# Greater Heretaunga and Ahuriri Land and Water Management Collaborative Stakeholder (TANK) Group

TANK

## Meeting 25:
## 13 December 2016

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REGIONAL COUNCIL

# Karakia

# Karakia

Ko te tumanako

Kia pai tenei rā

Kia tutuki i ngā wawata

Kia tau te rangimarie

I runga i a tatou katoa

Mauriora kia tatou katoa

Āmine

# Agenda

| | |
|---|---|
| 9:30am | Welcome, karakia, notices, meeting record |
| 9:45am | Karamu solutions |
| **12:30pm** | **LUNCH** |
| 1:15pm | Groundwater/Surfacewater model |
| **3:00pm** | **COFFEE BREAK** |
| 3.15pm | …GW/SW model continued |
| 3:45pm | Verbal update from working groups |
| 3:55pm | Agenda for next meeting |
| **~4:00pm** | **FINISH** |

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# Meeting objectives

**Karamu**

1. Understand the current state of surface water quality in the Karamū and impact on values
2. Confirm Karamū values and attributes
3. Agree desired attributes state options for modelling purposes
4. Consider draft Karamū management solutions

**Water quantity**

5. Understand what the groundwater/surface water model can do and can't do
6. Agree further scenarios to be modelled and reported back.

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# Engagement etiquette

- Be an active and respectful participant / listener
- Share air time – have your say and allow others to have theirs
- One conversation at a time
- Ensure your important points are captured
- Please let us know if you need to leave the meeting early

# Ground rules for observers

- RPC members are active observers by right (as per ToR)
- Pre-approval for other observers to attend should be sought from Robyn Wynne-Lewis (prior to the day of the meeting)
- TANK members are responsible for introducing observers and should remain together at break out sessions
- Observer's speaking rights are at the discretion of the facilitator and the observer should defer to the TANK member whenever possible.

# Meeting Record – TANK Group 24

- Matters arising
- Action points

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# Action points

| | | Person | Status |
|---|---|---|---|
| 24.1 | TANK Group members to RSVP to Desiree for the jet boat trip and the social function afterwards. | TANK Group | Completed |
| 24.2 | TANK Group members to send Desiree ideas for where to stop on the jet boat trip. | TANK Group | Completed |
| 24.3 | TANK Group members to let Desiree know if they can't access email on Sunday morning and want to be contacted by phone. | TANK Group | Completed |
| 24.4 | HBRC Groundwater Scientist to come back to the TANK Group with more information on the cause of increasing Phosphorous trend in the confined aquifer. | HBRC | Due 9 Feb |
| 24.5 | HBRC to come back with more information on the costs and benefits of sediment reduction, including quantified effects on the coastal environment, instream attributes, biodiversity benefits, sediment removal for flood conveyance and on-farm productivity. (TBC) | HBRC | Various workstreams, incl Oli's work and Part 1-2 economics assessment |
| 24.6 | A sub-group is tasked with ironing out some of the flaws with the SedNet model, particularly the overestimation of erodable area by erosion type. (TBC) | EAWG | To be included in EAWG programme for 2017 |

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# Action points

| | | Person | Status |
|---|---|---|---|
| 24.7 | HBRC to provide a link to Plan Change 6 sediment provisions, noting the TukiTuki catchment has different issues so this should be for interest rather than a model. http://www.hbrc.govt.nz/hawkes-bay/projects/tukituki/plan-change-6/ | Mary-Anne | Completed |
| 24.8 | Economics Assessment Group to consider who and how the detailed analysis of sediment management packages should be done (due March 2017) and report back to the TANK Group. | EAWG | To be considered at next EAWG |
| 24.9 | Investigate inserting biological farming and ecological economics expertise into the Economics Assessment Working Group. | HBRC/ EAWG | To be considered at next EAWG |
| 24.10 | HBRC to come back to the TANK Group with some advice on the purported changes to the Hastings District Plan regarding land use rules for activities on land above the unconfined aquifer | HBRC | Summary Omahu/ Irongate PC due 9 Feb |
| 24.11 | DOC and HBRC to discuss the recent funding for wilding pines offline, quantify impacts and bring advice to the TANK Group. | DOC/ HBRC | Links to 24.5 |
| 24.12 | HBRC to commission desktop research into the potential growth and demand for water bottling in the region. | HBRC | In progress |
| 24.13 | Summarise the list of issues and call for any additional issues to be added, particularly as many people had left the meeting by this stage. | Desiree | Draft in Meeting Record |
| 24.14 | HBRC to report back to TANK Group on when the Wetlands and Lakes Working Group is likely to be convened. [March 2017 following pre-circulation info pack] | Gavin/Rina | Completed |

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# Karamū

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# To be covered:

- Values, attributes, attribute states, options for managing stressors (Sandy)
- Minimum flows (Thomas)
- Drainage and flood management (Gary)

# Karamu Catchment Values

| Location | Values | Comments |
|---|---|---|
| All water - surface and groundwater (overlap with Ngaruroro values) | Ecological and Mauri values<br>Life-supporting capacity<br>Ki Uta Ki Tai<br>Habitat and biodiversity - native fish, eels, plants and birds, stygofauna<br>Potable water supply<br>Stock drinking water<br>Taonga species<br>Connectivity | Household water supply may need treatment because of natural water quality. This especially includes surface water, as there are animals and birds in the catchment.<br>SEV (stream ecological valuation) assessment of urban streams with TLA's has shown where ecosystem values could effectively be improved) |
| All surface water | Recreational, cultural and social values<br>Swimming/Uu (immersion)<br>Ki Uta Ki Tai<br>Mahinga kai,<br>Nohoanga<br>Taonga raranga, taonga rongoa.<br>Natural character/amenity<br>Fishing - whitebait, eels, trout<br>Refugia | Provision of access not part of this water quality management consideration<br>Swimming not at flood flows or for some urban streams Needs specifying which are not for suitable for swimming, and require signage |
| Surface - main stem and tributaries - and groundwater | Abstraction, economic values<br>Food and fibre production/ processing (and employment)<br>Industrial and commercial use (and employment) | Food production needs to include aquatic foods |
| Surface waters | Drainage and flood carrying capacity | Relevant consideration is council's asset management plan (Heretaunga Plains Flood Control Scheme) |
| Main stem Clive River | Tourism, Cycleways<br>Boating - Kayaking, Rowing, Power Boat, Rafting | To be covered in more detail at separate meeting |
| Karamu/Clive Main stem (specific lower reaches) | Whitebait and patiki<br>~~Gravel extraction??~~ Fish breeding grounds / kohanga | To be covered in more detail with Clive River in separate meeting. |
| Surface and groundwater | Direct discharges (including stormwater, particularly urban stormwater from Hastings and Havelock North) and non-point source discharges | More details (consent data) about direct discharges are required before making a decision about the use of surface waters for discharge of contaminants . Take into account land drainage networks and field tile/novaflow outlets, roadside drains into surface water as they are specific point source discharges |
| Waitangi Estuary | Contribution to estuary ecosystem and other values<br>Birdlife | |
| Lakes and Wetlands (Lake Poukawa, PekaPeka Swamp) | Very significant for habitat for wide range of bird species | |


Meeting 25
Karamu catchment
Water Quality and Ecology
1. Values and attributes
2. Attribute states
3. Options managing stressors

# Karamu stakeholder values

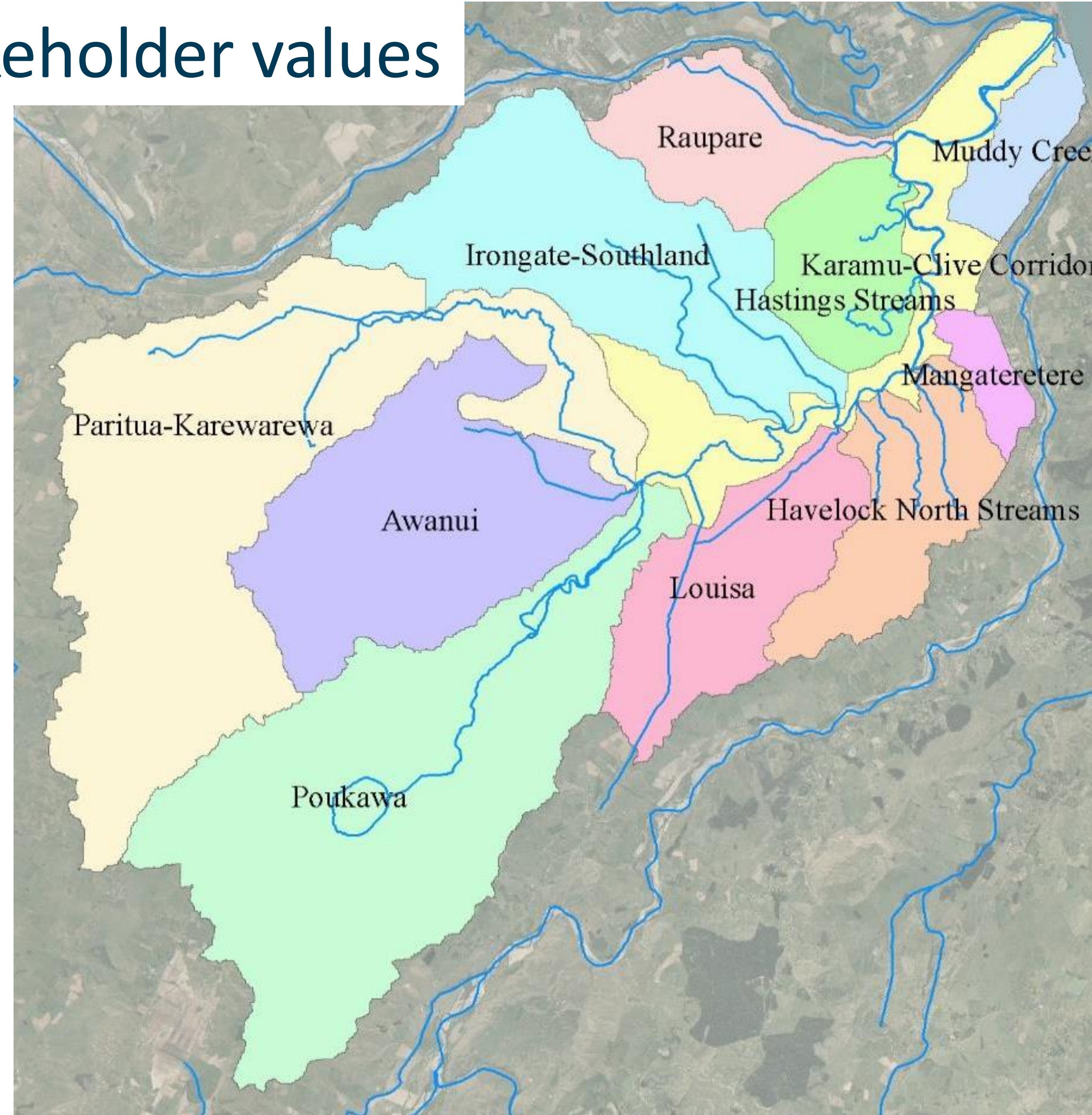
ECOSYSTEM HEALTH

TANGATA WHENUA

RECREATION, SOCIAL

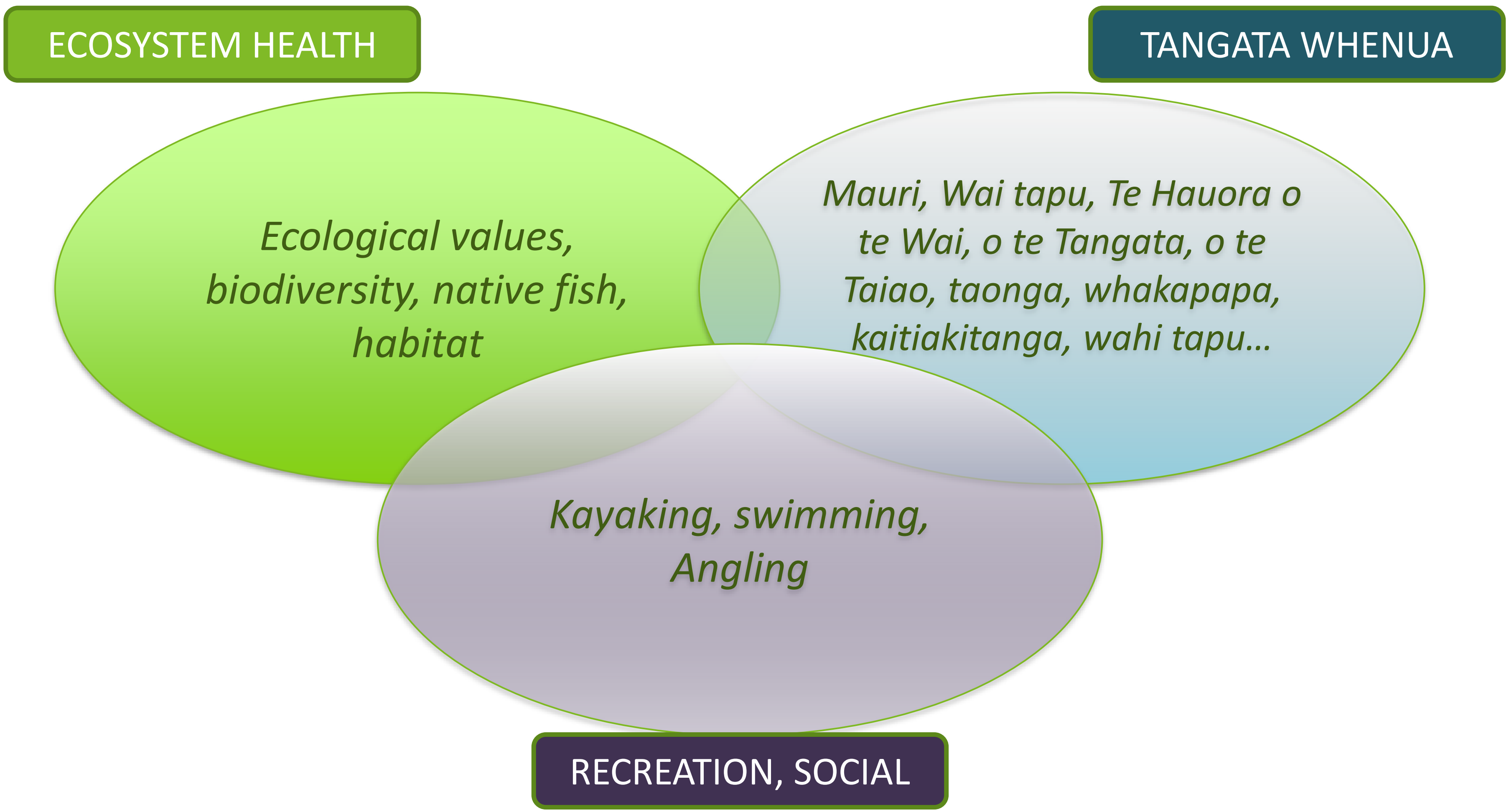
SOCIAL, CULTURAL

ECONOMIC, TOURISM

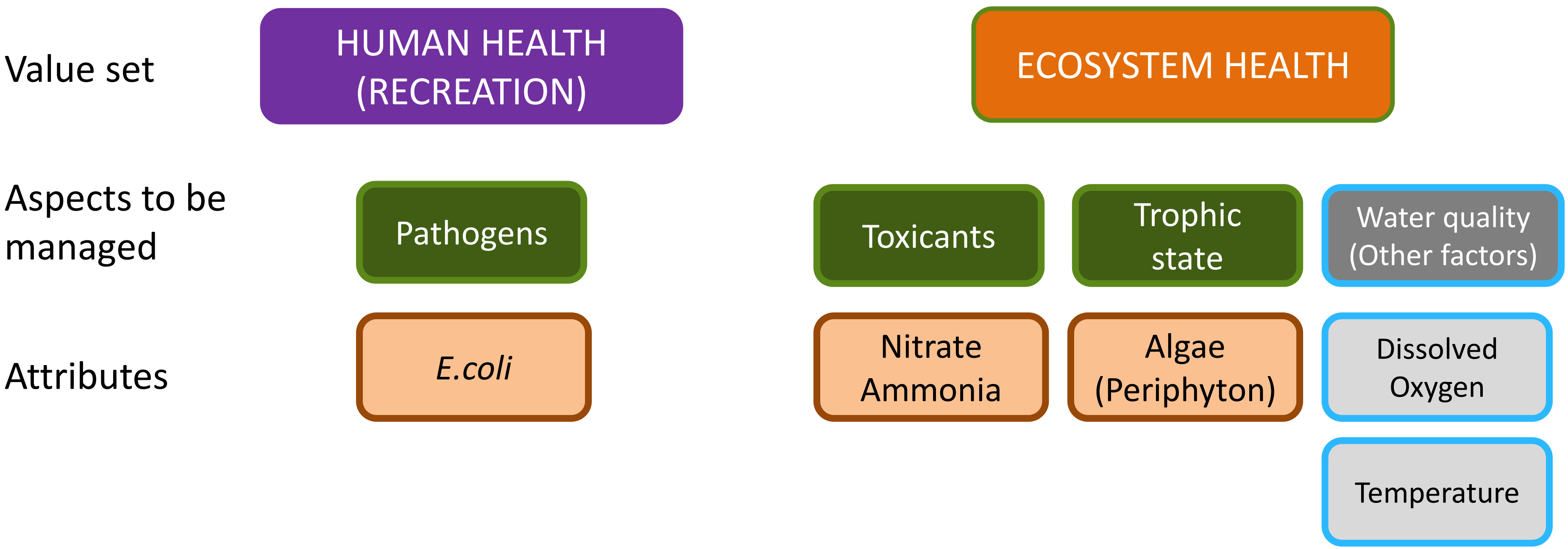


# Value sets for water quality in the Karamu catchment

Confirming water quality values..



# NPS: NOF Attributes



# NPS: NOF Attributes

## Contact recreation/ human health: *E. coli*

| Site | *E. coli* | |
|---|---|---|
| | 5 year median | 95th percentile |
| Karewarewa Strm | B | D |
| Awanui Strm | B | D |
| Poukawa Strm | A | D |
| Herehere Strm | C | D |
| Mangarau Strm at Te Aute Rd | B | B |
| Clive Rv | A | D |
| Taipo Strm | B | D |

Faecal source tracking:

*E.coli* source tracking:
10% ruminants, but mainly from plant material and birds

→ How pathogenetic?
→ Management?

# NOF Bands example

## Nitrate toxicity on aquatic organisms

- Below acute impact (band D)
- Long-term chronic effect (growth)
- All year versus seasonal

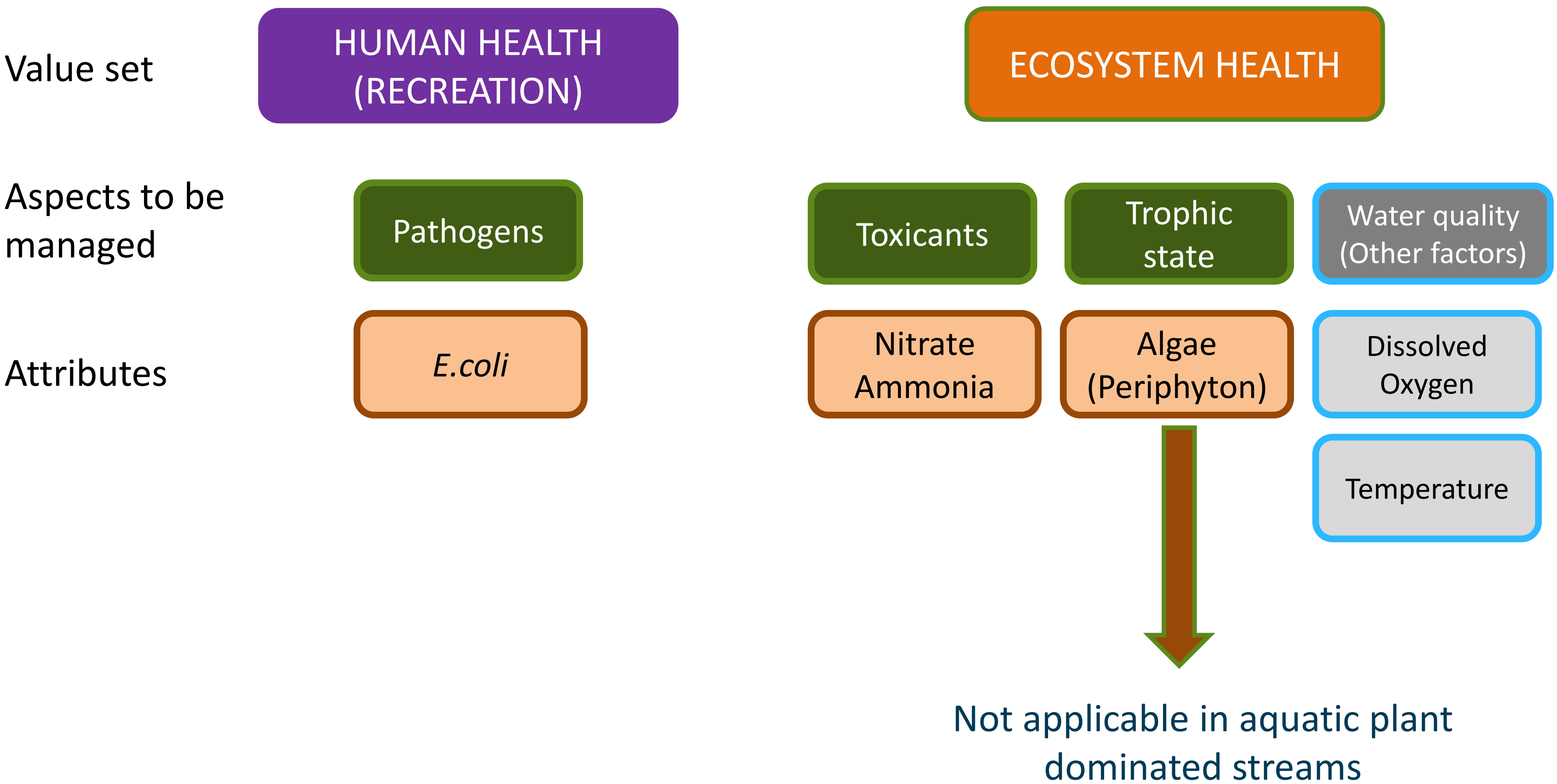
| Attribute State | Annual median (mg/l) | Annual 95th percentile | Narrative State |
|---|---|---|---|
| A | ≤ 1.0 | ≤ 1.5 | High conservation value system. Unlikely to be effects even on sensitive species. |
| B | > 1.0 and ≤ 2.4 | > 1.5 and ≤ 3.5 | Some growth effect on up to 5% of species. |
| C | > 2.4 and ≤ 6.9 | > 3.5 and ≤ 9.8 | Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects. |
| D | > 6.9 | > 9.8 | Impacts on growth of multiple species, and starts approaching acute impact level (ie risk of death) for sensitive species at higher concentrations (>20 mg/L) |

# NPS: NOF Attributes

## Nitrate, ammonia toxicity on aquatic organisms

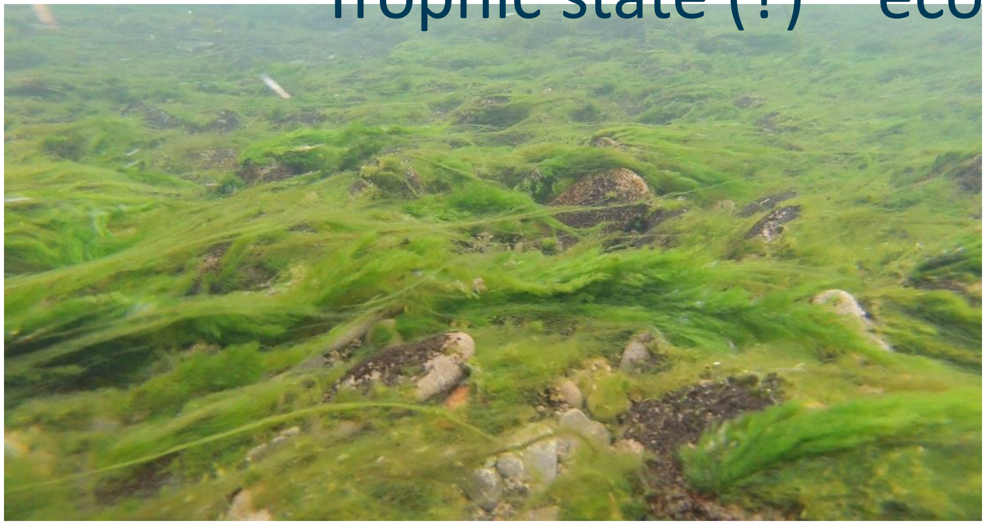
| Site | Nitrate (toxicity) | | Ammonia (toxicity) | |
|---|---|---|---|---|
| | 5 year median | 95th percentile | 5 year median | Maximum |
| Karewarewa Strm | B | C | B | C |
| Awanui Strm | A | B | B | C |
| Poukawa Strm | A | A | A | B |
| Herehere Strm | A | B | A | B |
| Mangarau Strm at Te Aute Rd | A | B | A | B |
| Clive Rv | A | B | B | B |
| Taipo Strm | A | B | B | B |

# NPS: NOF Attributes



# Macrophytes in the Karamu catchment

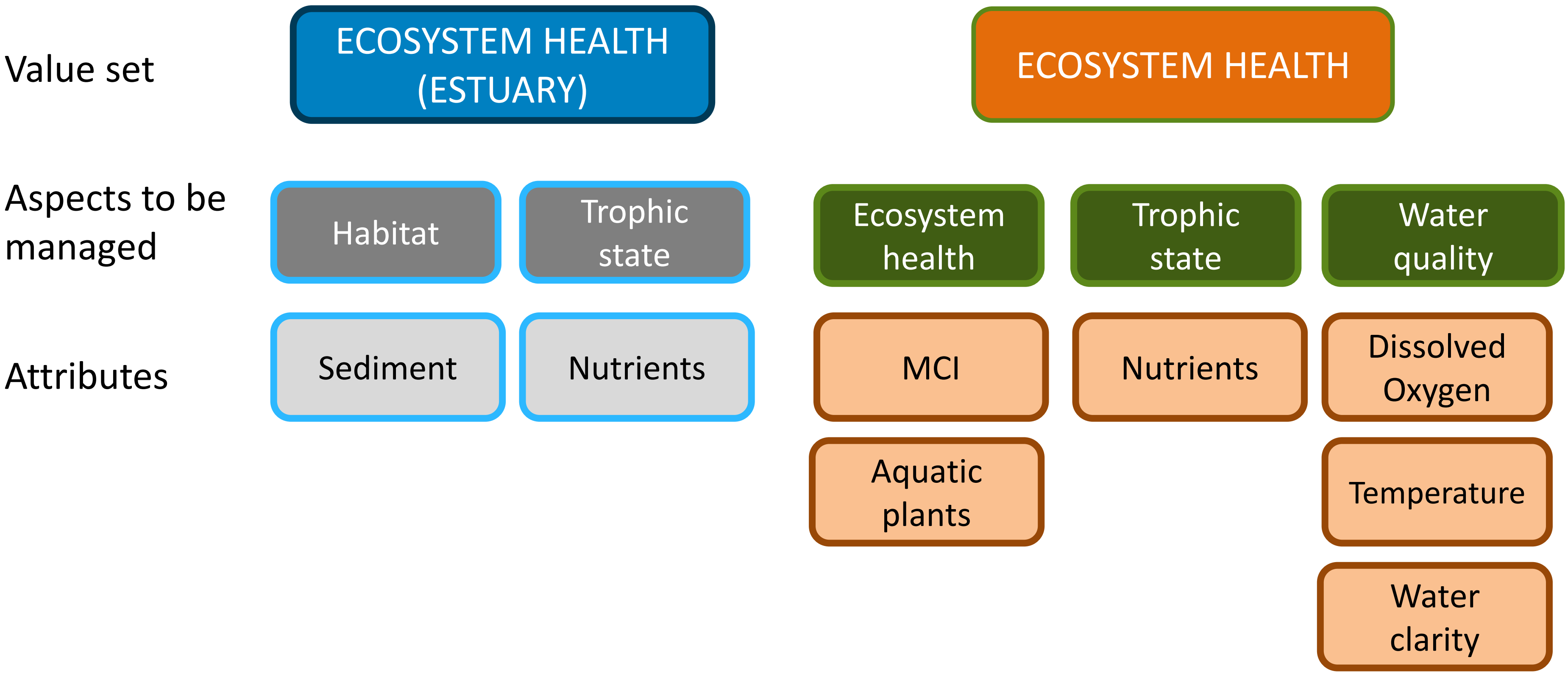
Trophic state (?) – ecosystem health



Algae:
Tutaekuri and Ngaruroro

Aquatic plants (macrophytes):
Karamu

# Other Attributes



# Other attribute states (SOE)

| | Algae, Aquatic plants | | Nutrients | | | | Clarity | | Ecosystem health |
|---|---|---|---|---|---|---|---|---|---|
| **Site name** | **Chla** | **MPh** | **DIN** | **TN** | **DRP** | **TP** | **Bdisk** | **Turbidity** | **MCI** |
| Ruahapia Strm | | | D | D | F | F | E | C | poor |
| Karewarewa Strm | | | E | F | F | F | D | C | poor |
| Awanui Strm | | | E | F | F | F | D | B | poor |
| Poukawa Strm | | | C | F | F | F | D | A | poor |
| Herehere Strm | | | C | D | F | F | C | C | poor |
| Mangarau Strm at Keirunga Rd | D | | B | C | F | F | E | C | fair |
| Mangarau Strm at Te Aute Rd | C | | F | F | F | F | E | B | poor |
| Clive Rv | | | D | D | F | F | D | B | poor |
| Taipo Strm | | | D | E | F | F | F | D | poor |

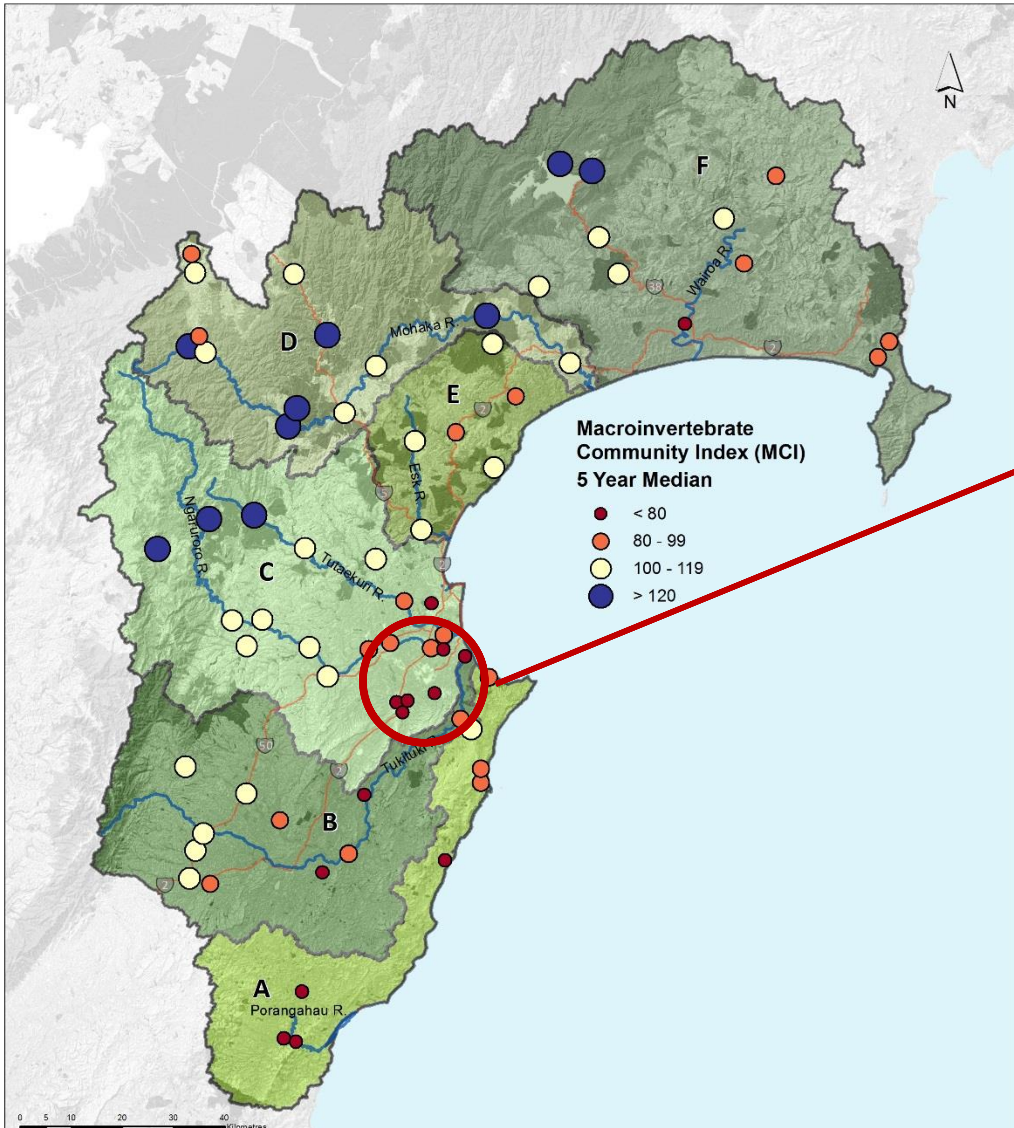
| | |
|---|---|
| A | all data below GL |
| B | 90th percentile above one or more GL, median below all |
| C | 75th precentile above all GL, median above some GL |
| D | median above all GL |
| E | 25th precentile above all GL |
| F | 10th precentile above all GL |
| | not applicable |
| | no data |

| **MCI** | |
|---|---|
| excellent | **> 120** |
| good | **100 - 120** |
| fair | **80 - 100** |
| poor | **< 80** |

Very poor ecosystem health – why?

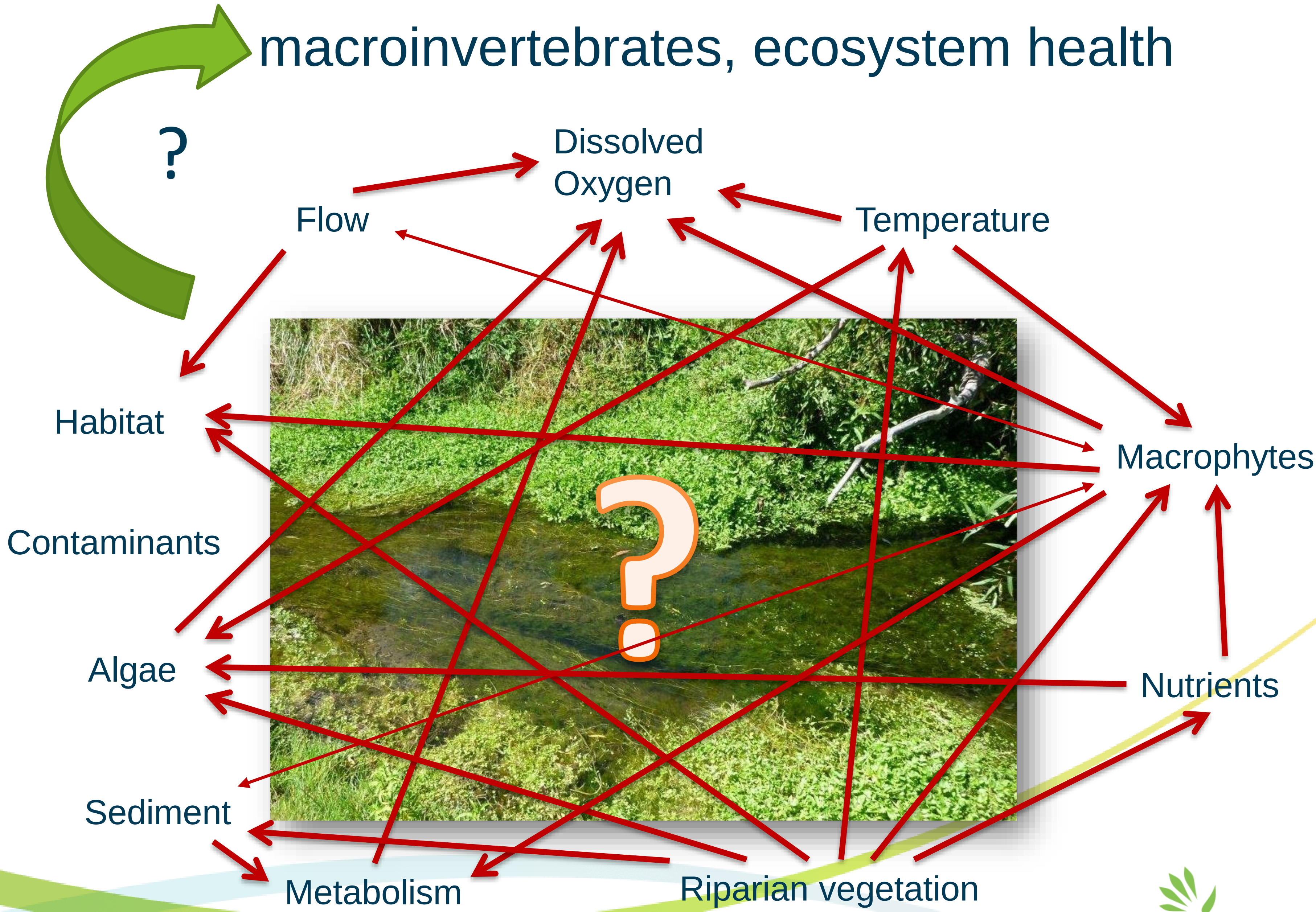
→ Targeted study with more water quality variables tested than SOE monitoring

# MCI – Ecosystem health indicator




Karamu catchment:

- Poorest MCI values in Hawke's Bay
- Few or no sensitive EPT taxa
- Some only ca 10 taxa in total!

