Cotton Storages Project:

Measuring Losses to Improve Performance

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Australian Government
National Water Commission
Raising National Water Standards Program

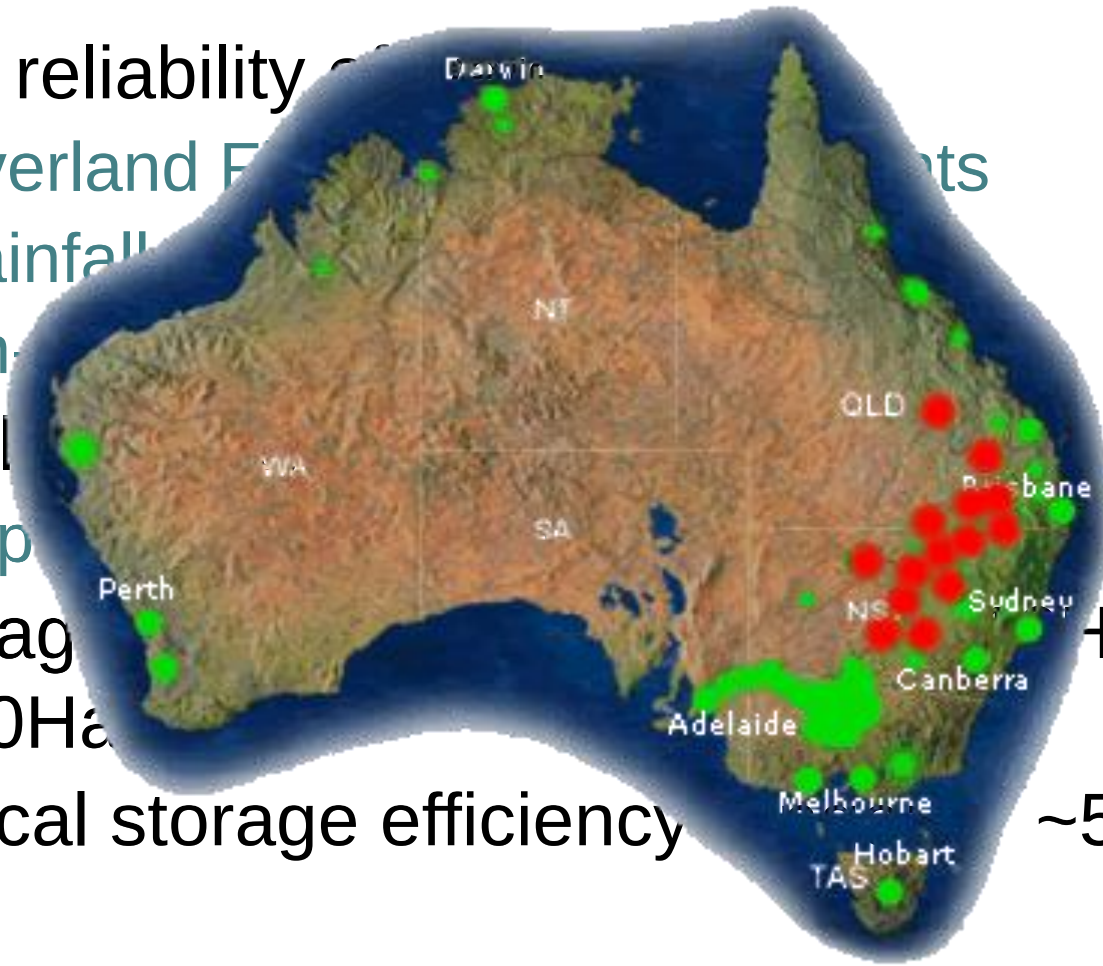
Cotton Catchment Communities CRC

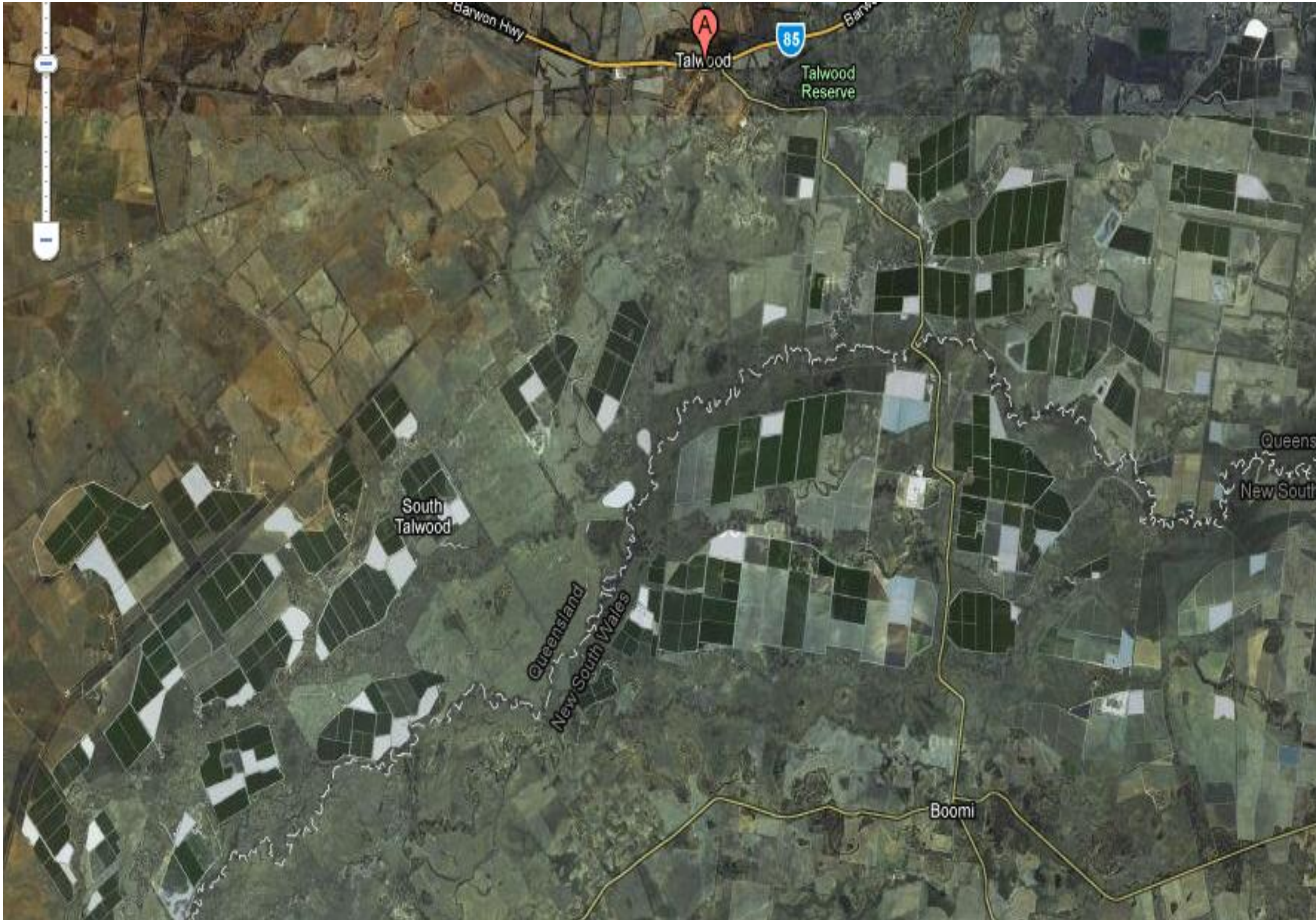
NCEA

Queensland Government

Water Storage in the Cotton Industry

- Low reliability
  - Overland F ... ts
  - Rainfall
  - On-
- Total
  - app
- Storag ... Ha → >100Ha
- Typical storage efficiency ... ~50 – 85%




Barwon Hwy
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Talwood
85
Talwood Reserve
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Queensland
New South Wales
Boomi

Commercial Measurement Technology

- Previous measurement techniques are not commercially viable
  - Expensive
