AQUALINC

Takaka Catchment

Flow & Water Quality
Scenario Modelling

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GROUNDWATER | IRRIGATION | RESOURCE CONSENTS | FARM ENVIRONMENT PLANS | EFFLUENT MANAGEMENT | WATER MANAGEMENT

22 May 2015

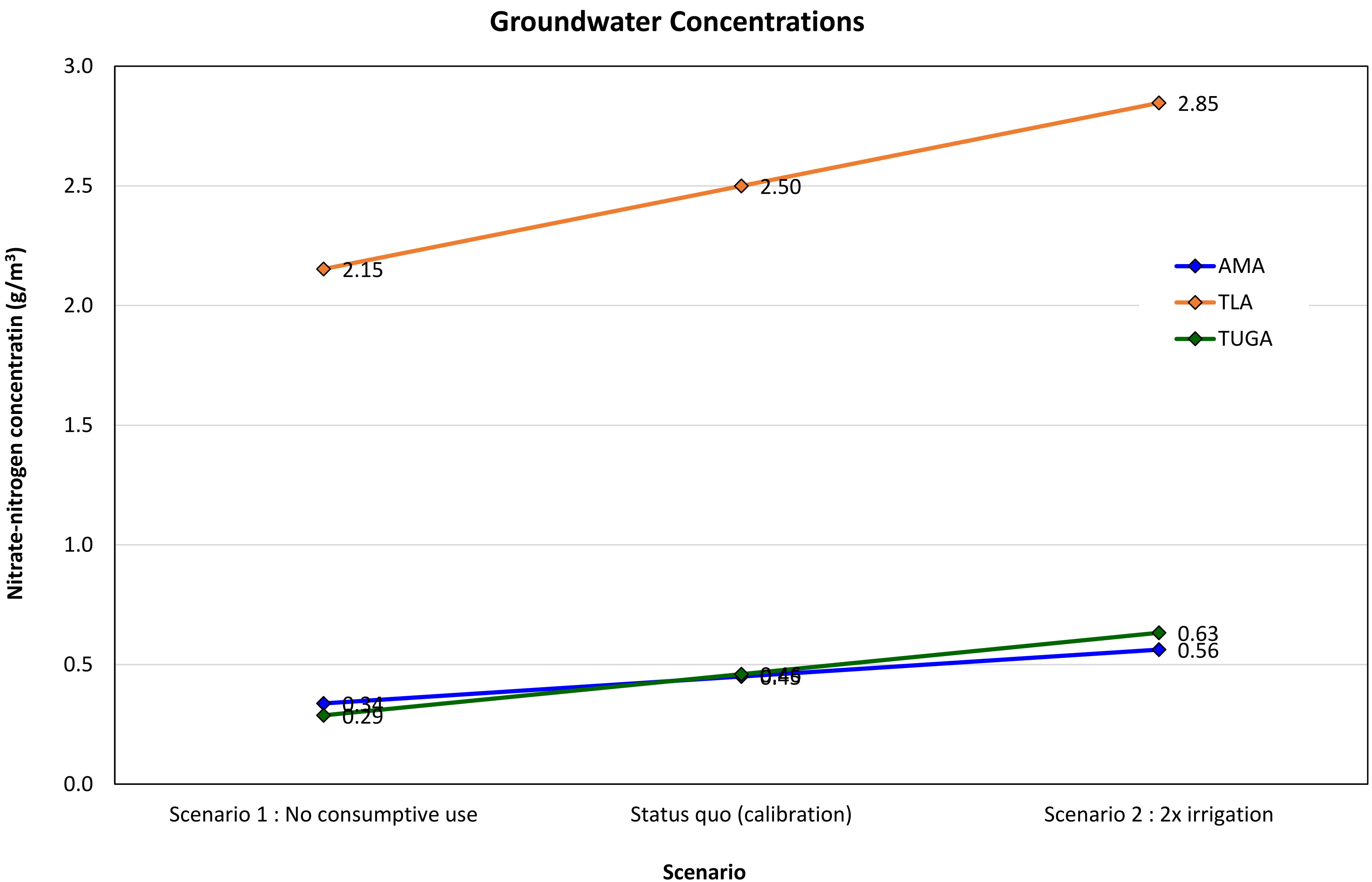
Inputs

Land cover	Area (ha)	Average NO_3-N (kg/ha/year)	Loading reference	Mass of NO_3-N (tonnes/year)
Forestry	67,400	3	Aqualinc (2014) Table 9, adjusted	202
Intensive pasture/dairying	2,226 [(1)]	50	Aqualinc (2014) Table 9, adjusted	111
Dryland/low intensity pasture	5,514 [(2)]	14	Aqualinc (2014) Table 9	77
Native grassland / hill scrubland	16,860	2.5	Hanson (2010) Tables 1-4	42
		Total		**433**

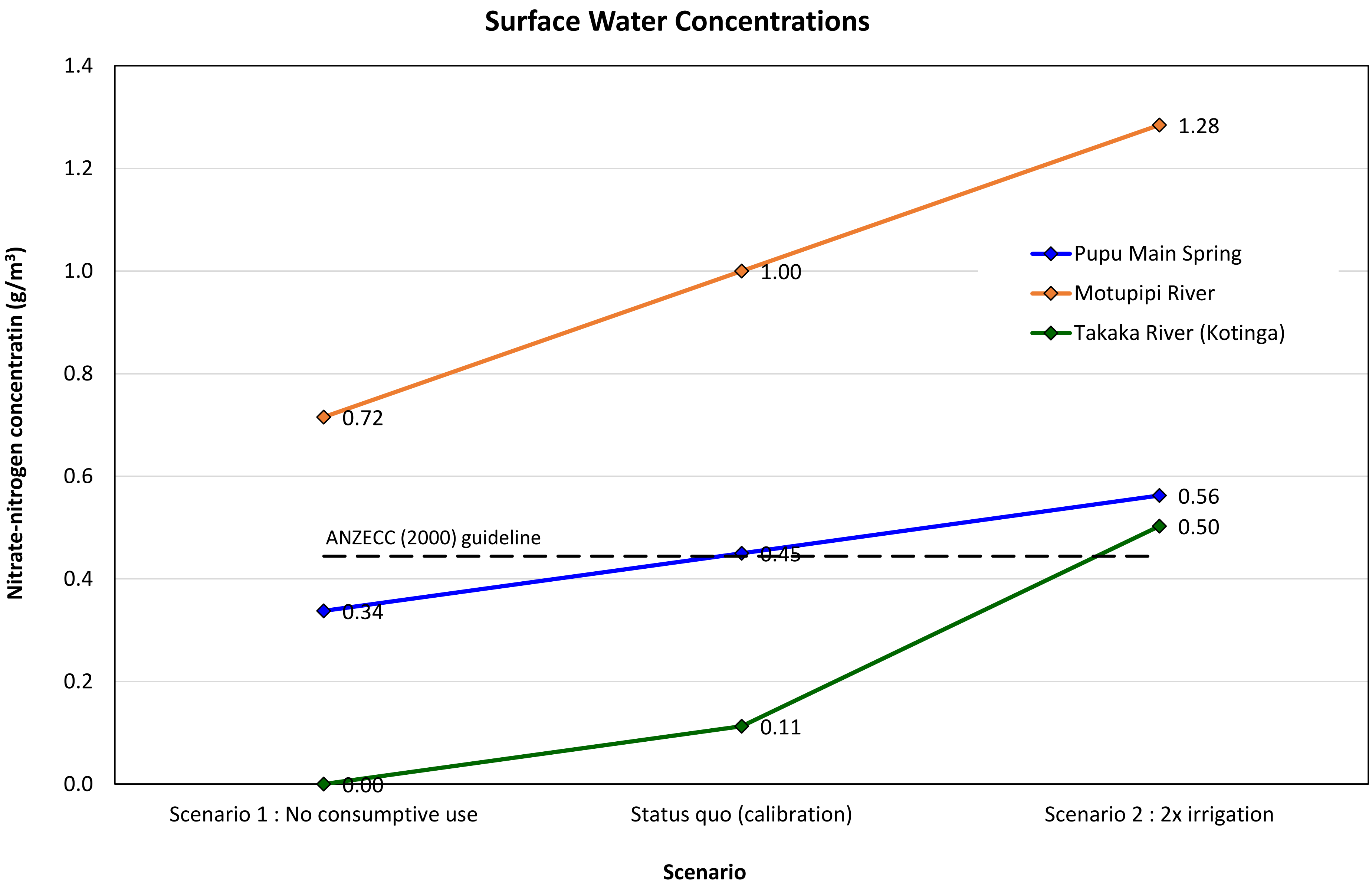
(1) Existing irrigated area (Table 6).
(2) Estimated based on remaining unirrigated area on valley floor.

