Development of a Reconciliation Strategy for the Olifants River Water Supply System

Moving From a Preliminary Reconciliation Strategy Towards the Final Strategy

Presentation to
the Study Steering Committee

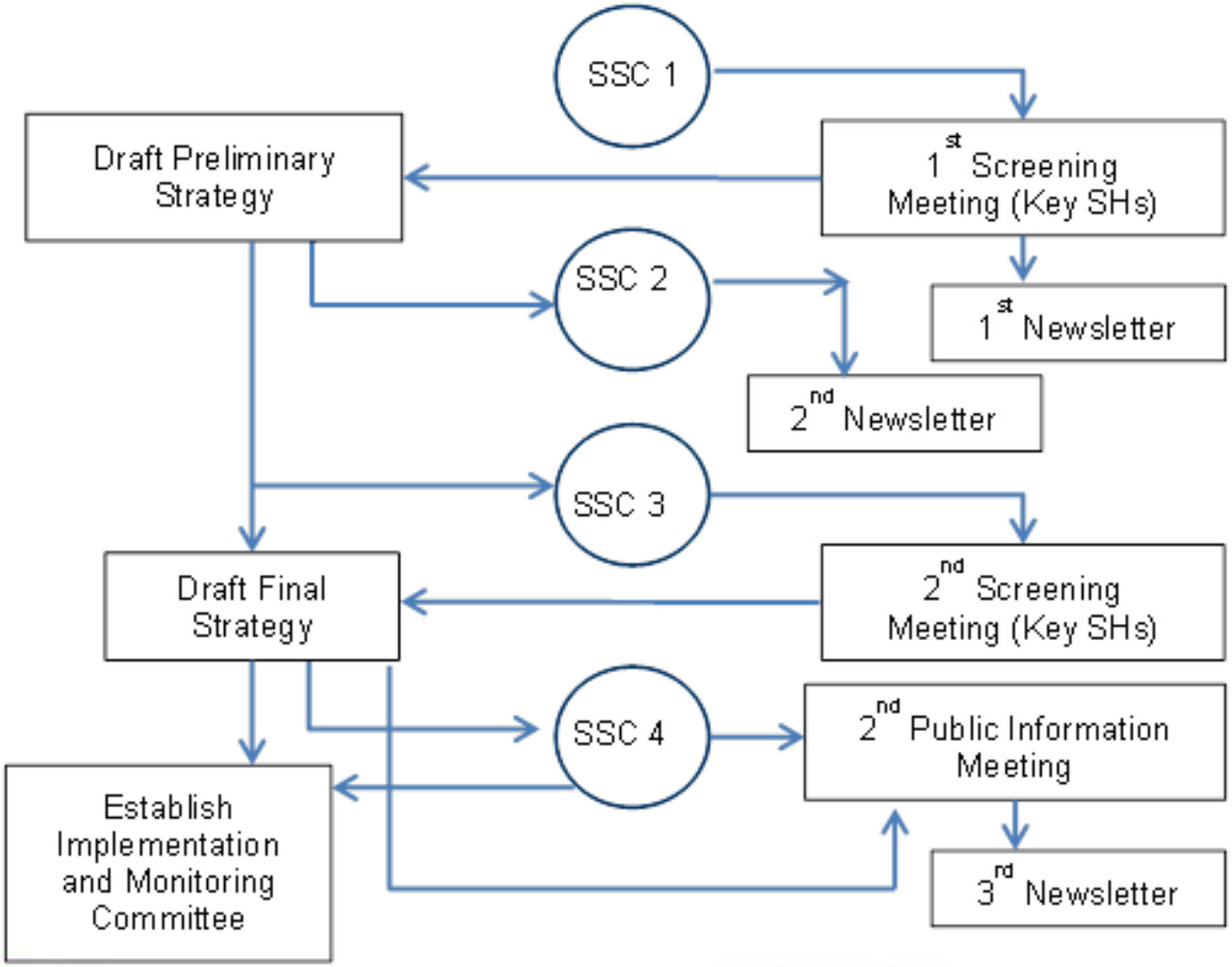
25 May 2011

Introduction

Purpose of the Prelim Strategy Report

- Provide understanding of water situation in study area
- Describe possible interventions
- Sequence these interventions
- Pave the way for the final reconciliation strategy

Overview of the Study Procedure



How the presentations are set up

- Recap on the contents of the Preliminary Reconciliation Strategy presented on 24 Nov 2010
- Investigations since then
- Updated information that will be used in the Final Reconciliation Strategy

Contents

- The Reserve - Dr Martin Van Veelen
- Water Quality - Dr Martin Van Veelen
- Groundwater - Dr Mannie Levin
  - Availability
  - Additional Yield From Decommissioned Coal Mines
- Surface Water - Mr Stephen Mallory
  - Availability
  - Current Water Use
  - Projected Future Water Requirements
  - The Water Balance
- Possible Reconciliation Options - Mr Dale Timm
- Reconciliation Scenarios - Mr Johnny Beumer
- Recommendations – Mr Johnny Beumer

The Reserve

by Dr Martin Van Veelen

Previous EWR Study

- Comprehensive Reserve Study was undertaken – 1999
- Eighteen EWR sites were selected.
- The approaches used were as follows:
  - A qualitative assessment of the ecological state to determine the Ecological Categories (ECs).
  - The Building Block Methodology was followed to set the ECs.
  - EWRs were set for a range of ecological states or categories at each of the 18 chosen sites.

Ecological Changes Since Previous EWR Determinations

- Eco-Classification was re-evaluated.
- The main objective was to check how the EWRs were affected.
- The EWRs (i.e. the flow pattern associated with an ecological category at a specific site) were not determined again and are still the same as determined in the 1999 study.

Implications

- Not many changes in PES or REC from the 1999 study to 2010.
- Description of the changes

Key
- Negative Change
+ Positive Change
= No Change

EWR Site	1999 PES	2010 PES		1999 REC	2010 REC	Change	EWR Rule
1	D	D		C	D	-	D
3	D	D		C	D	-	D
4	B	C		B	B	-	B
5	C	C		C	C	=	C
6	E	C/D		D	C/D	+	C
8	E	C/D		D	C/D	=	D
9	D	C/D		D	C/D	=	D
12	B	B/C		B	B	=	B
13	C	C		C	C	=	C
15	C	C		B	B	=	C
16/17	C	C		C	B	=	B

Further Investigations into the Ecological Reserve

Scenario	Impact on yield (million m3/a)
Original Reserve	183
Revised EMC	221
Remove floods	124
Remove floods and accept PES	83
Optimised Reserve	In progress

Water Quality

Dr Martin Van Veelen

Actual Water Quality vs Water Quality Objectives

- Localised water quality problems are experienced in the catchment
- Previous studies have found the following problems:
  - Defunct mines discharging acid mine drainage water
  - Overloaded WWTW (nutrients)
  - Irrigation return flows (salinity)
- The Middelburg Dam (station B1H004) is under pressure as reflected by the pH, levels of ammonia as well as nitrite / nitrate levels

Actual Water Quality vs Water Quality Objectives *(continued)*

- The phosphates are slightly high throughout the study area, but within acceptable range
- The EC values are also slightly high, but within acceptable and tolerable ranges
- Most of the dams in the Olifants River System are oligotrophic, except for the Bronkhorstspruit Dam, which is in a hypertrophic state.

Actual Water Quality vs Water Quality Objectives *(continued)*

Future Trends:

- Although the chlorides are generally within the ideal range, trend analysis shows that they are on an upward trend
- The trends analysis also shows EC as being in an upward trend for most of the stations.
- The Olifants River and the Loskop Dam are fast approaching eutrophic state.

Actual Water Quality vs Water Quality Objectives *(continued)*

Summary of Findings:

- The water quality problems in the catchment have to do with contamination from point sources that need to be addressed.
- Treatment of AMD is essential to maintain water quality in the Loskop Dam catchment
- The water quality problems won't affect the availability of water for the purposes of the reconciliation study.

