



Government of Western Australia  
Department of Water

# Climate change impacts on water resources in Western Australia



Swan River Floods, Guildford 1926



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# Outline of Presentation

- Observed climate variability
- Climate change scenarios
- Water resource management in a changing climate

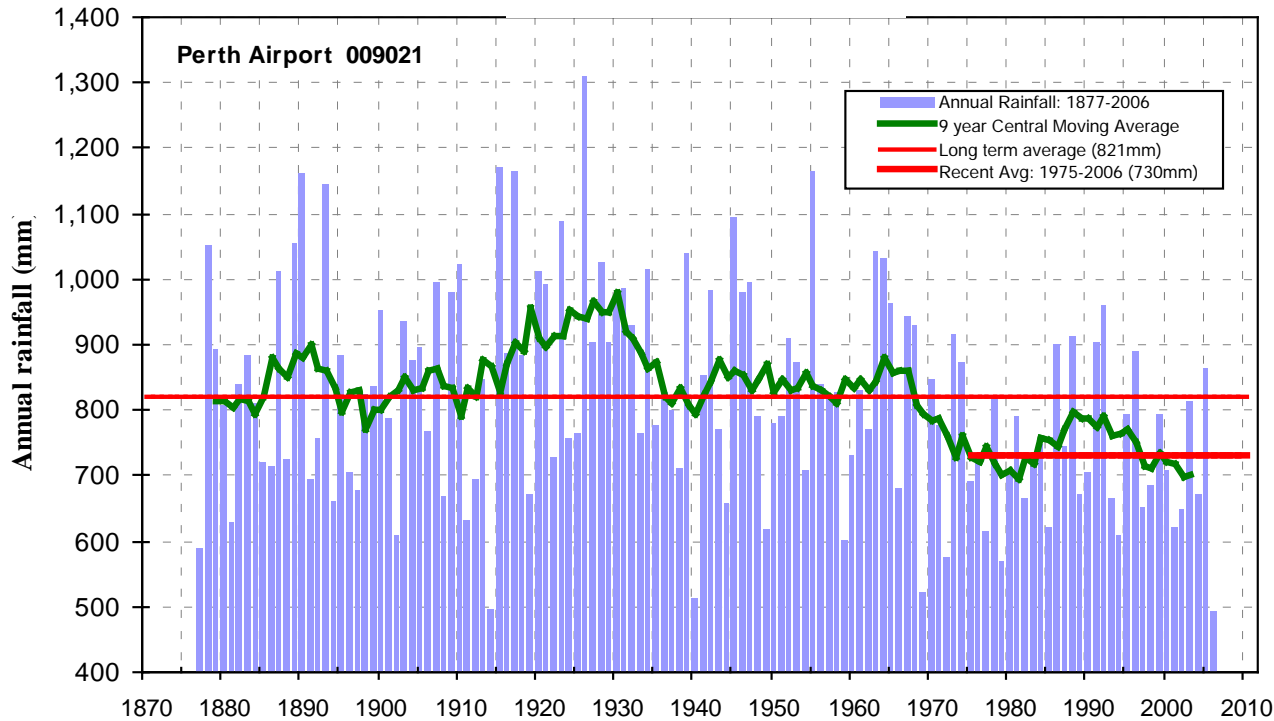


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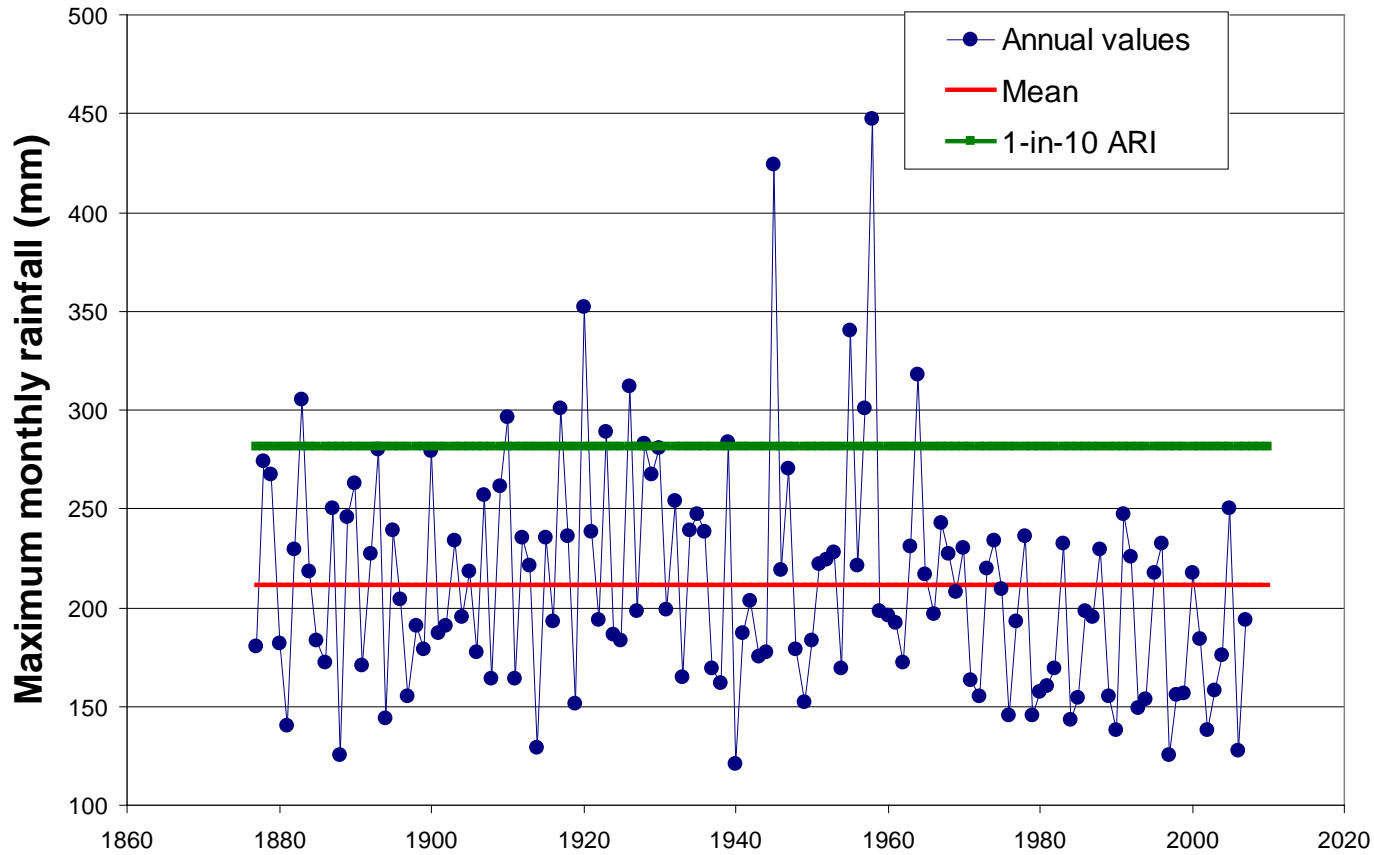
# Observed climate variability



