





WaterSmart Farms – Water Security now and beyond 2030

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Todays focus...WaterSmart Farms

Emphasis – self sufficiency

- 1. Drier climate its here to stay
- 2. Sources
 - Dams (climate sensitive)
 - Groundwater (secure decade scale)
- 3. Groundwater desalination & disposal
- 4. Examples

• "....Water forever whatever the weather...(and salinity)"

How much water per year....

- Mixed farm: < 10,000 kL (10 ML)
- Feedlot: ~ 100 ML
- Processor: ~ 300 ML (0.3 GL)
- (Irrigator 2 GL)
- Fit-For-Purpose quality





Part 1 – Smart Dams

Criteria – key dams

- Deliver design water 9 out of 10 years •
- Storages 5,000 to 10,000 kL
- **Engineered catchments**
- Leakage < 2mm day •
- Costs < \$1 kL
- Cant rely on natural catchments •



desalination

Another Innovative Western Australian Initiative by:

Develop climate effective surface and

groundwater capture and storage

systems that make best use of local

cost to the community.

sources, has high reliability and least

Su

Outputs

161 Primary Inda

economic evaluation

Murdoch WWA

Enhance the guality and availability of

information for innovative on-farm water

supply development for farm businesses,

communities and agribusiness growth

Changes in daily rainfall



Winter daily rainfall has declined since 2000

30% less >10mm rainfallrunoff events

(12mm design for a roaded catchment)

Winter rainfall (fill frequency) reduced by much more that 30%



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Dams

Usually farmers first choice water...

Nicks 2020 project learning

- 196,705 dams
- 30% saline or shallow watertable
- ~14 M sheep need 30 GL/yr
- add cattle, pigs etc
- ~7 M ha crop need 3 GL for sprays (nutrition, weeds etc)

Dam density in the SW of WA

Note

196,705 dams
Fresh, saline, dry
Fewer dams in Northern Wheatbelt (scheme water)

NB few roaded catchments





20/8/20 Draft - DPIRD Machine Learning – Nick Wright (see DPIRD display)

Most dams designed on historic rainfall records

Dams fed by natural runoff – unreliable



Dams; Built >50 years ago on design 1970/80s, now operating on 2020 climate !!

WaterSmart Farms: Large (deep) dams with engineered - improved catchments



Slope

Landgate Imagery

Other options to improve farm water security

- Audit & Plan
- Double dams, deeper dams
- Seepage control clay
- Evaporation control covers, shade
- Polymers improve runoff
- Plastics







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Future runoff...

Global Climate models

Zheng et al CSIRO Dec 2019

> 1976-2005 v 2046-2075



Figure 1. Projected change in mean annual runoff (median and the 10th and 90th percentile values from GR4J hydrological modelling informed by climate change projections from the 42 CMIP5 GCMs) for RCP8.5 for 2046–2075 relative to 1976–2005. The projections also reflect change in runoff for a ~2.2°C global average warming relative to the 1986–2005 IPCC AR5 reference period. The large range in the projections mainly reflects the uncertainty in rainfall projections across the 42 CMIP5 GCMs.



• Part 2 – Groundwater

Criteria - reliable supply

- Supplies 20 86 kL/day
- Salinity < 8,000 mg/L
- Used 200 days per year
- Deliver design flows by testing
- Salinity increases slowly
- Target costs <\$1 kL

Fit-for-purpose salinity





100 km

114°

116°

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Yilgarn Block – bedrock

24°-

26°-

28°-

30°-

32°---

34°---

🔆 1888 Ma dyke samples

126°

124°

Bryah Basin WARRYER TERRANE Earaheedy Capricom ration Orogen Yerrida Basin Officer Basin Basin Yiigam Craton 400 km YOUANMI TERRANE Phanerozoic EASTERN GOLDFIELDS **Gunbarrel Basin** SUPERTERRANE P MC Carnarvon Basin **Canning Basin** N Perth basin Proterozoic R Paleoproterozoic basins R SOUTHWEST Arid A TERRANE Mesoproterozoic basins Basin O Perth Neoproterozoic basins 16 R Pinjarra Orogen OGE Albany-Fraser Orogen Gascoyne Province 1210 Ma Marnda Moorn LIP N Archean Barren 1888 Ma Boonadgin dykes LC FRASE Basin Yilgarn Craton 2408 Ma Widgiemooltha Supersuite 🛊 1852 Ma Yalgoo dyke

118°

120°

122°



Coolgardie - Artesian Basin?

- July 1896 2 years drilling
- Finished at 900m •
- Small flow salty water 36m ٠



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Great Southern aquifers

Major Aquifers	Security	Where
Granite – saprock	High	Yilgarn block
Soaks	Low	"
Hard rock	Med ??	u
Sediments -	Low	"
 palaeochannels 	Medium to high	" Gt Sthn to South Coast; Dardadine and Wellstead





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1968-70 Drought Drilling (wheatbelt)

- GSWA (DMIRS)
- 2639 bores drilled at 521 Farms; 162 Government Reserves
- Drilled 67,294m (average bore <30m)
- 263 bores successful (1000 gallons; 11,000 TDS)
 - 10% wet suitable
 - 13% wet insufficient
 - 17% wet saline
 - 60% dry/abandoned
- Average flow 21 kL/day
- Private 1:3 farms; reserves 1:4
- If every good bore equipped = ~2 GL/yr

CONCLUSIONS

While the methods used may be criticised they proved successful under the emergency circumstances. The results more than justified the expense incurred when considered in the long term.

