

The tools of Managed Aquifer Recharge (MAR)

Wairarapa Workshop – 16 February
2017

Golder Associates (NZ) Limited
Bob Bower - *Principal Hydrologist*



Overview

MAR – concepts and principles

Practical NZ example(s)

Questions and discussion

Systems Approach



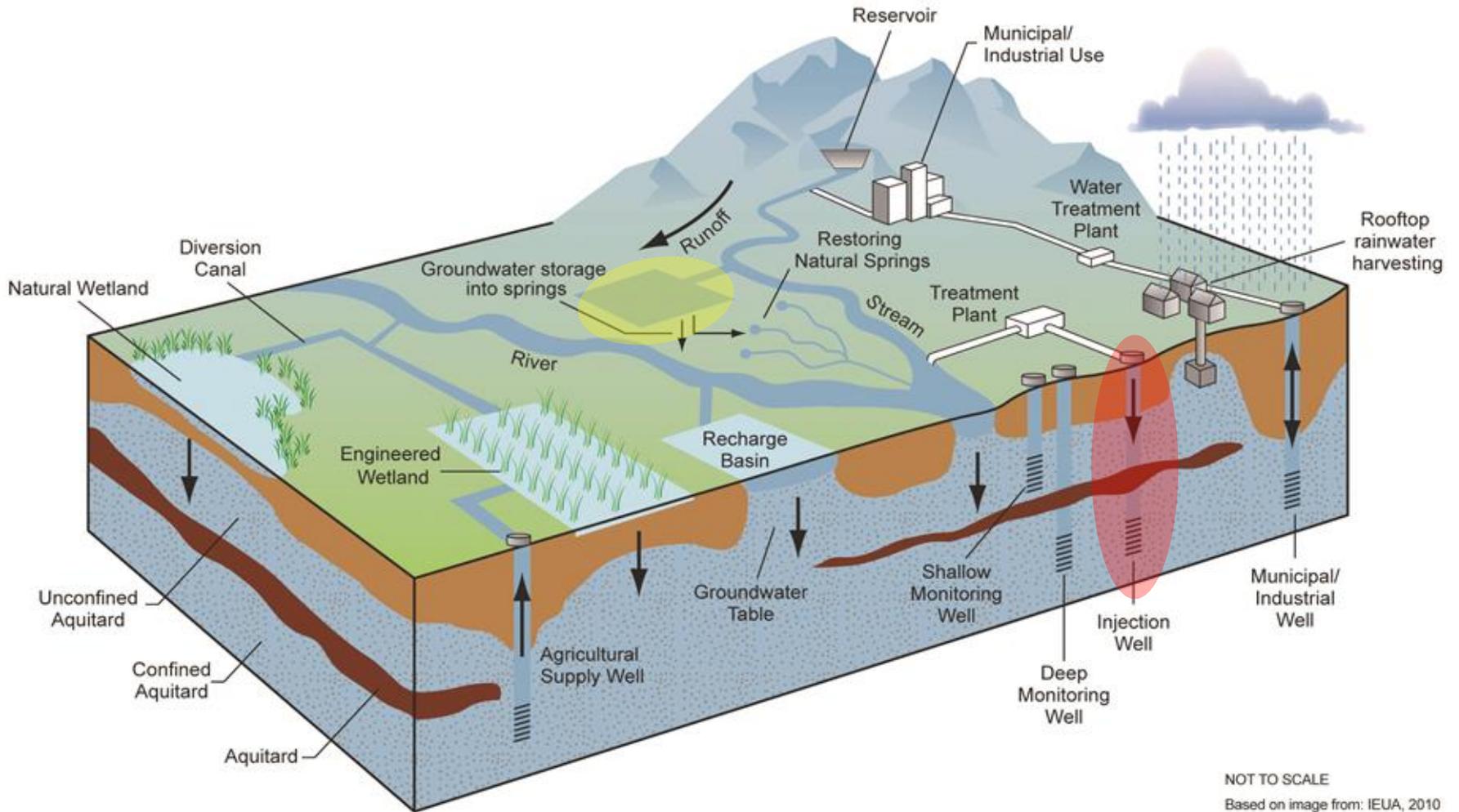
- A 'healthy aquifer' is good for everyone
- Catchment-scale and conjunctive management solutions
- Integration of surface and groundwater resources
- MAR trial sites – education and technical information gathering
- Build diverse partnerships from start

What is MAR?

Generally a set of physical tools to proactively manage the replenishment of groundwater supplies

Managed Aquifer Recharge

The physical tools



Infiltration Basins

A tool of MAR



CAP Recharge Program, Arizona



The Tools of MAR

Think of it as a toolbox



Means to an end...

Really its about catchment-scale, conjunctive, sustainable groundwater management.



Tools of MAR



Groundwater Replenishment System

A photograph of a large white cylindrical tank, likely a water storage tank, with a yellow ladder and platform on top. The tank is situated next to a modern building with a grey facade. The text "GROUNDWATER REPLENISHMENT SYSTEM" is prominently displayed in large, white, 3D block letters on a grey concrete wall in the foreground. The sky is blue with some clouds.

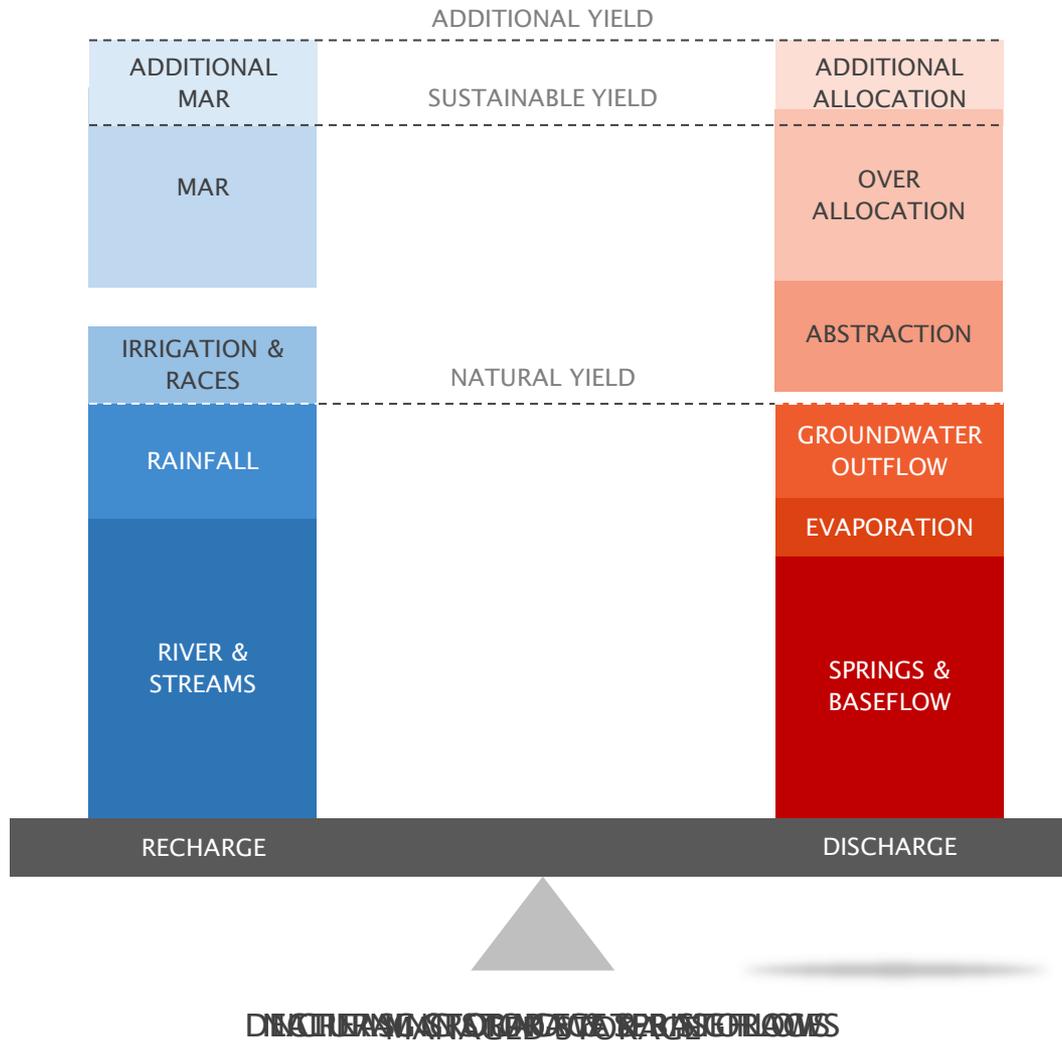
GROUNDWATER REPLENISHMENT SYSTEM

Ground Water
Replenishment Systems

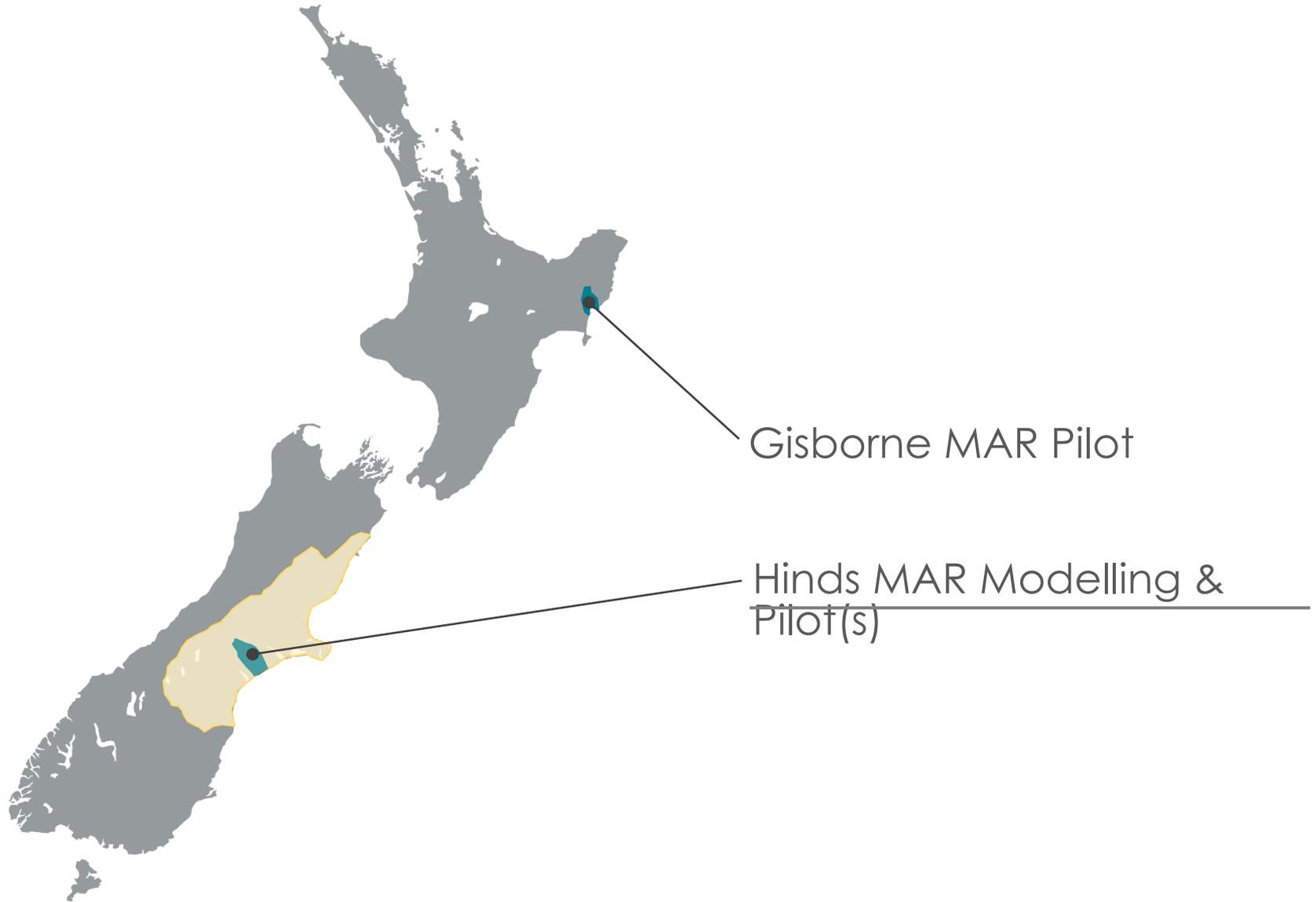
How does MAR work?