  - Not user friendly
  - Complicated

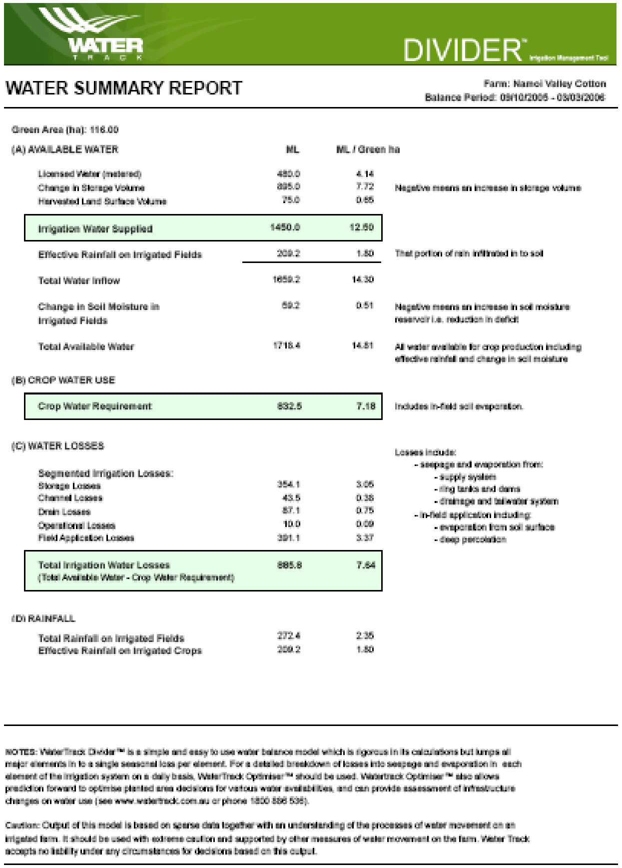
- Commercially viable storage measurement technology became available
  - Irrimate™ Seepage and Evaporation Meter
  - Evapcalc software

Project Objectives

- NWC Raising National Water Standards Funding
  - Raise awareness of losses and amelioration options
  - Measure seepage and evaporation losses (137 completed)
  - Build capacity for measurement delivery
- Healthy HeadWaters Water Use Efficiency Project
  - 30 Whole Farm Water Balances (QMDB)
  - 15 case studies of storage design modification

Whole Farm Water Balance

- Watertrack™ Divider
  - Whole farm irrigation performance
    - CWUI (yield ÷ ET)
    - IWUI (yield ÷ irrigation)
    - GPWUI (yield ÷ total water)
  - Segmented losses
    - Storages
    - Fields
    - Channels & Drains