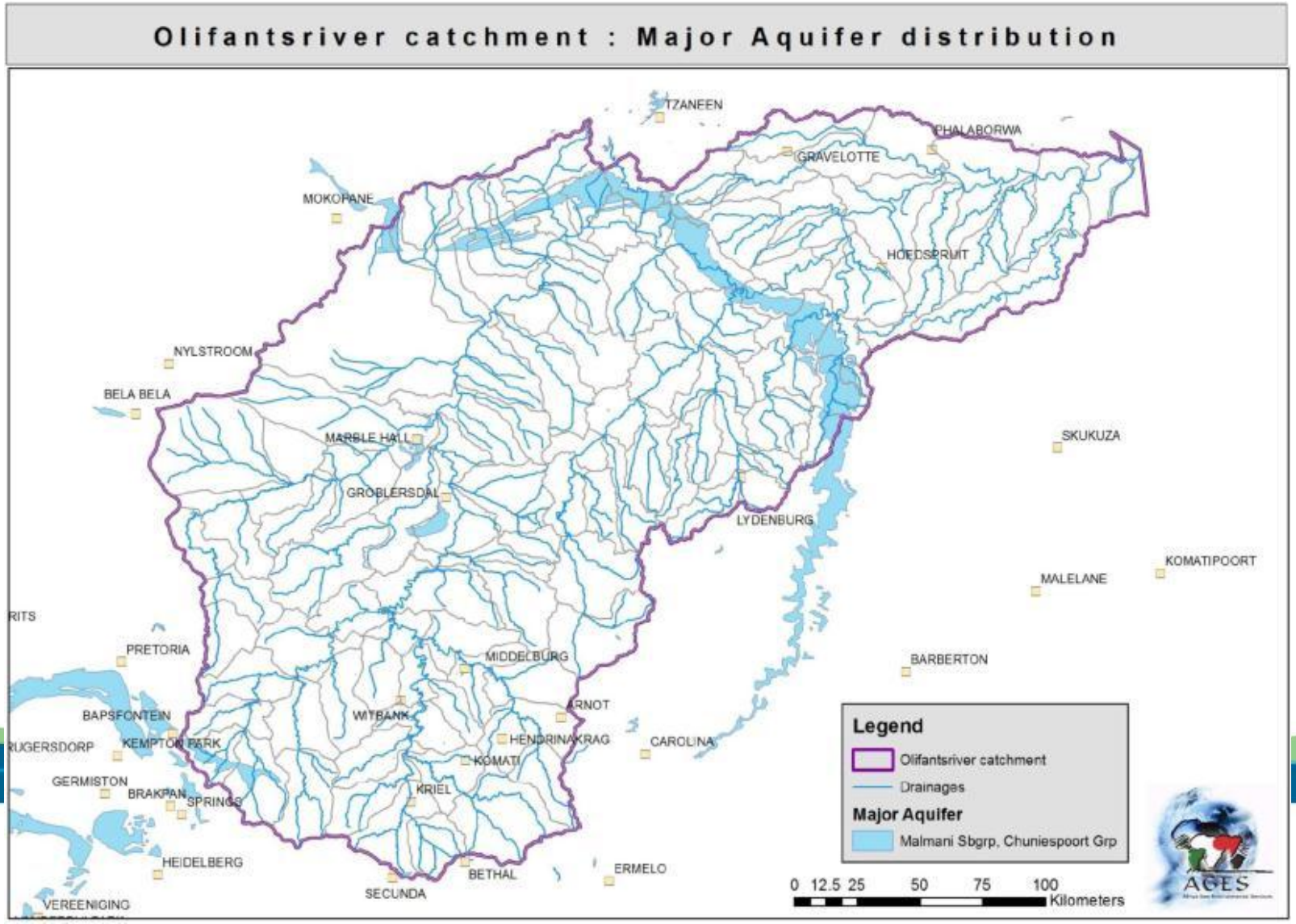
Groundwater

Dr Mannie Levin

Groundwater Availability

Aquifer Type	Potential Yield	Approximate km^2 area of Olifants Catchment	Approximate area % of Olifants Catchment
Intergranular (sand and alluvium)	> 0.5 ℓ/s	< 260	<0.5
Intergranular and Fractured (weathered and hard rock)	0.5–2 ℓ/s	51765	96
Fractured and Karst (dolomite)	> 5 ℓ/s	1825	3.5

Groundwater Availability: Olifants WMA Dolomitic Distribution



Groundwater Availability: Olifants River Groundwater Balance

- Estimated Recharge 860 million m^3 / a
- Estimate Evaporation Losses 500 million m^3 / a
- Community Water Supply 93 million m^3 / a
- Irrigation 72 million m^3 / a
- Estimate EWR 125 million m^3 / a

- POTENTIALLY AVAILABLE 70 million m^3 / a

Groundwater Options

- Management and Control of Overexploited Resources
- Use of groundwater from decommissioned coal mines
- Development of Under-exploited Resources
- Conjunctive Groundwater Surface water use
- Surface water Recharge

