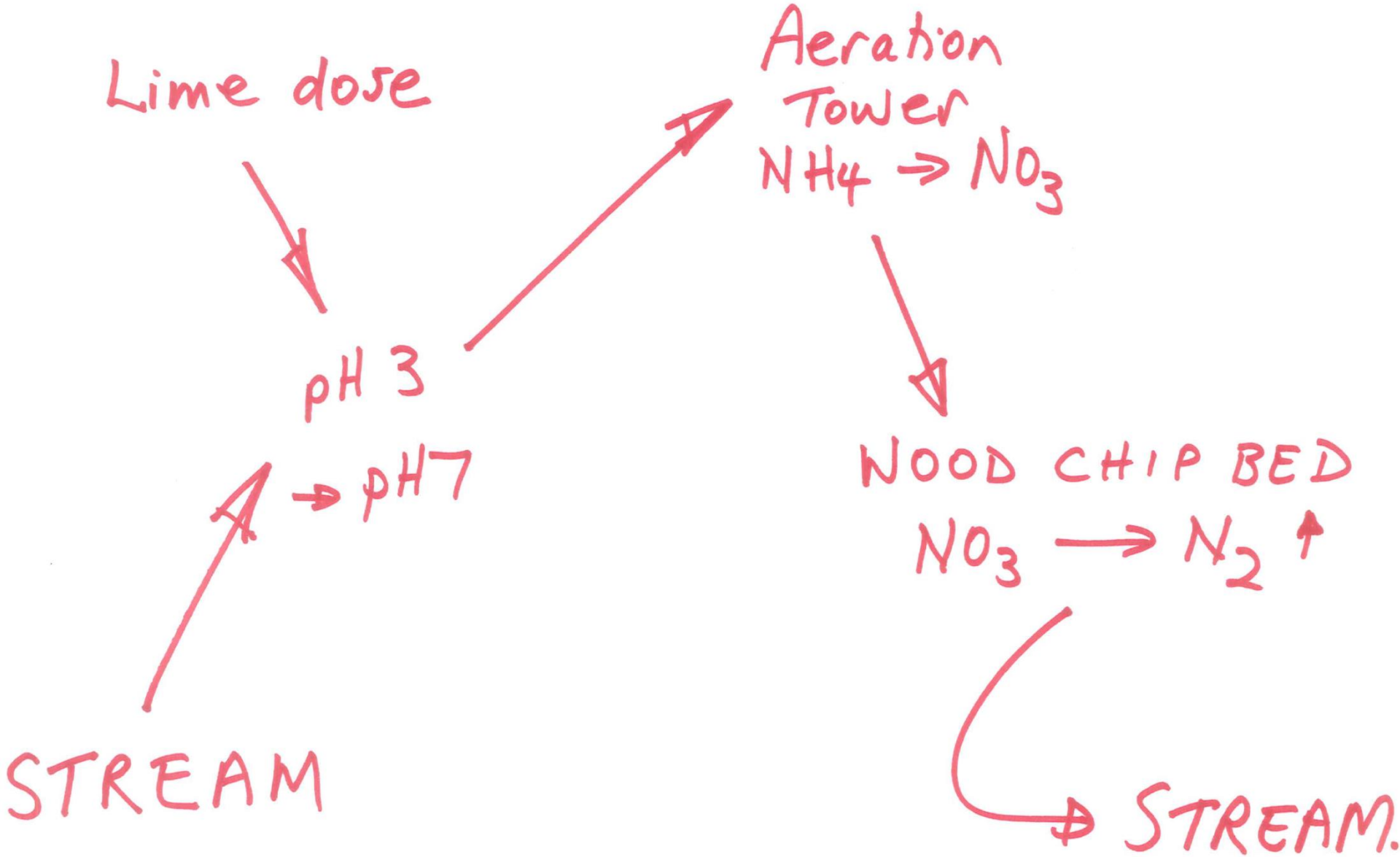
Lime dose
Aeration Tower
$NH_4 \rightarrow NO_3$
pH 3
→ pH7
WOOD CHIP BED
$NO_3 \rightarrow N_2 \uparrow$
STREAM
STREAM.

Sewage Reticulation and Urban Stormwater

- RDC
- 14 T N
- 750 Kg P
- Reticulate to centralised plant
- SW upgrades and mgt
- Lake specific

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