WATER TRACK DIVIDER™ Irrigation Management Tool

WATER SUMMARY REPORT

Farm: Namoi Valley Cotton
Balance Period: 09/10/2005 - 03/03/2006

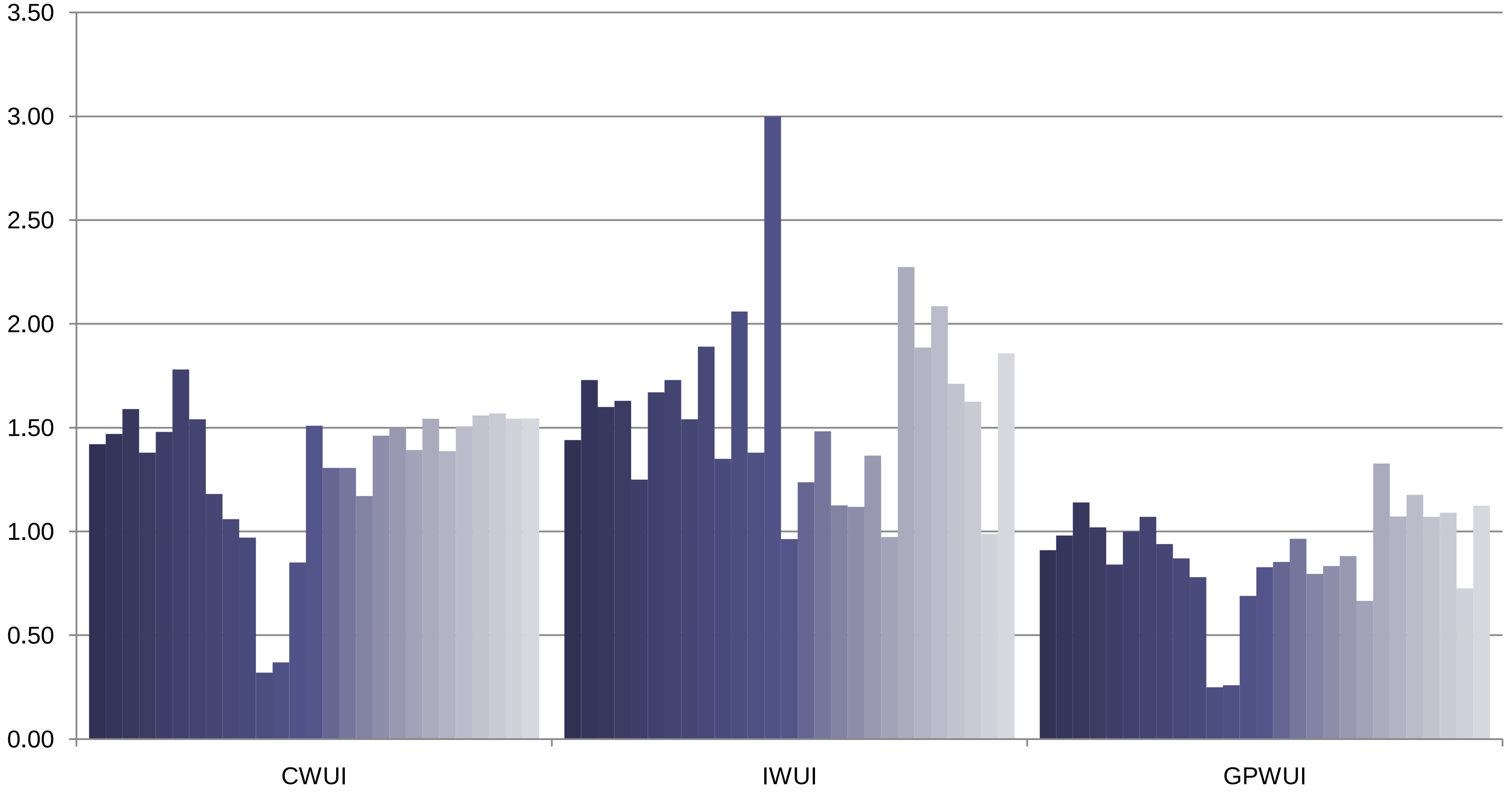
Green Area (ha): 116.00

	ML	ML / Green ha	
(A) AVAILABLE WATER			
Licensed Water (metered)	480.0	4.14	
Change in Storage Volume	895.0	7.72	Negative means an increase in storage volume
Harvested Land Surface Volume	75.0	0.65	
Irrigation Water Supplied	1450.0	12.50	
Effective Rainfall on Irrigated Fields	209.2	1.80	That portion of rain infiltrated in to soil
Total Water Inflow	1659.2	14.30	
Change in Soil Moisture in Irrigated Fields	59.2	0.51	Negative means an increase in soil moisture reservoir i.e. reduction in deficit
Total Available Water	1718.4	14.81	All water available for crop production including effective rainfall and change in soil moisture
(B) CROP WATER USE			
Crop Water Requirement	832.6	7.18	Includes in-field soil evaporation.
(C) WATER LOSSES			Losses include: - seepage and evaporation from: - supply system - ring tanks and dams - drainage and tailwater system - in-field application including: - evaporation from soil surface - deep percolation
Segmented Irrigation Losses:			
Storage Losses	354.1	3.05	
Channel Losses	43.5	0.38	
Drain Losses	87.1	0.75	
Operational Losses	10.0	0.09	
Field Application Losses	391.1	3.37	
Total Irrigation Water Losses (Total Available Water - Crop Water Requirement)	885.8	7.64	
(D) RAINFALL			
Total Rainfall on Irrigated Fields	272.4	2.35	
Effective Rainfall on Irrigated Crops	209.2	1.80	

