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Integrated water solutions:

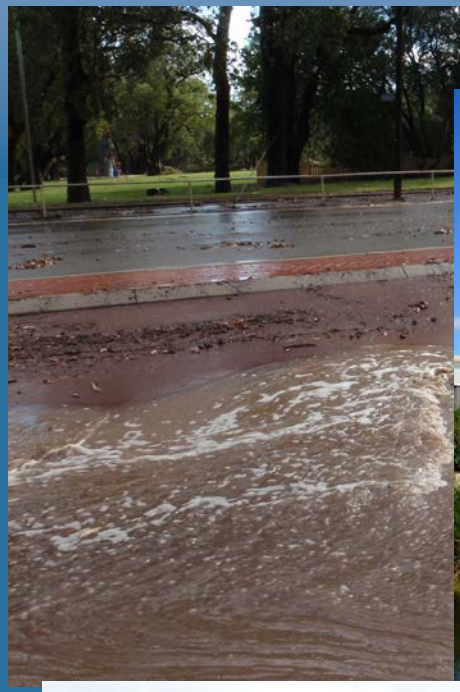
Feasibility of
Managed Aquifer Recharge
using drainage water

Funded by the Australian Government though the National Water Commission's Raising National Water Standards Program

Australian Government
National Water Commission

Peter Kretschmer, Tarren Reitsema
Emma Christie, Steve Fisher, Ben Marillier

Keep this in mind...

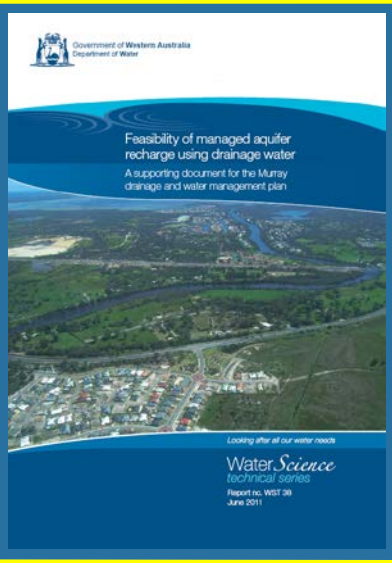


HOW DO WE MAKE THIS HAPPEN?

Contents

- Water constraints on development
- Planning for multiple needs

- **The MAR feasibility study**
  - Availability
  - Suitability
  - Demand
  - Assessment results
  - Knowledge gaps



- Where to next

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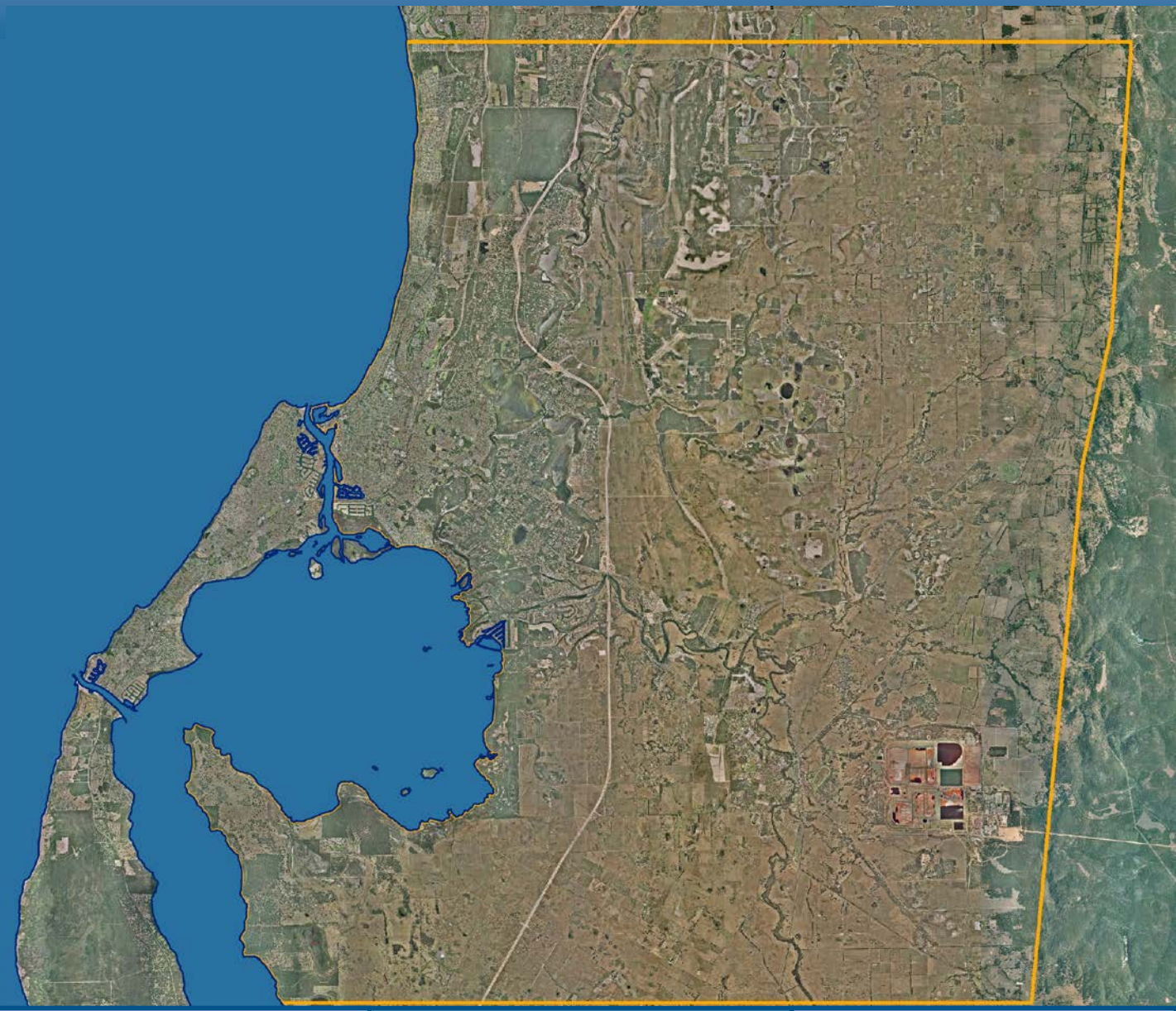
Study area

...not without its share of problems



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Highly connected,

Constraints | Availability | Suitability | Demand

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...water logged,

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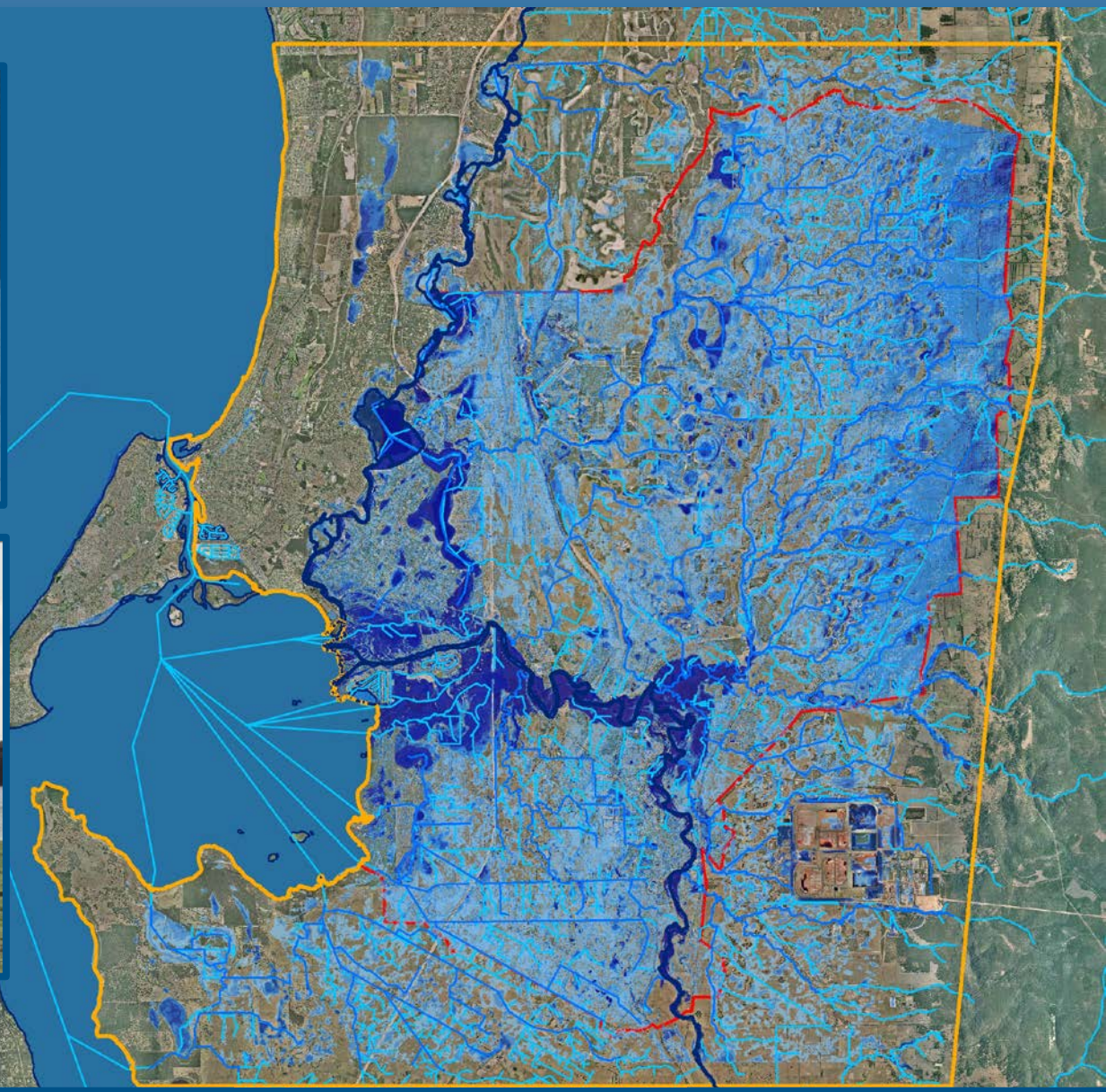
..and flood prone,



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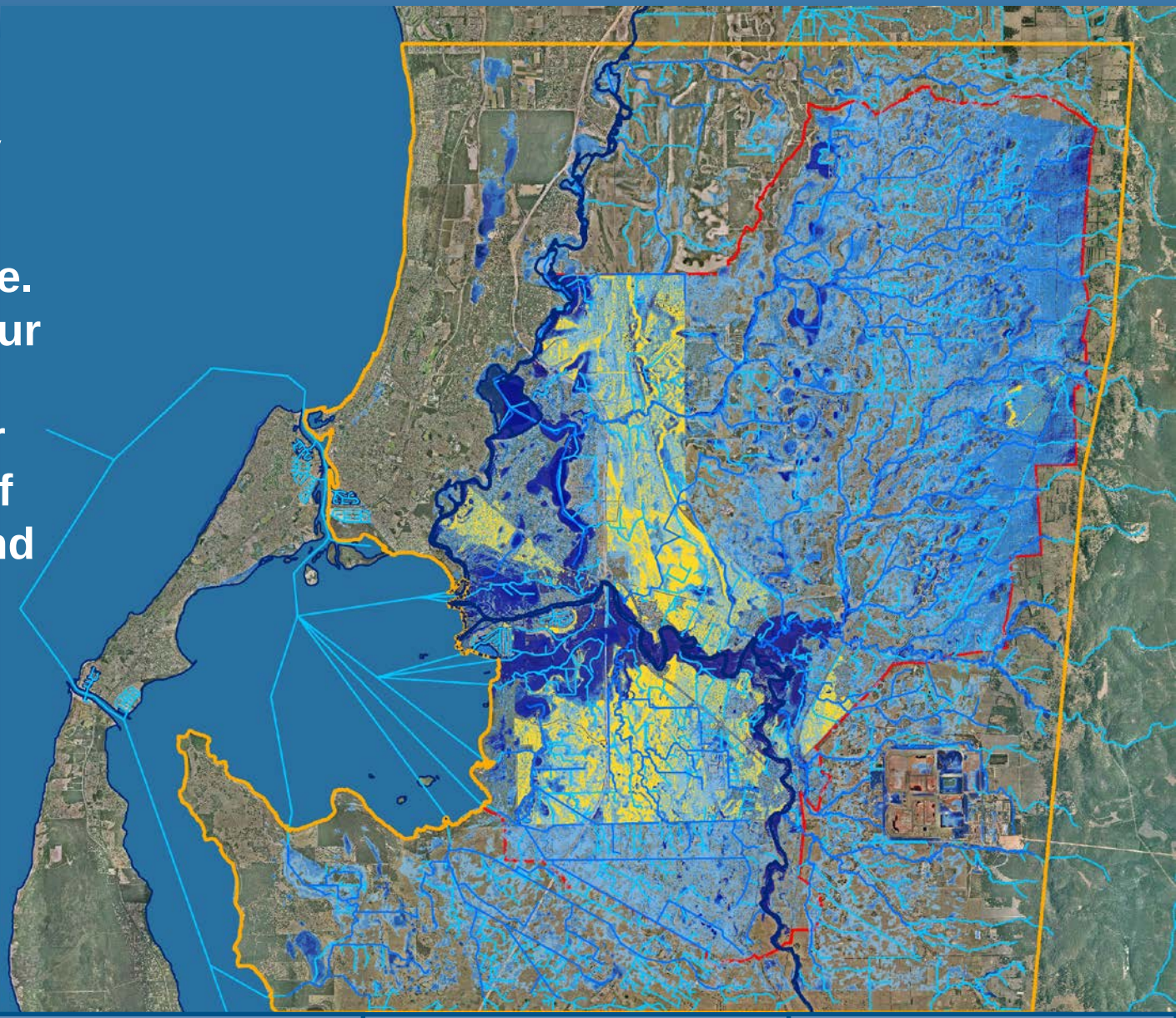
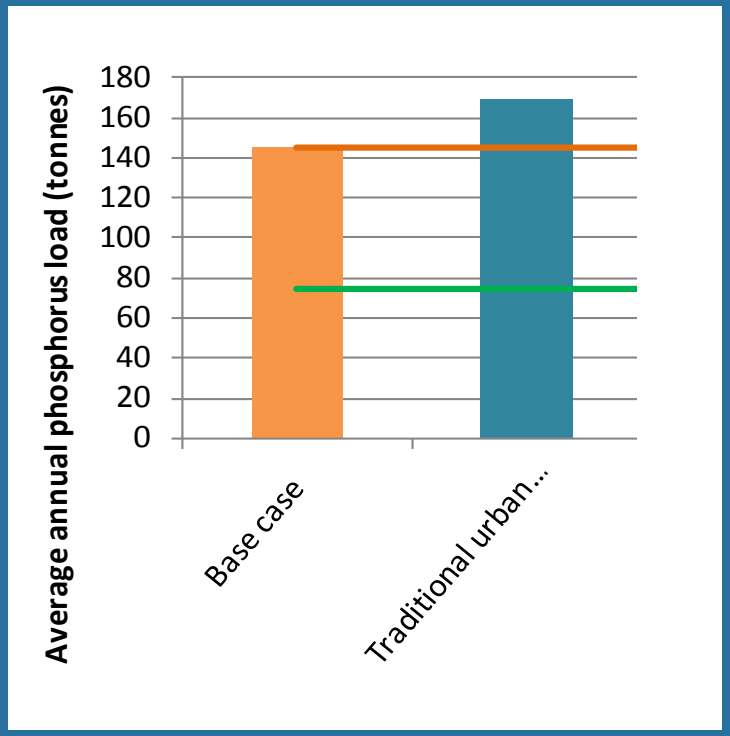
… and we want to build here.