## Perth Annual Rainfall



Major change in loss of flood years. Low rainfall years experienced in 1910s, 1940s, 1960s, and 2000s

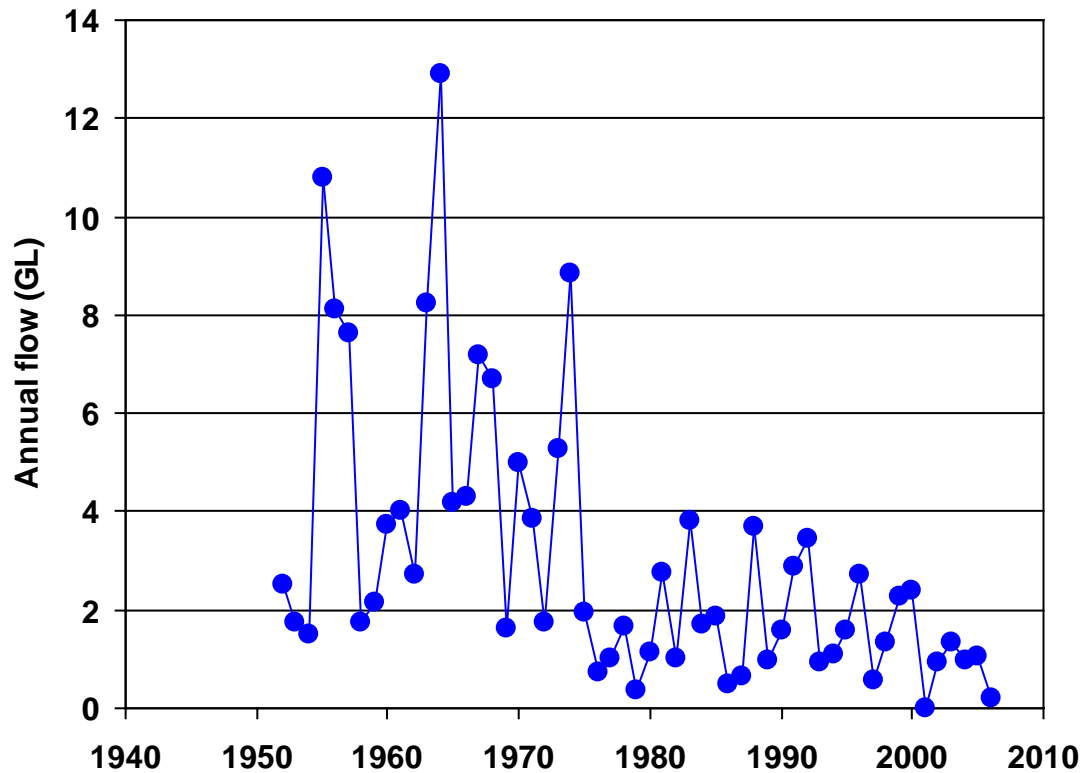


**Significant  
decline in wet  
months**

**- No months  
above a 1-in-10  
since 1964**



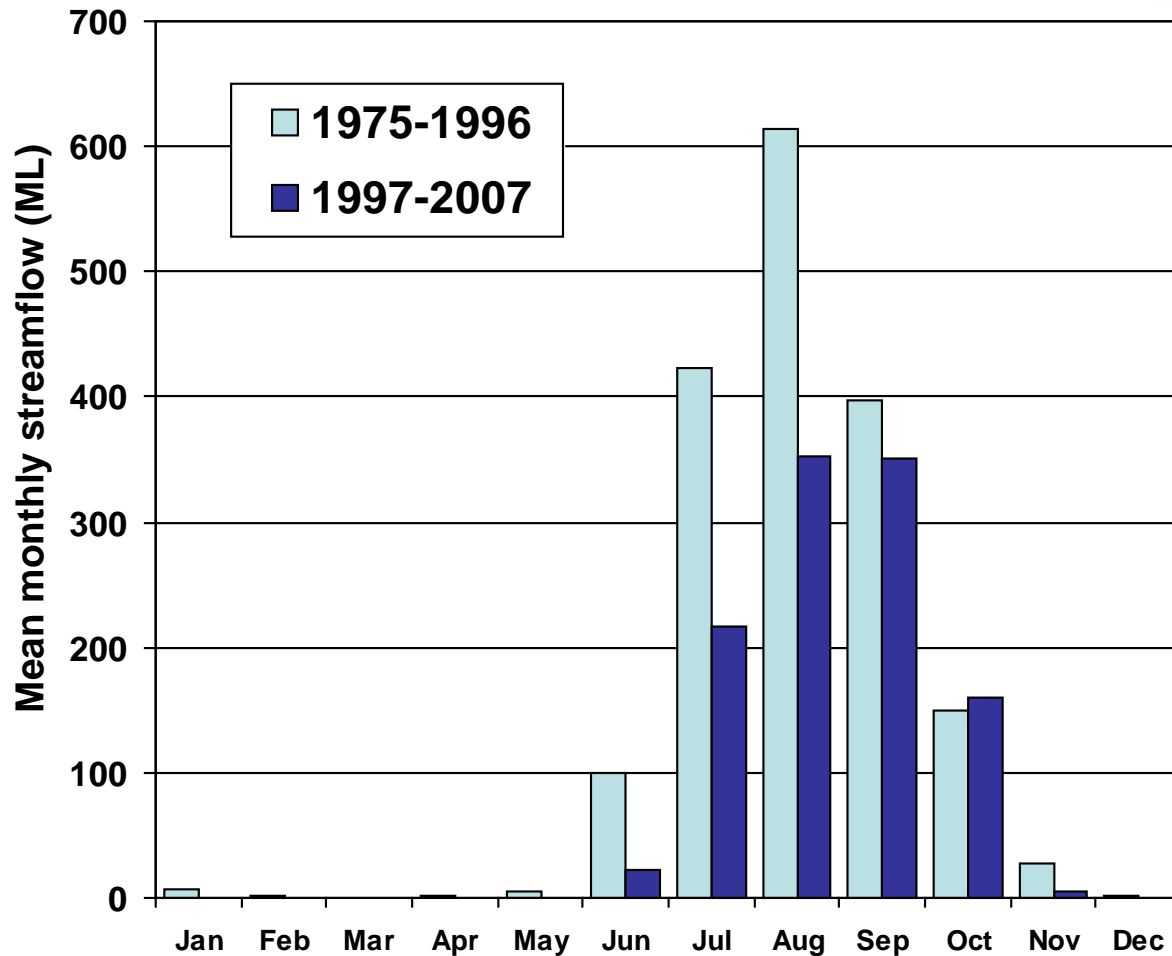
# South – West annual changes



Annual flow in forested streams