BALANCING GROUNDWATER STORAGE

MAR to offset mass balance changes

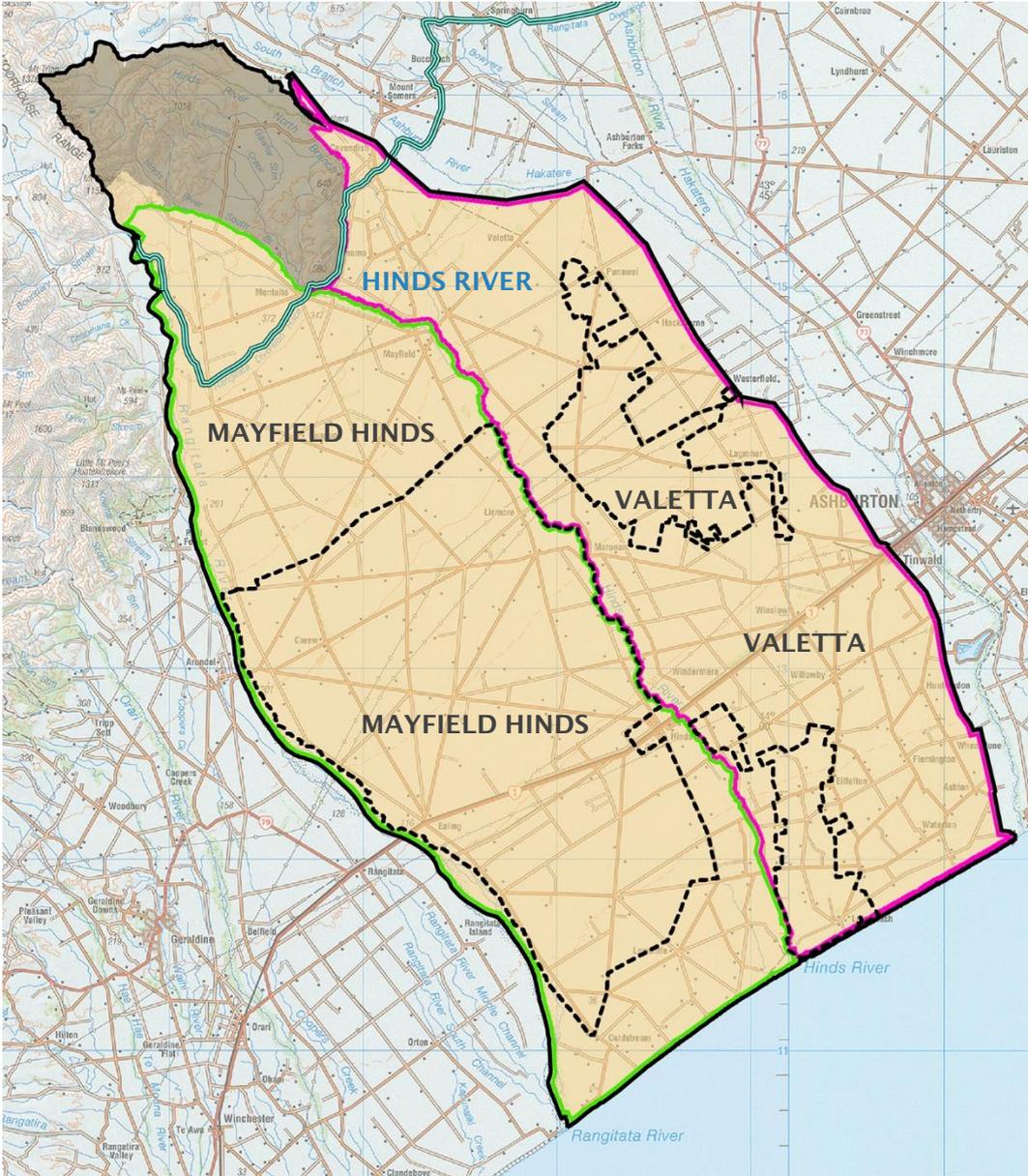


TWO MAR PILOT PROJECT CURRENTLY UNDERWAY IN NZ



Hinds Catchment

Between Rangitata to Ashburton Rivers



Pilot Project Partners

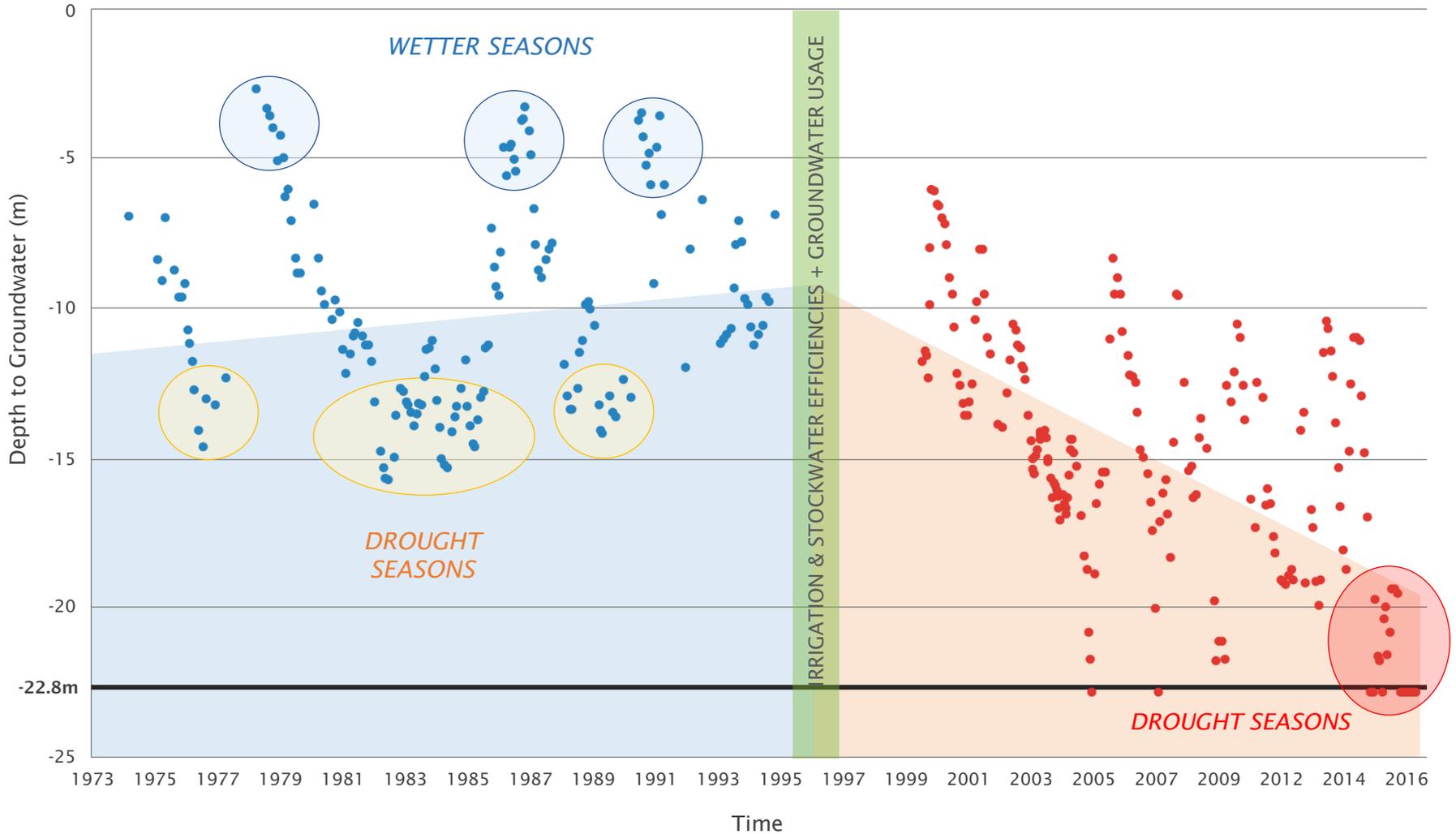
All the contributors



Changing dynamic groundwater storage

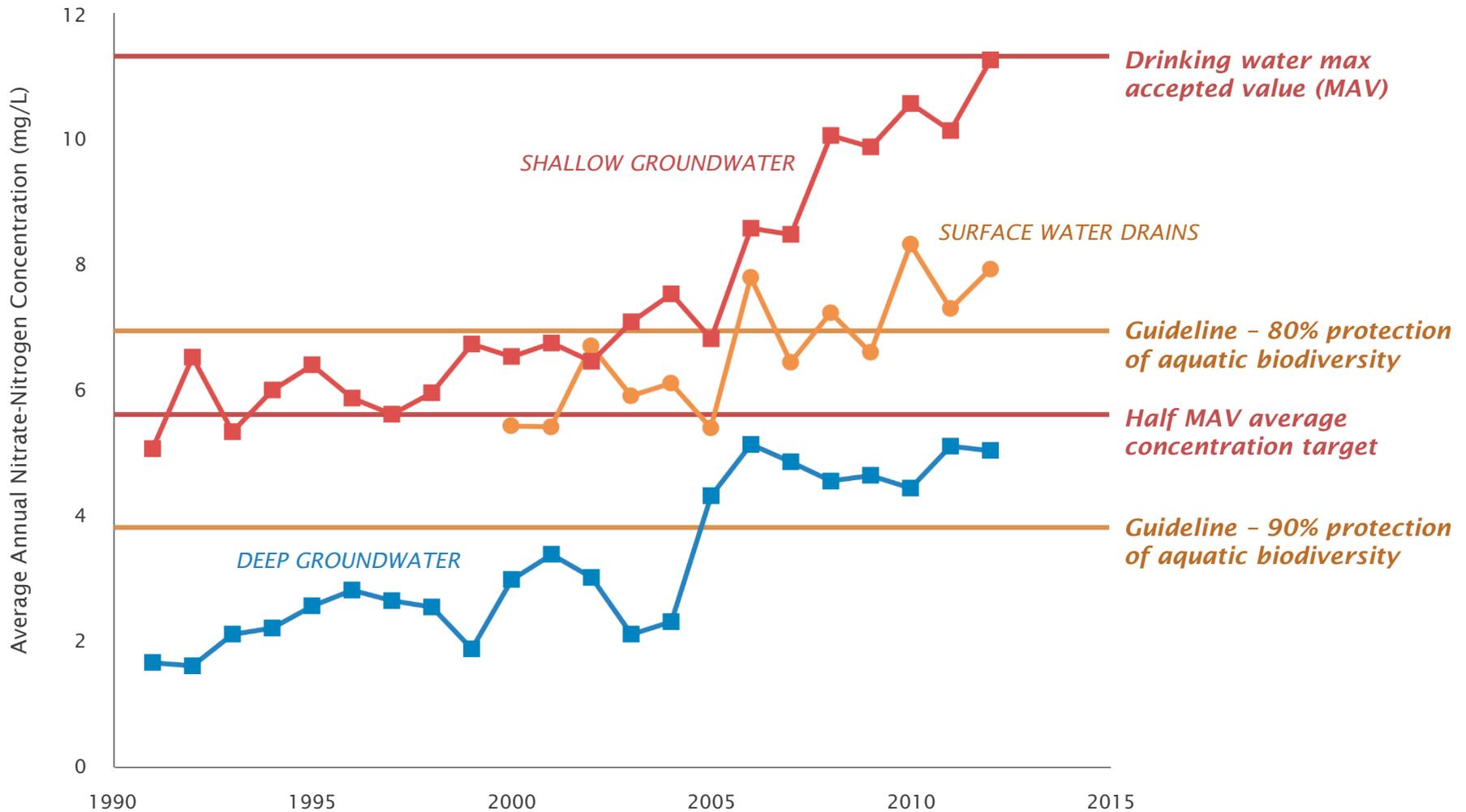
DEPTH OF BORE LEVELS (K37/0300 - GWE-4)

1973 - 2016



QUALITY TRENDS

Rise of Nitrate Levels



Hinds Mitigations

Community solutions

QUANTITY

Cap new groundwater allocations

Review existing permits for actual usage (metering rule)

Allow surface users to transfer to groundwater

Initiate MAR pilot for proof of concept testing

QUALITY

Reduce nitrogen losses at farm level up to 36% by 2035

Restriction of new 'intensification' of land use until target is reached (< 6.9 mg/L)

Initiate MAR pilot for proof of concept testing

MAR Pilot Project

2016 – 2021

5 YEAR CONSENT

Phase 1 (Year 1) and Phase 2

SOURCE WATER

Rangitata River ADC Existing Consent (500 L/s)