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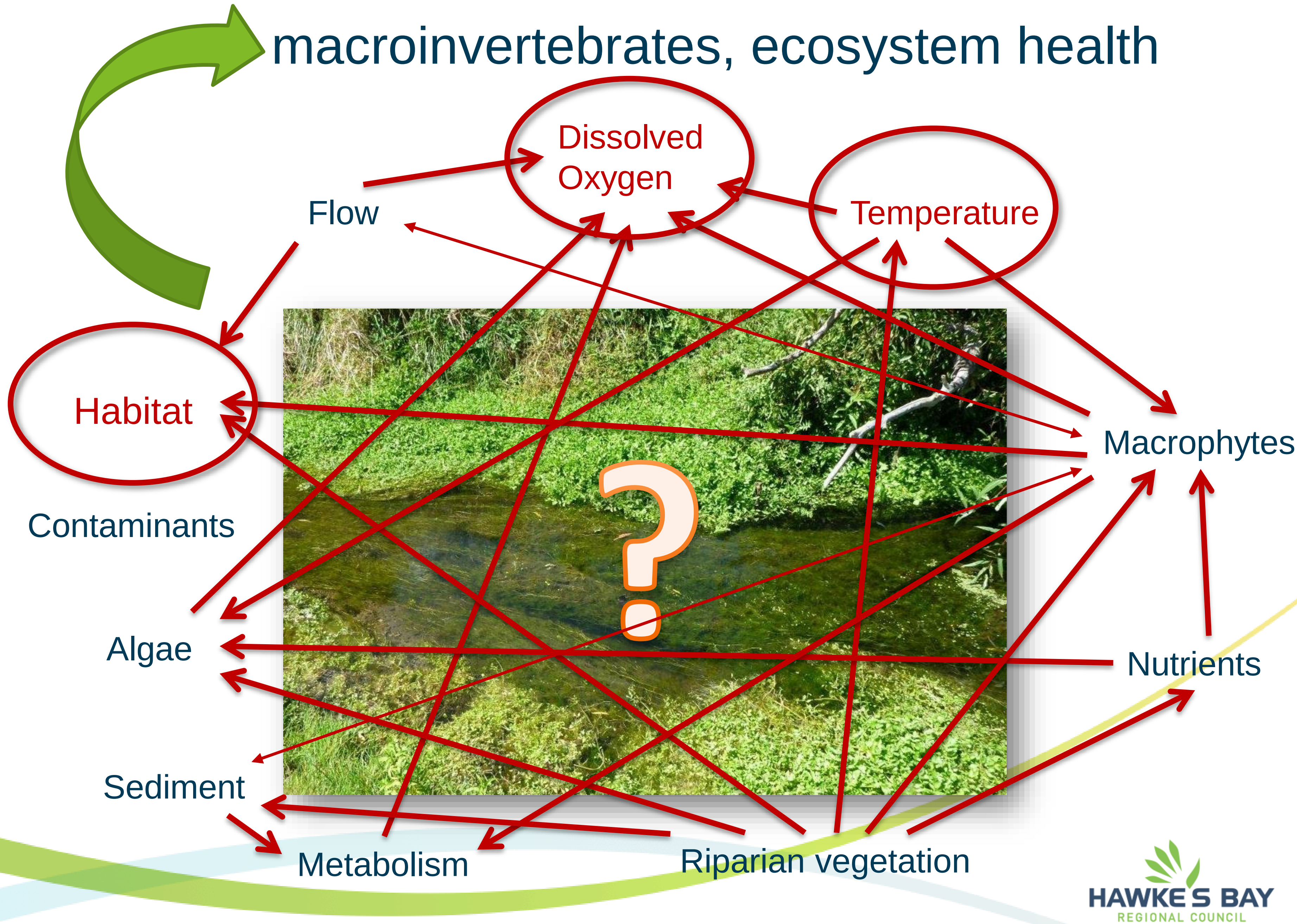
macroinvertebrates, ecosystem health
Dissolved Oxygen
Flow
Temperature
Habitat
Macrophytes
Contaminants
Algae
Nutrients
Sediment
Metabolism
Riparian vegetation
?
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# Examples ecosystem health:

## Good health

**Te Waikaha Stream: MCI good (>100)**

- Oxygen ok
- Temperature ok
- Good amount of aquatic plants, serves as habitat
- Habitat good

## Poor health

**Awanui Stream: MCI poor (< 80)**

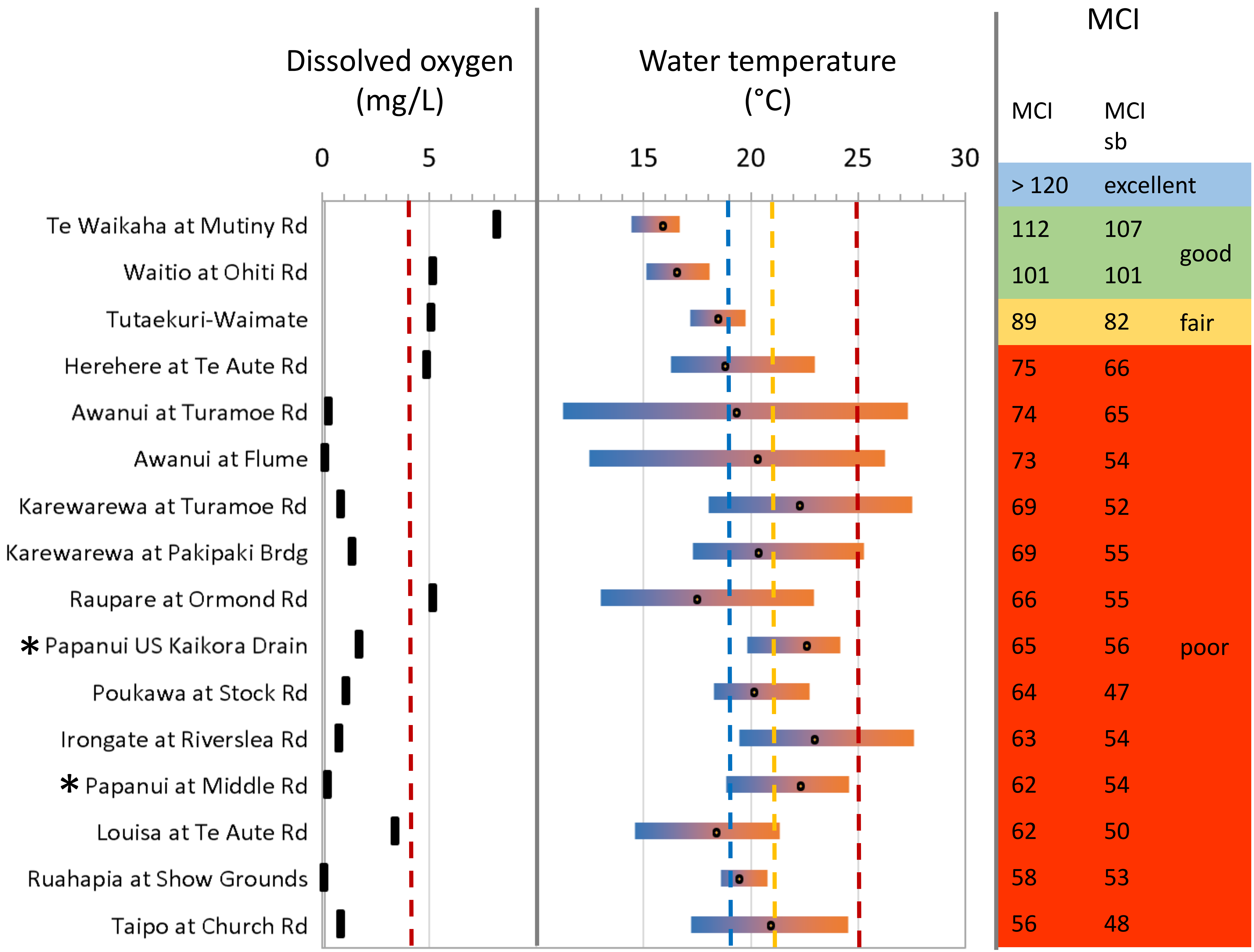
- Low oxygen
- High temperature
- Nuisance aquatic plant growth

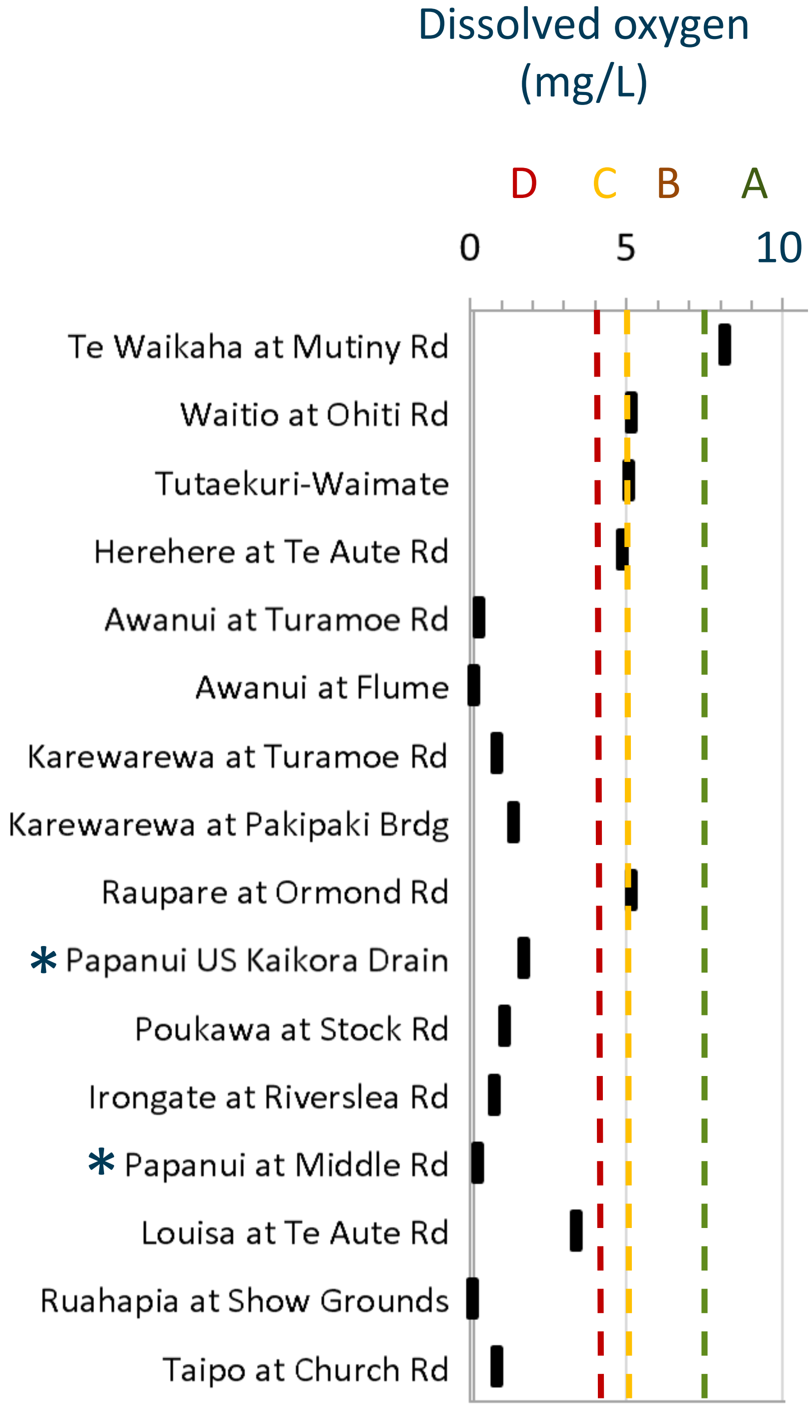
# Proposed NOF Bands for temperature
# Eastern Dry Region

- Temperature thresholds still in discussion
- Statistic s in discussion

| Attribute State | Temperature CRI* (°C) | Narrative State |
|---|---|---|
| A | ≤ 19 | No thermal stress on any aquatic organisms that are present at matched reference sites. |
| B | > 19 and ≤ 21 | Minor thermal stress on occasion (clear days in summer) on particularly sensitive organisms (insects and fish). |
| C | > 21 and ≤ 25 | Some thermal stress on occasion, with elimination of certain sensitive insects and absence of certain sensitive fish. |
| D | > 25 | Significant thermal stress on a range of aquatic organisms. Risk of local elimination of keystone species with loss of ecological integrity. |

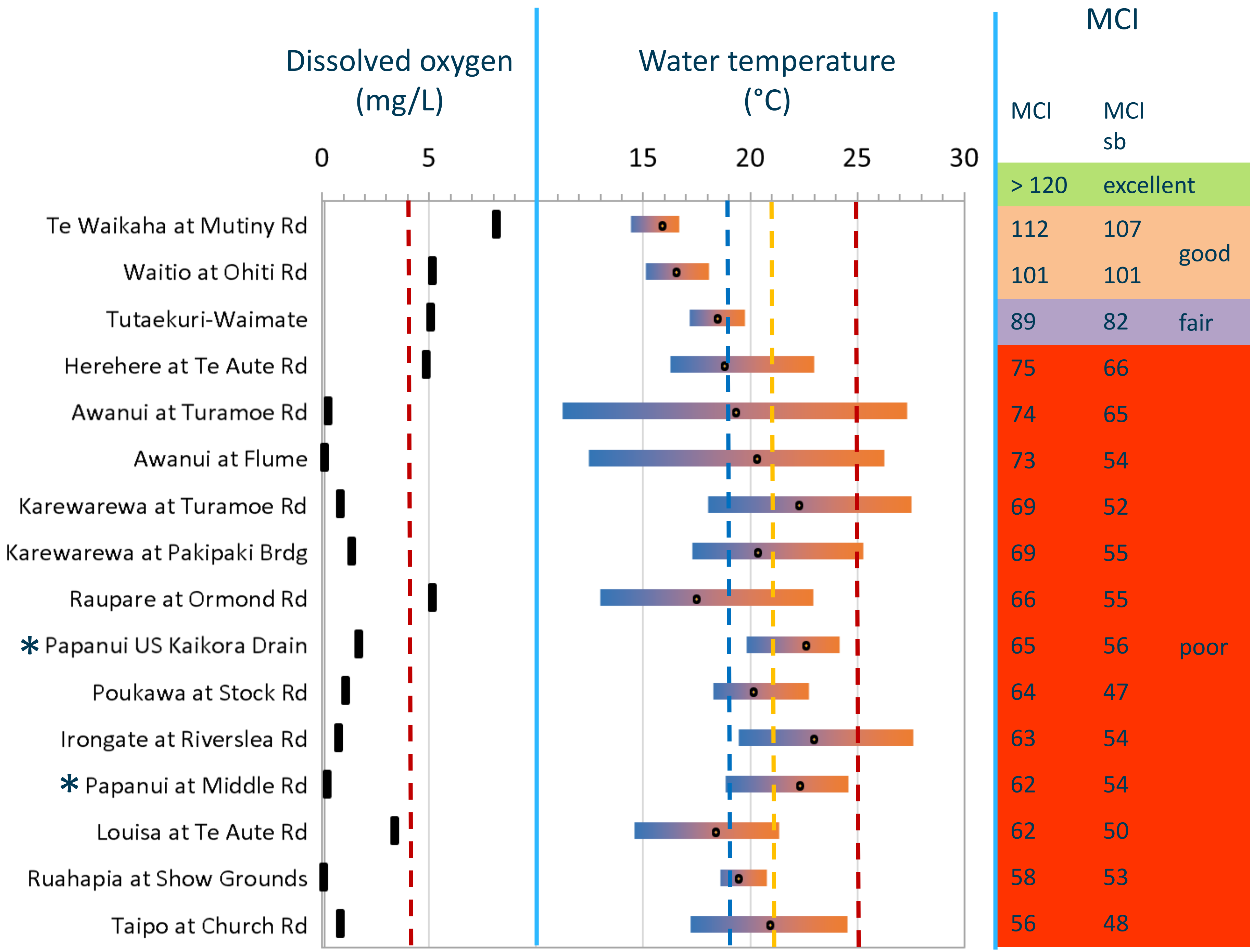
* CRI or $95^{th}$ percentile


Dissolved oxygen (mg/L)
Water temperature (°C)
MCI
0
5
15
20
25
30
Te Waikaha at Mutiny Rd
Waitio at Ohiti Rd
Tutaekuri-Waimate
Herehere at Te Aute Rd
Awanui at Turamoe Rd
Awanui at Flume
Karewarewa at Turamoe Rd
Karewarewa at Pakipaki Brdg
Raupare at Ormond Rd
* Papanui US Kaikora Drain
Poukawa at Stock Rd
Irongate at Riverslea Rd
* Papanui at Middle Rd
Louisa at Te Aute Rd
Ruahapia at Show Grounds
Taipo at Church Rd
MCI
MCI sb
> 120 excellent
112 107
101 101
good
89 82 fair
75 66
74 65
73 54
69 52
69 55
66 55
65 56
poor
64 47
63 54
62 54
62 50
58 53
56 48



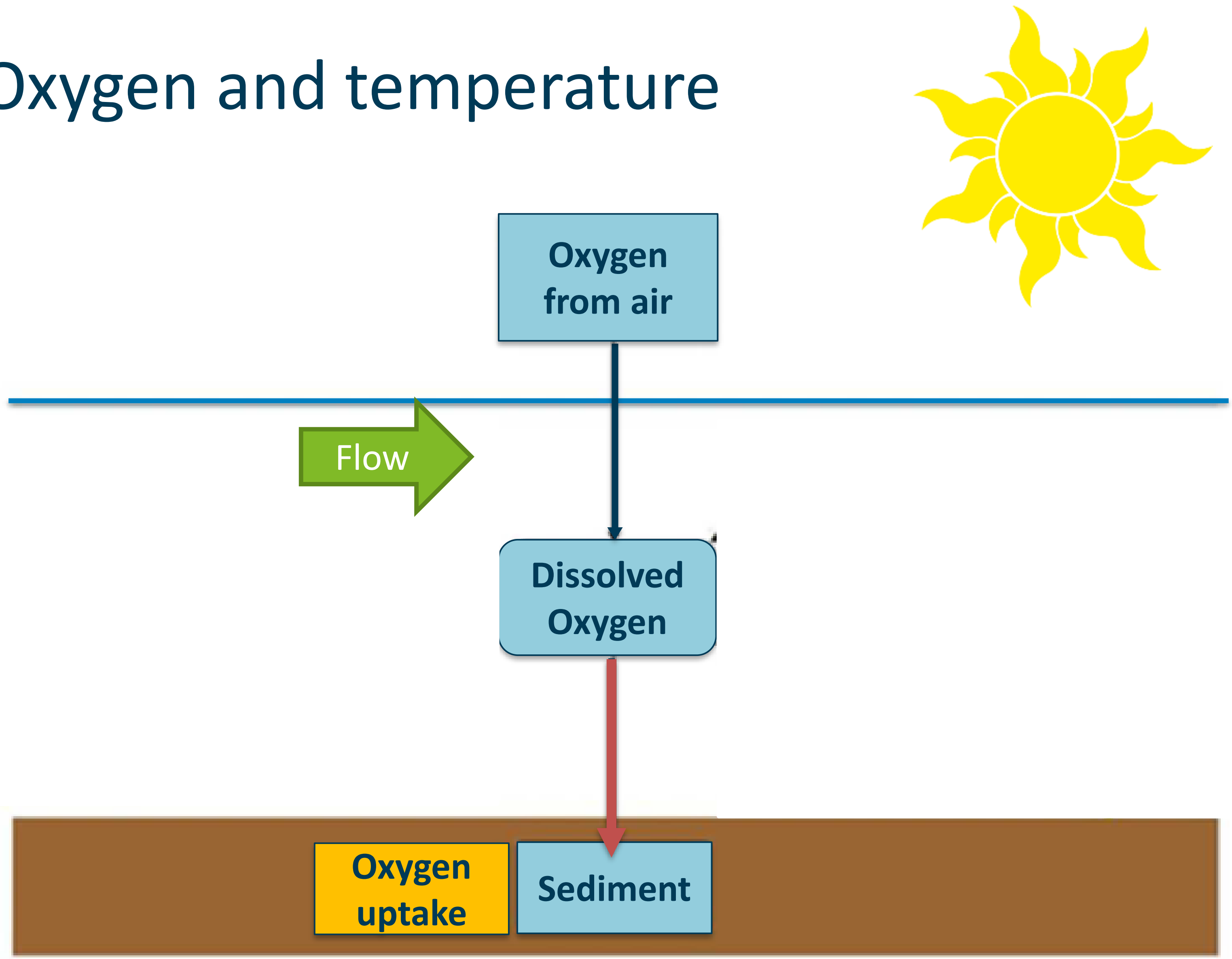

## DO < 4 mg/L bottom line

- Significant, persistent stress
- Local extinctions of keystone species likely
- Loss of ecological integrity

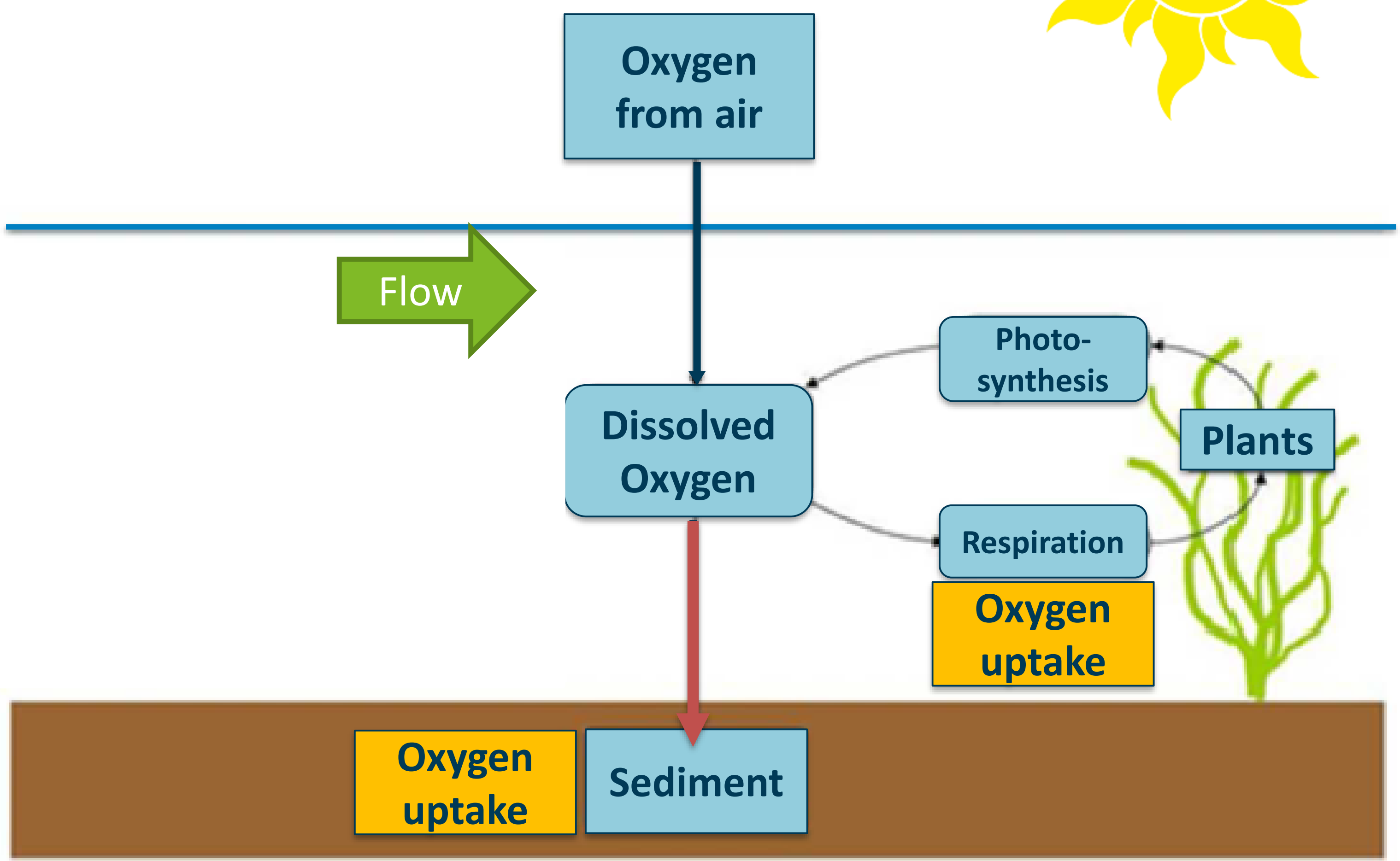


Dissolved oxygen (mg/L)
0
5
Water temperature (°C)
15
20
25
30
MCI
MCI
MCI sb
> 120
excellent
Te Waikaha at Mutiny Rd
112
107
good
Waitio at Ohiti Rd
101
101
Tutaekuri-Waimate
89
82
fair
Herehere at Te Aute Rd
75
66
Awanui at Turamoe Rd
74
65
Awanui at Flume
73
54
Karewarewa at Turamoe Rd
69
52
Karewarewa at Pakipaki Brdg
69
55
Raupare at Ormond Rd
66
55
* Papanui US Kaikora Drain
65
56
poor
Poukawa at Stock Rd
64
47
Irongate at Riverslea Rd
63
54
* Papanui at Middle Rd
62
54
Louisa at Te Aute Rd
62
50
Ruahapia at Show Grounds
58
53
Taipo at Church Rd
56
48

# Oxygen and temperature



# Oxygen and temperature

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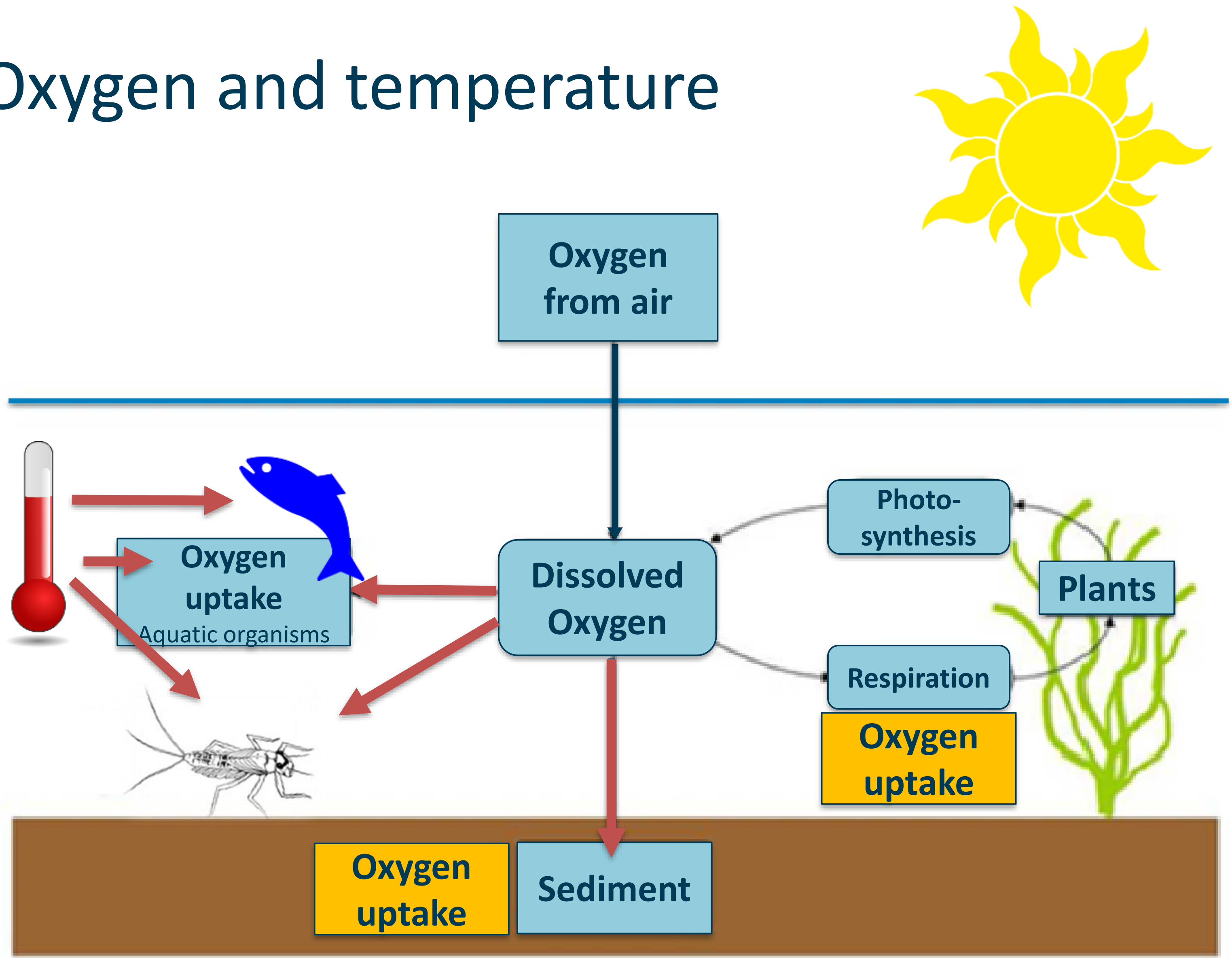
# Oxygen and temperature

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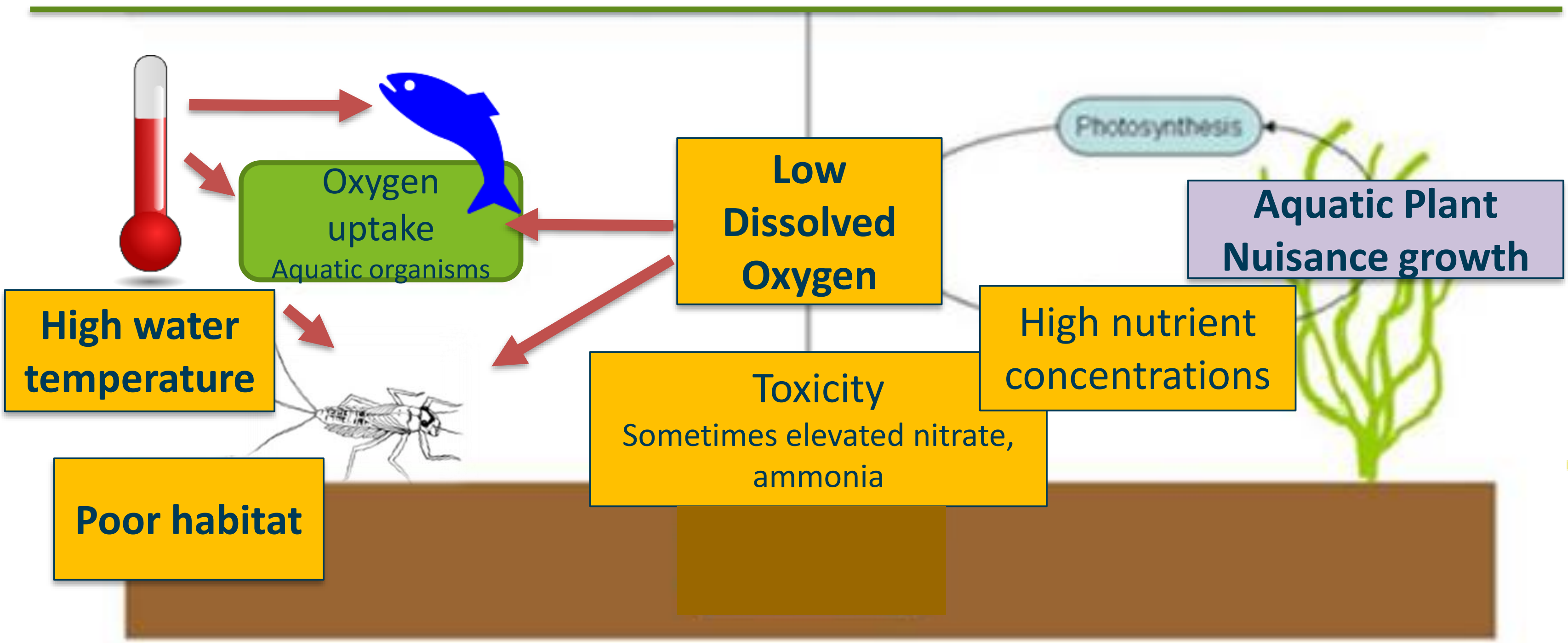
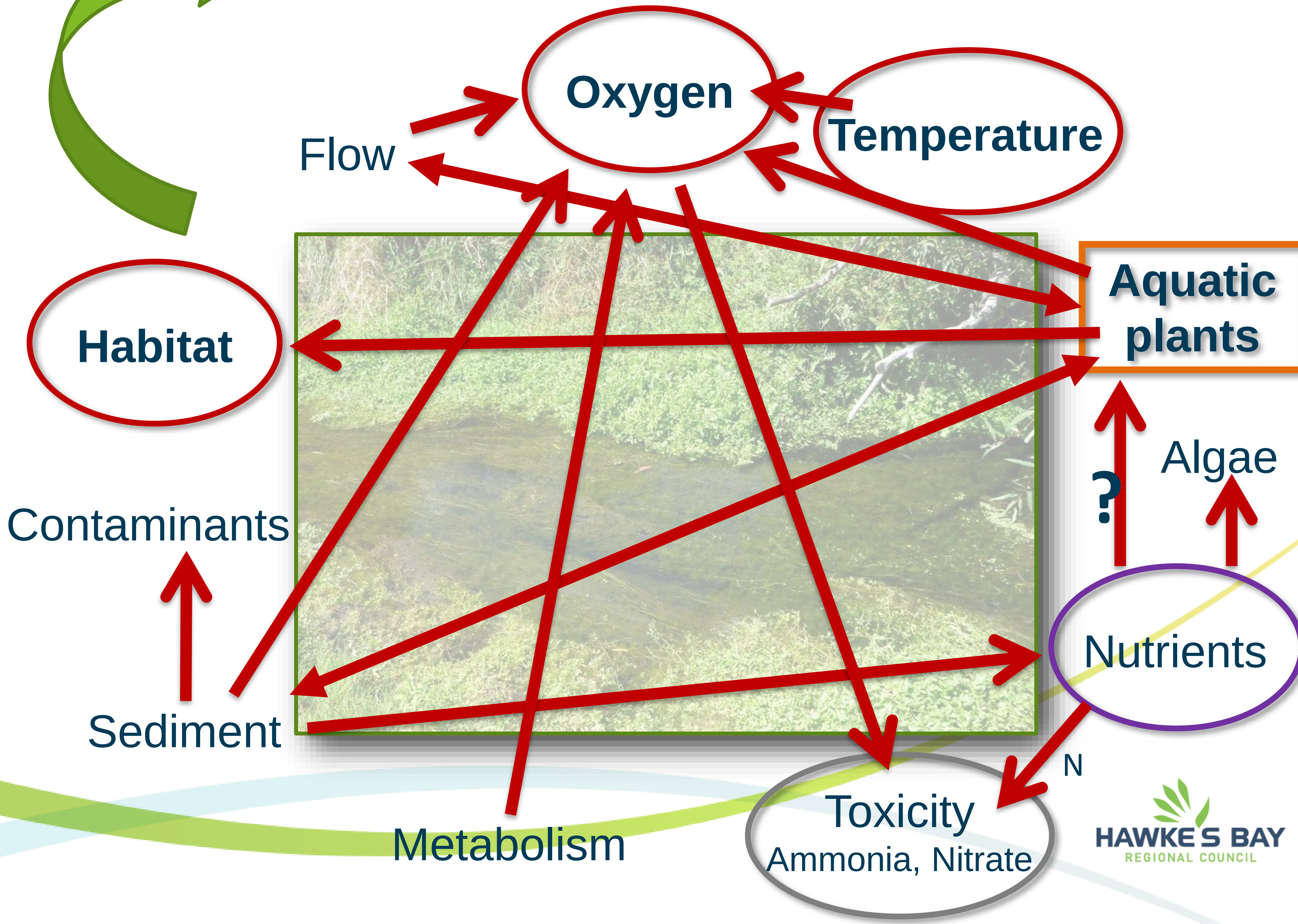
# Summary

## Water quality issues in the Karamu catchment

Limiting factors for life supporting capacity



# WHERE TO FROM HERE?

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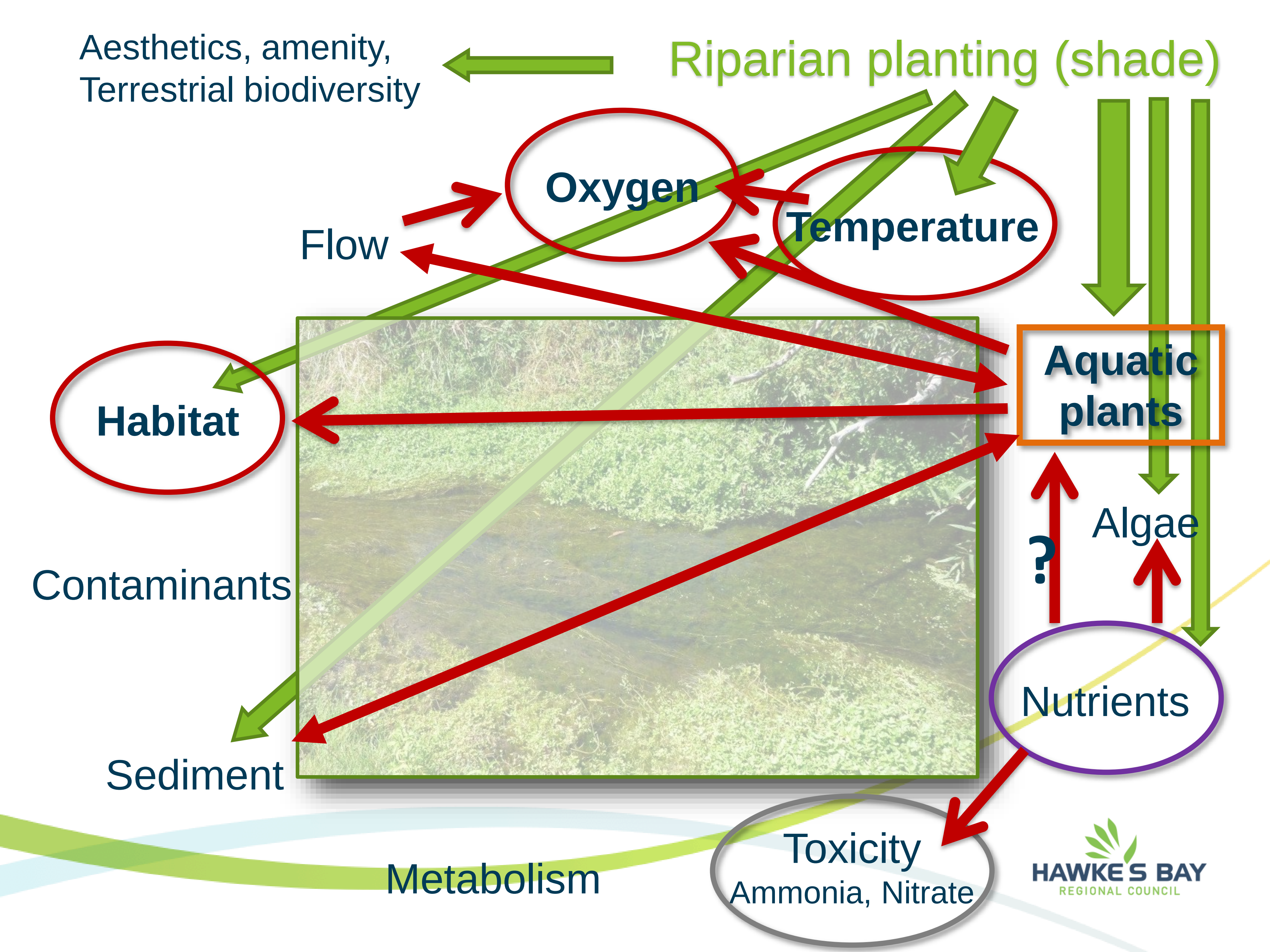
Aesthetics, amenity,
Terrestrial biodiversity
Riparian planting (shade)
Oxygen
Temperature
Flow
Habitat
Aquatic plants
Algae
?
Contaminants
Nutrients
Sediment
Metabolism
Toxicity
Ammonia, Nitrate
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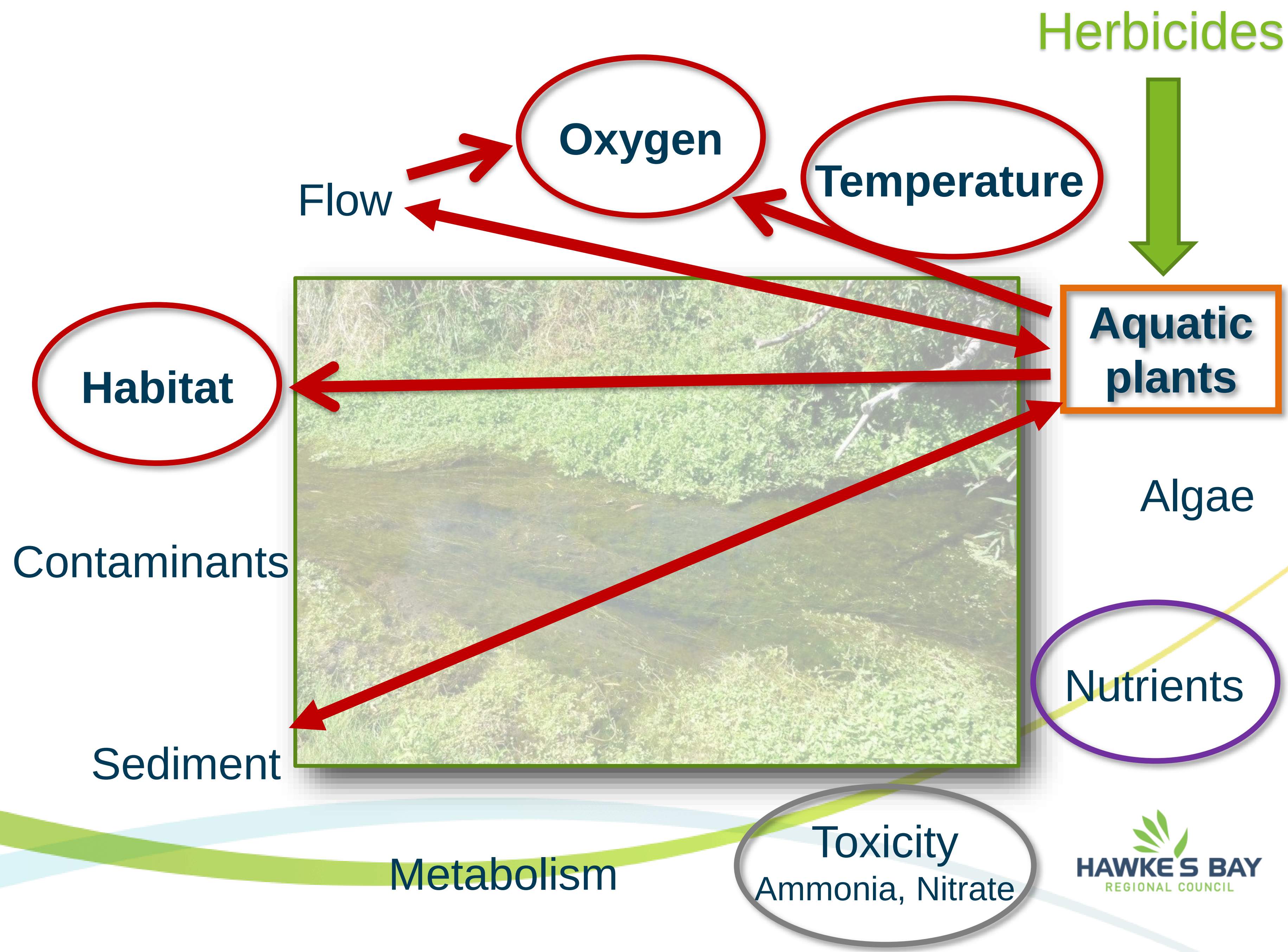
Management for main stressors: temperature, low dissolved oxygen, habitat

| Management tool | Achievements / values | downsides |
| --- | --- | --- |
| Riparian planting - shade | 1. Moderated water temperature<br>2. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance<br>3. Additional benefits possible: sediment and nutrient retention, better habitat<br>4. Improved aesthetics (recreation, amenity) | • Restricted channel access<br>• In early years high maintenance (terrestrial weeds)<br>• In early years effects on sediment, channel morphology<br>• In early years high cost of planting<br>• Uncertainty in macrophyte – instream nutrient interaction |


Herbicides
Oxygen
Temperature
Flow
Aquatic plants
Habitat
Algae
Contaminants
Nutrients
Sediment
Metabolism
Toxicity
Ammonia, Nitrate
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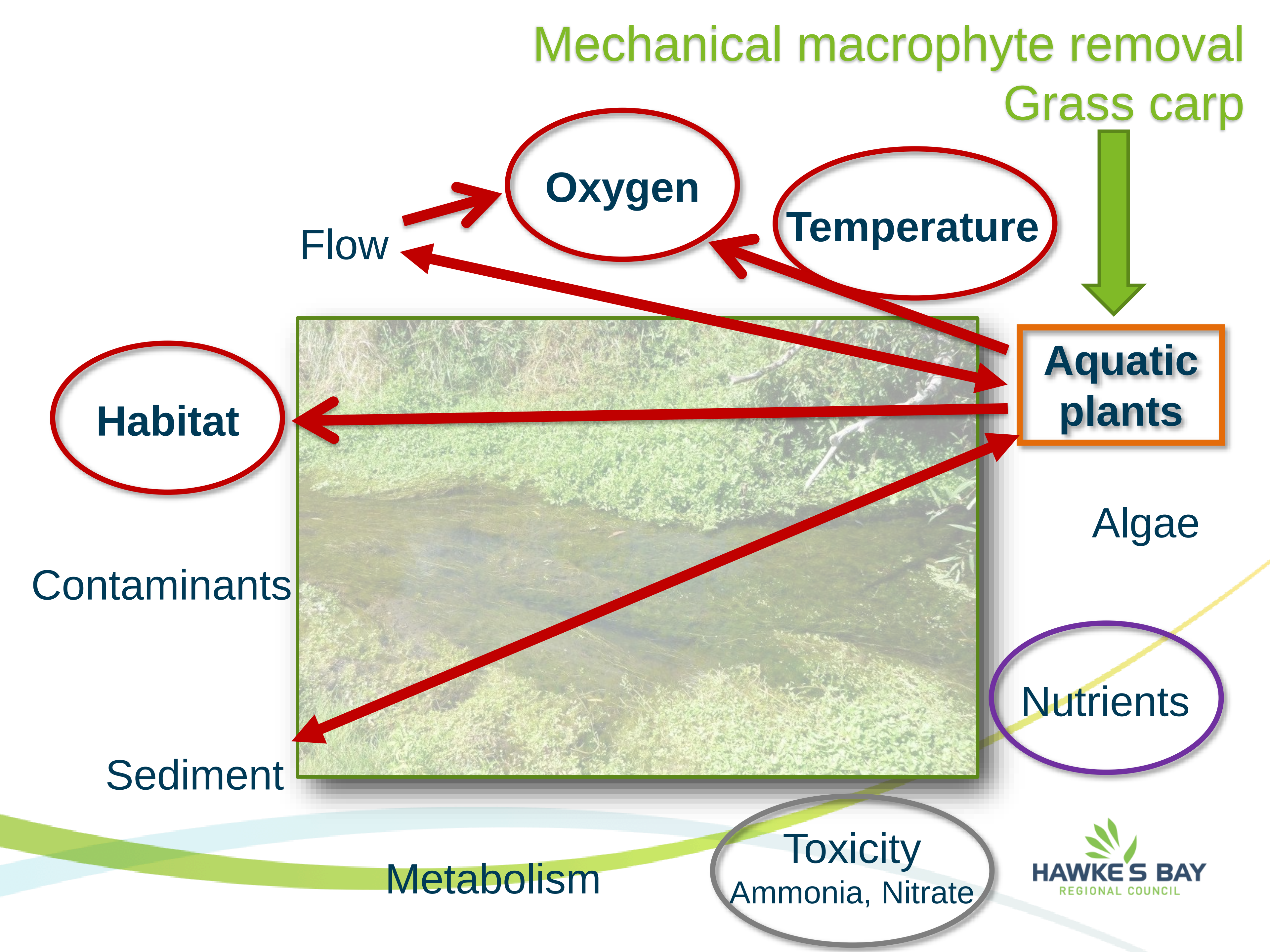
## Management for main stressors: temperature, low dissolved oxygen, habitat

| Management tool | Achievements / values | downsides |
| --- | --- | --- |
| Herbicides | 1. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance | • Low efficacy in turbid water<br>• Ongoing treatment necessary<br>• Public concerns about toxicity of herbicides<br>• Concern about deoxygenation following plant decay<br>➢ Toxicity and deoxygenation not observed in studies |



Mechanical macrophyte removal
Grass carp
Oxygen
Temperature
Flow
Aquatic plants
Habitat
Algae
Contaminants
Nutrients
Sediment
Metabolism
Toxicity
Ammonia, Nitrate
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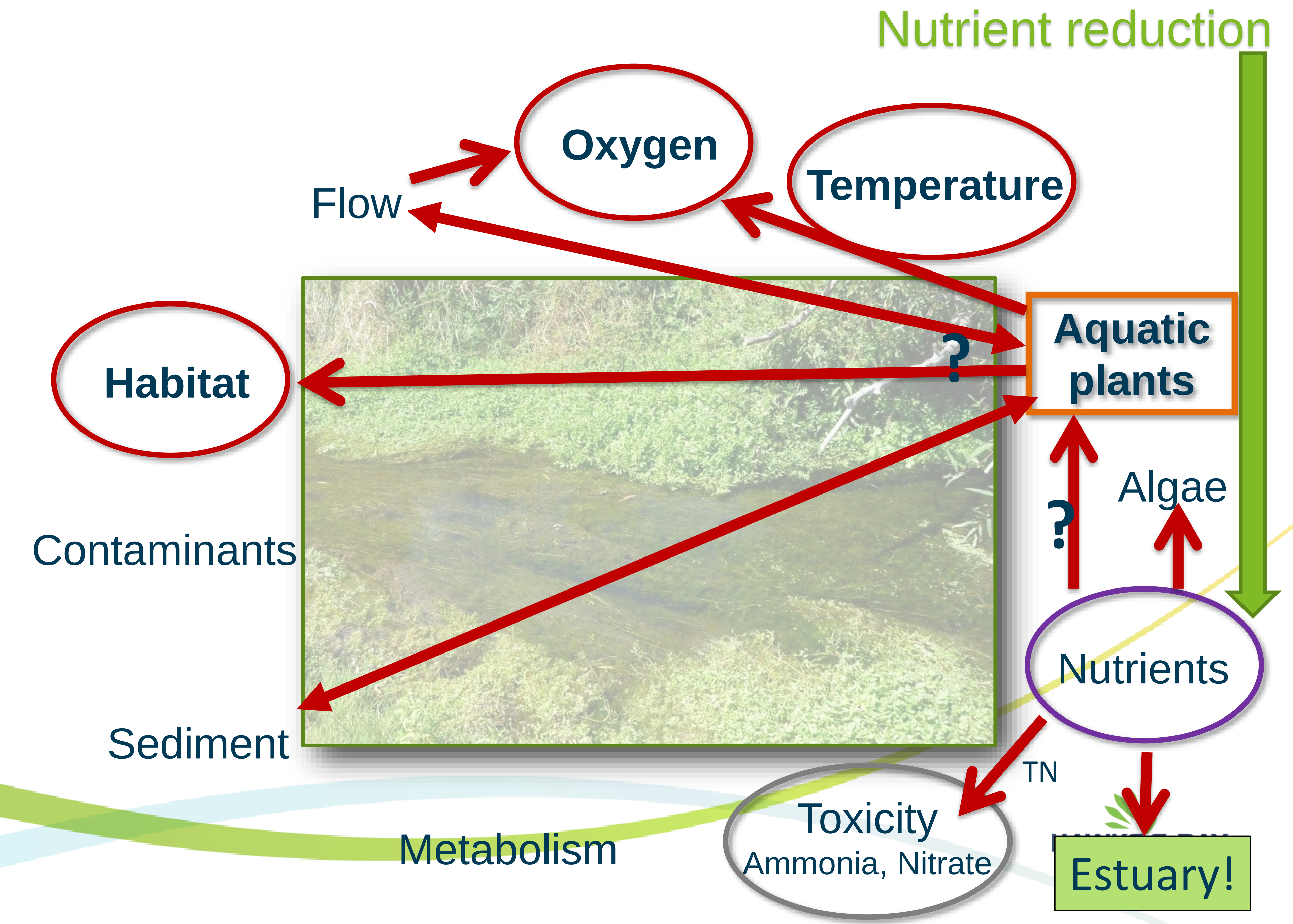
Management for main stressors: temperature, low dissolved oxygen, habitat

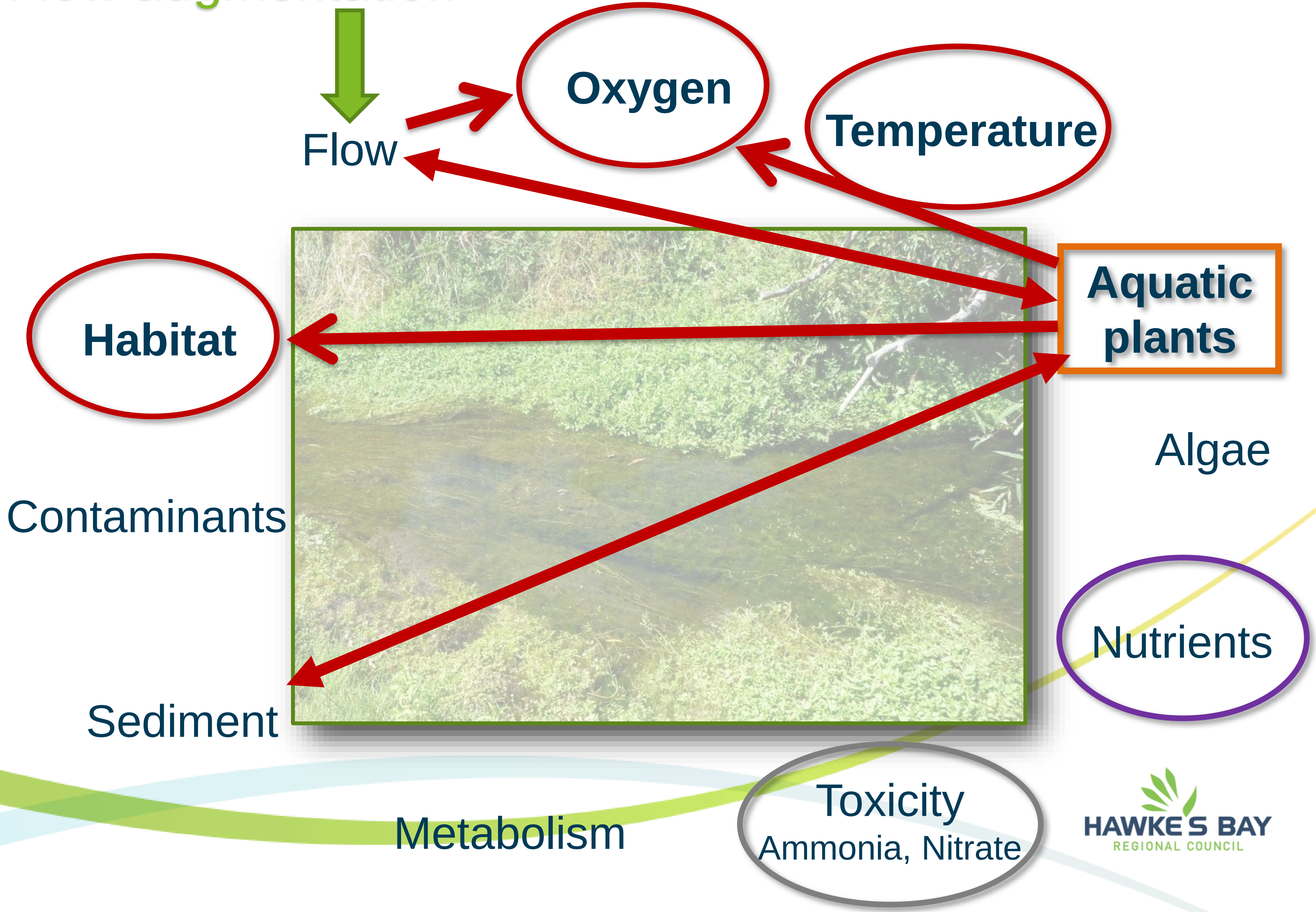
| Management tool | Achievements / values | downsides |
|---|---|---|
| Grass carp | 1. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance | • Complete devegetation → loss of habitat in soft sediment streams<br>• Survival doubtful as sensitive to high temperature, low oxygen and polluted water<br>• Needs MfE approval |
| Mechanical macrophyte removal | 1. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance | • Digging: damages ecosystem health (invertebrates, eels), disturbed sediment, associated anoxia, mobilises nutrients, increases turbidity, labour intensive<br>• Cutting: labour intensive, ongoing maintenance, downstream effect of cut weeds, habitat disturbance |


Nutrient reduction
Oxygen
Temperature
Flow
Habitat
?
Aquatic plants
?
Algae
Contaminants
Nutrients
Sediment
TN
Toxicity
Ammonia, Nitrate
Metabolism
Estuary!