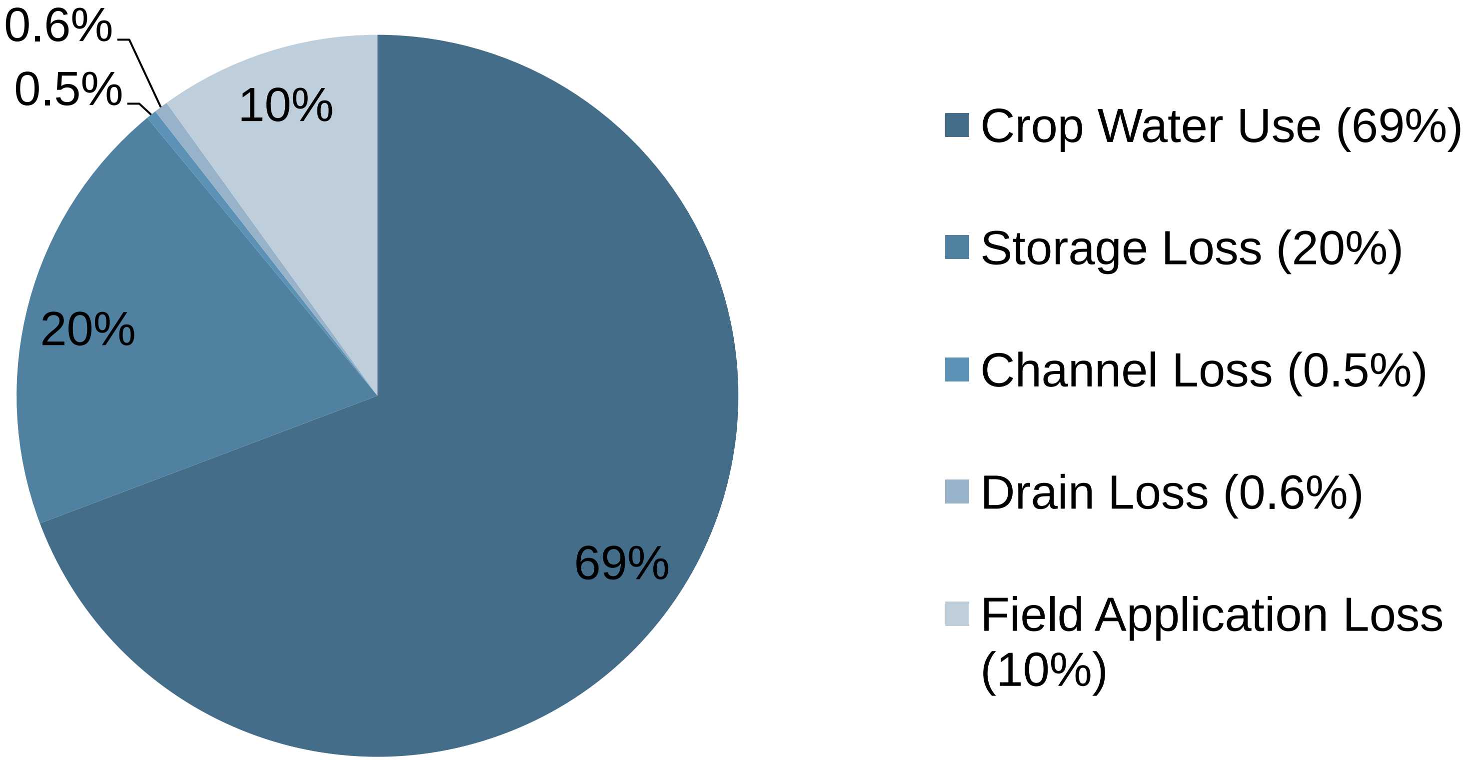
NOTES: WaterTrack Divider™ is a simple and easy to use water balance model which is rigorous in its calculations but lumps all major elements in to a single seasonal loss per element. For a detailed breakdown of losses into seepage and evaporation in each element of the irrigation system on a daily basis, WaterTrack Optimiser™ should be used. Watertrack Optimiser™ also allows prediction forward to optimise planted area decisions for various water availabilities, and can provide assessment of infrastructure changes on water use (see www.watertrack.com.au or phone 1800 686 536).

Caution: Output of this model is based on sparse data together with an understanding of the processes of water movement on an irrigated farm. It should be used with extreme caution and supported by other measures of water movement on the farm. Water Track accepts no liability under any circumstances for decisions based on this output.