such as Yarragil Brook have experienced dramatic reductions



# South – West monthly changes

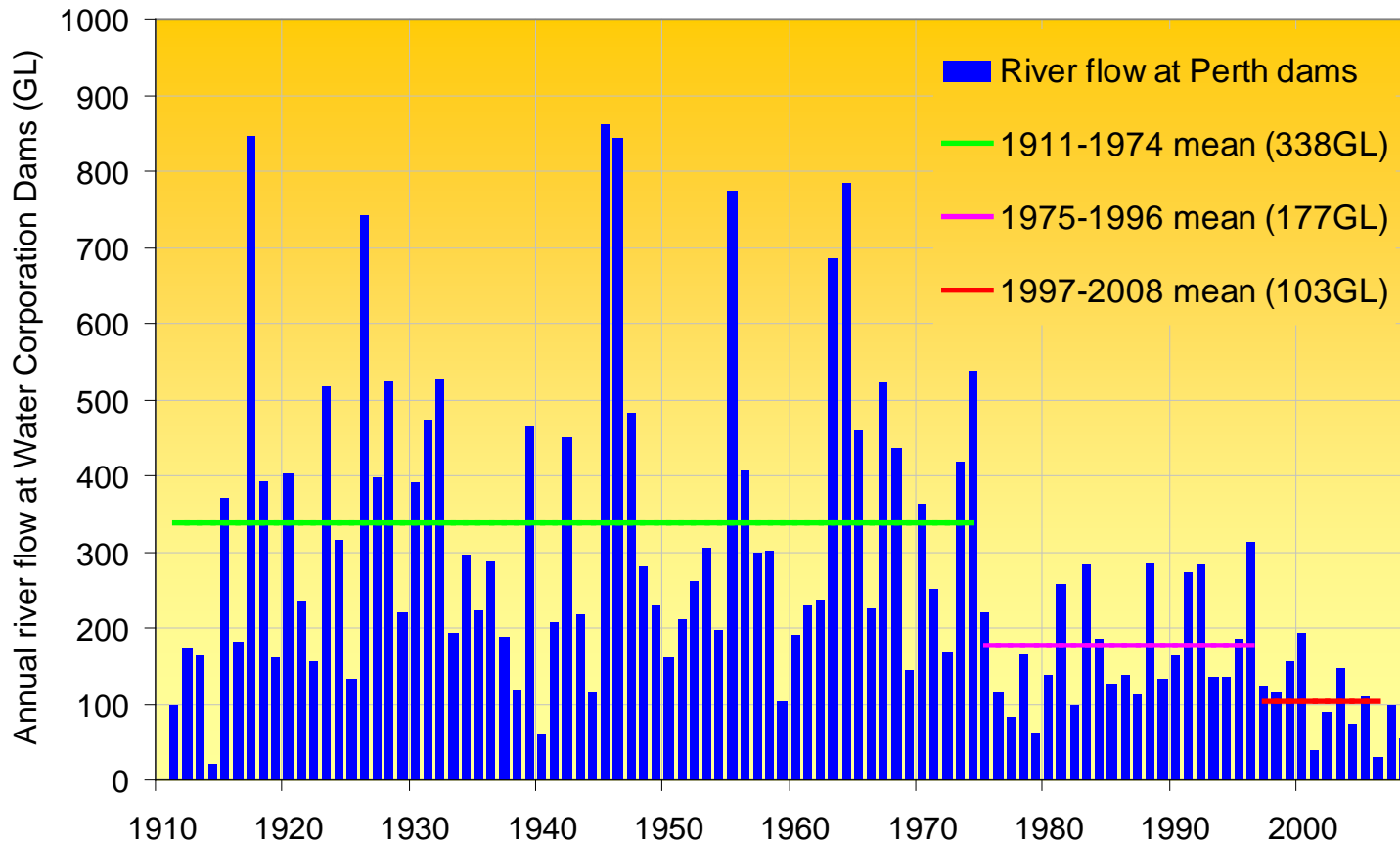


Many forested south west rivers show a marked change in monthly flows with a major reduction in early winter flows

In addition many high rainfall forested streams are ceasing to flow during summer – which has not been observed before