Water is already integrated into the landscape. We need to turn our attention to harnessing it for the betterment of the community and environment



Constraints | Availability | Suitability | Demand

Nutrient overload



- We do not meet EPP targets
- Status quo will continue degradation of the estuary

Traditional urban has greater nutrient inputs and increased flows that efficiently convey nutrients to streams

(see Peel-Harvey nutrient modelling, Kelsey et al. 2010)

Why?

The allocation issue

Diminishing resource:

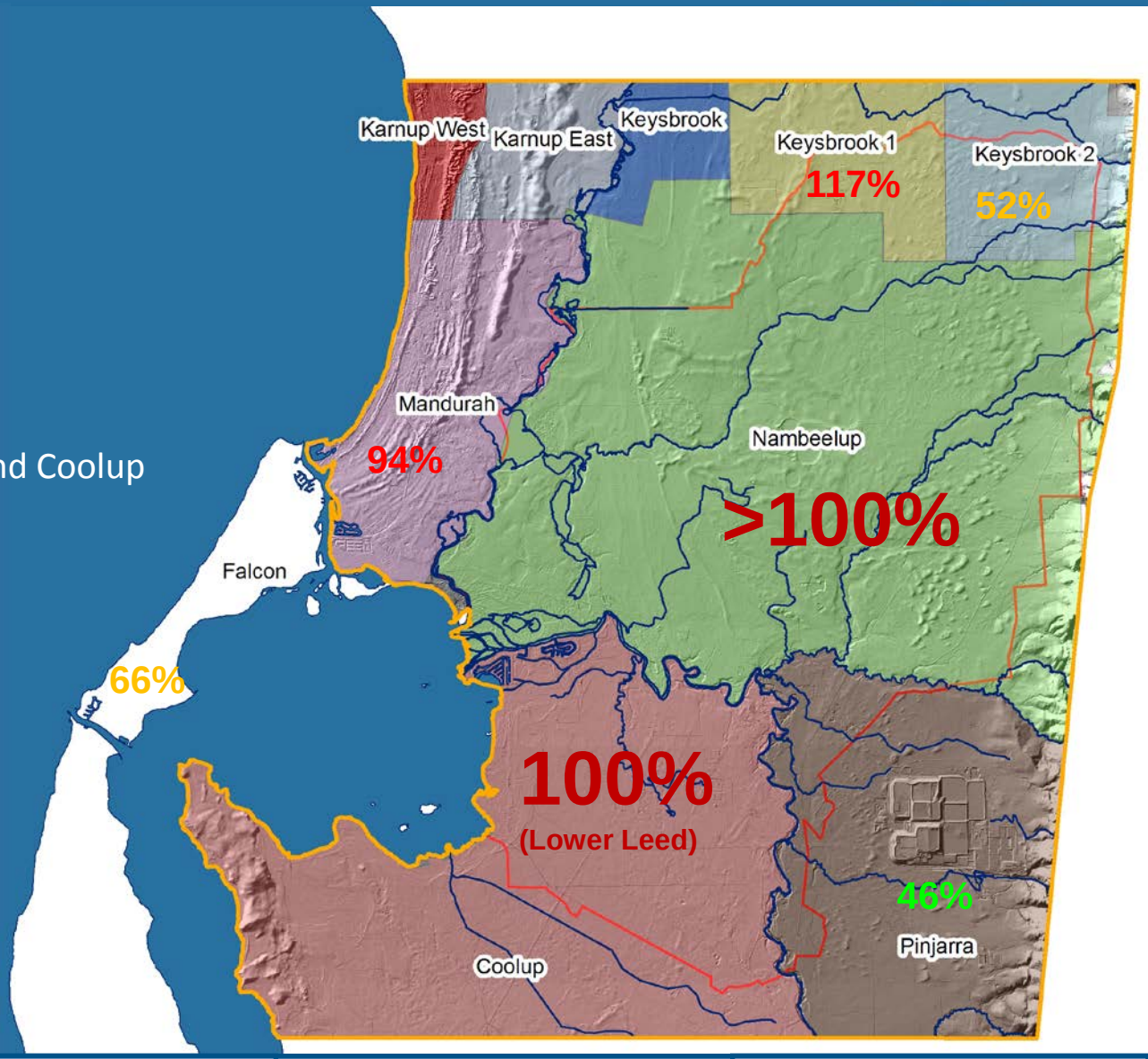
Cattamarra Aquifer

100% allocated everywhere

Leederville Aquifer

Fully allocated in Nambeelup and Coolup

The end of 'easy' water?



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Many competing needs

Environmental values

- Existing users
- RAMSAR estuary
- Recreation
- Traditional culture
- CCW wetlands
- Aquatic ecosystems

- Development
- Livestock
- Man-made lakes
- Acid sulfate soils
- Sand supply issues
- EPP for phosphorous

- Climate change
- Mozzies

- Industry
- Tourism

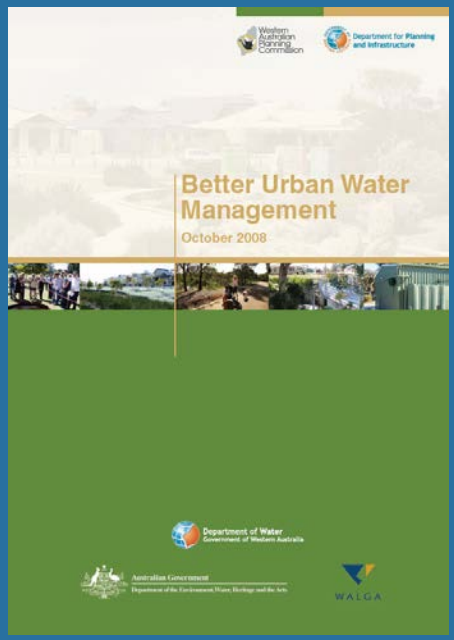
Hence the DWMP, BUWM, stormwater manual, and the MAR feasibility study...

Planned approach

Better Urban Water Management framework

- **State water planning**
  - Perth-Peel regional water plan
    - Drainage and Water Management Plan

- **Drainage and Water Management Plan**
  - Hydrology technical studies
  - Flood study
  - Nutrient study
  - ASS & hydrochemistry review
  - EWR study
  - Flora and fauna studies
  - MAR feasibility study



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DWMP outcomes

- **Key Principle 1**
  - Manage catchments to maintain or improve water resources
- **Key Principle 2**
  - Manage flooding and inundation risks to human life and property
- **Key Principle 3**
  - Ensure the efficient use and re-use of water resources

MAR can be integrated with all three principles

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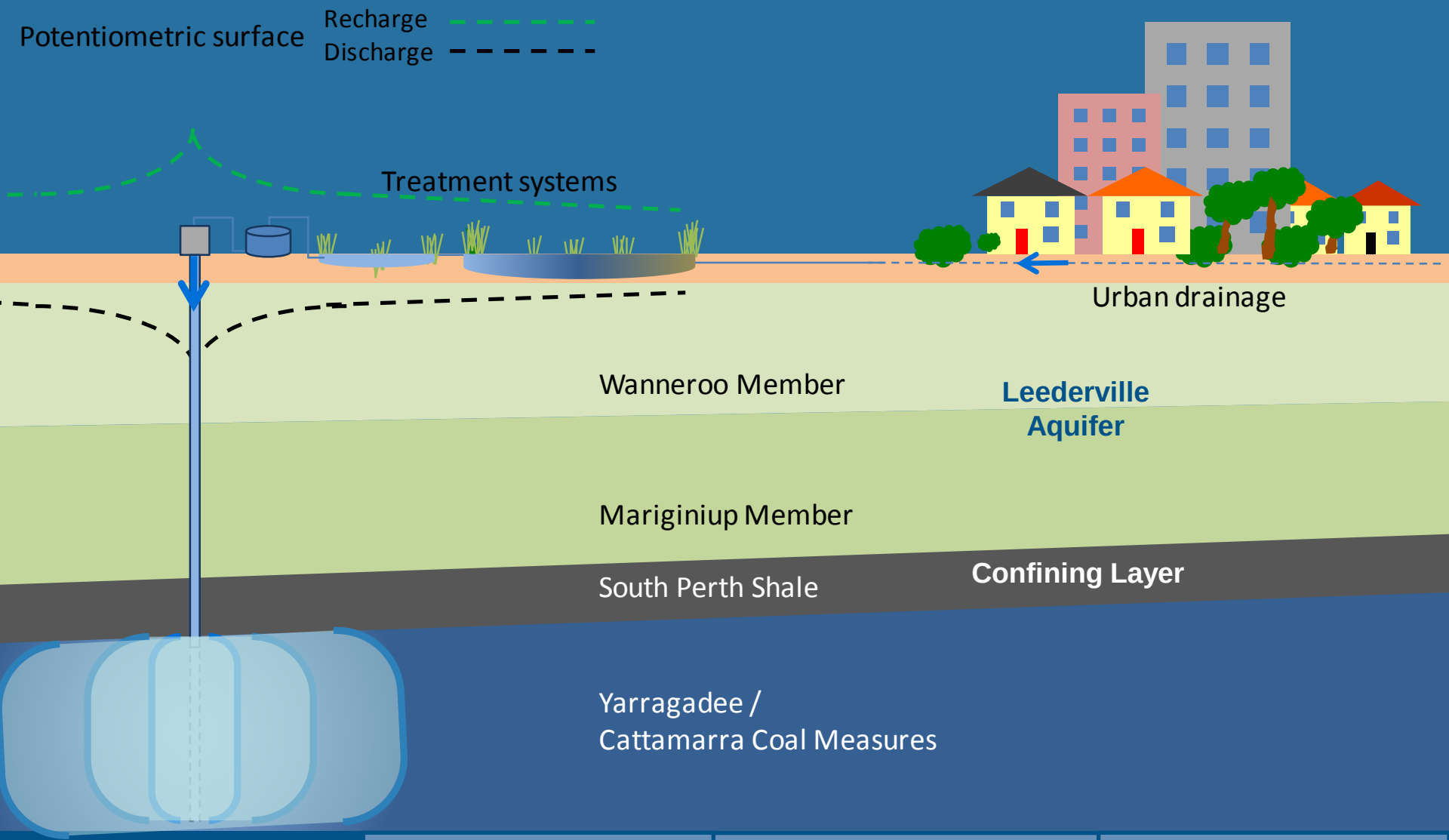
MAR feasibility study