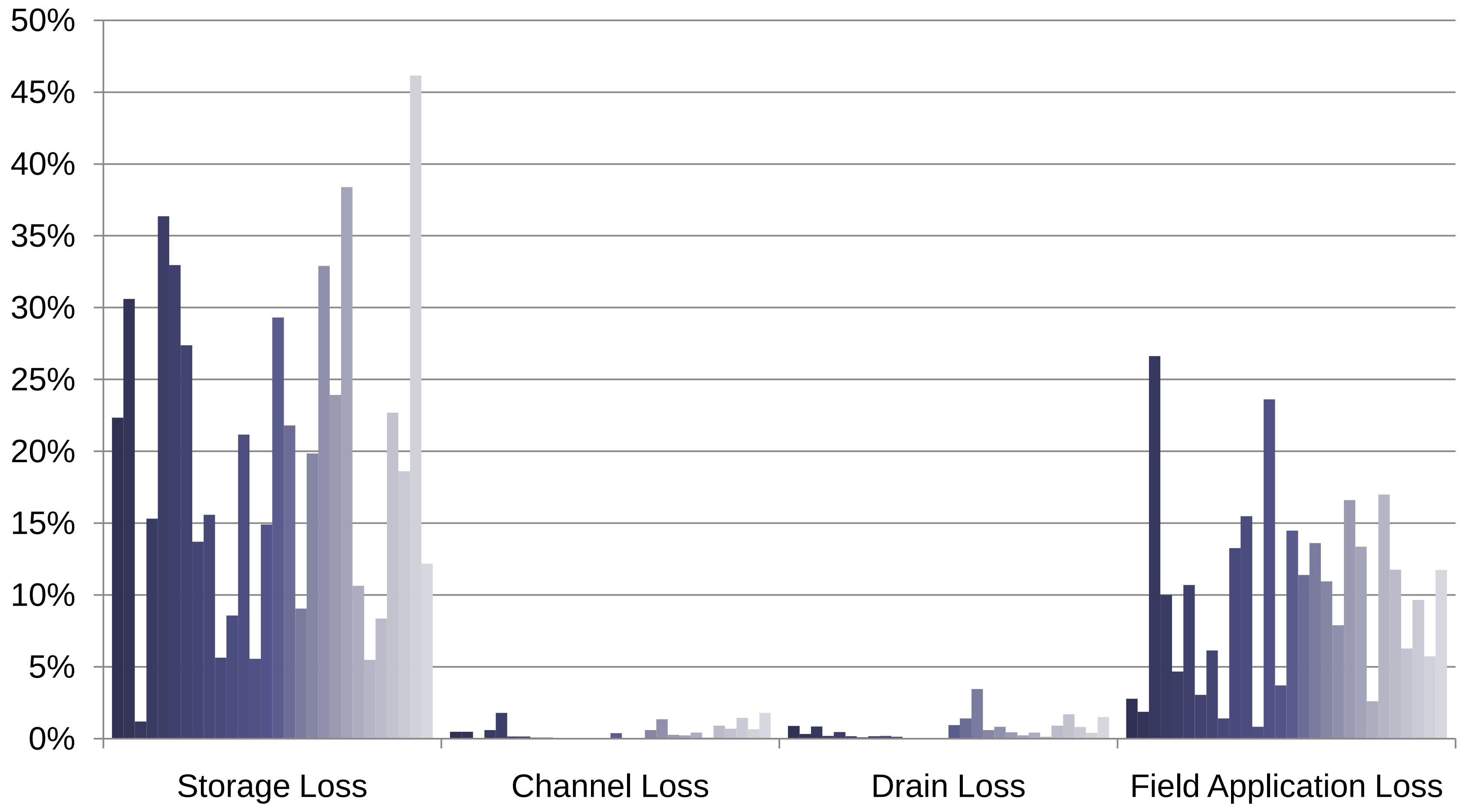
Whole Farm Performance



Water Use


0.6%
0.5%
10%
20%
69%
Crop Water Use (69%)
Storage Loss (20%)
Channel Loss (0.5%)
Drain Loss (0.6%)
Field Application Loss (10%)

Individual Results



Key Points

- 69% of all water is used by the crop with 31% lost
  - Fields 10%
  - Channels 1%
  - Storages 20%
- Storages account for two-thirds of all losses.
- On an individual farm, storage loss can be as high as 45% or as low as 5%
  - Which farm are you?

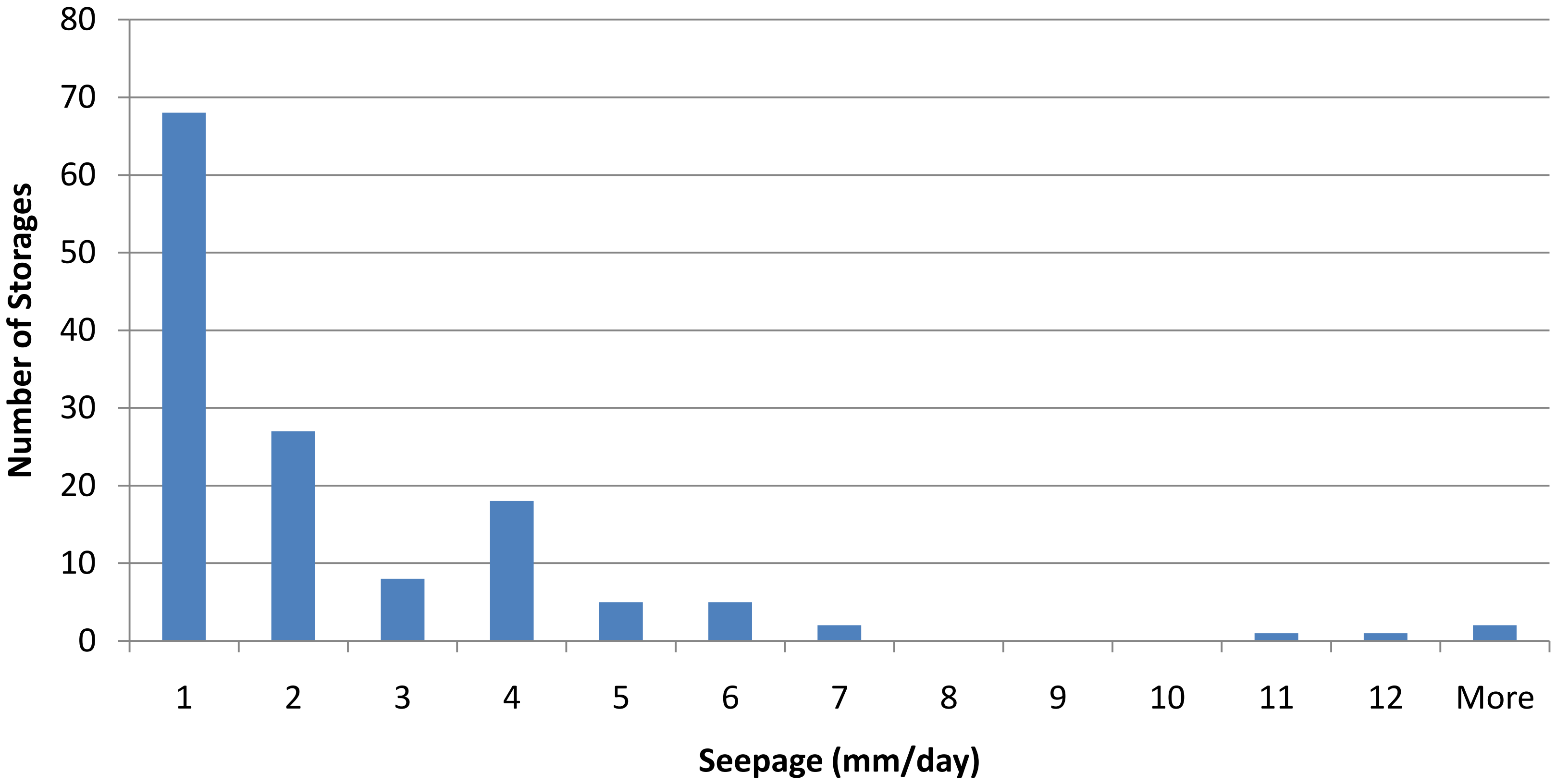
Storage Losses: Measurement

- Irrimate™ Seepage and Evaporation meter
- Equipment deployed for 5-6 weeks per storage
- Regression to separate seepage and evaporation (Evapcalc)