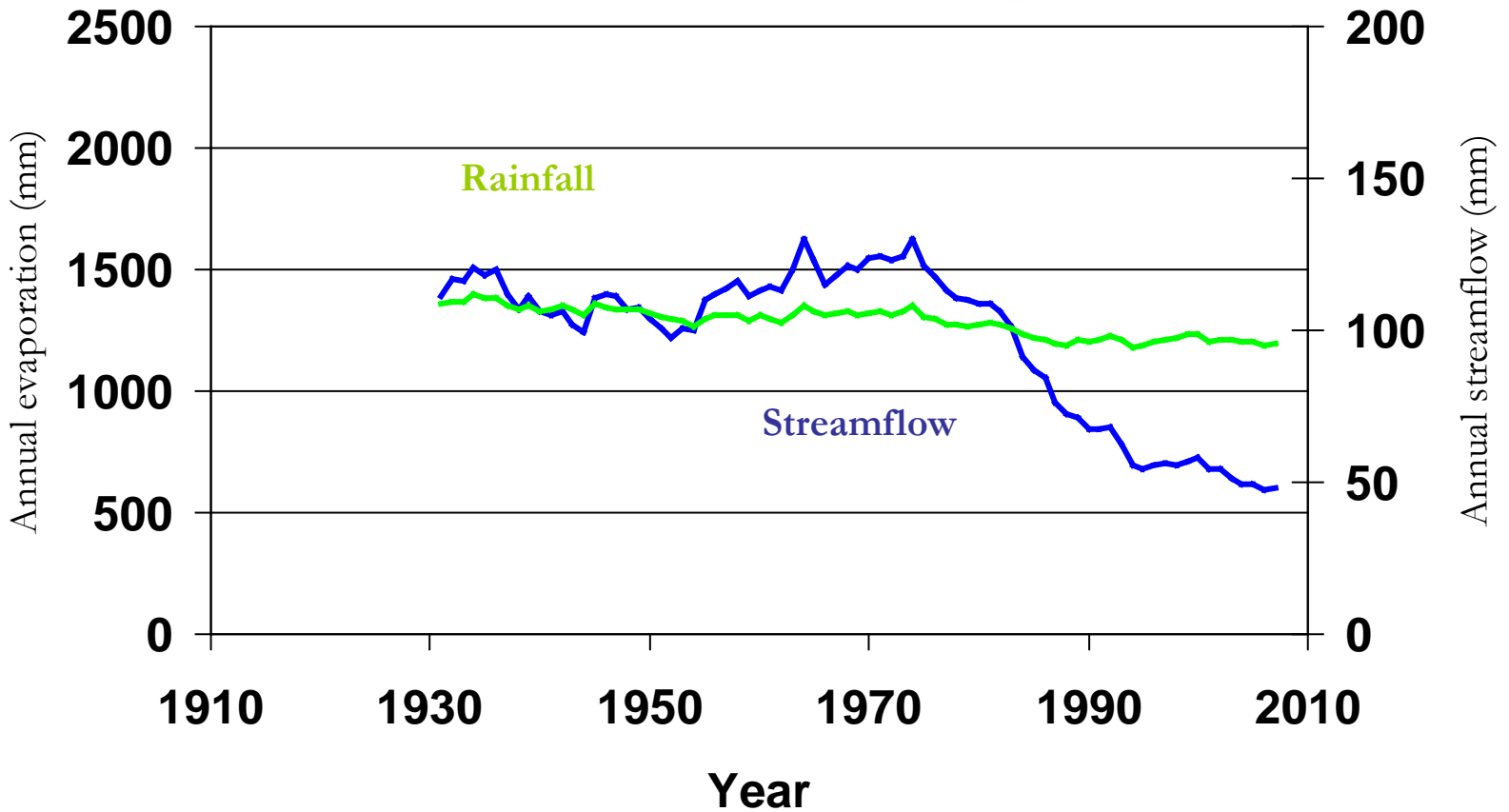
# Surface water supplies for Perth



Based on modelled, gauging data and water balance on reservoirs



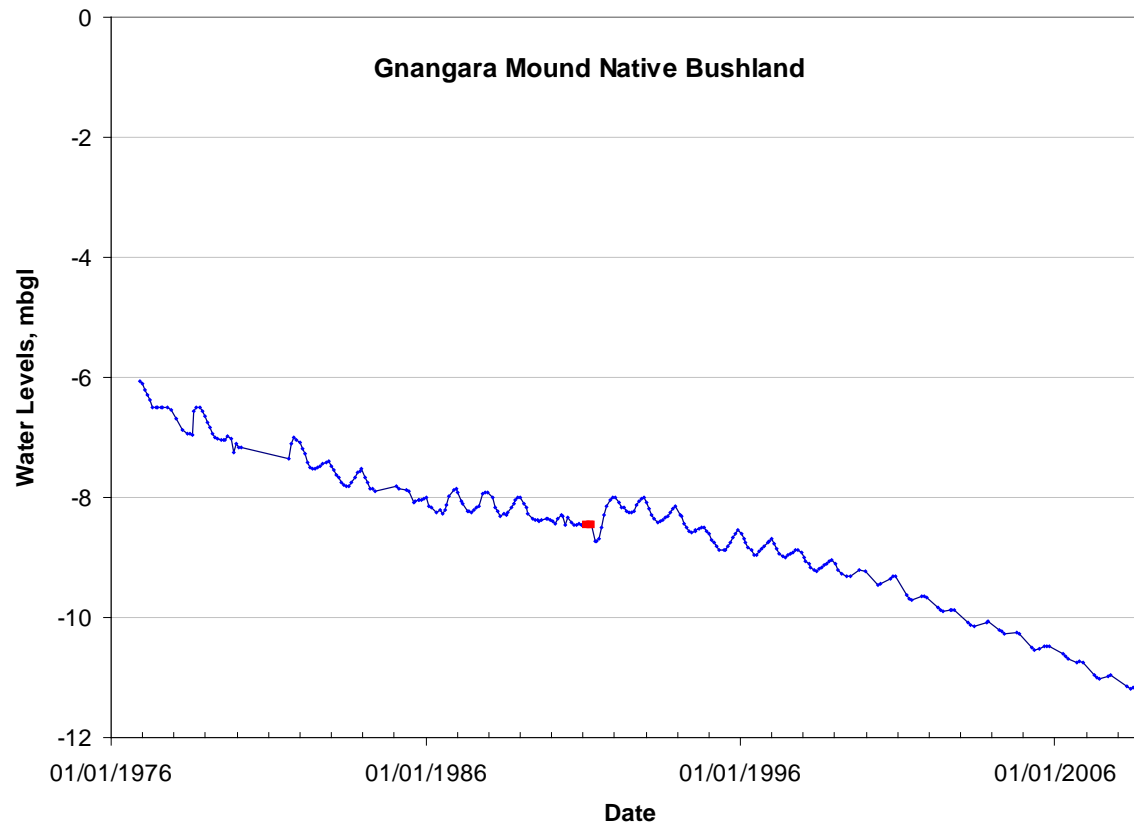
# Changing components of the water balance