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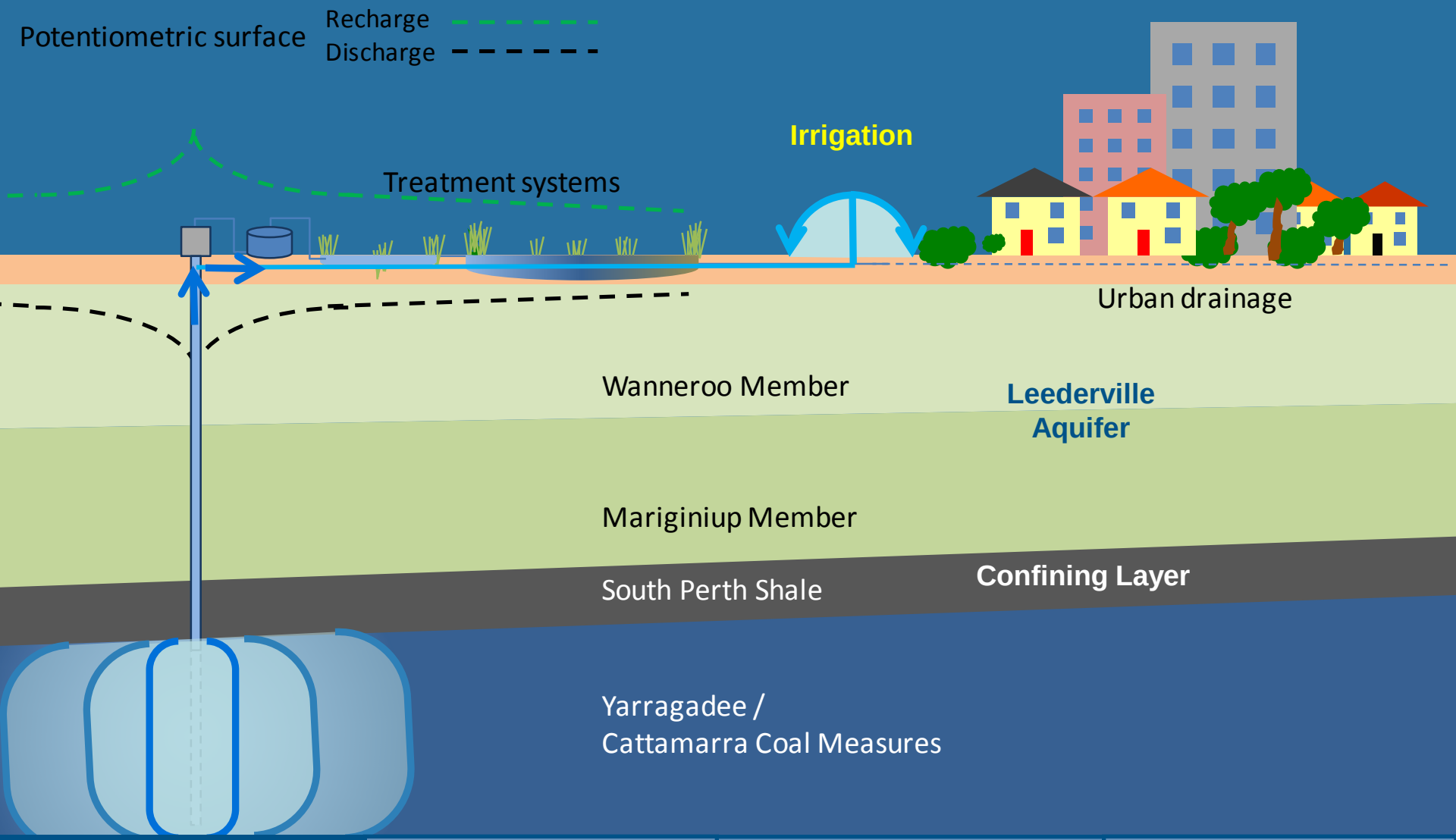
MAR feasibility study



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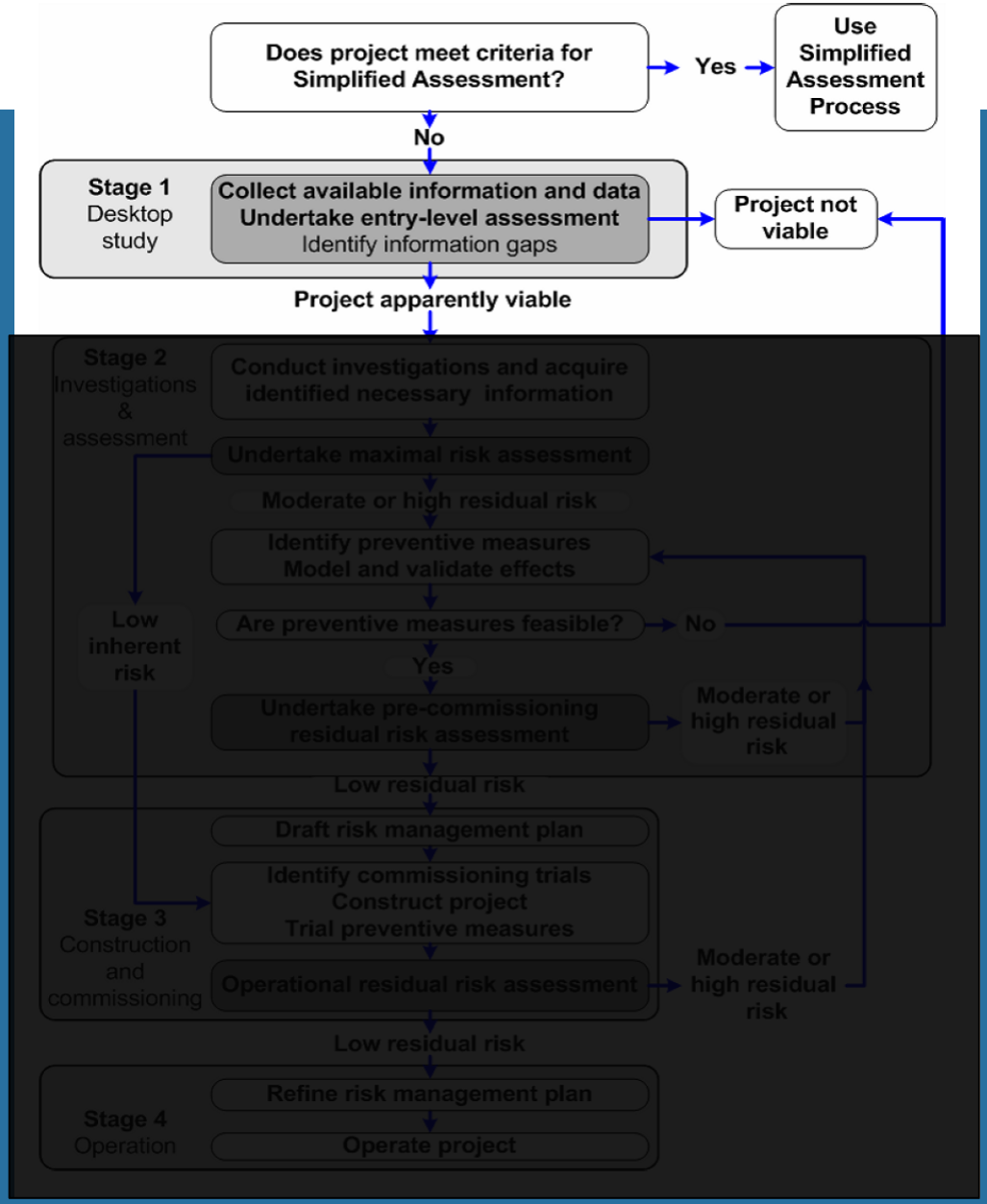
Aust. Guidelines for Water Recycling

- **Australian Guidelines for Water Recycling – MAR**
- **Four stage investigation**
  - feasibility assessment is Stage 1
  - desktop

ASR feasibility flow-chart



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Availability - Drainage

Total drainage from all developments:

Min: 12 GL/yr (Dry climate, drains at ground level)

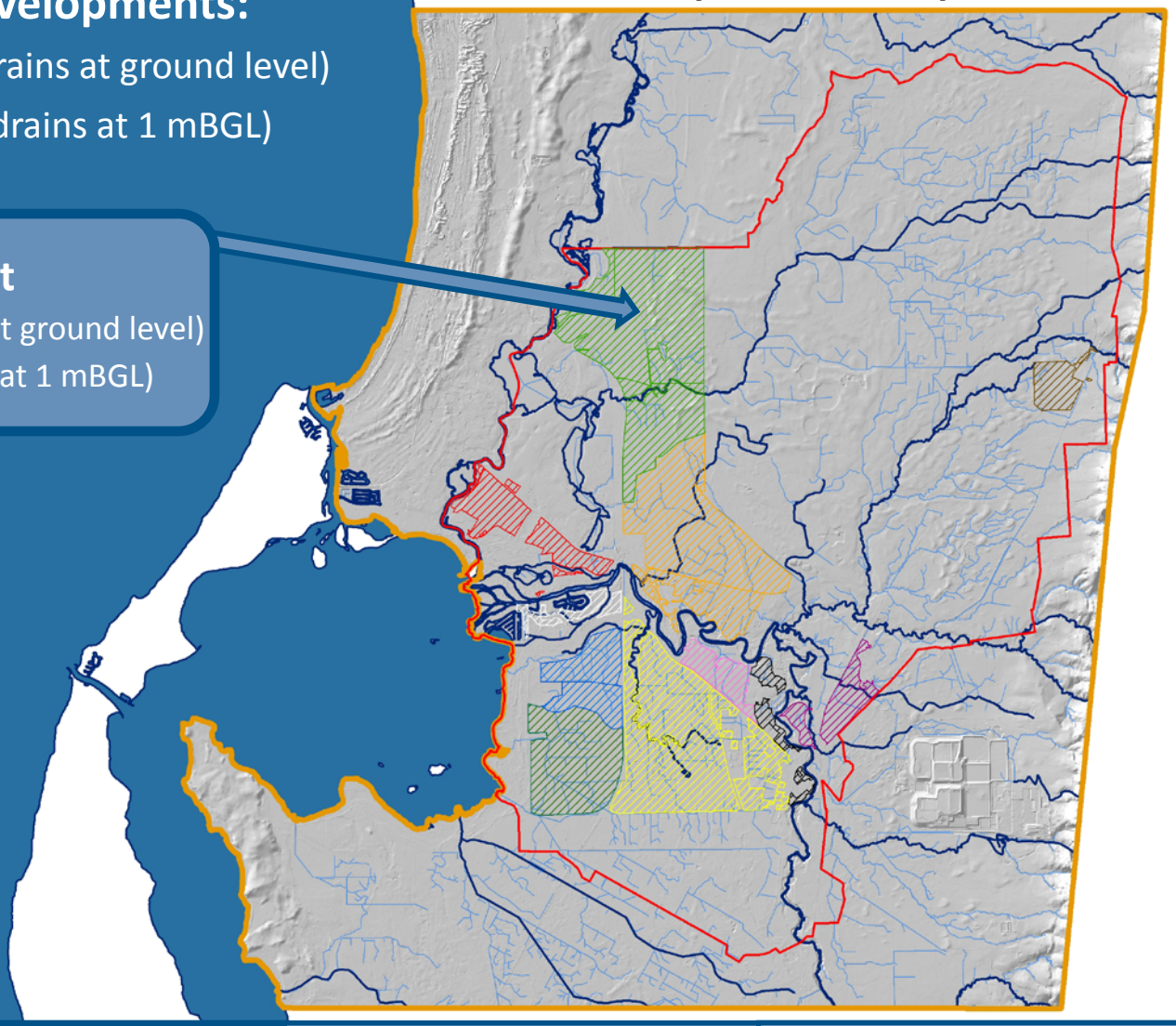
Max: 22 GL/yr (Wet climate, drains at 1 mBGL)

e.g. Nambeelup Development

Min: 2.7 GL/yr (Dry climate, drains at ground level)

Max: 4.6 GL/yr (Wet climate, drains at 1 mBGL)

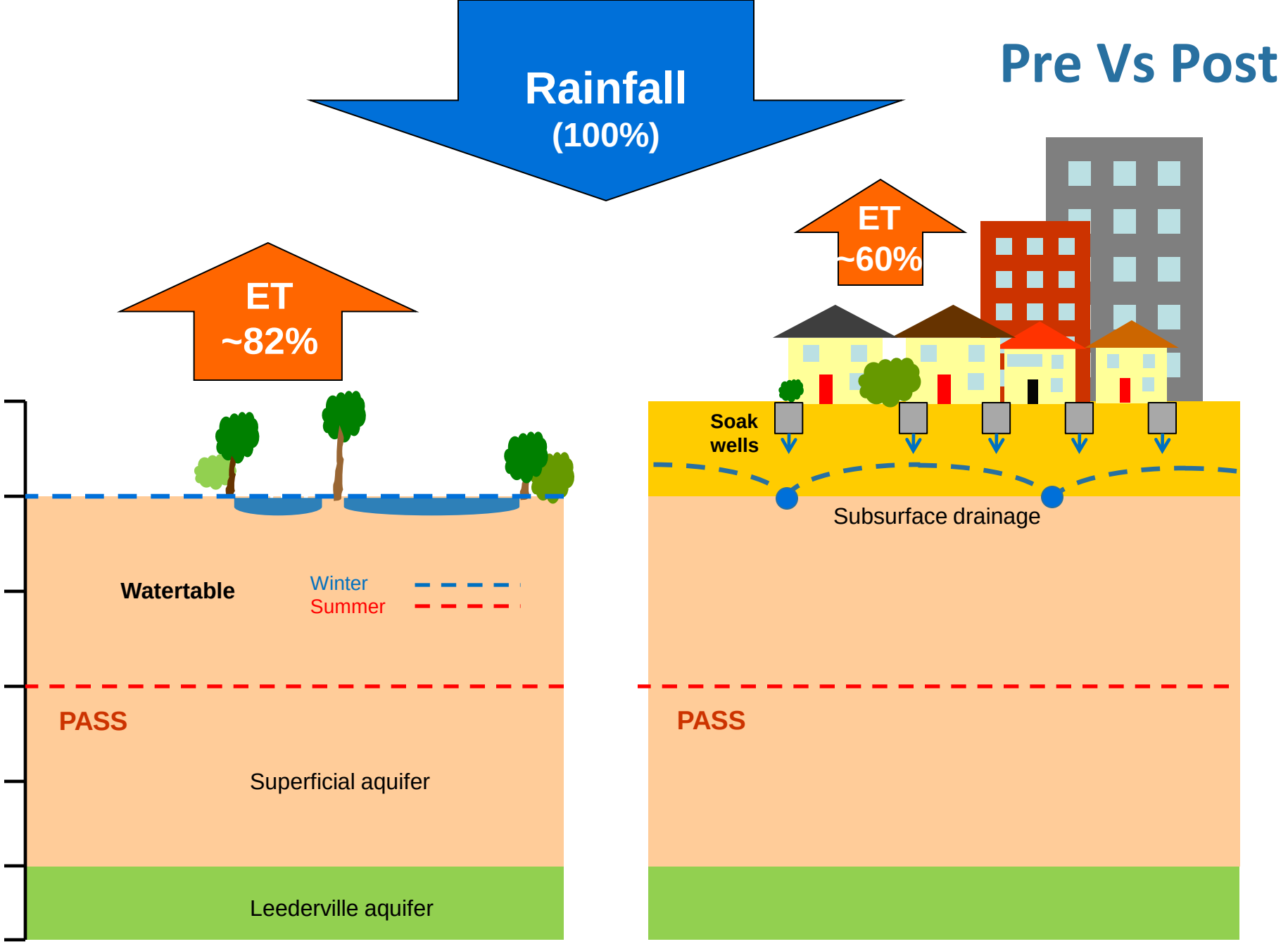
See: Murray hydrological studies (Hall et al. 2010)