Storage Losses

	Mean	Minimum	Maximum
Seepage (mm/day)	**2.31**	0.5	35.20
Evaporation (m/year)	**1. 8**	1.4	2.6
Storage Size (ML)	**1950**	75	14000
Water Depth (m)	**3.5**	2	9.1

Seepage



80
70
60
50
40
30
20
10
0
Number of Storages
1
2
3
4
5
6
7
8
9
10
11
12
More
Seepage (mm/day)

Grower Seepage Estimate

Grower Seepage Estimate	Number of Storages	Average Seepage (mm/day)	Minimum Seepage (mm/day)	Maximum Seepage (mm/day
Low <5 mm/day	109	1.67	0.1	7
Med 5-10 mm/day	23	2.93	0.5	10.5
High 10-15 mm/day	2	7.10	2.7	11.5
Very High >15 mm/day	3	17.73	3	35.2

Key Points

- Most storages had low seepage (1 to 2 mm/day)
- **However** 20% of storages had seepage of 4 to 8mm/day
  - big enough to be a problem but small enough to be hard to identify without precise measurement
- Seepage not related to region or soil type.
- Seepage was typically due to underlying faults:
  - sand lenses, gravel patches or prior streams.

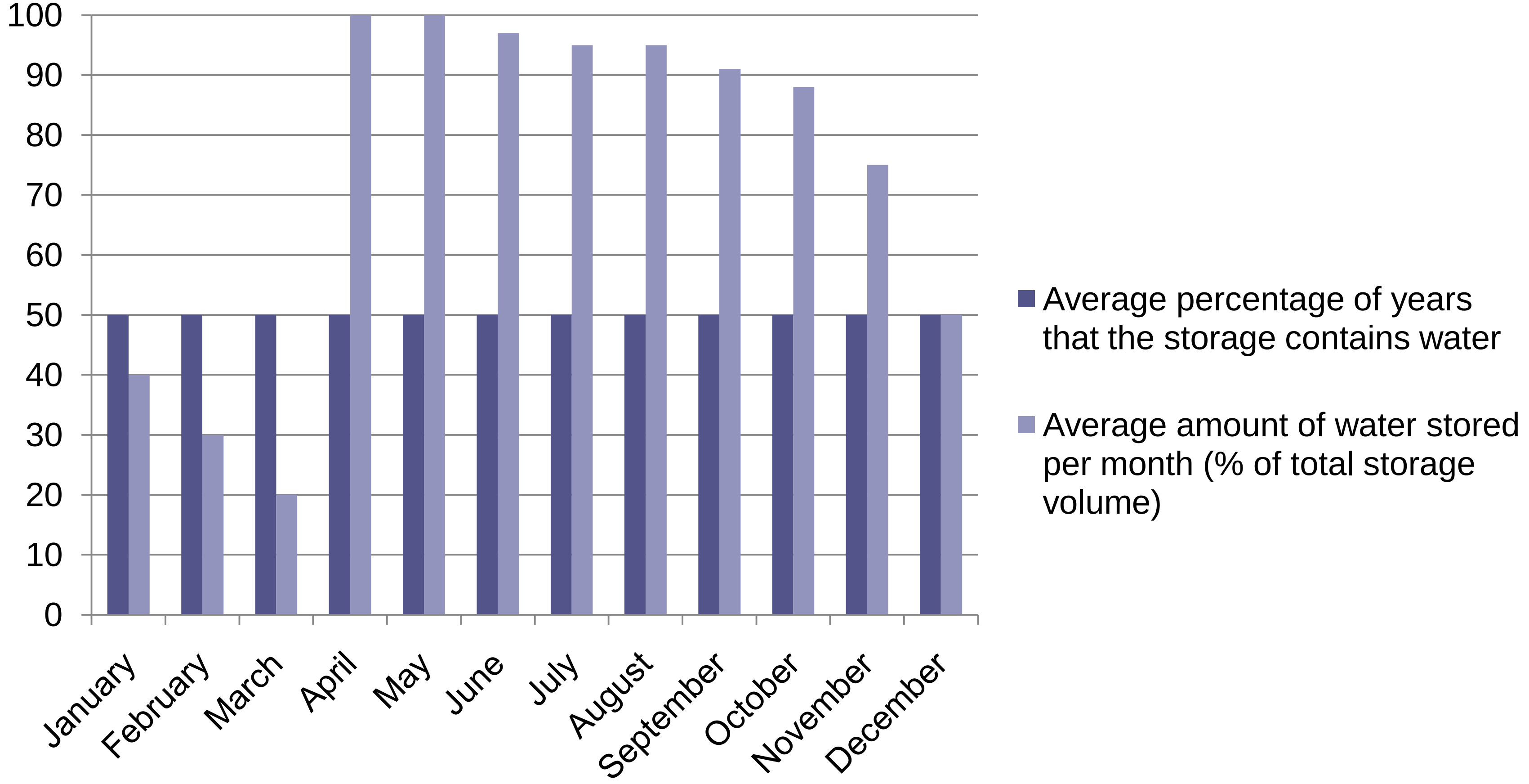
Storage Modifications

- Cell division (11 Scenarios)
  - Split storage into 2 cells
  - Wall position determined by optimum water savings, within practical limits
- Wall height (6 Scenarios)
  - Increase wall height
  - Extra volume equal to volume of second storage
  - Second storage decommissioned/not used