## Management for main stressors: temperature, low dissolved oxygen, habitat

| Management tool | Achievements / values | downsides |
|---|---|---|
| Nutrient reduction | 1. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance | • Very low nutrient concentrations required for reduction in macrophyte growth (roots).<br>• Not all studies corroborate efficacy of nutrient reduction<br>• Nutrient concentrations in the Karamu catchment very high, difficult to achieve effective concentrations. |

# Flow augmentation

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## Management for main stressors: temperature, low dissolved oxygen, habitat

| Management tool | Achievements / values | downsides |
|---|---|---|
| Flow management | See Thomas's presentation<br>1. Reduction nuisance macrophyte and attached periphyton growth<br>➢ Increase dissolved oxygen<br>➢ Increase flow conveyance | • Impact on water users<br>• Risk that flow management may lead to reduced flow/water levels elsewhere |

# Summary downsides

| Management tool | **downsides** |
| --- | --- |
| Riparian planting - shade | • Restricted channel access<br>• In early years high maintenance (terrestrial weeds)<br>• In early years effects on sediment, channel morphology<br>• In early years high cost of planting<br>• Uncertainty in macrophyte – instream nutrient interaction |
| Herbicides | • Low efficacy in turbid water<br>• Ongoing treatment necessary<br>• Public concerns about toxicity of herbicides (not observed in studies)<br>• Concern about deoxygenation following plant decay (not observed in studies) |
| Grass carp | • Complete devegetation → loss of habitat in soft sediment streams<br>• Survival doubtful as sensitive to high temperature, low oxygen and polluted water<br>• Needs MfE approval |
| Mechanical macrophyte removal | • Digging: damages ecosystem health (invertebrates, eels), disturbed sediment, associated anoxia, mobilises nutrients, increases turbidity, labour intensive<br>• Cutting: labour intensive, ongoing maintenance, downstream effect of cut weeds, habitat disturbance |
| Nutrient reduction | • Very low nutrient concentrations required for reduction in macrophyte growth.<br>• Not all studies corroborate efficacy of nutrient reduction<br>• Nutrient concentrations in the Karamu catchment very high, difficult to achieve effective concentrations. |
| Flow management | • Impact on water users<br>• Risk that flow augmentation may lead to reduced flow/water levels elsewhere |

# Summary benefits

| Management tool | Stressors | | | | | |
|---|---|---|---|---|---|---|
| | Temp °C | Aquatic plants | Oxygen | Habitat | Flow | More benefits |
| Riparian planting - shade | ✓ | ✓ | ✓ | ✓ | ✓ | Habitat<br>Amenity<br>Biodiversity<br>(Nutrients)<br>(Sediment) |
| Herbicides | | ✓ | ✓ | (✓?) | ✓ | |
| Grass carp | | ✓ | | loss | | |
| Mechanical macrophyte removal | | ✓ | ✓ | damage | ✓ | |
| Nutrient reduction | | (✓?) | (✓?) | (✓?) | (✓?) | Nutrient load to estuary reduced, Algae reduced |
| Flow management | | ✓ | ✓ | | ✓ | |

# Breakout session

- Do you agree with the recommendation to focus on the attributes DO/temperature?
- Discussion on management recommendations by the TAG

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# Minimum Flows for the Heretaunga Plains

Dr Thomas Wilding

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# Direction from Previous Meetings

- "Minimum flow setting needs to take into account the impacts on environmental, cultural, social and economic values using a variety of methodologies (e.g. Mātauranga Māori; economic models)"
  *Interim Agreements report (Feb 2014)*

- "Other ways to protect fish etc. than just minimum flows… Riparian planting and other measures may improve aquatic habitat in some waterways better than increasing minimum flows"
  *From Meeting 6 (May 2013) minimum flow discussions*

- "lowland tributary indicator species: inanga"
  *From Meeting 16 (June 2015)*

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# Background

- In-stream oxygen levels linked with flow
- Oxygen is more critical for Karamu ecology than depth and velocity, which are both important for the Ngaruroro
- TANK Group will recommend minimum flows and limits for oxygen in streams
- Those limits have consequences for *ecosystem health* and *water use* (e.g. irrigation)


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# Aim of investigations:

- To *INFORM* setting of **minimum flows**, in particular:
  - Magnitude of oxygen limits
  - Magnitude of minimum flows
  - Location of minimum flow sites

To *INFORM* **Stakeholder Group** recommendations

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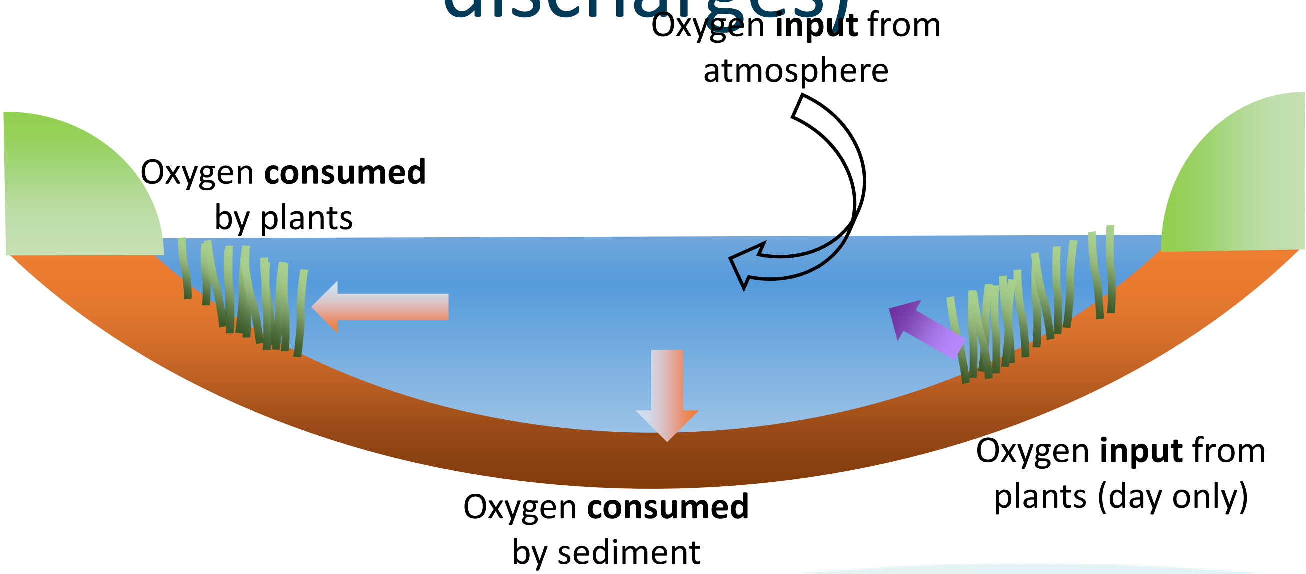
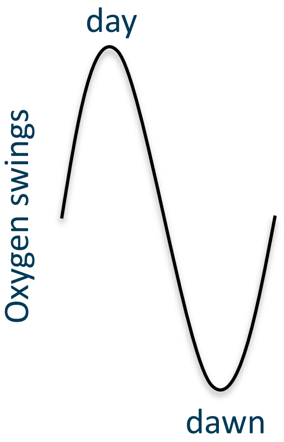
# Oxygen – focus on aquatic-plant drivers (not pollution discharges)

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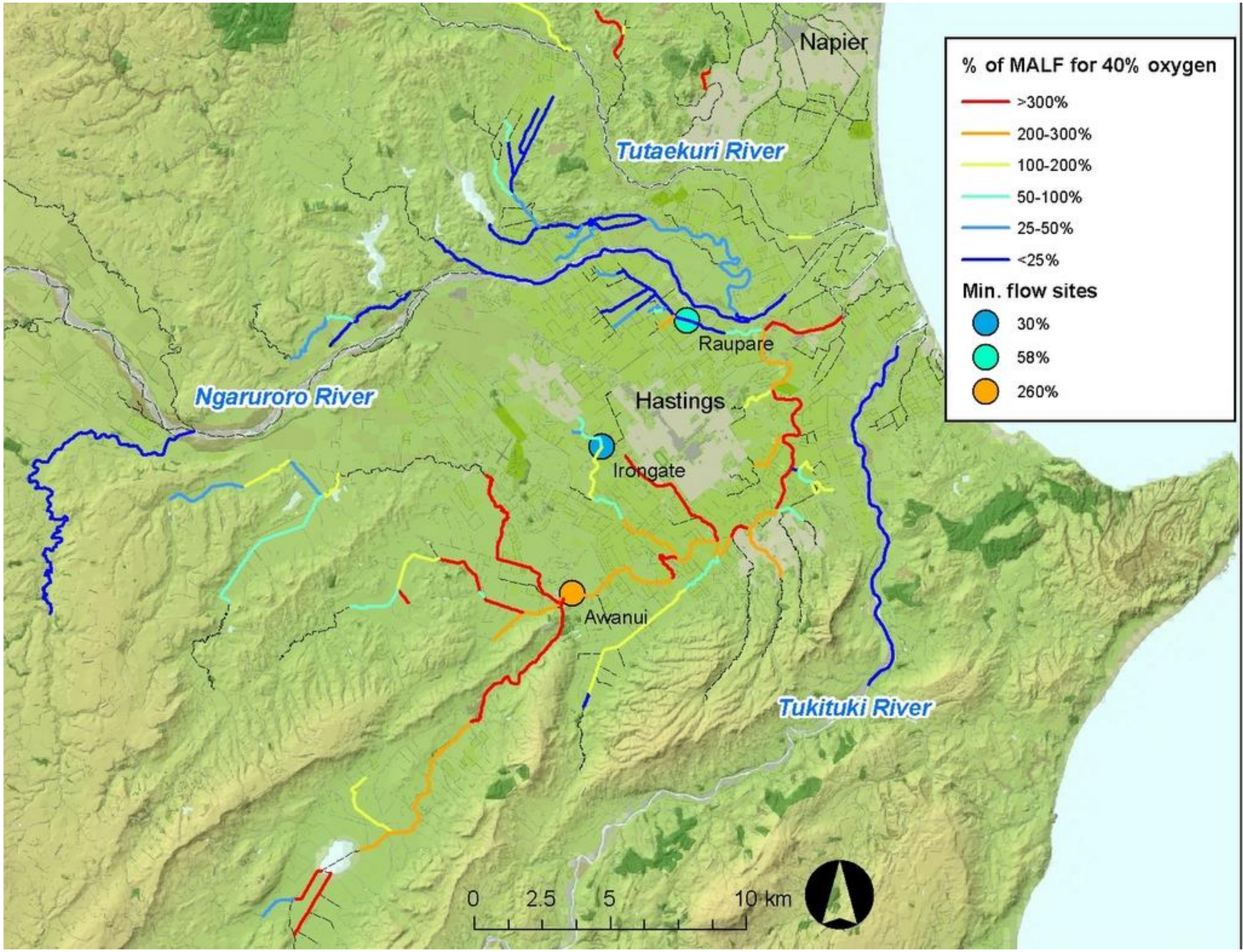
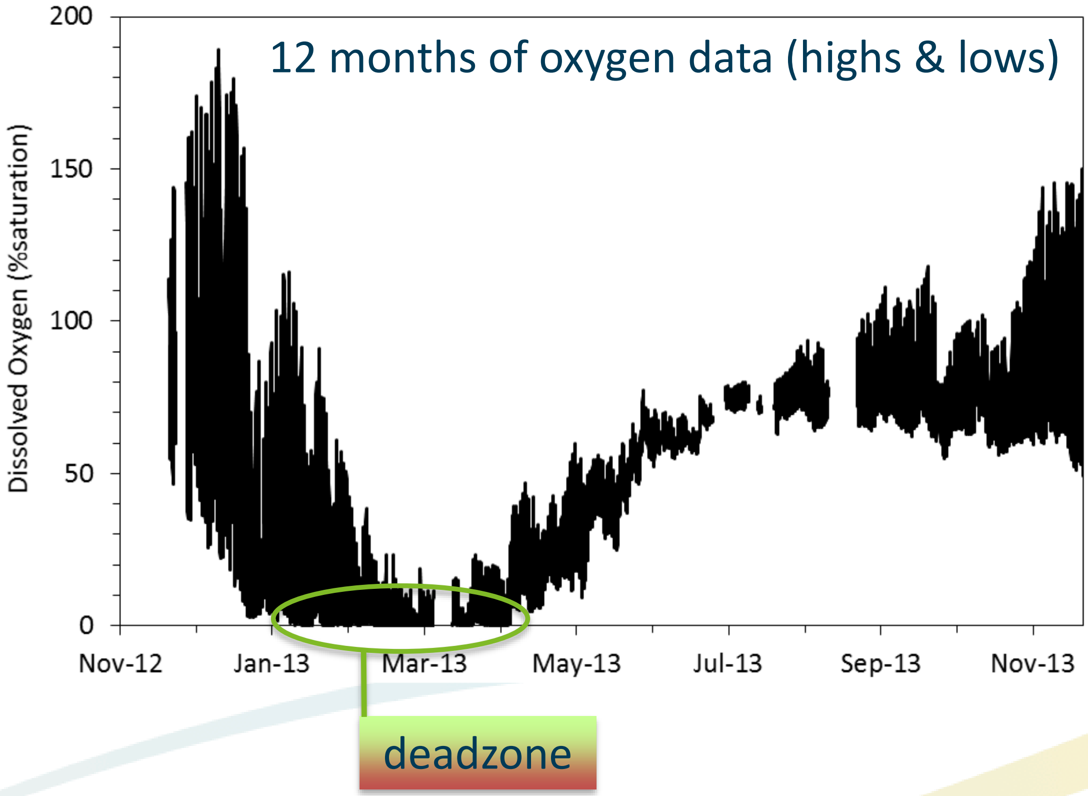
# Where is oxygen a problem?

- Red - worse
- Blue - better



# Red line on the map – Awanui Stream

- No oxygen every morning for 77 days (Jan-Mar 2013).

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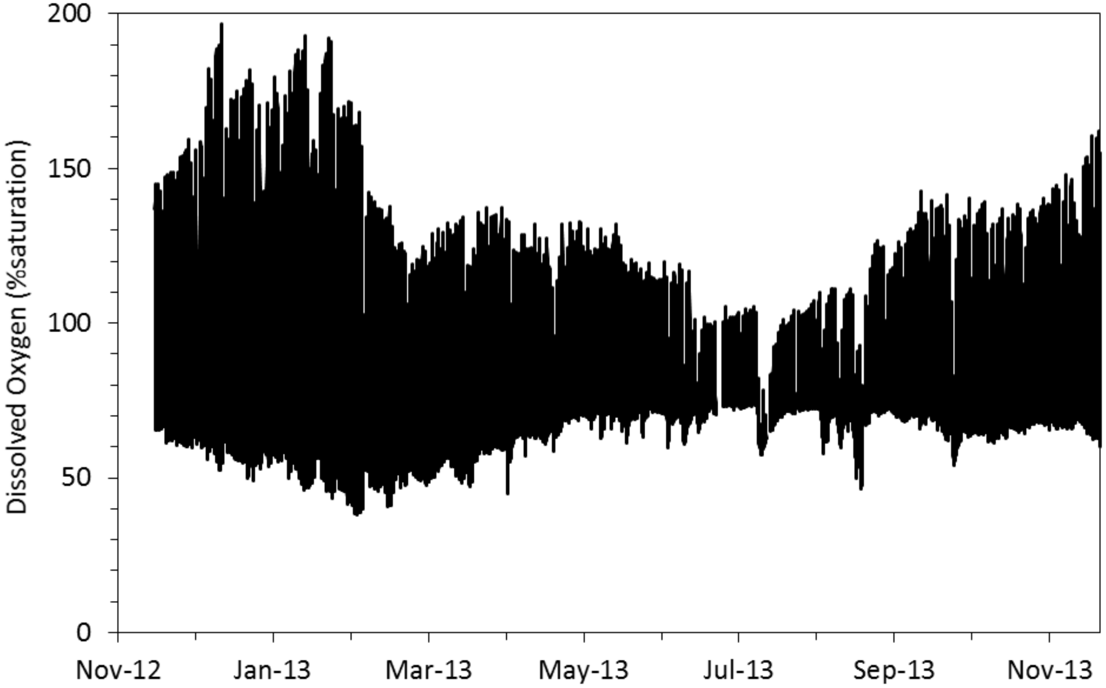
# Blue line on the map – Raupare Stream

- Remained above 40% oxygen saturation for 99.1% of the time (2013-2015)

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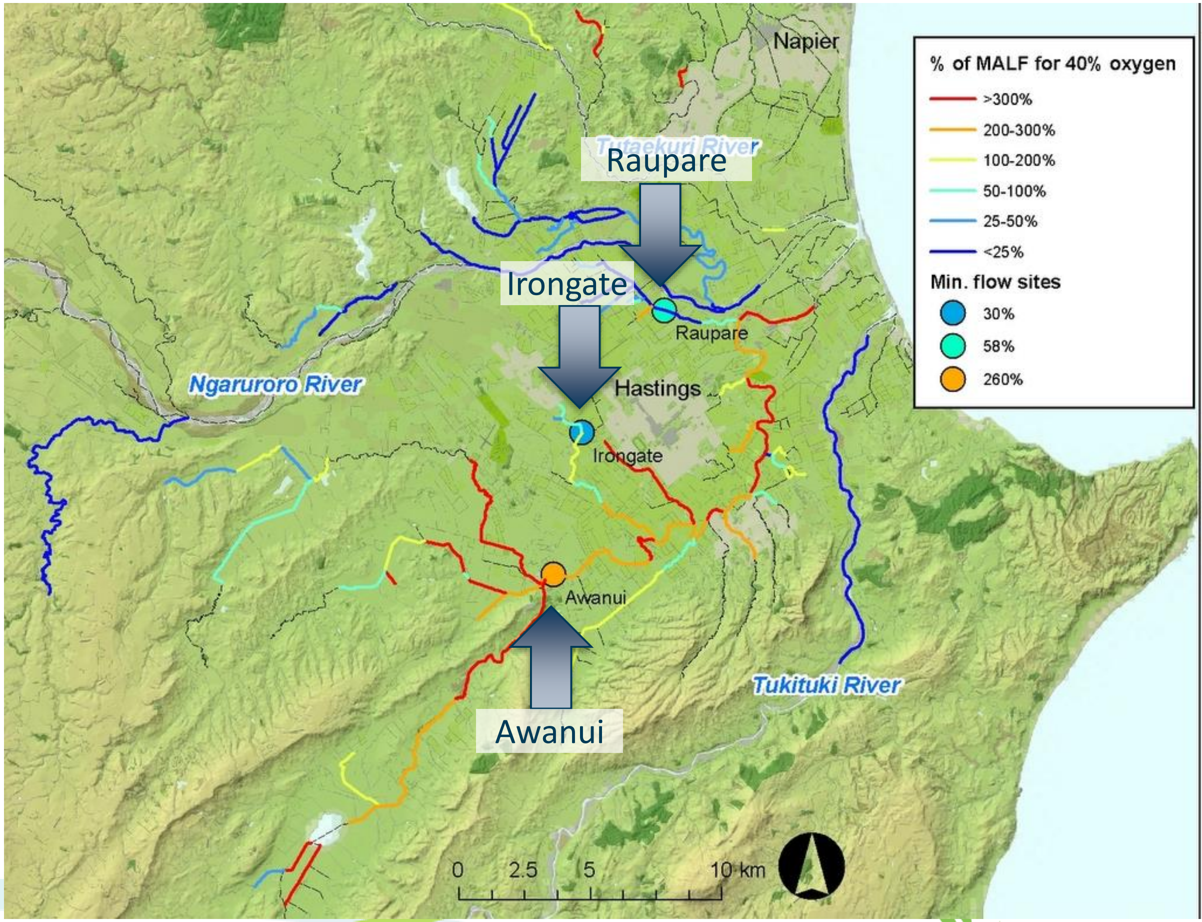
# Minimum flow study sites

- Three sites investigated compared to more than 20 existing sites

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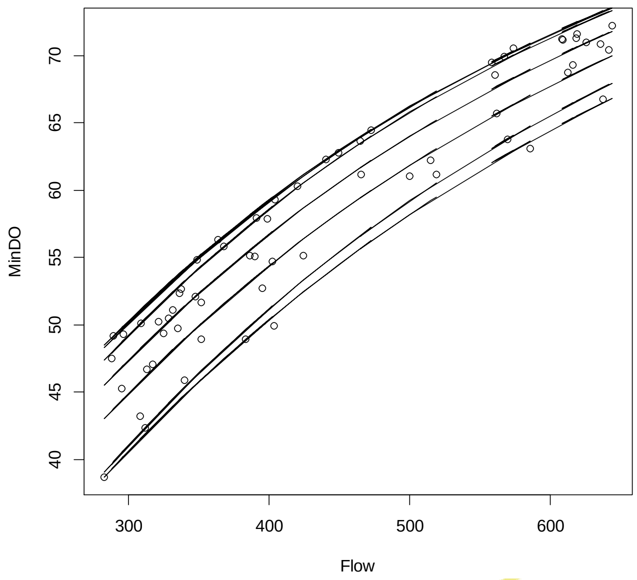
# Oxygen and flow

- Flow is not the sole determinant of oxygen
- Seasonal plant growth changes the oxygen-flow response

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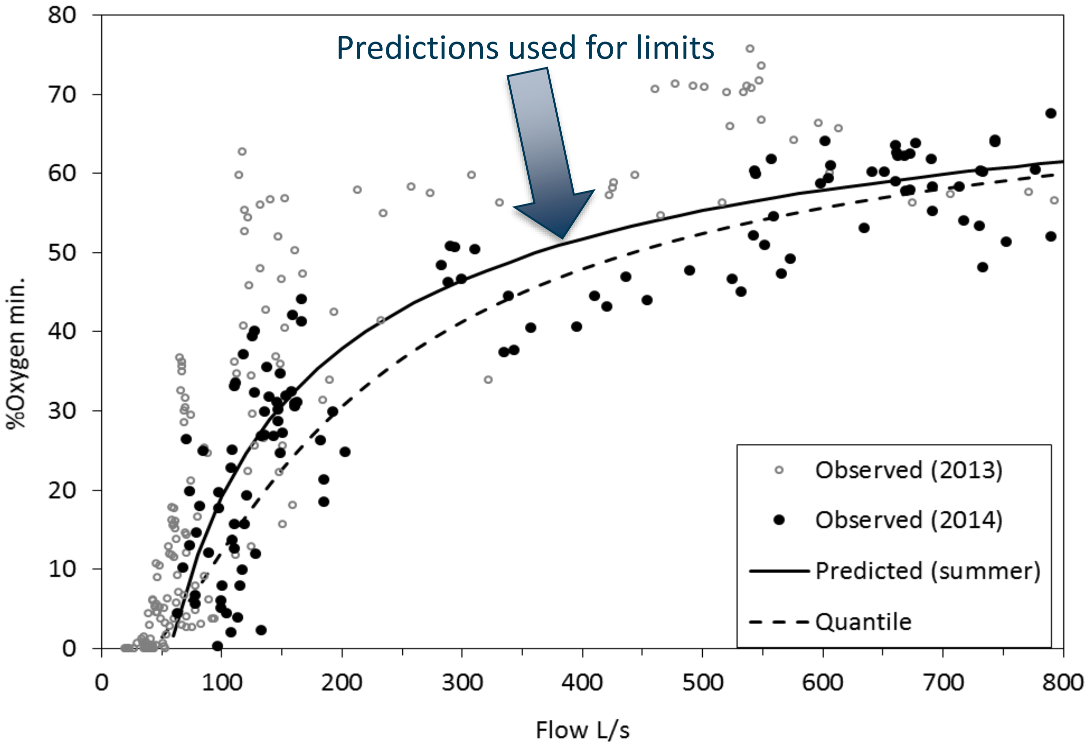
# Certainty in Model Predictions

Seasonal plant growth changes the oxygen-flow response




- Awanui Stream – comparing model predictions (black line) to observed oxygen (training circles and validation dots)

# Flow requirements for oxygen at the study sites

| Stream | Scenario | | Oxygen Satn. | | | Min. Flow |
|---|---|---|---|---|---|---|
| | | 30% | 40% | 50% | 60% | (2006) |
| **Raupare (Ormond Road)** | Autumn | *160 L/s | 240 L/s | 350 L/s | 510 L/s | 300 L/s (46%) |
| | Summer | *110 L/s | *200 L/s | 390 L/s | | (46%) |
| **Awanui (flume)** | Summer | 170 L/s | 270 L/s | 510 L/s | - | 120 L/s (<30%) |
| **Irongate (Clark's weir)** | Summer | 21 L/s | 33 L/s | 67 L/s | 190 L/s | 100 L/s |

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# Oxygen Limits – narrowing down to draft scenarios

- No oxygen limits apply in this situation
- Stakeholders therefore need to chose

*"It is up to communities and iwi to determine the pathway and timeframe for ensuring freshwater management units meet the national bottom lines"*

*2014 National Policy Statement for Freshwater Management*

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# Option 1:

## These limits do not apply, but are the obvious first choice

“..oxygen shall **exceed 80%”** “…except in areas of groundwater upwelling…”
**Tukituki Plan Change** 6 for the River Catchment

“...discharge shall not cause… oxygen in any river or lake to drop below **80%** after reasonable mixing.”
**RRMP 2014**

***National Policy Statement*** *for Freshwater Management* (2014)

| Attribute State | Oxygen (7-day mean min. at 15 °C Nov-April) |
|---|---|
| A | >80% |
| B | 70-80% |
| C | 50-70% |
| D | <50% (National Bottom Line) |

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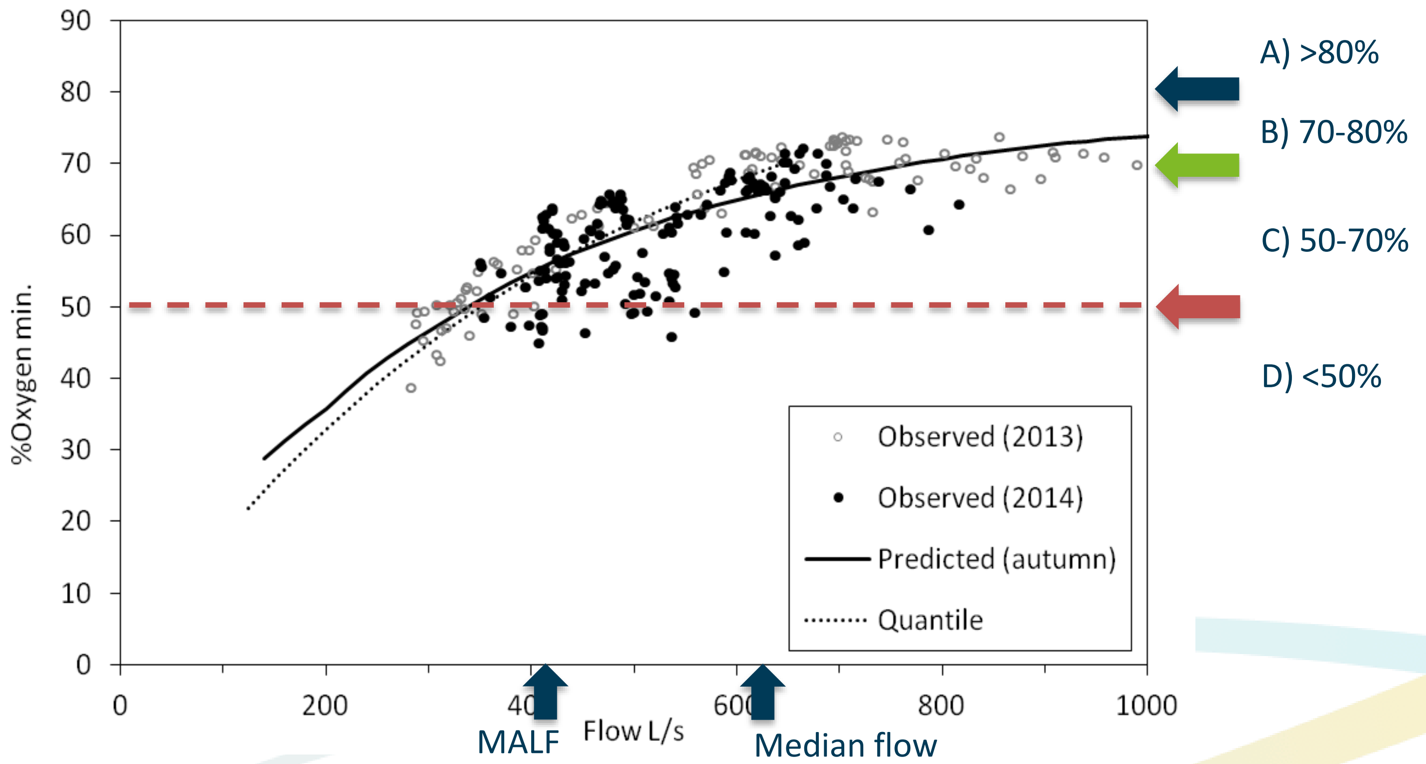
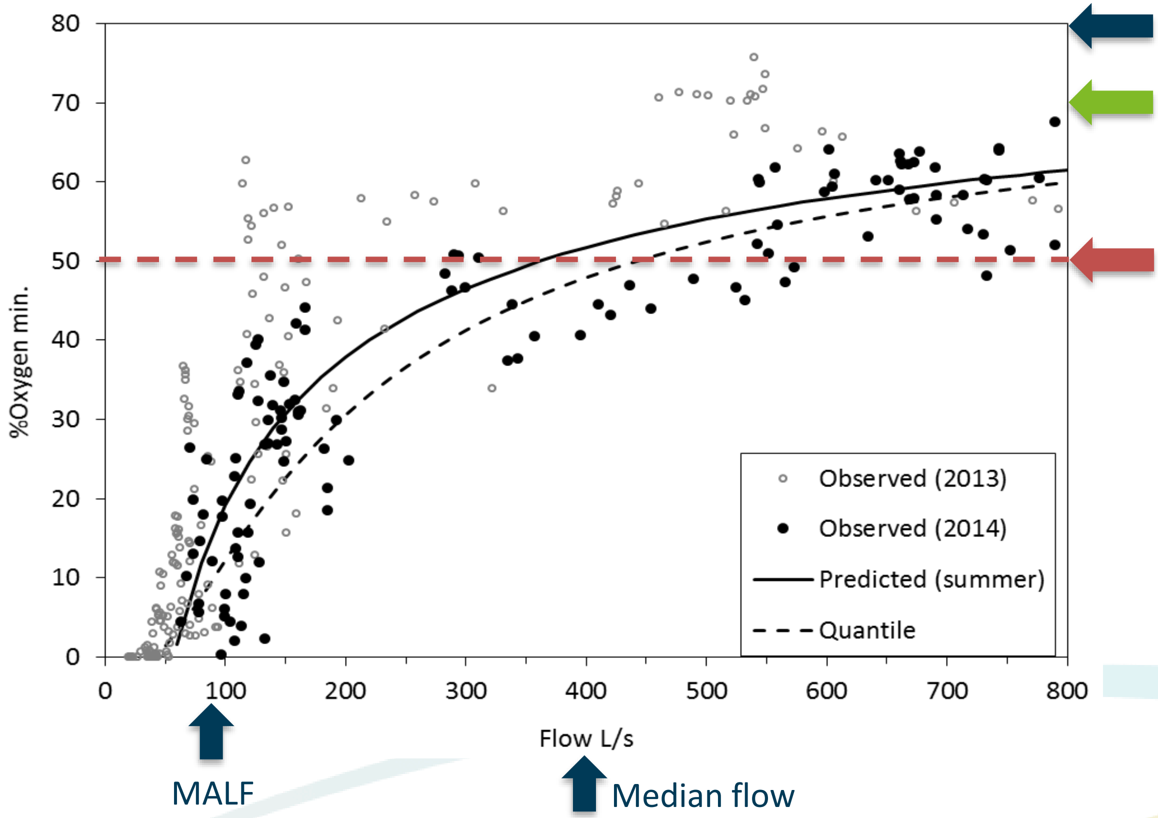
# Achieving NPS limits for Raupare



# Achieving NPS limits for Awanui




A) >80%

B) 70-80%

C) 50-70%

D) <50%

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# Option 2

- I recommend oxygen limits that are **LOWER** than the NPS National Bottom Line for native fish in low-gradient streams
- External peer reviewer disagreed with my recommendations
- This is a second option for stakeholders to chose from

# Option 2: My Recommended Limits

**A. 40% oxygen saturation**

- to protect adult native freshwater fish - **NOT a "Good" MCI -** in low-gradient streams where aquatic plants drive oxygen dynamics

**B. Water velocity of 0.04 m/s**

- To prevent complete collapse of aquatic plant communities that results in enduring anoxia, for streams where flow management cannot achieve 40% saturation

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# Rationale for lower oxygen standards

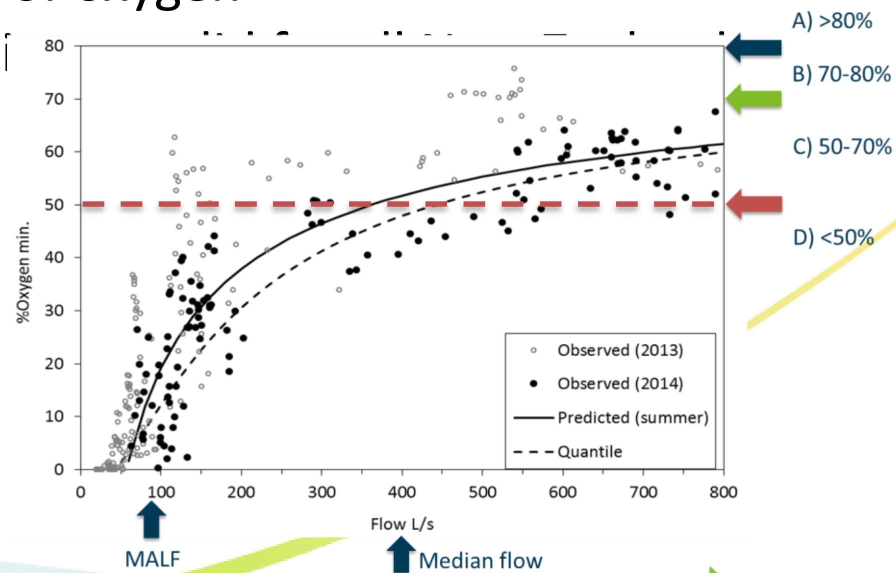
1. **NPS Not achievable** for many streams

2. **Healthy fish** in Raupare despite dropping below bottom line

3. **Too conservative** compared to scientific literature

# 1. NPS Not achievable

- Oxygen potential depends on physical constraints, in addition to resource management
- If flow alteration is a driver of oxygen, then natural flow variability must also be a driver of oxygen
- Therefore, a single bottom line i
  streams

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# 2. Healthy fish despite dropping below bottom line

- More fish species in the Raupare, than the Awanui, including oxygen-sensitive trout and smelt

- Healthier inanga in the Raupare than the Awanui

- MCI score not good Raupare (MCI 70)

| Species | Raupare | Awanui |
|---|---|---|
| yelloweyed mullet | 66% | too far |
| inanga | 27% | 96% |
| patiki (flounder) | 1% | |
| rainbow trout | 3% | 0.4% |
| koura | 1% | |
| eels (shortfin & longfin) | 1% | 2% |
| common bully | 0.4% | present |
| Gambusia | present | 1% |
| common smelt | present | |
| goldfish | present | present |
| freshwater mussel | present | |

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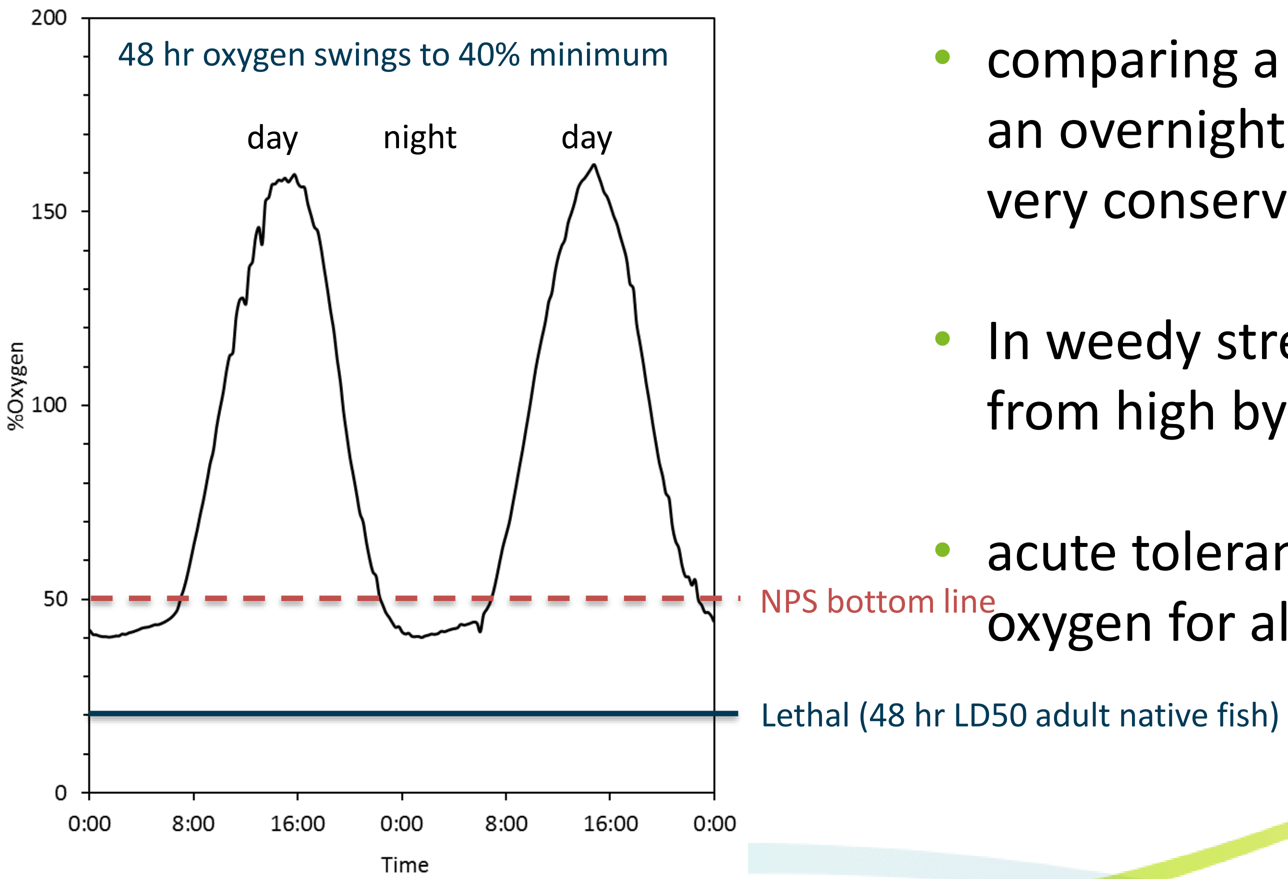
# 3. **Too conservative** compared to scientific literature