MANAGEMENT

Hinds MAR Working Group

FUNDING

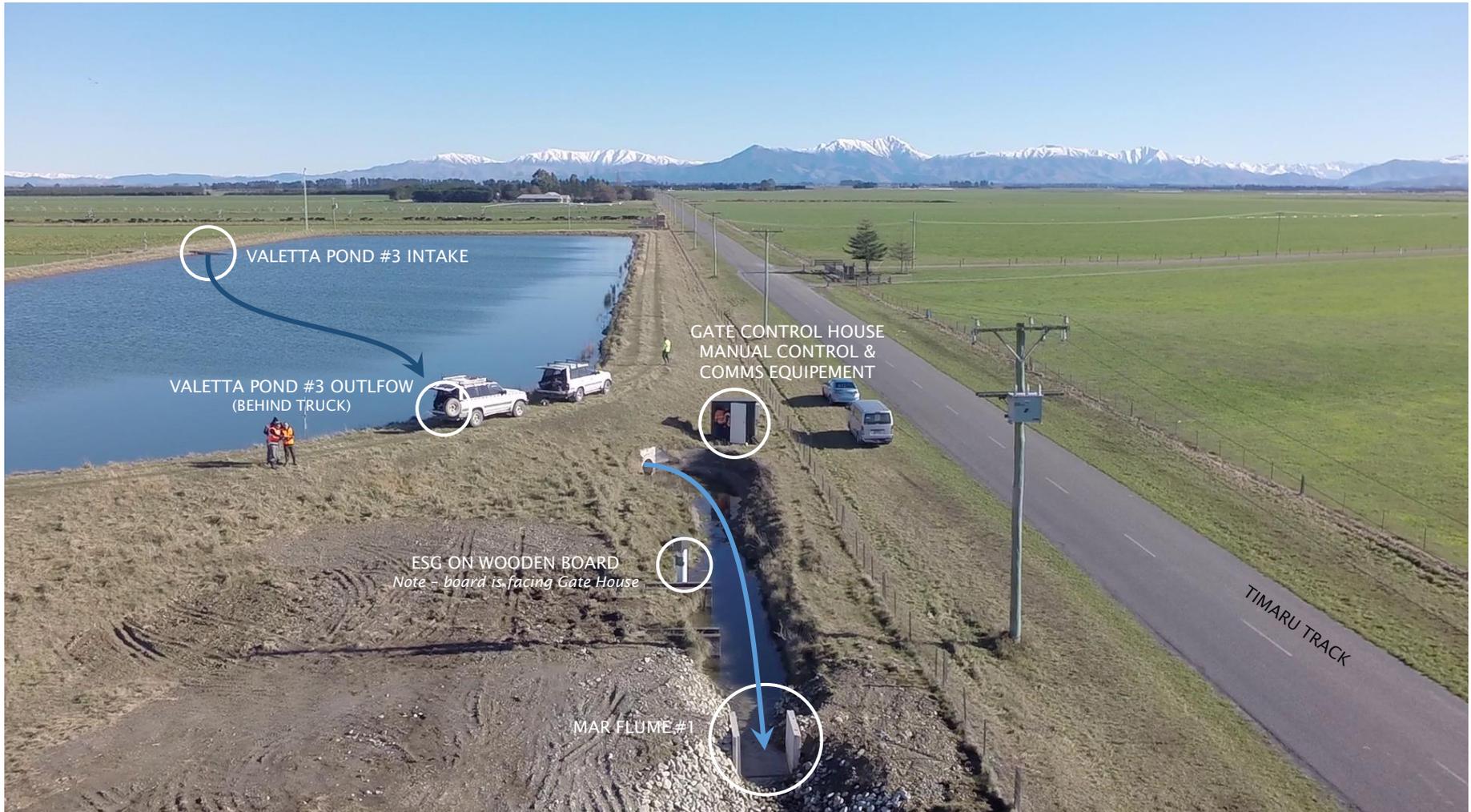
MPI, Ecan, Community & *In-kind*

PROJECT RESEARCH

Nitrogen tracking, rural drinking water, aquifer mapping & modelling

SITE FUNCTIONALITY

MAR Site - Intake off Valetta Irrigation



MAR OPERATIONS

Infiltration Basin with Forebay, and Monitoring



Site Operations Results

At the MAR Site

General operations – progressing
well

Current recharge rates – 100 to 105 L/s

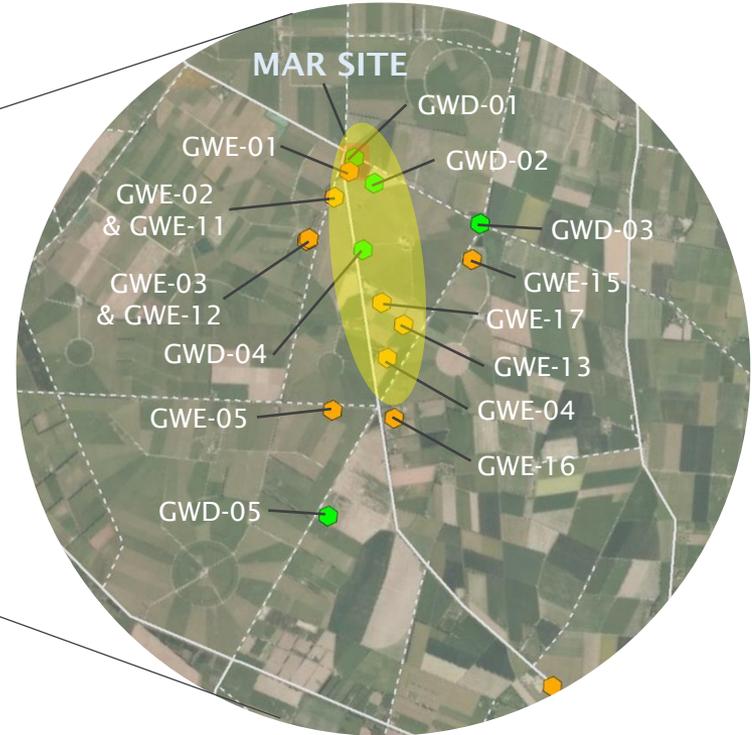
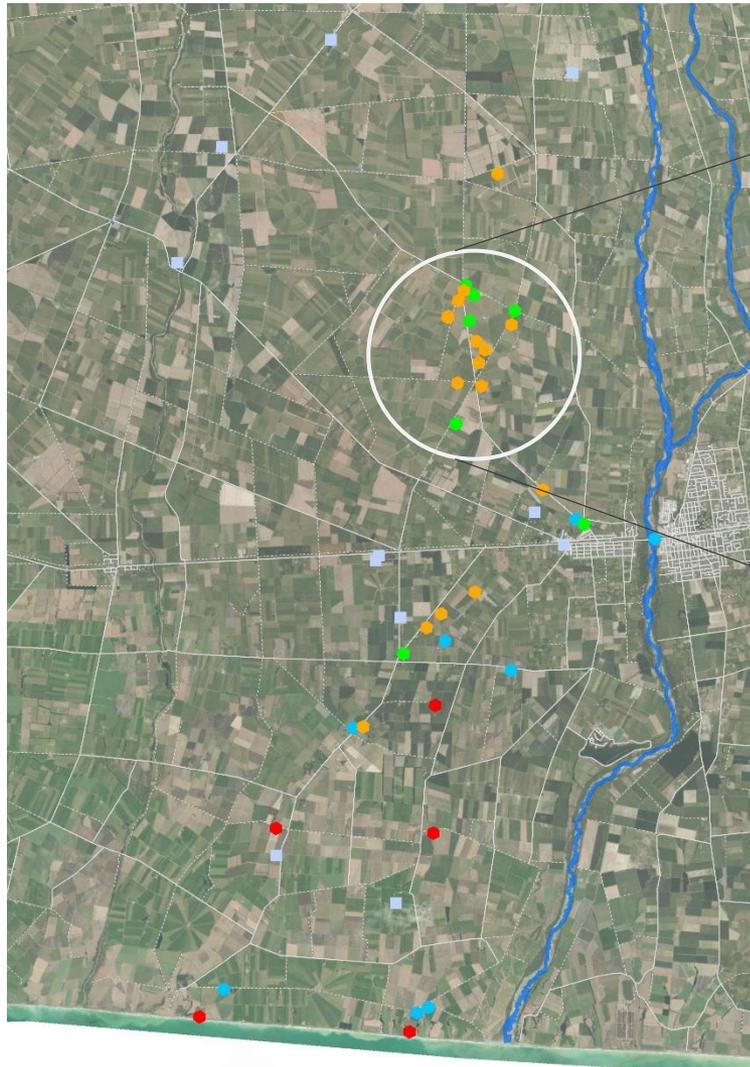
Total recharge (to date) – 1.9 million m³

(2% of allocation limit)

>220 days operations (started 10 June
2016)

HINDS MAR PILOT PROJECT MONITORING NETWORK

Mountains to the sea – monitoring surface and groundwater, dependent ecology



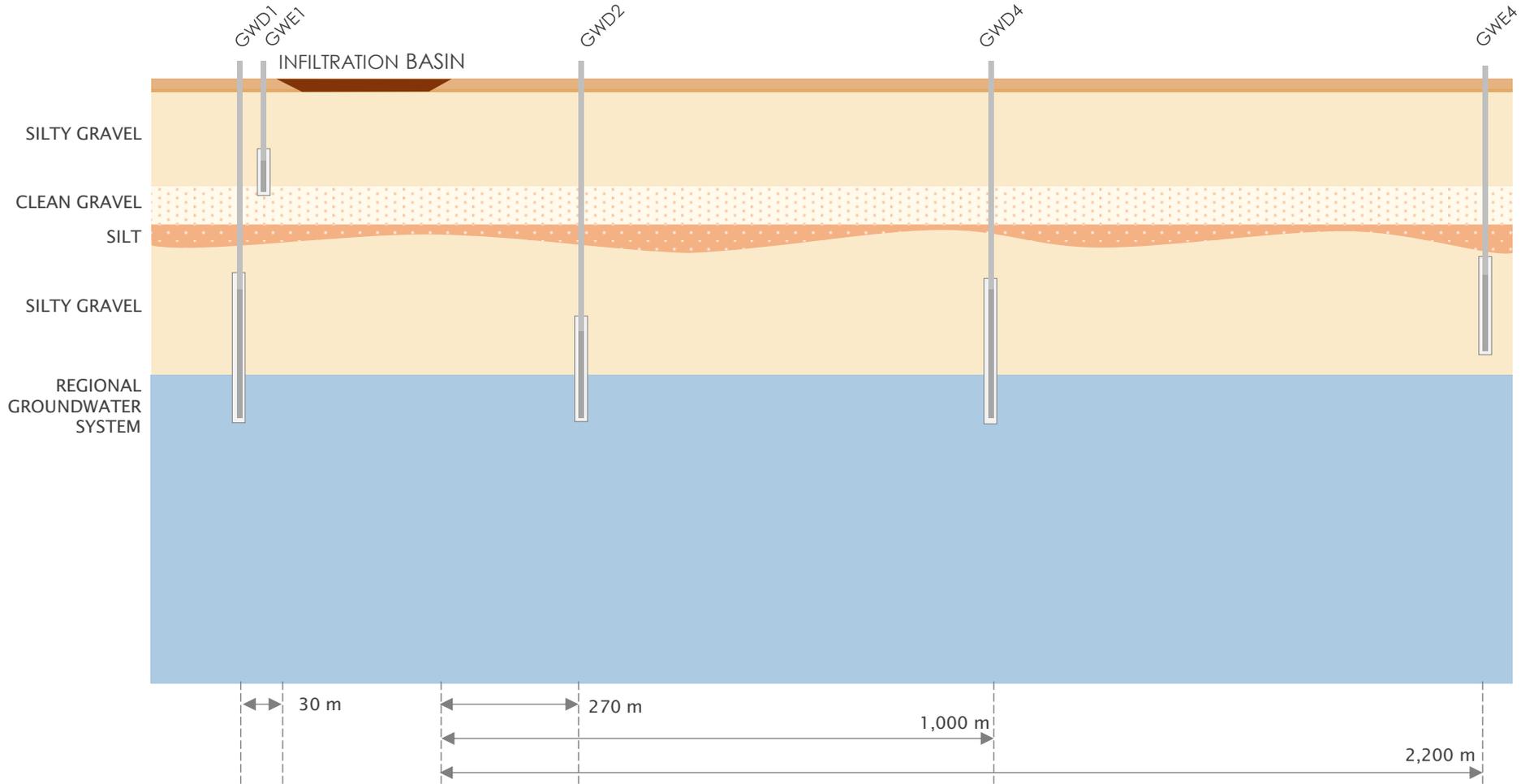
- Existing monitoring sites
- New monitoring sites (Golder 2016)
- Surface water
- Ecology monitoring sites
- ECAN water quality wells