Outputs

- Surface water: 376 tonnes/year
- Groundwater (subsurface flow): 155 tonnes/year
- **Total: 531 tonnes/year**



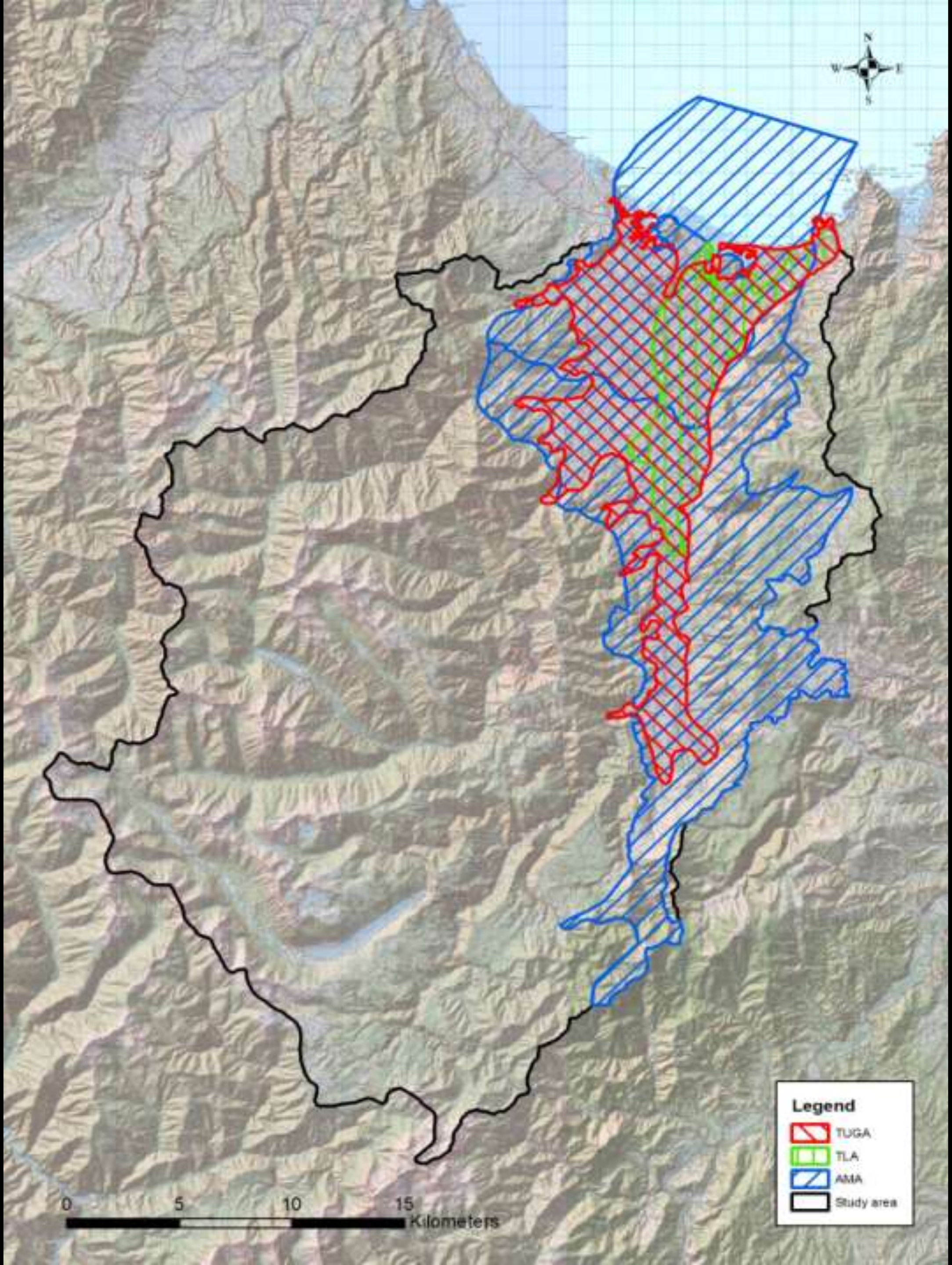
Groundwater Concentrations
Nitrate-nitrogen concentratin (g/m³)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.85
2.50
2.15
0.63
0.56
AMA
TLA
TUGA
Scenario 1 : No consumptive use
Status quo (calibration)
Scenario 2 : 2x irrigation
Scenario


Surface Water Concentrations
Nitrate-nitrogen concentratin (g/m³)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1.28
1.00
0.72
0.56
0.50
ANZECC (2000) guideline
0.45
0.34
0.11
0.00
Pupu Main Spring
Motupipi River
Takaka River (Kotinga)
Scenario 1 : No consumptive use
Status quo (calibration)
Scenario 2 : 2x irrigation
Scenario

Data Recap

- Thomas & Harvey (2013)
- Eigen models set up using:
  - Geology
  - Climate (rainfall and PET)
  - Soils
  - Land use
  - Consents and irrigated areas
  - Monitoring data (groundwater levels; river flows; quality)