The use of coal mine water decant as a possible source of water

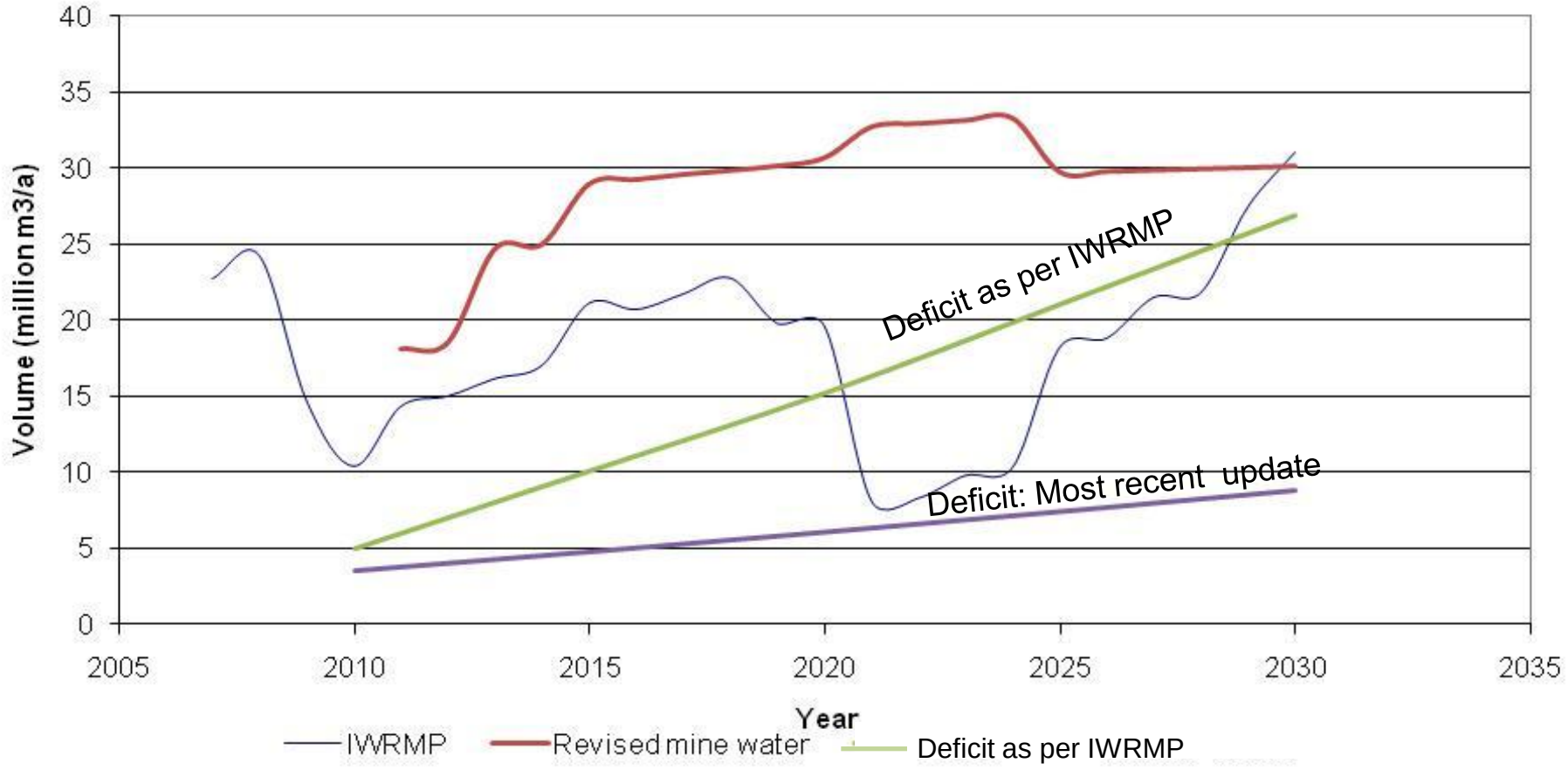
Background

- 25 Ml/day of coal mine decant water is already being treated to potable standard and supplied to eMalahleni.
- Another plant of 15 Ml/day is being planned to treat the water from the Middelburg North Mine.
- The eMalahleni plant is to be expanded by 25 Ml/day.
- Additional yield of the existing eMalahleni plant estimated to be $\pm$ 4 million m^3/a

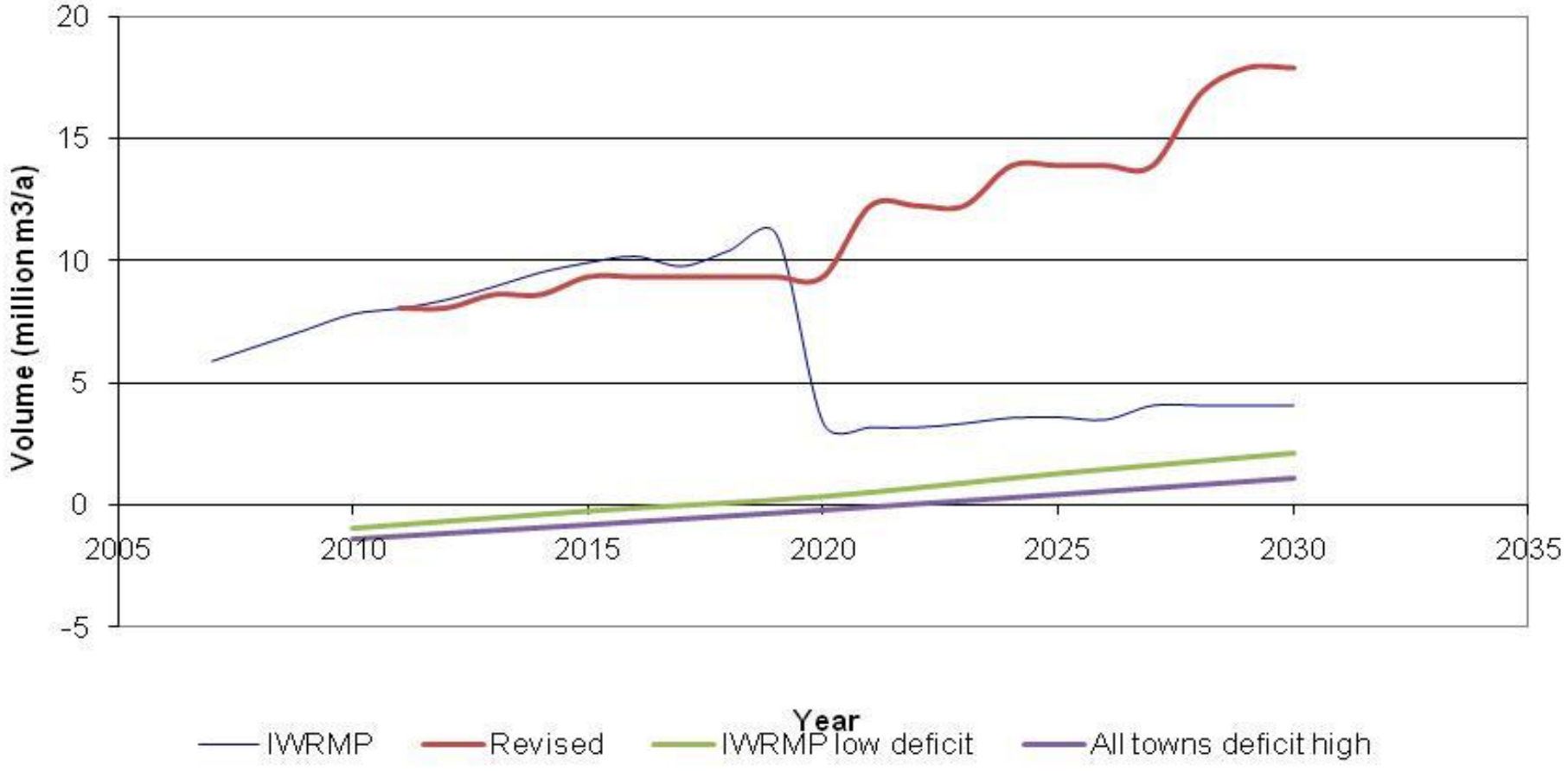
Future decants

- In the near future, water from other coal mines will start to decant
- This additional decant can be harnessed as utilisable yield (according to Golder Associates).
- These are significant quantities of water (up to 45 million m^3/a in 2035)
- The platinum mines in the north have suggested that this additional yield be considered as a source for the expansion of their operations.
- In the IWRMP this additional water was earmarked for eMalahleni.

Excess Mine Water – Witbank Dam Catchment



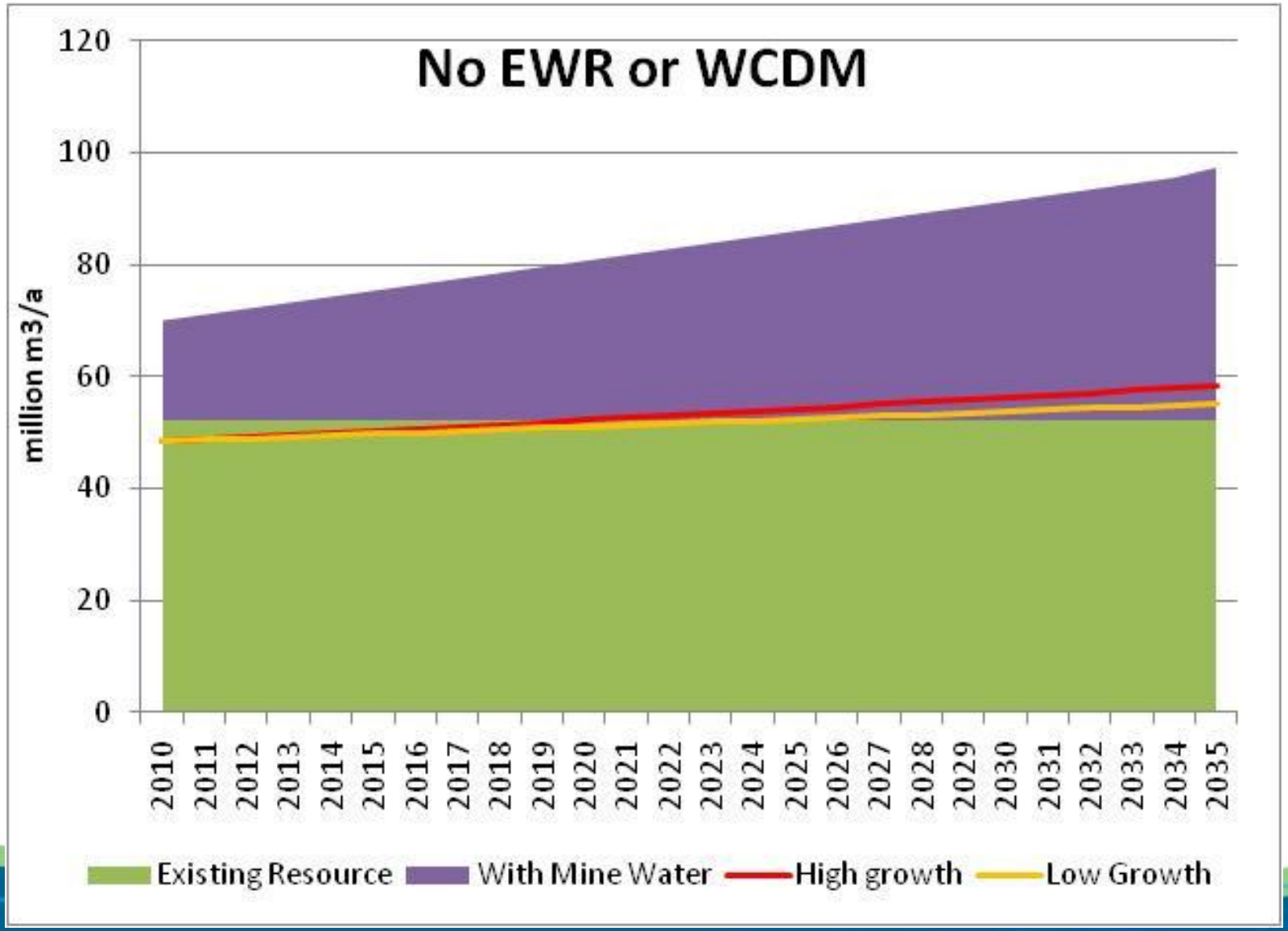
Excess Mine Water – Middelburg Dam Catchment