Water Quantity Results

Start 10 June 2016 - 150+ days of operations

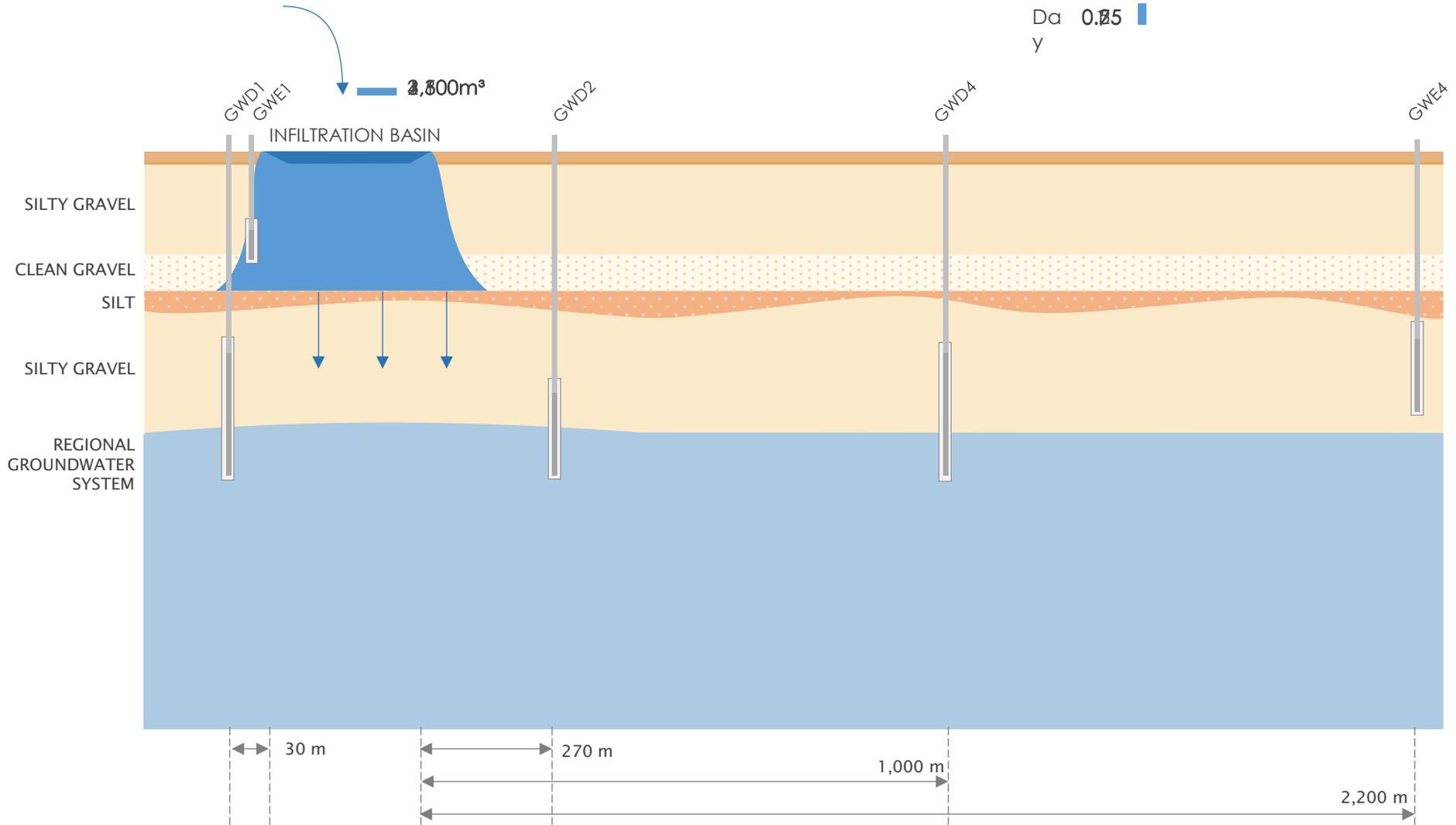
CROSS SECTION FROM MAR SITE TO FRASTERS ROAD

What is going on down below



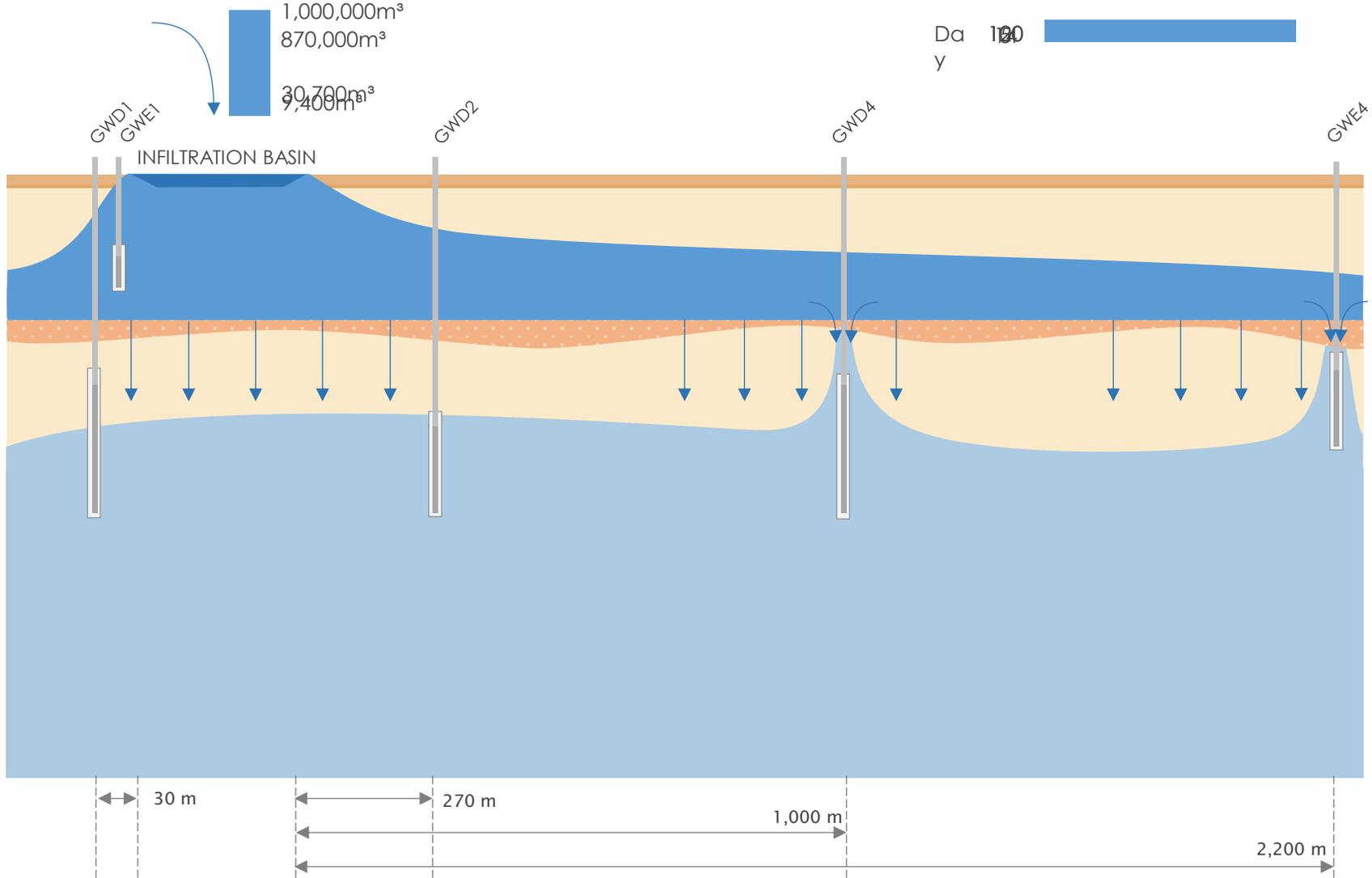
CROSS SECTION FROM MAR SITE TO FRASTERS ROAD

What is going on down below



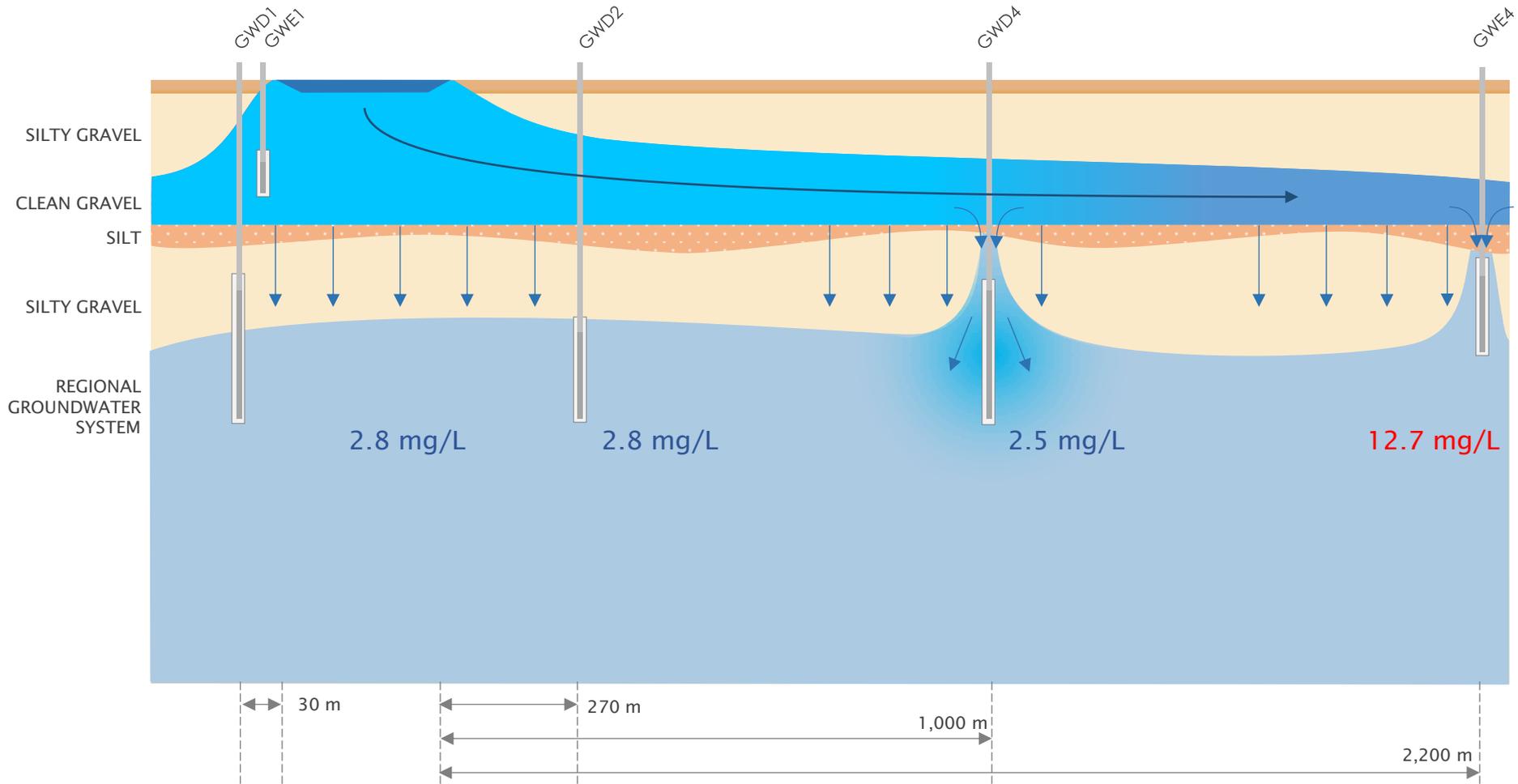
CROSS SECTION FROM MAR SITE TO FRASTERS ROAD

What is going on down below

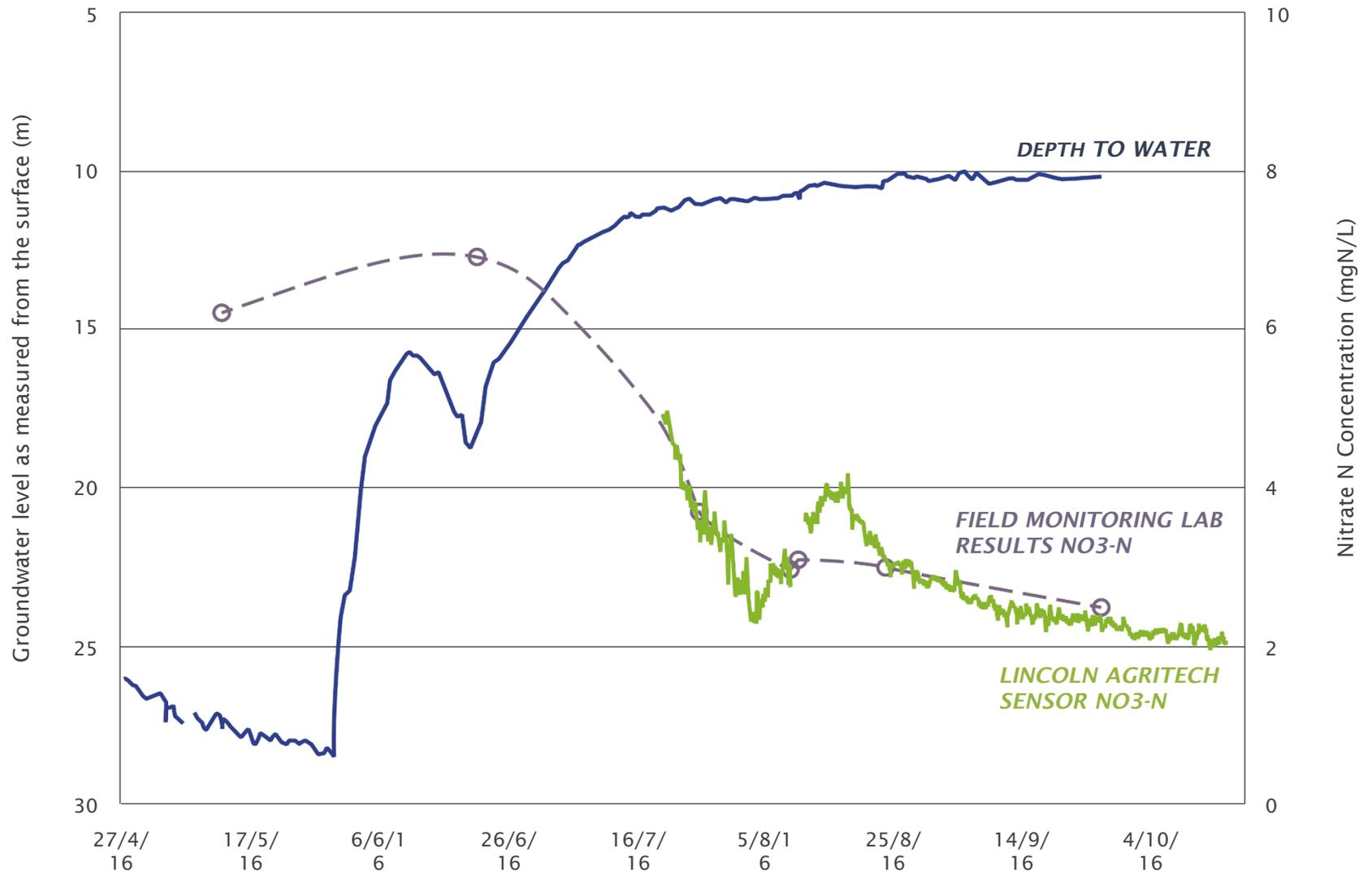


Movement of clean water plume

Slower than pressure response of groundwater



GROUNDWATER LEVELS MEASURED FROM SURFACE



Project Summary

Where we're at

Year 1 operations – 9 June 2017

Final reports – August 2017

Year 2 operations would start on 10 June 2017

Phase 2:

Governance Group 1st March 2017

**Develop business case for Groundwater
Replenishment Scheme for Mid-Canterbury**

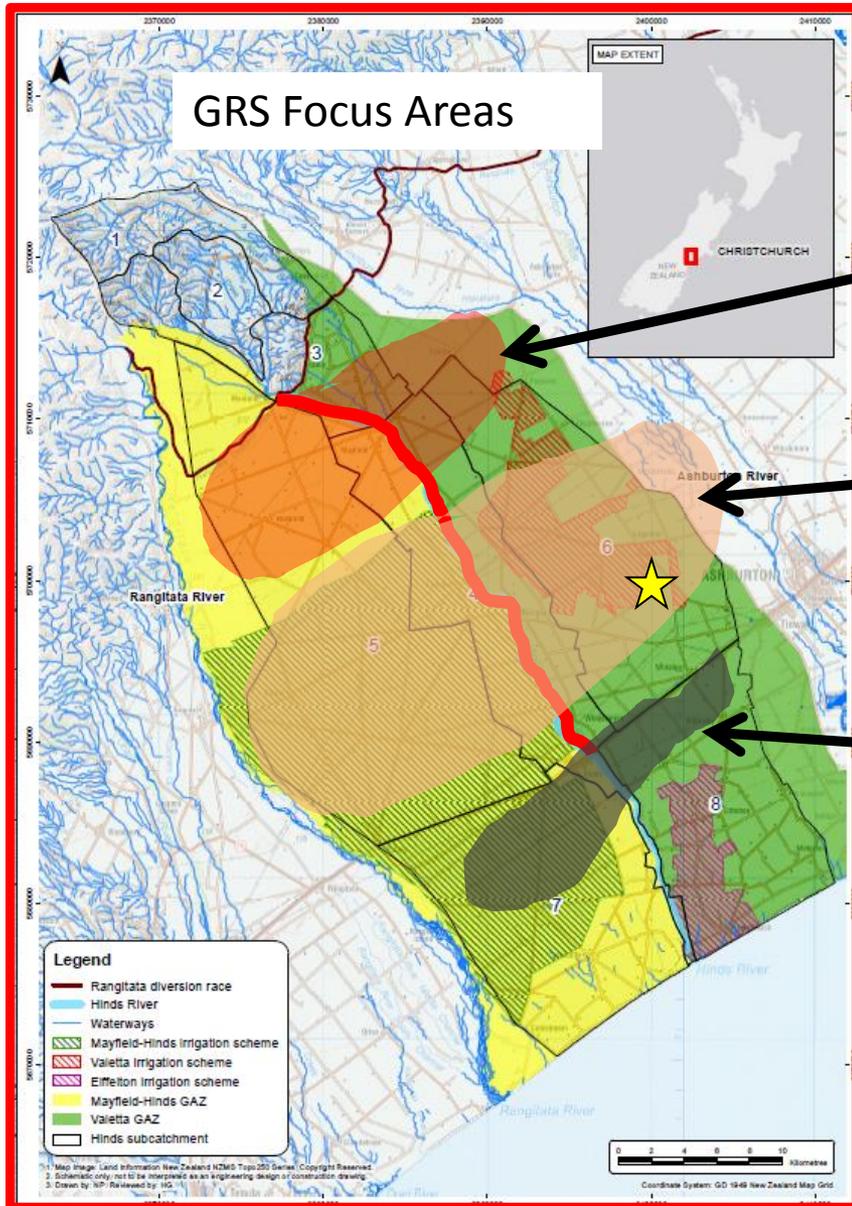
Peter Lowe, Chairman - Hinds MAR Pilot

Working Group -

Managing Groundwater at Catchment Level