The programme has clarified the underground water potential in many difficult areas and the results, which are incorporated in the records of the Geological Survey, will be of great assistance in the future.

In some areas, such as Holt Rock, North and South Stirling, and Ongerup, property owners should be encouraged to investigate their properties for stock supplies of underground water. The methods used for drought relief are recommended for such testing.

In other areas, such as South Yilgarn, South Burracoppin, Mount Walker, and Lake Grace, the search for underground water by individual farmers cannot be recommended as the chances of success are very remote. Wheatbelt - 15 M ha

Salinity = Rising watertables

>1000 GL/a recharge

Pulses... 2017







Water after 2017 – recharging valleys (and hills – slowly)



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Hardrock aquifers - watch this space as R&D

Untapped water source in Merredin



Fractured rock drilling 74m – June 2020 at York

4 Nov 2010, 1:19 p.m.

Agribusiness



Fault line: This photograph was taken by a remote-controlled camera inside the Merredin drill hole. As they drilled through solid granite at a depth of 327 metres, Globe Drill came across this fault line (seen here as a dark crack), from which water was flowing in vast quantities.



Where do I drill?? (saprock, faults & desalination)



Case study 2 – Badgebup (saprock & hardrock)



Case study 1 – Newdegate (saprock)









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Dardadine palaeochannel











South Coast aquifers

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Pipelines & on-farm supply?

	GAWS (Mundaring to Southern Cross)	GSTWSS (Harris – Binningup)
Length of mains	8800km	3000km
Farmlands customers	2900 out of 19900 total customers	1290 out of 37900 total customers
Farmlands usage	3.85GL out of a total of 9.9GL	1.68GL out of a total of 5.00GL
		Charge \$2.66 (~\$13 OPEX)

Comparing other sources (on farm)

- 163,000 dams x 1000 m3 = 168 GL/a
- 6000 farms/bores x (20 kL x 365 days) = 44 GL/a
- Sheds/tanks = 6000 x 250kL = 1.5 GL
- Gov. community dams = 130 x 20,000 kL = 2.6 GL

Farm use – 33 GL plus domestic

Assumes: 14 M sheep * 6 litres = 30 GL, Grains - 7 M ha crop = 3 GL, 6000 farms



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Where to get groundwater information?

- DWER database called Water Information Reporting
- DPIRD groundwater monitoring AgBores database
 - (Dams app & Geology app soon)
- DMIRS geological related online GIS Geoview
- Consulting hydrogeologists
- Geophysics tailored to the geology (eg AEM)
- Local drillers
- Your neighbours
- Others...

Come and see us at the DPIRD display

Desalination NOID Forms – www DPIRD



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Notice and Intent to Desalinate



https://www.agric.wa.gov.au/watermanagement/groundwaterdesalination-farms-western-australia

Climate, land & water		
Water		
Water management		

Groundwater desalination on farms in Western Australia

Page last updated: Thursday, 1 October 2020 - 3:50pm

Groundwater in the Western Australian grainbelt is a useful resource for on-farm water. However, in this environment it is often saline and unsuitable for livestock or other onfarm uses.

Desalination can remove much of the salt from groundwater and produce suitable water for livestock, crop spraying, horticulture and domestic uses.

This page provides information on desalination - with reverse osmosis (RO) systems of groundwater on farms in the Western Australian grainbelt.



Compliance with regulations

Disposal of saline reject water (brine) from desalination is covered by Soil and Land Conservation Regulations 1992, requiring owners or occupiers to notify the

Groundwater desalination on farms in Western Australia

1. Compliance with regulations

- 2. Benefits of reverse osmosis systems on farms
- 3. Will a reverse osmosis (RO) system suit you?
 - 3.1. Conditions that would favour using an RO plant
- 3.2. Are your bores suitable for attaching an RO plant?
- 3.3. Technical requirements of an RO plant
- 4. Designing the system for desalination
- 4.1. We recommend that you take these steps
- 5. More information on desalination technologies
 - 5.1. Membrane processes
- 5.2. Thermal processes
- 5.3. Ion exchange technology
- View on one page

Documents

Notice of intent to drain or pump - Desalination - complete form

See Also

- > Groundwater desalination and regulation for farm water supply in Western Australia
- > Water quality for livestock
- > Managing dryland salinity in south-west Western



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Water Smart Farms

Developing water security and increased water resilience in a drying climate.

Negate the rising costs associated with water deficiencies, asset renewals and introducing advances in fit for purpose water technology and management.