- comparing a 48-hour lethal level to an overnight 5 minute minimum is very conservative
- In weedy streams, oxygen swings from high by day to low at night
- acute tolerances are less than 20% oxygen for all for adult native fish

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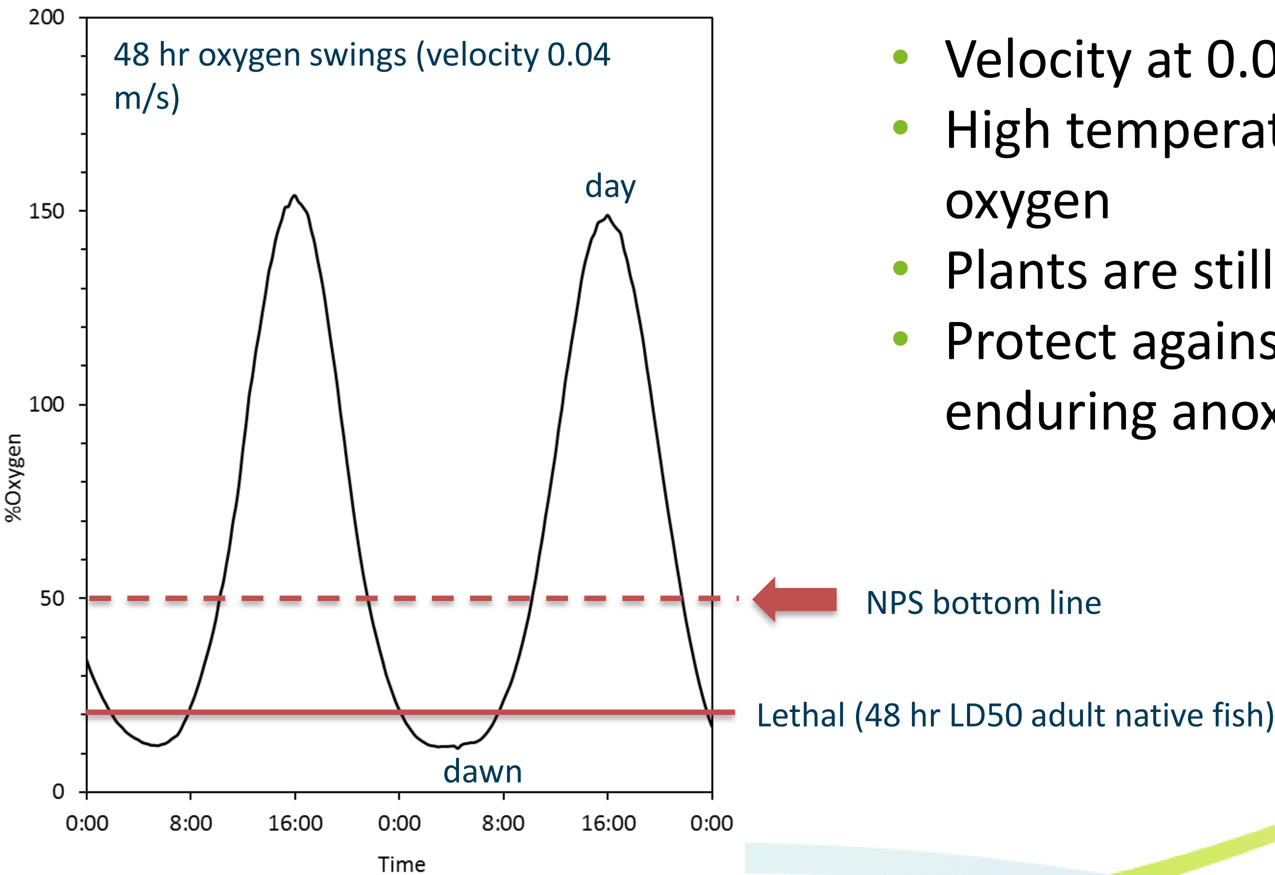
# Velocity Standard




- Velocity at 0.04 m/s
- High temperatures coincide with high oxygen
- Plants are still producing
- Protect against plant-collapse and enduring anoxia

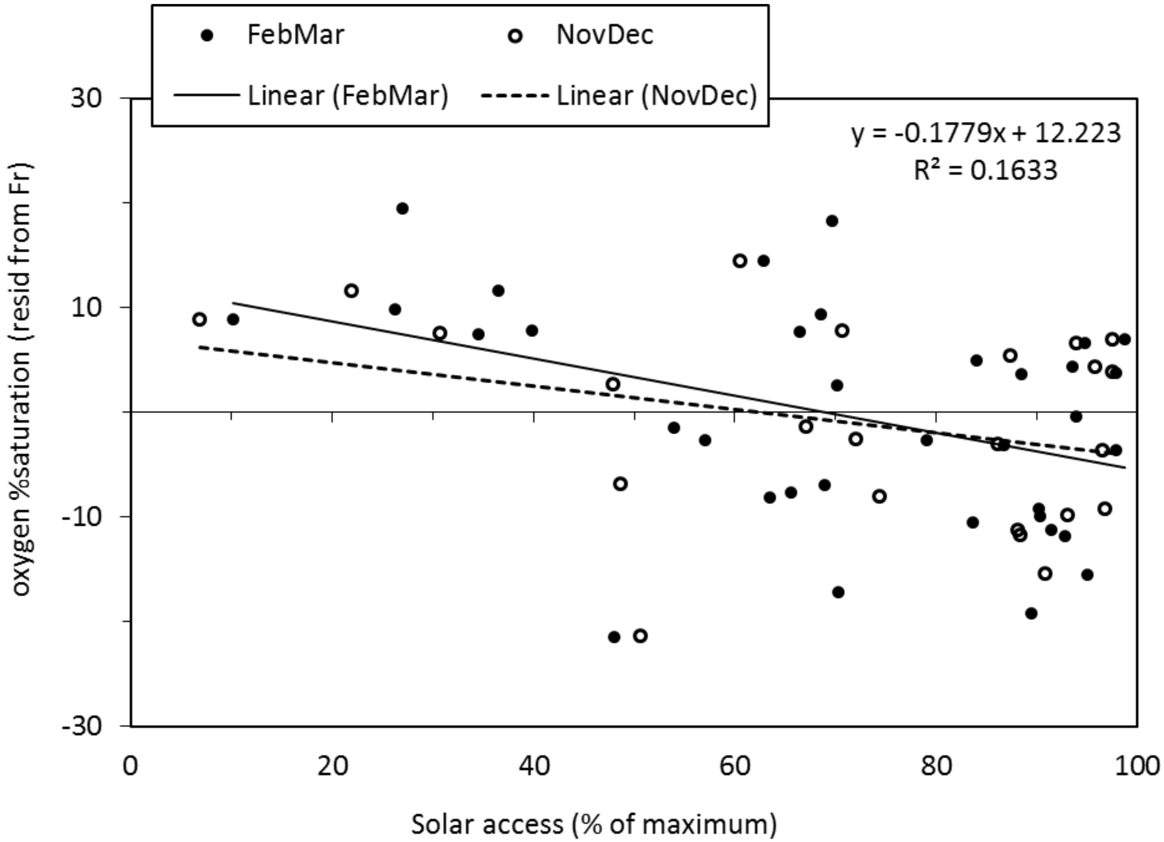
# Flow is not the only way to manage oxygen

*"Other ways to protect fish etc. than just minimum flows"*

# More shade = less weed

| 2% shade | 56% shade |
| --- | --- |

# More shade = more oxygen *supply* (...a bit)

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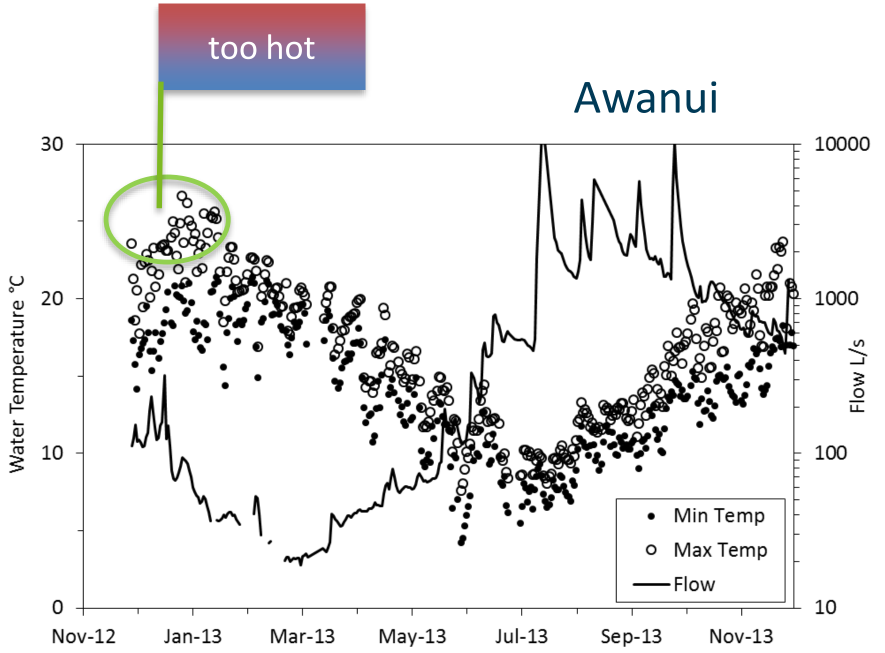
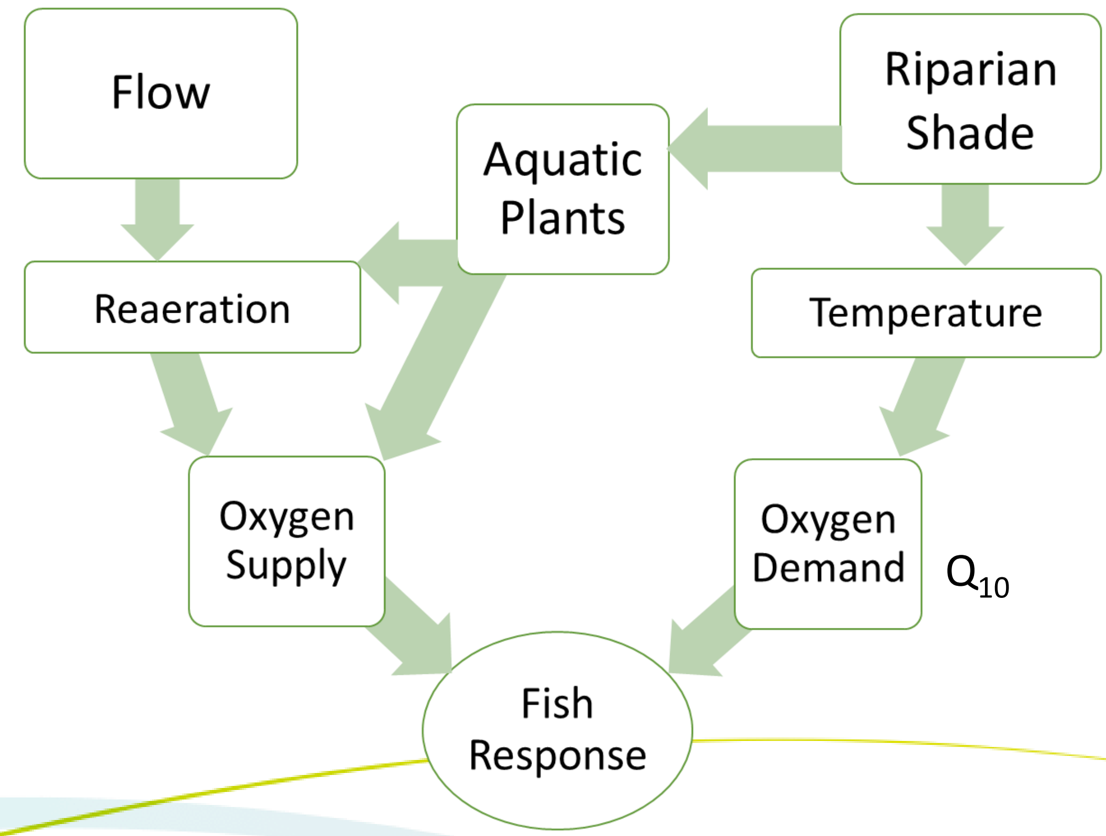
# Temperature



# Managing oxygen *SUPPLY* to exceed *DEMAND*




Benefits of shade even greater, because oxygen DEMAND also reduced

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# Summary

thomas@hbrc.govt.nz

1. Low-gradient streams need more flow to achieve the same oxygen
2. Alternative to NPS oxygen limits proposed
3. Riparian shading increases oxygen *supply* and reduces oxygen *demand*

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# Break-out session

# Minimum flow levers for low-gradient streams (example options)

| | | | |
|---|---|---|---|
| **Oxygen attribute** | 60% | 40% | (velocity 0.04 m/s) |
| **Indicator** | invertebrate MCI | Health of adult native fish | Fish survival / aquatic plant health |
| | | | |
| **Restriction Regime** | Ban or Staged Reduction | | |

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# Karamu Catchment :
# Drainage and Flood Management

Presentation by:
Gary Clode
Hawke's Bay
Regional Council

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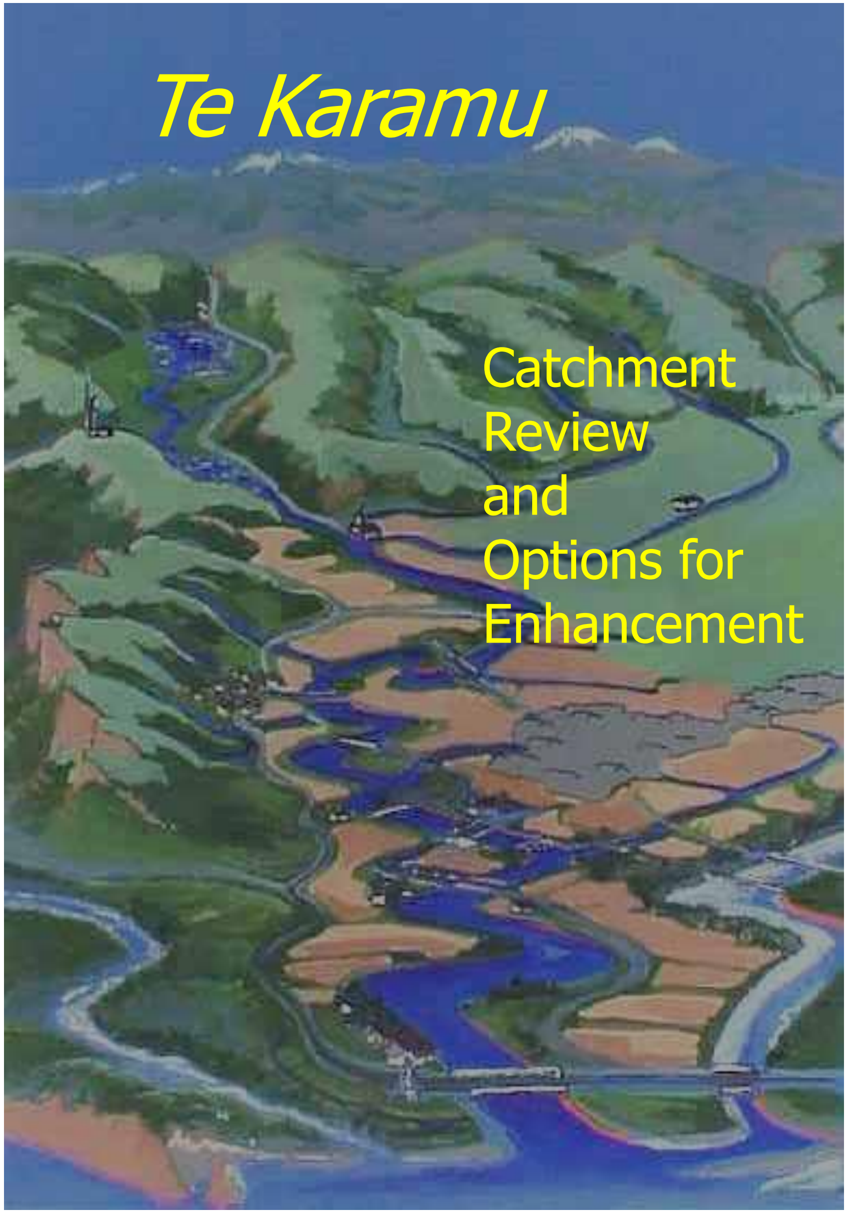
## Short History

Te Karamu Report (June 2004) has succinct history of past flooding and all the other issues such as water quality and quantity.



# Major Floods

1867 – Course of Ngaruroro changed- 450mm in 5 days
According to Māori no flood to compare with it in the previous 40 years.

1897 – Water covered 60% of Heretaunga Plains –530mm in 48 hours
1917 – Bigger flood than 1897 not a bad as 1867
1924 – Tutaekuri broke its banks and flooded Moteo area towards Omahu (511 mm in 10 hrs at Rissington).

1933 – Tutaekuri broke its banks in 6 places, flooding in Meeanee similar to 1897.
1938 – 1000mm of rain fell at Rissington in 3 days
1936 – Cyclone. Major flooding in Tutaekuri, rose 3.8m flooded Puketapu valley.

1980 – Stopbank breach Twyford – 157mm in 48 hours
1988 – Cyclone Bola

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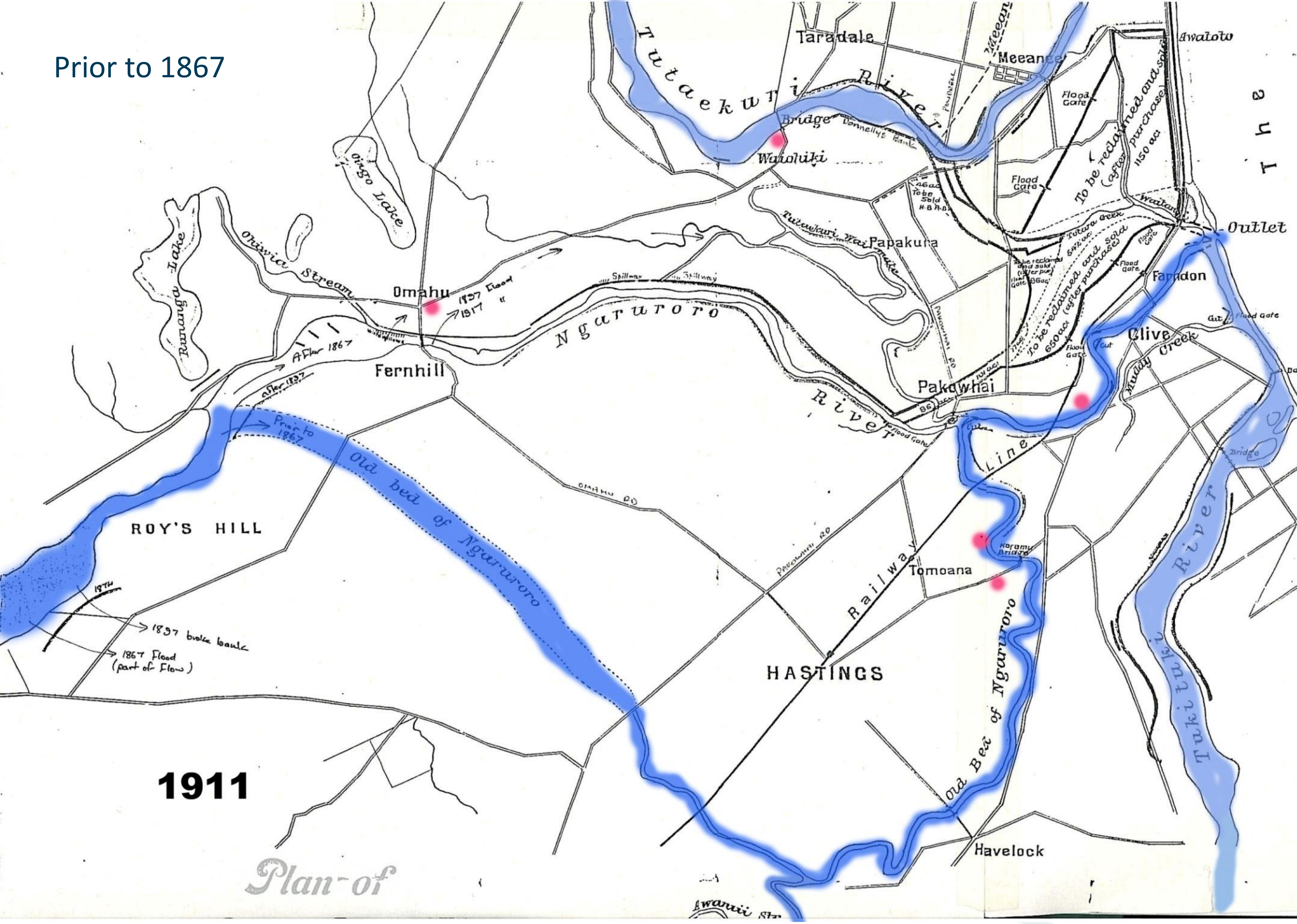
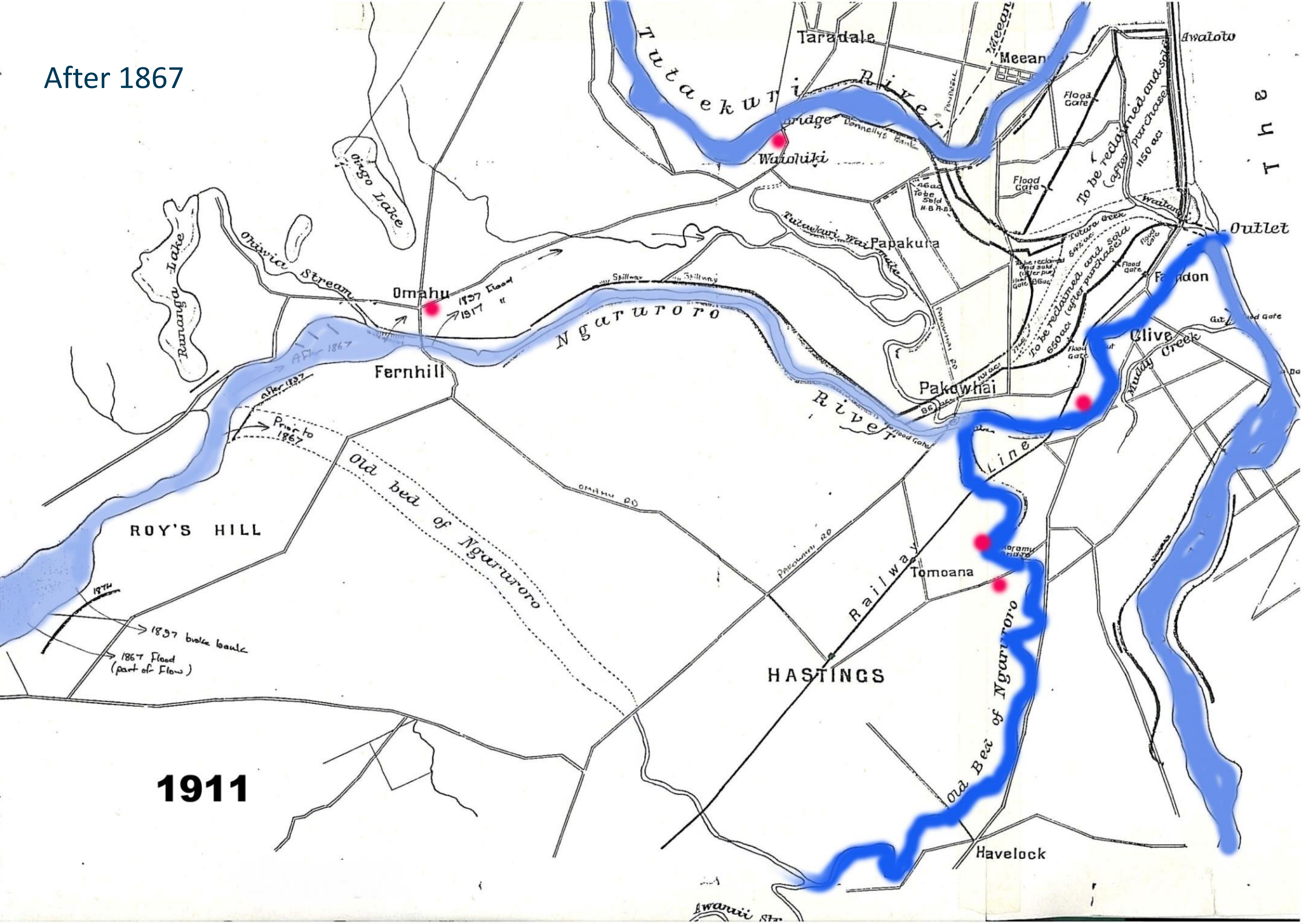
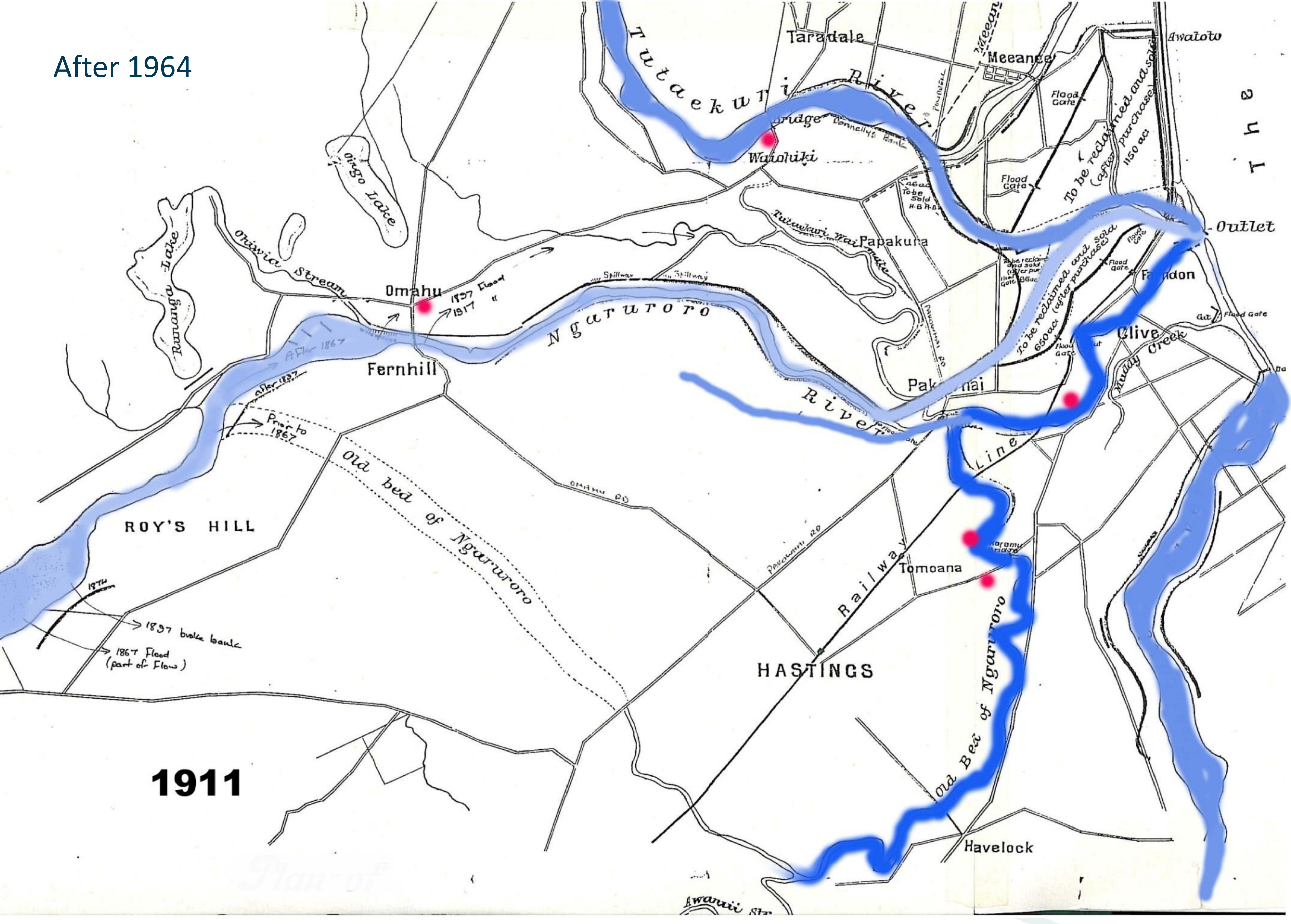
## Prior to 1867



After 1867


Tutaekuri River
Taradale
Meeanee
Awatoto
Waiohiki
Bridge
Oingo Lake
Ruanga Lake
Ohiwia Stream
Omahu
1897 Flood
1917
Ngaruroro River
Fernhill
After 1867
after 1897
Prior to 1867
Old bed of Ngaruroro
Papakura
Pakowhai
Clive
Muddy Creek
Outlet
Farndon
Flood Gate
To be reclaimed and sold (after purchase) 1150 ac
To be reclaimed and sold (after purchase) 650 ac
ROY'S HILL
1897 broke bank
1867 Flood (part of Flow)
Railway Line
Tomoana
HASTINGS
Old Bed of Ngaruroro
Havelock
Omahu Rd
1911

## After 1964


Tutaekuri River
Taradale
Meeanee
Meeanee
Awatoto
Flood Gate
Bridge
Donnellys Bank
Waiohiki
Flood Gate
To be reclaimed and sold (after purchase) 1150 ac
The
Outlet
Oingo Lake
Roto-a-Kiwa Lake
Ohiwia Stream
Tutaekuri Wai
Papakura
Spillway
Spillway
Omahu
1897 Flood
1917
Ngaruroro River
Fernhill
After 1867
after 1897
Prior to 1867
Flood Gate
Farndon
Flood Gate
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Muddy Creek
To be reclaimed and sold (after purchase) 650 ac
Pakowhai
Line
Old bed of Ngaruroro
OMAHU RD
ROY'S HILL
PAKOWHAI RD
Railway
Tomoana
1874
1897 broke bank
1867 Flood (part of Flow)
HASTINGS
Old Bed of Ngaruroro
1911
Havelock
Awanui Str

# Drainage & Flood Management Values

- Karamu catchment part of the Heretaunga Plains Flood Control Scheme (HPFCS).
- Scheme development more fully described in the HPFCS Asset management Plan. (AMP's describe the scheme and how it is to be managed).

- First proposal 1919, commenced 1934, reviews 1959, 1967, 1980, 1987 to 1995.
- Rivers Levels of Service review for 1 in 500 year flood. (currently 1 in 100 year).
- Drainage for 10 year minimum standard (currently 1 in 5 year, or to drain 32mm of runoff in 24 hours)

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# Drainage Schemes

- After completion of HPFCS in 1970, greater demand for drainage improvements.
- Between 1973 to 1989 close co-operation between landowners and the HB Catchment board - a number of major drainage schemes were completed.
- Many smaller schemes completed on behalf of individual landowners.
- Many schemes were given government subsidies until 1987 when subsidies were discontinued.

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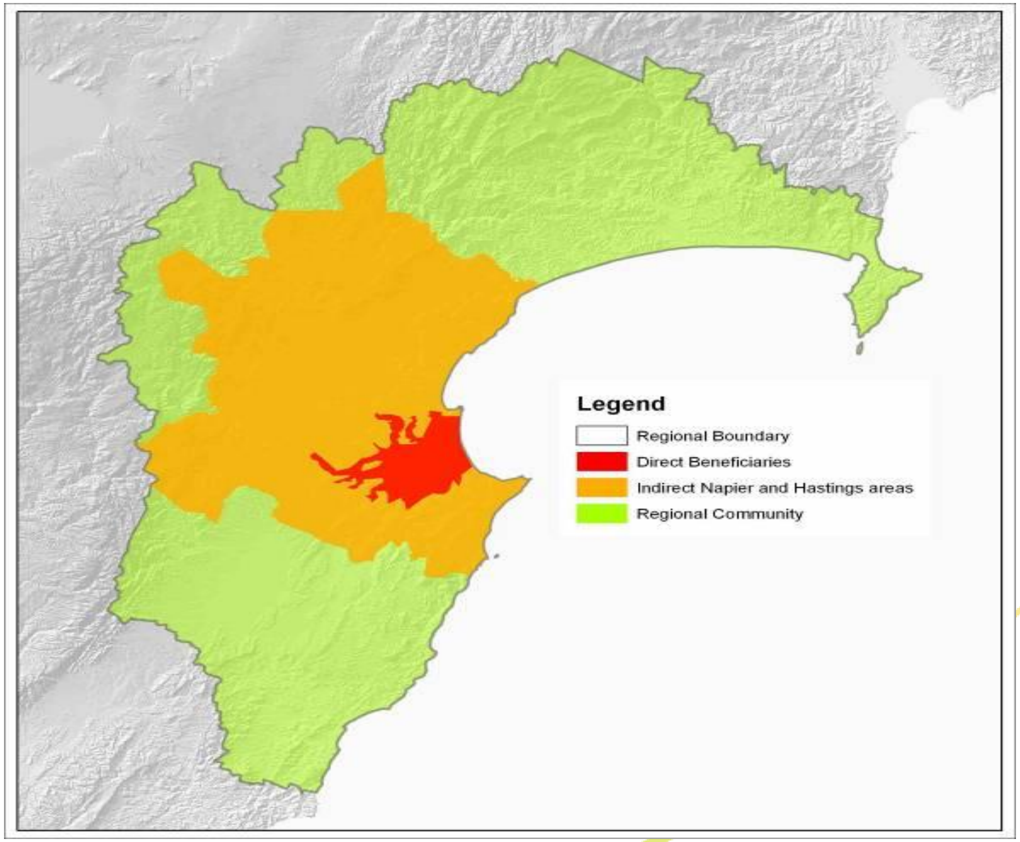
# Who benefits?

138,000 people within the scheme boundary.
This is 86% of Hawke's Bay population.
50,800 households
38,000 ratepayers (including businesses)

*(2006 census)*

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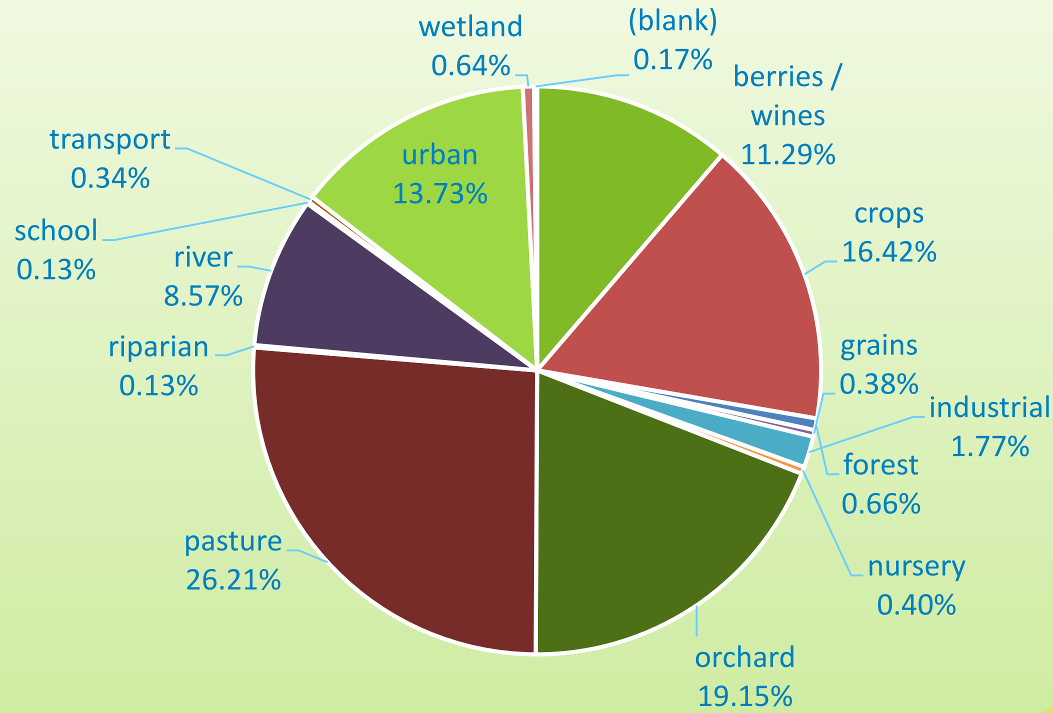
# Land Use

| Land Use | Percentage |
|---|---|
| Pasture | 26.21 |
| Orchard | 19.45 |
| Crops | 16.42 |
| Urban | 13.73 |
| Berry /Grapes | 11.29 |
| Rivers | 8.57 |
| Industrial | 1.77 |
| Riparian | 0.13 |



# Values

Council adopted a multi-value approach for the rural and urban waterways under its ownership.

Flood control and drainage have primacy, and ecology, cultural, landscape, amenity and recreation values are considered equally.

# Karamu drainage

Karamu: 164 km drains (and associated culverts, weirs etc)
Twyford:  46 km  (Total 210 km)
Plus 5 Havelock Streams (HDC management)

Five key issues:

- Land Ownership
- Maintenance access
- Erosion and slumping
- Excessive weed growth
- Drainage issues (grade, water and sediment quality)

***Land Ownership:*** Waterways are largely on private land, require goodwill and co-operation for the scheme to be successful. There are some powers under the Land Drainage Act 1908 to require works to be carried out.

***Maintenance Access:*** essential to enable maintenance (mowing, spraying, excavation). Activities within 6m of the bed (top of bank generally) of a river or artificial watercourse require a resource consent (Discretionary Activity).

***Weed:*** a significant issue resulting from high levels of nutrients, high water temperatures, low base flows, low DO, lack of shading.

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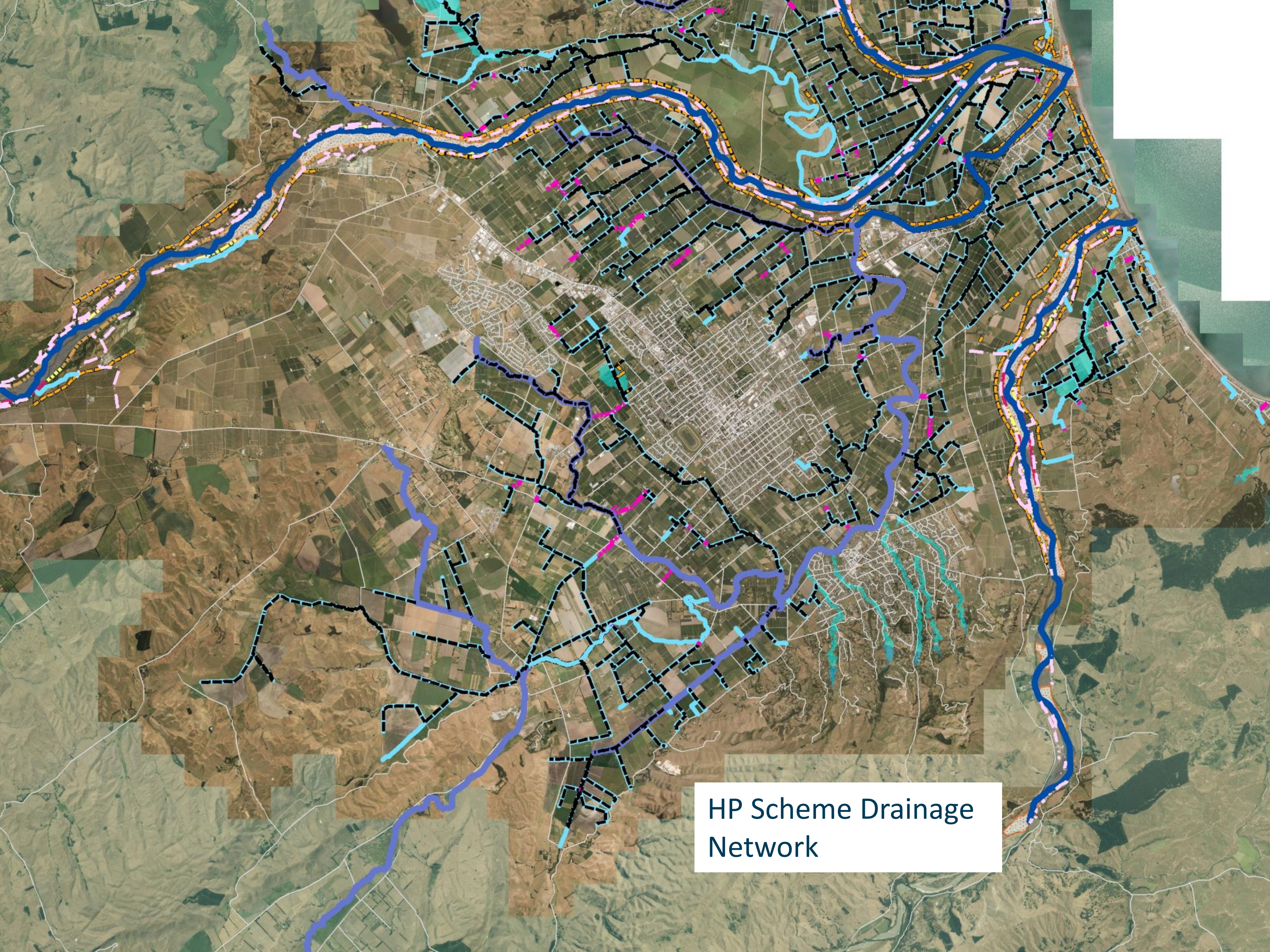
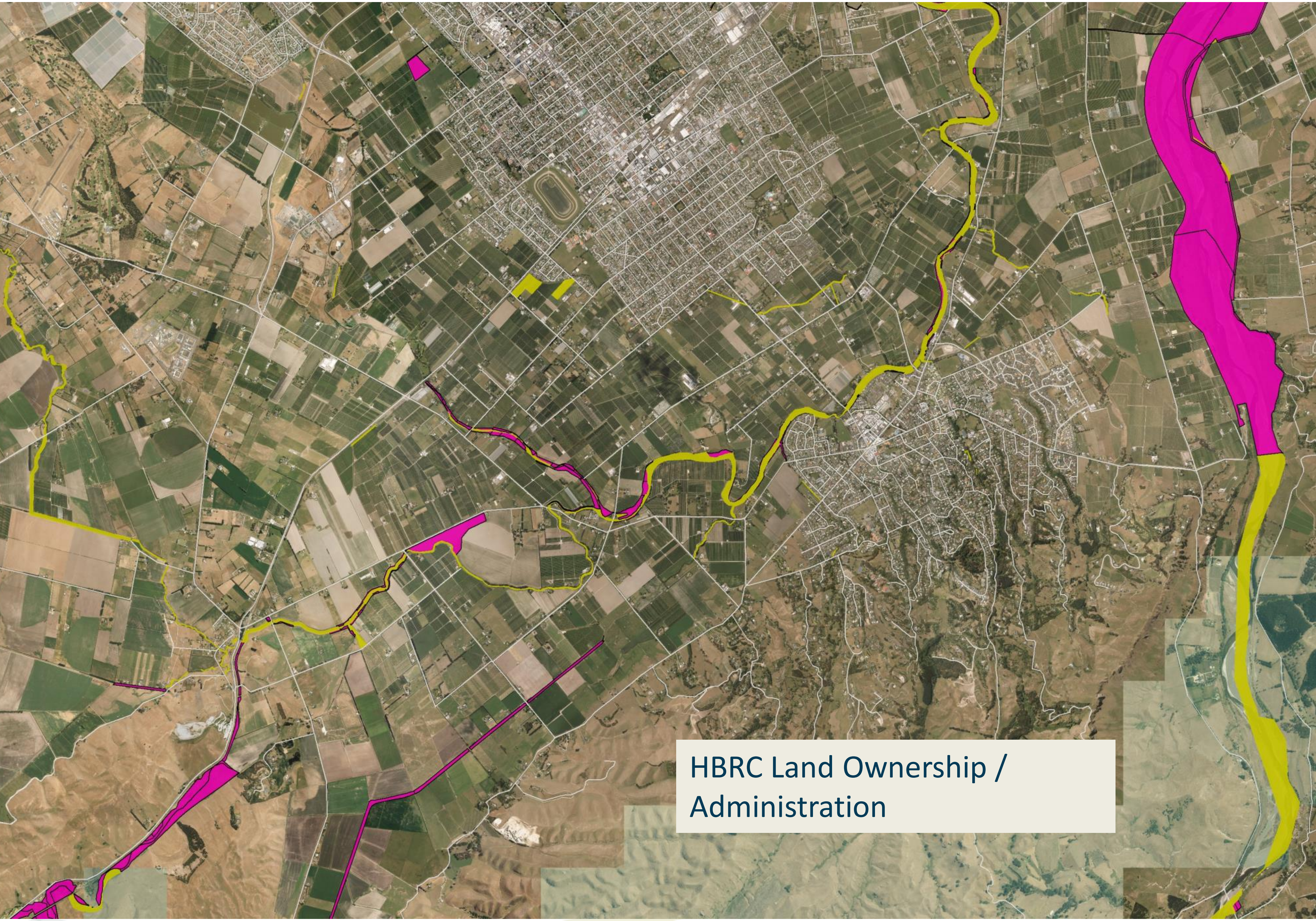

HP Scheme Drainage Network


HBRC Land Ownership /
Administration

# Riparian Management Options and Limitations

Drain conveyance needs to be maintained (or increased for new LOS)

Realign, natural meander, flatten channel banks (rough rule, allow double the existing conveyance if plants replace mown grass.

