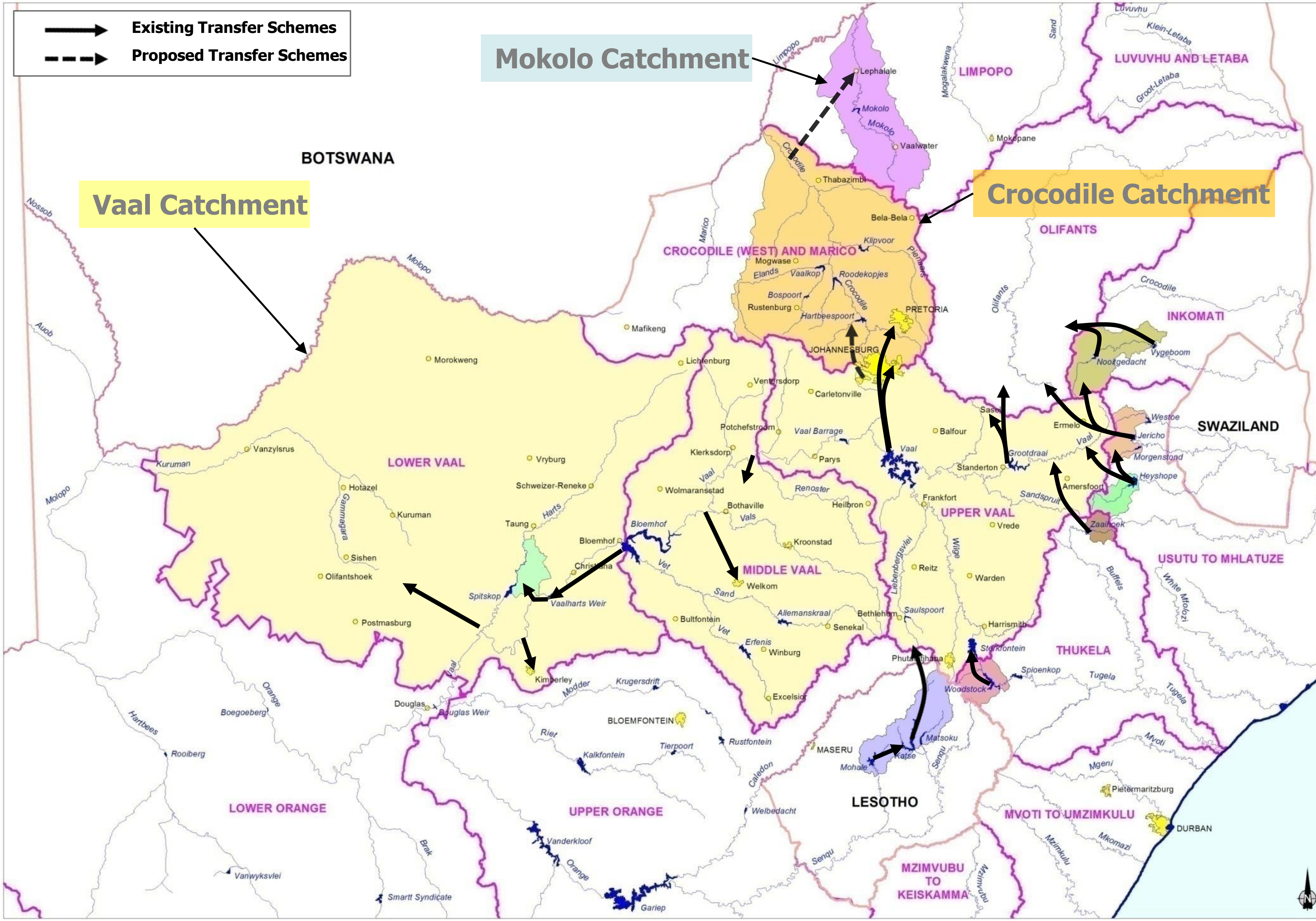
Revised Water Balance

Maintenance of the Crocodile West River System Reconciliation Strategy Study

Jonathan Schroder

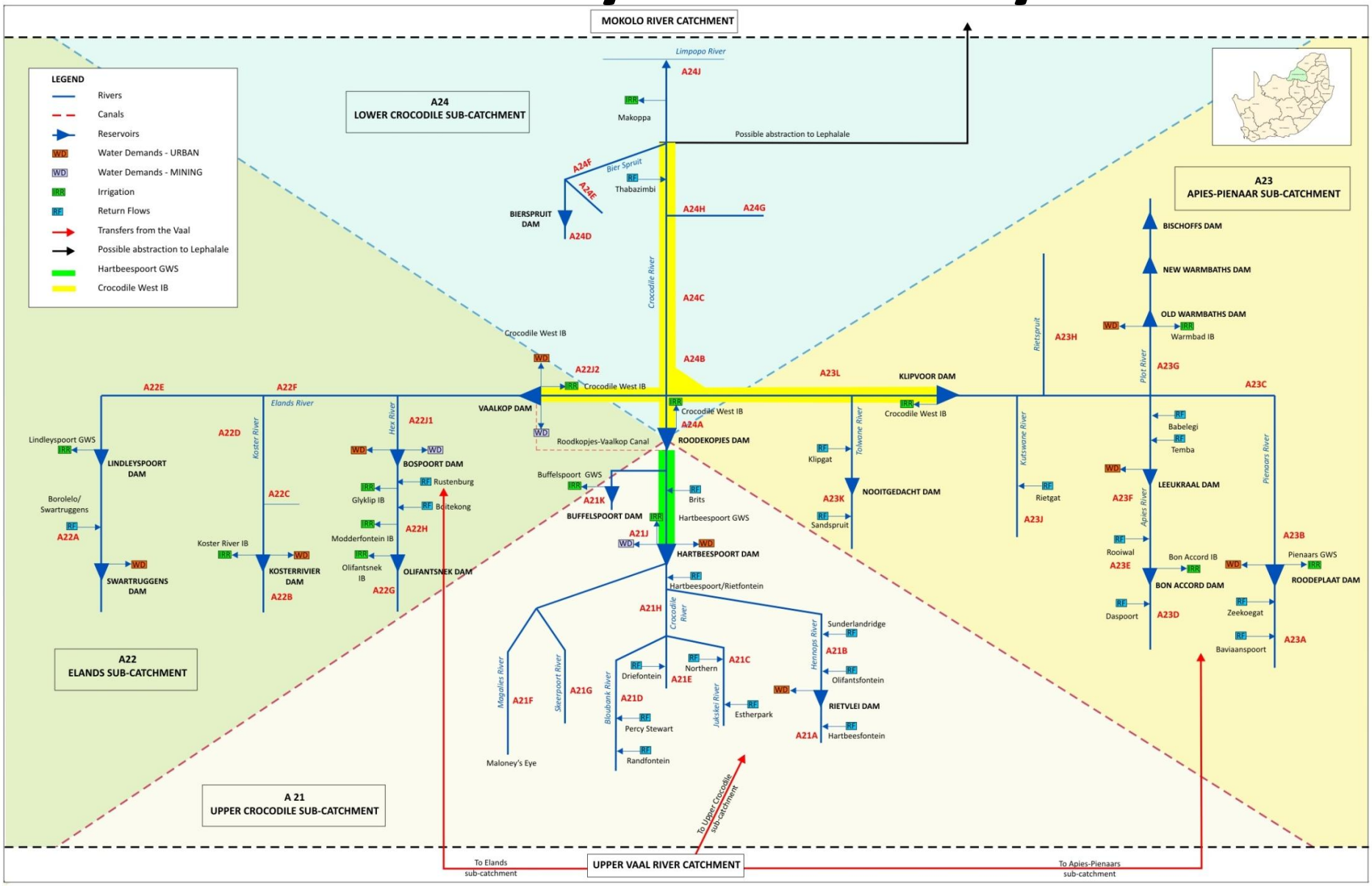
Presentation Layout

- The system
- Water requirements
- Water sources
- Return flows
- Demand centers
- Water requirements split
- Risk analysis (Water Resource Planning Model simulations)
- Water resources balances
- Possible transfers to Lephalale



Existing Transfer Schemes
Proposed Transfer Schemes
Mokolo Catchment
Vaal Catchment
Crocodile Catchment
BOTSWANA
SWAZILAND
LESOTHO
LIMPOPO
LUVUVHU AND LETABA
OLIFANTS
CROCODILE (WEST) AND MARICO
INKOMATI
LOWER VAAL
MIDDLE VAAL
UPPER VAAL
USUTU TO MHLATUZE
THUKELA
LOWER ORANGE
UPPER ORANGE
MVOTI TO UMZIMKULU
MZIMVUBU TO KEISKAMMA
Lephalale
Mokolo
Vaalwater
Mokopane
Thabazimbi
Bela-Bela
Klipvoor
Mogwase
Vaalkop
Roodekopjes
Bospoort
Rustenburg
Hartbeespoort
PRETORIA
JOHANNESBURG
Mafikeng
Morokweng
Lichtenburg
Ventersdorp
Carletonville
Potchefstroom
Vaal Barrage
Klerksdorp
Parys
Balfour
Standerton
Grootdraai
Ermelo
Nooitgedacht
Vygeboom
Westoe
Jericho
Morgenstond
Heyshope
Amersfoort
Zaaihoek
Frankfort
Heilbron
Vrede
Reitz
Warden
Harrismith
Bethlehem
Saulspoort
Senekal
Sterkfontein
Spioenkop
Woodstock
Phuthaditjhaba
Katse
Matsoku
Mohale
MASERU
Vanzylsrus
Kuruman
Hotazel
Sishen
Olifantshoek
Postmasburg
Vryburg
Schweizer-Reneke
Taung
Bloemhof
Christiana
Spitskop
Vaalharts Weir
Wolmaransstad
Bothaville
Kroonstad
Welkom
Allemanskraal
Bultfontein
Erfenis
Winburg
Excelsior
Kimberley
Douglas
Douglas Weir
Krugersdrift
BLOEMFONTEIN
Tierpoort
Rustfontein
Kalkfontein
Welbedacht
Boegoeberg
Rooiberg
Vanderkloof
Gariep
Vanwyksvlei
Smartt Syndicate
Pietermaritzburg
DURBAN

Schematic layout of study area



AC01_2011_J01330

Schematic of the Crocodile West River Catchment

The System – Water Balance

Water requirements

Water Availability

RAND WATER

Magalies Water

Urban Water Requirements (1)

- Main drivers
  - Population
  - Economic activity
  - Standard of living
  - Efficiency of use

Urban Water Requirements (2)

- Current water requirements
- Update based on actual recent water supply figures for 2008/2009 and 2009/2010 from:
  - Rand Water
  - Magalies Water
  - Municipalities e.g. Tshwane
  - Other studies i.e. *All Towns Study;* and *Feasibility studies 2007/08 - Magalies Water to Waterberg*

Urban Water Requirements (3)