20 year moving average for Serpentine River



# Changes in groundwater levels



Impact of climate and native vegetation management led to decline in groundwater levels of 5m of 30 years



Terrestrialisation of a wetland in the Lexia System

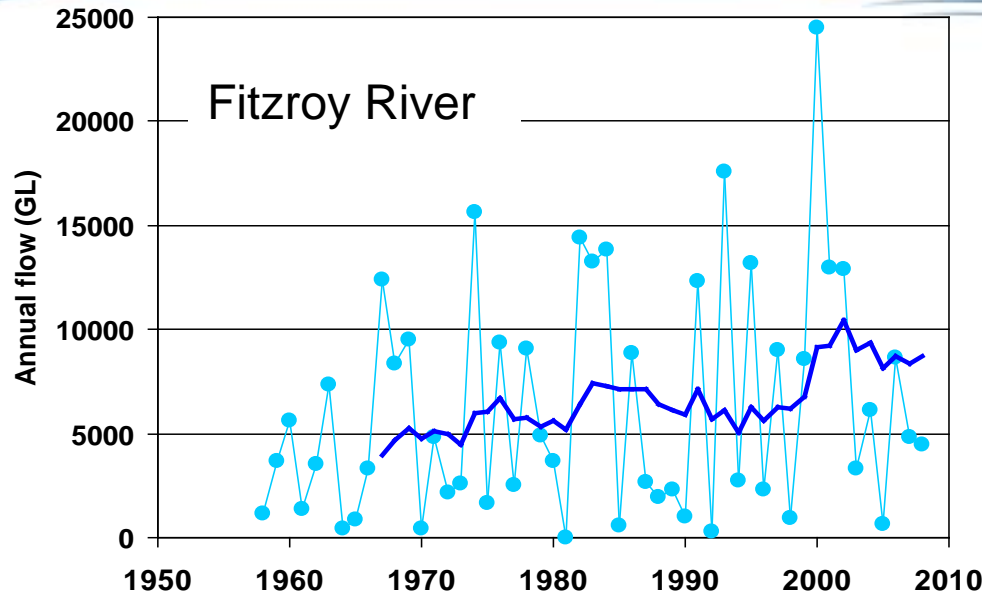
Photographs taken at the same site 15 years apart

Environmental water requirements, water management outcomes, waterway restoration, floodplain management all need to take account of the drying climate

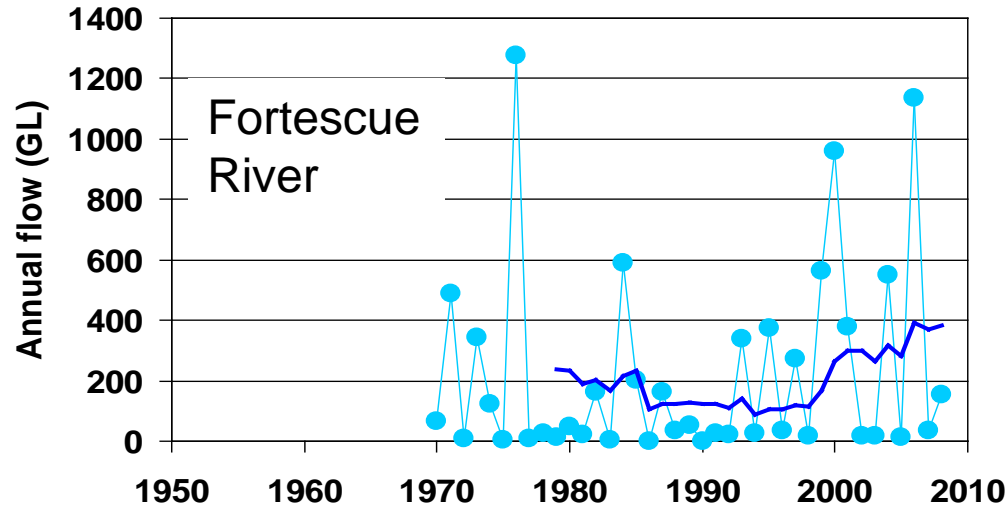
The environment that we have studied over the last 100 years is not the environment of the future



# River flow in the North



Rivers in the Kimberley such as the Fitzroy River and in the Pilbara such as Fortescue River have not seen the same reduction in river flows





# Observed changes to climate in SWWA - Summary

- Since 1970 the number of storms have decreased and they bring less rain
- Annual rainfall has decreased by 10% since 1970s
- May-July rainfall has decreased by 15% since 1970s
- Reduced rainfall has resulted in 50% less runoff

## Key Message:

Water managers can not assume that the climate baselines of the 20<sup>th</sup> century will be valid in the 21<sup>st</sup> century



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# Climate Change Scenarios





# Projected temperature, rainfall and moisture

Perth – Now and Future	Now ≠	2030	2070
Annual av. Max. daily temp. (°C)	23.3	24.3 ± 0.7	26.3 ± 2.2
Dec-Feb days above 35°C	15	19 ± 3	29 ± 10
Annual rainfall (mm)	869	800 ± 105	660 ± 310
Annual moisture demand (mm)	-882	-960 ± 45	-1125 ± 155