Shading provided by bank planting with sedges, aquatic plants, bolboschoenus

Mid bank area left open for flood conveyance

No shading v's partial shading. Some loss of conveyance, but is this a bad thing ?

Left: Open drain, typical HP drain, no shade, macrophytes present in bed
Right: Same drain, same location, well shaded, practically no macrophytes in bed

How do we manage these streams for shade?
Issues: bank erosion, barely 6m access, little room to widen and improve conveyance, no shade, landowner may not want shade trees.
Time for a radical re-think of the function of our drainage network

# Karamu Stream Enhancement Project

- Initiated in 2007, this project involves increasing biodiversity through revegetation with predominantly native plant species,
- Engagement with hapu to restore and strengthen cultural values,
- Seek means to improve aquatic ecology by targeting water quality and recognising the wider community issues associated with rural and urban stormwater discharges.
- The project extent covers 30km of the Karamu Stream from Pakipaki to Clive. The enhancement work is based on research done in the '*Te Karamu*' Report (HBRC 2004).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# Heretaunga Modelling to Support TANK Decision Making

Dr Jeff Smith

# Introduction

1. Purpose of modelling presentations:
   a. To introduce the models
   b. Describe capability
   c. Discuss limitations
   d. Demonstrate some applications
   e. Stimulate discussion of scenarios for modelling – to inform decision making

# Introduction

1. Overview of modelling
2. MODFLOW GW flow modelling
    a. Model description and capability
    b. Applications for demonstration
3. Application of GW and SW models
    a. Implications for MALF7d and minimum flows
    b. Ngaruroro @ Fernhill, including Groundwater Recharge Scheme
4. SOURCE SW modelling
    a. Model description and capability
    b. Applications for demonstration

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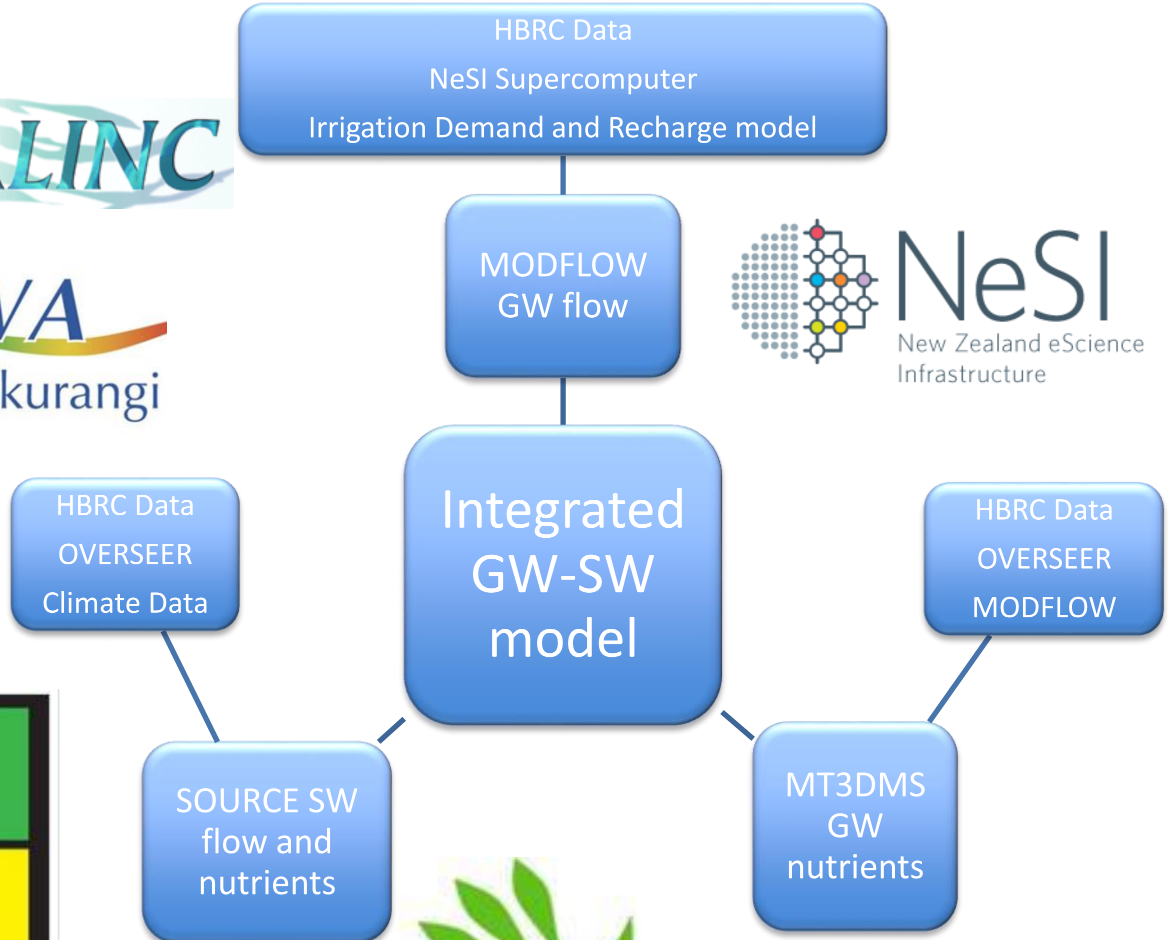
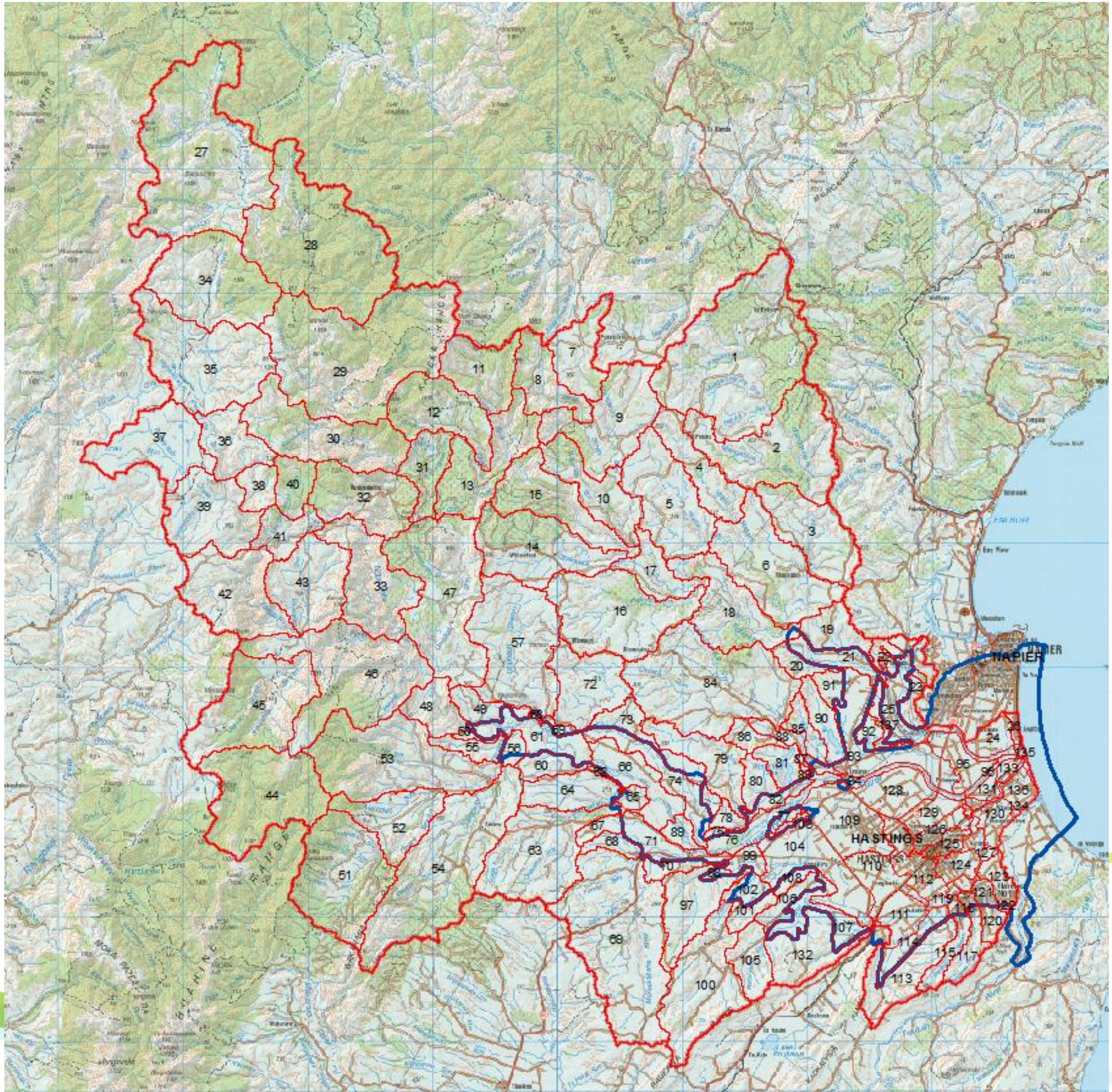
# 1. Overview of modelling



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# Introduction

1. Overview of modelling
2. MODFLOW GW flow modelling
    a. Model description and capability
    b. Applications for demonstration

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GNS SCIENCE TE PŪ AO

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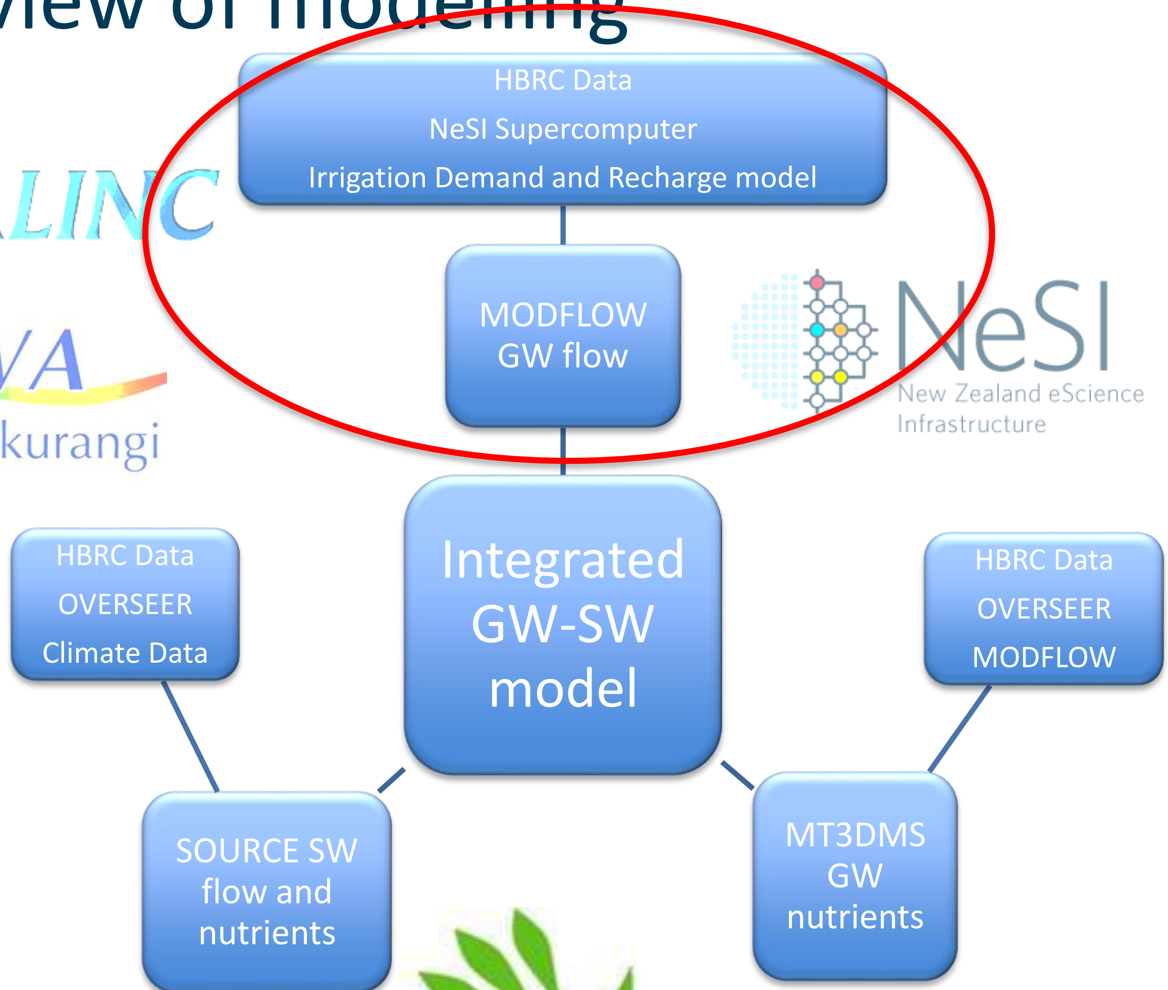
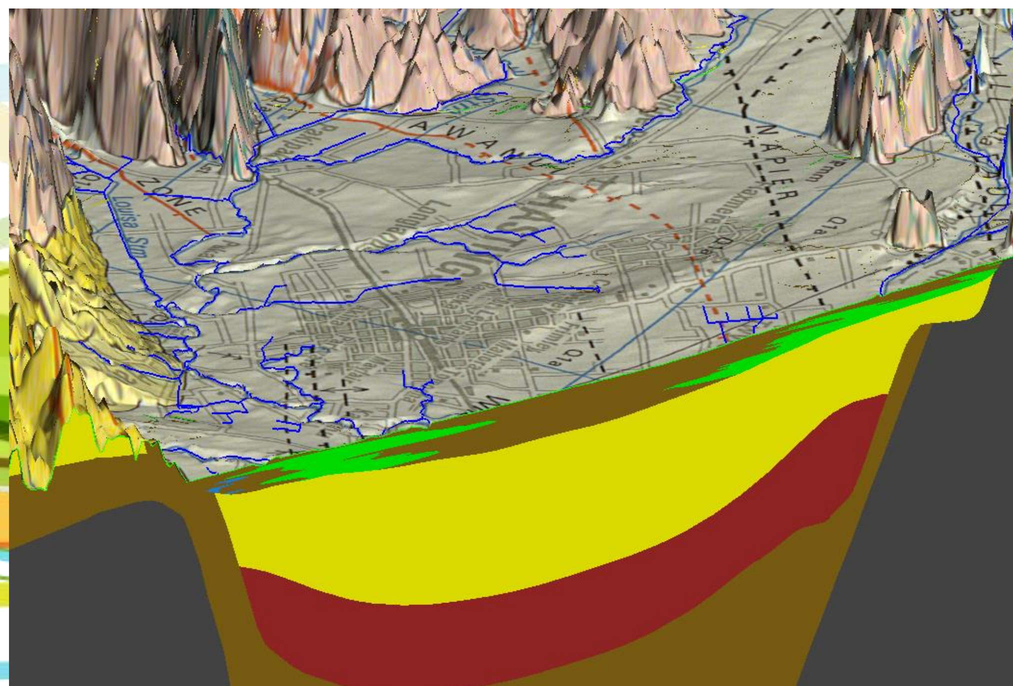
# Overview of modelling



# Heretaunga Aquifer Groundwater Model

Presentation for TANK group 2016-12-13
By Pawel Rakowski

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# Presentation outline

- Heretaunga Plains conceptual model
- Groundwater model setup
- Model calibration
- Preliminary model results
- Modelling capability
- Modelling uncertainty

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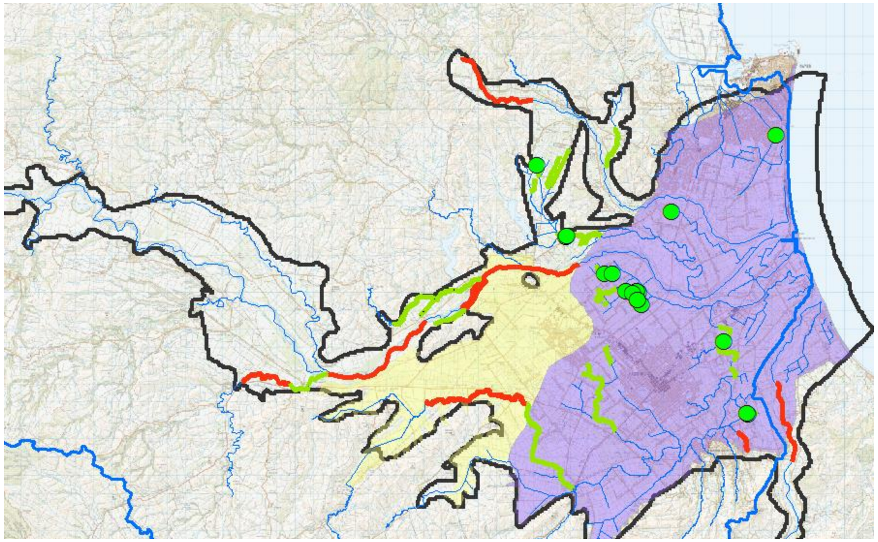
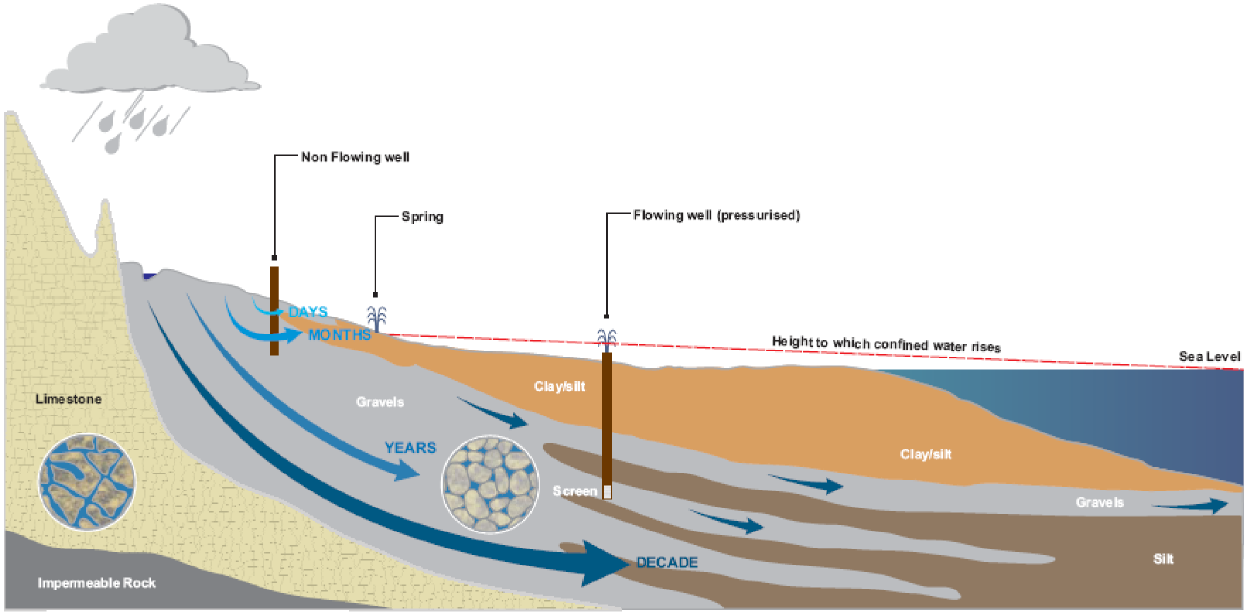
# Heretaunga Plains conceptual model



- Deep sedimentary basin
- Unconfined recharge zone
- Confined, artesian head at the coast
- River recharge
- Spring fed streams
- Estimated pumping 75 mln $m^3$/yr
- Significant irrigation demand

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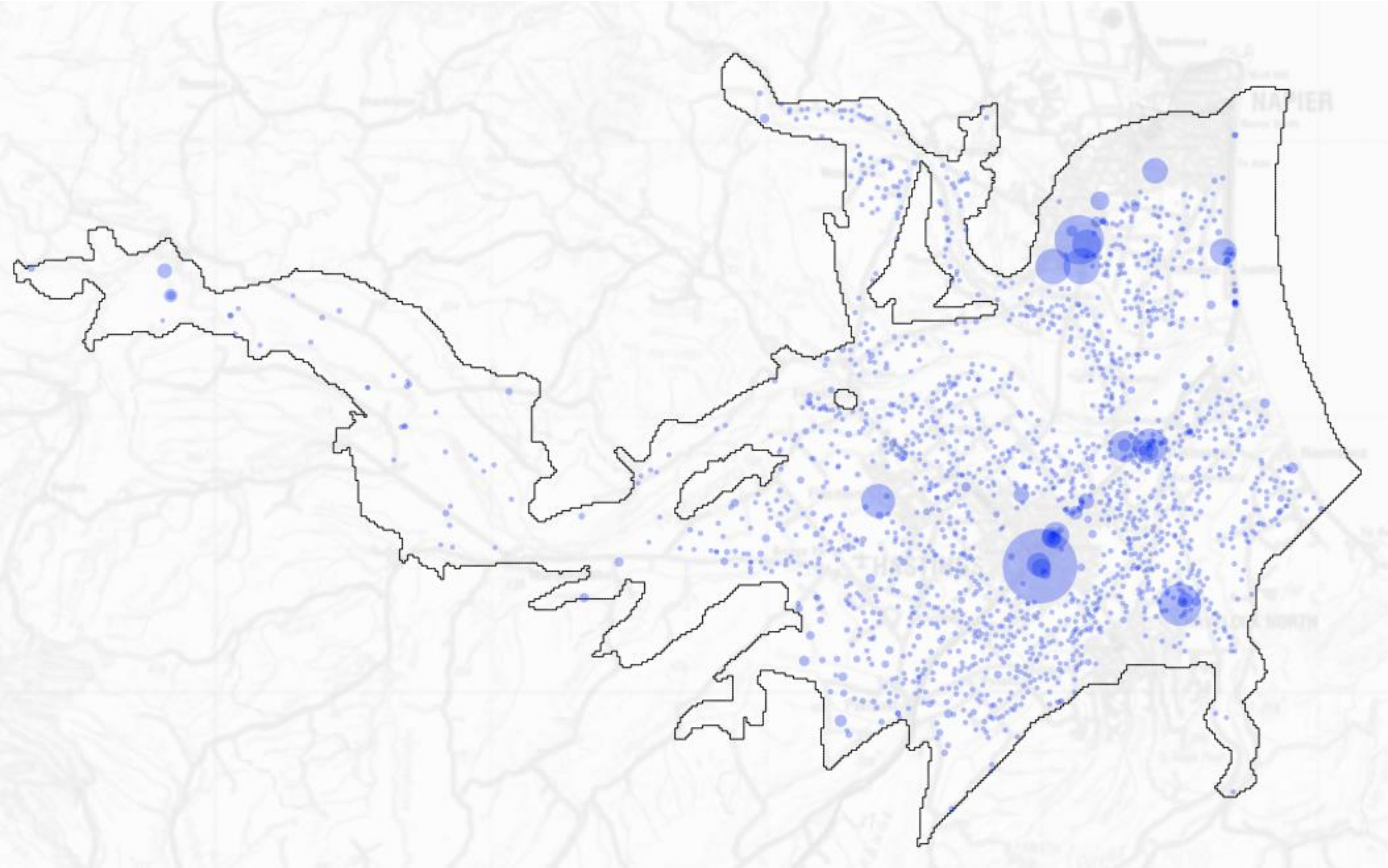
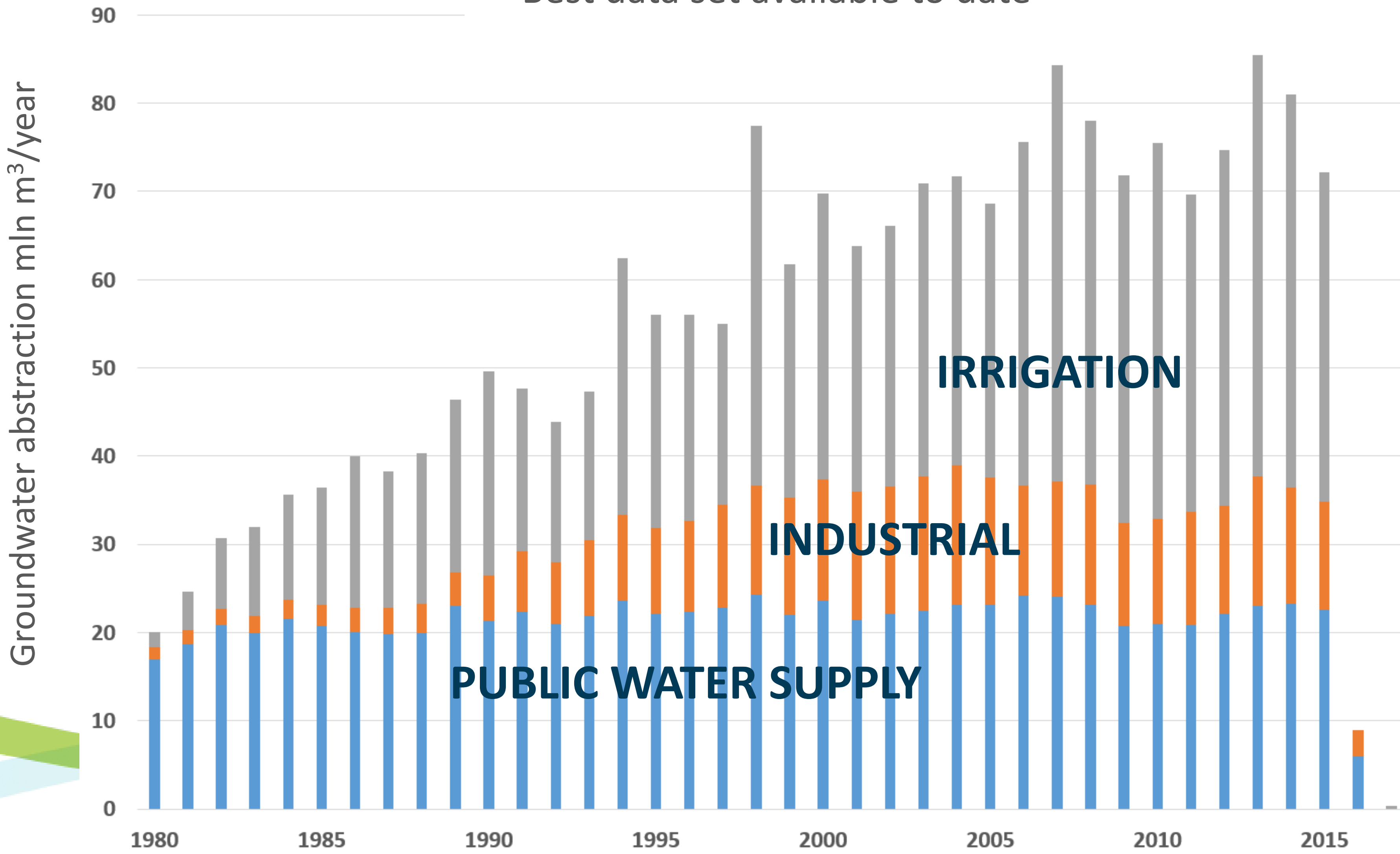
# Groundwater abstraction



# Groundwater Abstraction

Abstraction data:

- Comprehensive review of water use data since 1980
- Historic irrigation not available
- Reliance on water demand modelling for irrigation
- Best data set available to date



# Abstraction vs Allocation

| Type | Number of take points | Abstraction volume mln m3/yr | Allocation volume mln m3/yr |
|---|---|---|---|
| Irrigation | 1542 | 37 | 109 |
| Public water supply | 36 | 22 | 58 |
| Industrial | 117 | 13 | 38 |
| Frost protection | 245 | 1 | |
| permitted | 5323 | 2 | |

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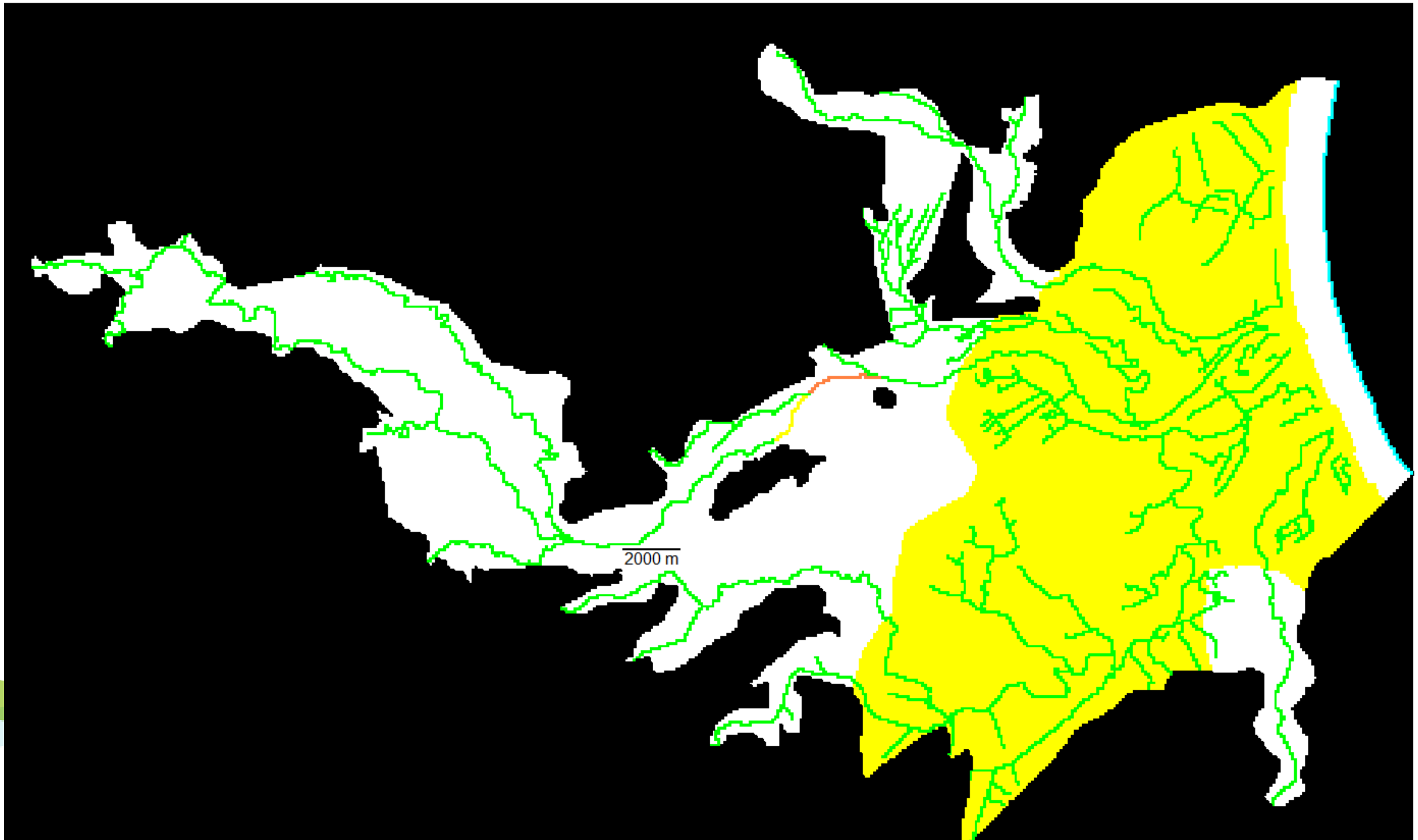
# Model setup

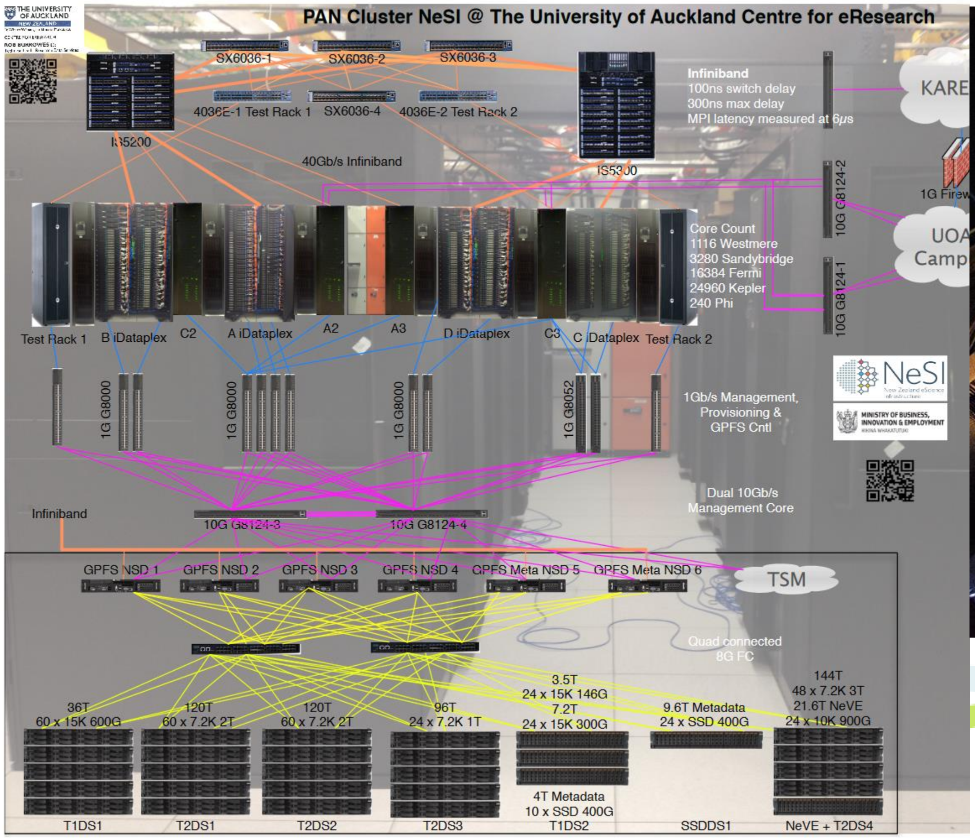
High resolution grid 100x100m
2 layers
MODFLOW
Simulation time: 1980 – 2015, monthly timestep

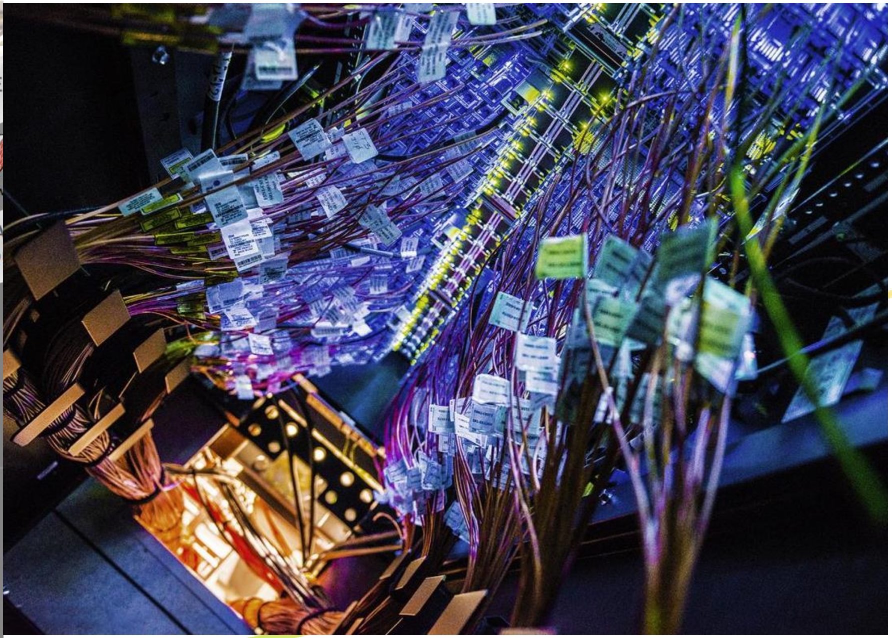



BAY
ICIL

# Model calibration

- Multiple model runs to test how changing individual parameter values affects fit to observation data
- Hundreds of model parameters
- Thousands of observations (Groundwater levels, river gain/loss)
- High computation demand, use of supercomputer
- Used 50000 hours = 6 years of computing on one PC



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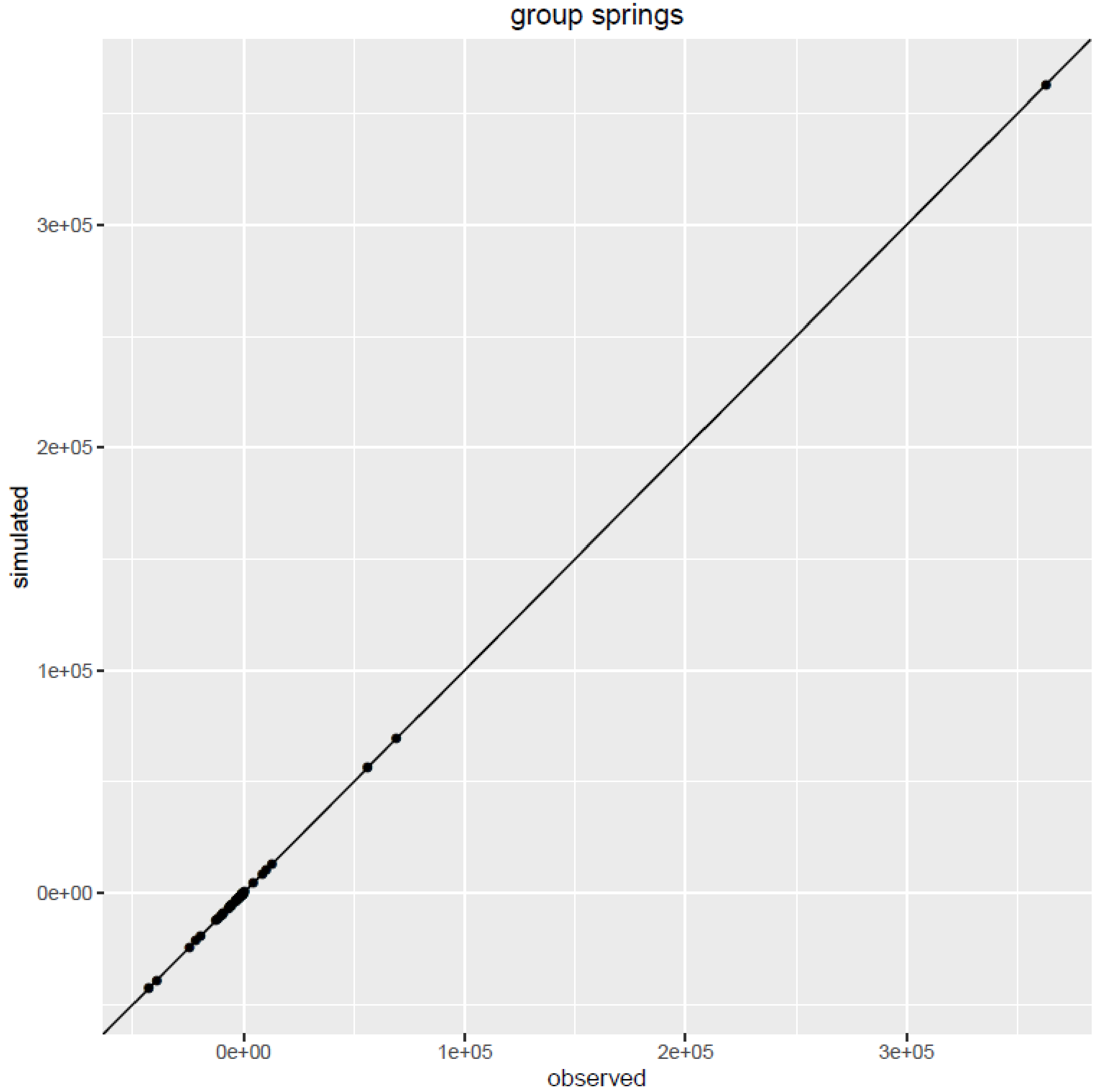
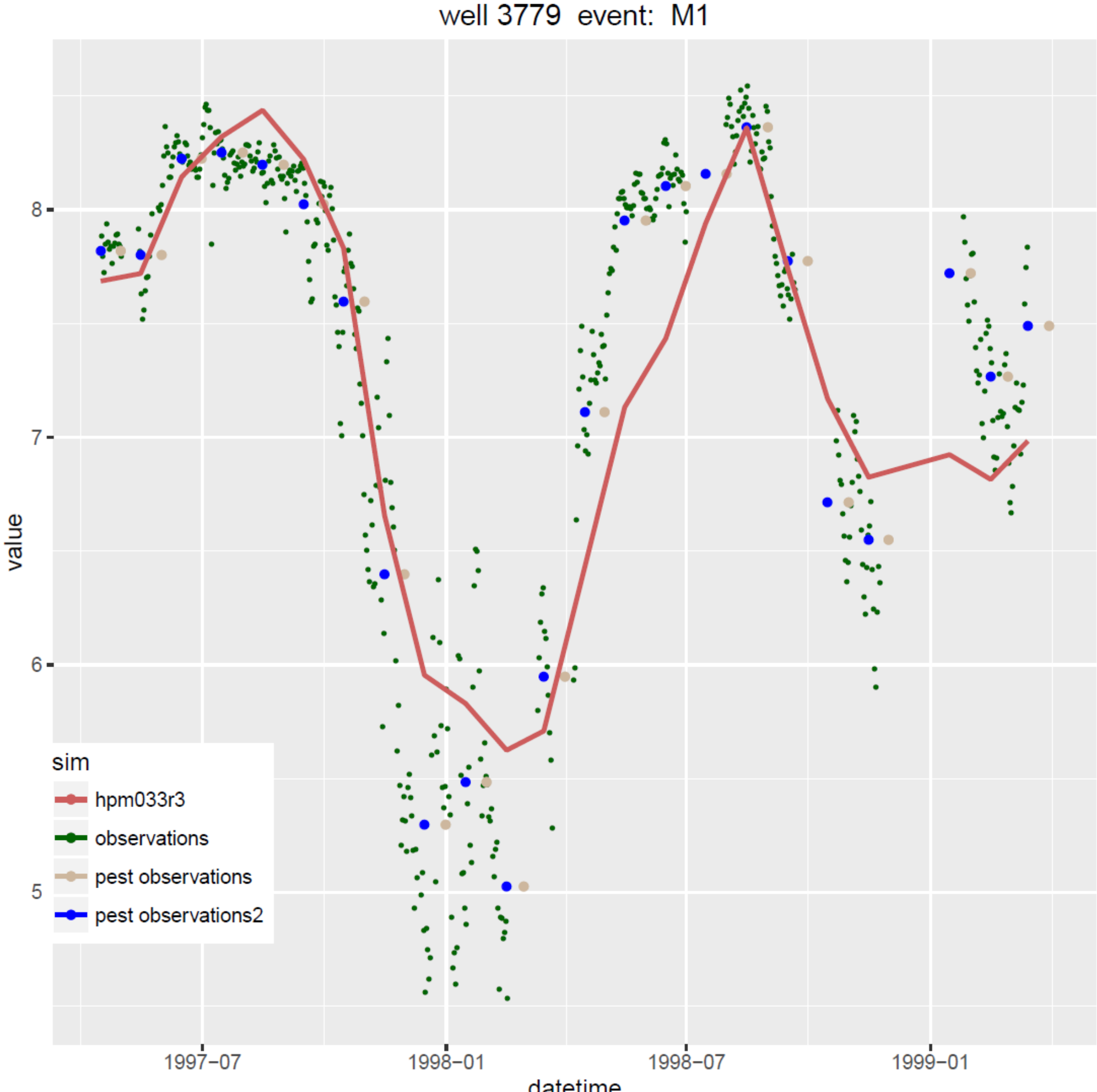
# Calibration outcome