Smart Dams **Ground Water** Desalination Case Studies Modelling Case studies · Climate impacts Improve targets for Range of trial units hores · Planning tools Improved power and · Assess bedrock aquifers water efficiency New runoff methods · Assess water quality Predictive tools · Define effective desal · Evaporation control brine disposal Stockta Review technology Review and expand Monitor existing units existing data systems Identify barriers and · Early adopter studies areas to optimise Decision upport Tools Develop reliable Industry Brackish and salt water solutions for locating Assessment and desalination decision groundwater with low farm water support tools and salinity, or suited for economics economic evaluation desalination Develop climate effective surface and Outputs Enhance the quality and availability of groundwater capture and storage information for nnovative on-farm water systems that make best use of local supply development for farm businesses, resources, has high reliability and least communities and agribusiness growth cost to the community. Another innovative Western Australian Initiative by: 161 Primary Inc Murdoch 🐺 UWA

• Part 3 – Desalination

Criteria

- Supplies farm high quality water
- 10 100 kL/day
- Brackish bore water 3000 to >15,000 mg/L
- Climate independent
- Brine Management
- Target <\$2 kL OPEX

Climate Impact



- Rainfall significantly below average across South Coast since 2018 – reduced runoff.
- Water carting at its peak:
 - Potable water: 9ML/week.
 - Agricultural water: 13 ML/week.

Western Australian rainfall deciles 1 September 2017 to 31 August 2020 Australian Gridded Climate Data Rainfall decile ranges Highest or record Very much above average 8-9 Above average 4-7 Average 2-3 Below average Very much below average Lowest on huoco Base period: 1900-2020 Dataset: AGCD v2 Commonwealth of Australia 2020, Bureau of Meteorolog Issued: 02/09/2020



Research Focus

- 1. Water Sources
 - Use of brackish/saline groundwater (TDS 3000 15000 mg/L) to provide a major and reliable water source of on farm water.
 - Evaluate potential of higher salinity water (TDS 15000-35000mg/L)
- 2. Technologies
 - Investigate commercially ready desalination technologies in combination with renewable energy, using WA manufacturers.
 - Emerging technologies to assist brine management
 - Brine Management
- 3. Liveability
 - Sustainable water, climate independent
 - Adoption







RO Desalination

- First trial mid-1980s
- Initial farmer 2014
- Build up 2019-20 with dry seasons

Estimated from industry and NOIDs





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Delivery Method

<u>Scope</u> Install and operate 6 Reverse Osmosis units suitable to farm conditions and monitor early adopters

<u>Objective</u> Generate essential data on Desalination and Energy efficacy

<u>PROJECT AIM</u> Determine Operating costs under real farm conditions

<u>Demonstrate</u> <u>Technology</u> Field Days, information sessions

<u>Decision</u> <u>Support Tools</u> for transition, adoption and evolution

Pros and Cons - the good news first





Multi purpose water.

Can blend water to be fit for purpose and use for a range of purposes

Climate Independent. Can hold onto or grow stock levels

Current Investments are being realised. Full investment is realised if it doesn't rain



Pros and Cons - now the cons



Brine Disposal.

Significant part of study on brine reinjection and pond alternatives

Operating Costs. Higher than other options and if significant ongoing rain may not realise investment





Power Options













Costs From Vendors For Desal Technologies



Brackish Water RO (3,000- 15,000mg/LTDS)	Unit cost	Solar	Ancillaries (new or existing)
10 kL/day	\$18,000 - \$50,000	\$5,000 - \$20,000	Approx. \$15,000 - \$40,000
50 kL/day	\$40,000 - \$120,000	\$20,000 - \$60,000	Approx. \$20,000 - \$45,000
120kL/day	\$80,000 - \$200,000	\$40,000 - \$90,000	Approx. \$30,000 - \$60,000
Seawater Water RO (15,000-35,000mg/LTDS)	Unit cost	Solar	Ancillaries
10 kL/day	\$30,000 - \$80,000	TBD	Approx. \$15,000 - \$40,000

35

Fresh Water Thinking



Case Study - Solar Powered Reverse Osmosis Desalination Plant

- 4,000L/d operating 6 to 8hr/day on solar only
- Sand filter with automatic back wash, 20, 5 and 1 micron filters and dosing system for anti-scalant.
- Automatic start at 90% and stop.
- System automatically flushes at each shutdown with permeate.
- 14 Solar panels ~320 Wp each.
- 4 x 12V 120AH AGM batteries to ensure a safe shutdown of the plant







- 1. Performs well with solar and the automatic shutdown when sunlight is reduced.
- 2. Operational adjustments must be carefully monitored,
- 3. Membrane life projections a key to operating costs
- 4. Operating Cost approximately \$2-2.88/kL
- 5. Next stage is looking to optimise the plant to improve recovery and lower operating costs.



The Future

R&D partnerships established - seeking WA technology partners.

Looking at opportunity with \$100m Federal Drought Fund

8 x National Research, Adoption and Resilience Hubs

Outcome:

- WaterSmart farms
- Water Forever whatever the weather... and salinity to support industry and regional development