eMalahleni Future Demands

- The All Towns study indicates much lower growth rates than the IWRMP (2008).
- The All Towns study's growth is based on population projections provided by Stats SA.
- There are unacceptably high losses in the eMalahleni area. An estimated 50% of the water treated for municipal use is unaccounted for.

Reconciliation of the eMalahleni Area



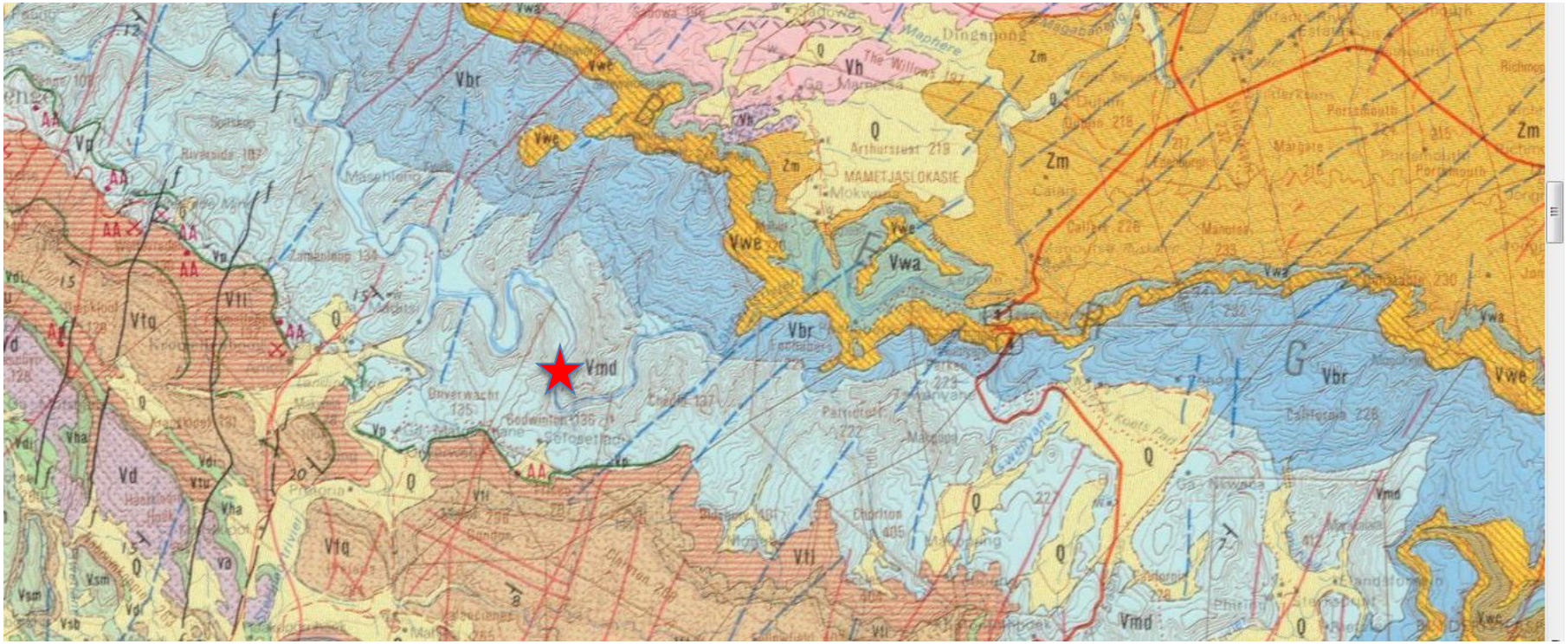
Conclusion on Decanting Mine Water

- Depending on how the upper reaches of the Olifants River are managed, there could be between 25 and 40 million m^3/a additional yield available by 2035.
- There are numerous uncertainties to these estimates that will require detailed analysis.
  - Growth in eMalahleni (widely different estimates from one study to the next).
  - Detailed groundwater modelling required to confirm the future decant.

Development of Underexploited Groundwater Resources

- Dolomite Escarpment Aquifer
- Possible Recharge of Dolomite Aquifer at Godwinton