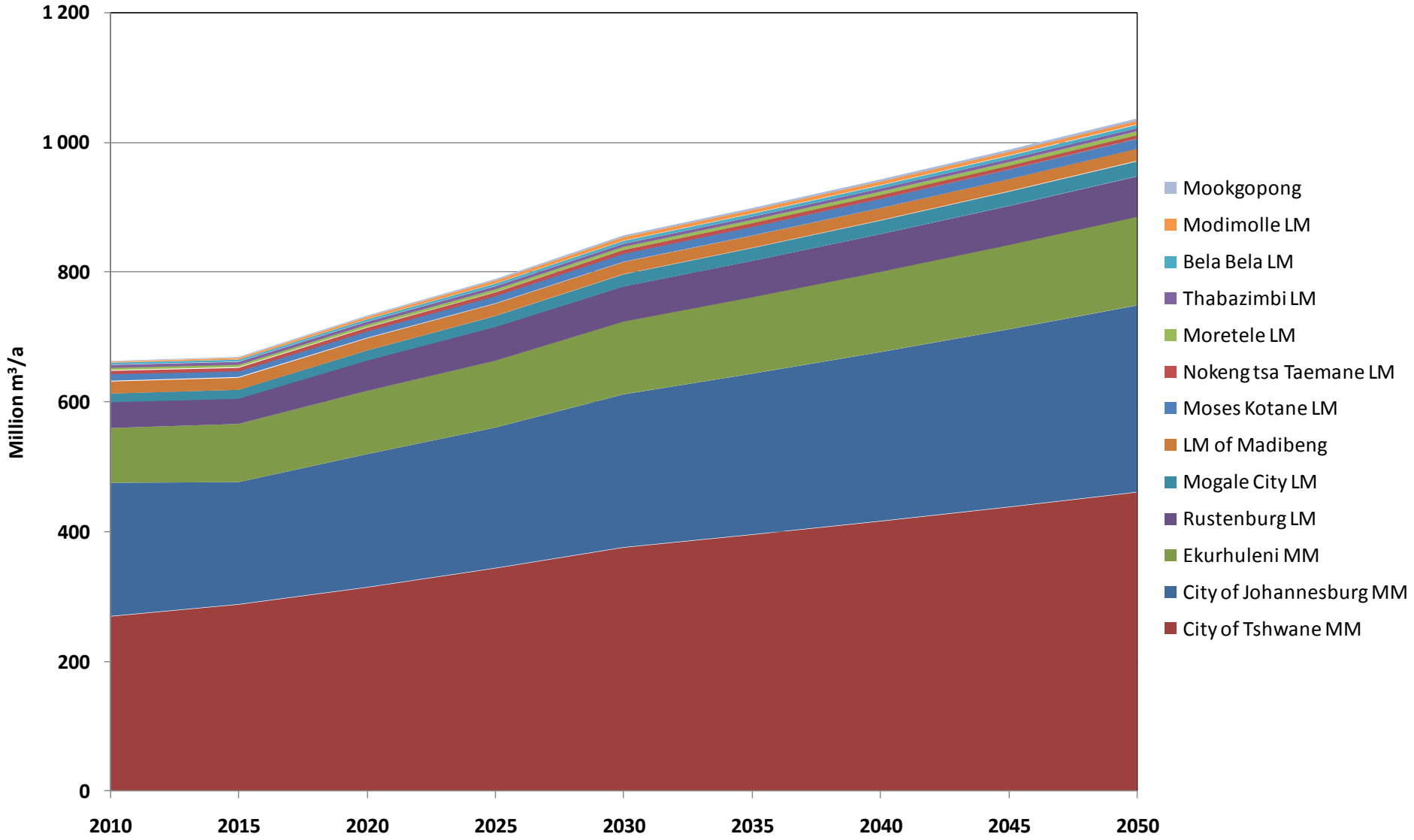
- Water requirement scenarios
  - High population growth rate used for planning purposes
  - Assume medium WC/WDM efficiency (15% saving achieved within 5 years)
  - Updated water requirement projections for the Rand Water supply area of the catchment obtained from the Vaal Reconciliation Strategy Study
  - Water requirement projections for other areas based on existing information on using population growth and various water sector use – updated with current figures

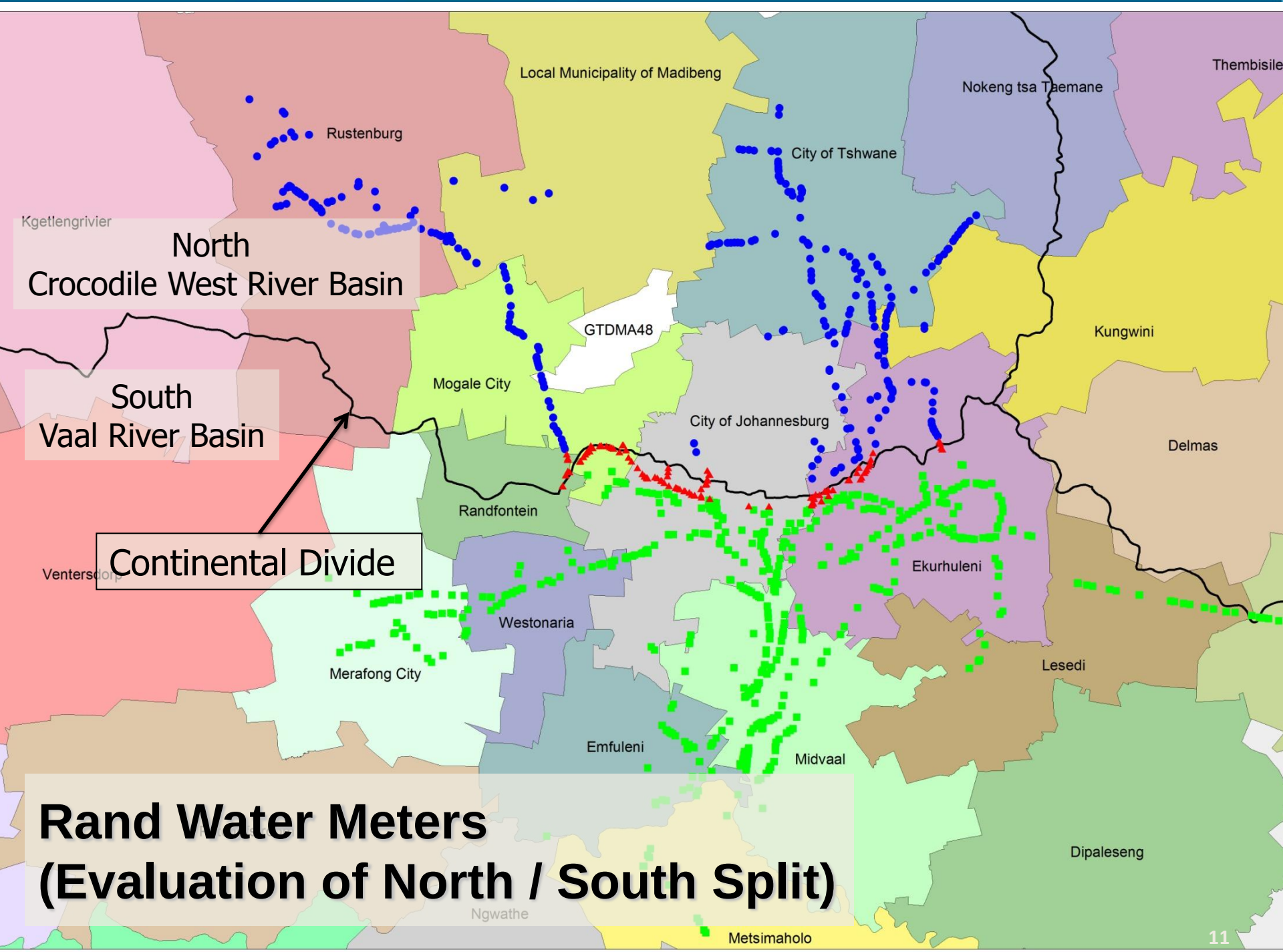
Urban water requirements (4)

Area	Water requirement (million m^3/a)								
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Bela Bela LM	2.9	2.9	3.3	3.6	4.0	4.3	4.5	4.8	5.0
City of Johannesburg MM	206	188	205	216	236	248	260	274	288
City of Tshwane MM	269	288	314	344	376	395	416	438	461
Ekurhuleni MM	84	90	98	103	112	118	124	131	137
Kgetlengrivier LM	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.3	2.5
Kungwini LM	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
LM of Madibeng	18.5	18.5	18.5	18.5	18.5	18.6	18.6	18.7	18.7
Mogale City LM	13.5	14.0	15.6	16.9	18.7	19.7	20.7	21.8	22.9
Moretele LM	4.4	4.6	4.8	5.1	5.4	5.6	5.8	6.0	6.2
Moses Kotane LM	11.4	10.0	10.9	11.9	12.8	13.6	14.3	14.8	15.3
Nokeng tsa Taemane LM	5.3	5.5	5.6	5.8	6.0	6.1	6.2	6.3	6.4
Randfontein LM	9.2	9.7	10.7	11.3	12.4	13.0	13.7	14.4	15.1
Rustenburg LM	41	40	47	53	54	56	58	60	62
Thabazimbi LM	4.6	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9
Modimolle LM	1.3	2.4	3.4	4.5	5.5	5.6	5.7	5.7	5.7
Mookgopong	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.5	3.8
Total	**674**	**681**	**746**	**803**	**872**	**915**	**960**	**1 006**	**1 055**

Note: Municipalities in Blue are part of the Rand Water supply area
Numbers in red beyond 2030 show values that were extrapolated

Urban water requirements (5)