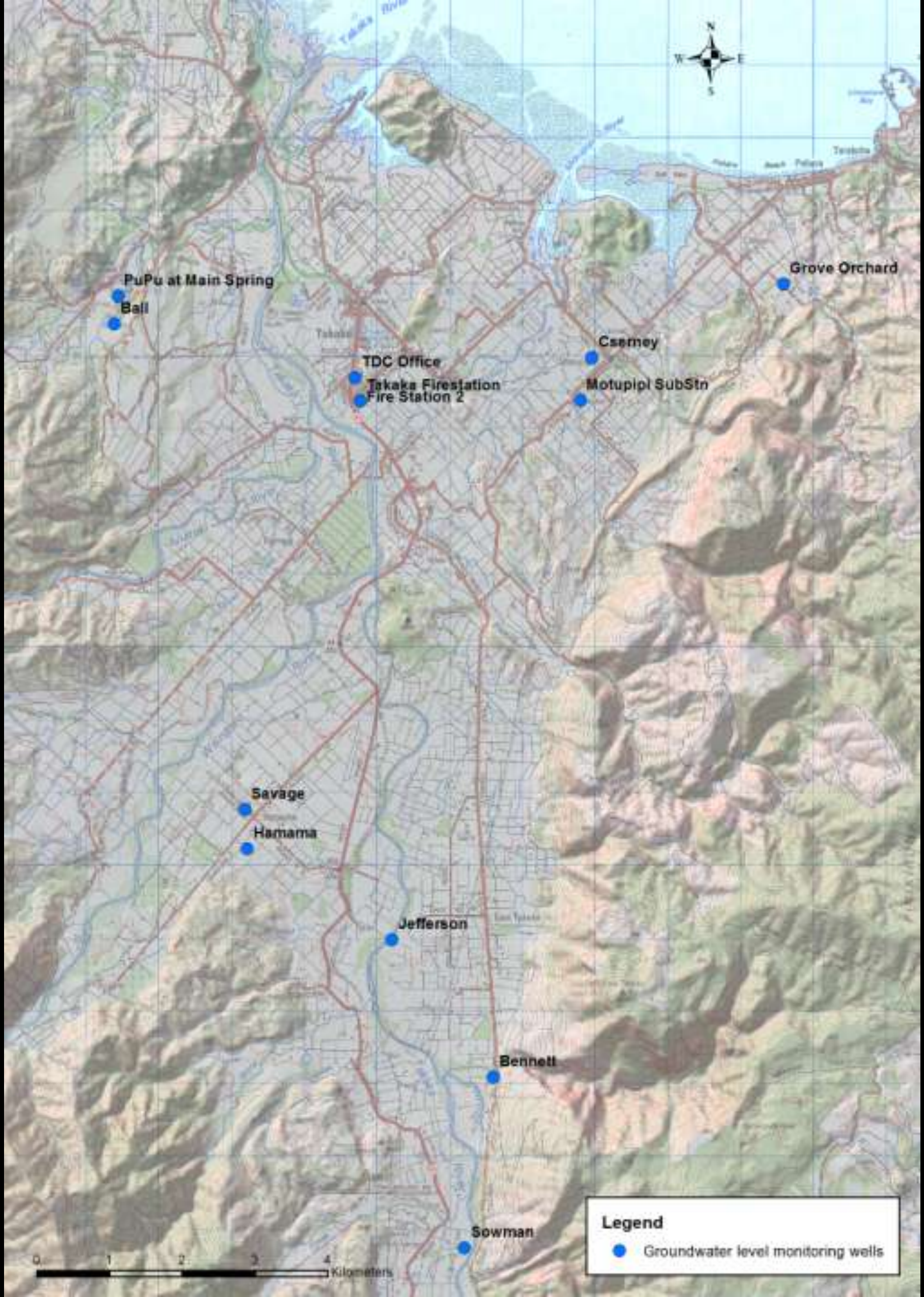
Aquifers

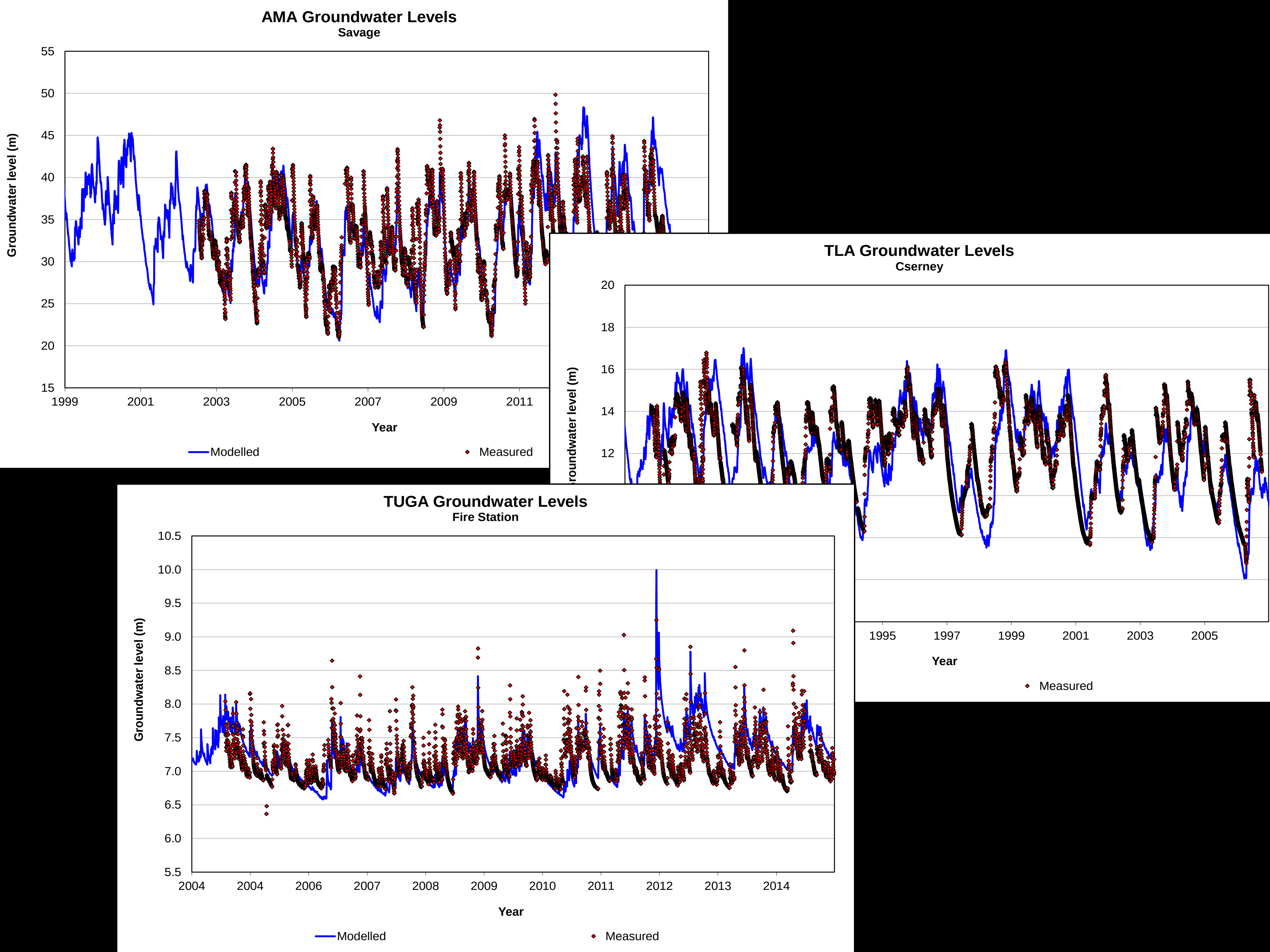


Calibration

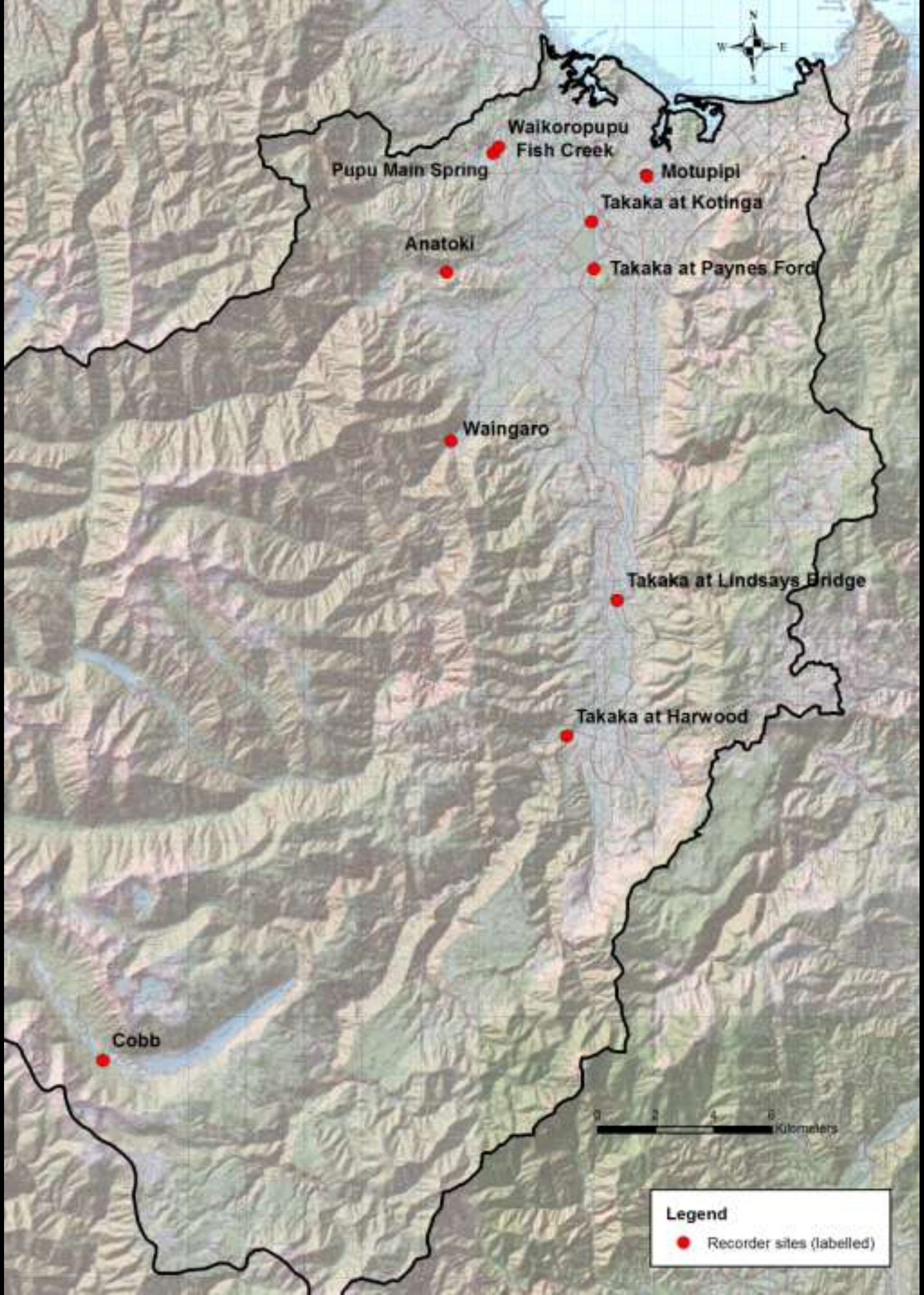
- Groundwater levels
- River flows

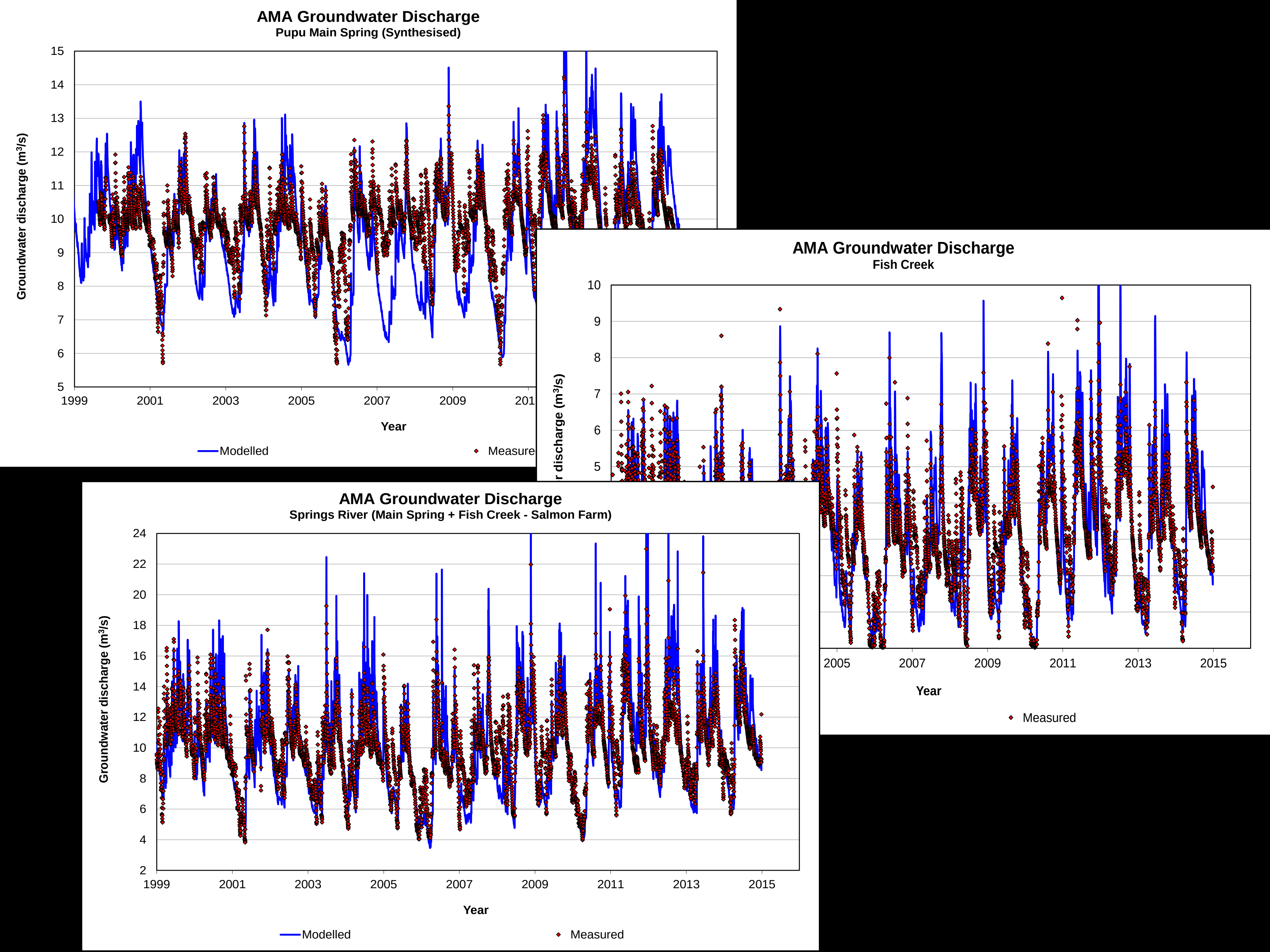
Groundwater levels

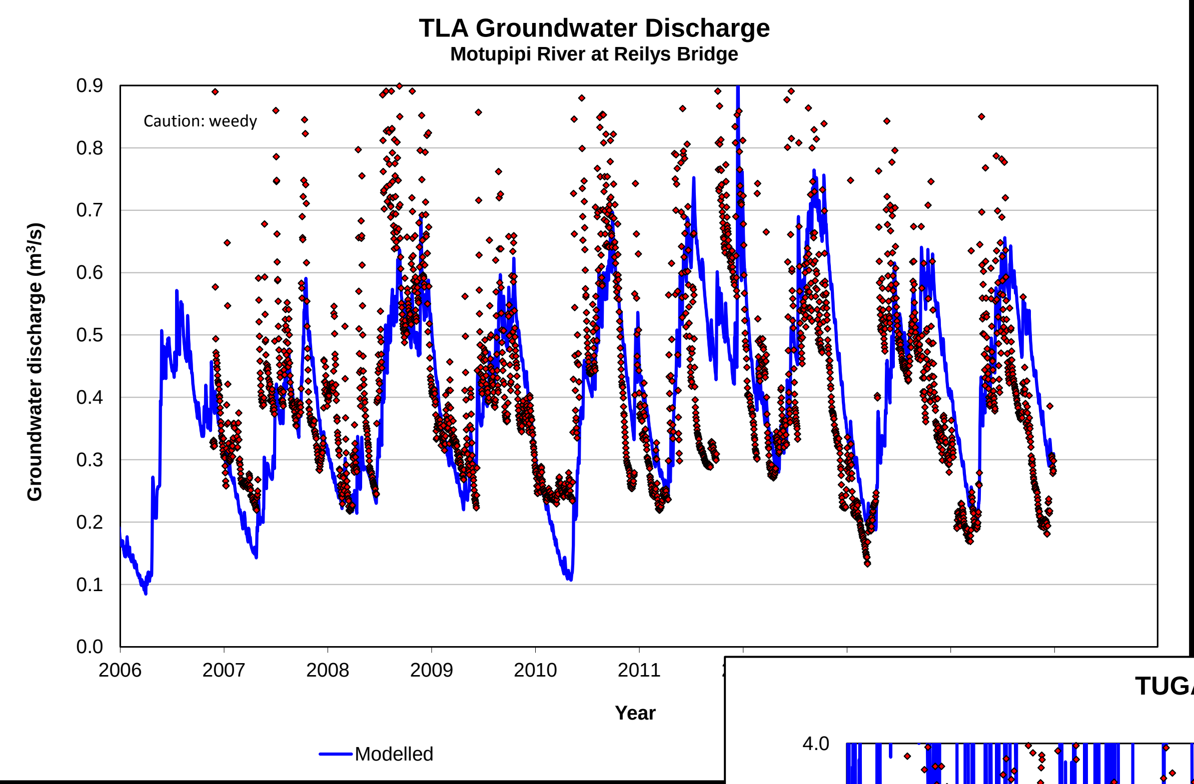


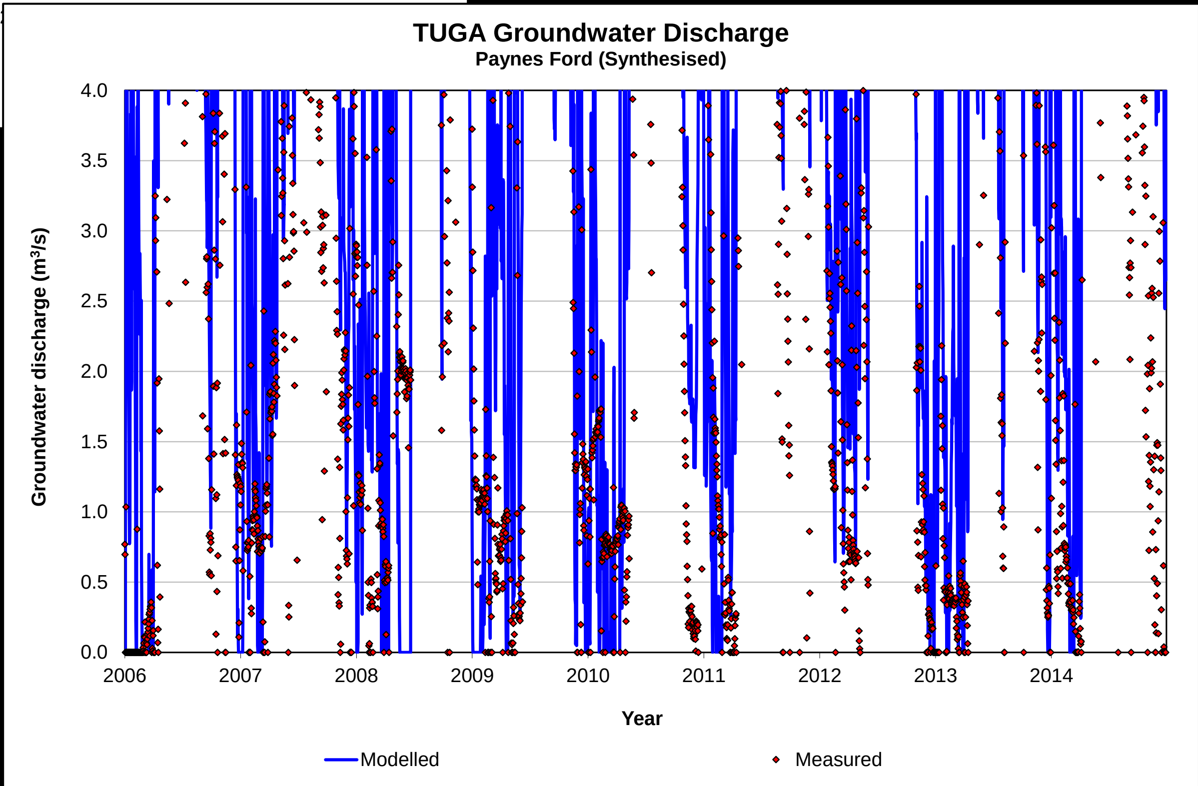

AMA Groundwater Levels
Savage
55
50
45
40
35
30
25
20
15
Groundwater level (m)
1999
2001
2003
2005
2007
2009
2011
Year
Modelled
Measured
TLA Groundwater Levels
Cserney
20
18
16
14
12
Groundwater level (m)
1995
1997
1999
2001
2003
2005
Year
Measured
TUGA Groundwater Levels
Fire Station
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
Groundwater level (m)
2004
2004
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Modelled
Measured

River flows


Waikoropupu
Fish Creek
Pupu Main Spring
Motupipi
Takaka at Kotinga
Anatoki
Takaka at Paynes Ford
Waingaro
Takaka at Lindsays Bridge
Takaka at Harwood
Cobb
0
2
4
6
Kilometers
Legend
Recorder sites (labelled)


AMA Groundwater Discharge