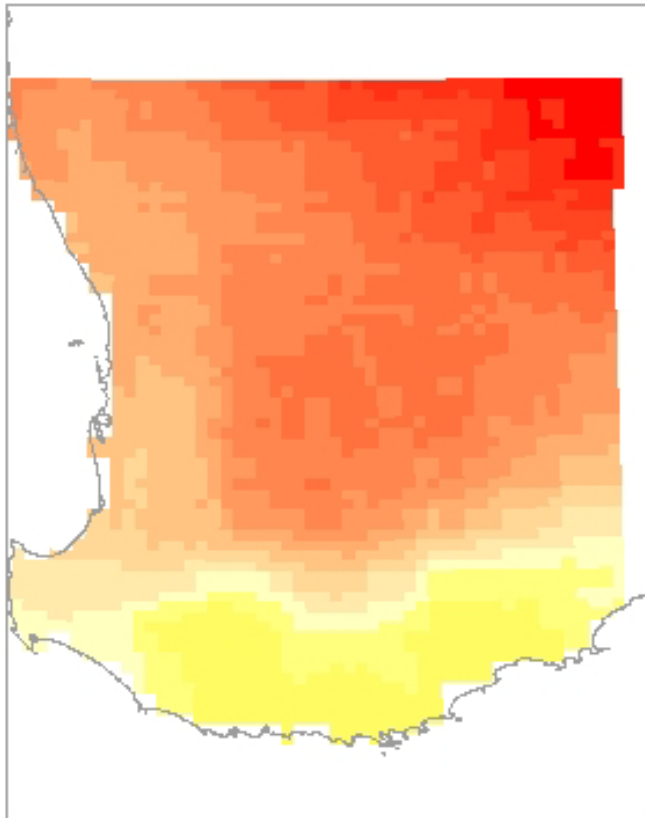
The climate change simulations show that even with the lowest conceivable greenhouse gas emission

scenarios,

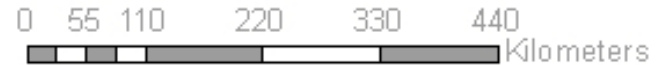
- the south-west of Western Australia is projected to be drier and warmer later in the century,
- with an increasing probability of dry weather patterns and a decreased probability of wet weather patterns



# Projected rainfall difference for SW-WA 2050



There are differences  
within south-west for  
impacts of greenhouse  
scenarios on rainfall



Rainfall difference (%)





# Climate change – Extreme events

Phenomenon and direction of trend	Likelihood that the trend established or consolidated in late 20 <sup>th</sup> century	Likelihood of a human contribution to observed trend	Likelihood of future trend under A2#/B1# scenarios
Decrease in frequency/intensity of extreme winter rainfalls (1 to 10 year return period)	Likely	More likely than not	More likely than not
Increase/decrease in frequency/intensity of extreme summer rainfalls (1 to 10 year return period)	Small or non-existent statistically inconclusive	No clear evidence	No clear evidence for significant change
Decrease in frequency/intensity of winter flood flows (Swan tributaries)	Extremely likely	Extremely likely	Likely
Increase or decrease in frequency/intensity of summer flood flows (Swan tributaries)	No clear evidence	No clear evidence	No clear evidence

- On a global scale, extreme events will become more common as air temperatures rise with enhanced greenhouse
- Extreme rainfall projections for regional locations such as south-west WA, are not yet clear.
- Due to uncertainty in both magnitude and probability of extreme events it will be always difficult to separate natural climate variability from climate change.



- The main economic impacts of climate change relate to the increasing costs of water quality management.
- Climate change is likely to exacerbate eutrophication and fish deaths in the upper Swan.
- Increased river and land values may require corresponding increased costs associated with monitoring and intervention programs such as oxygenation.
- The increased fish deaths and algal blooms may reduce community recreational benefits which may impact on local business in the region.
- Economic loss will result from a need to protect, retrofit, repair or replace infrastructure due to increased sea levels and storm surges.
- Mitigation or modification measures may be required to protect people's homes and riverside suburbs in the future.



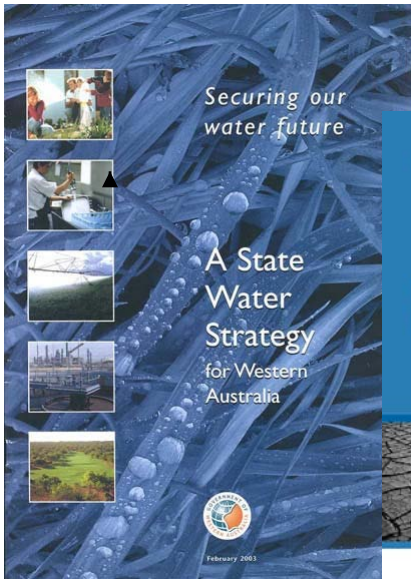
# Water resource management in a changing climate



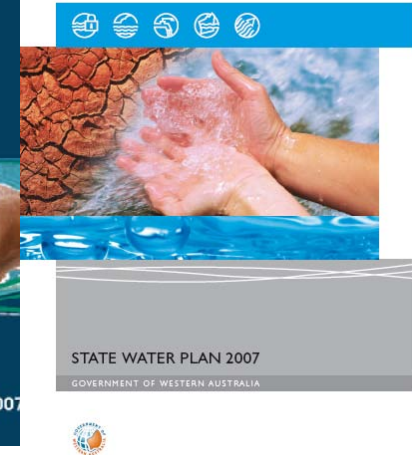
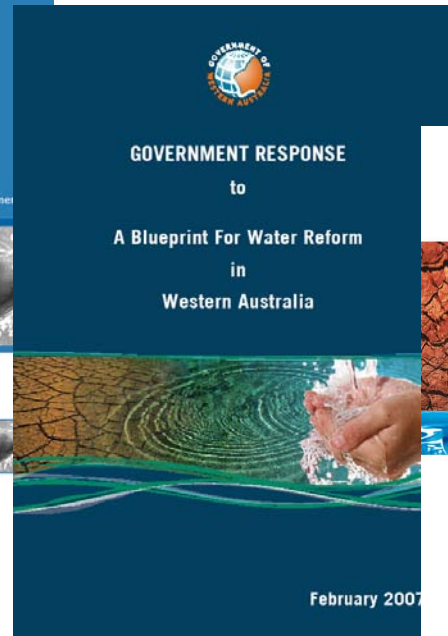
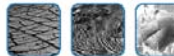
# New national plan on water – ‘Water for the Future’ - 2007