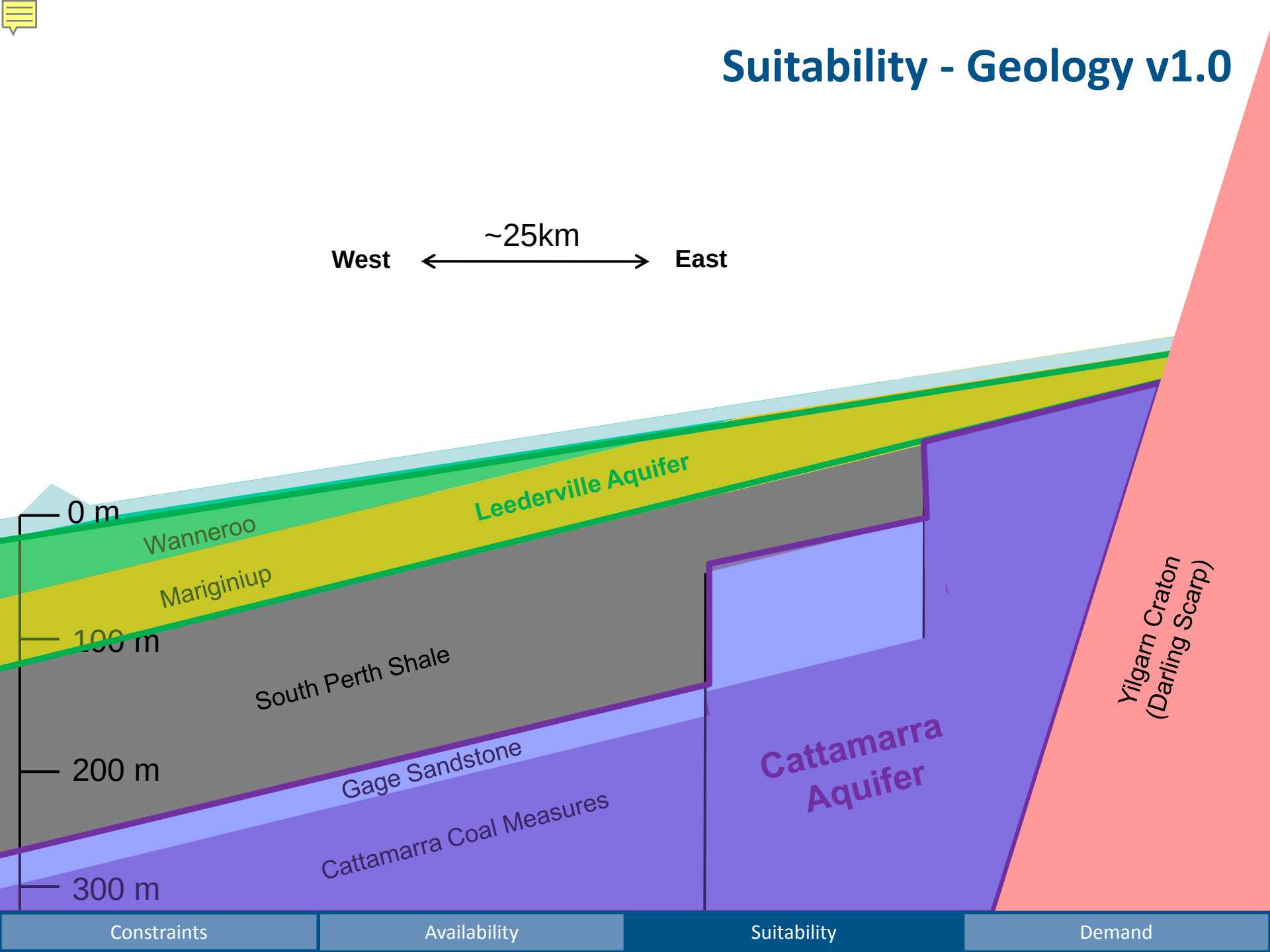
Development area

- Austin
- Barraghup
- Buchanans
- Carcoola
- Nambeelup
- Nerrima
- North Dandalup
- Pinjarra
- Ravenswood
- South Murray
- South Yunderup

Pre Vs Post


Rainfall
(100%)
ET
~82%
ET
~60%
Soak
wells
Subsurface drainage
Watertable
Winter
Summer
PASS
PASS
Superficial aquifer
Leederville aquifer

Suitability - Geology v1.0



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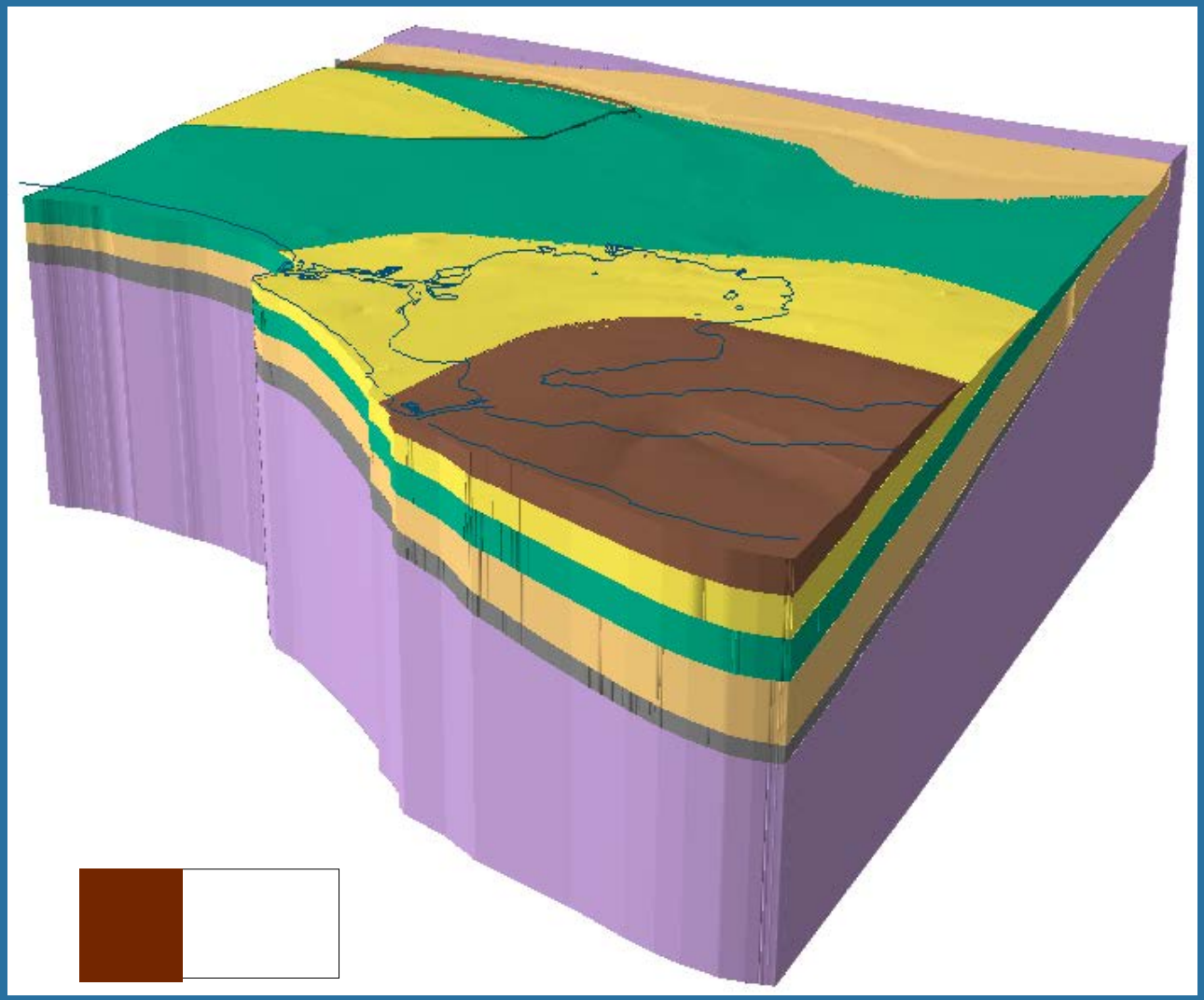
Suitability – Geology v2.0



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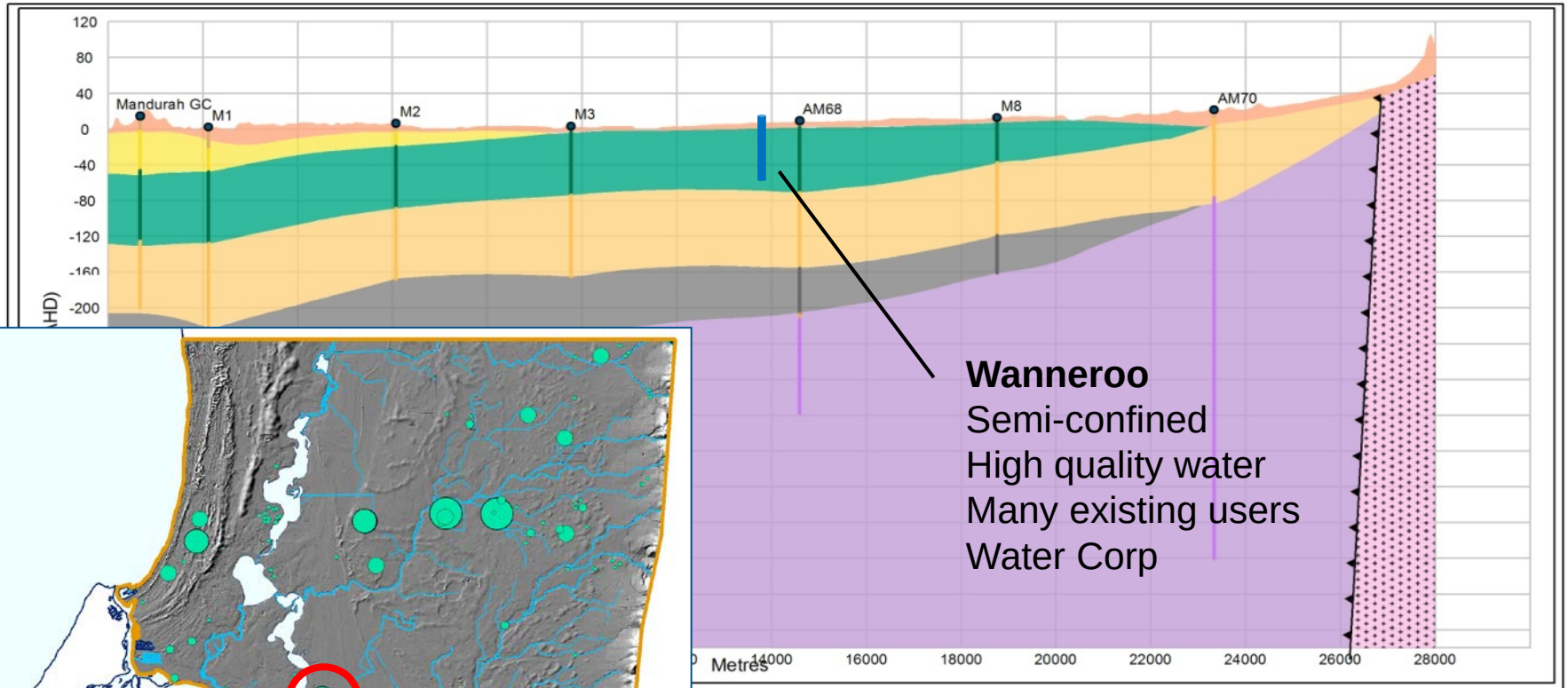
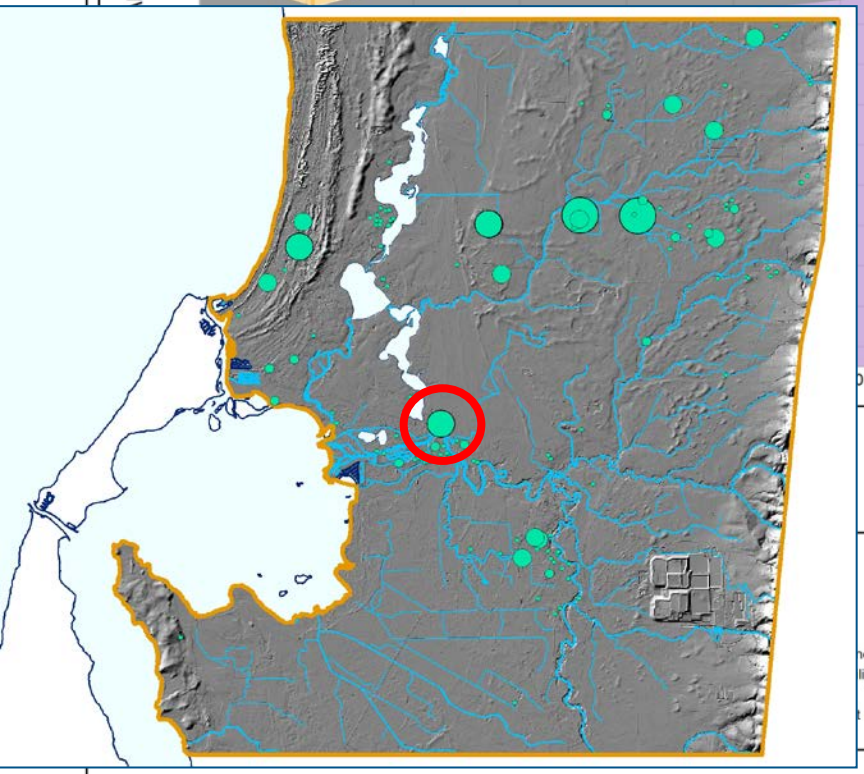
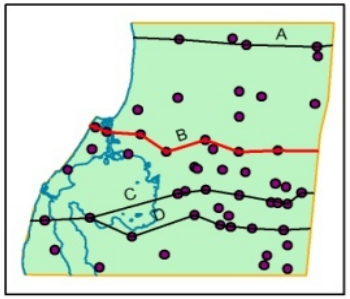
Suitability - aquifer