Godwinton Weir Recharge

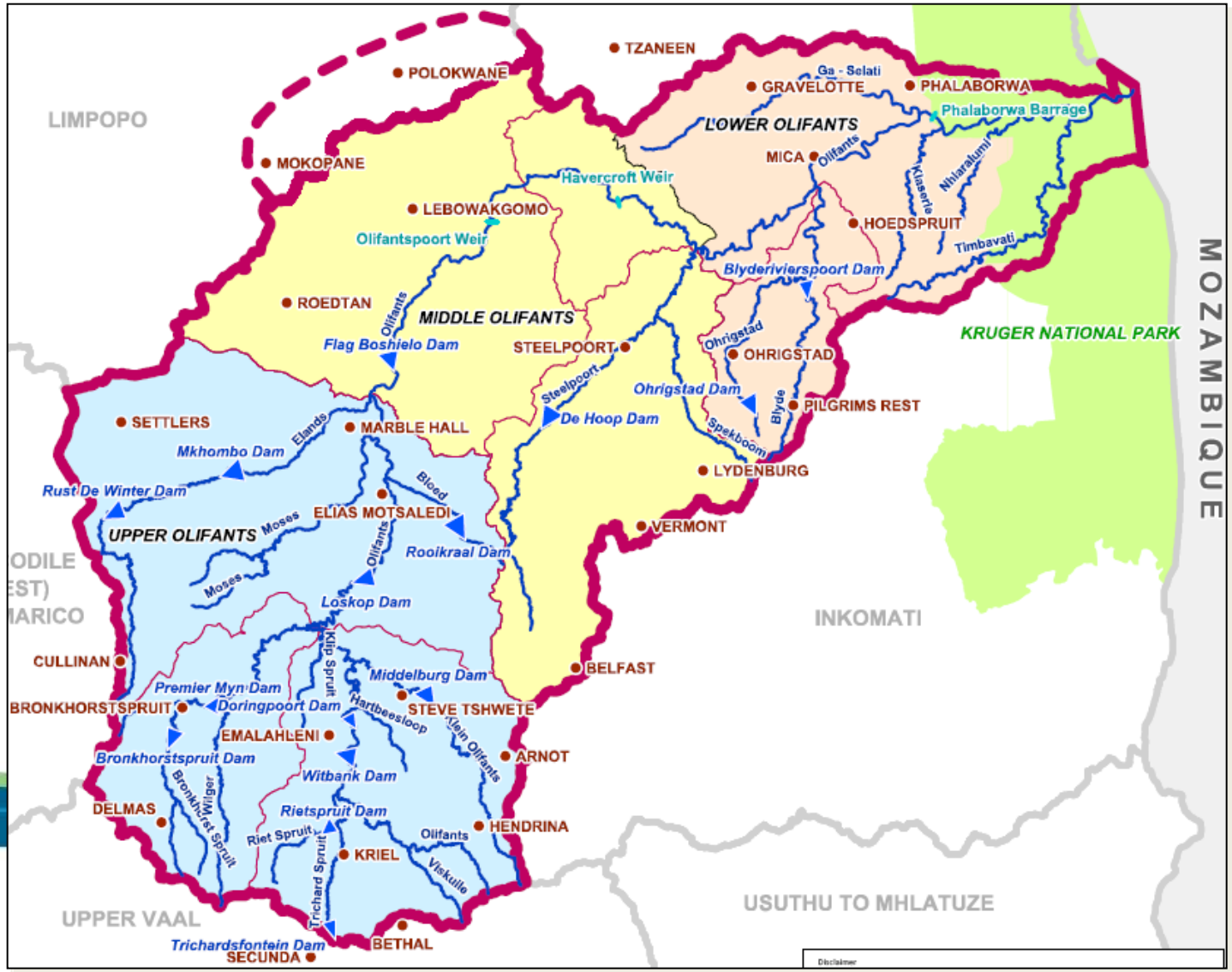


Faults at Godwinton

Surface Water

Mr Stephen Mallory

Surface Water Availability: The Three Water Management Zones



Summary Available Yield (As per Prelim Strategy)

Management Zone	Yield from Major Dams (1 in 50 y) million m^3/a	Yield from Farm Dams and Diffuse Sources million m^3/a	Transfers In million m^3/a	Total million m^3/a
Upper Olifants	262	128	228	**618**
Middle Olifants	56	71	1	**128**
Lower Olifants	150	49	3	**202**
Total	**468**	**248**	**232**	**948**

Excluding the additional yield of De Hoop Dam

Summary Available Yield (As recently updated)

Management Zone	Yield from Major Dams (1 in 50 y) million m^3/a	Yield from Farm Dams and Diffuse Sources million m^3/a	Transfers In million m^3/a	Other Sources million m^3/a	Total million m^3/a
Upper Olifants	272	116	230	4	**622**
Middle Olifants	87	44	0	0	**131**
Lower Olifants	199	43	3	0	**245**
Total	**558**	**203**	**233**	**4**	**998**

Excluding the additional yield of De Hoop Dam

Latest Information on Yield of Phalaborwa Barage

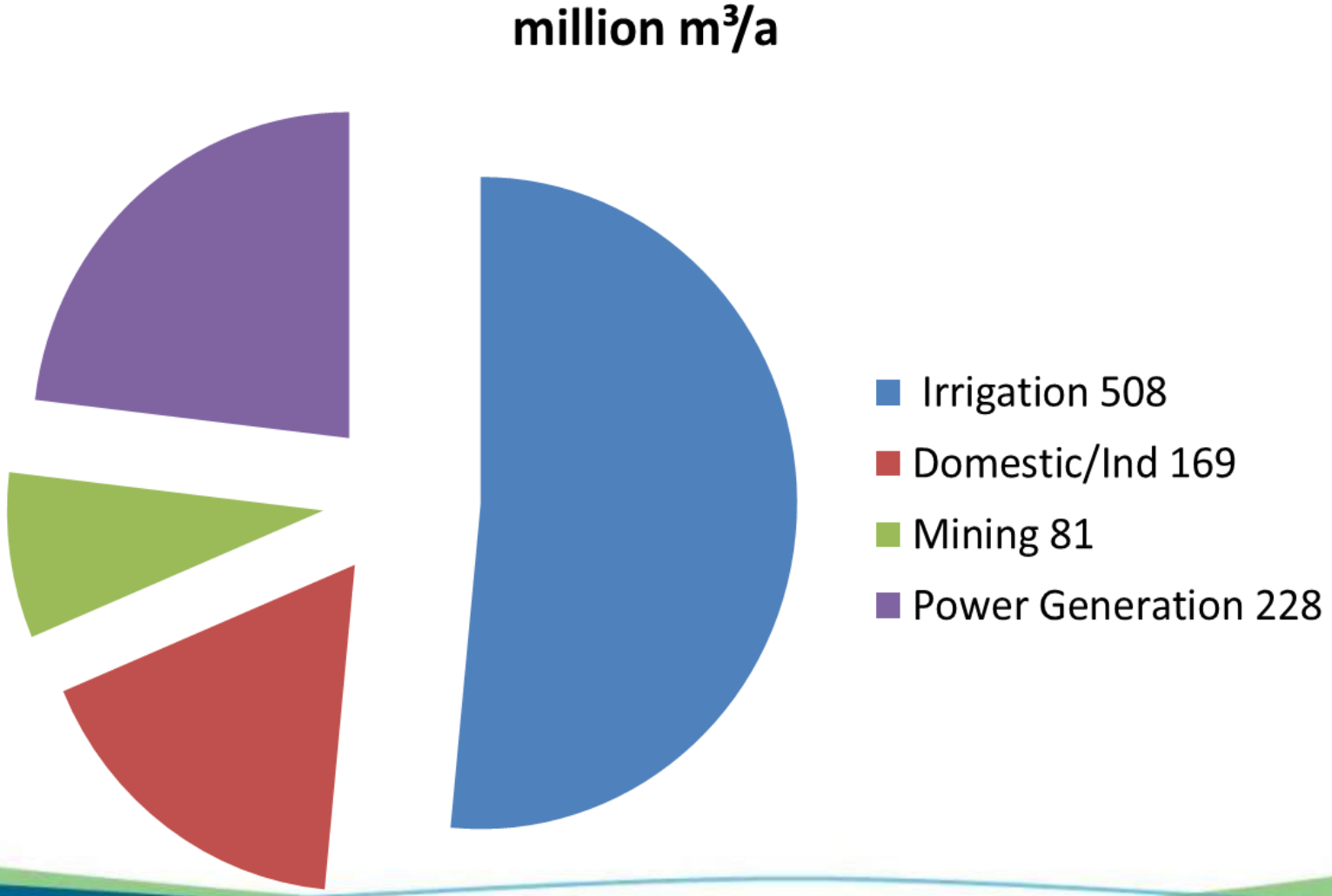
- The yield of the Palaborwa Barrage was not evaluated as part of the OWAAS study and therefore was not included in the Preliminary Strategy.
- Under present conditions, the yield at the Barrage is estimated as:
  - Historic yield: 42 million m^3/a
  - 1:50 year yield: 49 million m^3/a
- This assumes a minimum flow at the Mamba weir in the KNP.