Groundwater Replenishment Scheme – *“A systems approach”*

Hinds Catchment: Groundwater Replenishment Programme



Upper Plains – large infiltration basins (water banking)

Mid-Plains: 'on-farm' galleries or smaller basins (nitrogen mitigation and water banking)

Coastal springs: basins/galleries (targeted baseflows and offset pumping)

Ground Water
Replenishment
Scheme
Modelling



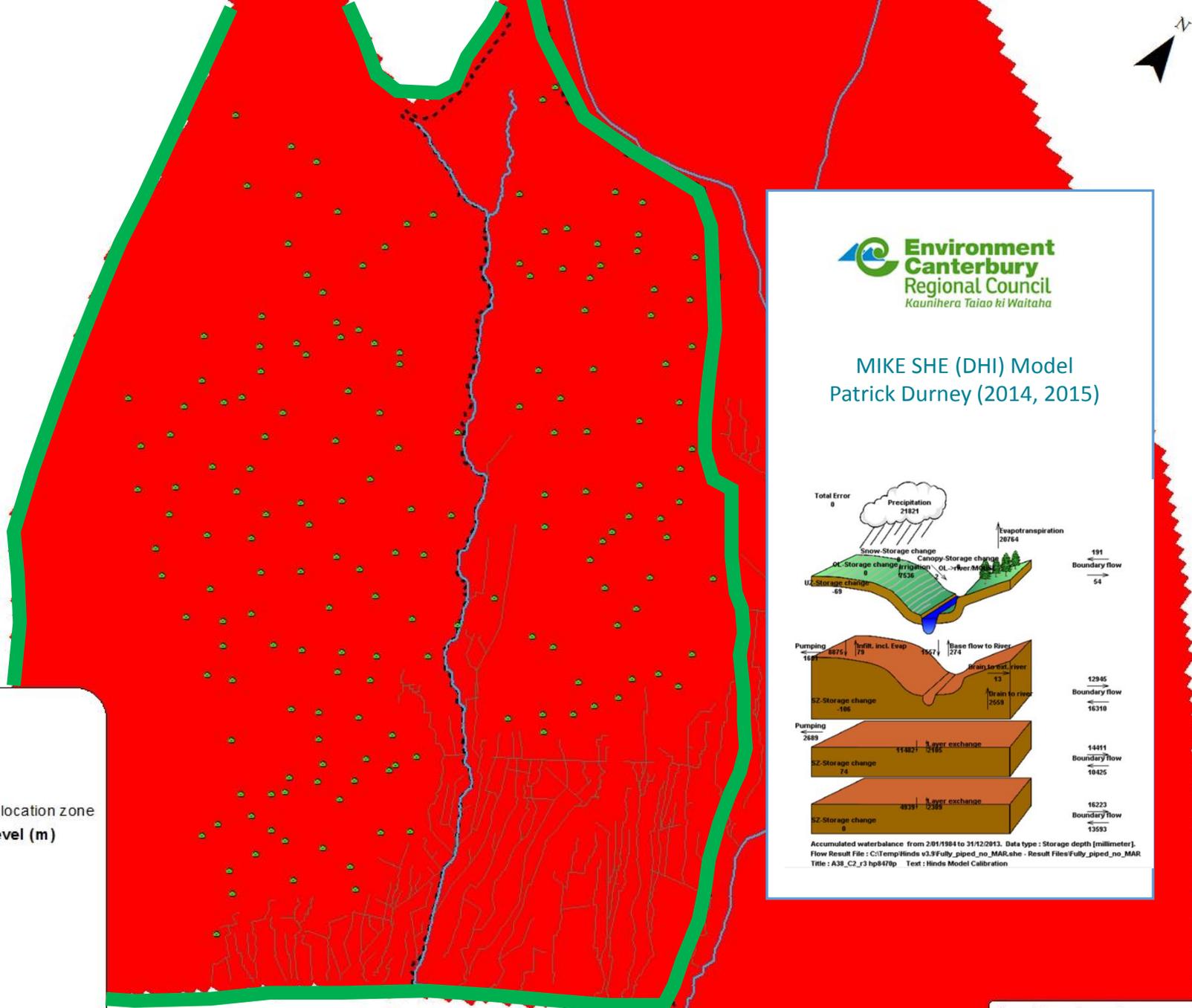
Model 0000

Legend

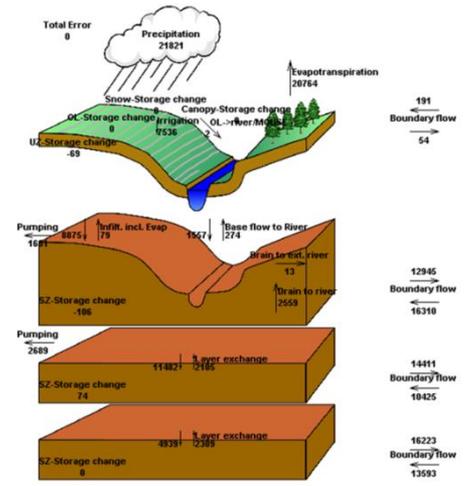
- MAR site
- River
- Coastal drains
- Valetta groundwater allocation zone

Modelled groundwater level (m)

	<+0.03
	+0.03 - +0.08
	+0.08 - +0.14
	+0.14 - +0.19
	+0.19 - +0.24
	+0.24 - +0.47
	+0.47 - +1.16
	+1.06 - +3
	+3 - +6
	>+6



MIKE SHE (DHI) Model
Patrick Durney (2014, 2015)



Accumulated waterbalance from 2/01/1984 to 31/12/2013. Data type : Storage depth (millimeter).
Flow Result File : C:\Temp\blinds v1.9\Fully_piped_no_MAR.she - Result Files\Fully_piped_no_MAR
Title : A38_C2_r3 hp8470p Text : Hinds Model Calibration