Pupu Main Spring (Synthesised)
Groundwater discharge (m³/s)
Year
Modelled
Measured
AMA Groundwater Discharge
Fish Creek
Year
Measured
AMA Groundwater Discharge
Springs River (Main Spring + Fish Creek - Salmon Farm)
Groundwater discharge (m³/s)
Year
Modelled
Measured


TLA Groundwater Discharge
Motupipi River at Reilys Bridge
Caution: weedy
Groundwater discharge (m³/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
2006
2007
2008
2009
2010
2011
Year
Modelled


TUGA Groundwater Discharge
Paynes Ford (Synthesised)
Groundwater discharge (m³/s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Modelled
Measured

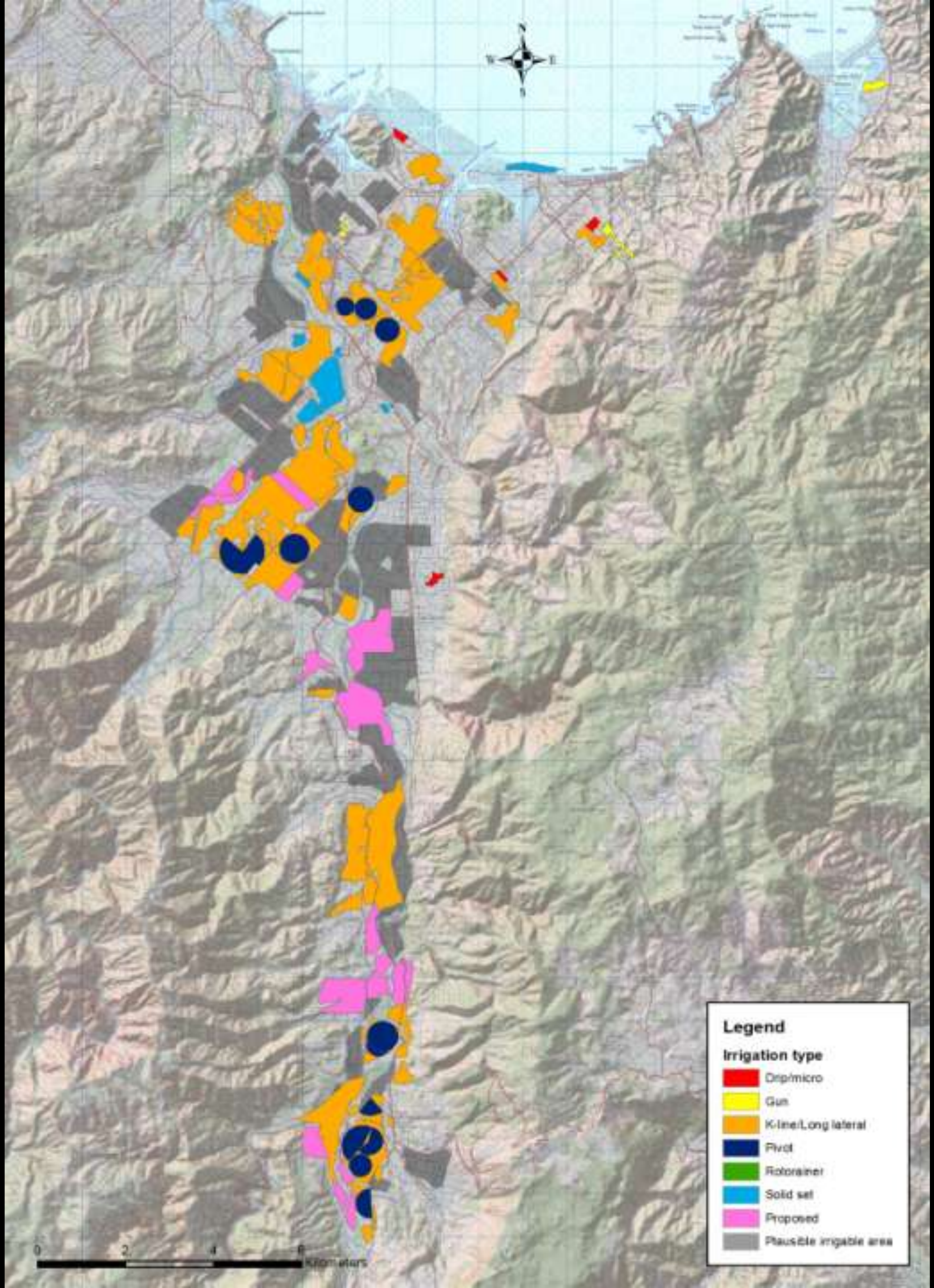
Scenarios

- Status quo (calibration)
  - Existing irrigated area (2,226 ha)
- Scenario 1: No consumptive use
  - No irrigation or other pumping/consumptive use (dryland)
  - Not ‘natural state’ because maintains existing land cover, stop banks/alignments, Salmon Farm and Cobb Dam diversions
  - Represents ‘what if’ all consumptive water use stops

Scenarios (cont.)