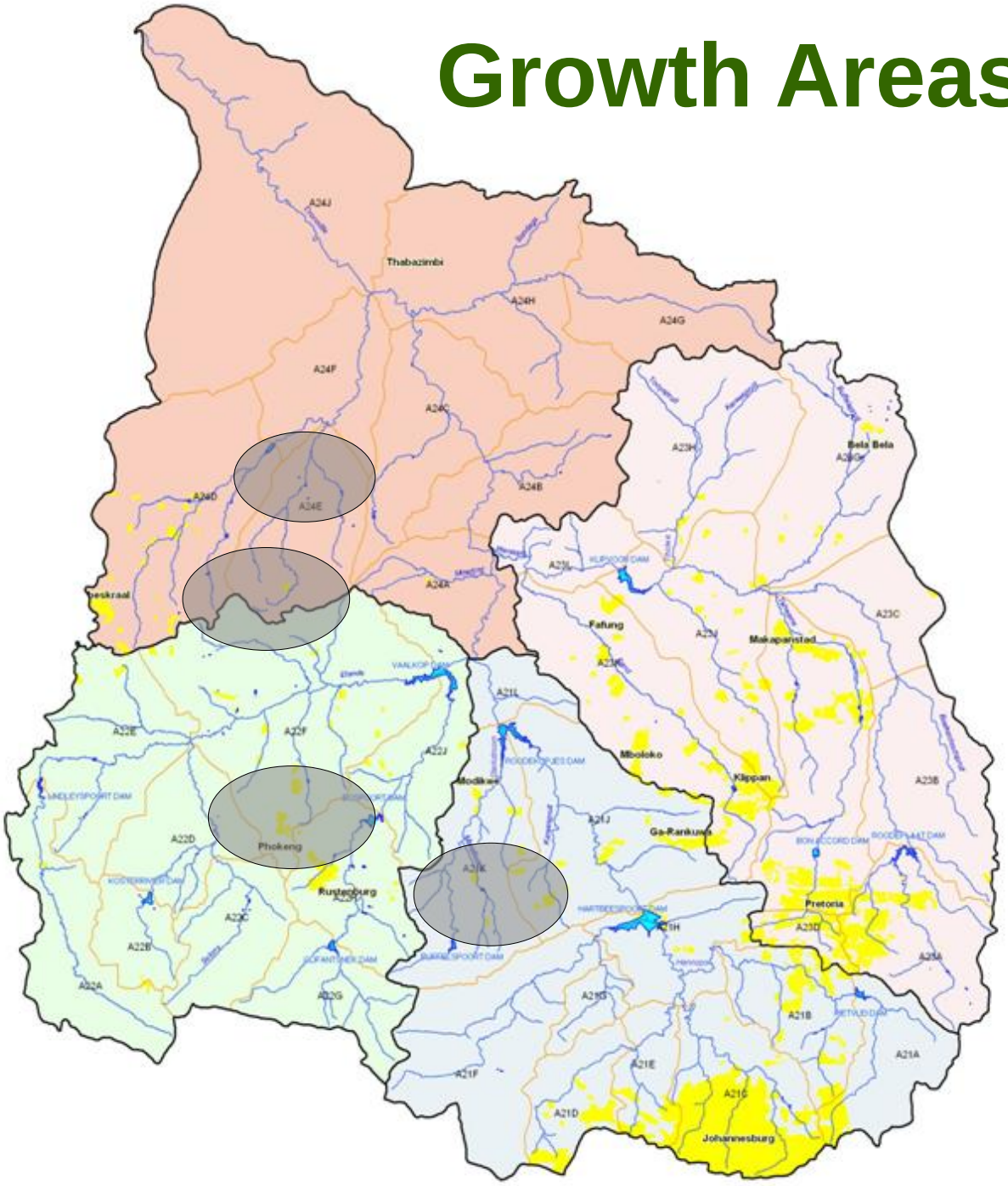




Rand Water Meters (Evaluation of North / South Split)

Growth Areas

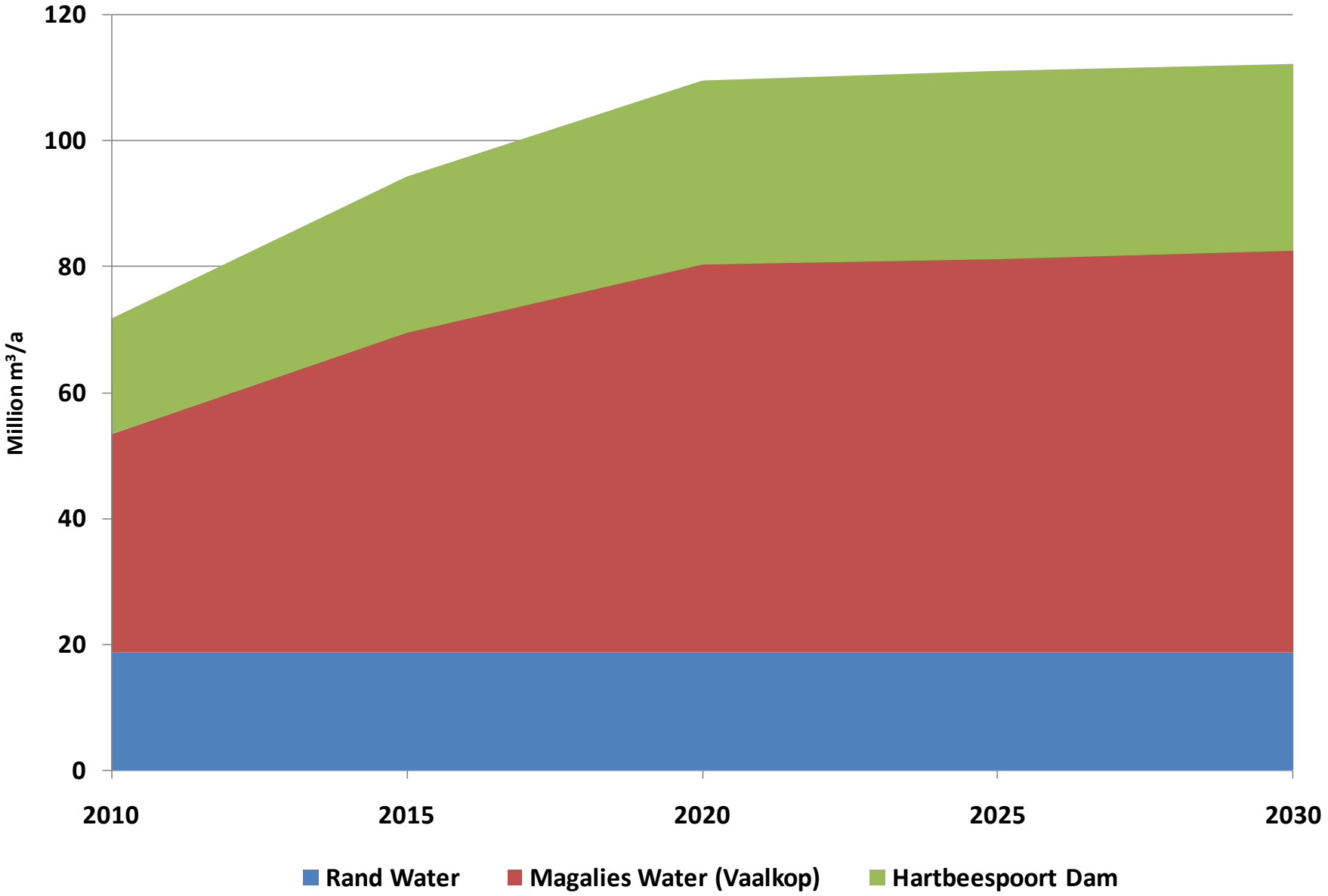
- Urban
- Mining



Mining Water Requirements

- Current water requirements based on recent (2009) measured supply from Rand Water and Magalies Water.
- Current supply indicates approximately a 5 year lag in water requirement growth from previous projections (2007 study).

Mining Water Requirements (2)



Irrigation and Rural Water Requirements

- Irrigation water requirements assumed to remain constant and volumes included as per previous versions of the Water balance.
- Irrigation from aquifers in the Lower Crocodile is now modelled in more detail with the inclusion of the aquifer model in the WRPM.
- Rural water requirements are assumed to be supplied from groundwater.

Water Sources (1)

- Water generated from runoff within the Crocodile catchment
- Return flows from large number of urban centers
- Transfers of water from the Vaal River catchment
- Groundwater

Water Sources (2)

- Groundwater to supply rural and stock water assumed to be developed as and when required.
- Rural water requirement growth within estimated regional groundwater potential.
- Transfers of Vaal water by Rand Water to urban users assumed to be developed as and when is required.

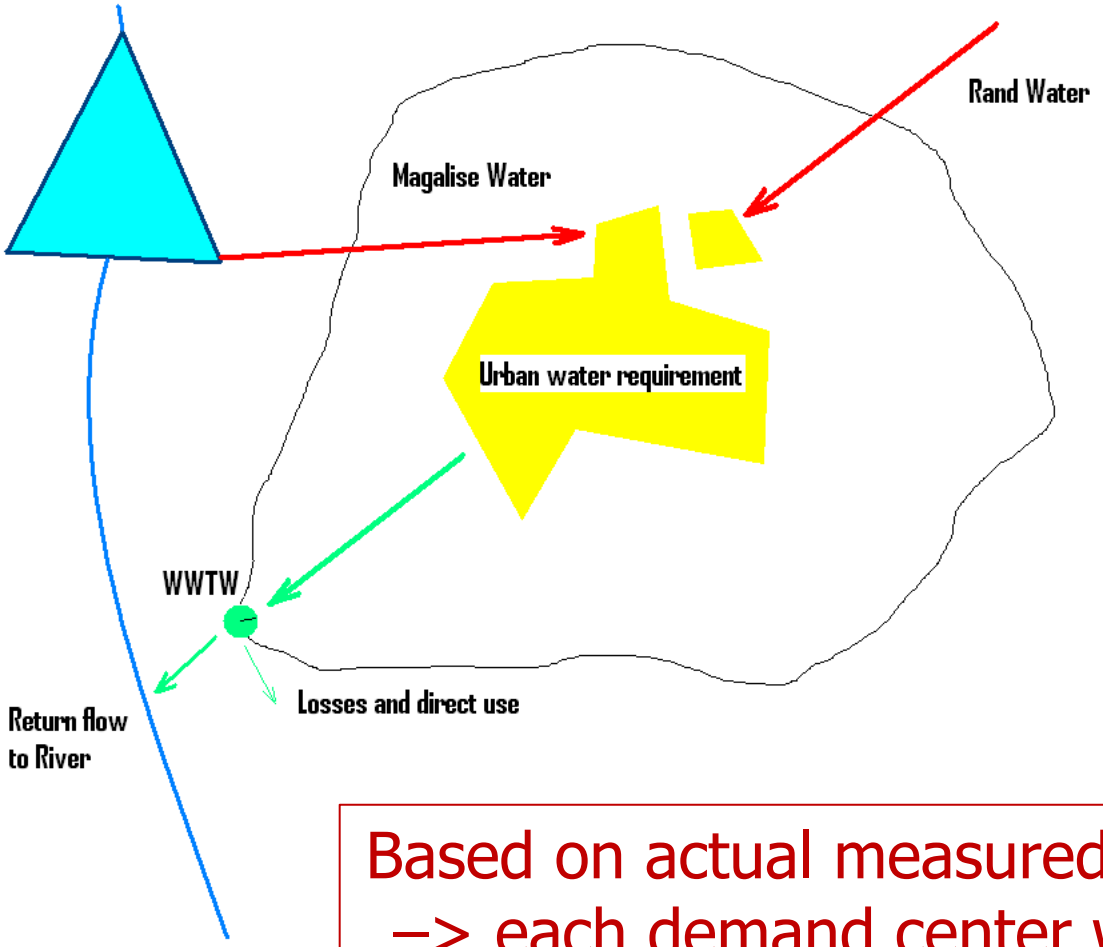
Water Sources (3)

- Local sources of water are a combination of water yielded from regulating runoff, and in-direct re-use of return flows.
- There is therefore a changing volume of water from local sources which can be used in combination with other sources i.e. Rand Water to reconcile growing water requirements.

Return flows and the demand centre drainage unit

- Return flows are a large and integral part of water availability in the Crocodile catchment -> these need to be carefully and accurately considered.
- Urban water supply and return flows are linked and dependant on the specific water within the drainage area.
- Hence the Demand center modelling unit which simulates return flows, taking into account water supply and the return flow characteristics specific to each drainage area.