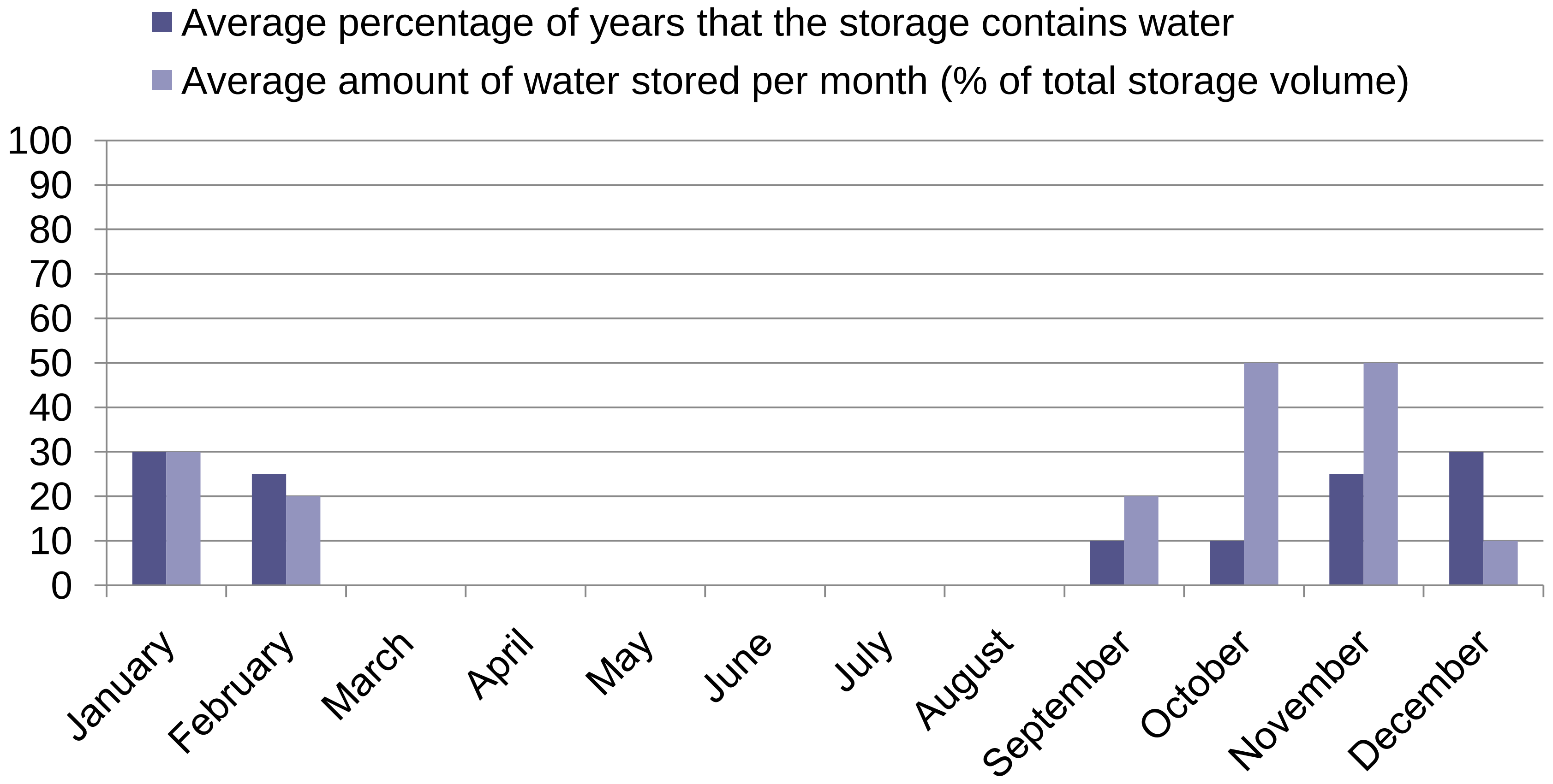
Analysis

- Evaporation and Seepage Ready Reckoner
  - www.readyreckoner.ncea.biz
- Applicable to wide variety of strategies
  - Monolayer
  - Physical cover (floating, modular, shadecloth)
  - Bentonite
  - Clay lining
  - PAM

Typical Usage Patterns



Typical Usage Pattern



Results

	Average	Minimum	Maximum
Cell Division (11 Scenarios)			
Cost of water ($/ML/year)	**$149**	$15	$350
Volume saved (ML)	**238**	15.5	1011
Capital Cost	**$218,551**	$93,150	$547,000
Wall Height Increase (6 Scenarios)			
Cost of water ($/ML/year)	**$146**	$61	$271
Volume saved (ML)	**1217.3**	184	2929
Capital Cost	**$2.9M**	$234,838	$6.2M

Key Points

- Average cost using either strategy approximately $150/ML/yr
- The cost was as low as $15/ML/yr for cell division and $61/ML/yr for wall height increase
- Larger water volumes saved through wall height increases, although the capital cost was also much higher.
- When dividing a storage into cells, the optimum size of each cell will depend on the typical water availability.