- **Water for the Future is built on four key priorities that integrate what all levels of government should be striving to achieve in the area of water:**
  - **taking action on climate change,**
  - **using water wisely,**
  - **securing water supplies; and**
  - **supporting healthy rivers.**
- **Climate change is a major threat – for much of Australia it means more droughts and less rain.**
- **The rapidly emerging threat of climate change, with its inherent uncertainties and risks, is something that we must plan for and manage.**





Water Reform  
Implementation Committee  
DECEMBER 2006





- **Management Strategies**
  - Gnamara Sustainability Strategy
  - State Water Recycling Strategy
  - Water efficiency program
- **Planning Strategies**
  - Drainage and water management plans
  - Better Urban Water Management Framework
  - Water allocation plans
- **Assessment, Monitoring and Evaluation**



- Gnangara Sustainability Strategy
  - A number of proposed land use options
    - exploring alternative land uses after the pines are cleared
    - establishing a horticultural precinct using treated wastewater
    - recycling wastewater for other uses
    - changing vegetation management such as burning Banksia woodland to increase recharge and maintain biodiversity values
    - revising groundwater allocation to public and private water supplies
- State Recycling Strategy
- Water Efficiency Program

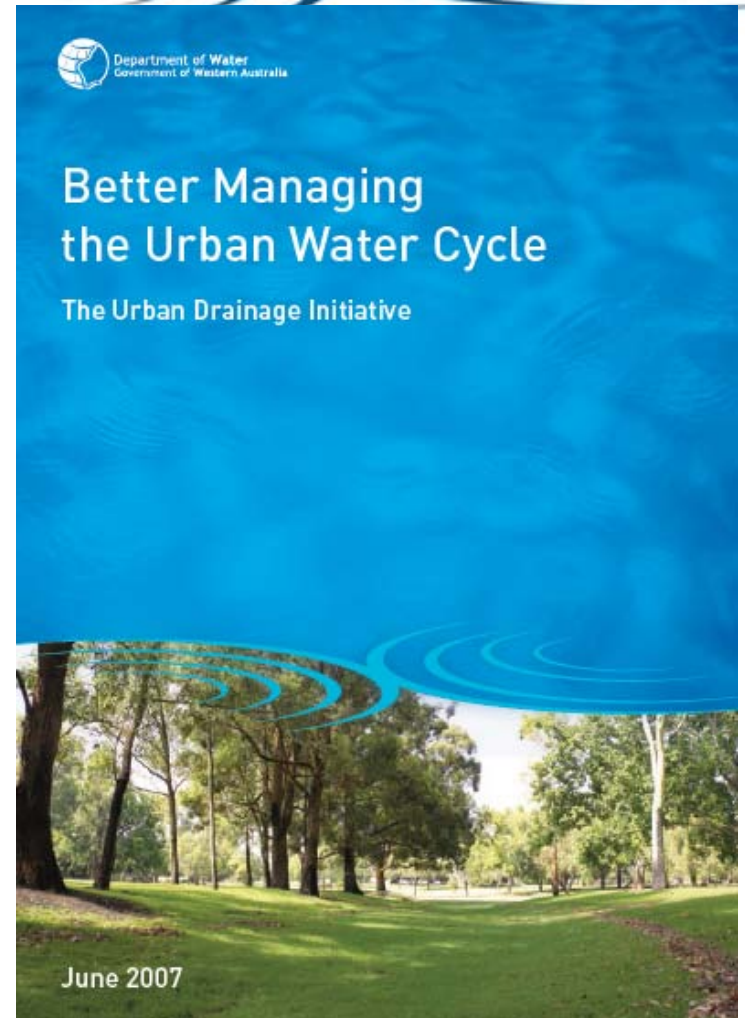




## Drainage and water management plans

- Water management plans
- Best practice tools
- Monitoring and Evaluation

Need to take into account  
climate scenarios into all  
three aspects





- **Regional Water Plans**
  - Accommodating the constraints of a varying and drying climate at a regional scale
  - Promoting the wise and careful use of existing resources
  - Supporting reasonable and efficient regional growth
- **Water Allocation Plans**
  - Focusing on priority areas
  - Allocation planning allows us to balance the **water demands** of competing users - such as the public, industry and agriculture - with what the **environment needs** – in a varying climate.





- **Indian Ocean Climate Initiative**
  - Provided improved understanding of climate – current and greenhouse
  - now at Phase 3
- **Assessment of impacts**
  - Completing report into regional climate change and risk management of water resources in WA
- **Monitoring and Investigation Programs**
  - Groundwater Investigation Program
  - Surface water monitoring network
- **Research and Development**
  - Decision support – MUSIC
  - Evaluation of best practice