Demand centres (1)

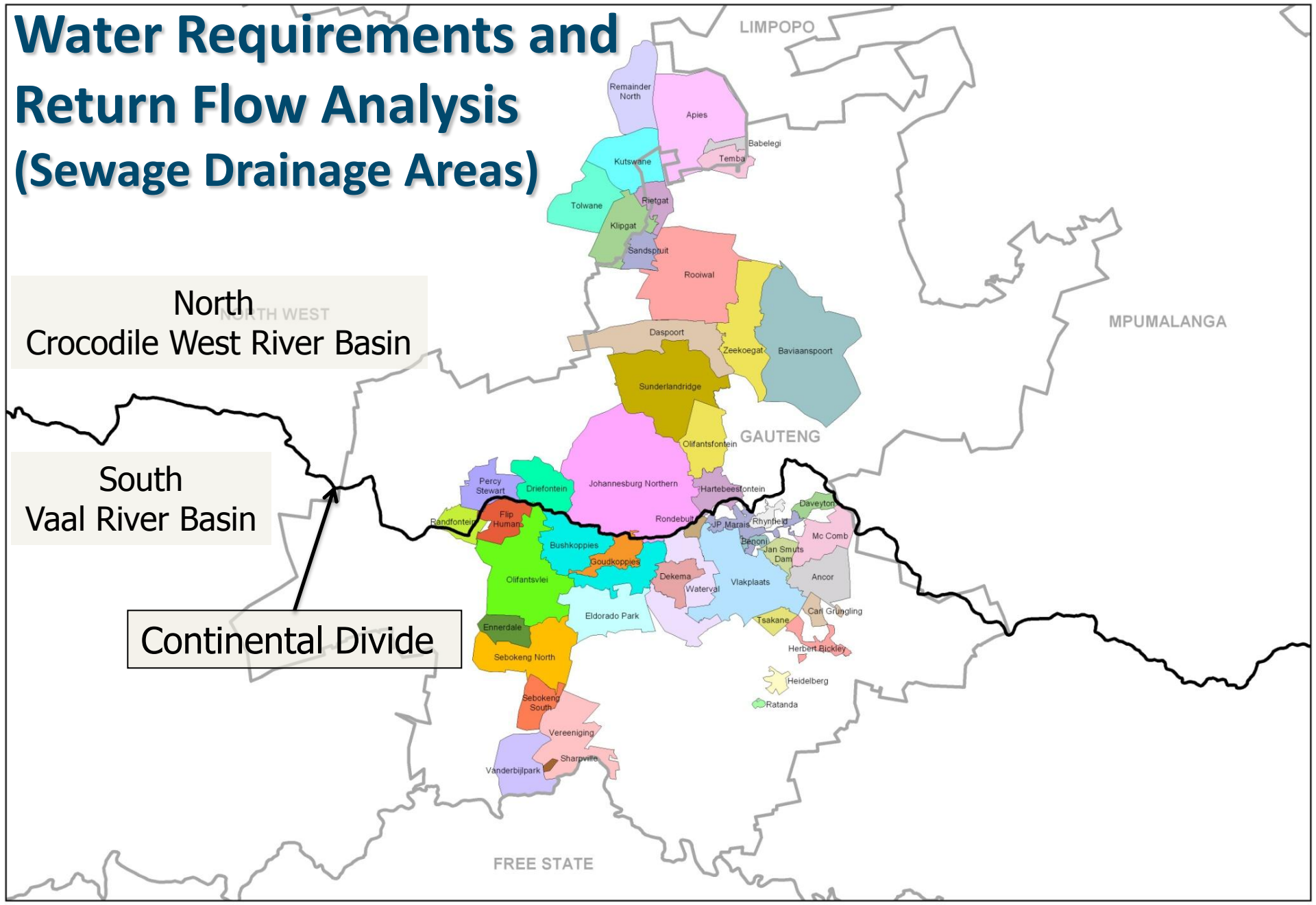


Factors that affect return flows:

- Water usage
- Evaporation
- Rainfall
- Routing of water through demand center

Based on actual measured supply and return flows –> each demand center was calibrated to obtain values/factors for the influencing variables

Water Requirements and Return Flow Analysis (Sewage Drainage Areas)



Demand centers (2)

- Demand centers calibrated -> known current water supply and corresponding return flows
- Future water requirement projections disaggregated from municipal level into demand centers – due to a lack of information on growth

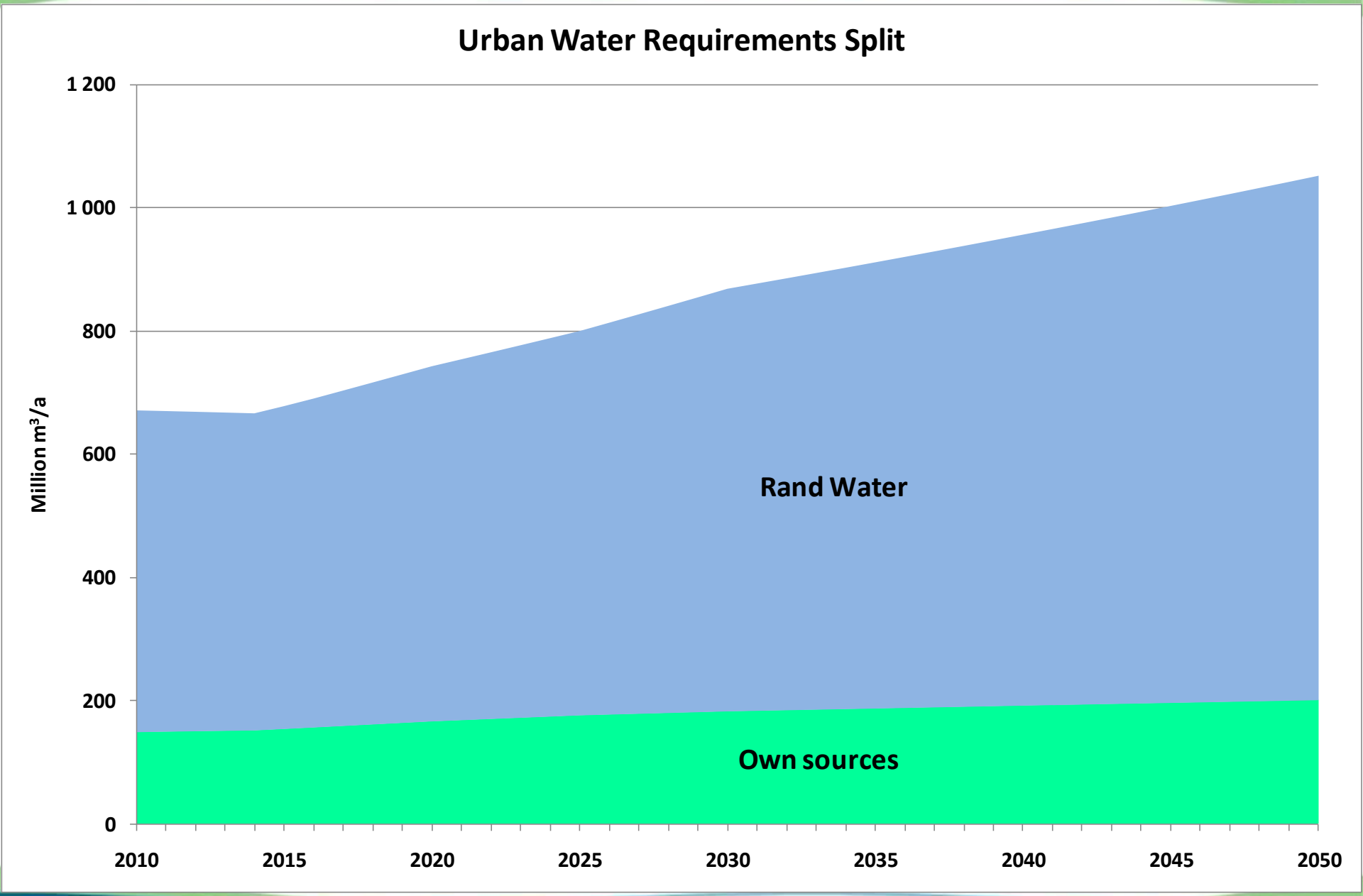
Assumption: existing ratios for disaggregating water requirements have been used for future scenarios.

Demand centers (3)

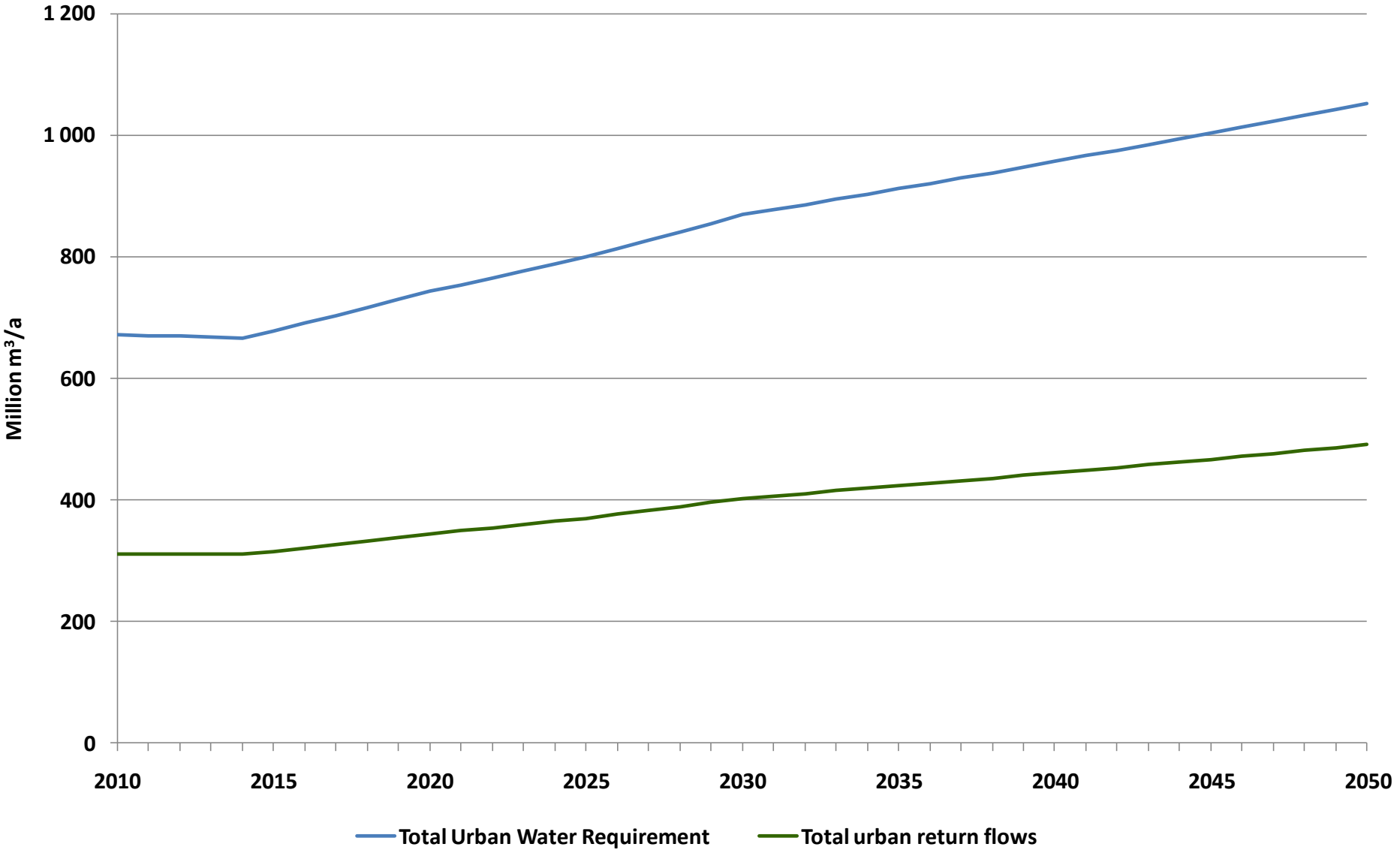
- Where a demand center is currently supplied by one source, future supply to augment growth in water requirements is assumed to come from that source.
- In Tshwane, where multiple sources of water currently supply demand centers, splits in future supply to augment growing water requirements needs to be assumed/established i.e. is growth taken up by Rand Water or own sources?
- Done by considering each demand center in Tshwane individually.