# Calibration outcome

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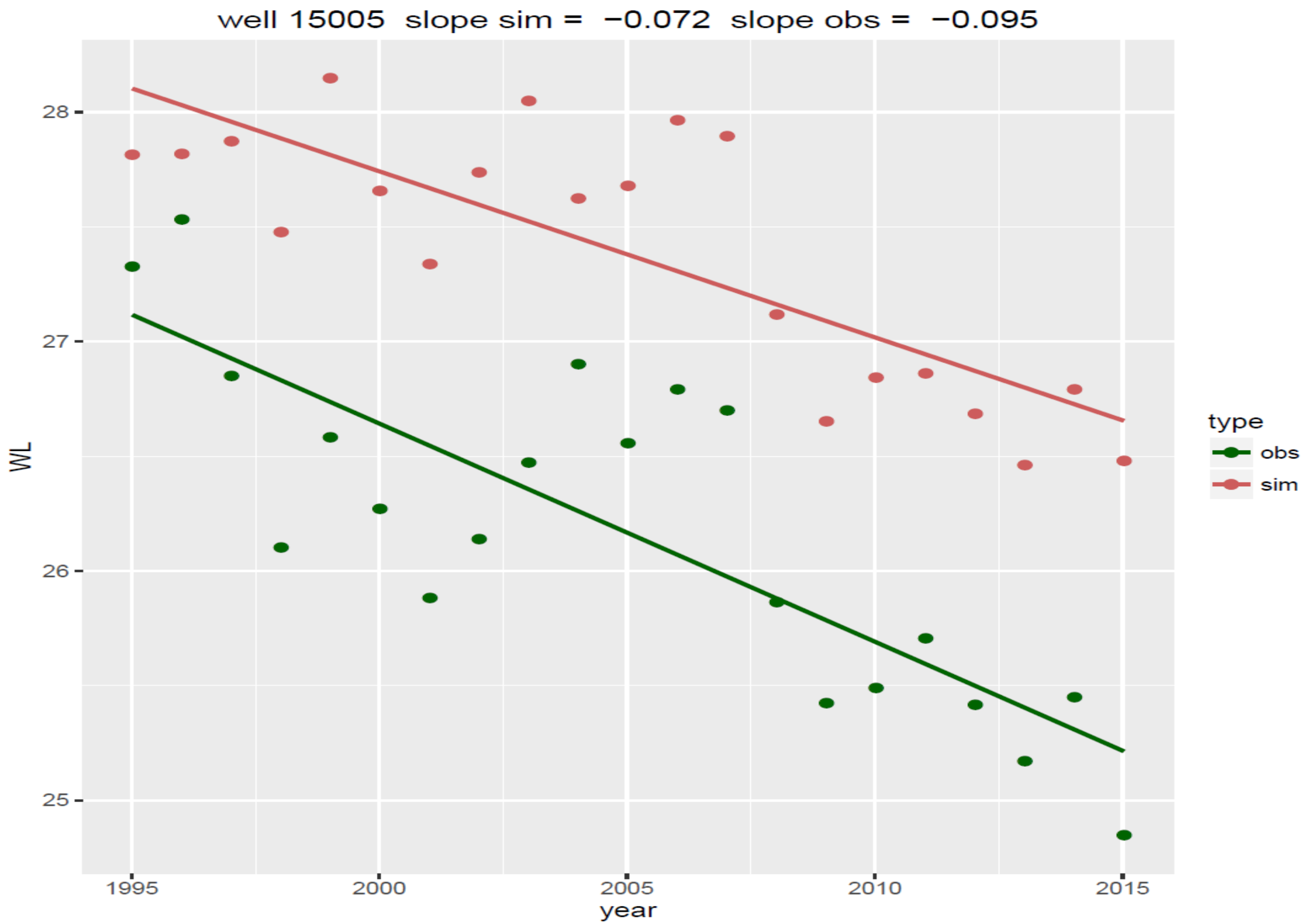
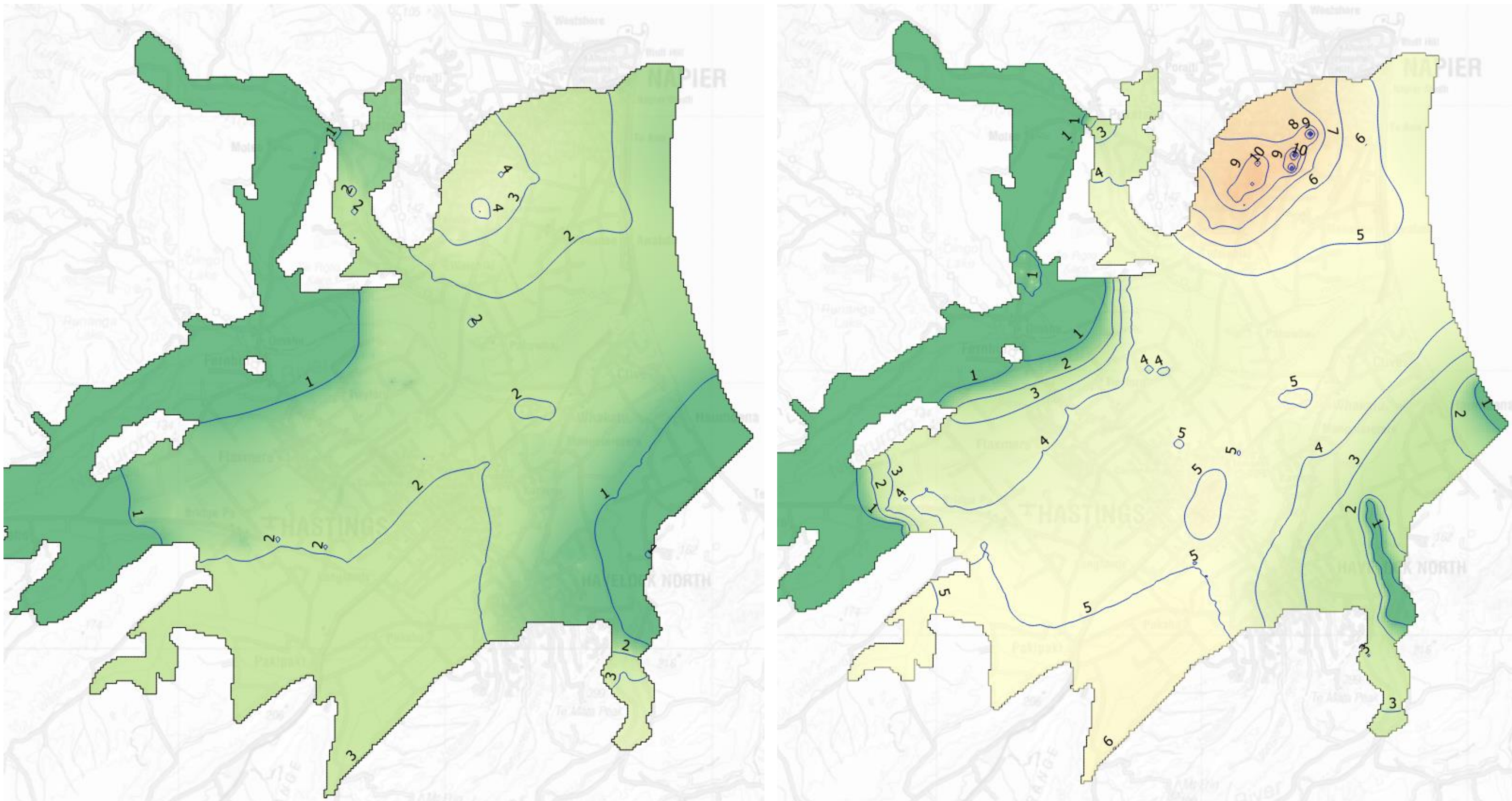
# Calibration outcome



# Model preliminary scenarios
# Aquifer drawdown




Drawdown produced by current (actual) abstractions

Drawdown if maximum allocation was taken

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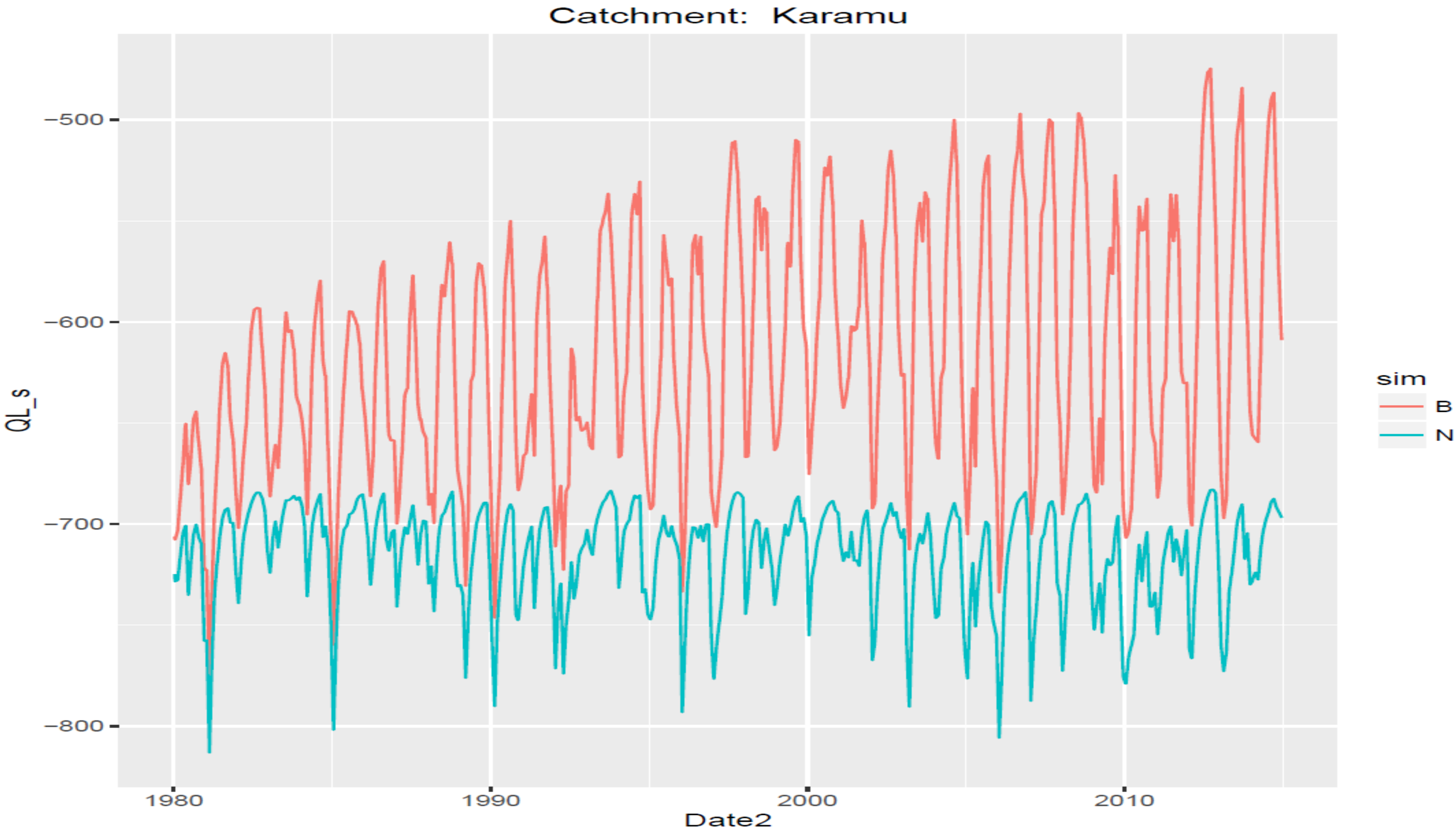
# Model preliminary scenarios
# Stream flow depletion per stream

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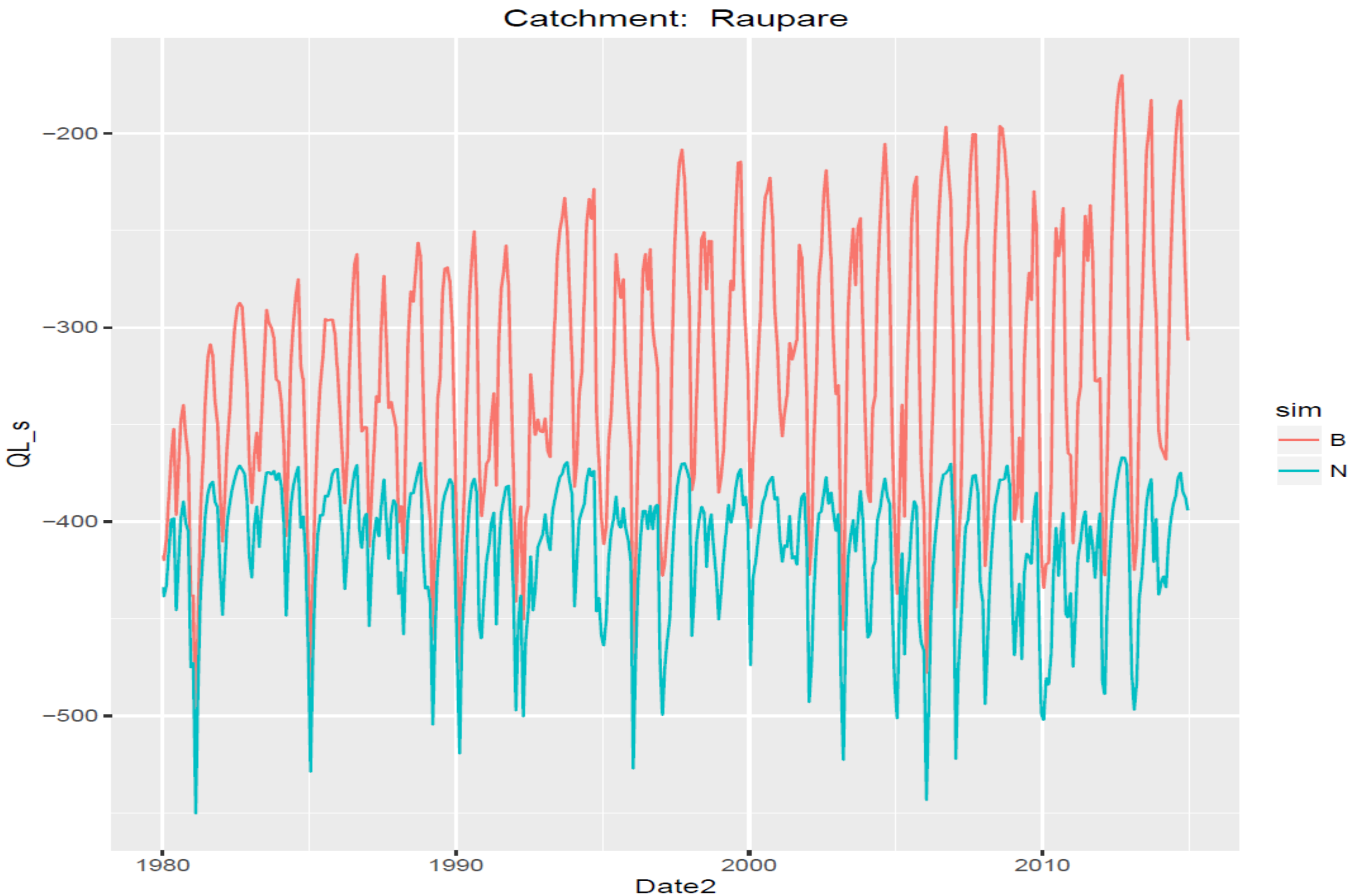
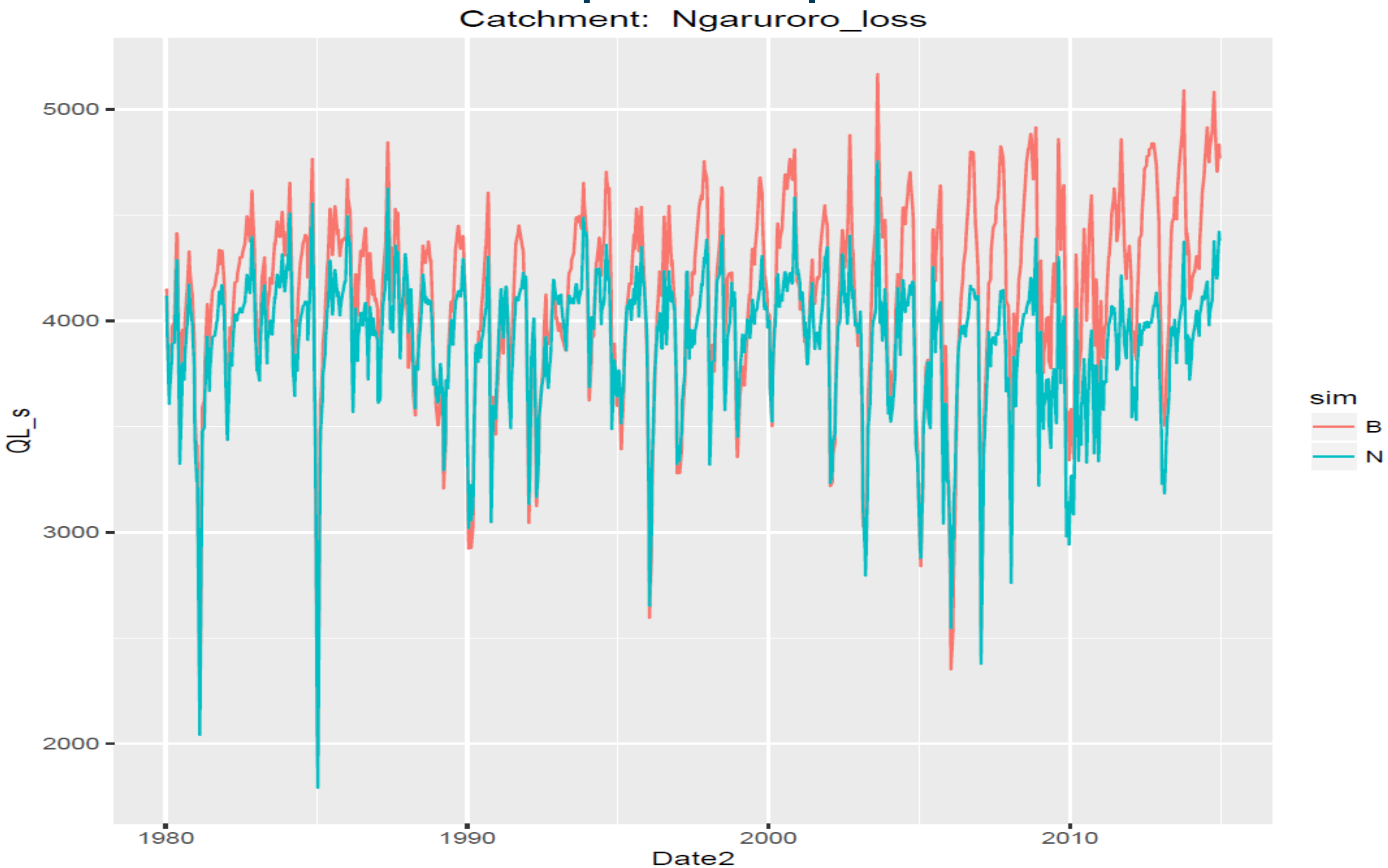
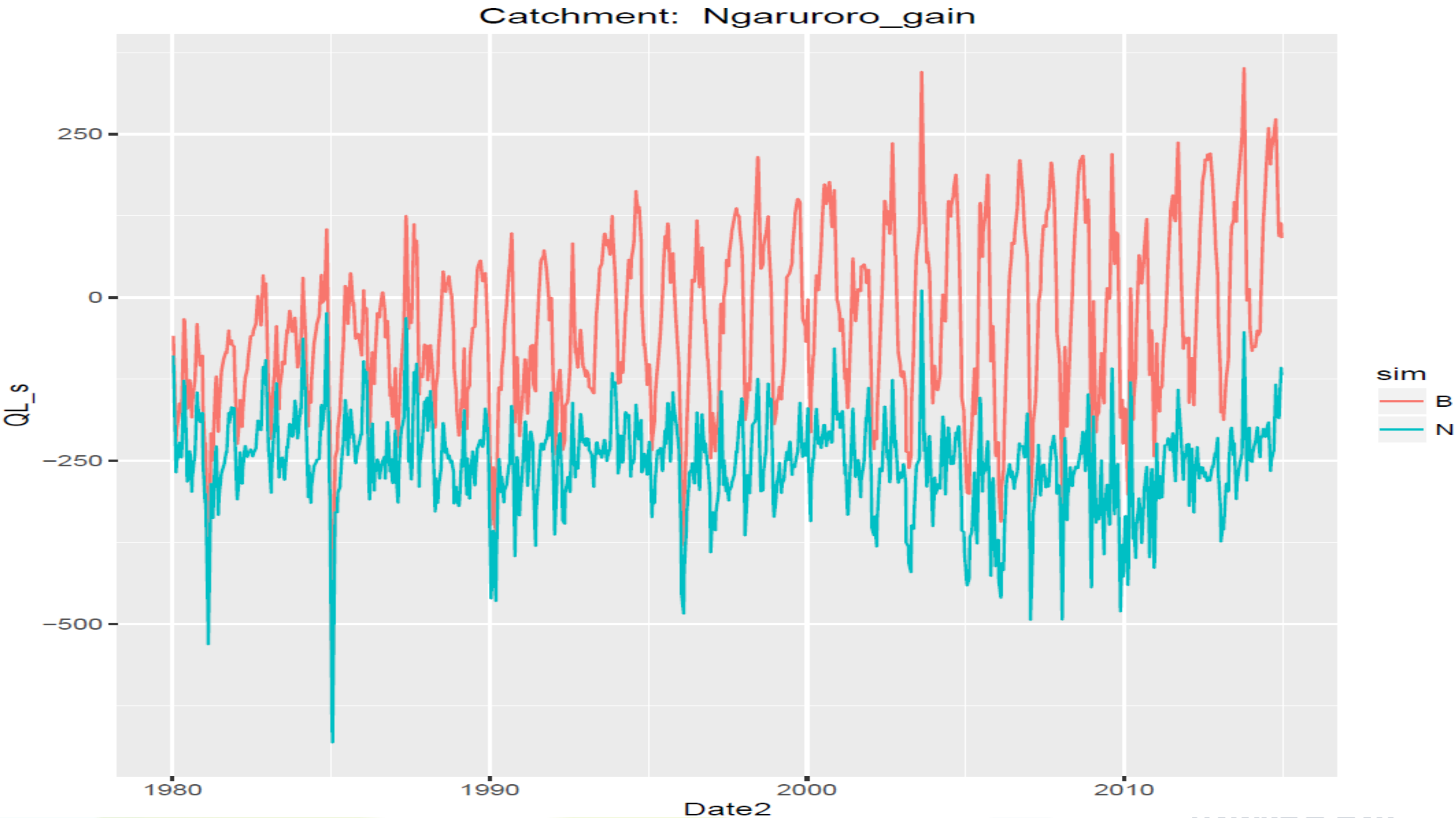
# Model preliminary scenarios
# Stream flow depletion per stream



# Model preliminary scenarios
# Stream flow depletion per stream



# Model preliminary scenarios
# Stream flow depletion per stream



# Model preliminary scenarios water budget change

| | RIVER LEAKAGE | GROUNDWATER PUMPING | RAINFALL RECHARGE |
|---|---|---|---|
| Naturalised - no pumping | 25 | | **79** |
| Current level of pumping | **92** | -85 | **79** |
| Full allocation pumping | **188** | -203 | **79** |

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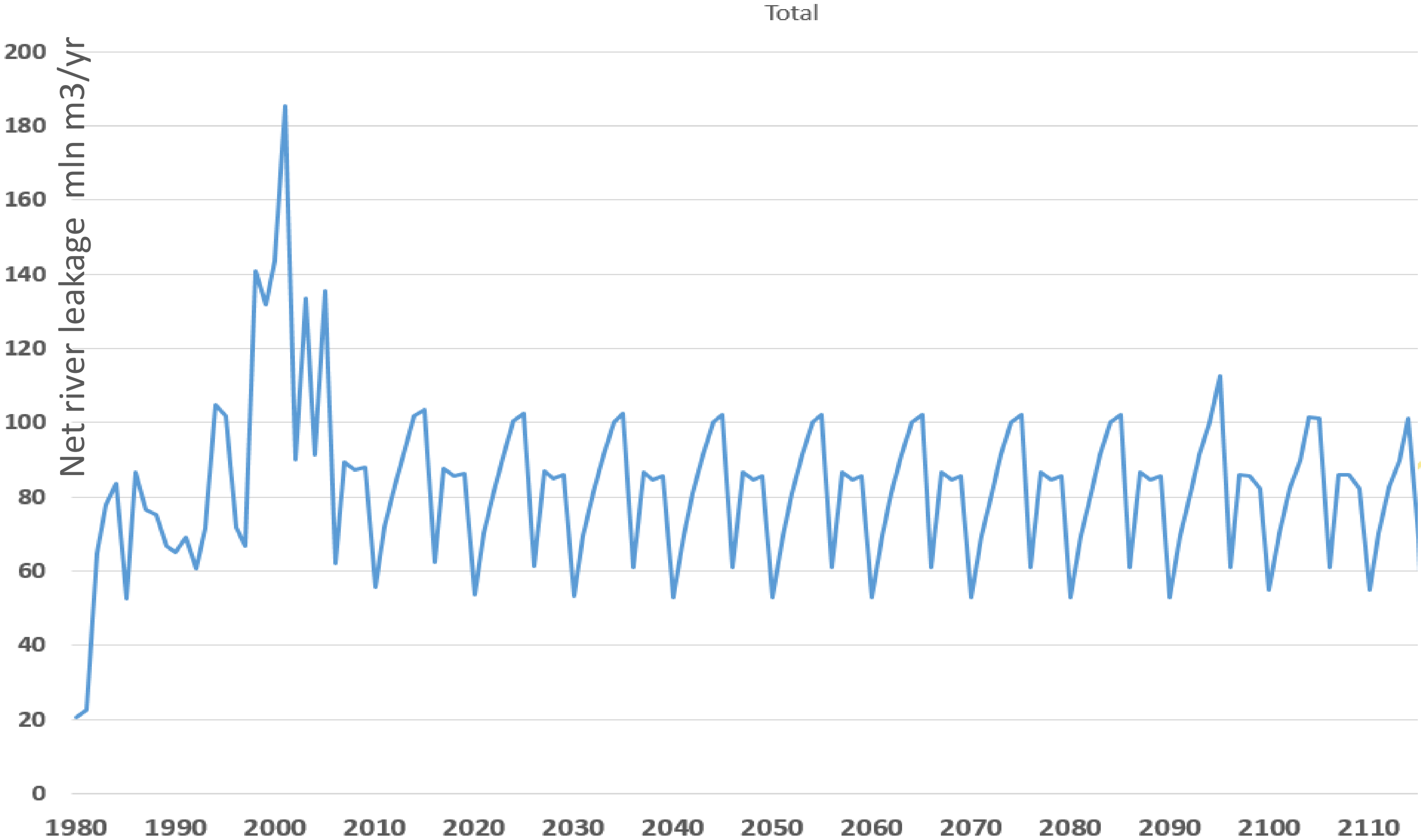
# Model preliminary scenarios

## long term aquifer response to current 2005-2015 pumping continued for 100 years



# Model capability

| scenario type | setup complexity | |
|---|---|---|
| Stream depletion zones | complex setup | |
| Impacts of abstraction strategies | easy to moderate, depending on detail (e.g. ban rules) | |
| Security of supply for different strategies | moderate to complex, required coordination with Source | |
| Establishing allocation limit | iterative setup, complex | |
| Verification of how effective are abstraction restrictions in stream flow recovery | easy to moderate | |
| Simulation of managed aquifer recharge | easy to moderate | |

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# Model limitations and uncertainties

- Actual water use
- Climate uncertainty
- Vertical resolution of the model
- Limited local scale detail

# Introduction

1. Overview of modelling
2. Climate change analysis
3. MODFLOW GW flow modelling
   a. Model description and capability
   b. Applications for demonstration
4. Application of GW and SW models
   a. Implications for MALF7d and minimum flows
   b. Ngaruroro @ Fernhill, including Groundwater Recharge Scheme

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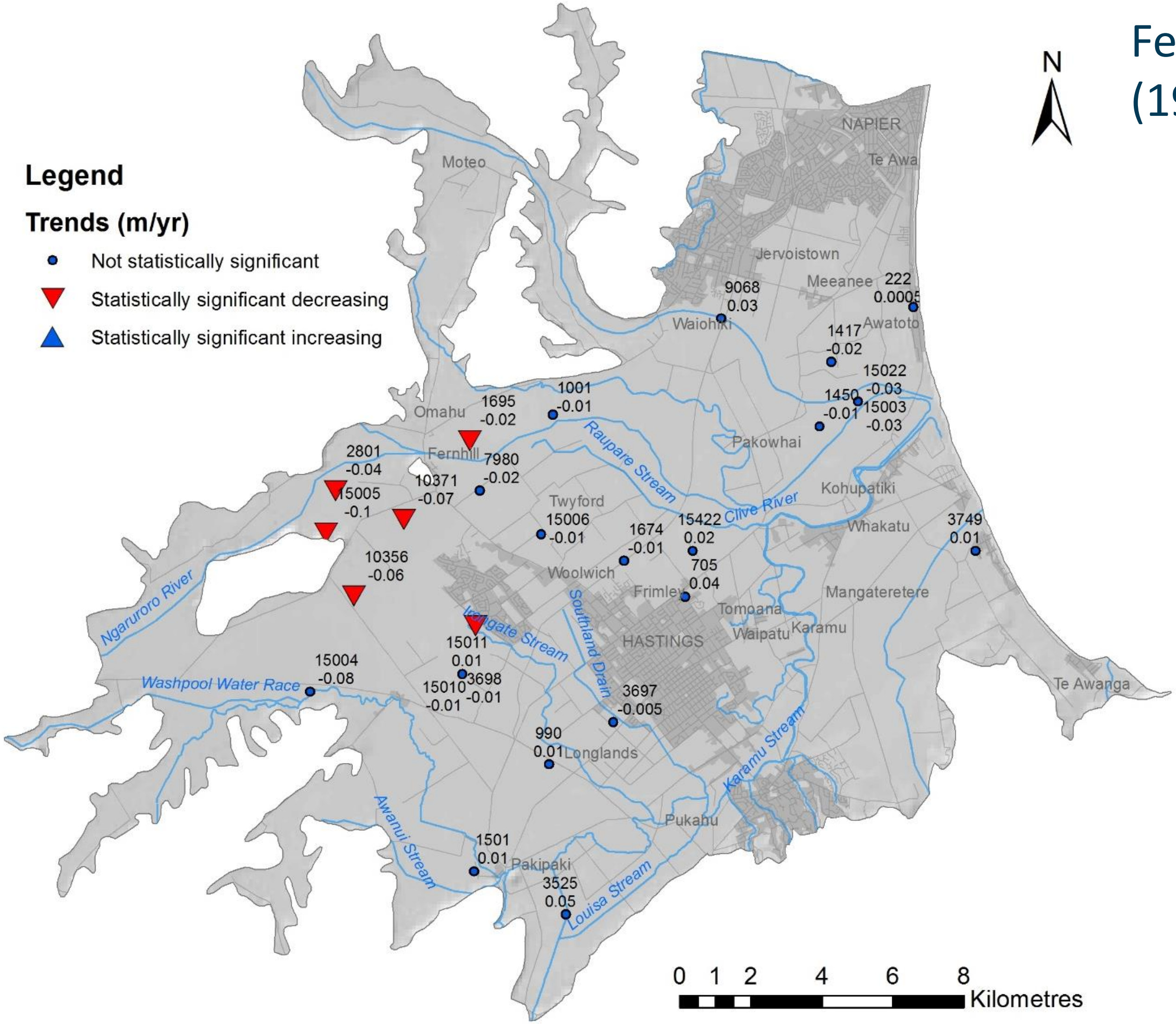
# 4. Model application – MALF7d Ngaruroro @ Fernhill

February trend detection (1994-2014)

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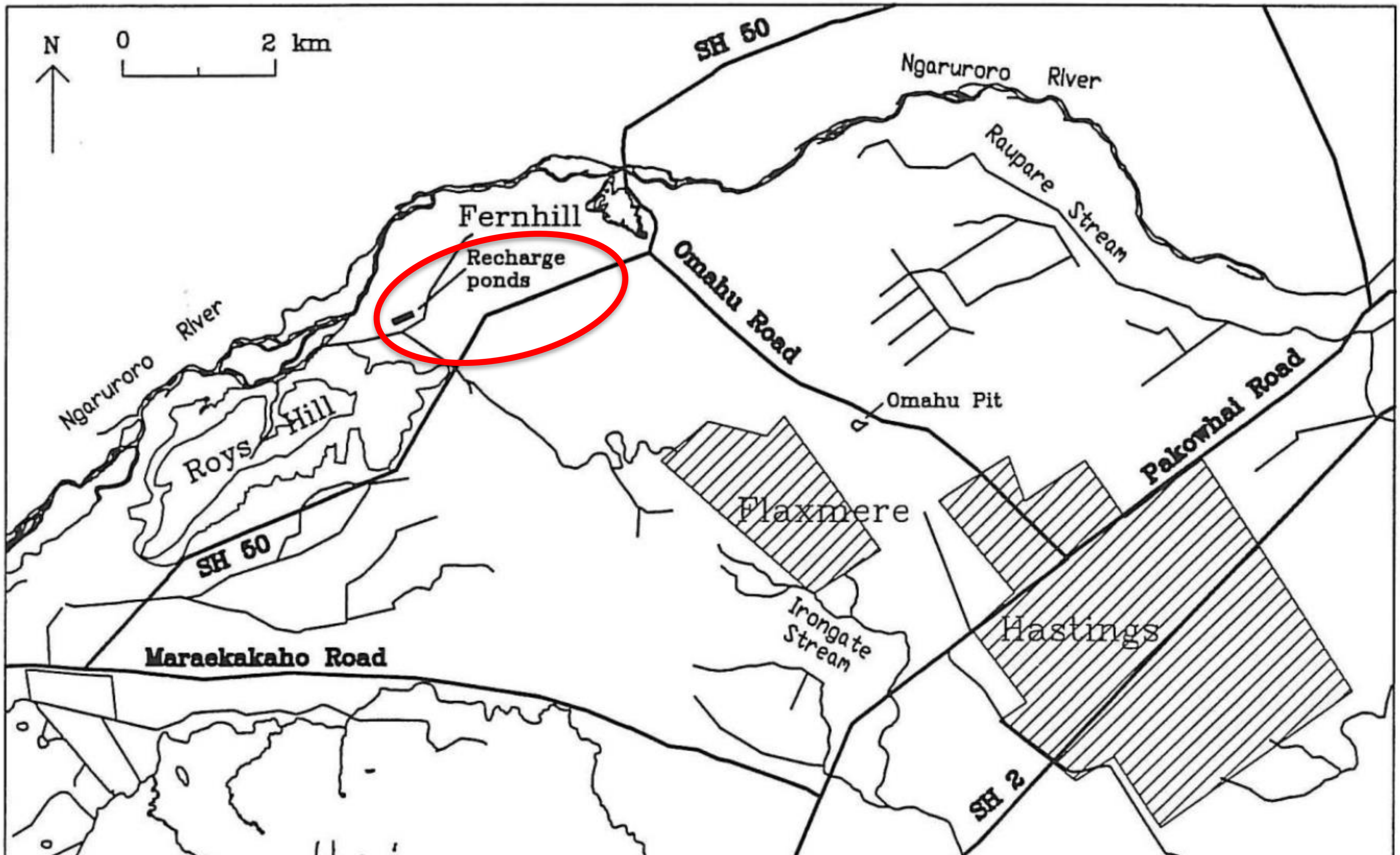
# 4. Artificial Recharge (AR) Scheme



# 4. Recharge Scheme

## Trials commenced 1982

Max take 8500 L/s, Min flow 2800 L/s

## Scheme commissioned 1988

Take 3000 L/s when flow > 3500 L/s

850 L/s @ flow 2800 L/s

## 1995 – consent renewal

Collection channel used because of siltation

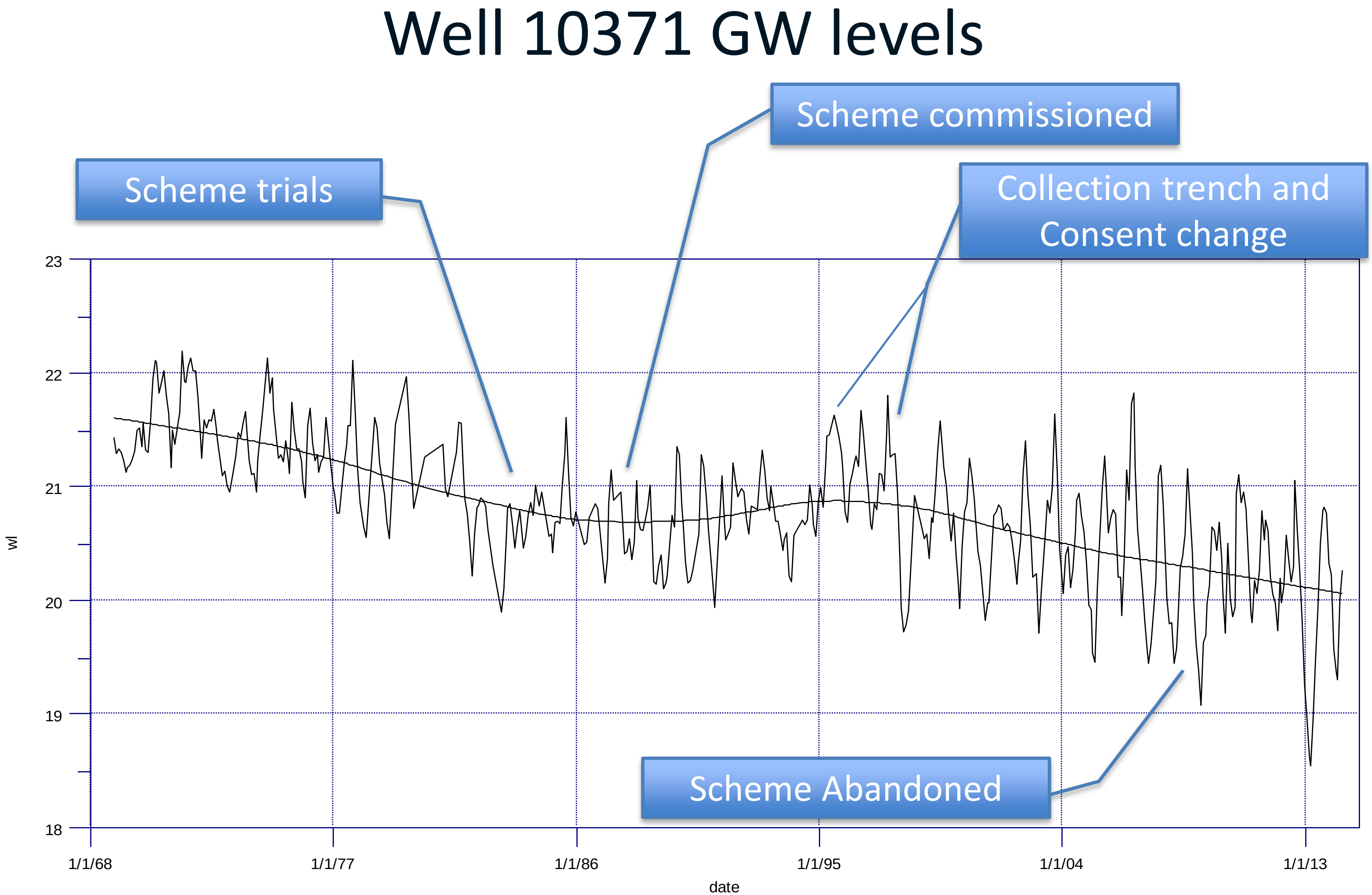
600 L/s for recharge, min flow 2800 L/s

Actual take ~400 L/s

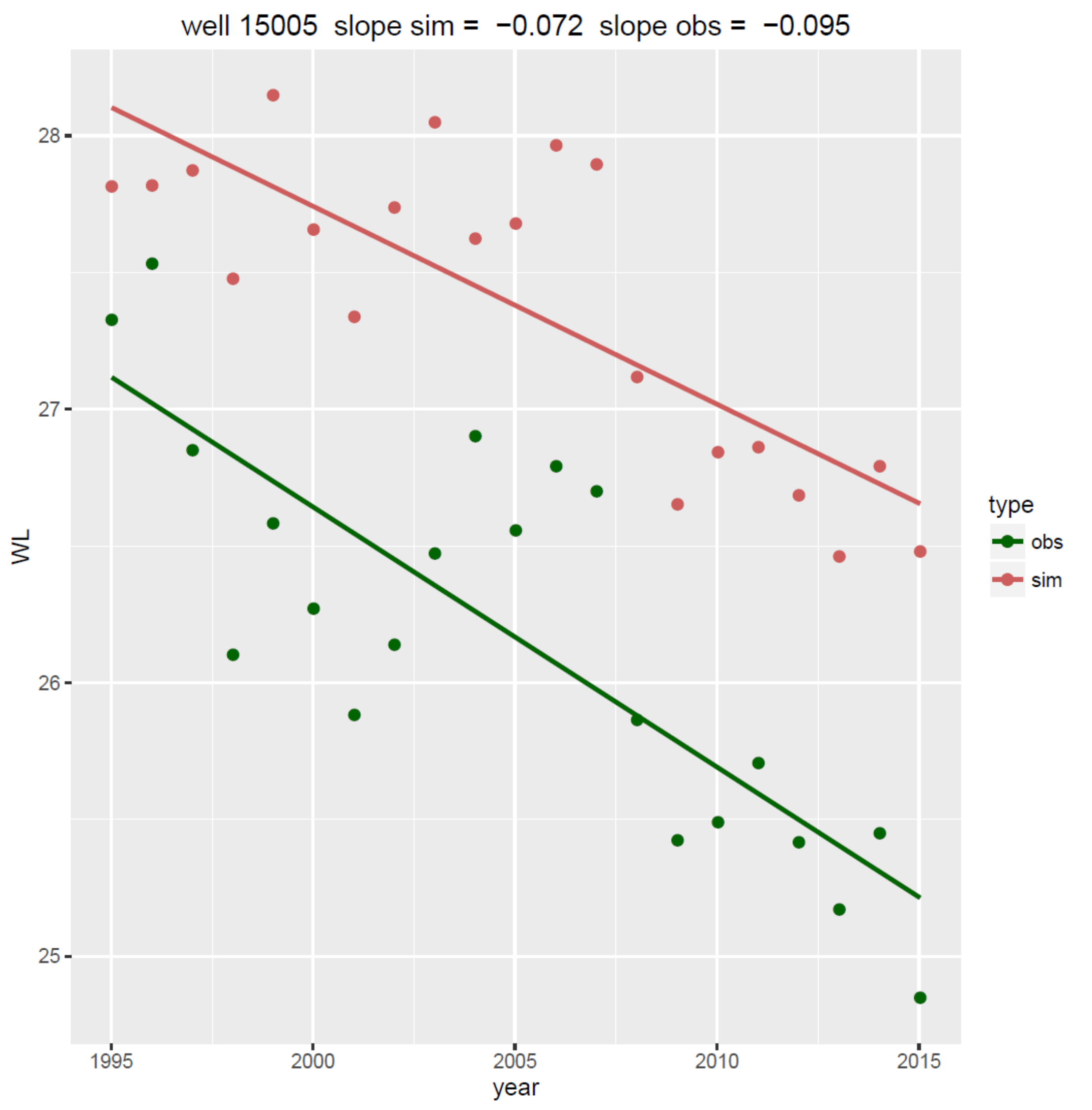
## 1997 – min flow increased to 5000 L/s