Ground Water
Replenishment
Scheme
Modelling

4th Year

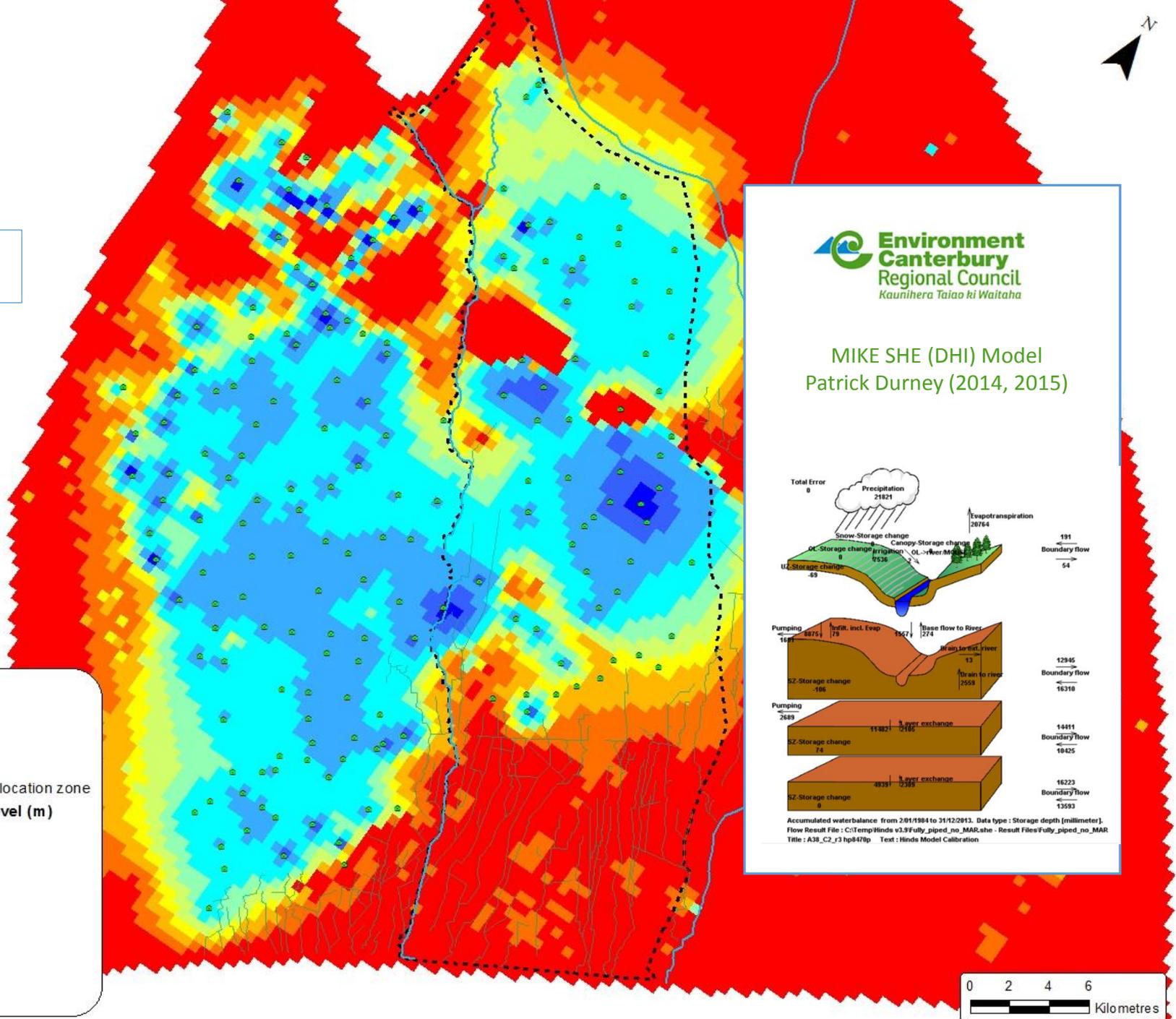
Model 0120

Legend

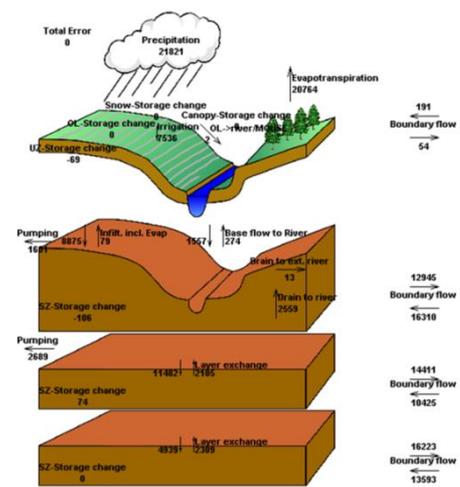
-  MAR site
-  River
-  Coastal drains
-  Valetta groundwater allocation zone

Modelled groundwater level (m)

-  <+0.03
-  +0.03 - +0.08
-  +0.08 - +0.14
-  +0.14 - +0.19
-  +0.19 - +0.30
-  +0.30 - +0.47
-  +0.47 - +1.06
-  +1.06 - +3
-  +3 - +6
-  >+6



MIKE SHE (DHI) Model
Patrick Durney (2014, 2015)



Accumulated waterbalance from 201/1984 to 31/12/2013. Data type : Storage depth (millimeter).
Flow Result File : C:\Temp\blinds v3.9\Fully_piped_no_MAR.she - Result Files\Fully_piped_no_MAR
Title : A38_C2_r3 hp8470p Text : Hinds Model Calibration



Ground Water
Replenishment
Scheme
Modelling

10th Year

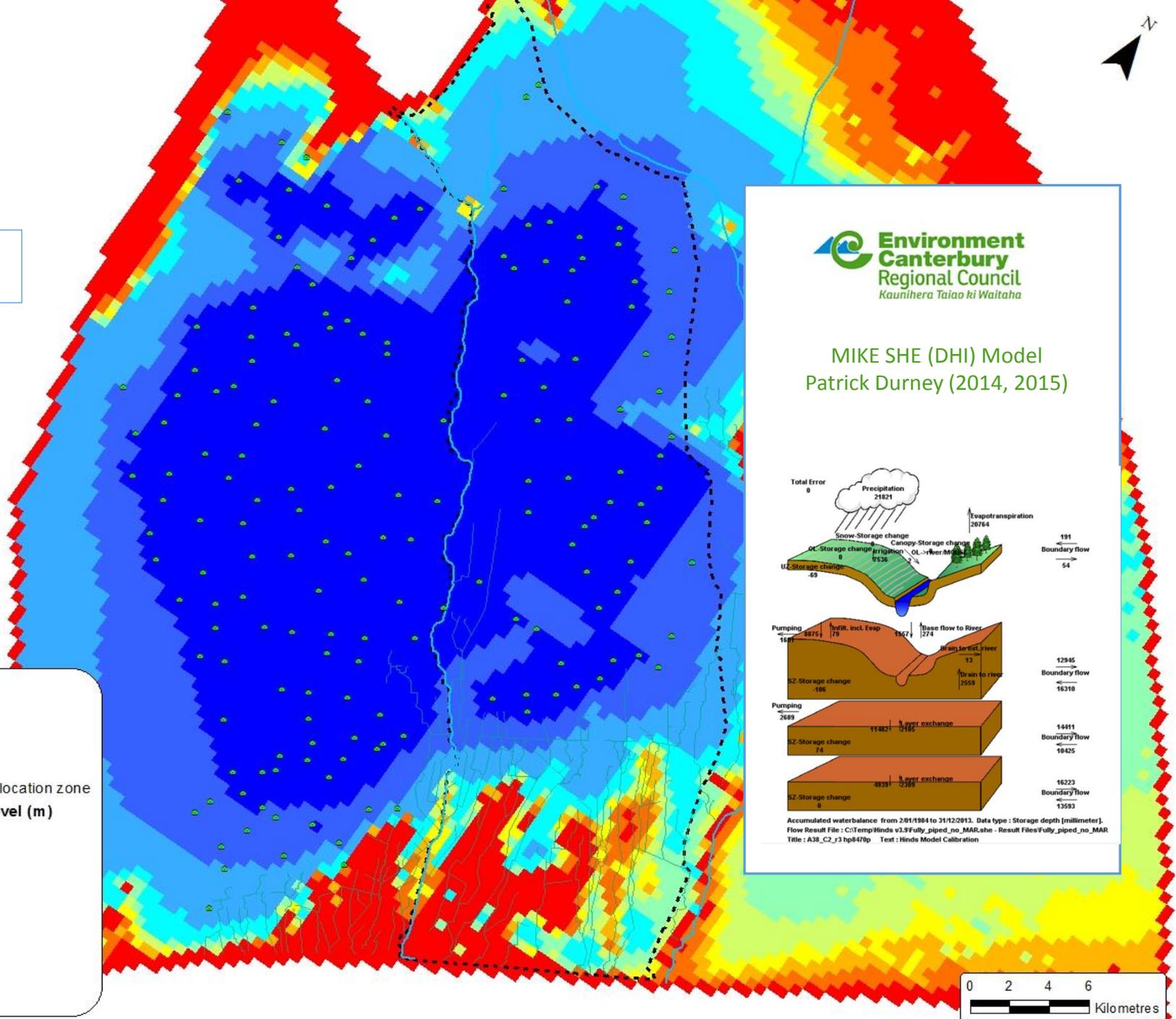
Model 1200

Legend

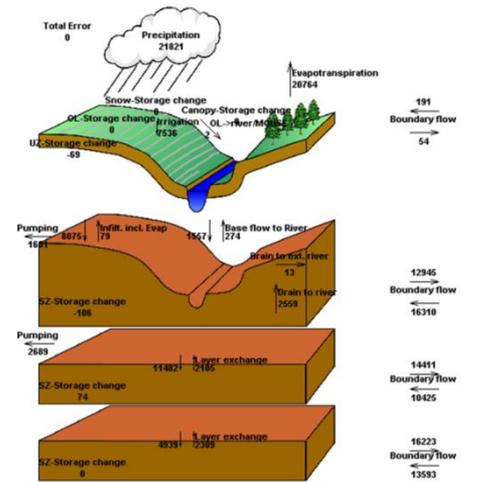
- MAR site
- River
- Coastal drains
- Valetta groundwater allocation zone

Modelled groundwater level (m)

- <+0.03
- +0.03 - +0.08
- +0.08 - +0.14
- +0.14 - +0.19
- +0.19 - +0.30
- +0.30 - +0.47
- +0.47 - +1.06
- +1.06 - +3
- +3 - +6
- >+6



MIKE SHE (DHI) Model
Patrick Durney (2014, 2015)

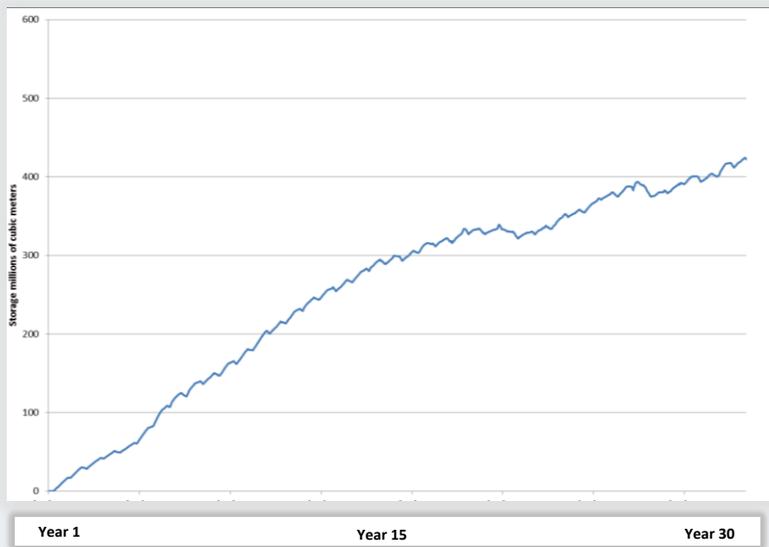


Accumulated waterbalance from 201/1984 to 31/12/2013. Data type : Storage depth (millimeter).
Flow Result File : C:\Temp\binds\v3.9\Fully_piped_no_MAR_she - Result Files\Fully_piped_no_MAR
Title : A39_C2_r3 hp8470p Text : Hinds Model Calibration