Demand centers (4)

- Local sources assumed to first supply growing water requirements up to water resource capacity or existing water use licenses.
- Further transfer of water assumed to augment any remaining water requirements.


Urban Water Requirements Split
1 200
1 000
800
600
400
200
0
Million m³/a
Rand Water
Own sources
2010
2015
2020
2025
2030
2035
2040
2045
2050

Urban Water Requirement and Return Flows



Risk analysis
Water Resource Planning Model simulations

What is the Water Resource Planning Model?

- Simulation model applied for operational and development planning
- Analyses the system as a network of dams, conveyance infrastructure and rivers
- Can simulate salinity dilution operating rules
- Perform risk analysis - projects risk of drought restrictions

How is the Water Resource Planning Model applied?

- Simulate scenarios of requirements and developments
- Determine annual risk of drought restrictions up to 2050 - defines date when further intervention is needed
- Produce reservoir storage levels for assessing the behavior of the system for a particular scenario
- Results of different scenarios are compared and evaluated to determine the implications of alternative future management options

Summary of WRPM and the Water balance

- Simulations of water balance based on High water requirements with medium WC/WDM measures

  -> These water requirements assigned to local sources and Rand Water as per split and assumptions discussed.

- The catchment as a whole is in SURPLUS!
- Surplus calculated at specific points in the catchment while ensuring existing users are not negatively impacted, i.e. assurance of supply within an acceptable range.
- Surplus has been calculated but can be further optimised.

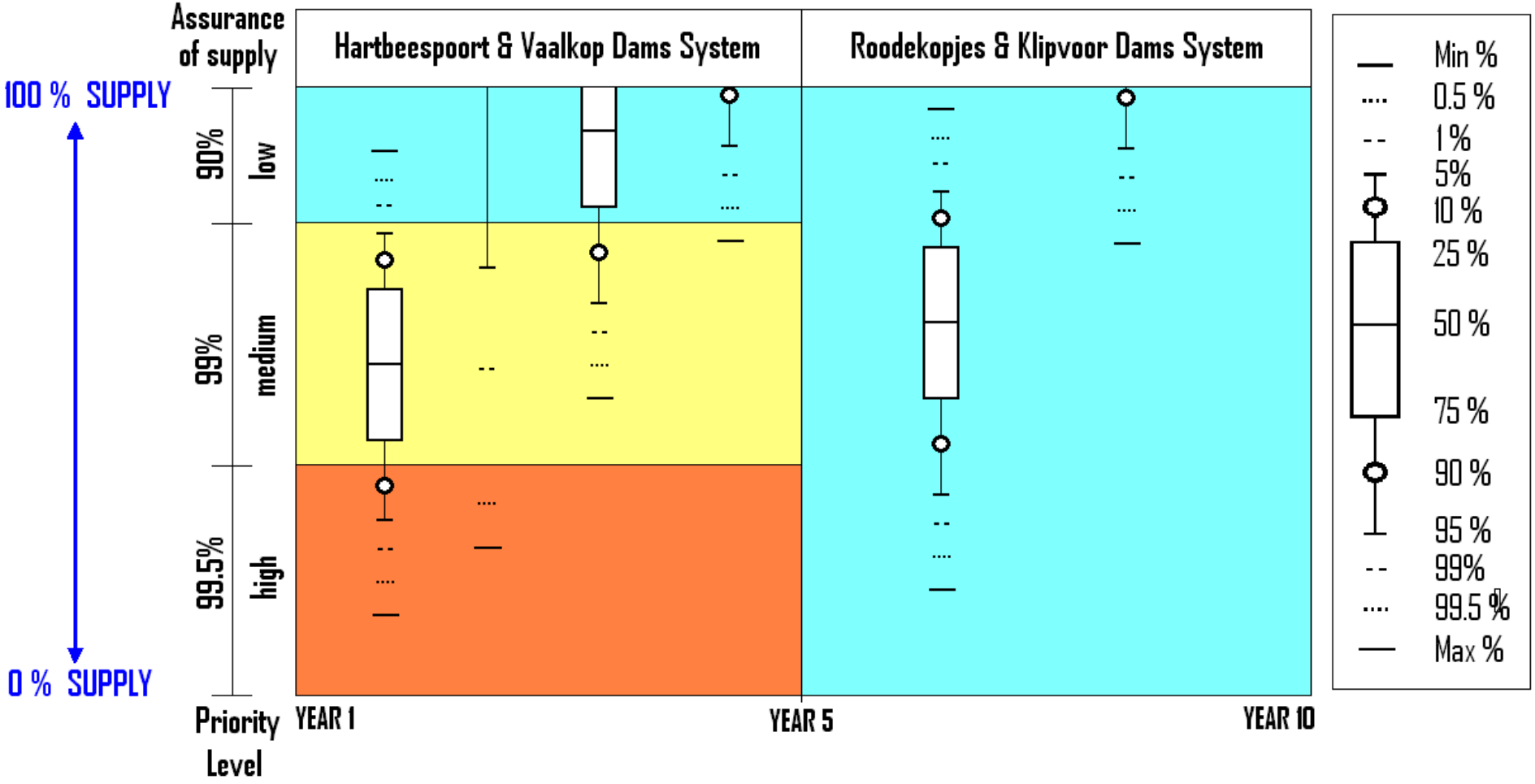
Water user criteria

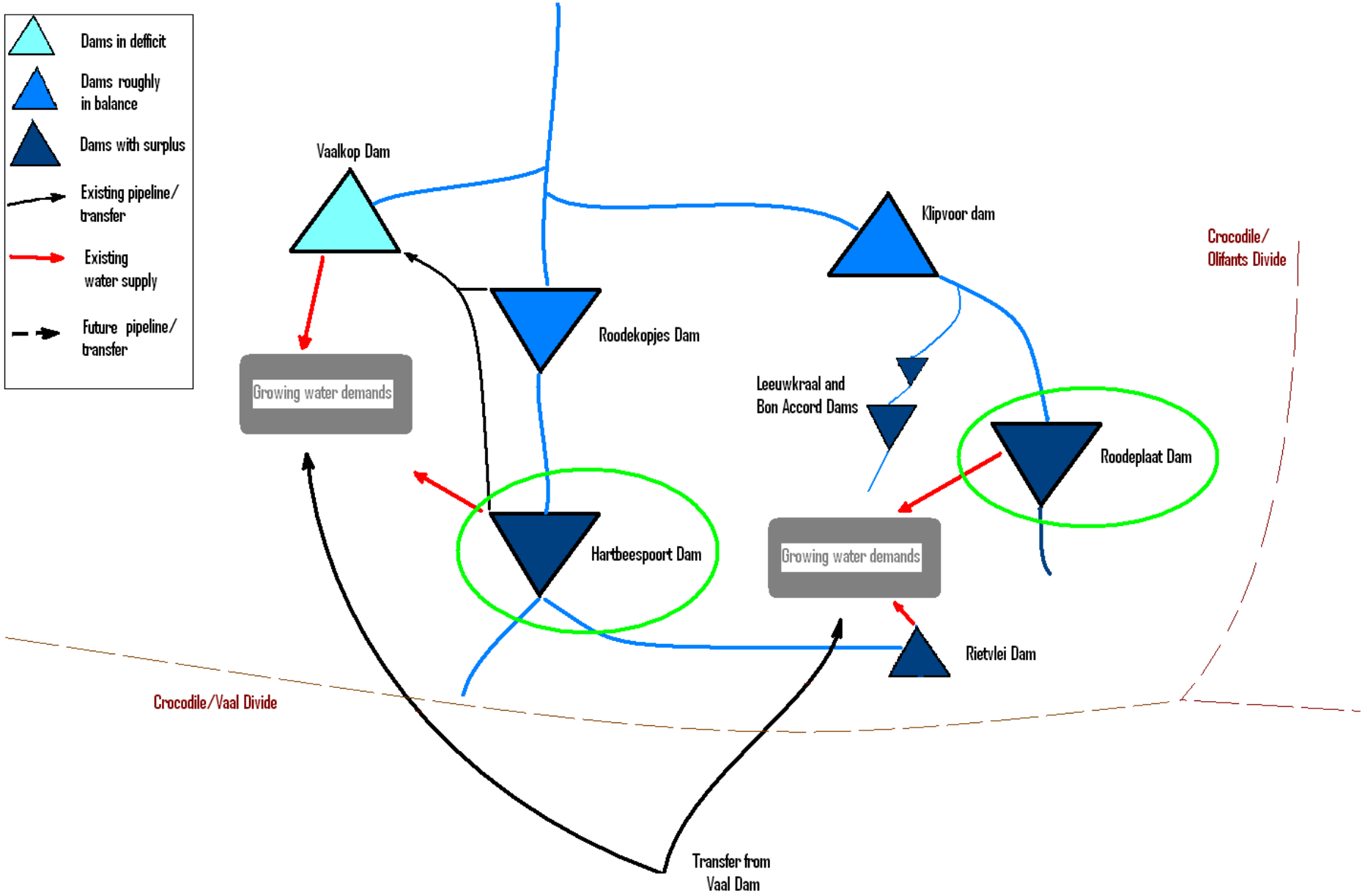
- Assurance of supply criteria of water used for water balance simulations:

Water user category	Percentage of supply and assurance				
	1:200 yrs (99.5%)	1:100 yrs (99%)	1:20 yrs (95%)	1:11 yrs (91%)	Total
Irrigation water supply	0	0	0	100	100
Urban water supply	50	30	20	0	100
Mining, industry and Power generation	70	30	0	0	100