## 2008 – scheme ceased

# 4. Recharge Scheme



# 4. Model calibration – with AR data

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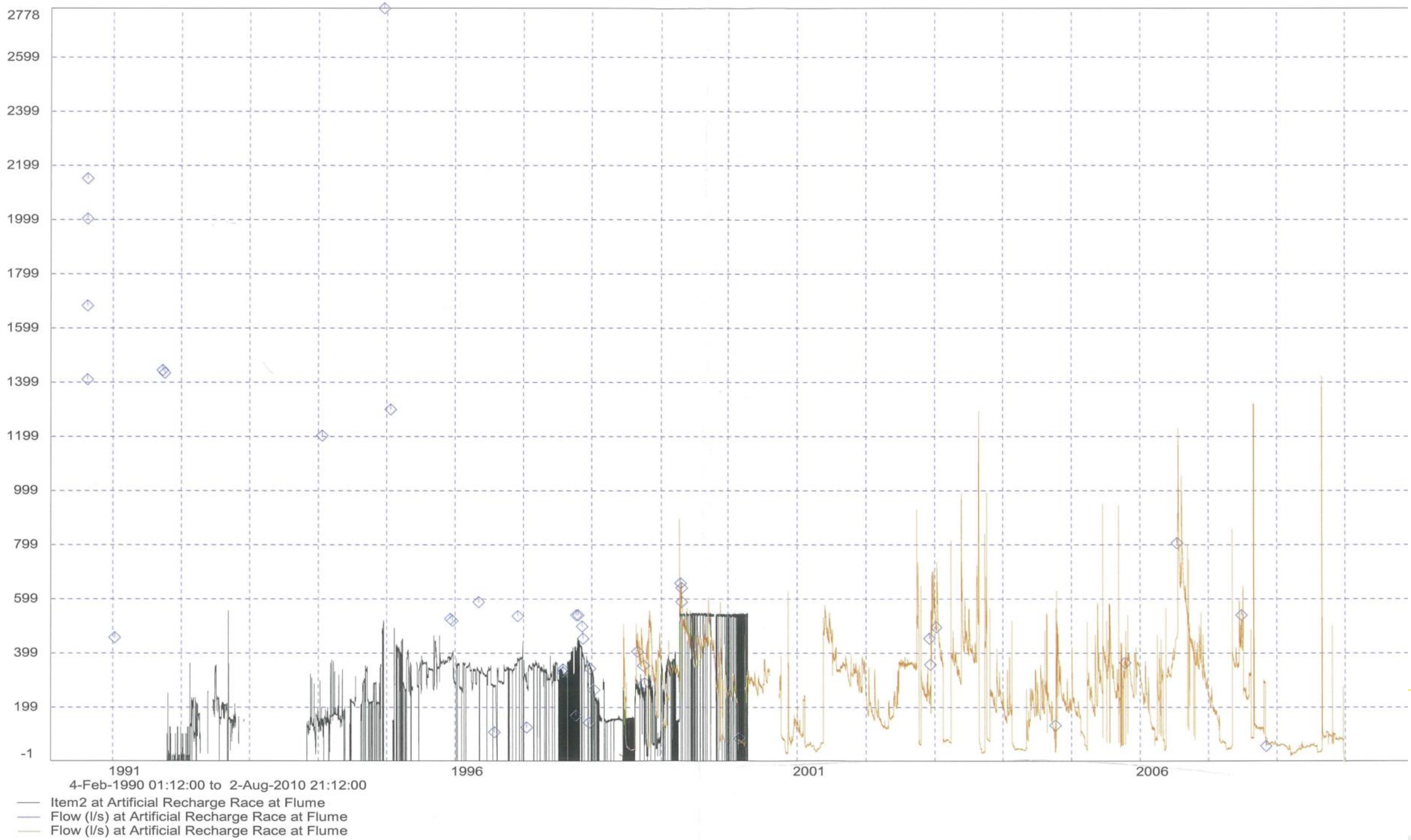
# 4. AR Scheme abstraction data



# 4. Implications for MALF

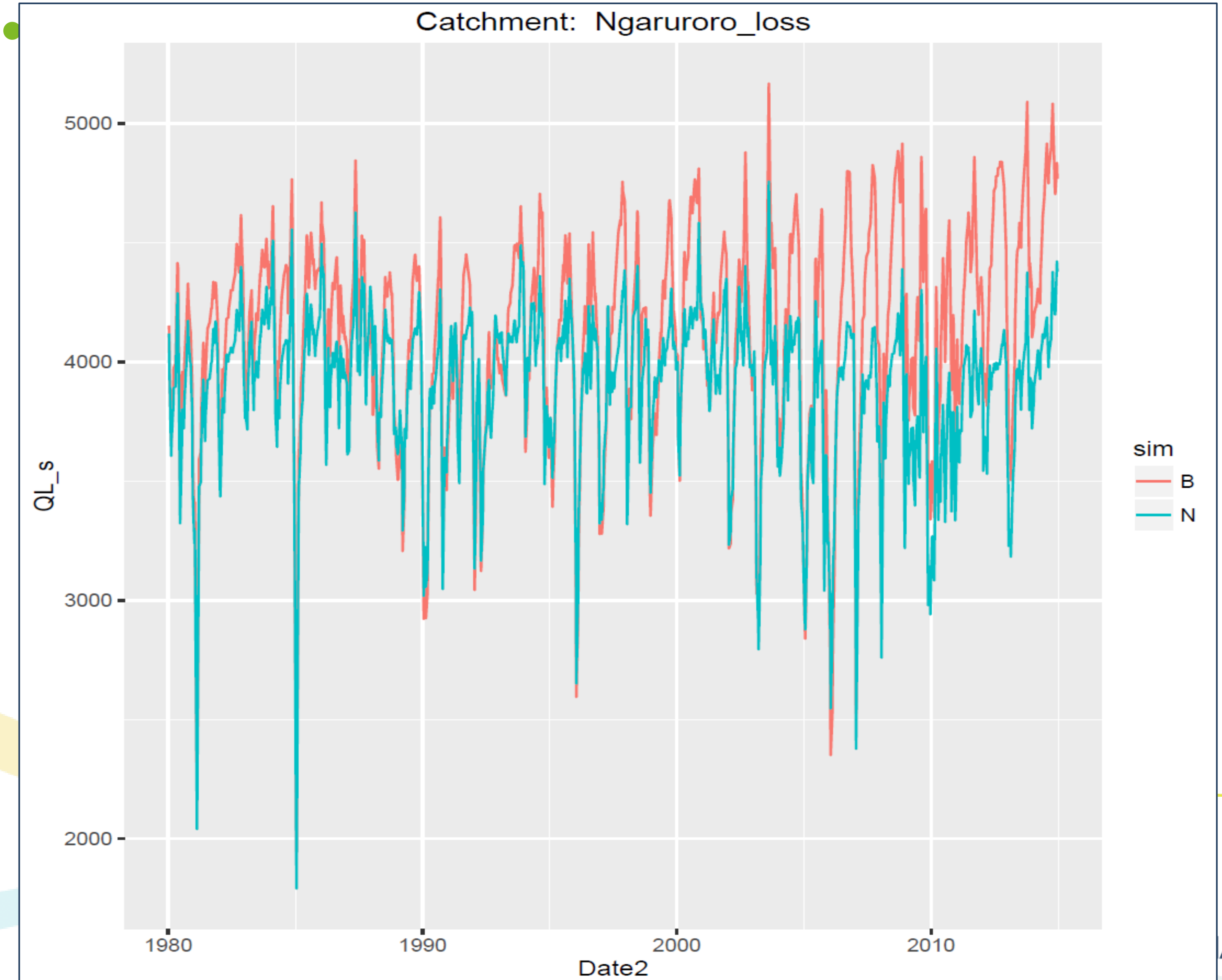
- HBRC IFIM report (Johnson 2011)
  - MALF(7d) **4500 L/s** (1969 – 2008)
  - Includes "worst case" AR abstraction (pre-1998)
  - **Min flow 4200 L/s** based on 90% habitat at MALF for torrent fish

# 4. Implications for MALF

- Recalculated flow statistics and suggested minimum flow
  - Naturalised flows from **1998 – 2015**
  - Calculate MALF(7d) for **1998 – 2015**
  - Reconsider minimum flow based on IFIM

# Naturalising – effects of groundwater abstraction

# Naturalising – effects of groundwater abstraction

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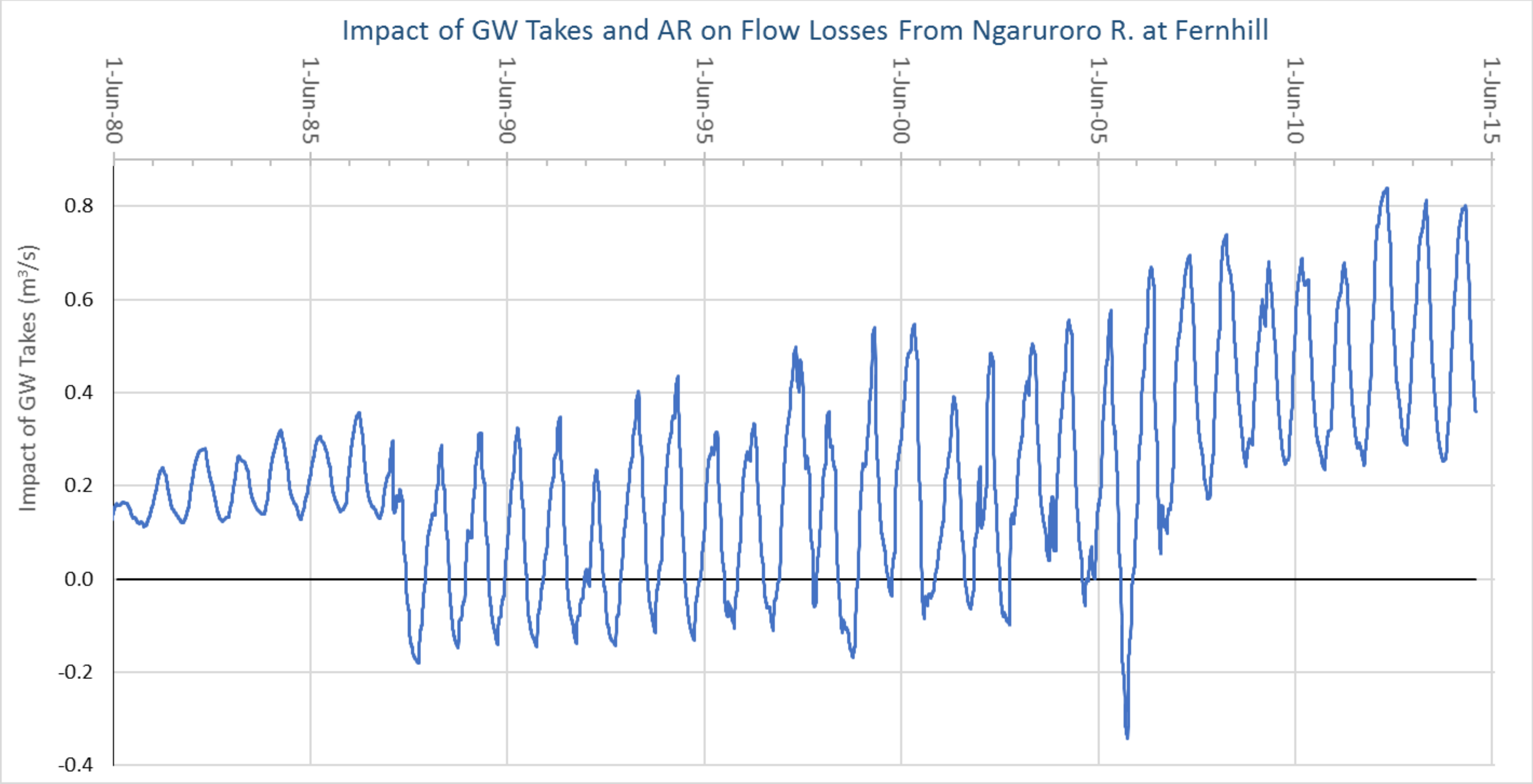
# Naturalising – effects of groundwater abstraction

- Preliminary results:
  - Modelling the effect of groundwater takes on Ngaruroro River at Fernhill



# 4. Implications for MALF

- Flow statistics and minimum flows
  - HBRC IFIM report (Johnson 2011)
    - MALF(7d) 4500 L/s (1969 – 2008)
    - Includes “worst case” AR abstraction (pre-1998)
    - **Min flow 4200 L/s** based on 90% habitat at MALF for torrent fish

**PROVISIONAL:**

- 1998-2015 MALF(7d) = 4180 L/s
- 90% habitat for torrentfish = **3,860 L/s**

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# 4. Summary

1. Recharge scheme operated 1980s to 2008
2. Abstraction data from 1998-2008
3. Prior to 1998 = guesswork
4. Flow statistics have been revisited
5. Provisional estimates:
   i. MALF(7d) = 4,180 L/s
   ii. Flow at 90% of WUA at MALF(7d) = 3,860 L/s
6. Other implications for TANK plan change including:
   i. Reliability of supply
   ii. Economic assessment

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# Introduction

1. Overview of modelling
2. MODFLOW GW flow modelling
3. Application of GW and SW models
   a. Implications for MALF7d and minimum flows
   b. Ngaruroro @ Fernhill, including Groundwater Recharge Scheme
4. SOURCE SW modelling
   a. Model description and capability
   b. Applications for demonstration

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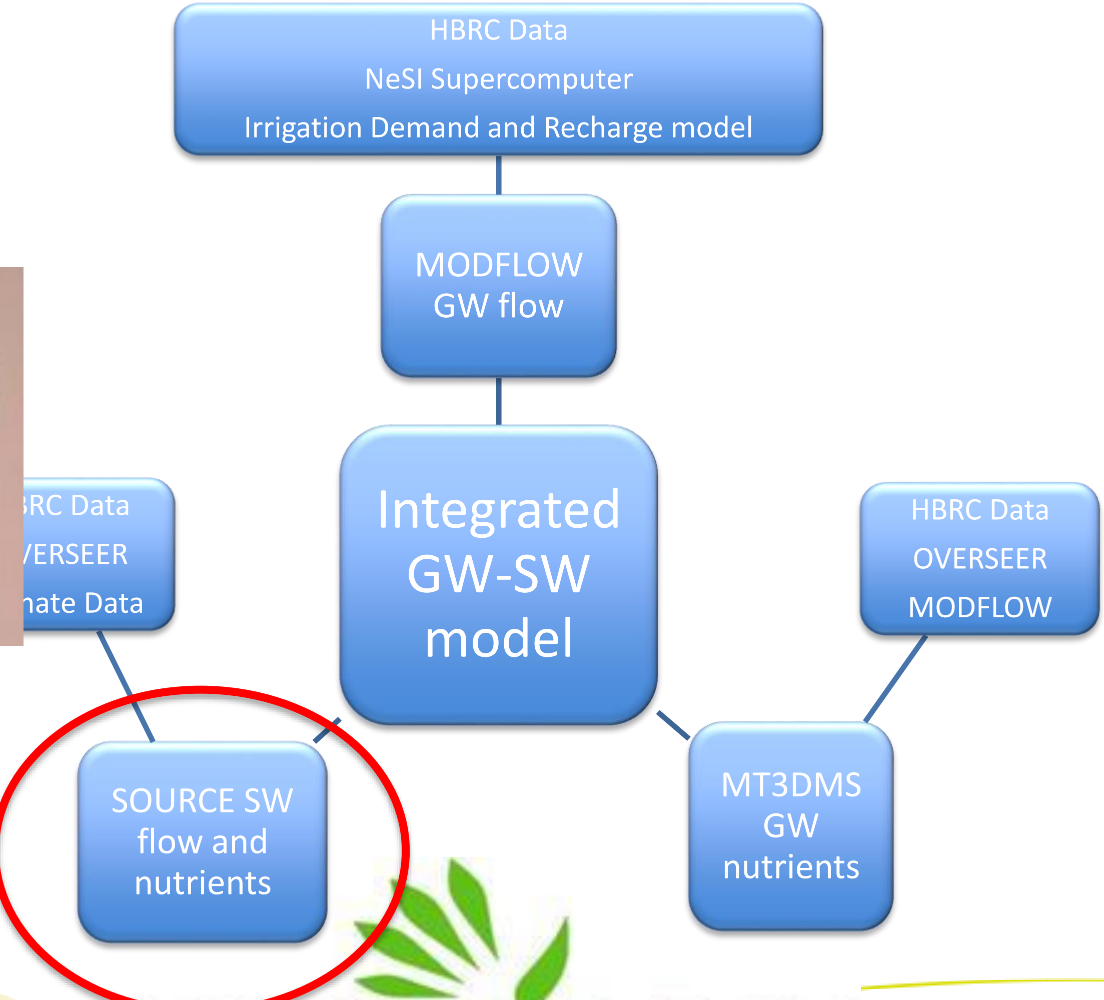
# Overview of modelling




Williamson Water Advisory

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# GW – SW Model

## A tool for now and the future –

- Regional plan reviews
- Water and land management
- Publically available
- Already interest from University of Waikato and Research Institutes to use the model

## There are limitations

- No model can answer all questions
- Models can be developed as needed, but takes time
- Complex scenarios may not be possible for TANK timeframes?
- Beneficial to identify (early) a small number of essential scenarios for modelling

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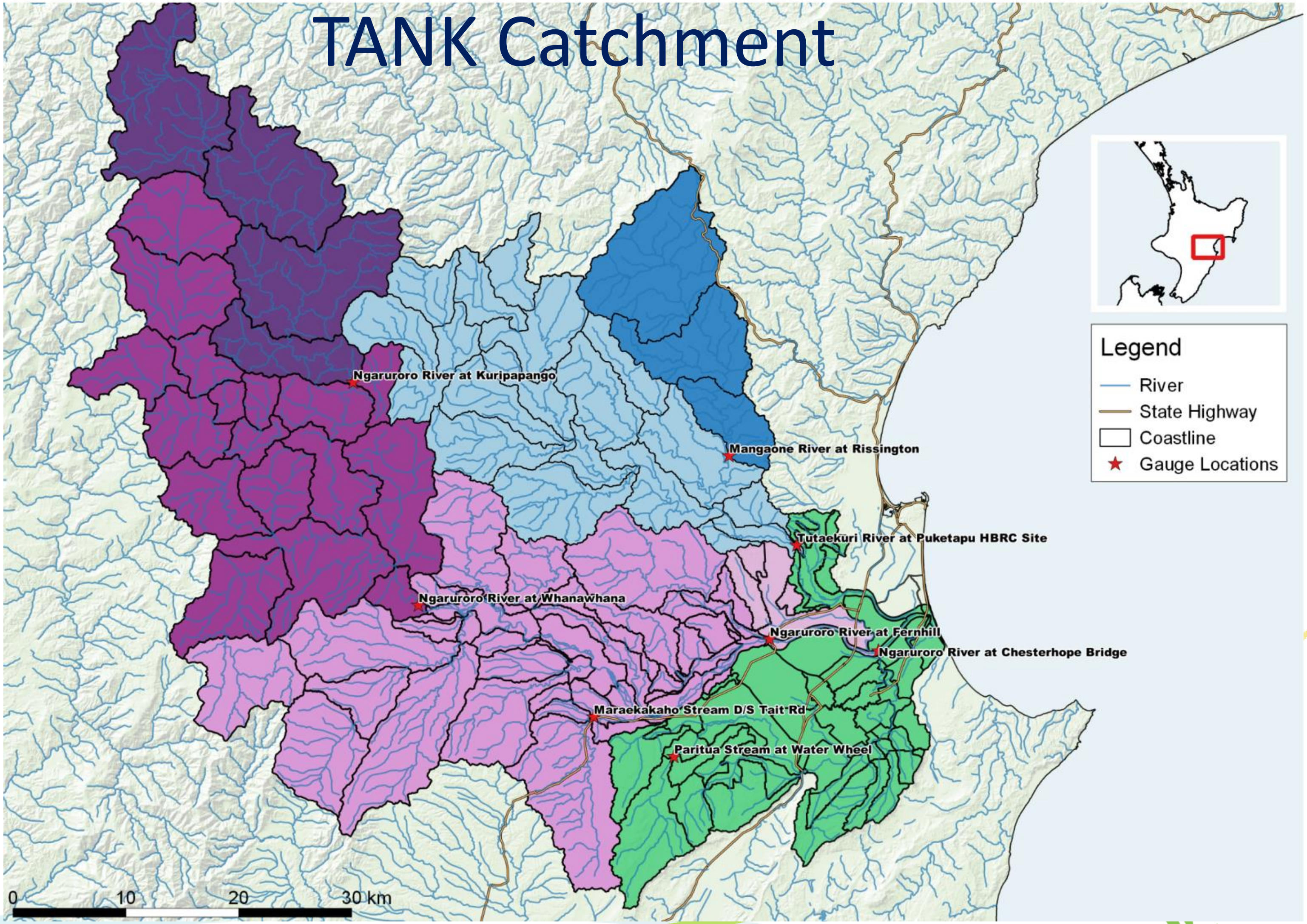
# The TANK Catchment SOURCE Model

Presentation to Land and Water Management Collaborative Stakeholder Group

13 December 2016

# TANK Catchment

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# The SOURCE Model

A hydrological and water quality modelling platform

Designed to simulate all aspects of water resource systems

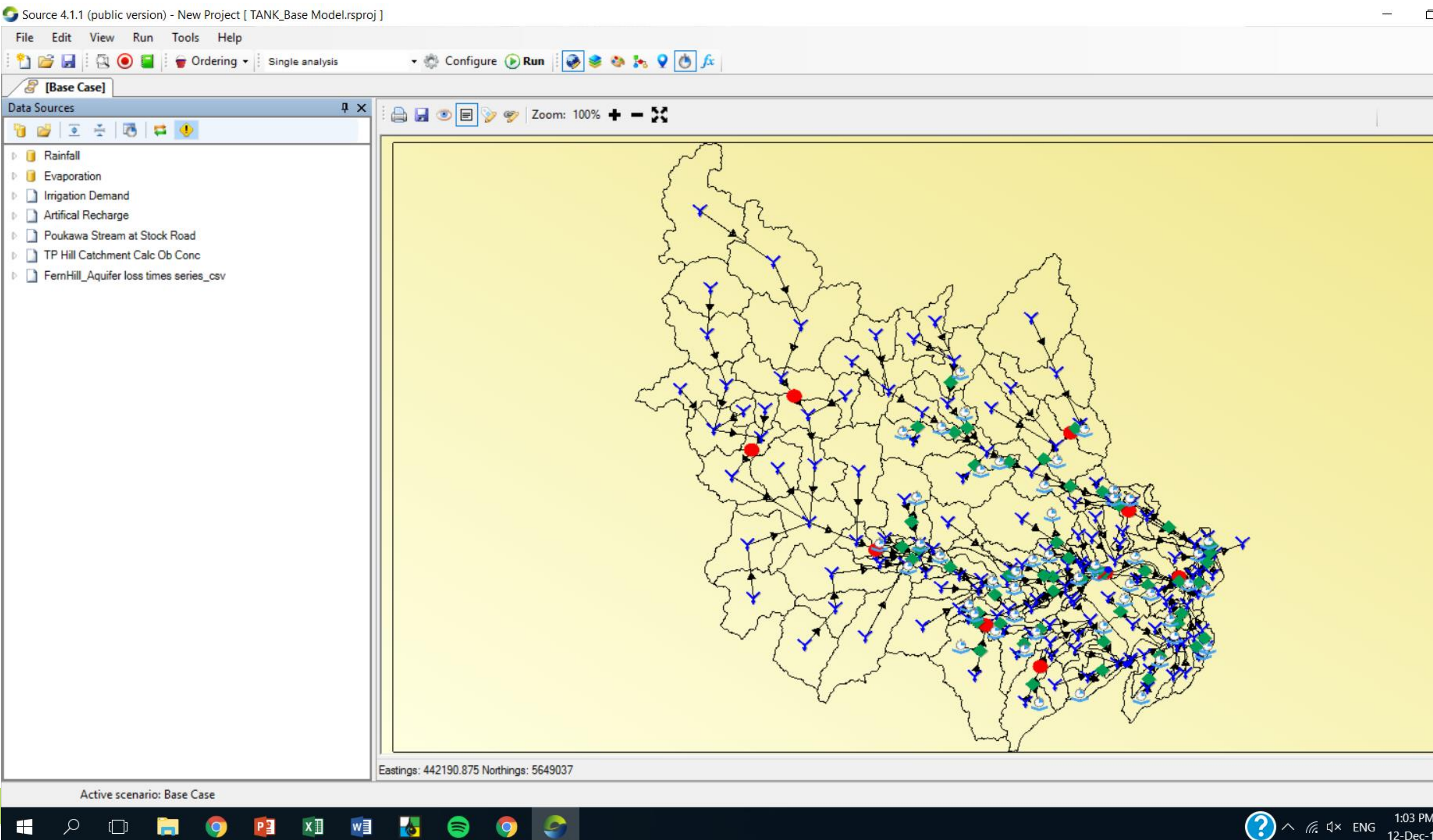
- Rainfall runoff
- Flow routing
- Dams
- Abstractions
- Wastewater discharges
- Constituent generation, transport and degradation

# The SOURCE Model

Capability is extremely flexible and expandable

- Works with wide range of input data
- Programmable through Functions
- Brings together numerous different models through Plugins
- Catchment discretisation framework permits distributed modelling

Core calculations performed on a daily time step

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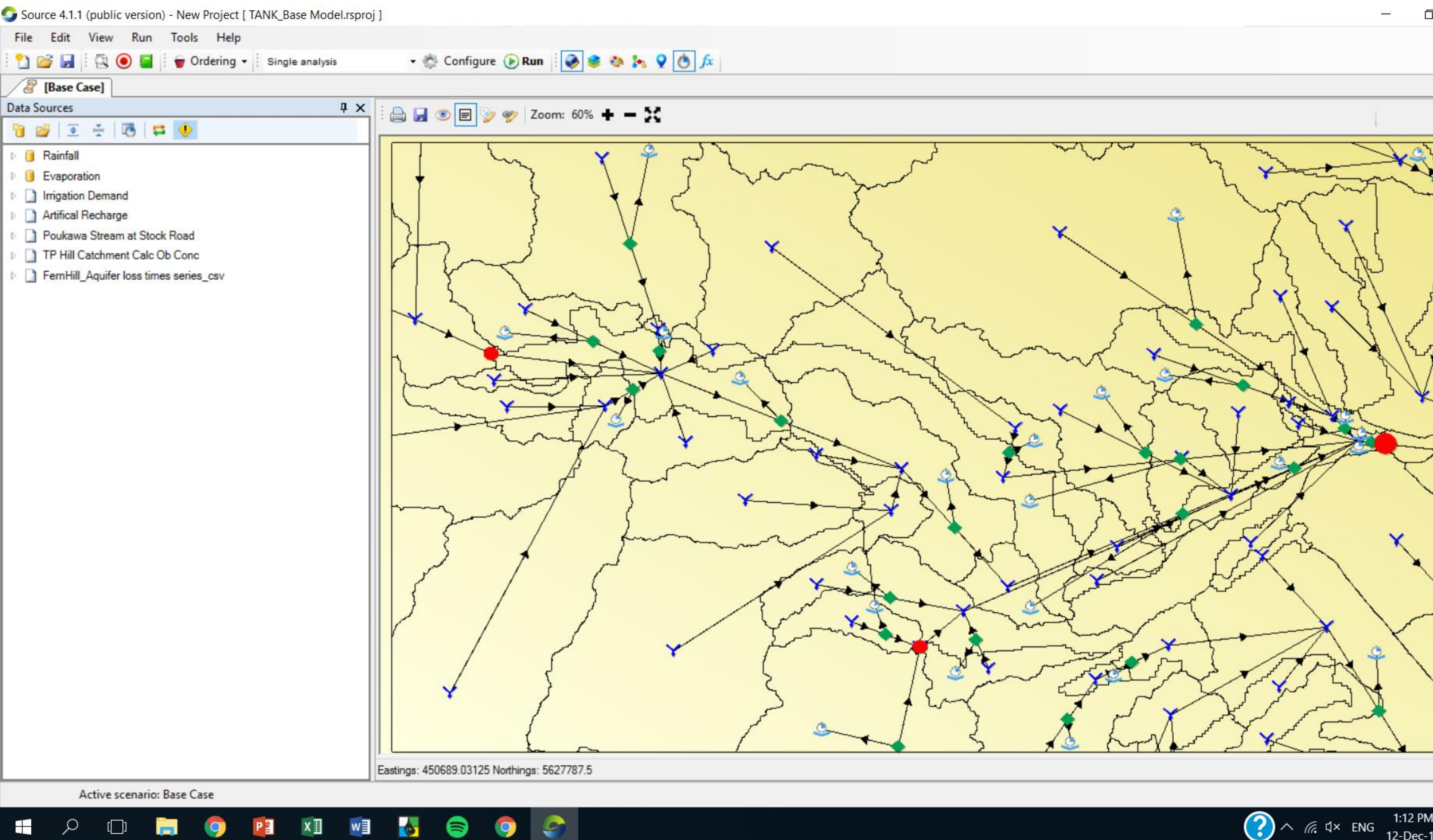


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# Limitations

Not many – depends on scale and nature of application

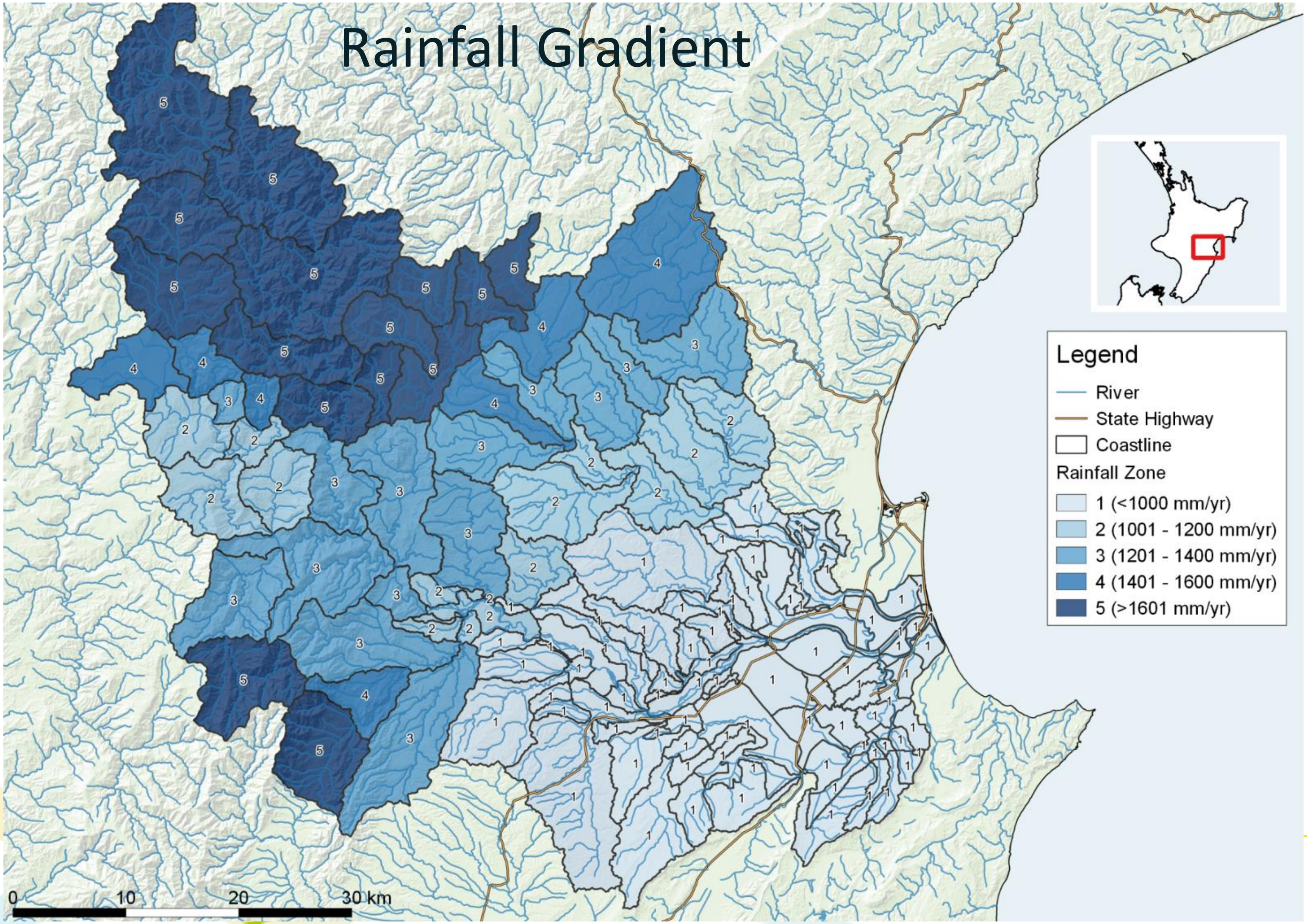
- Regional v local processes

Does not simulate detailed groundwater exchange

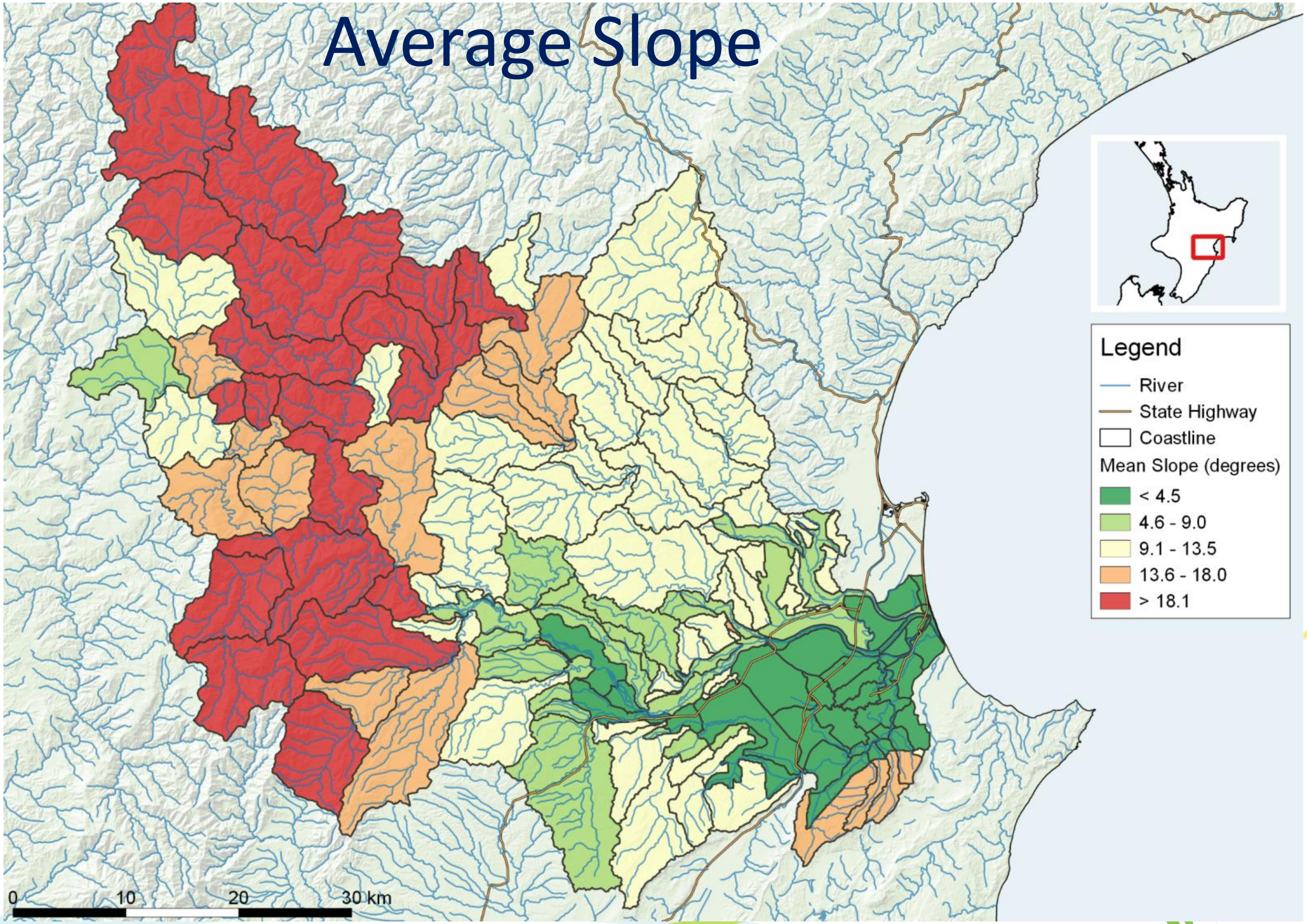
- To compensate we are integrating the SOURCE model with MODFLOW

Complexity = time

# Rainfall Gradient



# Average Slope

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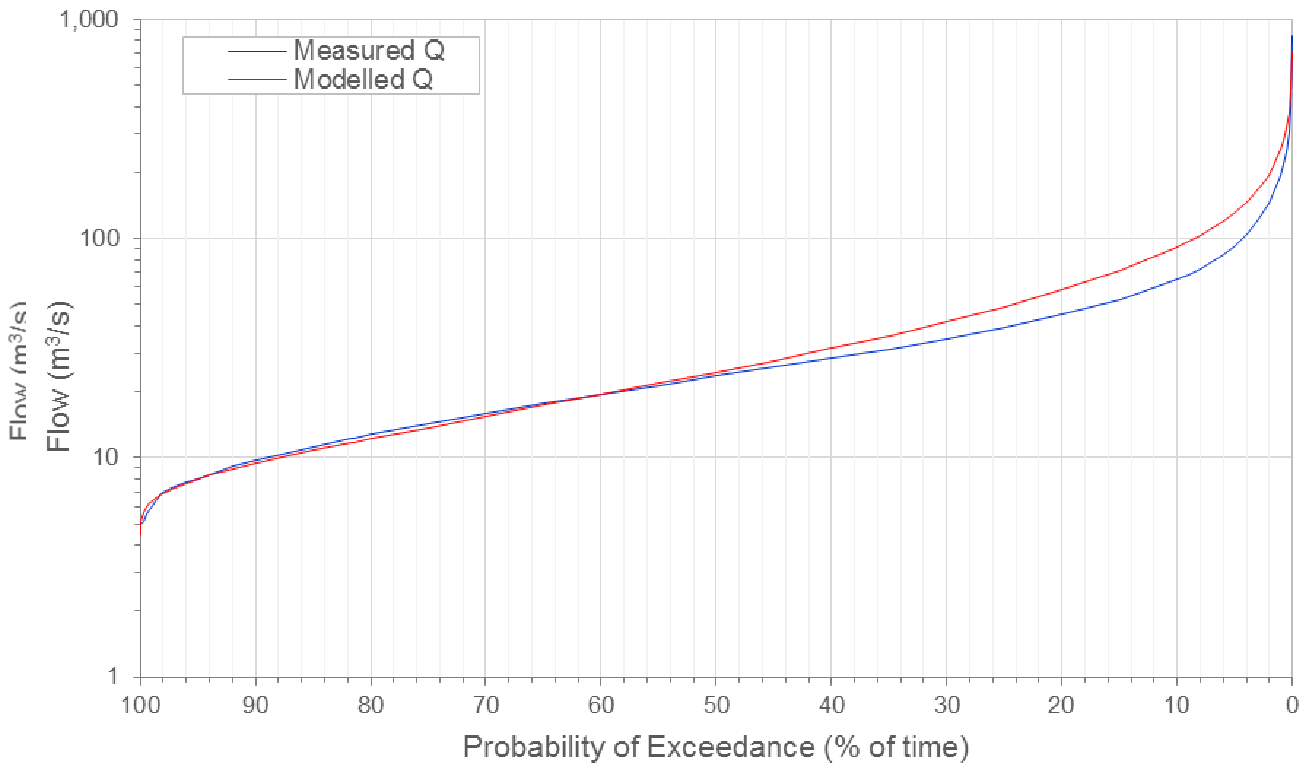
# Flow Calibration
# Ngaruroro @ Whanawhana

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# Take Reliability Statistics Ngaruroro @ Fernhill

| Recurrent Interval in Years | | | | |
|---|---|---|---|---|
| Naturalised Flow | Base Case (current day) | Max Abs. Scenarios (Low Flow Trigger @) | | |
| | | 2.40 $m^3/s$ | 3.86 $m^3/s$ | 4.20 $m^3/s$ |
| 1.72 | 1.64 | 1.59 | 1.26 | 1.10 |

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# Take Reliability Statistics
# Ngaruroro @ Fernhill

| Median no. days per year under restriction | | |
|---|---|---|
| Max Abs. Scenarios (Low Flow Trigger @) | | |
| 2.40 $m^3/s$ | 3.86 $m^3/s$ | 4.20 $m^3/s$ |
| 2.00 | 29.00 | 32.00 |

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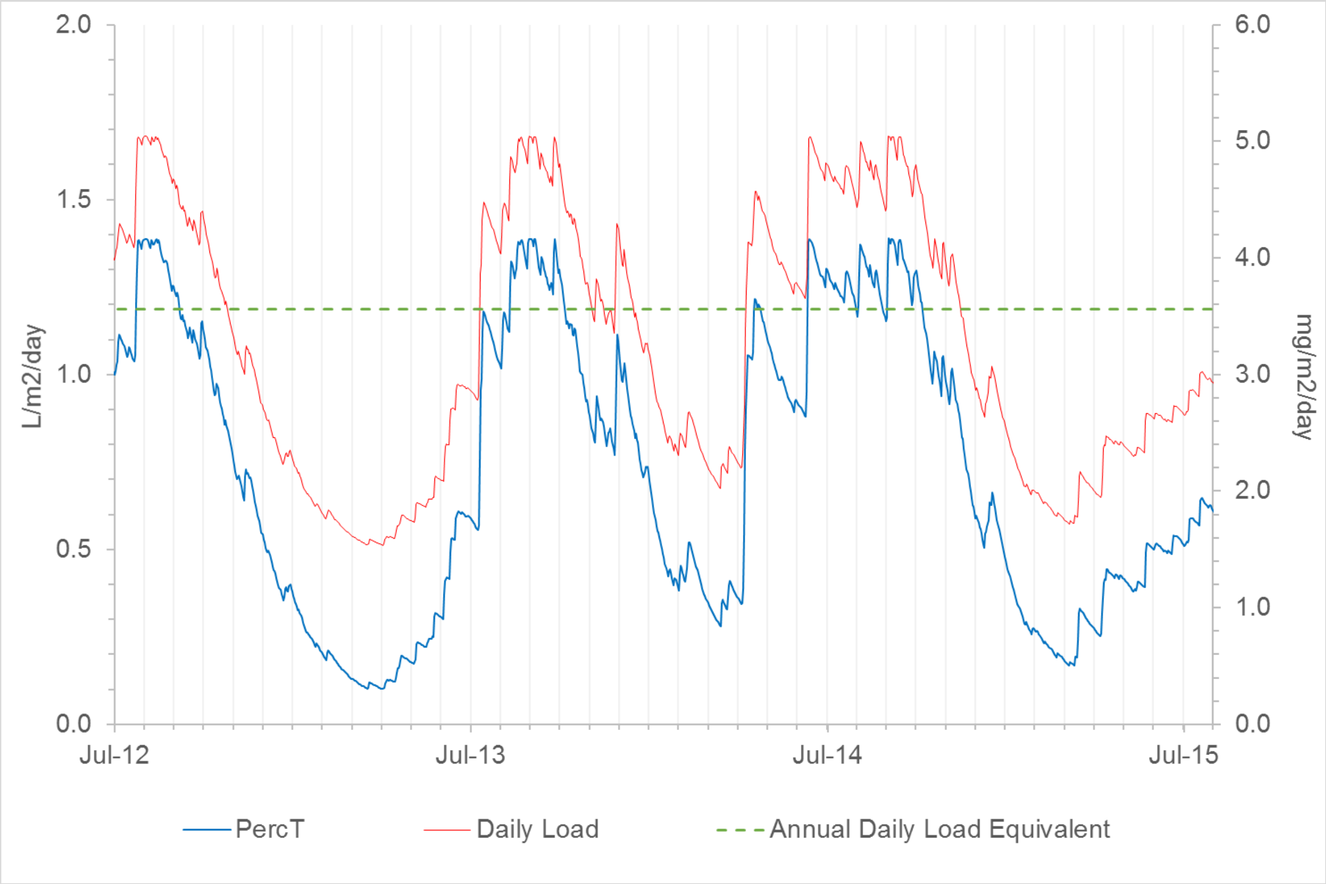
# Water Quality Modelling