Wanneroo
Semi-confined
High quality water
Many existing users
Water Corp





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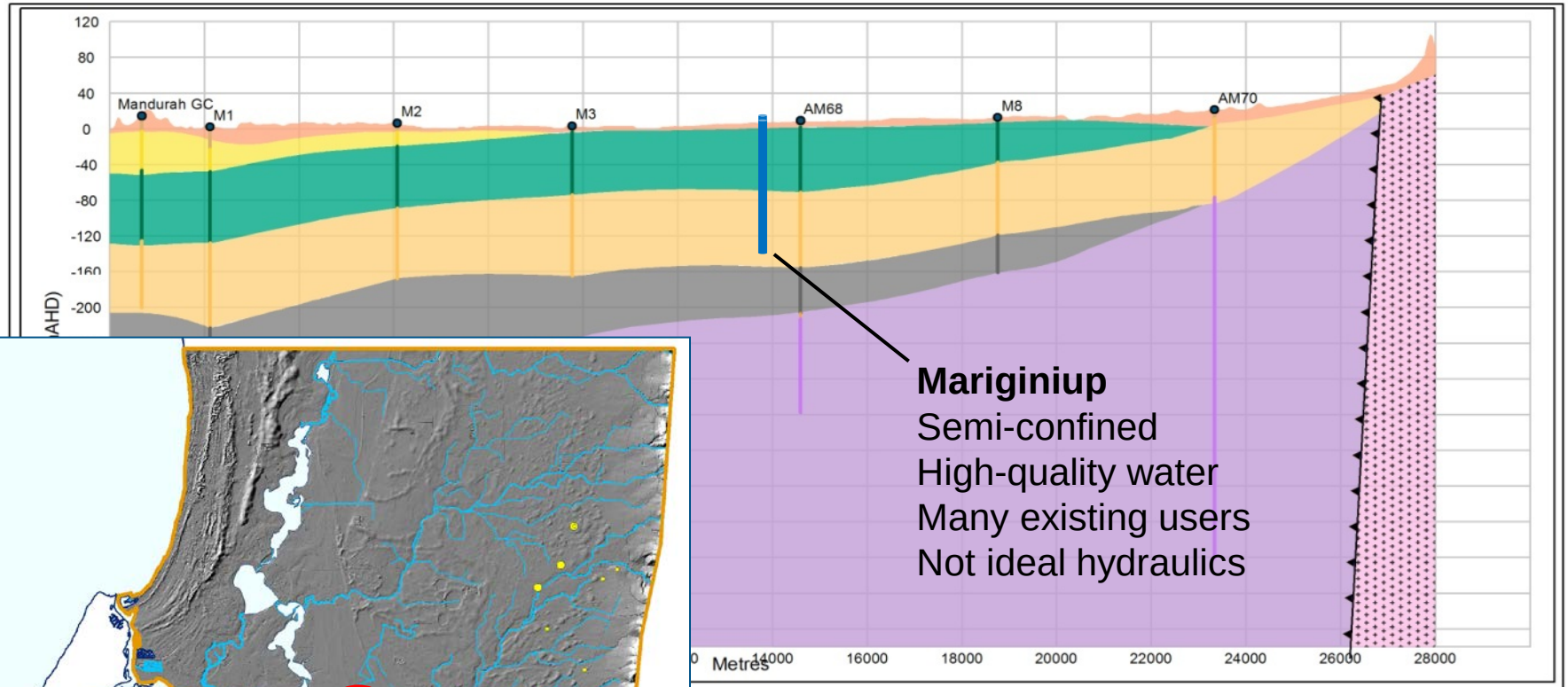
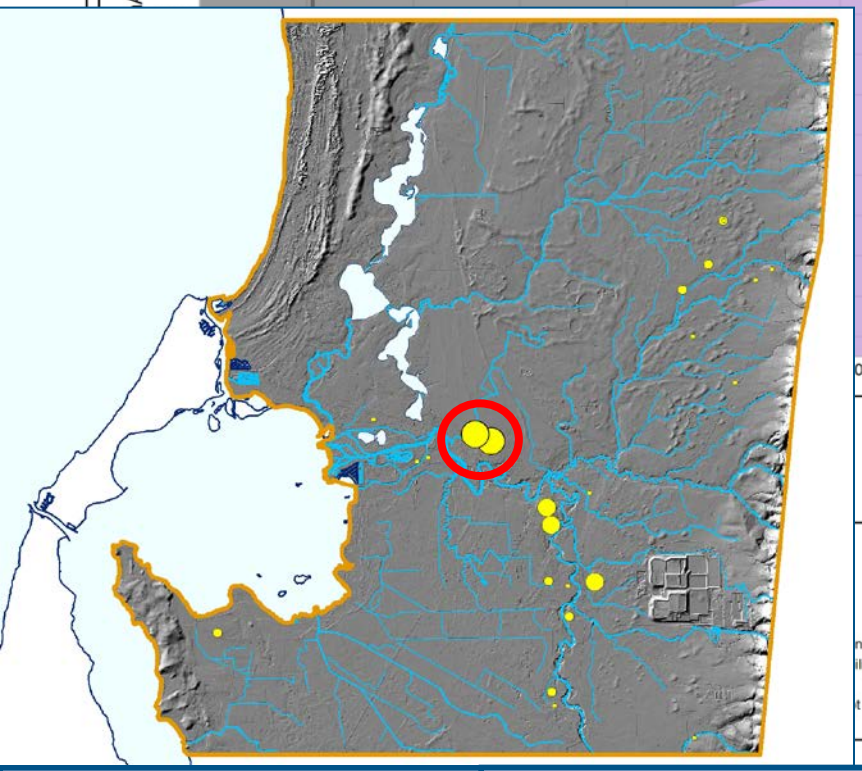
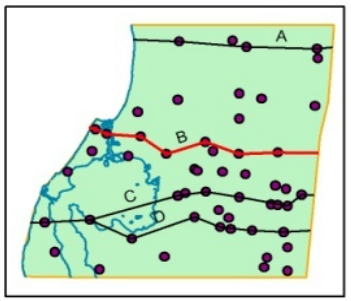
Suitability - aquifer



Mariginiup
Semi-confined
High-quality water
Many existing users
Not ideal hydraulics





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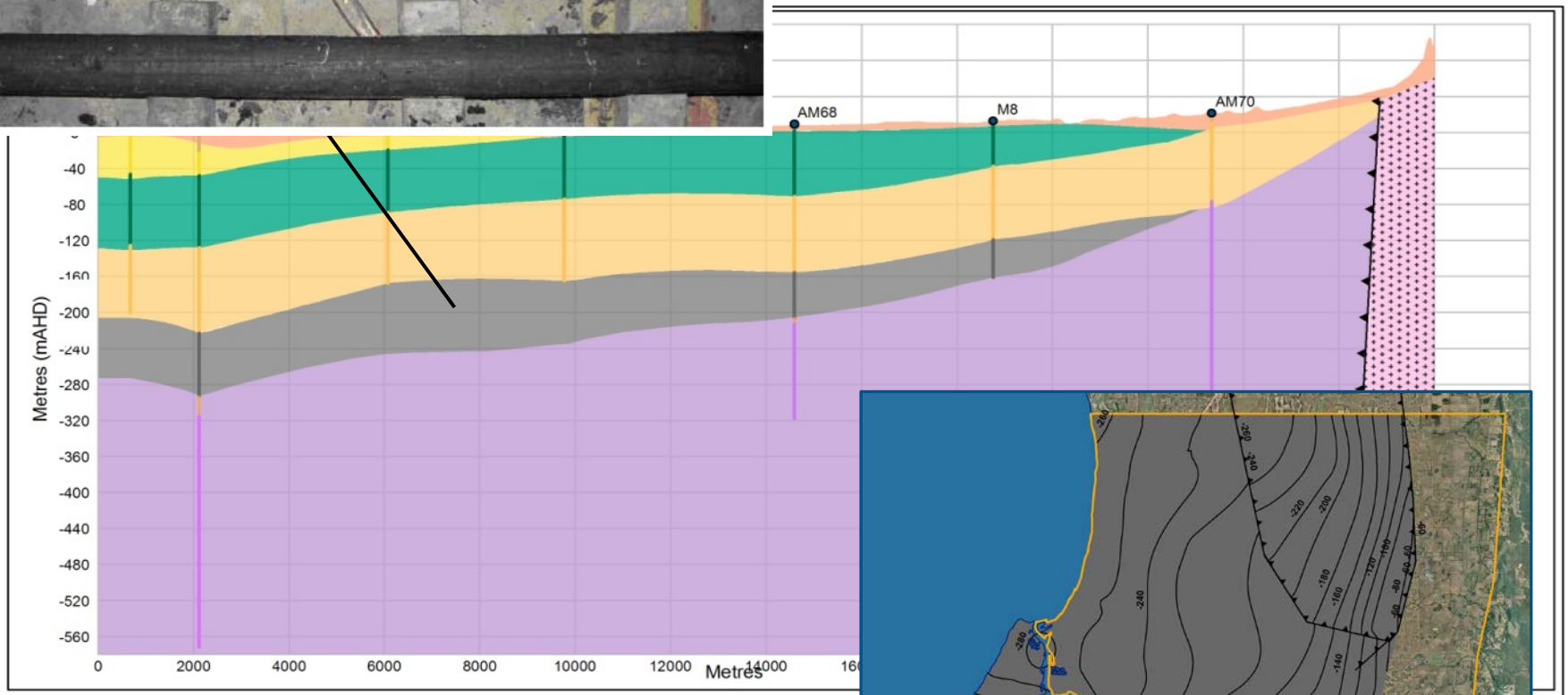
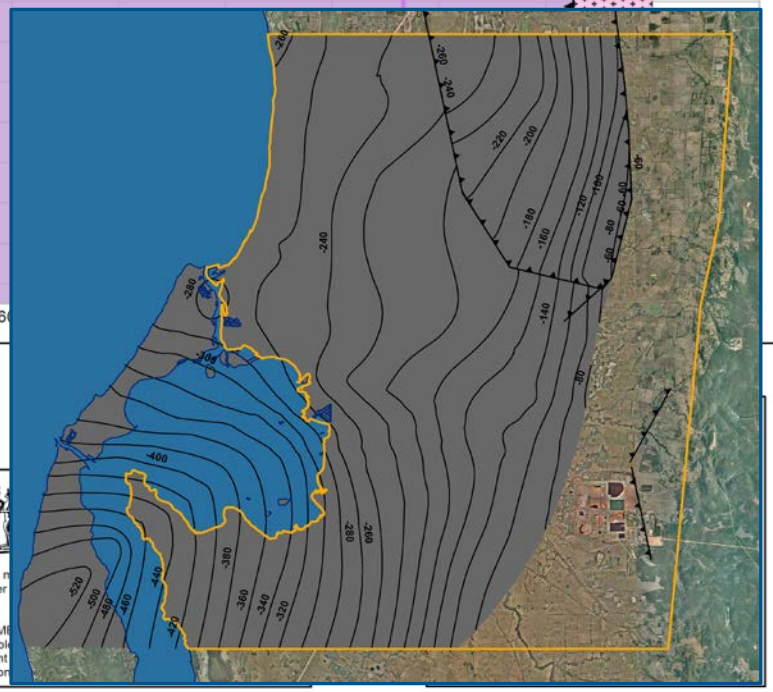
Suitability – confining layer





Stratigraphy

TQ	Kws
Kwlp	Jy
Kwlw	Jc
Kwlm	Basement

Datum & Projection:	GDA 1994 MGA Zone 50
Project name:	Murray MAR feasibility study
Project code:	33024604
Author:	P. Kretschmer (Dept of Water)
Date completed:	08/12/2010