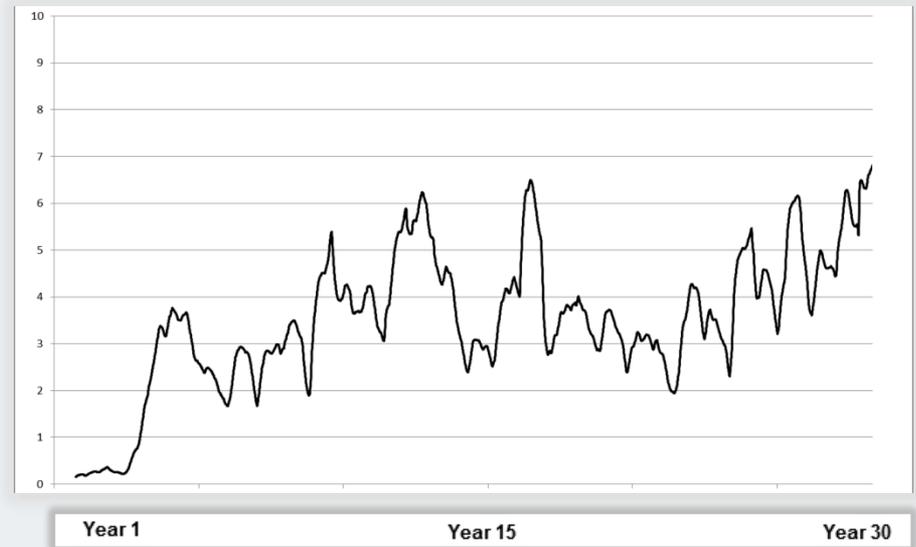
Groundwater storage and restored baseflows

Change in storage (Million m³)



1 Million m³ = 1 gigalitres

Spring-fed streams baseflows (m³/s)



1 m³/s = 1,000 L/s

TWO MAR PILOT PROJECT CURRENTLY UNDERWAY IN NZ

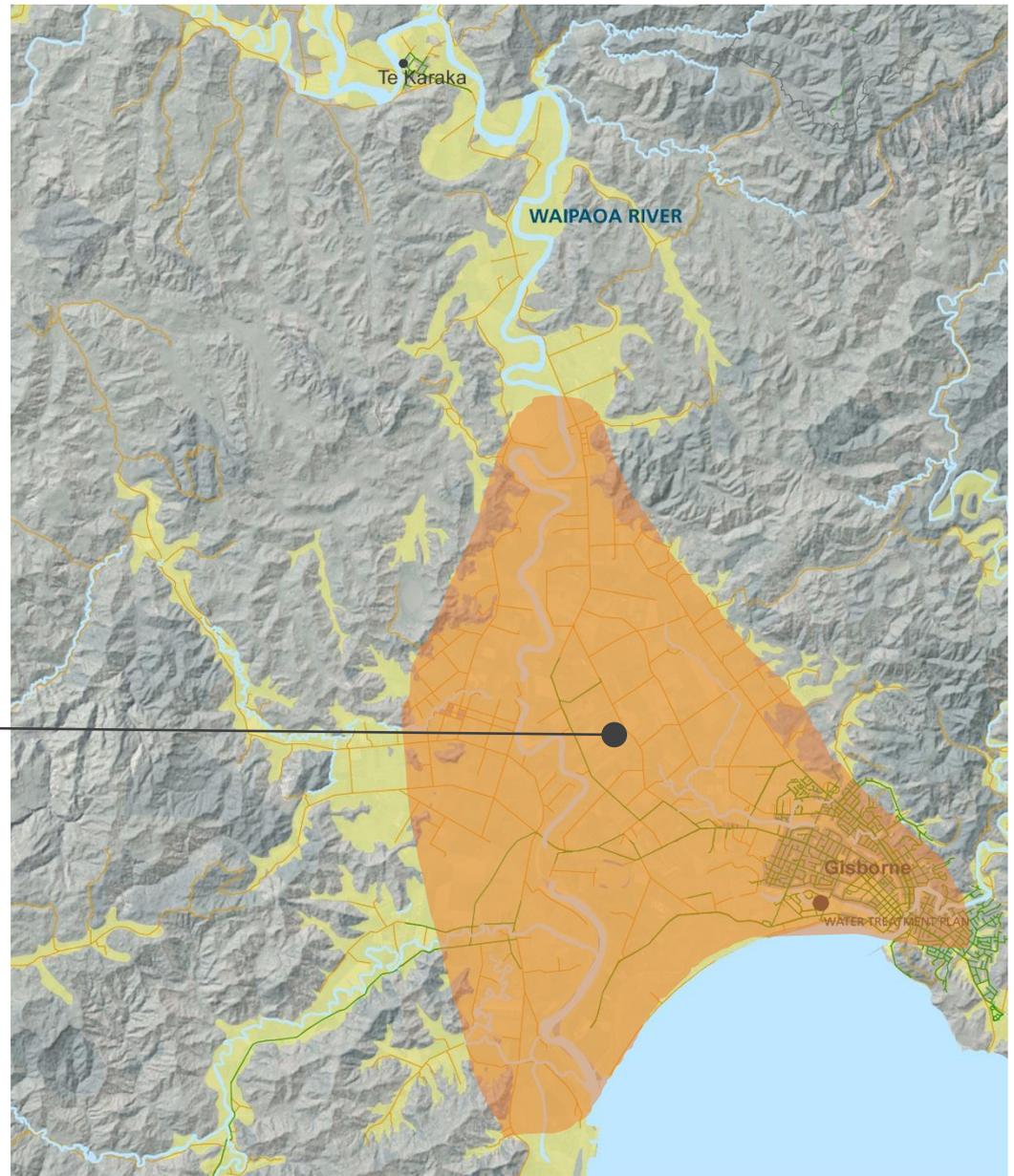


Gisborne MAR Pilot

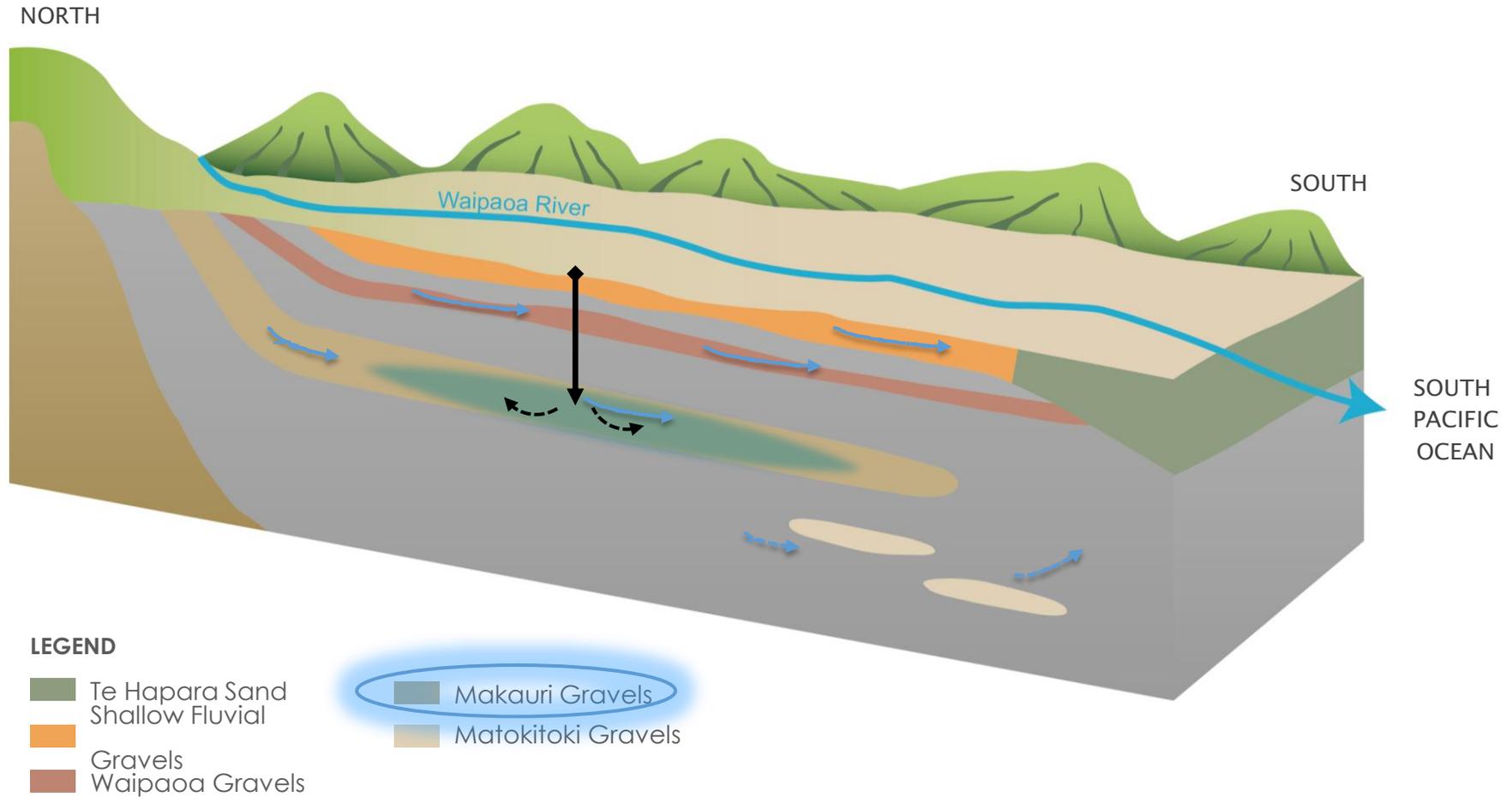
Hinds MAR Modelling & Pilot(s)