Current Water Use

Mr Stephen Mallory

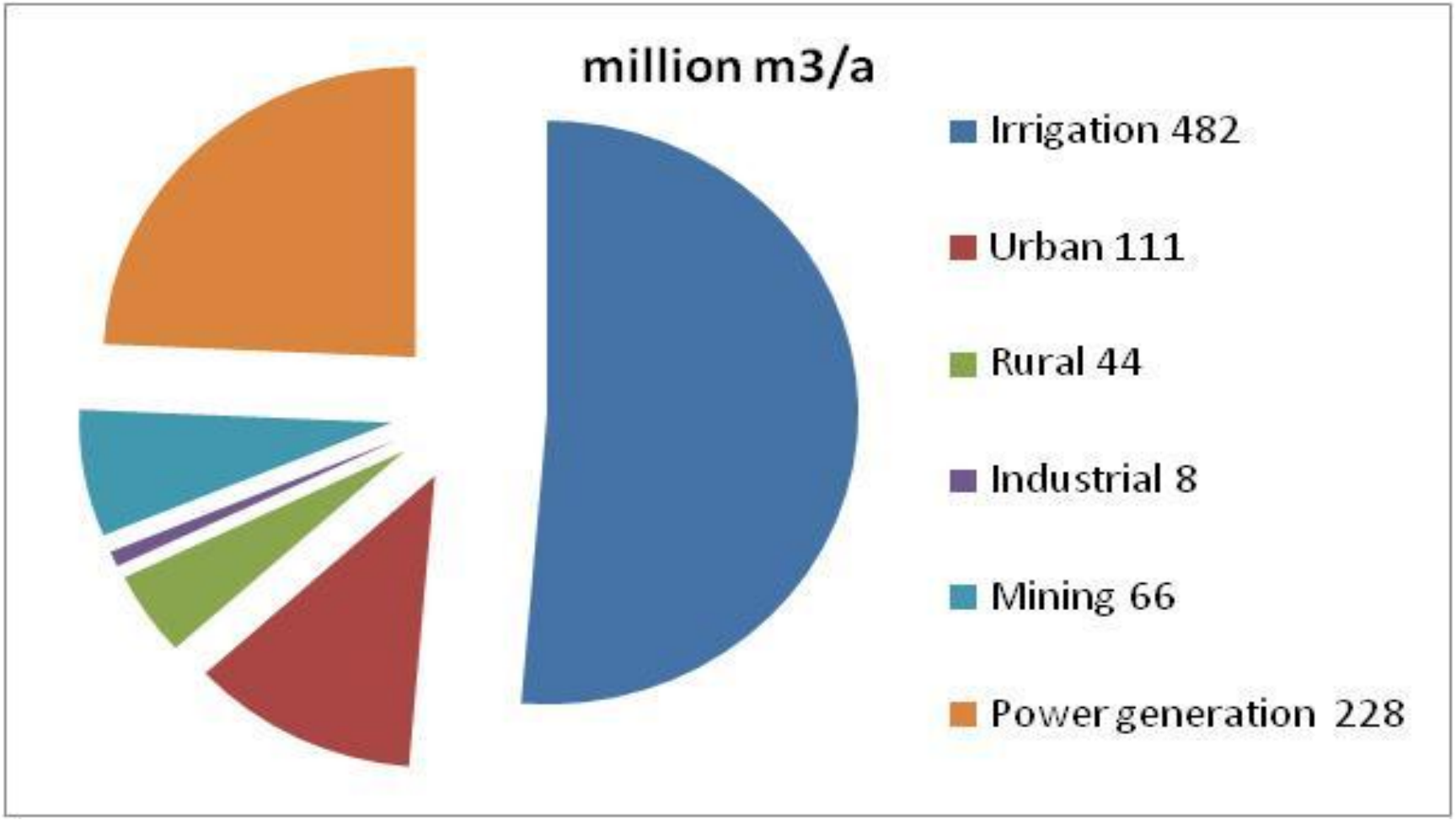
Current Water Use by Sector

As per Preliminary Strategy



Current Water Use by Sector

As Recently Updated



Current Water Use *(Continued)*

- Limited forestry water use – 31 million m^3/a
- Concern: Difference between the OWAAS and ARC surveys of areas of IAPs

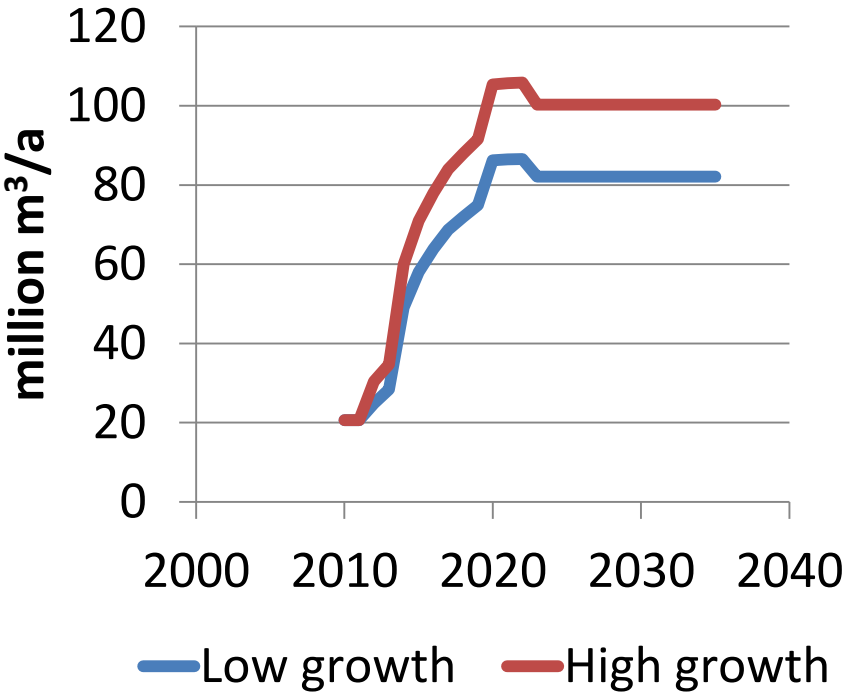
Management Zone	OWAAS (2010) km^2	ARC (2010) km^2
Upper Olifants	459	1540
Middle Olifants	929	651
Lower Olifants	529	485
Total	1917	2676

- Total estimated impact on yield of dams (ARC Report) – 31.4 million m^3/a
- If OWAAS area u/s of De Hoop Dam is accepted rather than ARC area, the total impact reduces to 21 million m^3/a

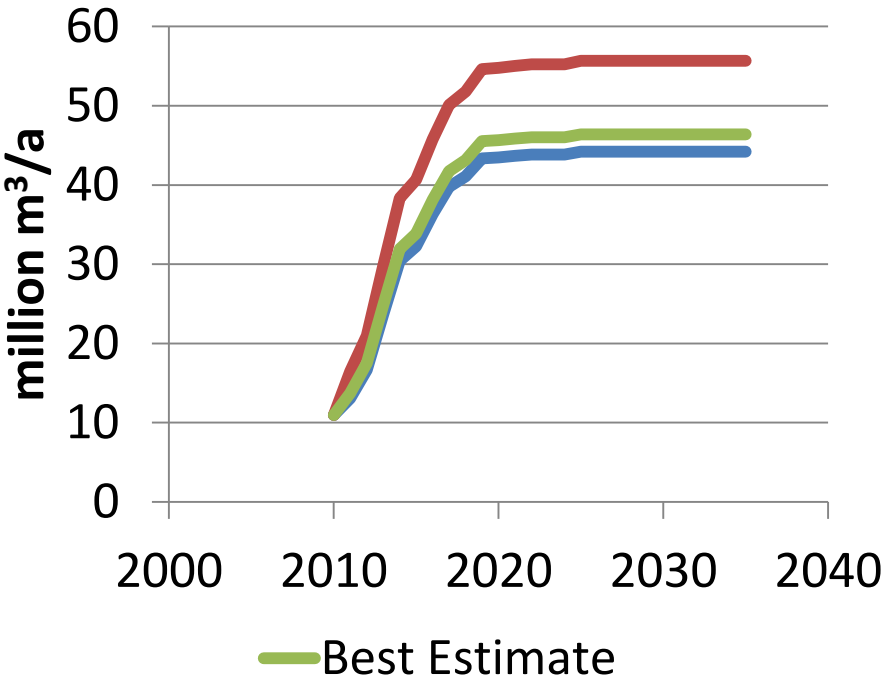
Future Water Use - Growth Projections

- The preliminary strategy was based on the growth projections from:
  - The Integrated Water Resources Management Plan (2008)
  - The Olifants Water Resources Development Project (2005)
- The mining sectors have provided updated growth projections.
- The demographic information from the All Towns recently became available and has been used to update the urban growth projections.