(Constituent Load Disaggregation)

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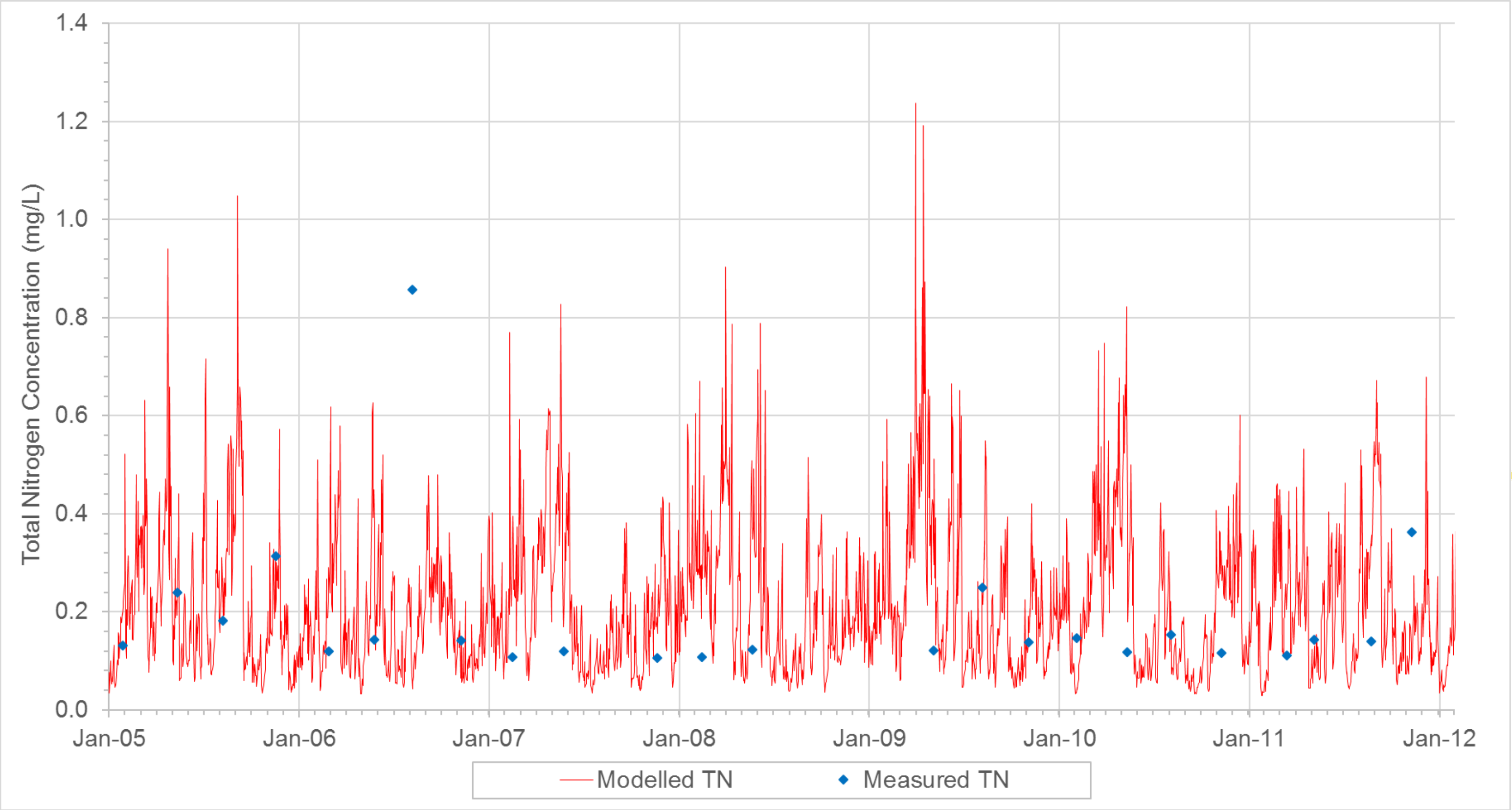
# TN Calibration
# Ngaruroro @ Whanawhana

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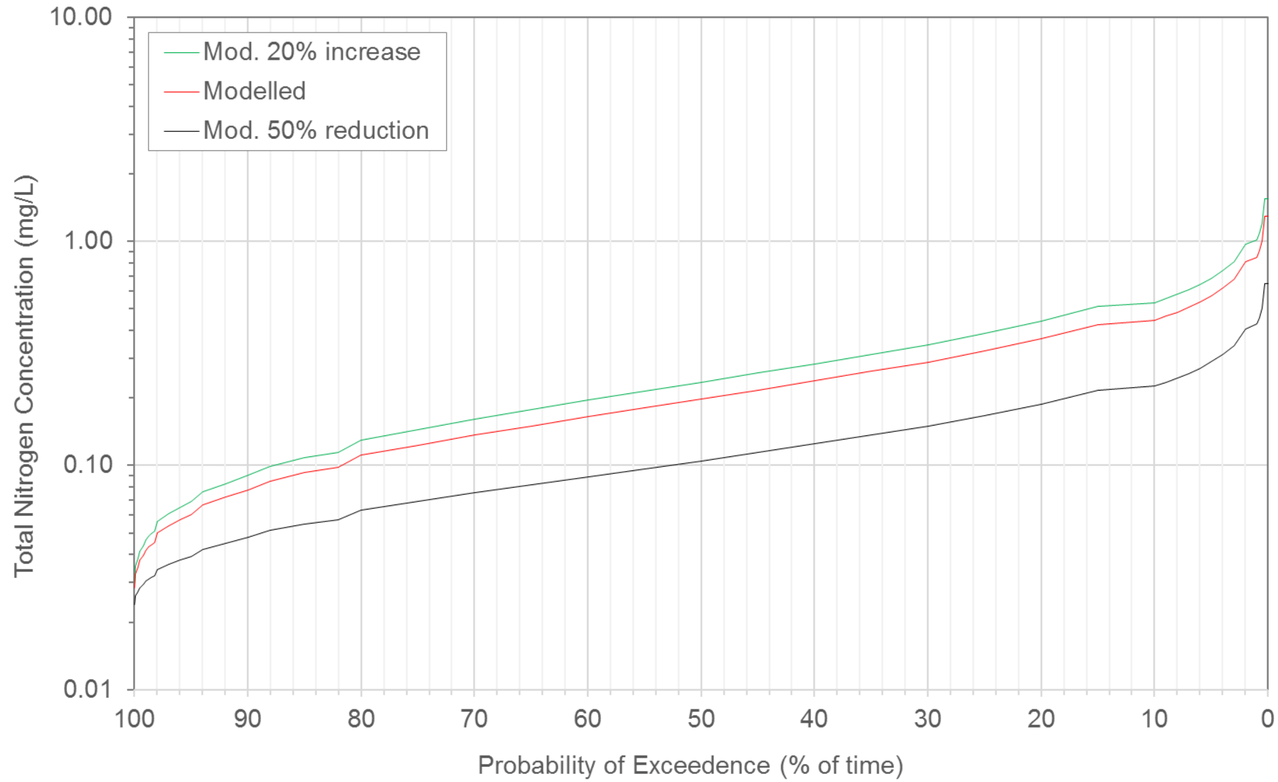
# TN Simulation
# Ngaruroro @ Whanawhana

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# Thank You !

Rob Waldron
Jeff Smith
Pawel Rakowski

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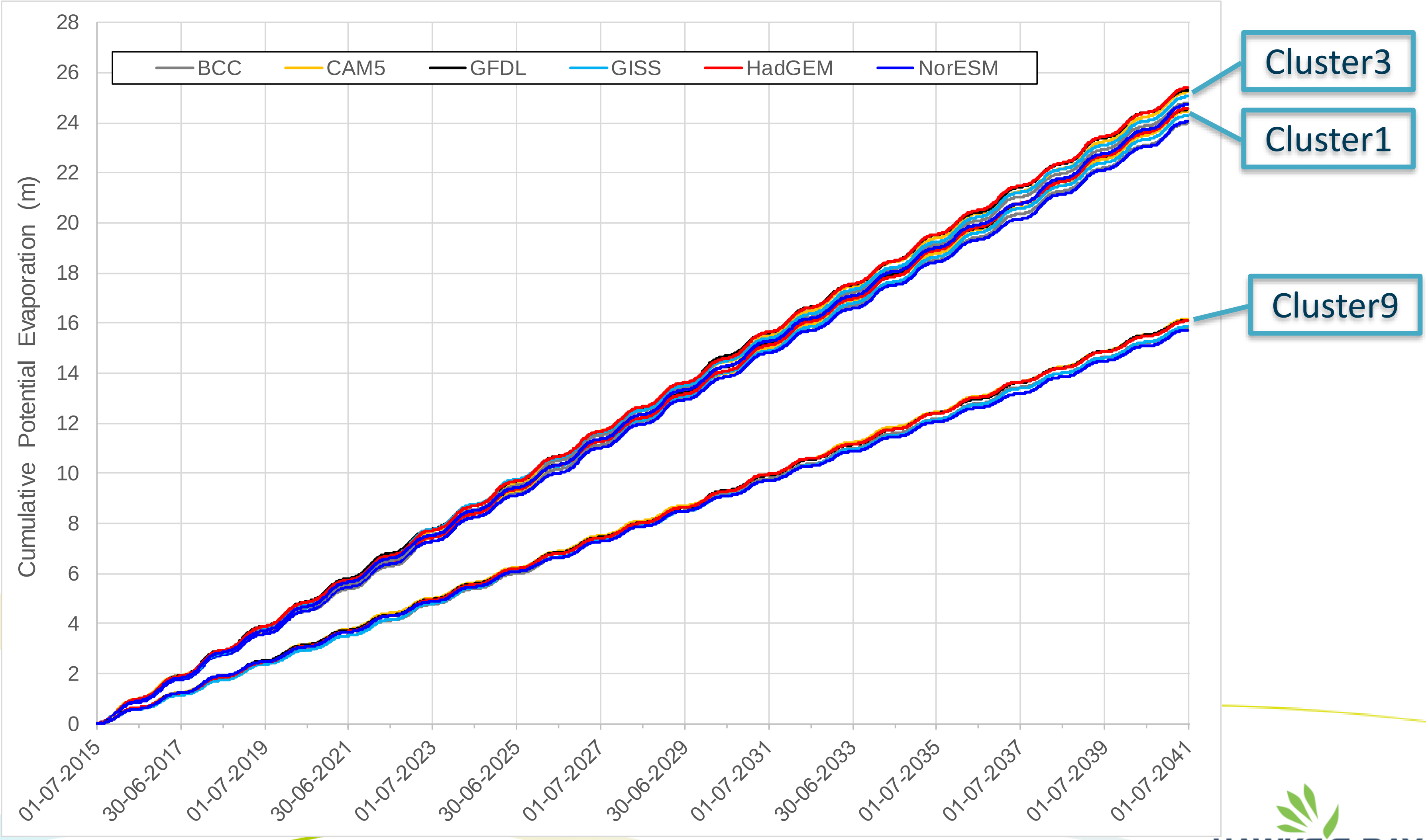
# Climate Change analysis – cumulative PET 2015 – 2041

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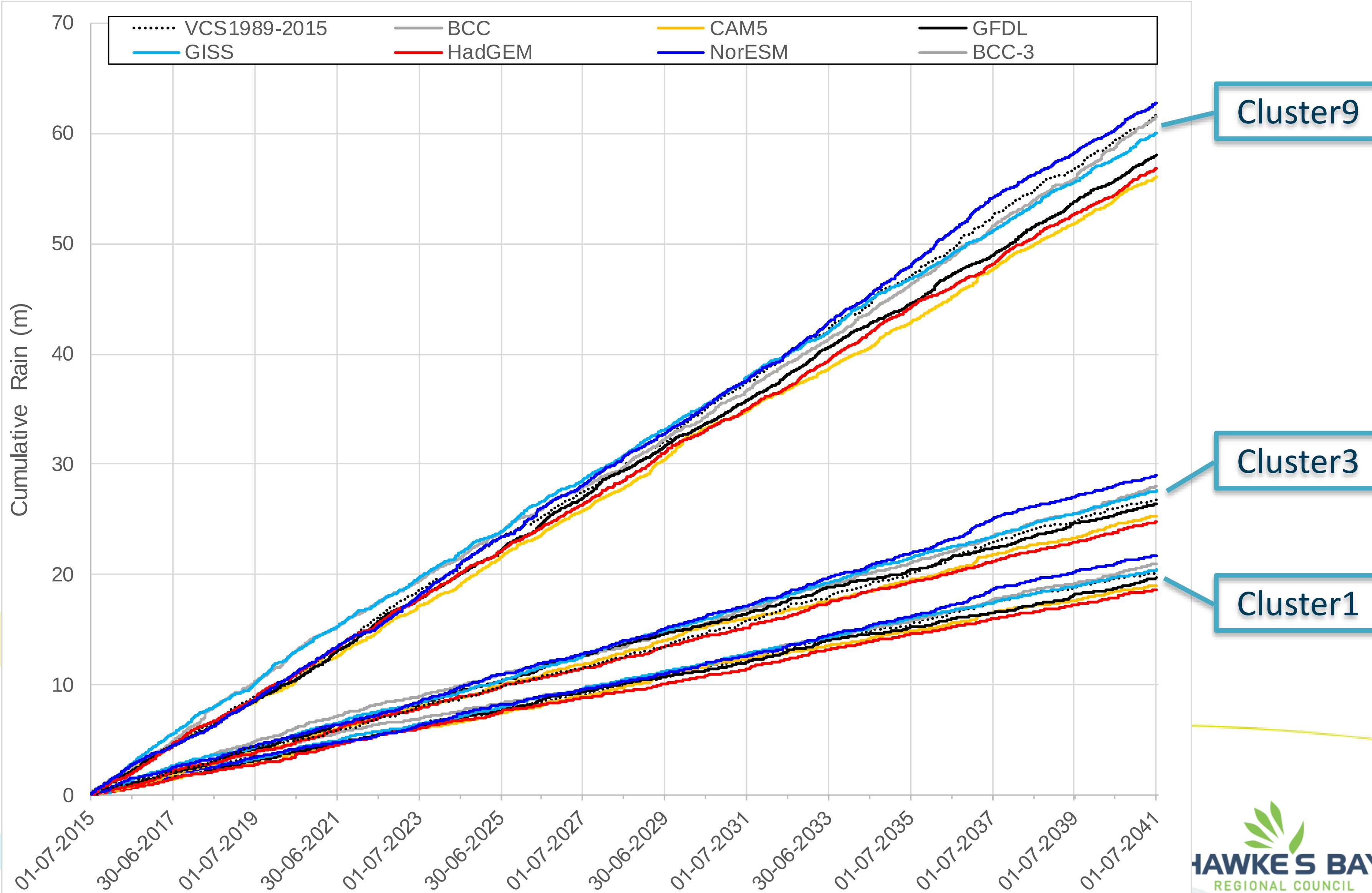
# Climate Change analysis – cumulative rain

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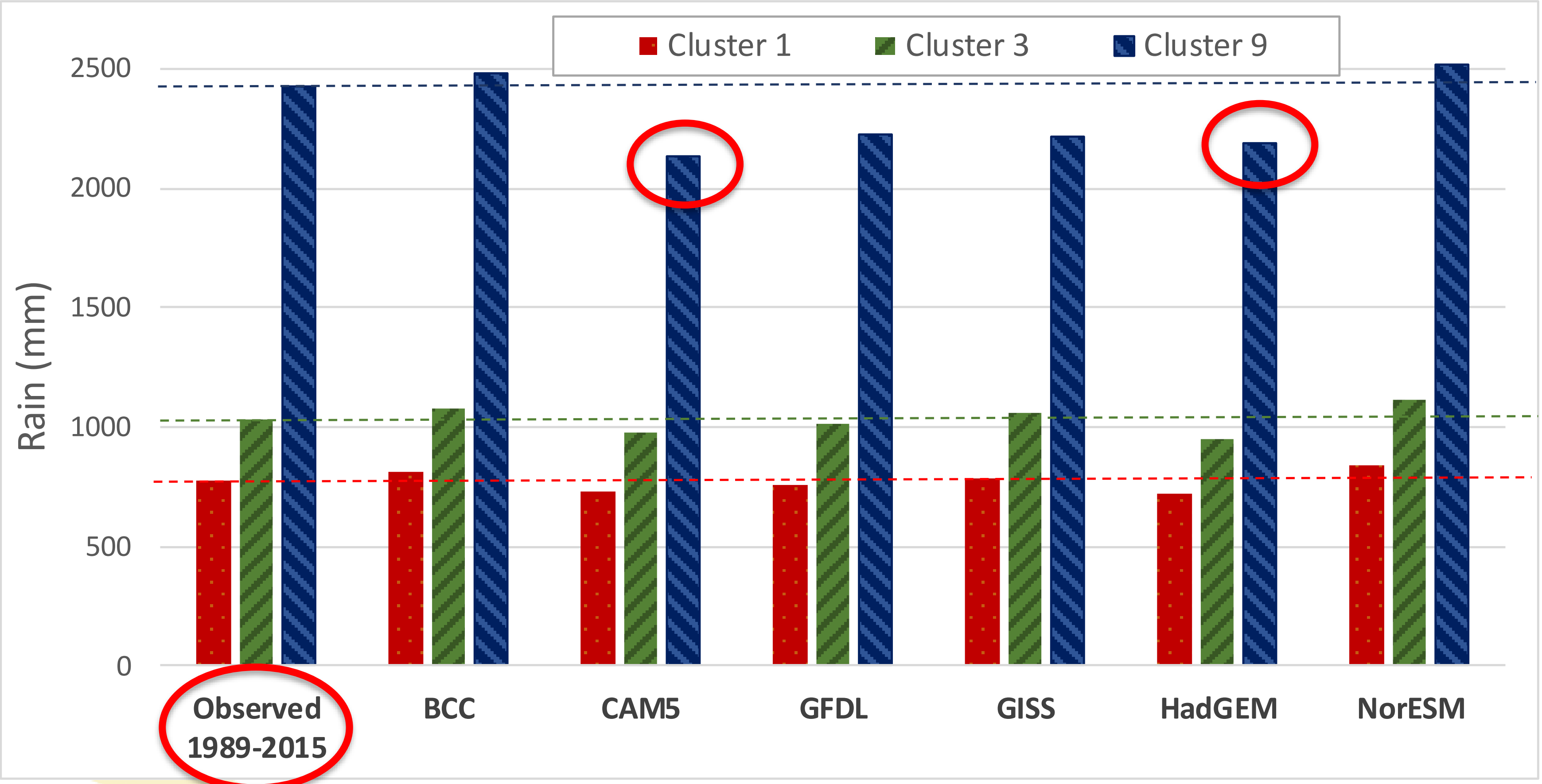
# Climate Change analysis – mean annual rain

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# Climate Change – NIWA report to MfE 2016

## 3 Projected changes in New Zealand atmospheric climate

- Projected changes are presented for 2040 (2031–2050 average), 2090 (2081–2100), and 2110 (2101–2120), all relative to the IPCC current-climate 'baseline' of 1986–2005.
- Temperature and precipitation projections are derived from both statistical (up to 41 models) and dynamical (six models) downscaling approaches.

**Temperature:**

i. The magnitude of the projected temperature changes increases with the RCP, with approximate increases by 2090 of +0.7°C under RCP2.6, +1.4°C under RCP4.5, +1.8°C under RCP6.0, and +3.0°C under RCP8.5. Warming is largest in the summer season, and least in winter and spring.

ii. The spatial variation in the warming trend is not large, except for faster warming in higher altitude South Island areas with the regional model dynamical downscaling.

iii. Temperature extremes change significantly. By the end of the century, the frequency of 'hot days' (maximum temperatures at least 25°C) doubles under the modest RCP4.5 forcing, and changes by a factor of 4 under RCP8.5. The frequency of 'cold nights' reduces dramatically at elevations below 50 metres – typically by around 90 per cent by 2090 under the highest RCP8.5 forcing.

iv. Air temperatures in the New Zealand region (over land and sea) are projected to increase at a rate about 75 per cent of the global warming rate, averaged across the models.

**Precipitation:**

i. The most common pattern of annual precipitation change shows the largest increases in the west of the South Island and the largest decreases in the east of the North Island and coastal Marlborough.

ii. Annual precipitation changes are small in many places, partly due to inter-model variability, but also to seasonal compensation, eg, in Hawke's Bay, models predict an increase in summer rainfall but a decrease in winter.

# Minimum Flows for the Heretaunga Plains

Dr Thomas Wilding

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# Instream flows for fish – Ngaruroro and Tutaekuri

author: Kolt Johnson



Fernhill, 12 March 2013, 1400 L/s

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# From Previous Meetings

- "Minimum flow setting needs to take into account the impacts on environmental, cultural, social and economic values using a variety of methodologies (e.g. Mātauranga Māori; economic models)"
- "The TANK Group supports the use of RHYHABSIM for minimum flow setting where appropriate, to assess the implications of different flow regimes on the level of habitat retention for agreed species."

  *Interim Agreements report (Feb 2014)*

- "Further discussions were required regarding indicator species in mainstem of Ngaruroro", after torrentfish proposed.

  *TANK Meeting 16 (June 2015)*

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# Ngaruroro River (Fernhill)

- RHYHABSIM model predicts river depth and velocity and relates this to where fish are found
- This is used to predict change in habitat with flow
- Output graph informs flow setting

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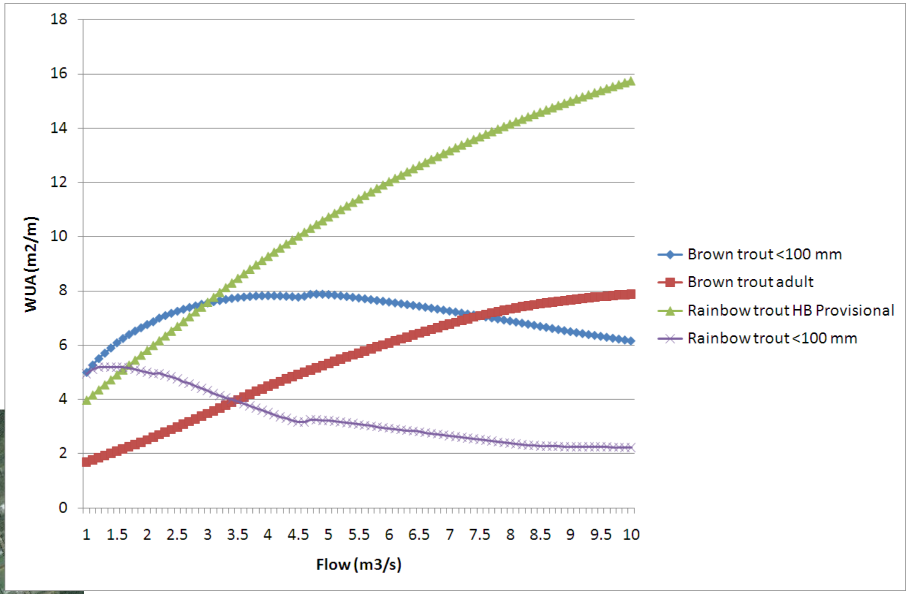
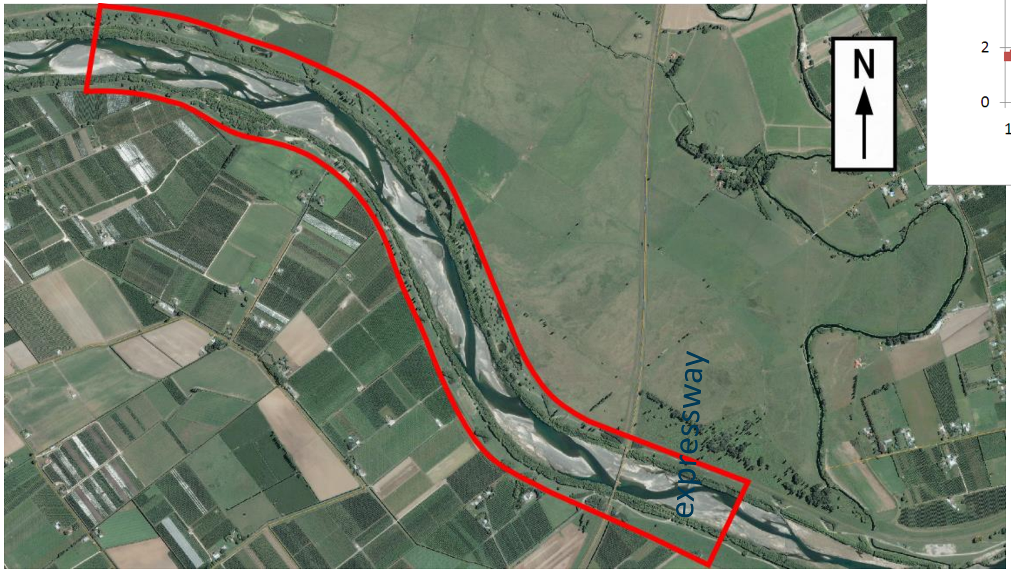
# Ngaruroro:
# trout habitat versus flow

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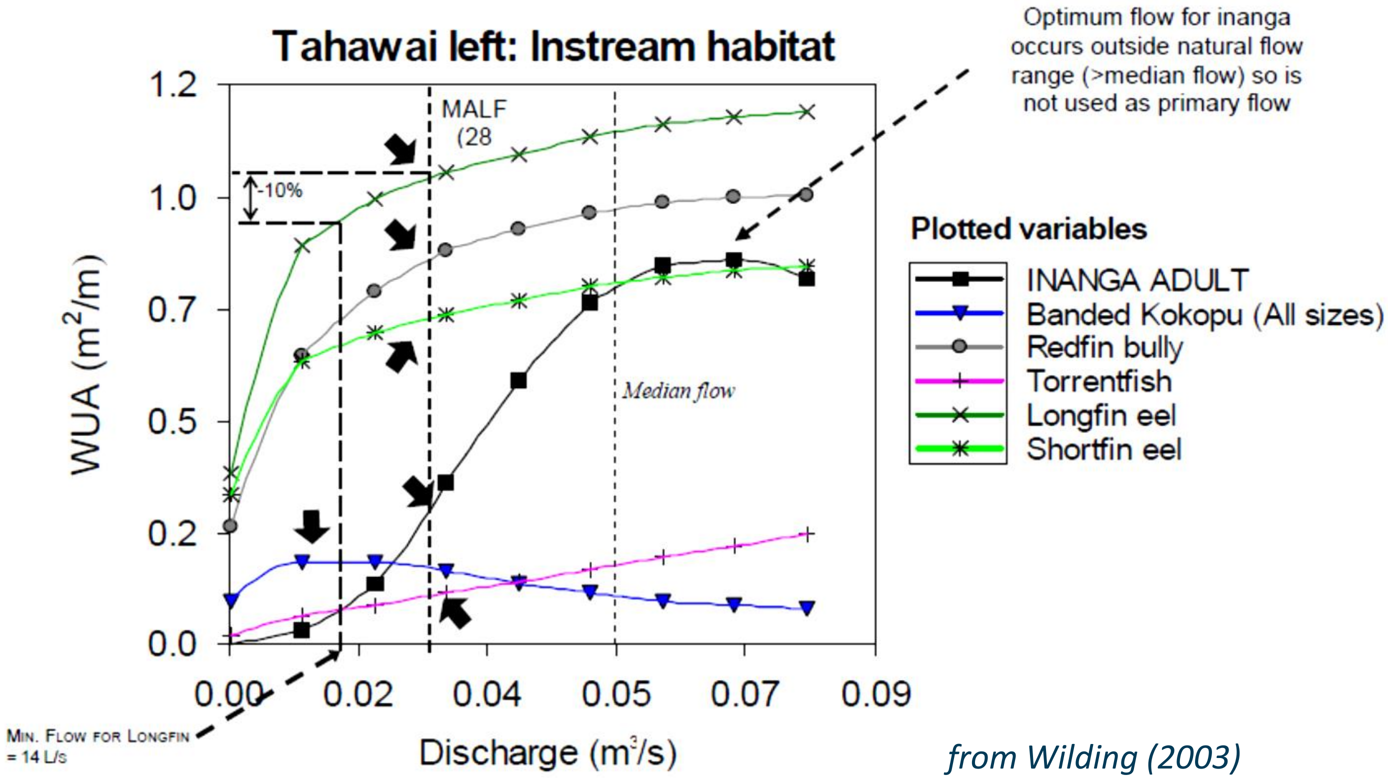
# Minimum flow from RHYHABSIM uses MALF (mean annual low flow)




*from Wilding (2003)*

# Ngaruroro minimum flow options

| NGARURORO RIVER at Expressway bridge | | Retention levels for WUA at MALF or optimum WUA flow (whichever less) | | |
|---|---|---|---|---|
| Habitat Suitability Criteria | **Flow at WUA Optimum (L/s)** | **90%** | **80%** | **70%** |
| Longfin eel <300mm (Jellyman et al 2003) | > | 2900 | 1400 | < |
| Longfin eel >300mm (Jellyman et al 2003) | > | 1900 | < | < |
| Longfin eel <300mm (Jowett & Richardson 2008) | 5100 | 2700 | 2000 | < |
| Longfin eel >300mm (Jowett & Richardson 2008) | 6000 | 2800 | 1900 | < |
| Shortfin eel <300mm | 3600 | 1200 | < | < |
| Shortfin eel >300mm | 3700 | 2000 | 1200 | < |
| Common bully | 2600 | 1200 | < | < |
| Torrentfish | 9500 | 4200 | 3900 | 3400 |
| Redfin bully | 2500 | 1200 | < | < |
| Inanga feeding | > | < | < | < |
| Crans bully | 1400 | < | < | < |
| Smelt | 4100 | 2700 | 2200 | 1800 |
| Lamprey | < | < | < | < |
| Koaro | 5200 | 2900 | 2200 | 1700 |
| Dwarf galaxias | 2300 | < | < | < |
| Bluegill bully | 6000 | 3900 | 3400 | 2800 |
| Rainbow trout <100mm | 1300 | < | < | < |
| Rainbow trout >200mm (Provisional Hawke's Bay HSC) | > | 3900 | 3400 | 2700 |
| Brown trout <100mm | 4800 | 2200 | 1600 | 1200 |
| Brown trout adult (Hayes and Jowett 1994) | > | 4000 | 3500 | 3000 |
| Mayfly (Jowett and Richardson 1990) | 9700 | 3200 | 2100 | 1300 |
| General Macroinvertebrate (Waters 1976) | > | 4000 | 3600 | 3200 |

These numbers will change - revised MALF

> Flow at WUA optimum exceeds modelled range
< Flow at specified WUA value is less than modelled range

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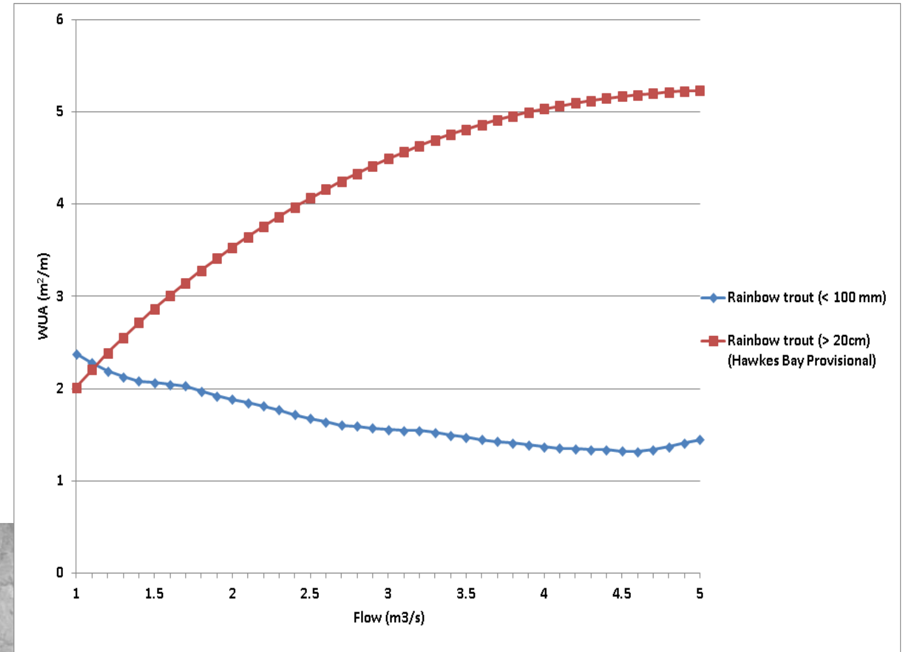
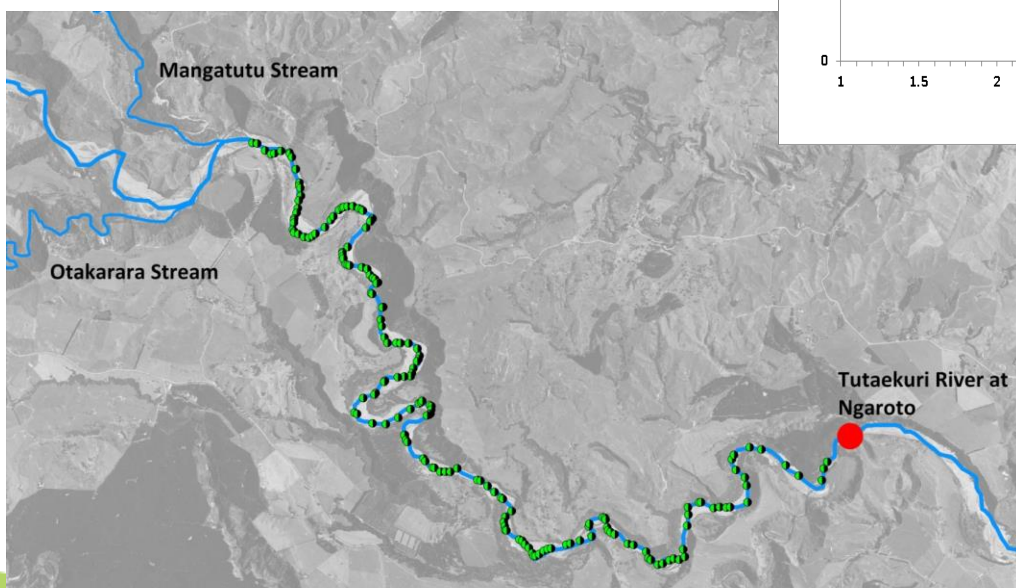
# Same for Tutaekuri

- Less water demand (about 60 takes, including 20 from surface water).

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# Tutaekuri minimum flow options

These numbers will change - revised MALF

| TUTAEKURI RIVER at Ngaroto | | Retention levels for WUA at MALF or optimum WUA flow (whichever less) | | |
|---|---|---|---|---|
| **Habitat Suitability Criteria** | **Flow at WUA Optimum (L/s)** | **90%** | **80%** | **70%** |
| Longfin eel <300mm (Jellyman et al 2003) | 1300 | < | < | < |
| Longfin eel >300mm (Jellyman et al 2003) | > | 2300 | 1800 | 1400 |
| Longfin eel <300mm | 1200 | 800 | 600 | 500 |
| Longfin eel >300mm | 1100 | 700 | 500 | < |
| Shortfin eel <300mm | 900 | 600 | < | < |
| Shortfin eel >300mm | 900 | < | < | < |
| Common bully | 500 | < | < | < |
| Torrentfish | > | 2100 | 1800 | 1600 |
| Redfin bully | 700 | < | < | < |
| Inanga feeding | < | < | < | < |
| Crans bully | < | < | < | < |
| Smelt | 900 | 600 | 500 | < |
| Koaro | 2200 | 1300 | 1000 | 800 |
| Bluegill bully | 1900 | 1400 | 1200 | 1000 |
| Rainbow trout <100mm | < | < | < | < |
| Rainbow trout >200mm (Provisional Hawke's Bay HSC) | > | **2400** | 2000 | 1700 |
| Mayfly (Jowett et al. 1991) | > | 1800 | 1200 | 900 |
| General Macroinvertebrate (Waters 1976) | 3500 | 2100 | 1600 | 1300 |

\> Flow at WUA optimum exceeds modelled range
< Flow at specified WUA value is less than modelled range

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# GW/SW Quantity Modelling

## Modelling Levers and Scenario Development

Rob Waldron

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# GW/SW Quantity Modelling

## Scenarios

- MODFLOW (GW) and SOURCE (SW) models have a number of parameters (levers) that can be changed to model different scenarios.
- Initial scenarios include:
  - Naturalised scenario
  - Current abstraction/allocation scenario
- More scenarios required to be developed to model alternative allocation and restriction regimes.

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# GW/SW Quantity Modelling

## GW Modelling Levers:

- Total abstraction
  - Estimated actual use
  - Full use of existing allocation
  - Reduce or increase
- Abstraction points/locations
  - Abstraction from existing bores
  - New abstraction from new bores
- Restriction Regime
  - Abstraction restricted only by allocation limit
  - Stream depleting abstractions linked to SW restriction regime (e.g. minimum flows, staged reductions, etc)

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# GW/SW Quantity Modelling

## SW Modelling Levers:

- Management Sites
  - Current (active) minimum flow sites
  - Proposed scenario - Rationalise minimum flow sites utilising oxygen-flow modelling work (TBC)

- Allocation Regime and Limit
  - Core and high flow allocation
    - Maintain existing allocation
    - Increase or reduce allocation

# GW/SW Quantity Modelling

## SW Modelling Levers:

- Restriction Regime
  - Minimum Flows
  - Staged Reductions
  - Flow sharing

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# GW/SW Quantity Modelling

## SW Modelling Levers: Restriction Regime

- Minimum Flows
  - Current Minimum Flows
  - New/Revised Minimum Flows - based on habitat-flow modelling (or oxygen limit for low gradient streams)

| | | |
|---|---|---|
| Target Species | Fast-Water | e.g. torrentfish, adult trout, bluegill bully |
| | Medium-Water | e.g. longfin eel, smelt, juvenile trout |
| | Slow-Water | e.g. other bullies, shortfin eel, dwarf galaxias |
| Level of Habitat Protection | High | 90% of habitat at MALF |
| | Medium | 80% of habitat at MALF |
| | Low | 70% of habitat at MALF |

# GW/SW Quantity Modelling

## SW Modelling Levers: Restriction Regime

- Staged Reductions
  - Potentially based on levels of habitat protection
  - Example of a 3-Stage Reduction and Minimum Flow

| **Reduction Stage** | **Flow Trigger** | **River Flow Status** | **Restriction Status** | **Allocation Available for Abstraction** |
|---|---|---|---|---|
| - | - | River Flow > Stage 1 Flow | No Restriction | 100% Available |
| Stage 1 | MALF | River Flow ≤ Stage 1 Flow | 25% Restriction | 75% Available |
| Stage 2 | 90% of habitat at MALF | River Flow ≤ Stage 2 Flow | 50% Restriction | 50% Available |
| Stage 3 | 80% of habitat at MALF | River Flow ≤ Stage 3 Flow | 75% Restriction | 25% Available |
| Minimum Flow | 70% of habitat at MALF | River Flow ≤ Minimum Flow | Full Restriction | 0% Available |

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# GW/SW Quantity Modelling

## SW Modelling Levers: Restriction Regime

- Flow sharing
  - Where available flow is shared between the abstractors and the river
  - Examples of flow sharing scenarios

| **50% Flow Share above Minimum Flow** |
|---|
| 50% of river flow is available for abstraction only when river flow is greater than the Minimum Flow |
| Minimum Flow = 3000 l/s |
| River Flow = 4000 l/s |
| 4000 l/s - 3000 l/s = 1000 l/s |
| **Flow available for abstraction = 50% of 1000 l/s = 500 l/s** |

| **10% Flow Share at all times** |
|---|
| 10% of river flow is available for abstraction at any flow |
| River flow = 6000 l/s |
| **Flow available for abstraction = 10% of 6000 l/s = 600 l/s** |
| River flow = 2000 l/s |
| **Flow available for abstraction = 10% of 2000 l/s = 200 l/s** |

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# Break-out Session

## SW Modelling Scenario Development: Ngaruroro & Tutaekuri

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# Break-out Session

## SW Modelling Scenario Development: Ngaruroro & Tutaekuri

| **Scenario** | **Example A** | **Example B** | **Example C** |
|---|---|---|---|
| **Catchment** | Ngaruroro & Tutaekuri | Ngaruroro & Tutaekuri | Ngaruroro |
| **Management Sites** | Current Minimum Flow Sites | Current Minimum Flow Sites | Current Minimum Flow Sites |
| **Allocation Regime + Limit** | Current Core & High Flow Allocation | Current Core & High Flow Allocation | Current Core & High Flow Allocation |
| **Restriction Regime** | Minimum Flows (Full Restriction) | Minimum Flows (Full Restriction) | Minimum Flows + Staged Reductions |
| **Restriction Regime Detail** | Current Minimum Flows | New/Revised Minimum Flows<br>*- Target Species = Fast-Water*<br>*- Level of Habitat Protection = 90% of habitat at MALF* | New/Revised Minimum Flows<br>*- Target Species = Fast-Water*<br>*- Level of Habitat Protection = 70% of habitat at MALF* |
| | | | 3-Stage Reduction<br>*- Stage 1 = MALF*<br>*- Stage 2 = 90% of habitat at MALF*<br>*- Stage 3 = 80% of habitat at MALF* |

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REGIONAL COUNCIL

# Break-out Session

## SW Modelling Scenario Development: Ngaruroro & Tutaekuri

| **Scenario** | **Example A** | **Example B** | **Example C** |
|---|---|---|---|
| **Catchment** | Ngaruroro & Tutaekuri | Ngaruroro & Tutaekuri | Ngaruroro |
| **Restriction Regime** | Minimum Flows (Full Restriction) | Minimum Flows (Full Restriction) | Minimum Flows + Staged Reductions |
| **Restriction Regime Detail** | Current Minimum Flows | New/Revised Minimum Flows<br>*- Target Species = Fast-Water*<br>*- Level of Habitat Protection = 90% of habitat at MALF* | New/Revised Minimum Flows<br>*- Target Species = Fast-Water*<br>*- Level of Habitat Protection = 70% of habitat at MALF* |
| | | | 3-Stage Reduction<br>*- Stage 1 = MALF*<br>*- Stage 2 = 90% of habitat at MALF*<br>*- Stage 3 = 80% of habitat at MALF* |

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# Verbal updates from Working Groups

- Engagement
- Economic Assessments
  - RfP
- Stormwater
- Wetlands/Lakes
- Mana whenua

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# Next meeting – 9 February 2017

## AGENDA - TANK #26

- Preliminary report from Stormwater Working Group
- Clive and Waitangi Estuary - nutrients and flows
- ~~SOURCE modelling report back~~
- Update on Socio-Economics assessment work-to-date
- Possible establishment of Water Augmentation Group
- Plan change skeleton

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# Schedule for 2017

| MEETING | PROPOSED DATE |
|---|---|
| **Meeting 25** | 13 December 2016 |
| **Meeting 26** | Thursday 9 February 2017 |
| **Meeting 27** | Wednesday 22 March 2017 |
| **Meeting 28** | Thursday 27 April 2017 |
| **Meeting 29** | Wednesday 14 June 2017 |
| **Meeting 30** | Thursday 27 July 2017 |
| **Meeting 31** | Thursday 7 September 2017 |
| **Meeting 32** | Wednesday 18 October 2017 |
| **Meeting 33 (reserve)** | Wednesday 22 November 2017 |

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# Closing Karakia

Nau mai rā

Te mutu ngā o tatou hui

Kei te tumanako

I runga te rangimarie

I a tatou katoa

Kia pai to koutou haere

Mauriora kia tatou katoa

Āmine

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