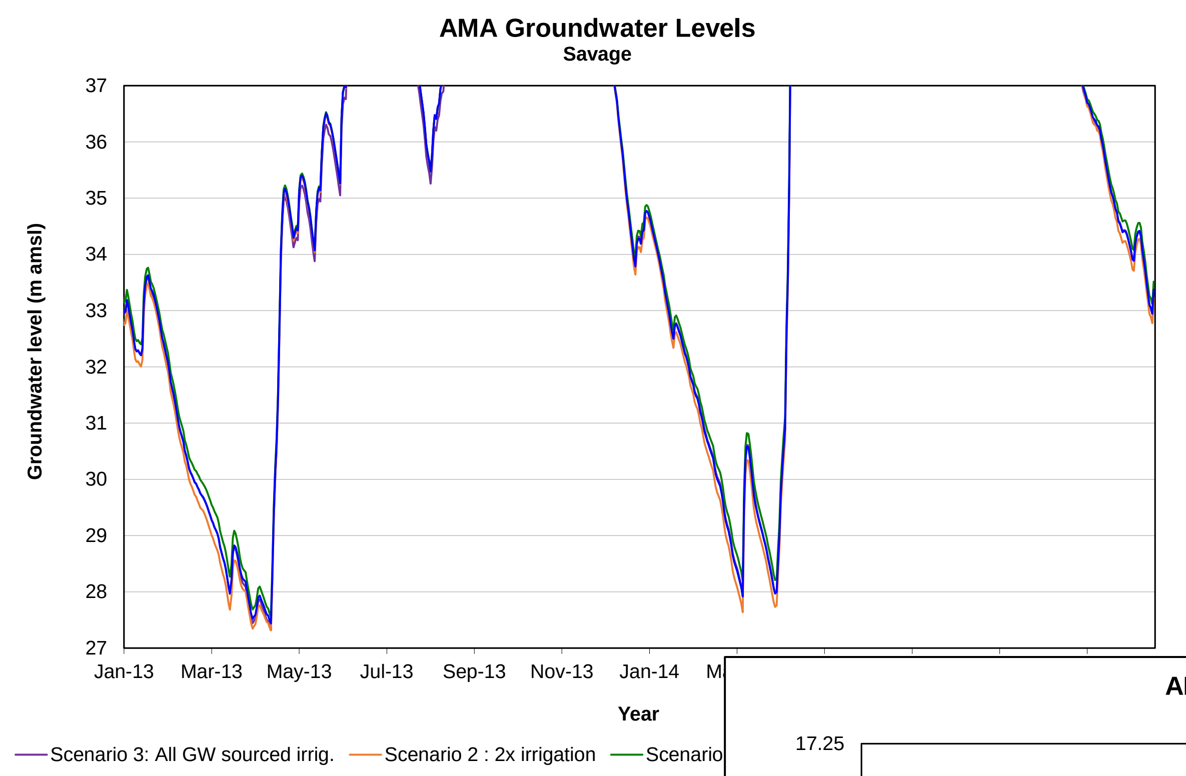
- Scenario 2: Double irrigation
  - Existing irrigated area (2,226 ha)
  - Plus waiting list (current applications) (551 ha)
  - Plus prediction of likely future development (1,876 ha)
  - Total = 4,653 ha (approximately double existing irrigation)
  - Assumed same vicinity and type as existing (see next map)