New Information on Mining Water Requirements

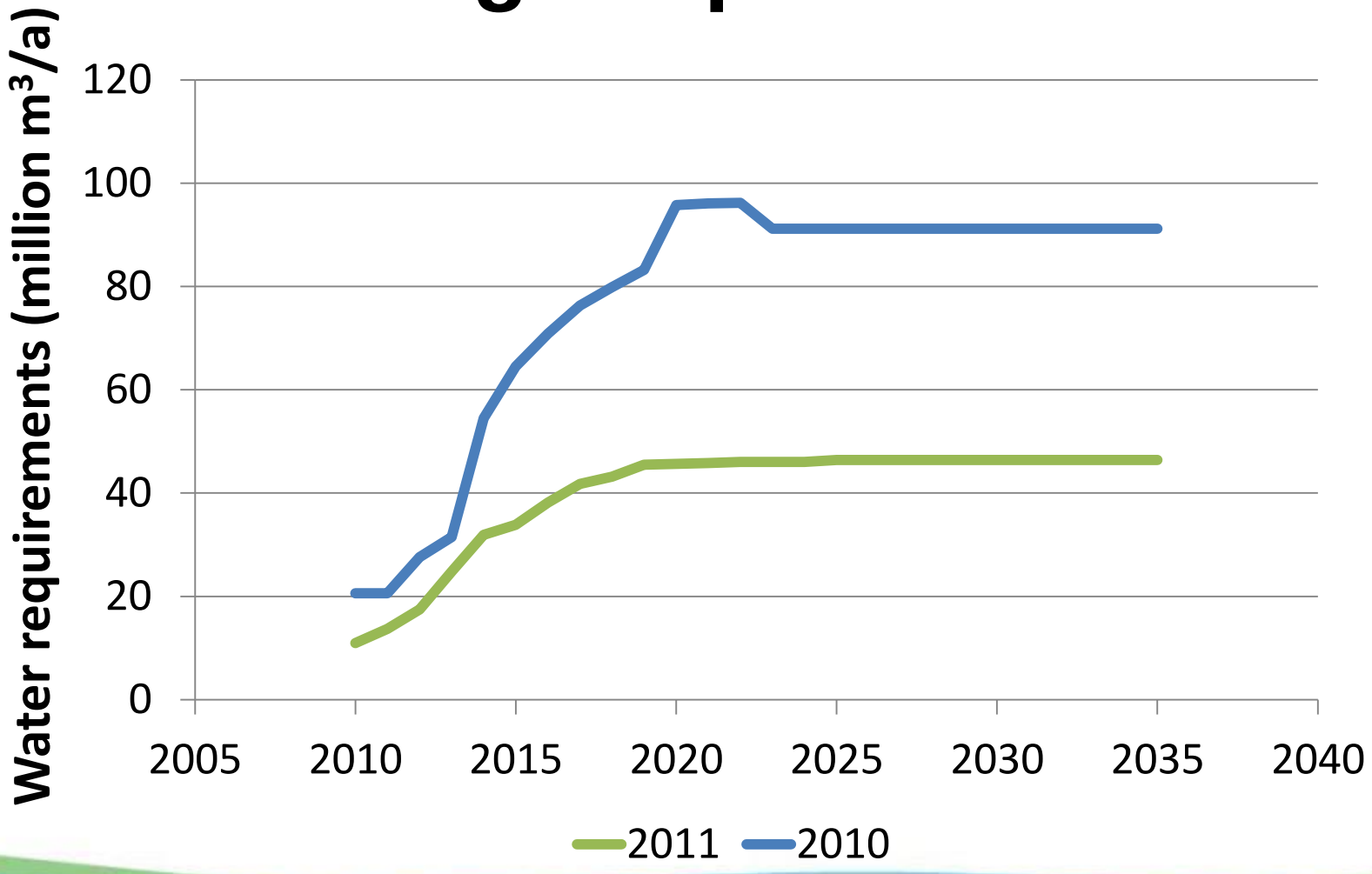


As Per Preliminary Recon Strategy



Latest Information

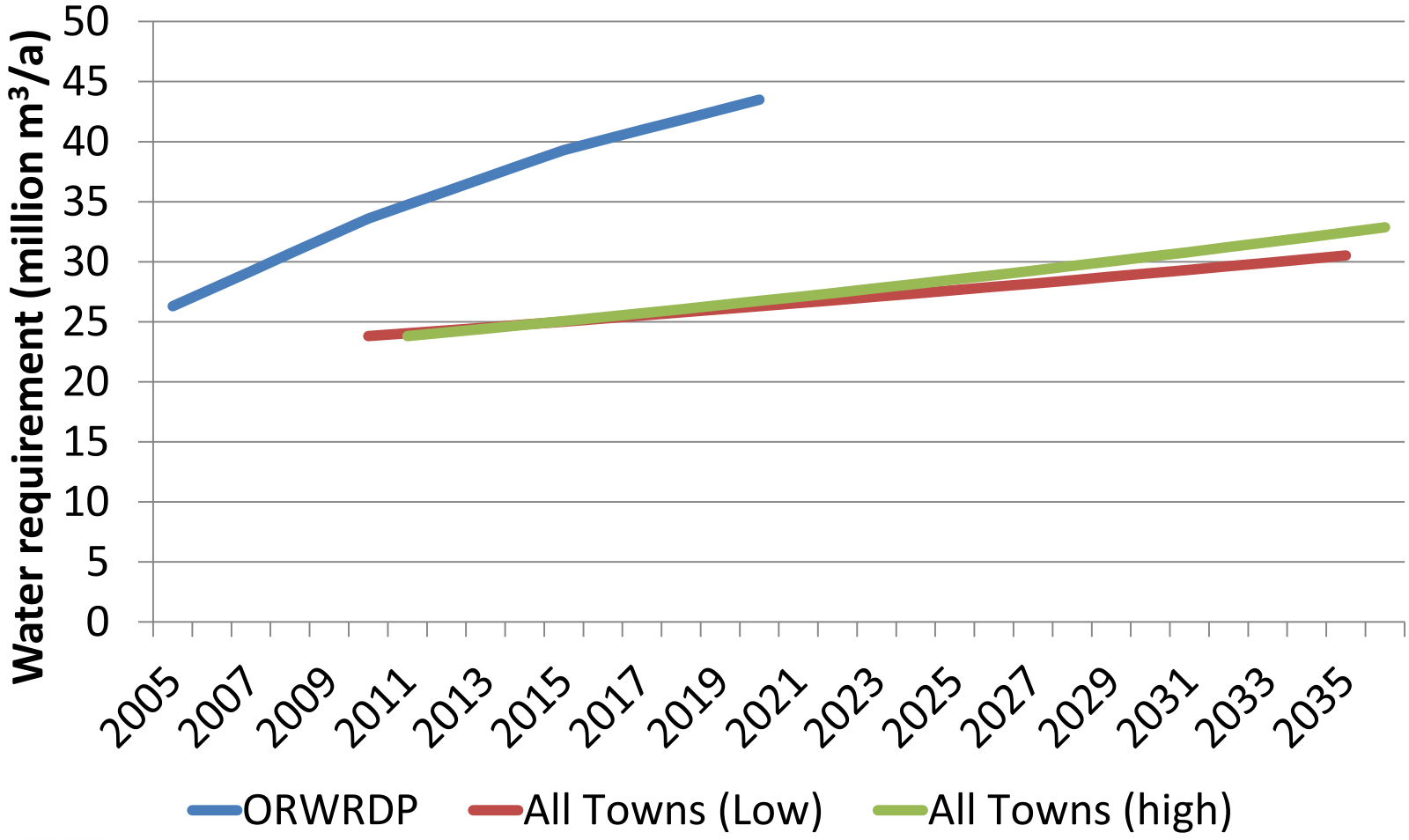
Comparison in Most Probable Mining Requirements