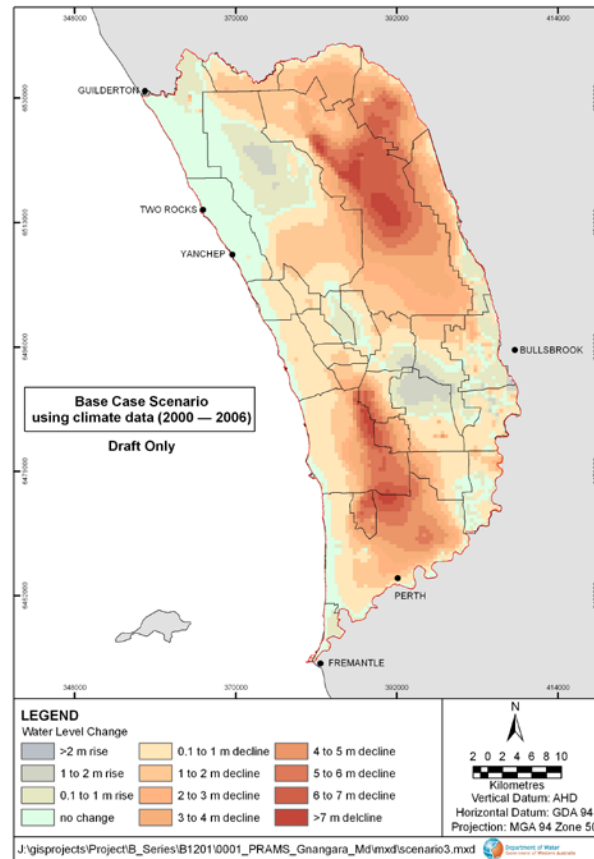
Indian Ocean Climate Initiative



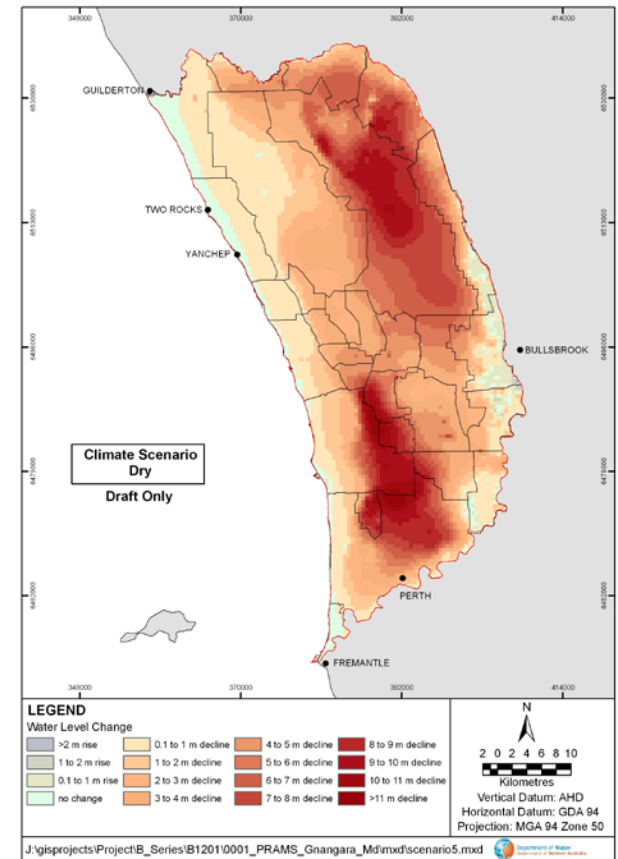


- Overlaying of different climate scenarios with current and future landuse mapping

## Gnangara Mound – current climate scenario



## Gnangara Mound – dry climate scenario





## Stormwater Harvesting

### Water Sensitive Urban Design (WSUD)

such as infiltration basins and swales

### Groundwater (GW) Storage (MAR):

stormwater is extracted and injected (via wells or infiltration basins) into suitable aquifers for later use in times of peak.

### Underground Storage Systems: capture and store runoff in large pipes.

### Above Ground Storage: such as stormwater ponds, detention basins and constructed wetlands.

### Modification of Main Drain Channel

Morphology to reduce winter gw losses and maintain the flood hydraulic capacity.



Liege St, 2004 before construction

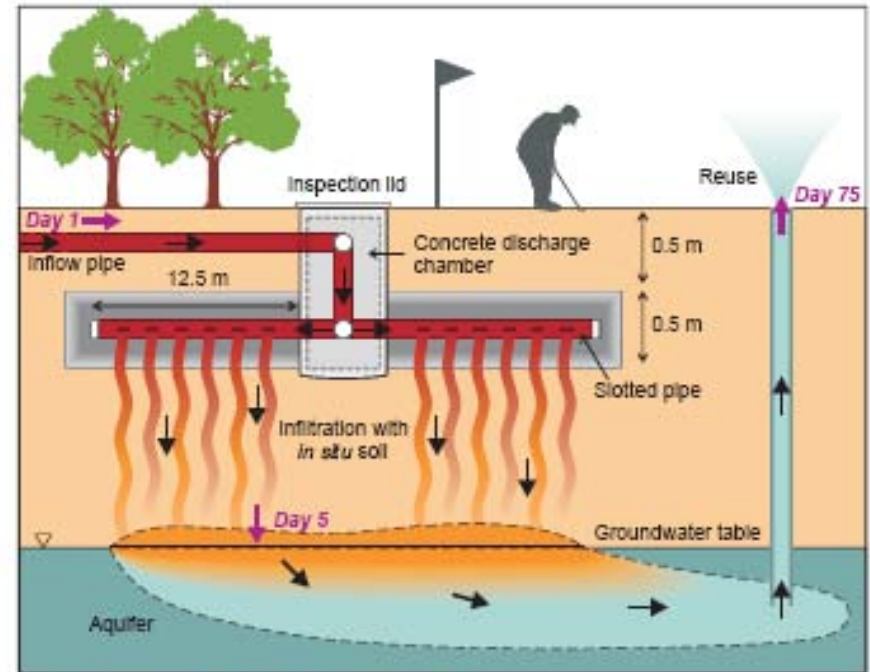


Liege St, 2005 after completion



## Managed Aquifer Recharge

- Roof runoff (rainwater)
- Superficial groundwater
- Drainage
- Domestic greywater
- Sewer mining
- Treated waste-water



*Cross-section of the infiltration gallery*

Source: CSIRO website

Infiltration galleries established at two sites:

- 1) CSIRO Floreat in Perth
- 2) Halls Head Waste-water Treatment Plant, Mandurah



# Final remarks



- Perth / south west have observed major changes in rainfall and water related aspects of the environment over the last 35 years
- The climate of the south-west and across Western Australia will continue to exhibit wet and dry periods due to natural climate variability and change
- New initiatives such as the Urban Drainage Initiative, Better Urban Water Management, Gnamptara Sustainability Strategy, State Water Recycling Strategy are about improving water management – in a changing climate.
- Current water resource management initiatives are starting to incorporate climate scenarios in plans – including impacts on river flows, groundwater levels, wetland levels, flood analysis, and tidal impacts.
- Water resource management will need to become more adaptive to change and incorporate approaches that provide solutions which are not only resilient, but also robust, flexible, and based on knowledge and understanding of the water resource.