Further Information

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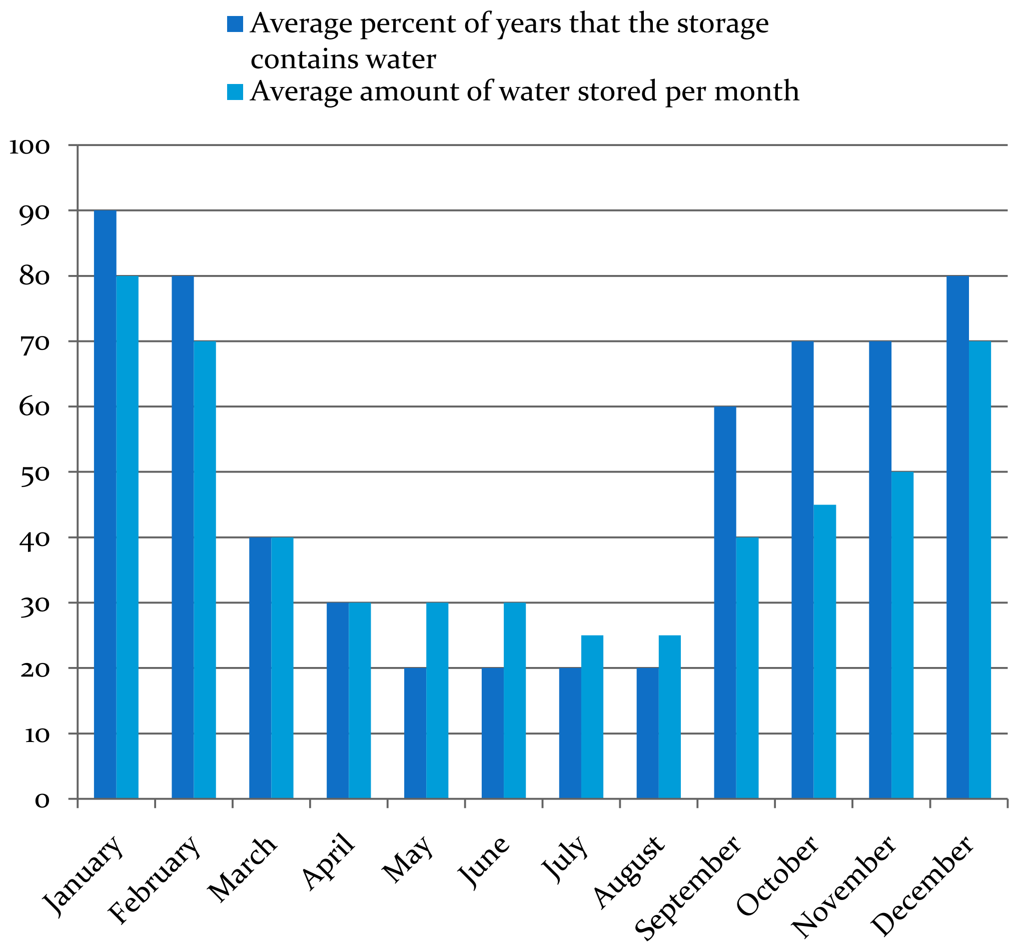
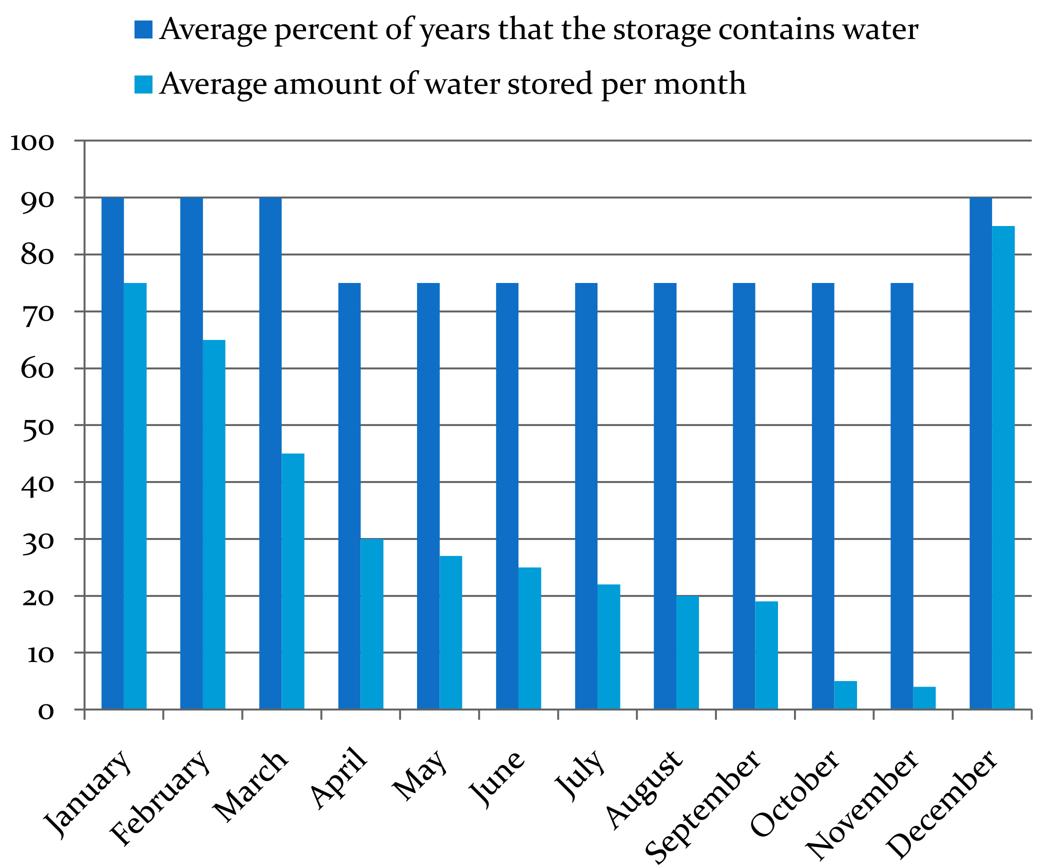
Volumetric Losses – Example 1



- Emerald Storage
- 5.6Ha, 180ML
- Typical Annual Loss:

Evaporation	67ML
Seepage	
1mm/day	17ML
2mm/day	33ML
3mm/day	50ML
5mm/day	83ML
10mm/day	165ML

Volumetric Losses – Example 2



- Darling Downs
- 27Ha, 1500ML
- Typical Losses:

Evaporation	423ML
Seepage	
1mm/day	89ML
2mm/day	178ML
3mm/day	267ML
5mm/day	445ML
10mm/day	890ML