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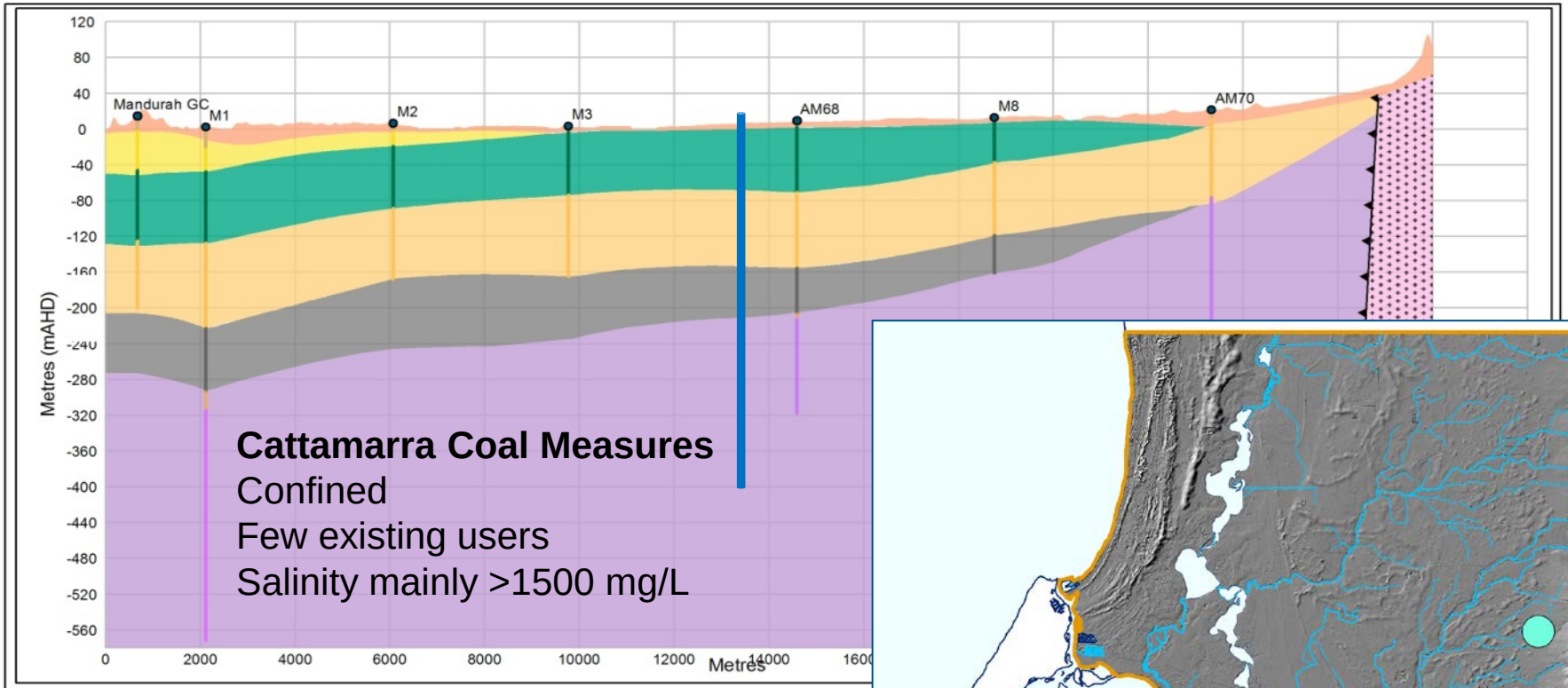
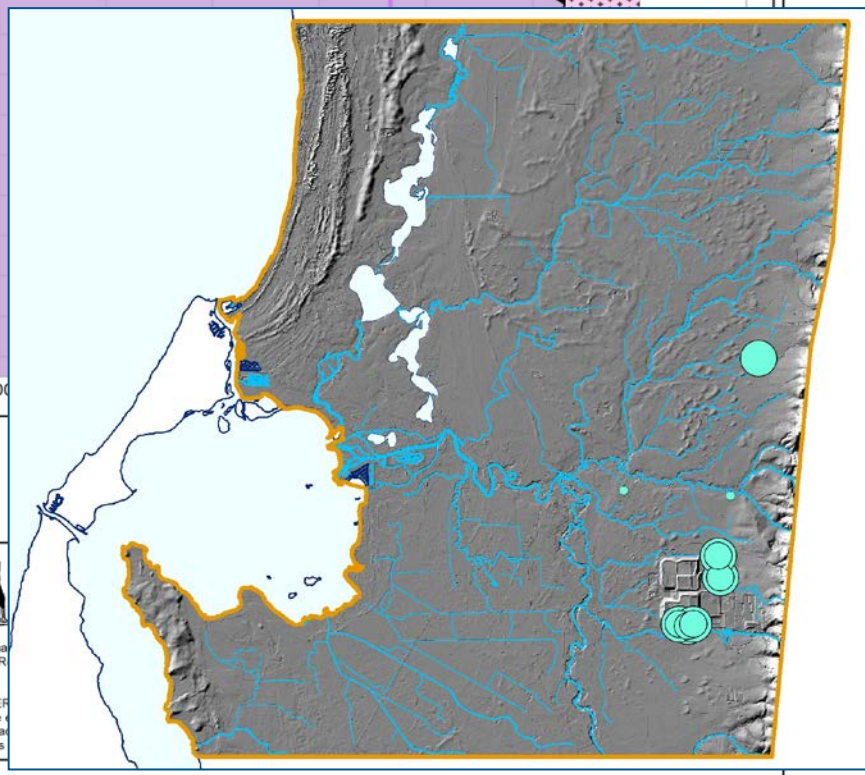
Suitability - aquifer





Stratigraphy

TQ	Kws
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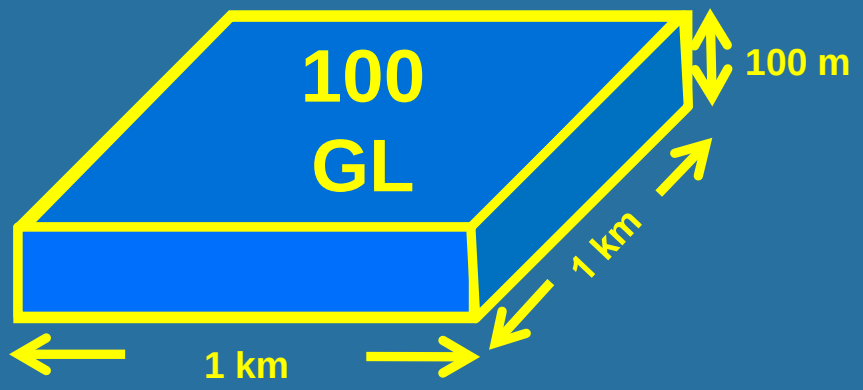
Project name:	Murray MAR feasibility study
Project code:	33024604
Author:	P. Kretschmer (Dept of Water)
Date completed:	08/12/2010

Suitability - aquifer storage

- **Balance a lack of measured data with conservative assumptions and value ranges, including:**
  - A brackish, hydraulically connected aquifer thickness of 50 m
  - A hydraulic head limited to 1984 levels (mostly pre-abstraction)
  - A confined aquifer extent limited to the interpreted extent of the South Perth Shale (confining layer)
  - An upper and lower storage coefficient of $1x10^{-4}$ and $5x10^{-4}$

- **Lower = 20 Gigalitres**
- **Upper = 100 Gigalitres**

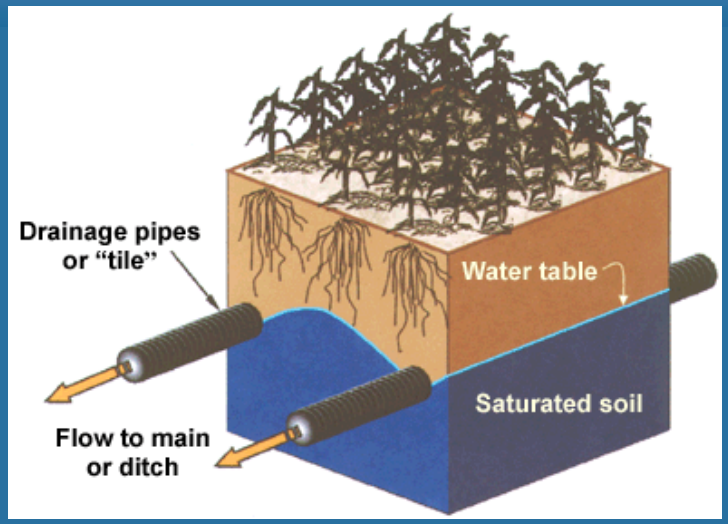


Cattamarra Aquifer – environmental values

- MAR should not lower the environmental value
- Spatially variable
  - Unconfined areas may interact with groundwater dependent ecosystems
  - Native water quality varies
  - Remoteness to existing users

- In confined, brackish areas, the environmental values should not be overtly difficult to maintain or *improve*

Stormwater suitability



- **Subsurface drainage**
  - First stage sand filter treatment
  - Reduced 'flashy' flows
- **Limited water quality data, major knowledge gap**
  - Nutrients may be an issue in superficial groundwater
    - P average 0.24 mg/L
    - TN average 2.6 mg/L

  (Subsurface drainage water in Ellenbrook has lower values)

- **Suspended sediment, turbidity, bacterial growth potential, pesticides and pathogens???**

(Thank you to those who helped us with data for subsurface drainage water quality)

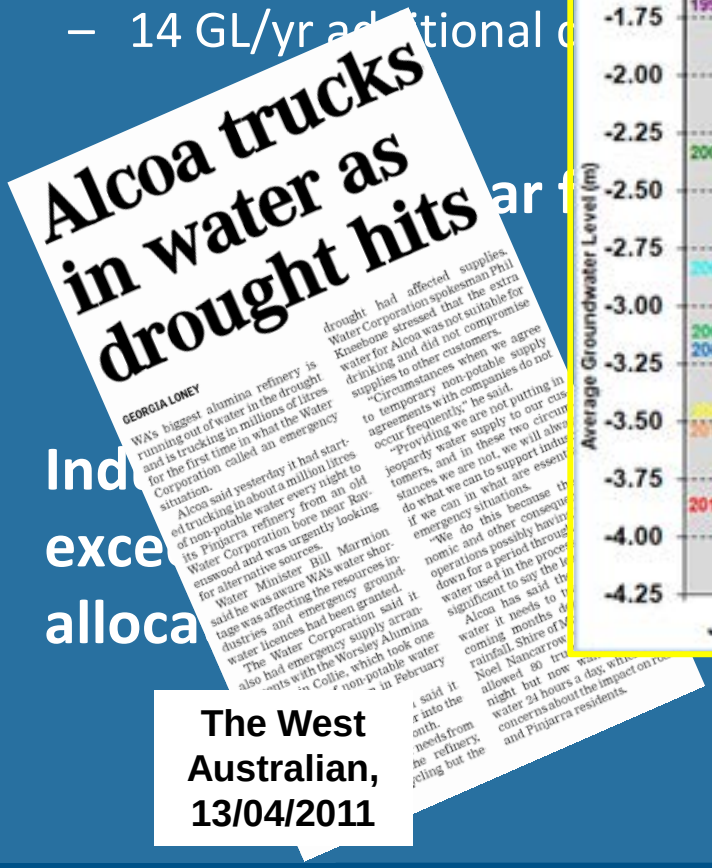
Suitability – treatment

- **Level of treatment dependent on:**
  - Environmental values of the aquifer
  - Native groundwater quality
  - The end use, for example, irrigation
  - END USER EXPECTATIONS

"fit for purpose"

Demand

- **Demand**
  - 13 GL/yr additional d
  - 14 GL/yr ad tional d
- ar f
- Ind
  exce
  alloca


Alcoa trucks in water as drought hits

GEORGIA LONEY

WA's biggest alumina refinery is running out of water in the drought and is trucking in millions of litres for the first time in what the Water Corporation called an emergency situation.

Alcoa said yesterday it had started trucking in about a million litres of non-potable water every night to its Pinjarra refinery from an old Water Corporation bore near Ravenswood and was urgently looking for alternative sources.

Water Minister Bill Marmion said he was aware WA's water shortage was affecting the resources industries and emergency ground-water licences had been granted.

The Water Corporation said it also had emergency supply arrangements with the Worsley Alumina Collie, which took one non-potable water in February

drought had affected supplies. Water Corporation spokesman Phil Kneebone stressed that the extra water for Alcoa was not suitable for drinking and did not compromise supplies to other customers.