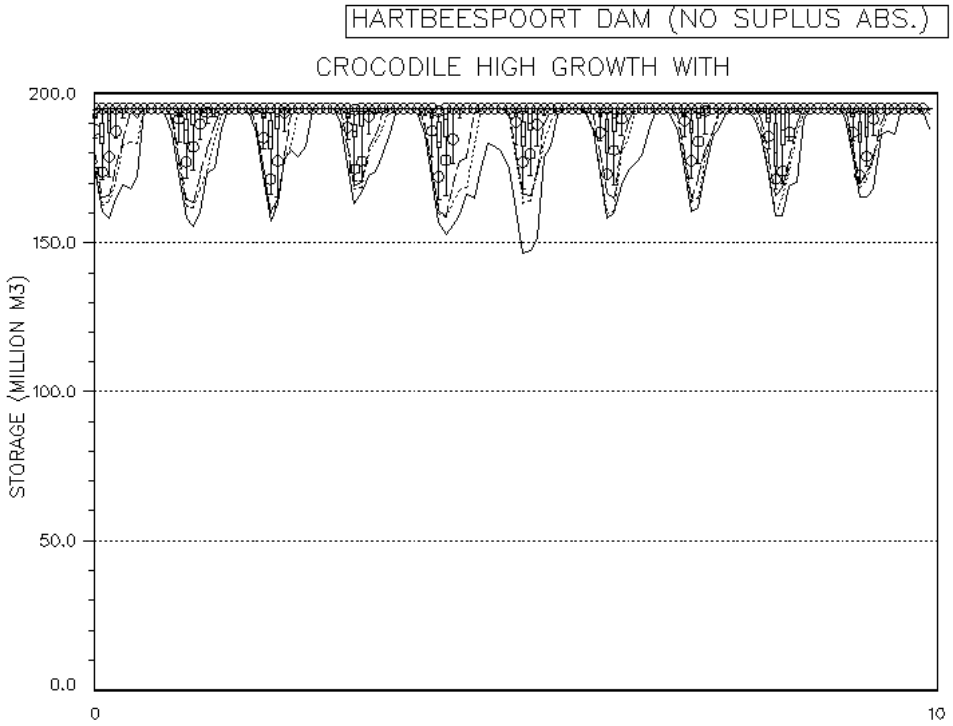
Note: Numbers in brackets indicate level of assurance

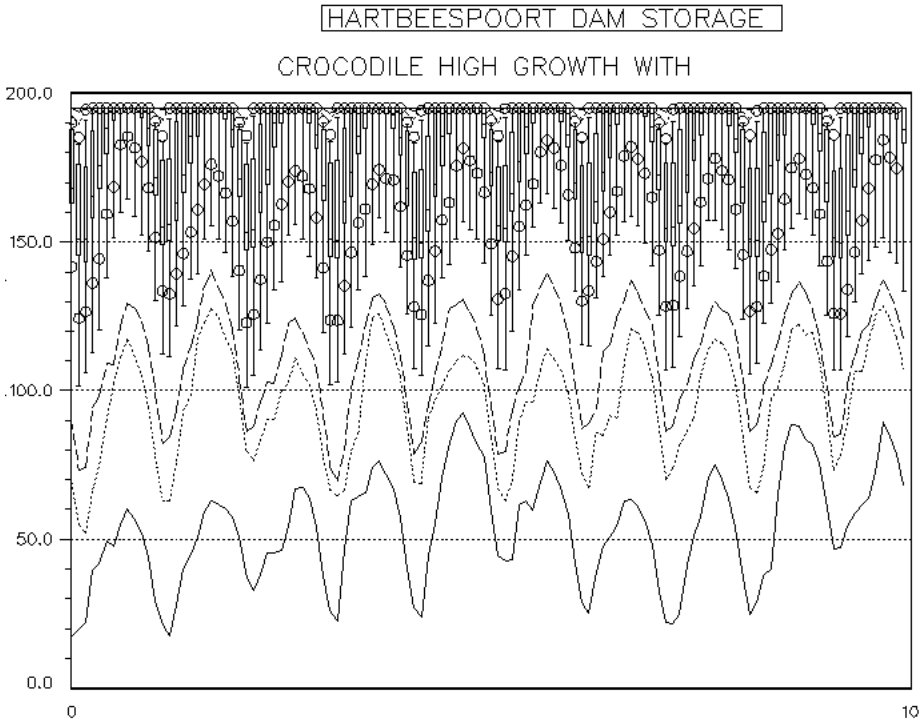
WRPM output - Boxplots



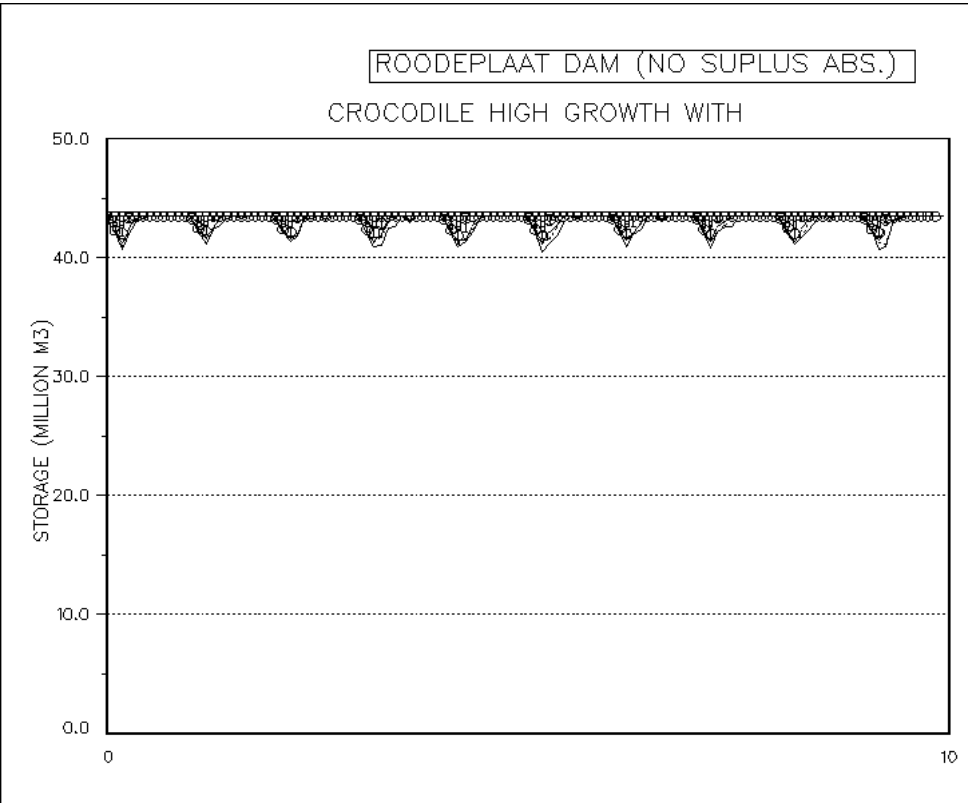

Dams in deficit
Dams roughly in balance
Dams with surplus
Existing pipeline/ transfer
Existing water supply
Future pipeline/ transfer
Vaalkop Dam
Roodekopjes Dam
Growing water demands
Klipvoor dam
Leeuwkraal and Bon Accord Dams
Roodeplaat Dam
Hartbeespoort Dam
Growing water demands
Rietvlei Dam
Crocodile/ Olifants Divide
Crocodile/Vaal Divide
Transfer from Vaal Dam

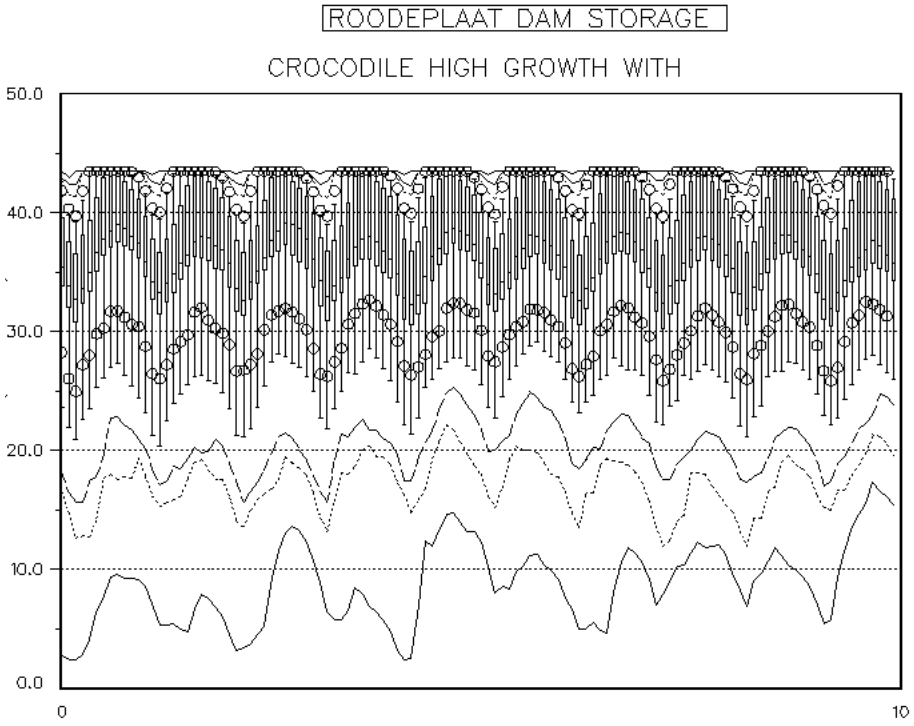
WRPM output – Boxplots (1)



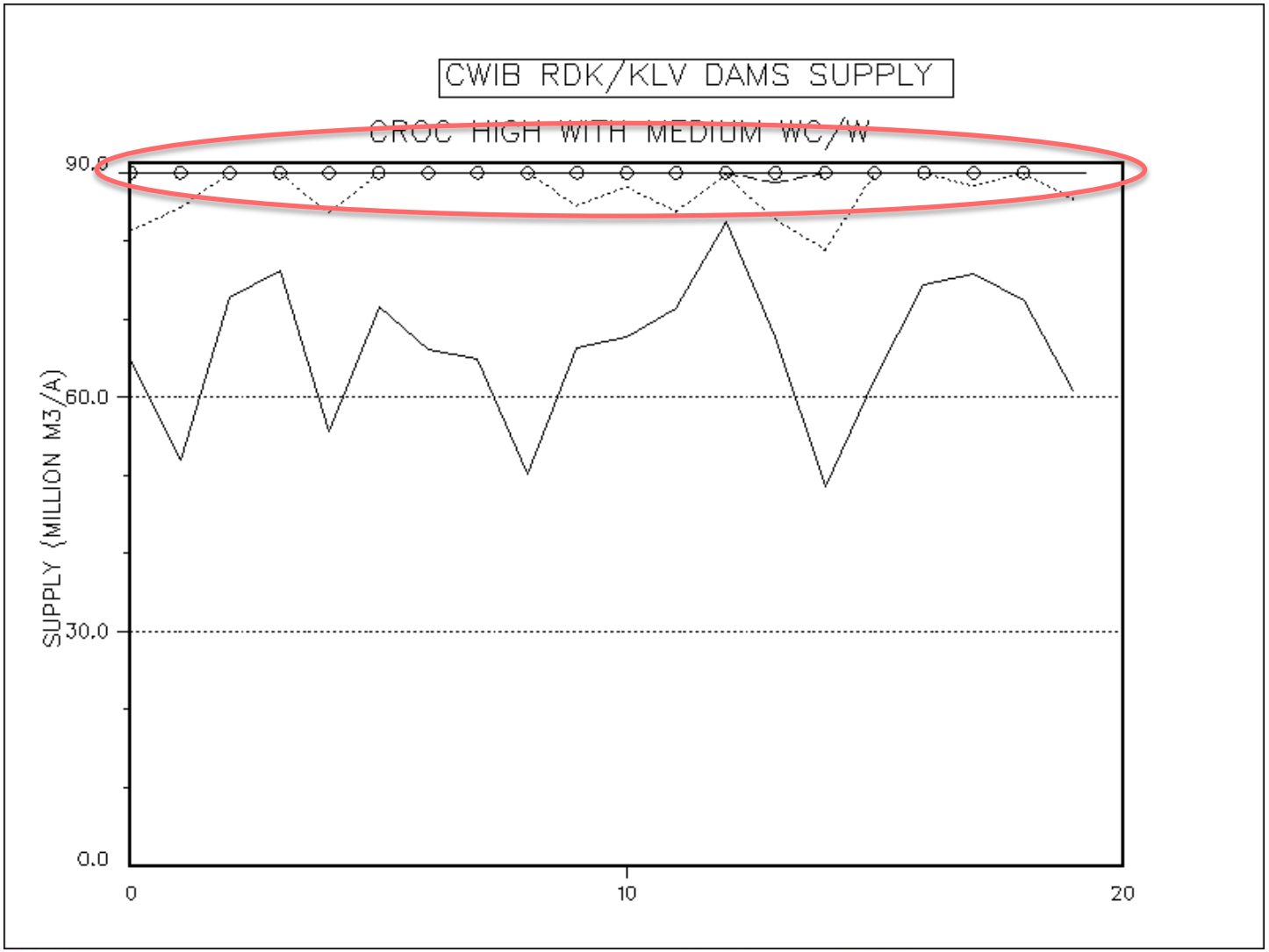


WRPM output – Boxplots (2)