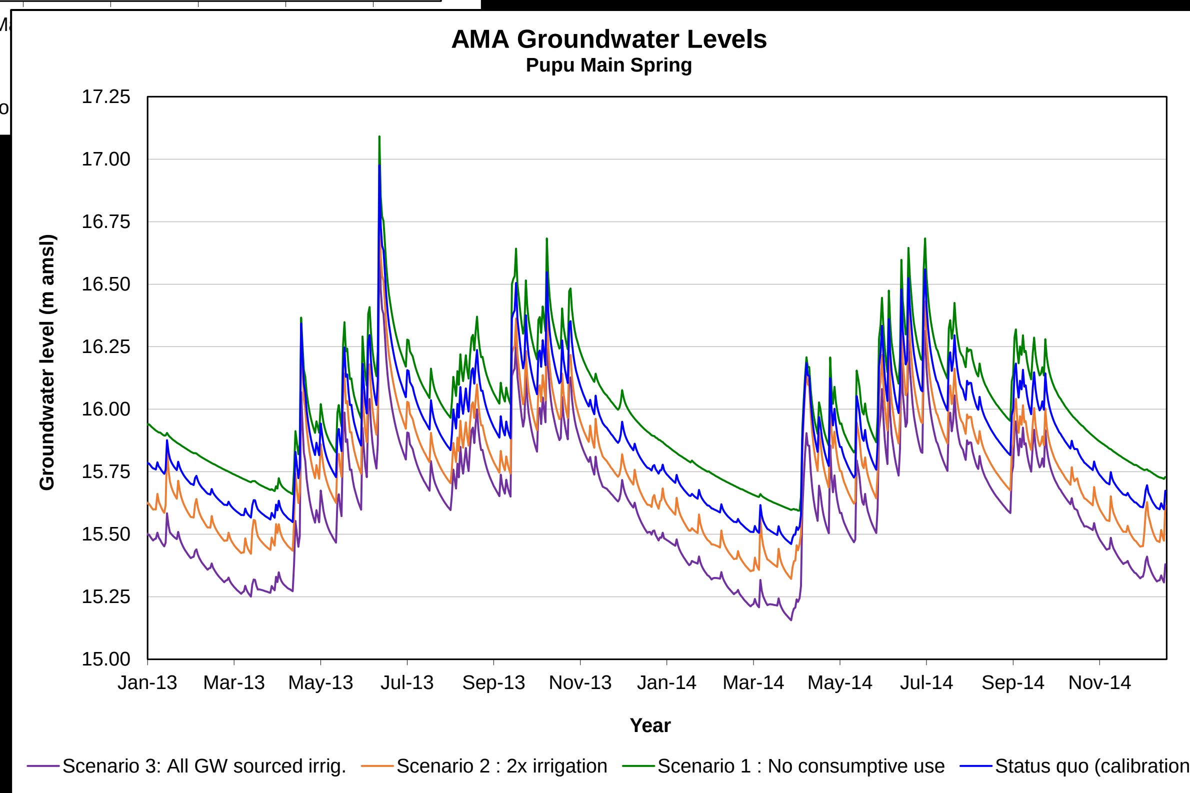
Mirka & Corrigan

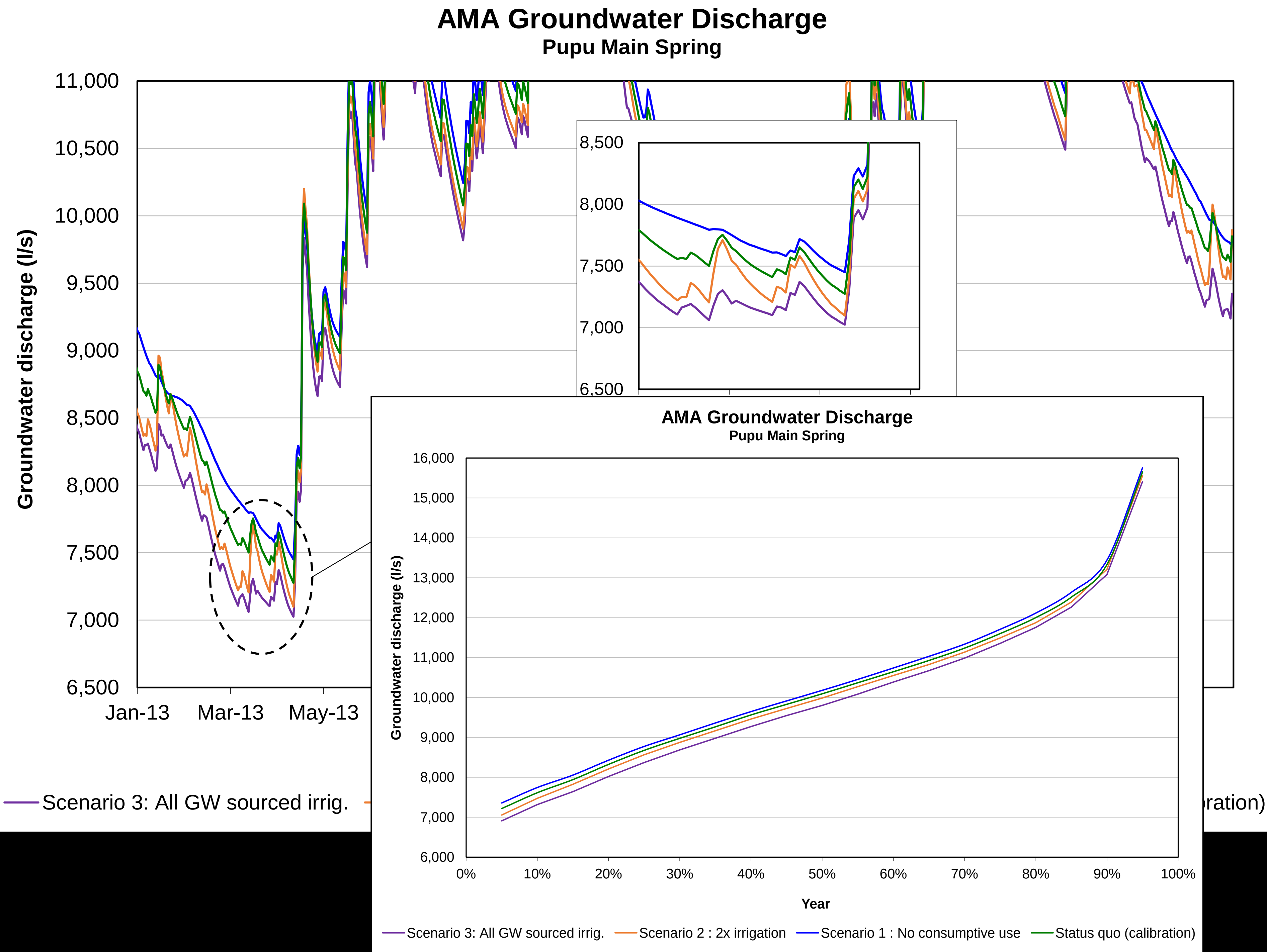


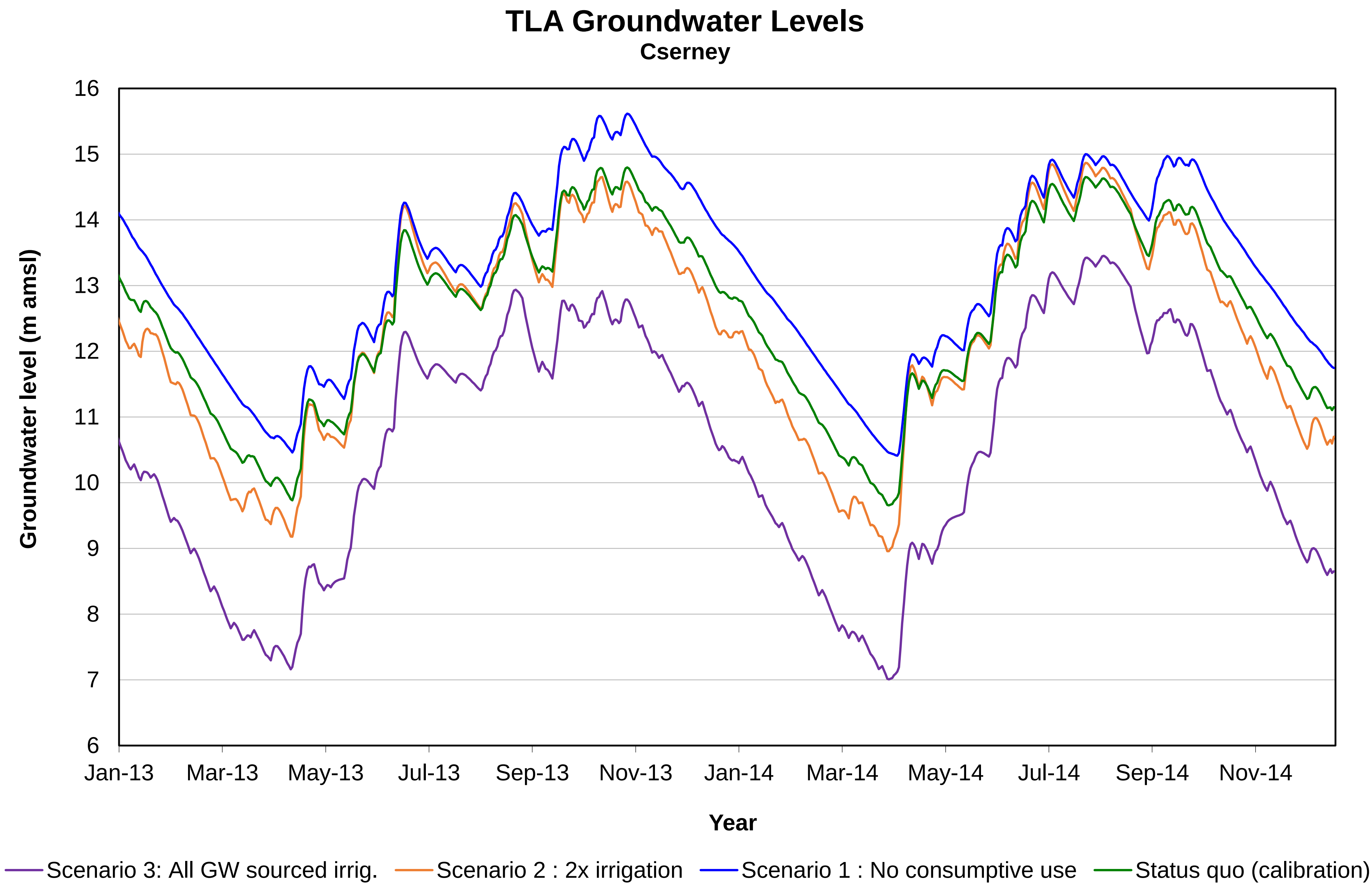
Scenarios (cont.)

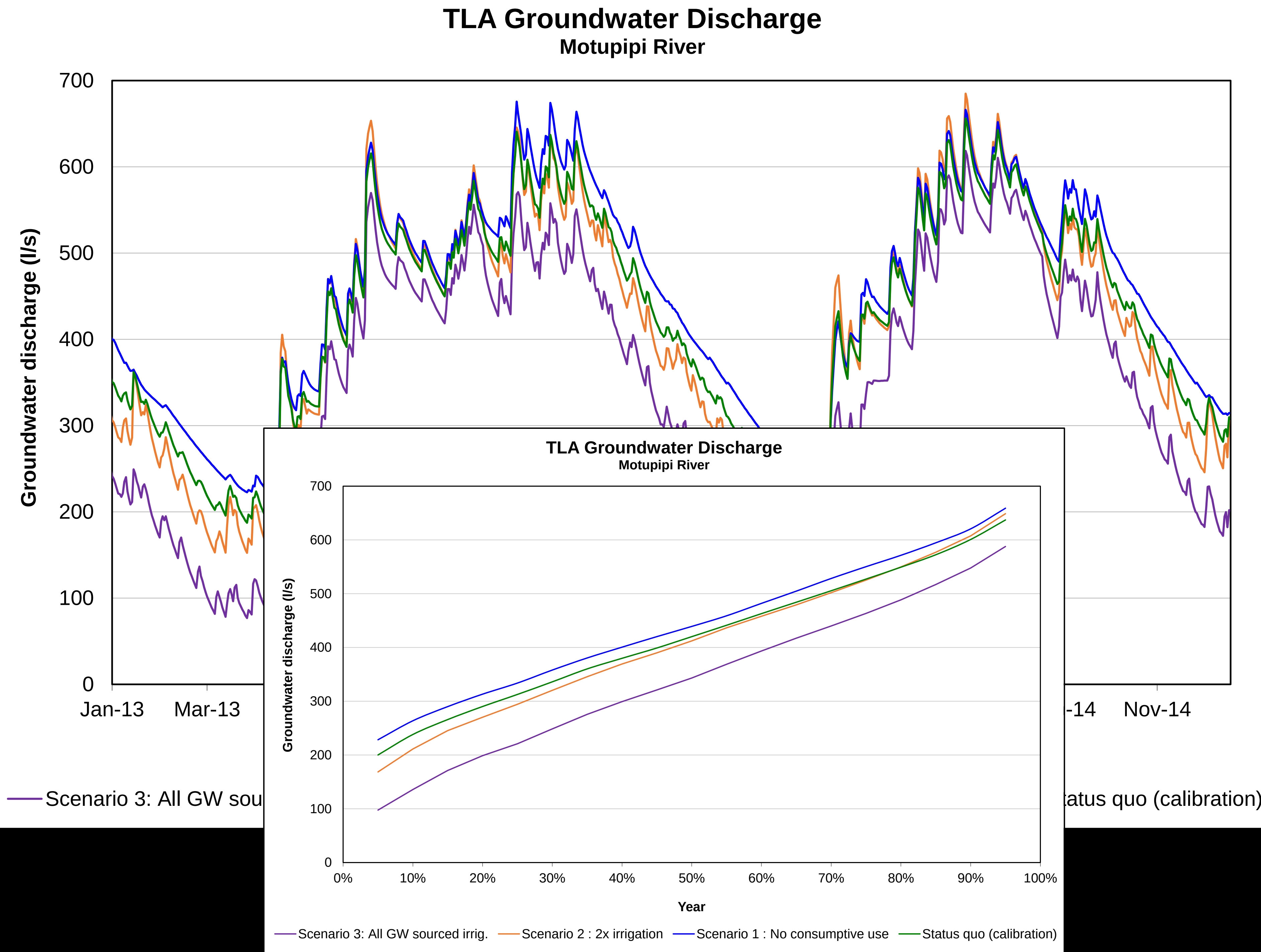
- Scenario 3: All irrigation GW sourced
  - Same land use, just SW irrigation now GW supplied; no restrictions (currently 75% surface water; 25% groundwater)
- Scenario 4: Cobb Dam
  - ‘What if’ Cobb Dam did not exist
  - Takaka at Harwood’s flow modified to estimate ‘natural’ flow
- Scenario 5: Waingaro River
  - Waingaro River recharge to GW = zero (sensitivity test)


AMA Groundwater Levels
Savage
37
36
35
34
33
32
31
30
29
28
27
Groundwater level (m amsl)
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation

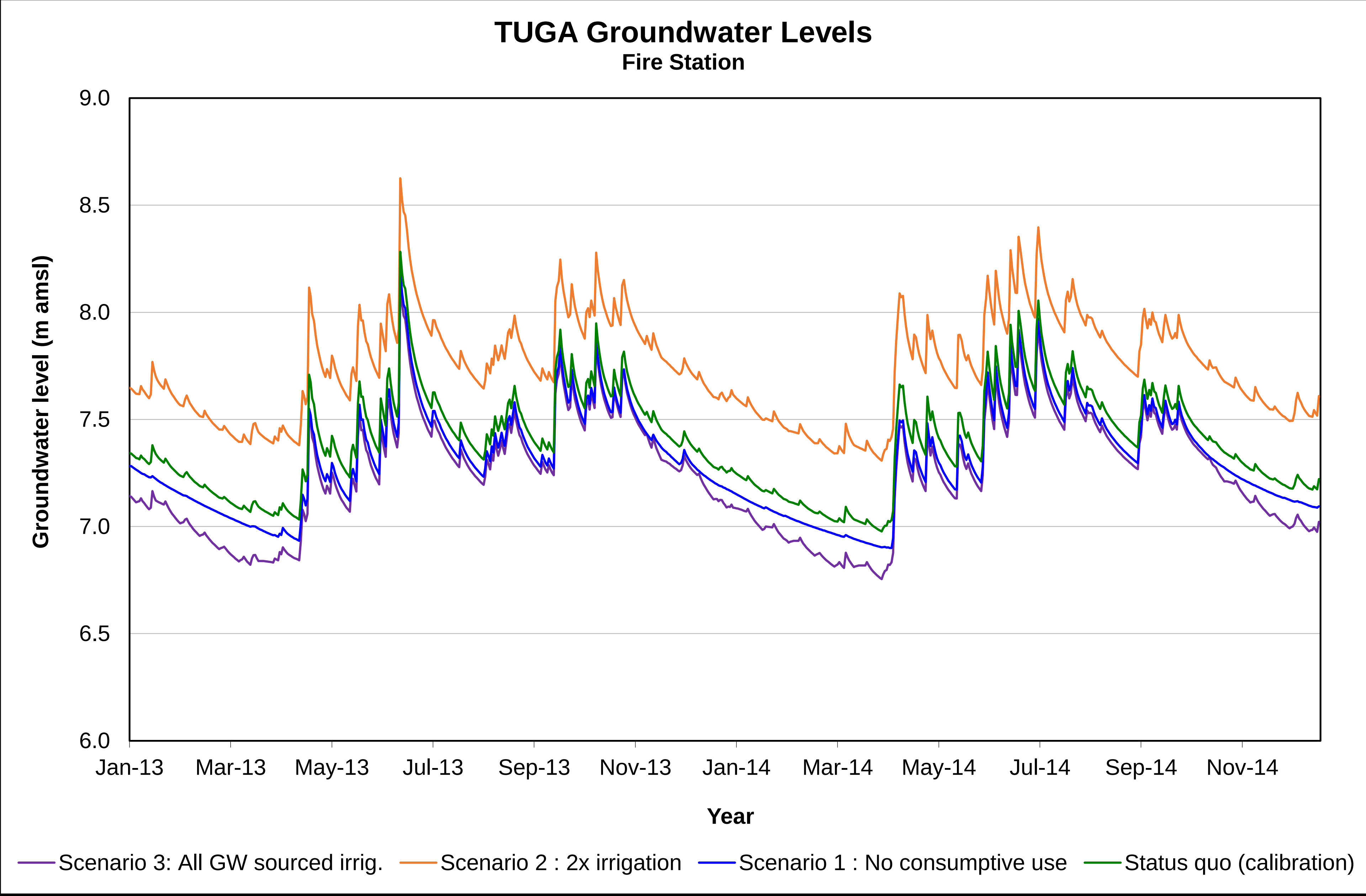

AMA Groundwater Levels
Pupu Main Spring
17.25
17.00
16.75
16.50
16.25
16.00
15.75
15.50
15.25
15.00
Groundwater level (m amsl)
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)

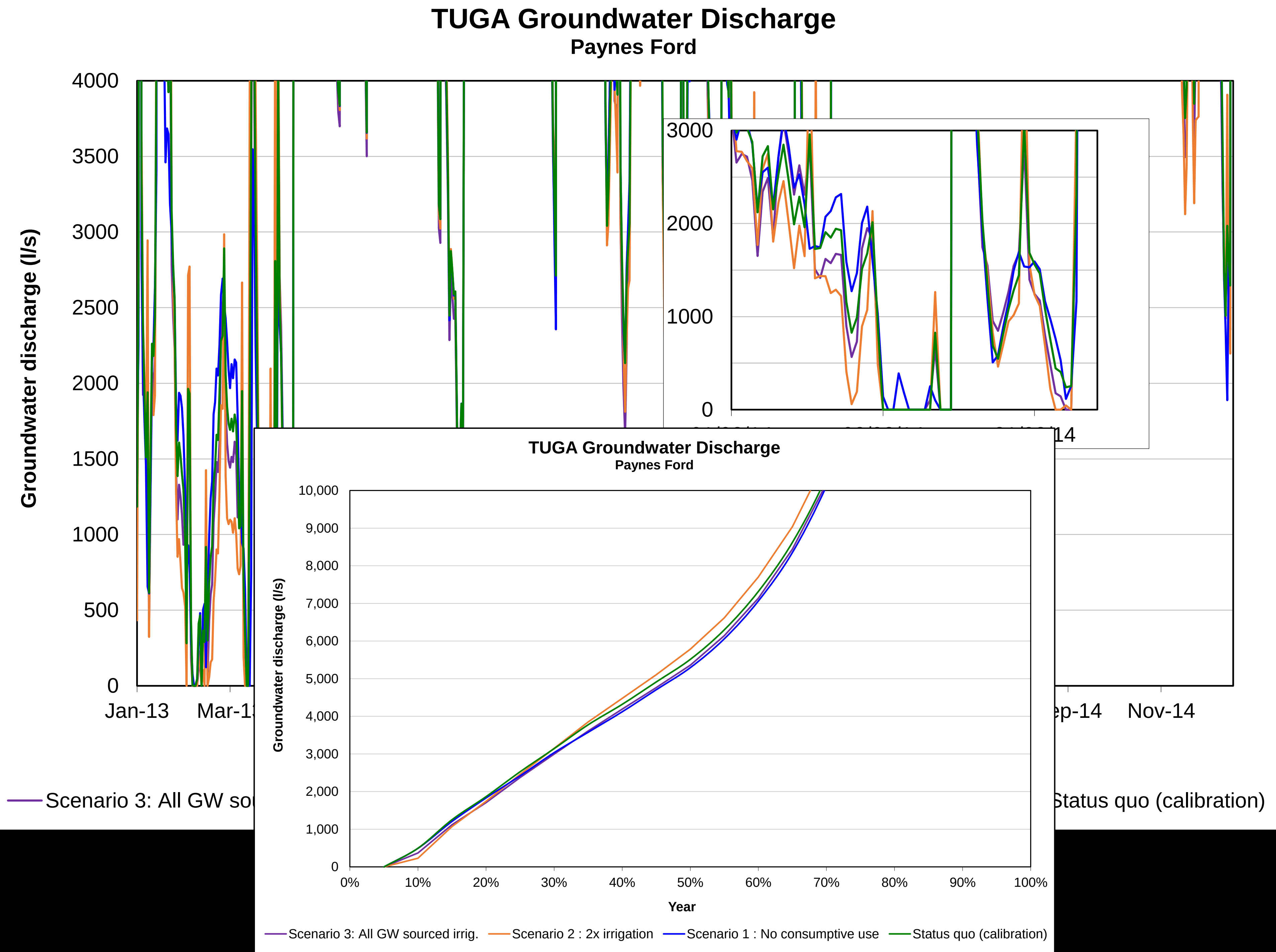

AMA Groundwater Discharge
Pupu Main Spring
Groundwater discharge (l/s)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
Jan-13
Mar-13
May-13
8,500
8,000
7,500
7,000
6,500
AMA Groundwater Discharge
Pupu Main Spring
Groundwater discharge (l/s)
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)
Scenario 3: All GW sourced irrig.
ration)


TLA Groundwater Levels
Cserney
Groundwater level (m amsl)
16
15
14
13
12
11
10
9
8
7
6
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)



TLA Groundwater Discharge
Motupipi River
Groundwater discharge (l/s)
700
600
500
400
300
200
100
0
Jan-13
Mar-13
-14
Nov-14
Scenario 3: All GW sou
tatus quo (calibration)
TLA Groundwater Discharge
Motupipi River
Groundwater discharge (l/s)
700
600
500
400
300
200
100
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)


TUGA Groundwater Levels
Fire Station
Groundwater level (m amsl)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)



TUGA Groundwater Discharge
Paynes Ford
Groundwater discharge (l/s)
4000
3500
3000
2500
2000
1500
1000
500
0
Jan-13
Nov-14
Scenario 3: All GW so
Status quo (calibration)
3000
2000
1000
0
TUGA Groundwater Discharge
Paynes Ford
Groundwater discharge (l/s)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Year
Scenario 3: All GW sourced irrig.
Scenario 2 : 2x irrigation
Scenario 1 : No consumptive use
Status quo (calibration)

River Flows

River flow statistics for the period 1990-2014 (unless otherwise stated)										
River	Measured	Status Quo (Calibration)	Scenario 1 (No Consumptive)	Scenario 2 (Double Irrigation)	Scenario 3 (GW Supplied)	Scenario 4 (No Cobb Dam)	Scenario 5 (Waingaro River)	Scenario 6 (???)	Scenario 7 (???)
			Average (l/s)						
Main Spring	9,910 (synthesised)	9,580	9,700	9,460	9,300	8,860	9,200		
Fish Creek	3,390	3,120	3,180	3,070	3,000	2,870	2,990		
Spring River	10,135	10,000	10,130	9,860	9,700	9,390	9,680		
Motupipi River	470 (2006-2014)	410	430	400	330	400	400		
Paynes Ford	12,100 (synthesised)	12,040	11,790	12,470	11,890	11,290	11,630		
			7-day MALF (l/s)						
Main Spring	7,290 (synthesised)	7,290	7,430	7,110	6,990	6,500	6,910		
Fish Creek	570	540	660	430	370	290	430		
Spring River	5,510	5,640	5,820	5,340	5,190	4,890	5,310		
Motupipi River	210 (2006-2014)	220	250	180	110	210	210		
Paynes Ford	140 (synthesised)	90	100	60	60	0	30		
			Zero-flow days (average/year)						
Main Spring	0 (synthesised)	0	0	0	0	0	0		
Fish Creek	0	2	0	5	7	9	4		
Spring River	0	0	0	0	0	0	0		
Motupipi River	0 (2006-2014)	0	0	0	2	0	0		
Paynes Ford	41 (synthesised)	41	40	52	47	109	59		