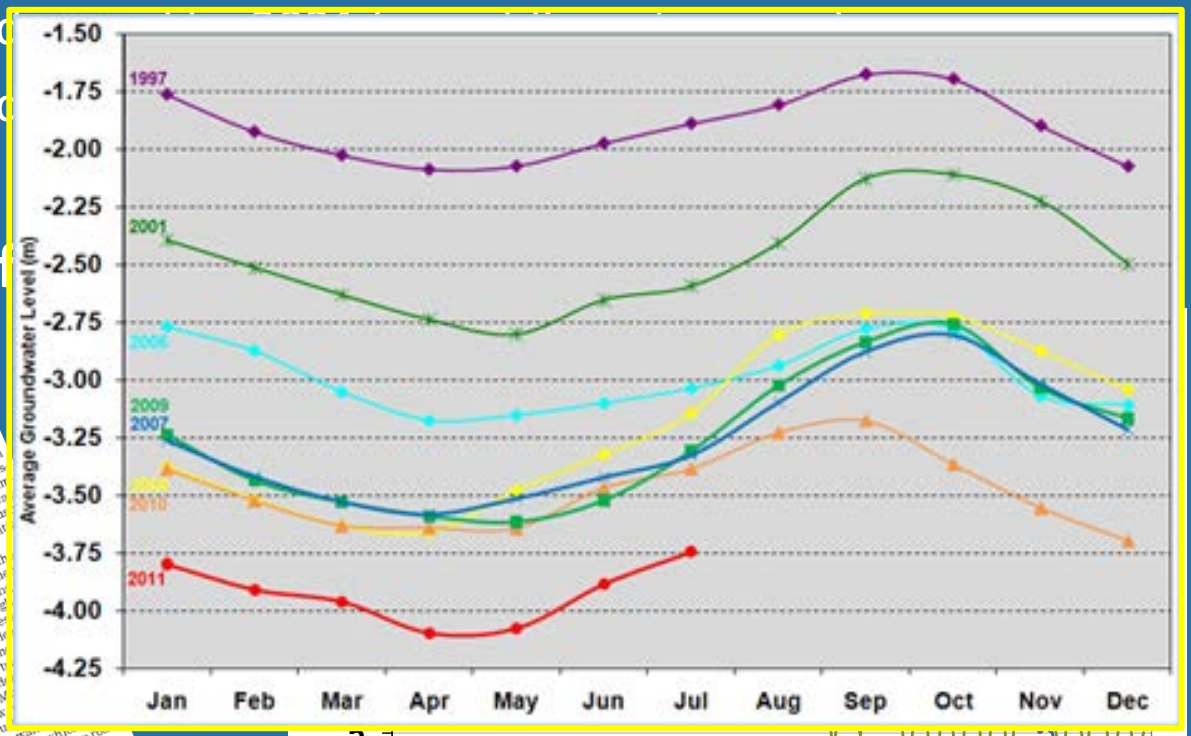
"Circumstances when we agree to temporary non-potable supply agreements with companies do not occur frequently," he said.

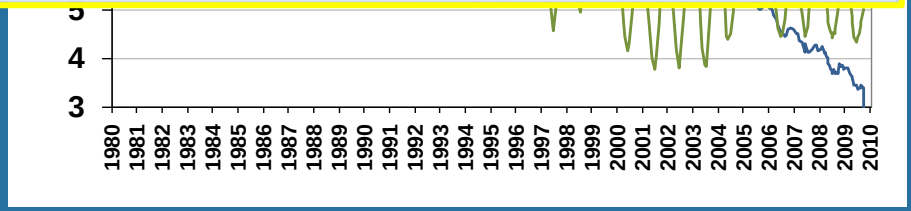
"Providing we are not putting in jeopardy water supply to our customers, and in these two circumstances we are not, we will always do what we can to support industry if we can in what are essential emergency situations.

"We do this because the nomic and other consequences operations possibly having down for a period through water used in the process significant to say the l Alcoa has said th water it needs to coming months d rainfall. Shire of N Noel Nancarrow allowed 80 tru night but now water 24 hours a day, wh concerns about the impact on and Pinjarra residents.

The West Australian, 13/04/2011

The Gnangara Mound





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Addressing the MAR guidelines

- **Worked example – hypothetical**
- **Desktop only – no drilling, additional sampling etc.**

- **2 part entry-level assessment:**
  - *Viability* :
    - coarse, designed to identify fatal flaws early on
  - *Likely degree of difficulty*:
    - Provide information on the likely amount of effort required to achieve approval for the scheme, and significant knowledge gaps

Viability assessment

- **1 – On going demand?**
  - Yes, there is predicted to be increasing demand for water
- **2 – Source water available?**
  - Yes, there is a predicted increase in discharge as a result of development
- **3 – Suitable aquifer?**
  - Yes, the Cattamarra Aquifer may store up to 100 GL in the study area
- **4 – Land available?**
  - Yes, the land requirements can be incorporated in to structure planning
- **5 – Capability?**
  - Yes, e.g. Beenyup Trial; plenty of hydrogeologists, engineers and management capability in WA

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Likely degree of difficulty

Lack of data / not applicable

	Degree-of-difficulty questions													
Development area	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Austin	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
Barragup	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
Buchanans	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
Carcoola	M/H		M/H	L	L	M/H		M/H	L	L	M/H	M/H		M/H
Nambeelup	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
Nerrima	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
North Dandalup	M/H		M/H	L	L	M/H		L	M/H	M/H	M/H	M/H		M/H
Pinjarra	M/H		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
Ravenswood	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
South Murray	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H
South Yunderup	L		M/H	M/H	L	M/H		L	L	L	M/H	M/H		M/H

Future work

- **Address the knowledge gaps**
  - **Subsurface water quality data**
    - **how clean is subsurface stormwater already?**
    - **Best way to passively clean it? (soil amend., wetlands, land use etc.)**
  - **STAGE 2 INVESTIGATION: Partner with a committed developer and local-government to create a demonstration site and align MAR infrastructure with district structure planning**
  - **Build knowledge to ensure the community feels MAR is a safe option**
- **CREATE THE 'ROAD-MAP' ON HOW TO MAKE IT HAPPEN**

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What to take away from this...

- There is water available, we just need to be smarter in the way we manage it
- There are existing costs to manage the water quality (KP1) and flood risks (KP2) anyway – we can design these systems to help address the needs of MAR (KP3)
- The Cattamarra Aquifer has very promising storage potential
- Proponents must follow the Aust. Guidelines for Water Recycling

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Department of **Water**

Thank you

Contact:
Water Recycling and Efficiency Branch
08 6364 7800
recycling@water.wa.gov.au

Feasibility of managed aquifer recharge using drainage water, a supporting document for the Murray Drainage and water management plan.
Available online: www.water.wa.gov.au

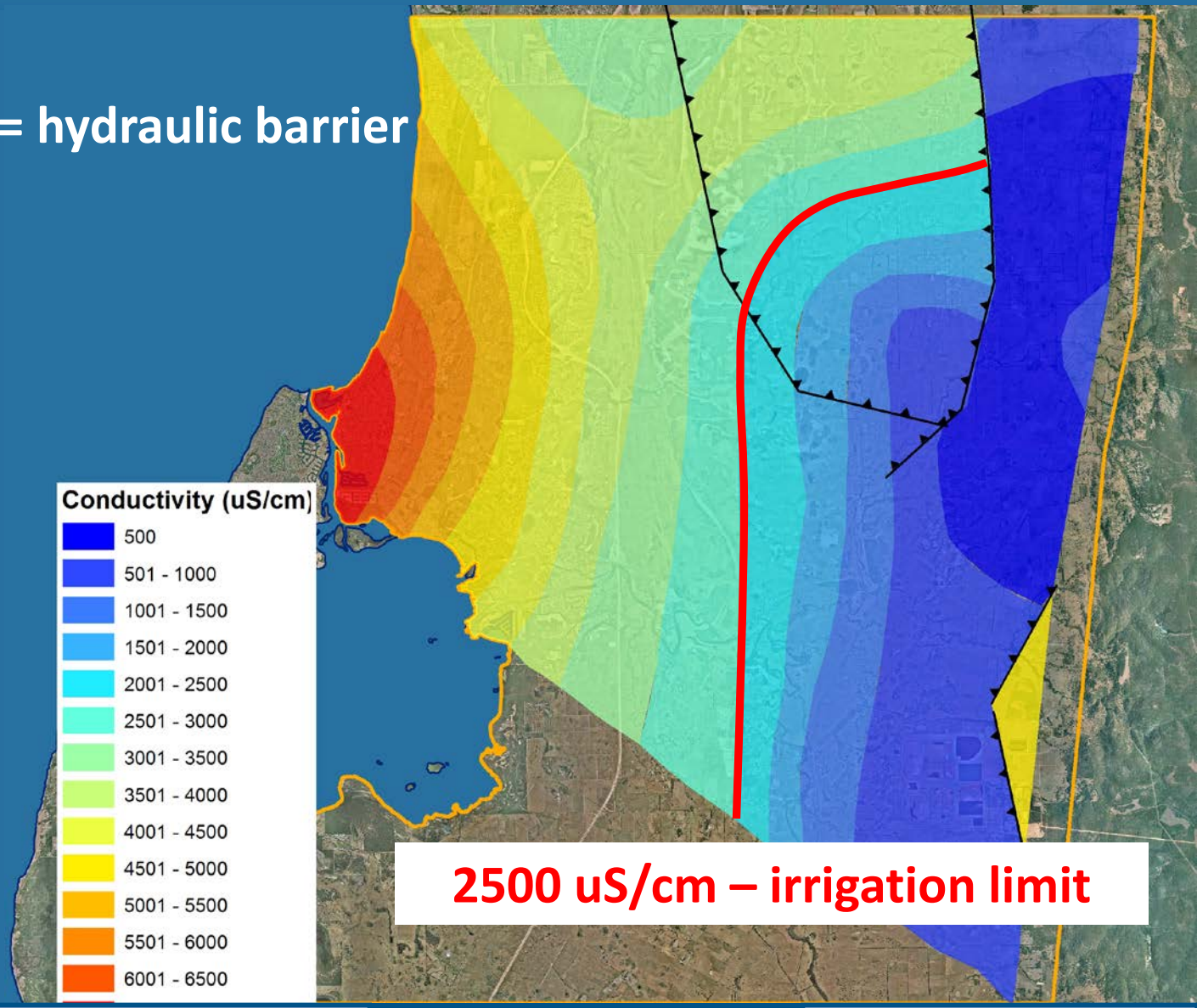
- **Spare slides / question slides**

click


Pennington
Mary St
Burleigh Ave
Ninth Ave
Tenth Ave
Eleventh Ave
Twelfth Ave
Thirteenth Ave
Owen St
Leeds St
Sheffield St
Sheridan St
York Pl
Edgecombe St
Stone St
Farr St
Glengyle St
Caskey St
Audley St
Burwood Ave
Fletcher St
Sheridan St
Percy St
Herbert St
Clifton
Carlton Cres
Cheltenham
Cheltenham Cemetery
Chippenham St
Cheltenham Parade
A7
Sa Manufacturing Park
Woodville North
Woodville High School
Murray St
Grace St
Port Rd
Rowley Tce
Woodville
AMF Bowling Centre
West Lakes Boulevard
Lewis St
James St
Claire St
Alma Tce
Woodville Rd
Russell Tce
Kemp St
Norman St
Evans St
Woodville
Woodville
The Grove
Alley St
Beaufort St
Stanley St
Harvey St West
Hughes St North
Raneleigh St
Park St North
Stanley St
Harvey St

Cattamarra aquifer EC

- Serpentine Fault = hydraulic barrier



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To answer your question...

Is MAR feasible...

Definitely YES

using stormwater...

Definitely YES

...in the Peel Region

Viability assessment ✓

Difficulty assessment – low to moderate*

Stage two...?

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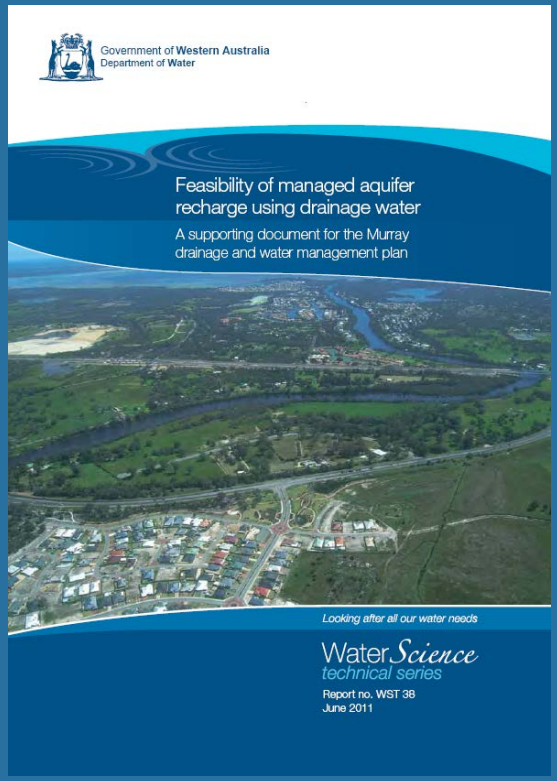
Peel's natural waters history

- 1890's – large scale clearing and agricultural development
- 1910 – first major algal bloom recorded
- 1916 – Harvey Dam
- 1961 – Serpentine Dam
- 1960 – large seagrasses losses due to eutrophication
- 1974 – South Dandalup Dam
- 1978 – huge bloom of cyanobacteria
- 1980's – ongoing algal bloom issues
- 1992 – public outcry, EPP legislated for phosphorus
- 1994 – Dawesville cut, North Dandalup Dam
- 2000's – eutrophication and algal problems continue...