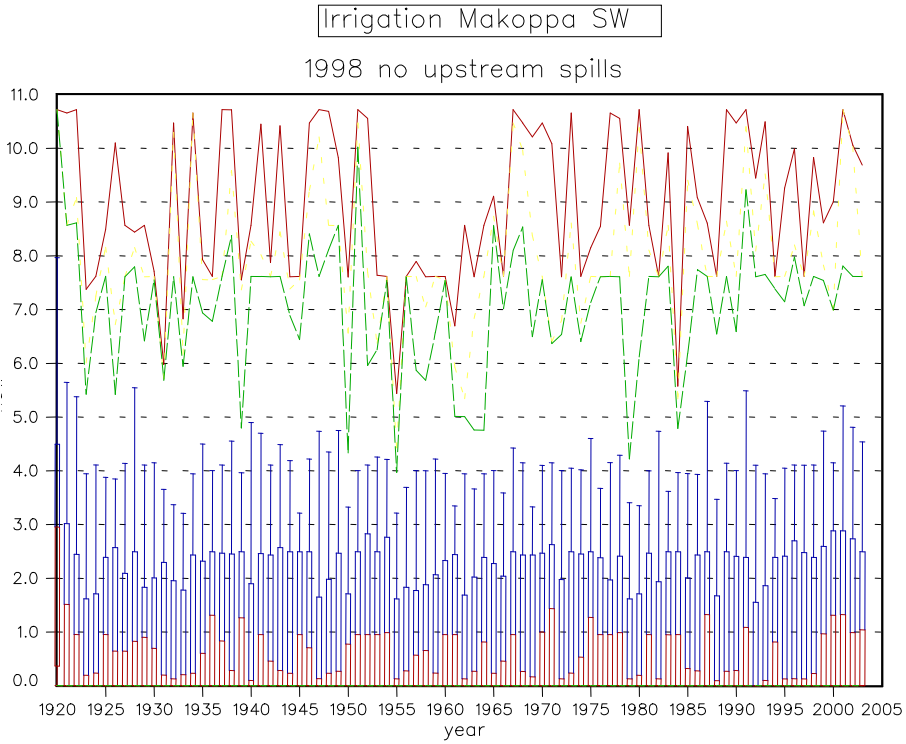


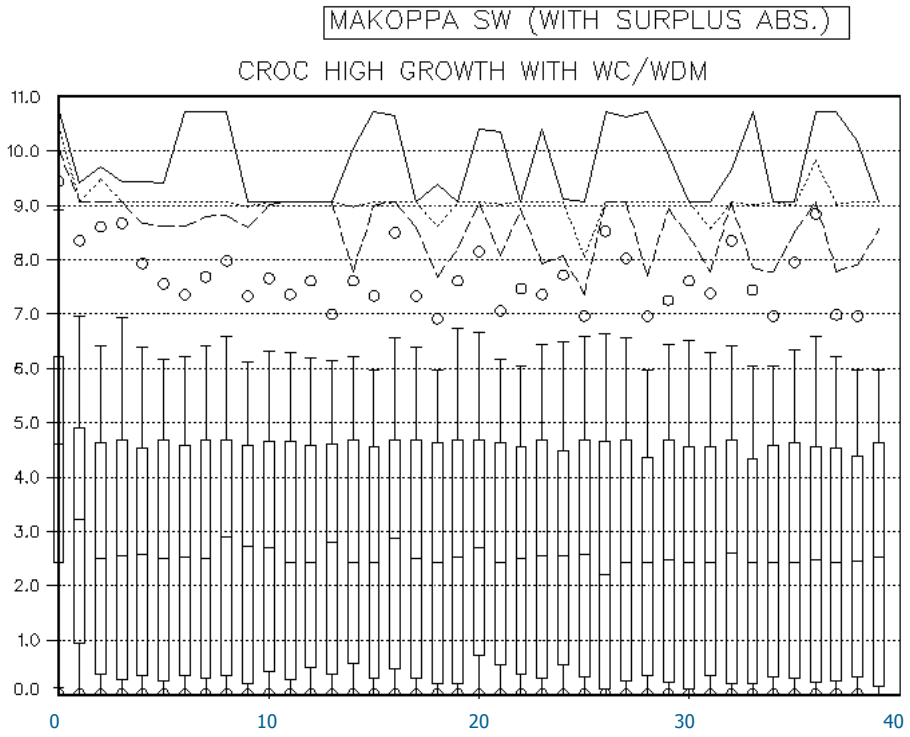


WRPM output – Boxplots (3)

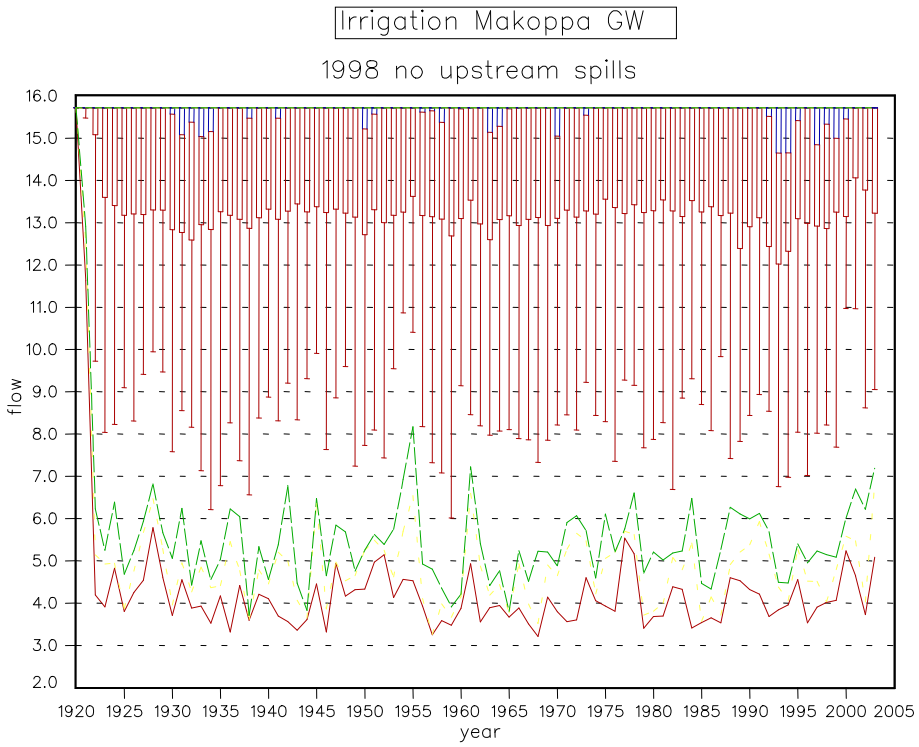


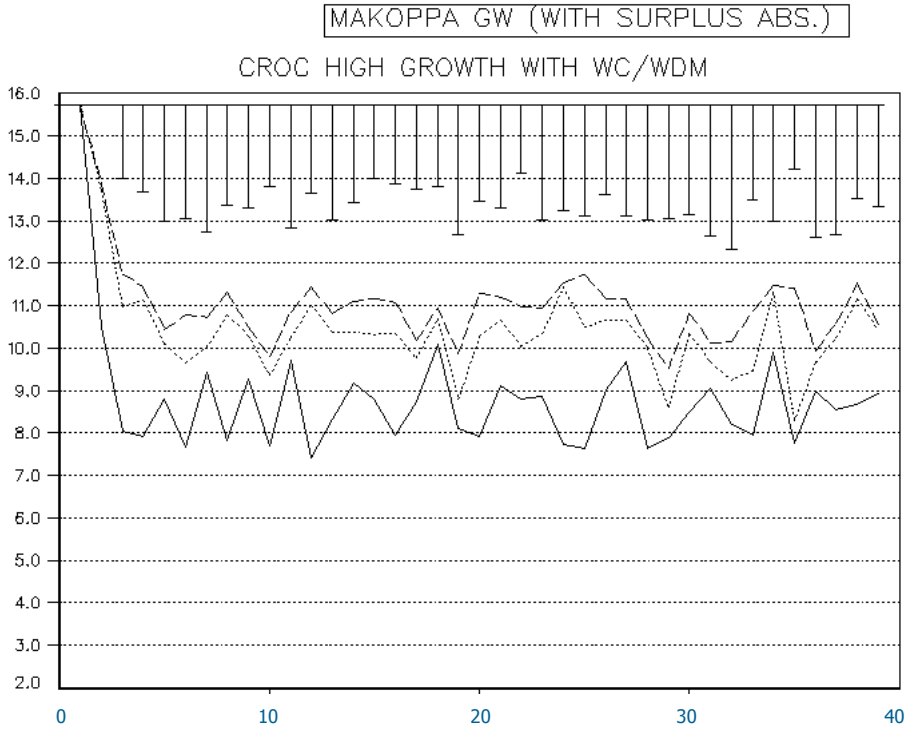
WRPM output – Boxplots (4)