River flow statistics for the period 1990-2014 (unless otherwise stated)									
River	Measured	Status Quo (Calibration)	Scenario 1 (No Consumptive)	Scenario 2 (Double Irrigation)	Scenario 3 (GW Supplied)	Scenario 4 (No Cobb Dam)	Scenario 5 (Waingaro River)	Scenario 6 (???)	Scenario 7 (???)
			1 in 5 year low flow (l/s) (2005/06 season) (approximate)						
Main Spring	6,385 (synthesised)	6,595	6,750	6,385	6,280	5,855	6,210		
Fish Creek	70	80	270	90	85	80	50		
Spring River	4,430	4,710	4,935	4,355	4,220	4,080	4,380		
Motupipi River	180 (2006-2014)	155	190	110	35	145	150		
Paynes Ford	0 (synthesised)	0	0	0	0	0	0		
			1 in 10 year low flow (l/s) (2009/10 season) (approximate)						
Main Spring	5,985 (synthesised)	6,280	6,440	6,060	5,960	5,565	5,900		
Fish Creek	35	40	195	50	50	50	20		
Spring River	4,005	4,330	4,565	3,965	3,830	3,750	4,000		
Motupipi River	165	130	165	85	20	120	125		
Paynes Ford	0 (synthesised)	0	0	0	0	0	0		

Groundwater Levels

Groundwater level statistics for the period 1990-2014 (unless otherwise stated)										
Aquifer	Site	Measured	Status Quo (Calibration)	Scenario 1 (No Consumptive)	Scenario 2 (Double Irrigation)	Scenario 3 (GW Supplied)	Scenario 4 (No Cobb Dam)	Scenario 5 (Waingaro River)	Scenario 6 (???)	Scenario 7 (???)
				Average (m amsl)						
AMA	Pupu Main Spring	15.8	15.9	16.0	15.8	15.7	15.4	15.6		
AMA	Savage	33.1	33.7	33.7	33.7	33.6	32.2	32.9		
AMA	Sowman	38.3	35.1	35.1	35.1	35.0	33.6	34.3		
TLA	Csemey	12.0	11.7	12.3	11.5	9.7	11.5	11.6		
TUGA	Fire Station	7.2	7.4	7.3	7.7	7.2	6.8	7.0		
TUGA	TDC Office	6.8	6.8	6.7	7.1	6.6	6.2	6.4		
				Minimum (m amsl)						
AMA	Pupu Main Spring	14.4	15.1	15.2	14.9	14.8	14.5	14.7		
AMA	Savage	21.0	20.6	20.8	20.4	20.5	19.7	19.8		
AMA	Sowman	19.7	19.8	20.0	19.6	19.7	19.0	19.0		
TLA	Csemey	6.8	6.1	6.7	5.1	3.4	5.9	5.9		
TUGA	Fire Station	6.4	6.6	6.5	6.9	6.3	5.8	6.2		
TUGA	TDC Office	6.4	6.1	6.0	6.3	5.9	5.6	5.8		

Fish Creek Limits Simulator

Water Wheel Diagram | How it works

Adjust settings

Update Scenario

Minimum Flows (% of the 7 day mean annual low flow)

0 — 0.8 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Allocation Flows (% of the 7 day mean annual low flow)

0 — 1.7 — 5

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

Indicators

Economic

- [ ] Irrigation Take (m3/s)
- [x] Minimum flow restrictions (% of time)
- [ ] Management flow restrictions (% of time)
- [ ] Irrigation Bulk Reliability
- [x] % of Irrigable area Irrigated
- [x] % of Allocation used

Recreational

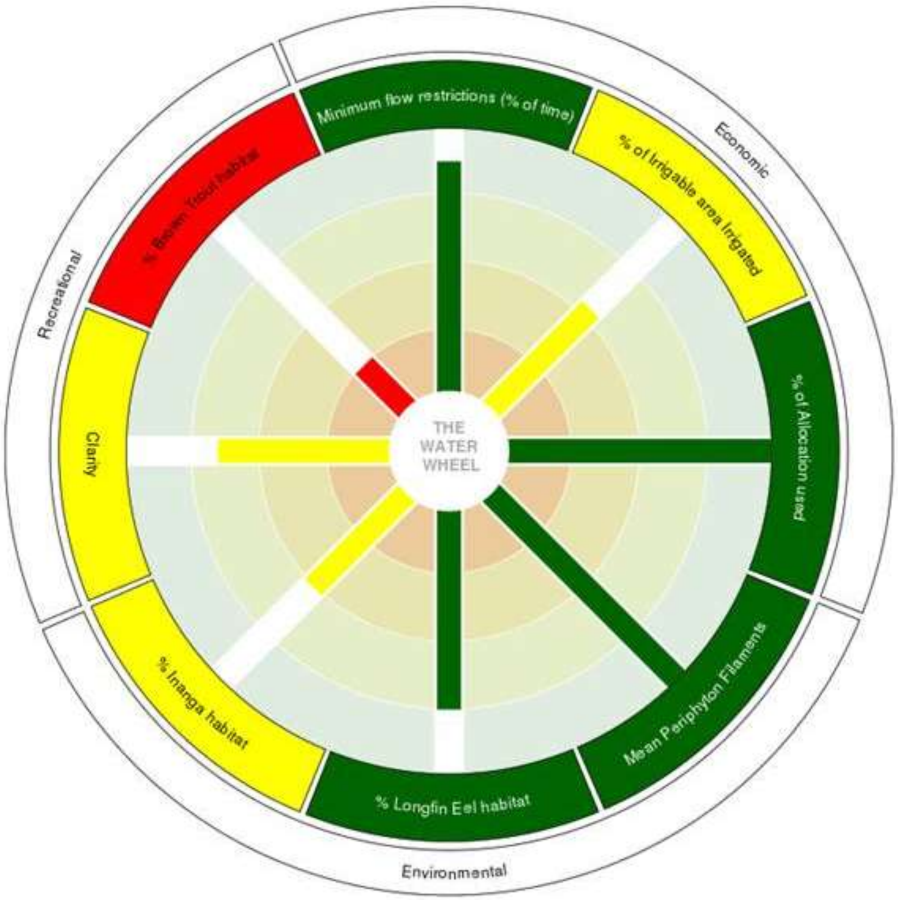
- [x] Clarity
- [x] % Brown Trout habitat

Environmental

- [ ] MCI
- [ ] % Reduction in river width
- [x] Mean Periphyton Filaments
- [ ] Max Periphyton Filament
- [ ] Mean Periphyton Mats
- [ ] Max Periphyton Mat
- [x] % Longfin Eel habitat
- [ ] % Shortfin Eel habitat
- [ ] % Brown Trout habitat
- [ ] % Bluegill Bully habitat
- [x] % Inanga habita
- [ ] % Torrent habitat
- [ ] % Kokopu habitat

This model was prepared as part of the Wheel of Water research project funded by the Ministry of Business, Innovation and Employment.

Interface design by Tim Kerr



Sub Catchment Nitrate Budgets

Flow component	Nitrate-nitrogen (tonnes/year)			
Aquifer	*AMA*	*TLA*	*TUGA*	*Combined*
		Input		
Land surface [(1)]	**91**	**35**	**115**	**241**
		Output		
Surface water (groundwater component)	101 [(2)]	31 [(3)]	55 [(4)]	**187**
Groundwater (off shore) [(5)]	32	106	17	**155**
Total out	**133**	**137**	**72**	**342**

[(1)] Calculated using the same method as presented in Table 12, but for surface areas overlaying individual aquifer systems.
[(2)] Calculated as the product of the groundwater component to Pupu Main spring and Fish Creek (7.4 m^3/s + 0.8 m^3/s, based on Figure 21 of Thomas & Harvey, 2013), and groundwater nitrate-nitrogen concentration in TDC's Pupu Main Spring monitoring bore (0.39 g/m^3, Table 11).
[(3)] Calculated as the product of Motupipi River flow (0.47 m^3/s) and Motupipi Spring concentration (2.5 g/m^3).
[(4)] Calculated as the sum of individual products of the TUGA groundwater flow component and concentration, estimated at various surface water sites.
[(5)] Individually calculated for each aquifer system as the product of calculated off-shore flow (Table 10) and representative groundwater concentration.

Groundwater Quality

- Assumes full mixing
- Ex. concentration: ~ 0.45 g/m^3 (Pupu GW bore, 2013-14)
  - ~ 51 tonnes/year additional nitrate nitrogen total due to intensification
  - ~ 38 tonnes/year discharge to Pupu Main Spring; remainder in GW
  - AMA through flow: ~ 10.8 m^3/s
- If reduce by 51 t/y (Scenario 1), Pupu GW conc reduces to 0.34 g/m^3
- If additional 51 t/y (Scenario 2), Pupu GW conc increases to 0.56 g/m^3

TLA Water Quality

- Ex. GW concentration: ~ 2.5 g/m^3 (Motupipi Spring, 2010)
  - ~ 30 tonnes/year additional nitrate nitrogen total due to intensification
  - ~ 4 tonnes/year discharge to Motupipi River
  - TLA through flow: ~ 2.8 m^3/s
- If reduce by 30 t/y (Scenario 1), TLA GW conc reduces to 2.15 g/m^3
- If additional 30 t/y (Scenario 2), TLA GW conc increases to 2.85 g/m^3
- Ex. Motupipi River concentration: ~ 1.0 g/m^3
  - 0.72 g/m^3 and 1.28 g/m^3 for Scenario 1 and 2 (4 t/y differences)

TUGA Water Quality

- Ex. GW concentration: ~ 0.46 g/m^3 (multiple coastal bores)
  - ~ 88 tonnes/year additional nitrate nitrogen total due to intensification
  - ~ 81 tonnes/year discharge to surface (mainly Takaka River)
  - TUGA through flow: ~ 15.4 m^3/s
- If reduce by 88 t/y (Scenario 1), TUGA GW conc reduces to 0.29 g/m^3
- If additional 88 t/y (Scenario 2), TUGA GW conc increases to 0.63 g/m^3
- Ex. Takaka River concentration: ~ 0.11 g/m^3 (Kotinga, 2014)
  - 0 g/m^3 and 0.50 g/m^3 for Scenario 1 and 2 (81 t/y differences)