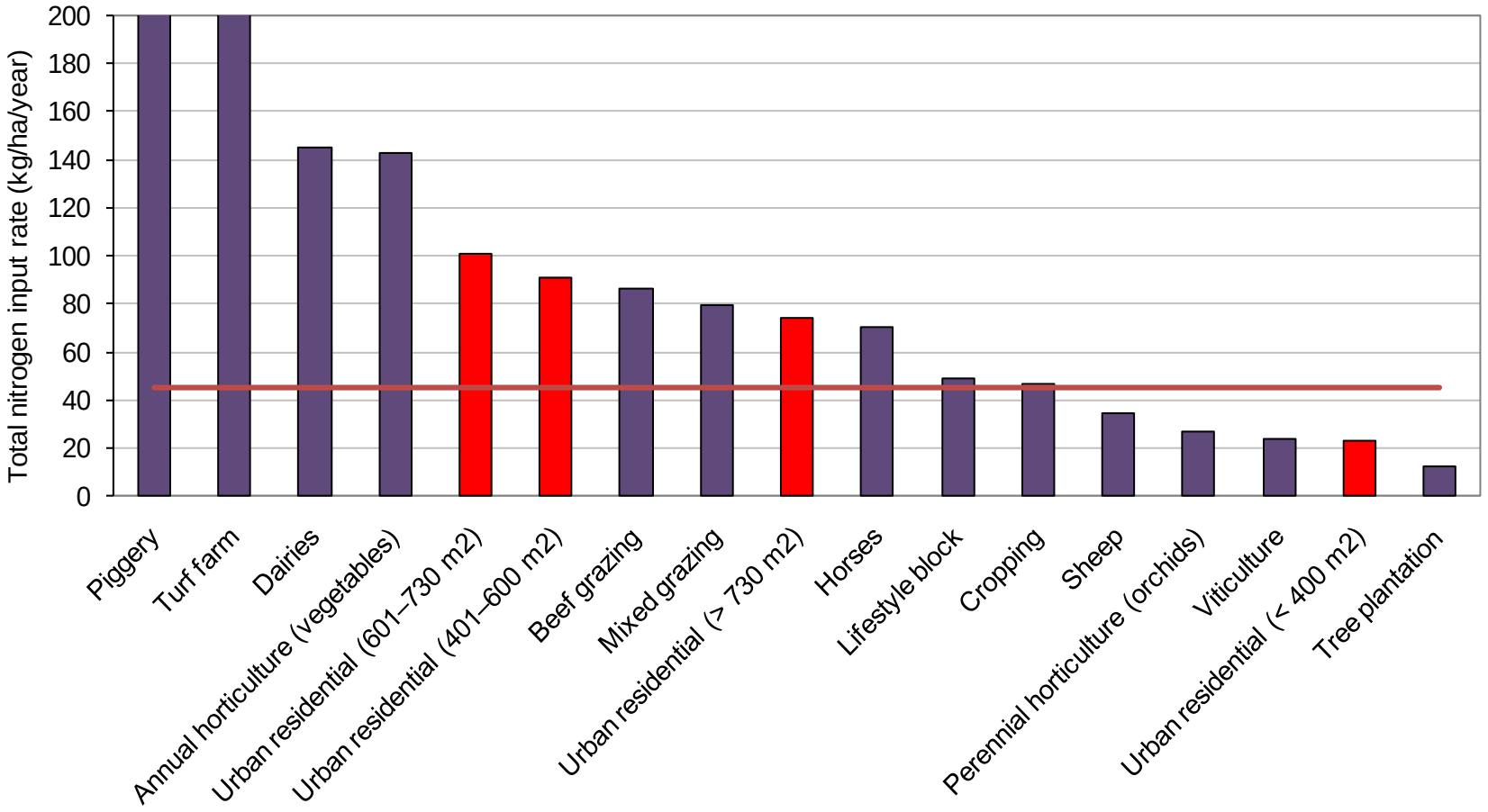
- 2011 – *Commencement of integrated water solutions*

MAR feasibility study

- **Availability**
  - how much drainage water will be available?
- **Suitability**
  - aquifer mapping
  - water quality information
  - environmental values assessment
- **Demand**
  - is there demand for an alternative water supply?
- **Viability Assessment**
- **Likely degree of difficulty Assessment**
- **Knowledge gaps**

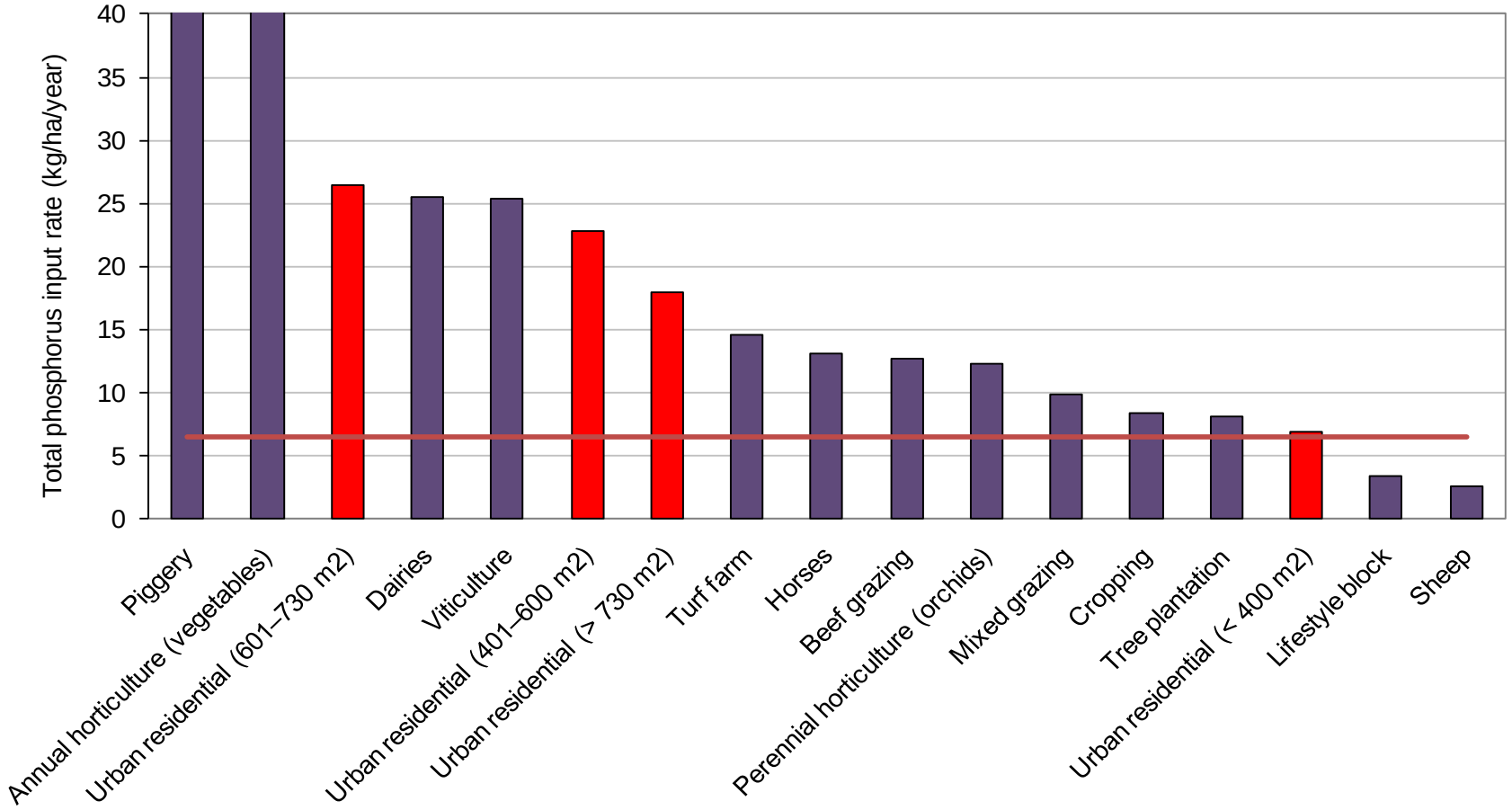


Why?



Traditional urban has greater nutrient inputs and increased flows that efficiently convey nutrients to streams

Why?


Total phosphorus input rate (kg/ha/year)
40
35
30
25
20
15
10
5
0
Piggery
Annual horticulture (vegetables)
Urban residential (601–730 m2)
Dairies
Viticulture
Urban residential (401–600 m2)
Urban residential (> 730 m2)
Turf farm
Horses
Beef grazing
Perennial horticulture (orchids)
Mixed grazing
Cropping
Tree plantation
Urban residential (< 400 m2)
Lifestyle block
Sheep

Short glossary

- MAR = Managed Aquifer Recharge
- ASR = Aquifer Storage and Recovery

- PASS = Potential acid sulfate soil
- AASS = Actual acid sulfate soil

- DWMP = Murray drainage and water management plan

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How is DoW helping proponents

This is what DoW is doing so far…

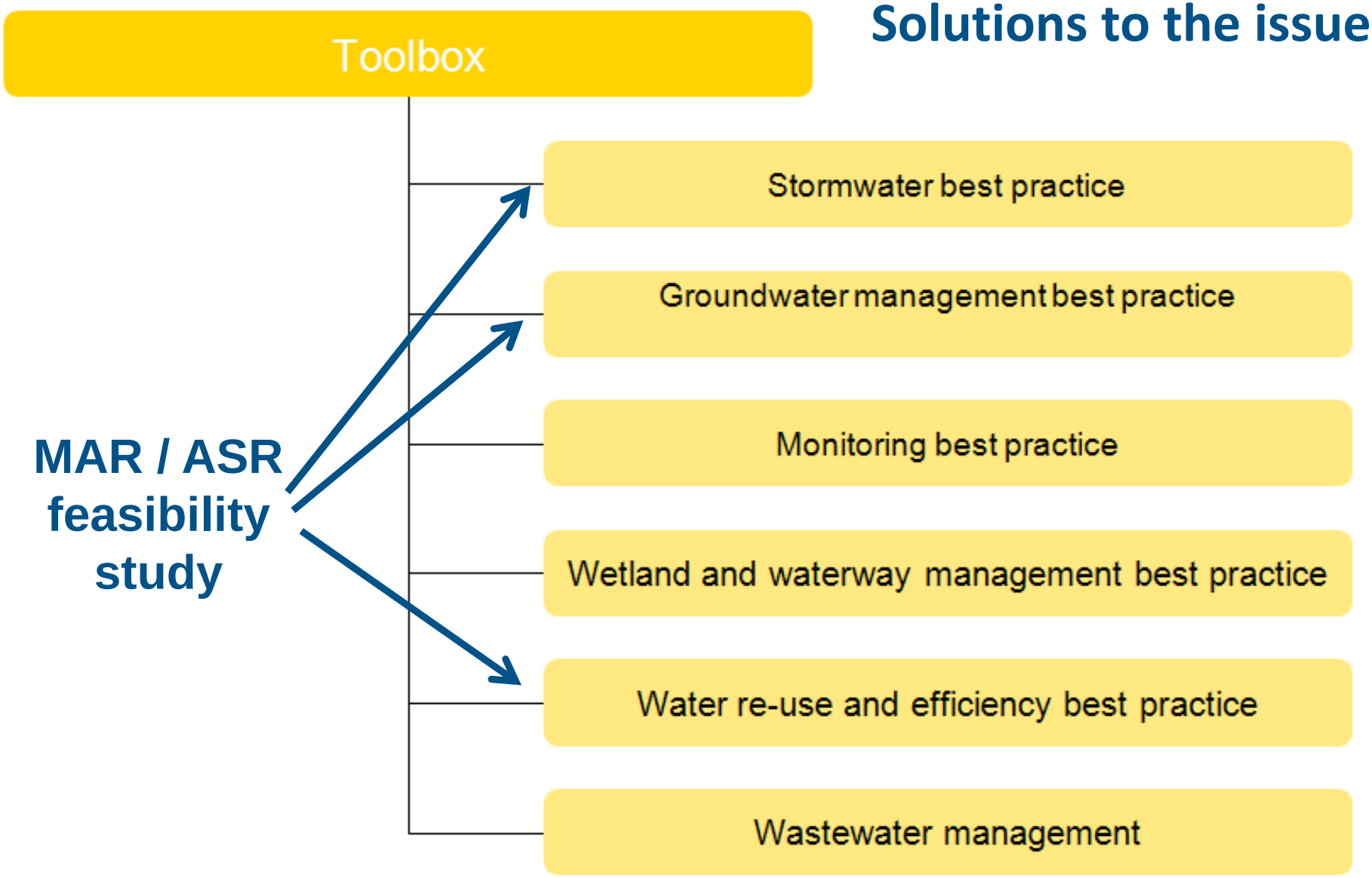
- Identify volumes and seasonality of suitable water supply
- Create a local geology model to identify

- Improve understanding of existing water quality constraints at:

- We are offering to help proponents through the regulatory process

- Assessing policy arrangements
- Simplifying the MAR guidelines
- Offer guidance wherever we can

Solutions to the issues



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Ellenbrook subsurface WQ

Physical characteristics	Unit	Subsurface drain in Ellenbrook			ANZECC Aquatic Ecosystem Guidelines[2]
		Mean	Min	Max	
TN	mg/L	1.03	0.79	1.4	1.5
NO_x -N	mg/L	0.18	0.08	0.38	0.1
NH_3 -N/ NH_4 -N (sol)	mg/L	0.23	0.14	0.33	0.9
P (sol)	mg/L	0.02	<0.005	0.016	0.03
EC @ 25 deg C	µS/cm	520	390	600	300-1500
TDS (cond)	mg/L	286	215	330	180-900*
pH		4.85	4.31	5.45	7.0-8.5

*A conversion factor of 0.6 was used to convert Electrical Conductivity to TDS

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The Problem

- *Murray hydrology studies* identified that there will be a significant volume of drainage water to be managed

- *Murray nutrient modelling* identified sources of the significant eutrophication problem in the Serpentine & Murray Rivers, & Peel – Harvey Inlet.
  - Urbanisation is a major concern

- DWMP toolbox developed to provide **solutions**

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Attention potential proponents

- Planning will be integral to success, integrate MAR at DWMS level
- Consider location of 'foundation' clients – e.g. industry, golf courses, schools, sporting grounds, public open space
- Work with surrounding local government / developers to reduce cost
  - other developments have to dispose of drainage water
  - other developments want it back in summer!
- Engage DoW early on, ask how we can help you
- See water as an asset, not a liability

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Confined MAR studies in WA

Beenyup

Jandakot ASR

Site specific studies

Westralia Airports

Burswood

Midland redevelopment

Integrating stormwater harvesting and managed aquifer recharge into new development in the Peel Region

Workshop networking session

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