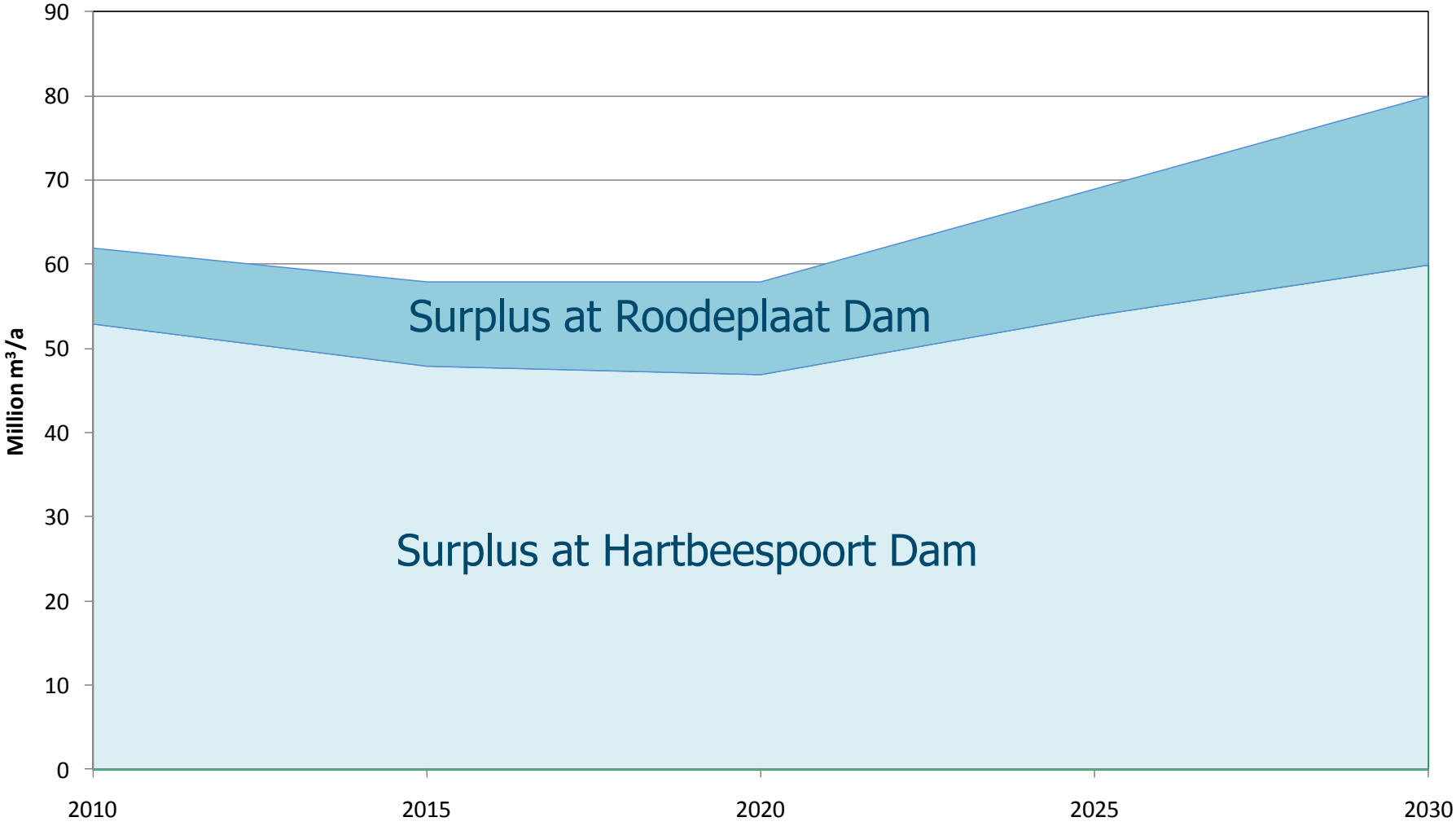
WRPM output – Boxplots (5)



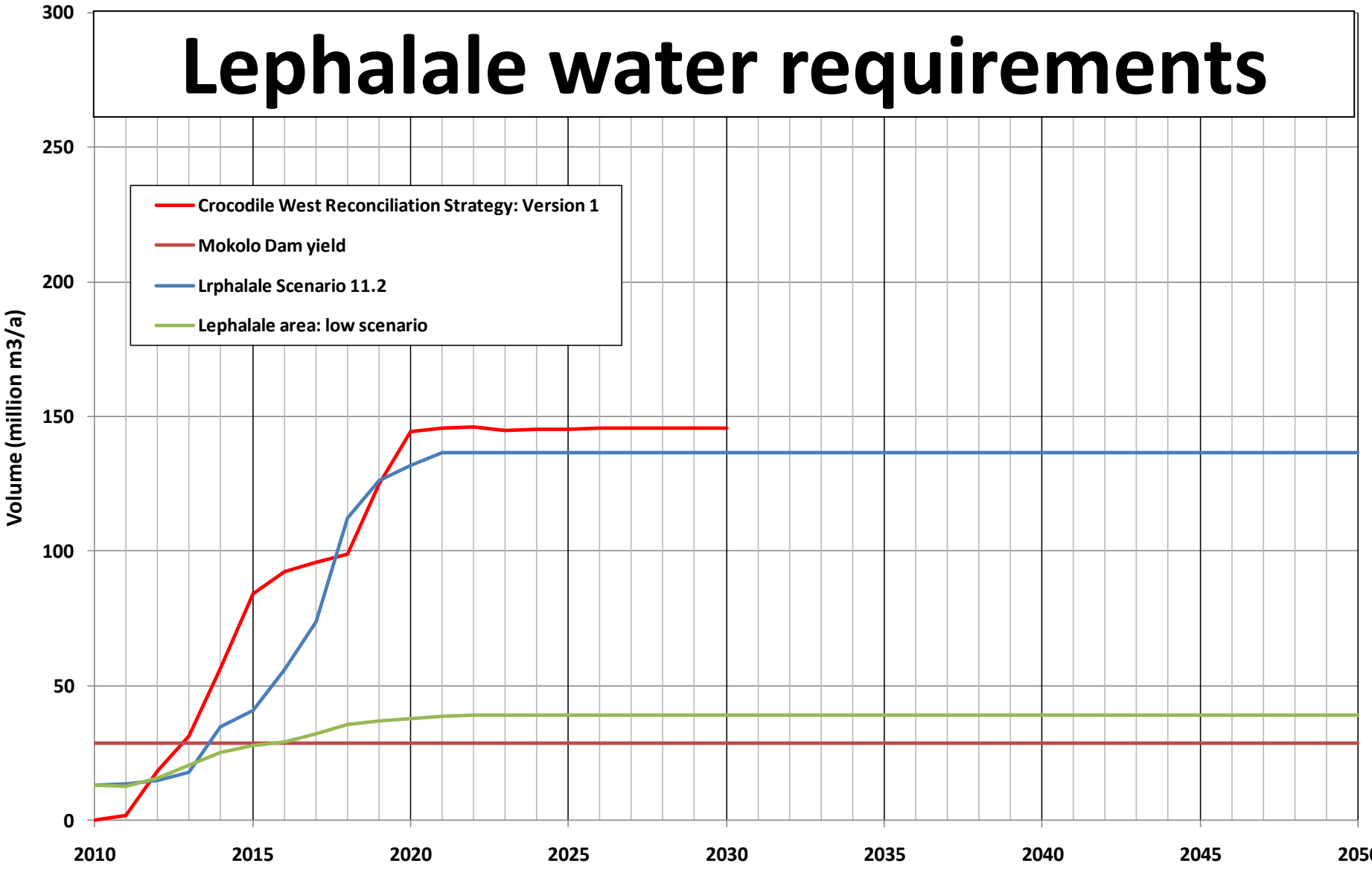


Surplus in Crocodile Catchment at Key points

Crocodile high growth with WC/WDM

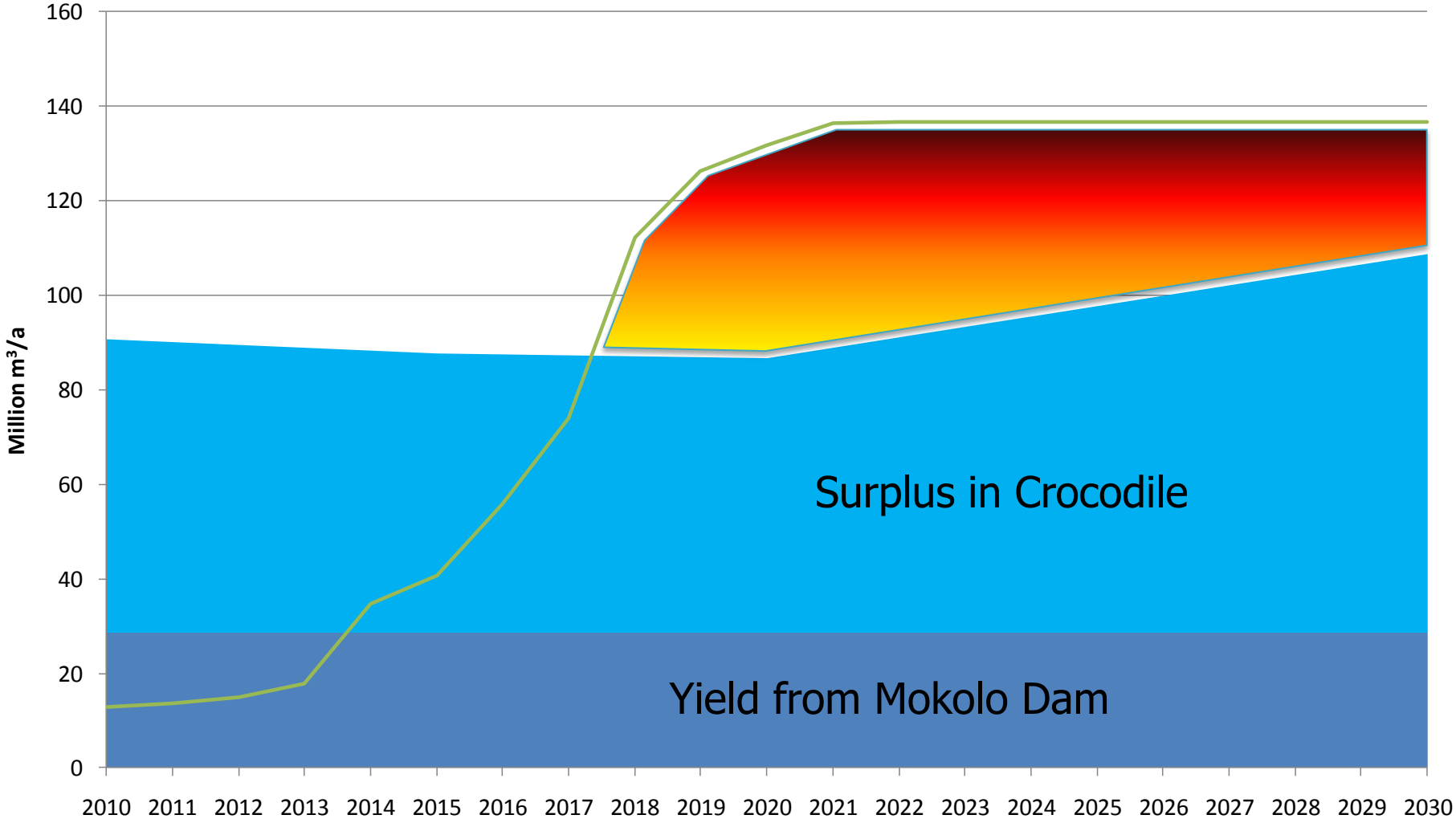


Lephalale water requirements



Lephalale Water Requirement Scenarios

Crocodile high growth with WC/WDM



Any Questions for clarification?
Thank You