The Gisborne MAR Pilot Area

Groundwater Basin

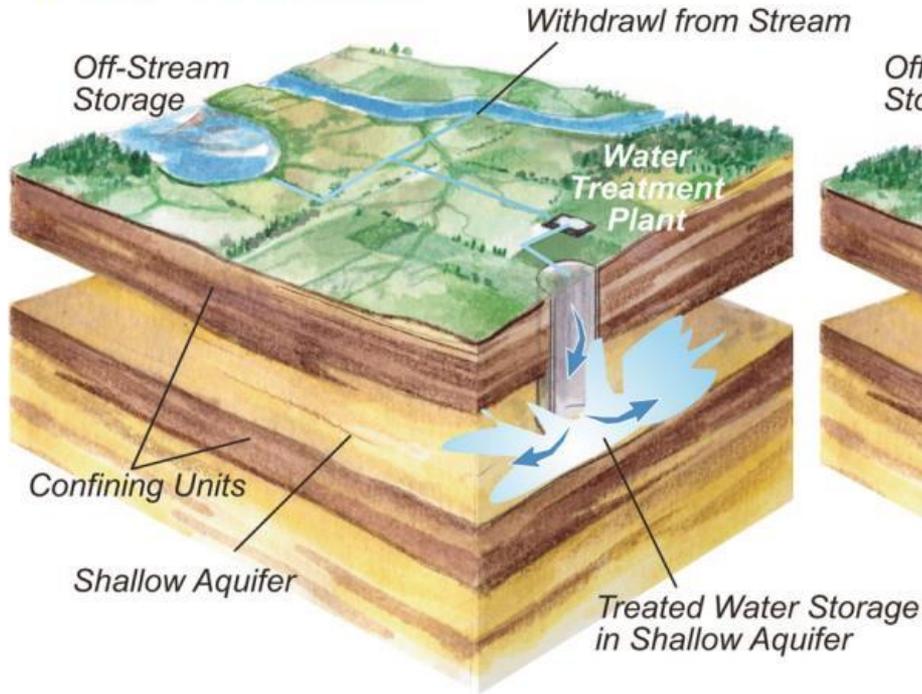


HYDROGEOLOGY POVERTY BAY

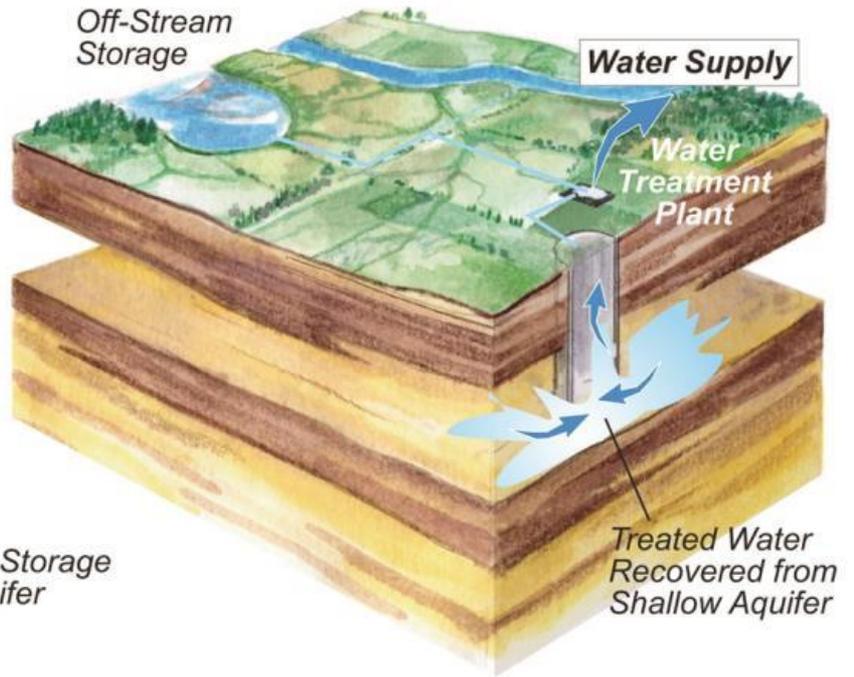


GISBORNE MAR TOOL - INJECTION

WET SEASON STORAGE

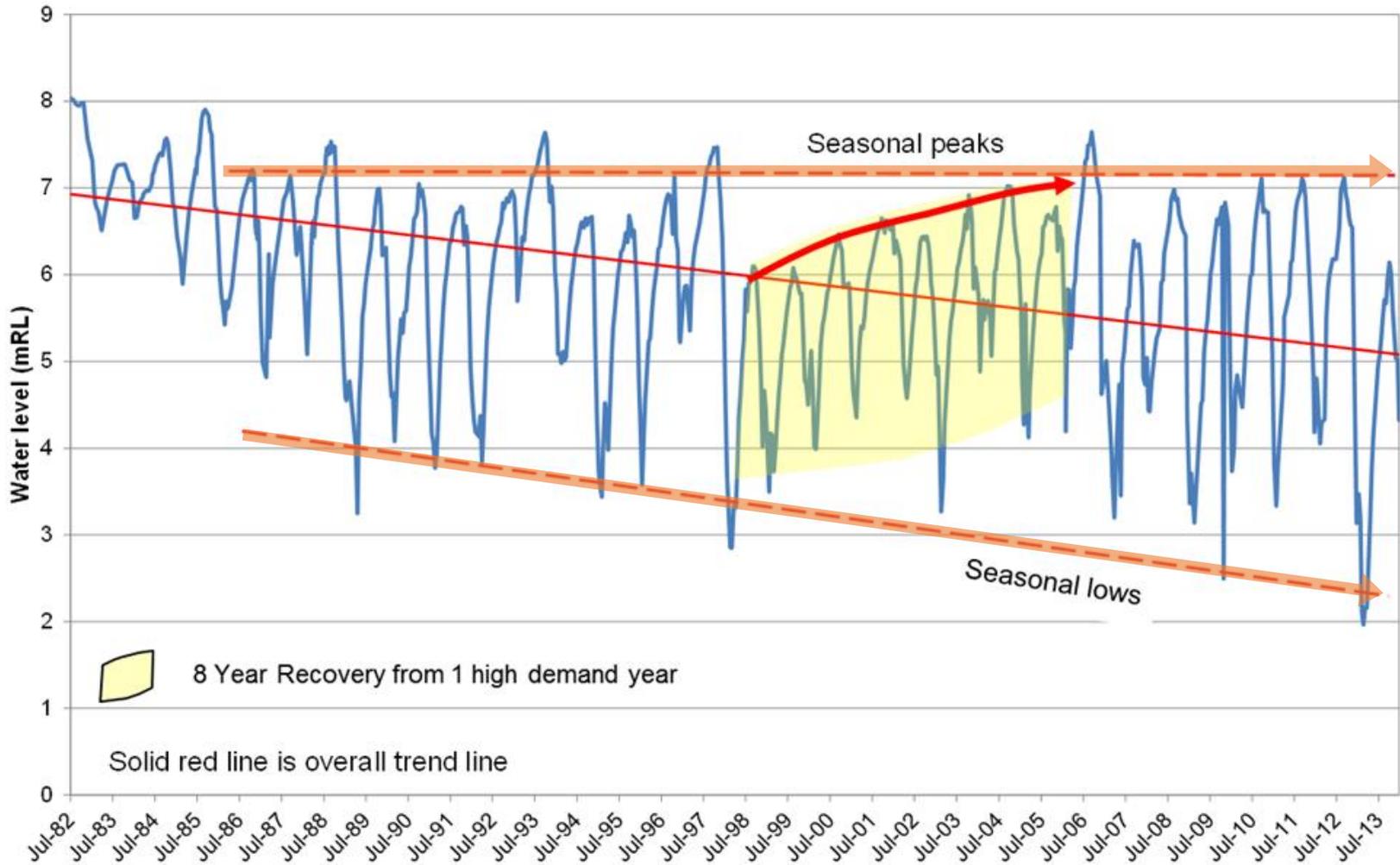


DRY SEASON DEPLETION

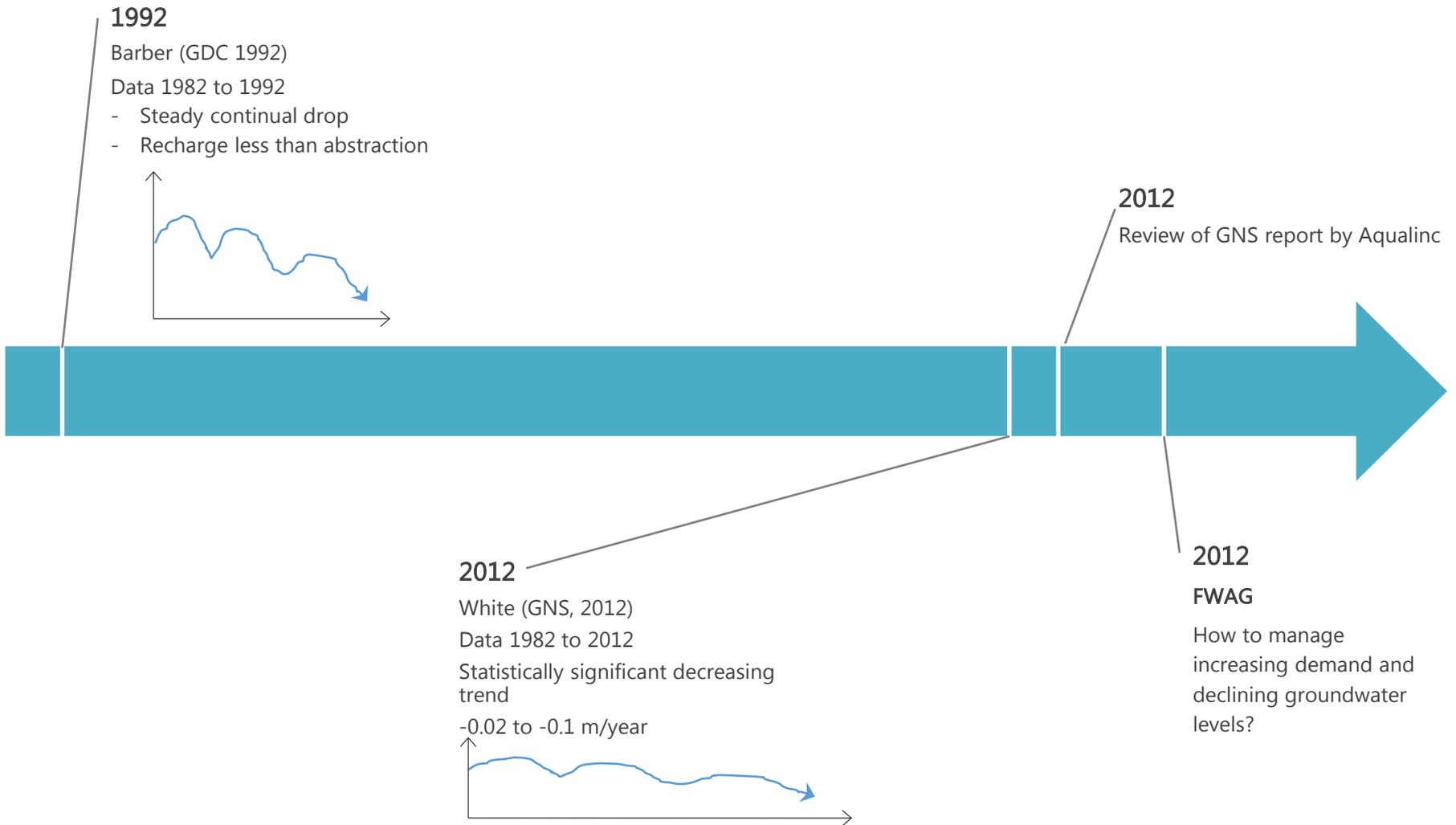


GROUNDWATER TRENDS

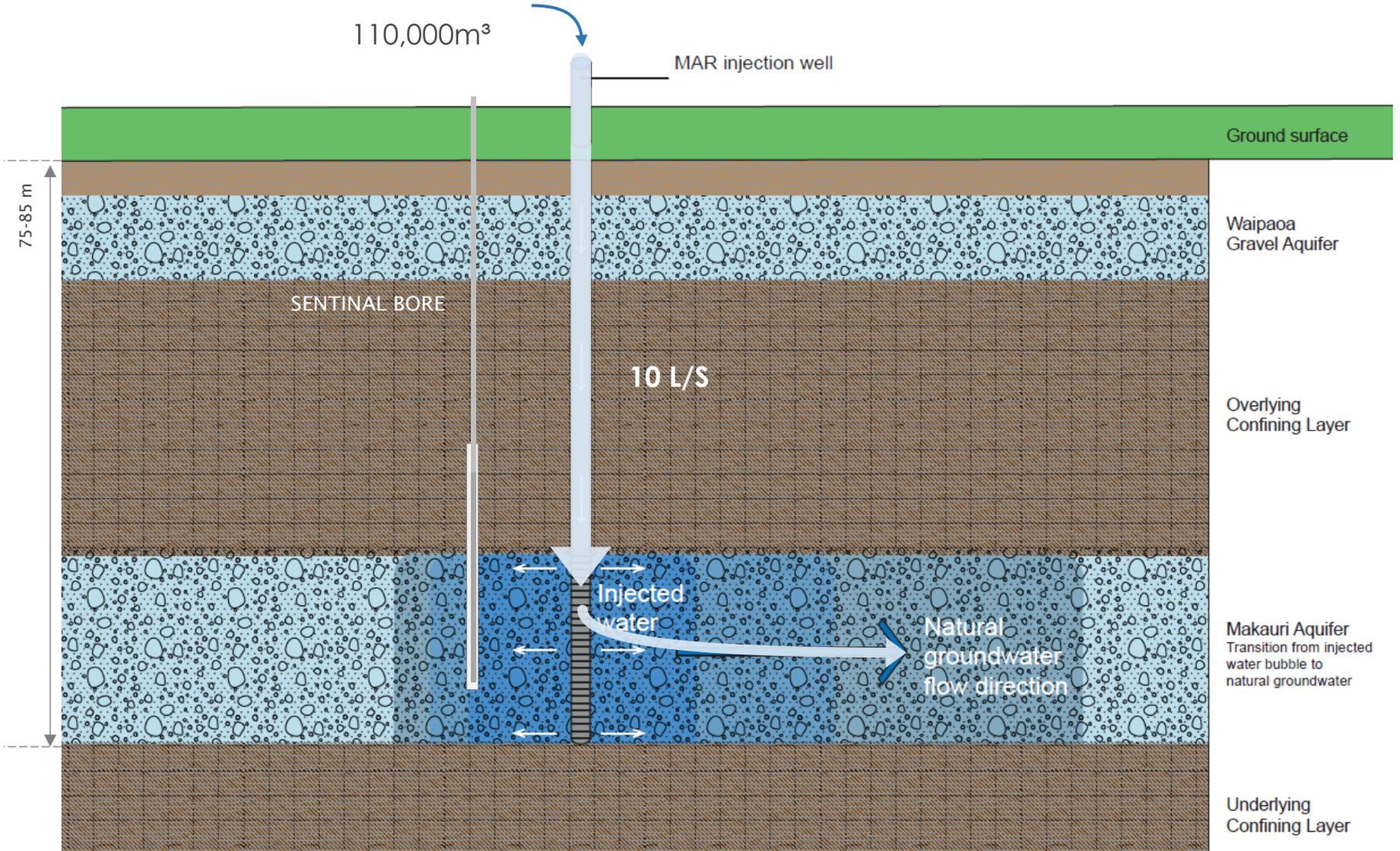
Declining median, increasing pumping effects, seasonal peaks & drought response



TIMELINE - 30 YEAR DISCUSSION - NOW ACTION



MAR INJECTION PROCESS



Poverty Bay MAR Pilot Project

2013 - 2016

5 YEAR CONSENT

Injection of a total volume of 110,000 m³

SOURCE WATER

Waipaoa River via Infiltration Gallery

MANAGEMENT

Gisborne District Council – for pilot, growers group forming a potential 'scheme'

FUNDING

MPI, Community & *In-kind*

TIMELINE

Drilling this summer, injection May 2017,
final report October 2017

Thank you