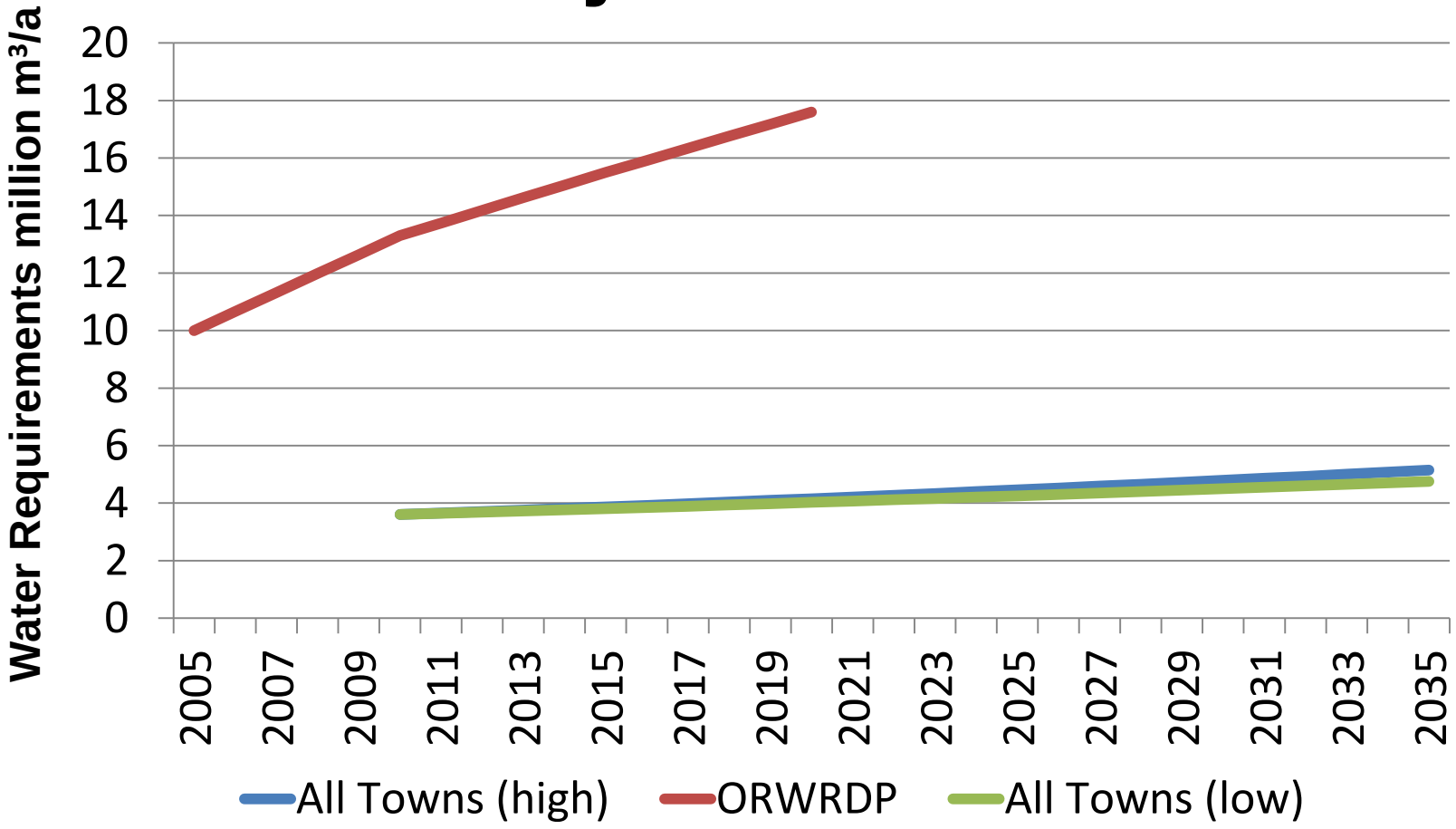
Urban water requirements

- Estimates in the preliminary strategy were based on the information from the All Towns study
- Polokwane and Mokopane urban water requirements were based on the ORWRDP.
- The All Towns study growth projections are generally low (less than the 2004 NWRS).
- The growth rates assumed in the ORWRDP were very high (up to 5%).
- The demographic projections carried out as part of the All Towns study have now been obtained and used to update the water balances.

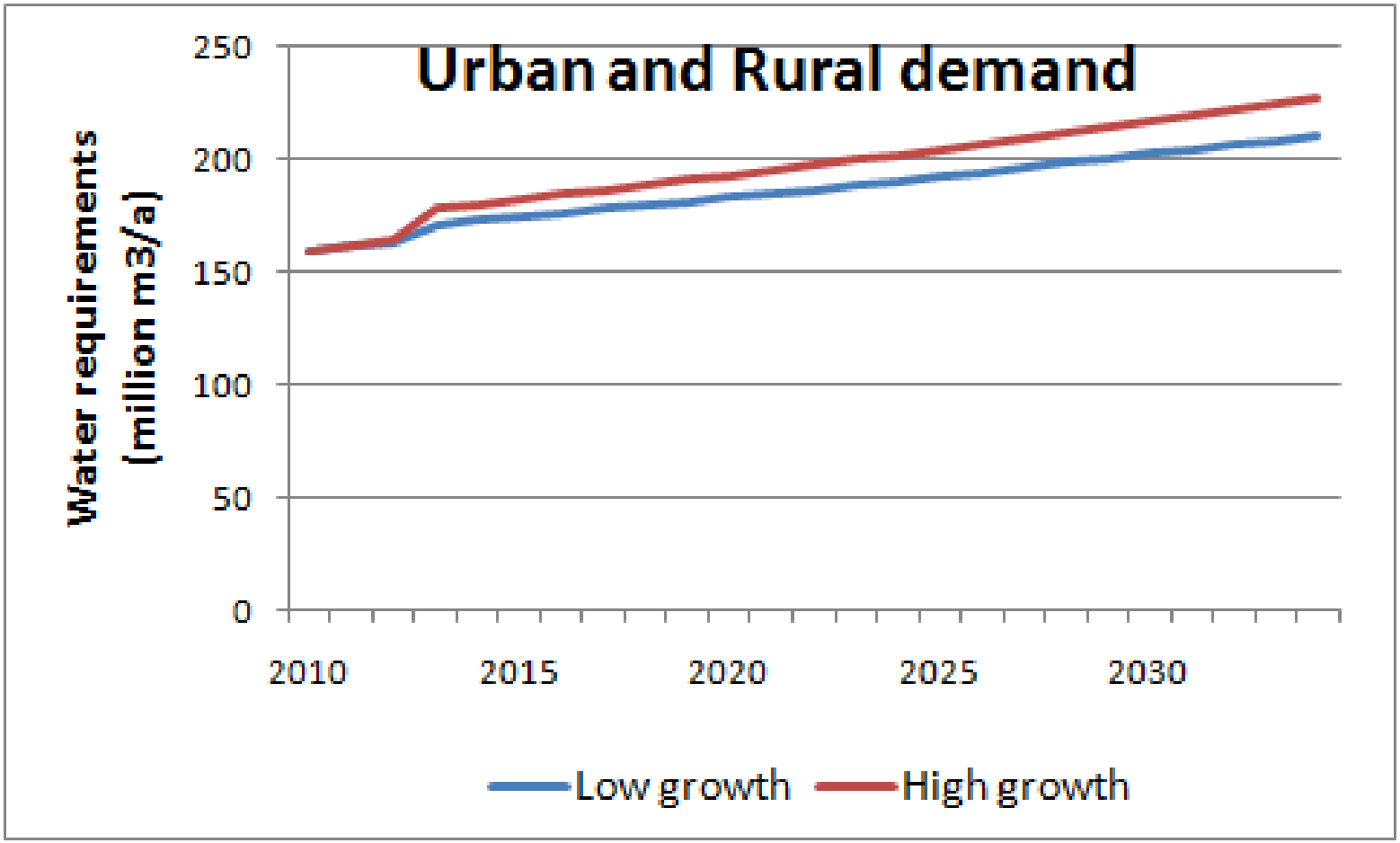
Polokwane's Water Requirement Projections



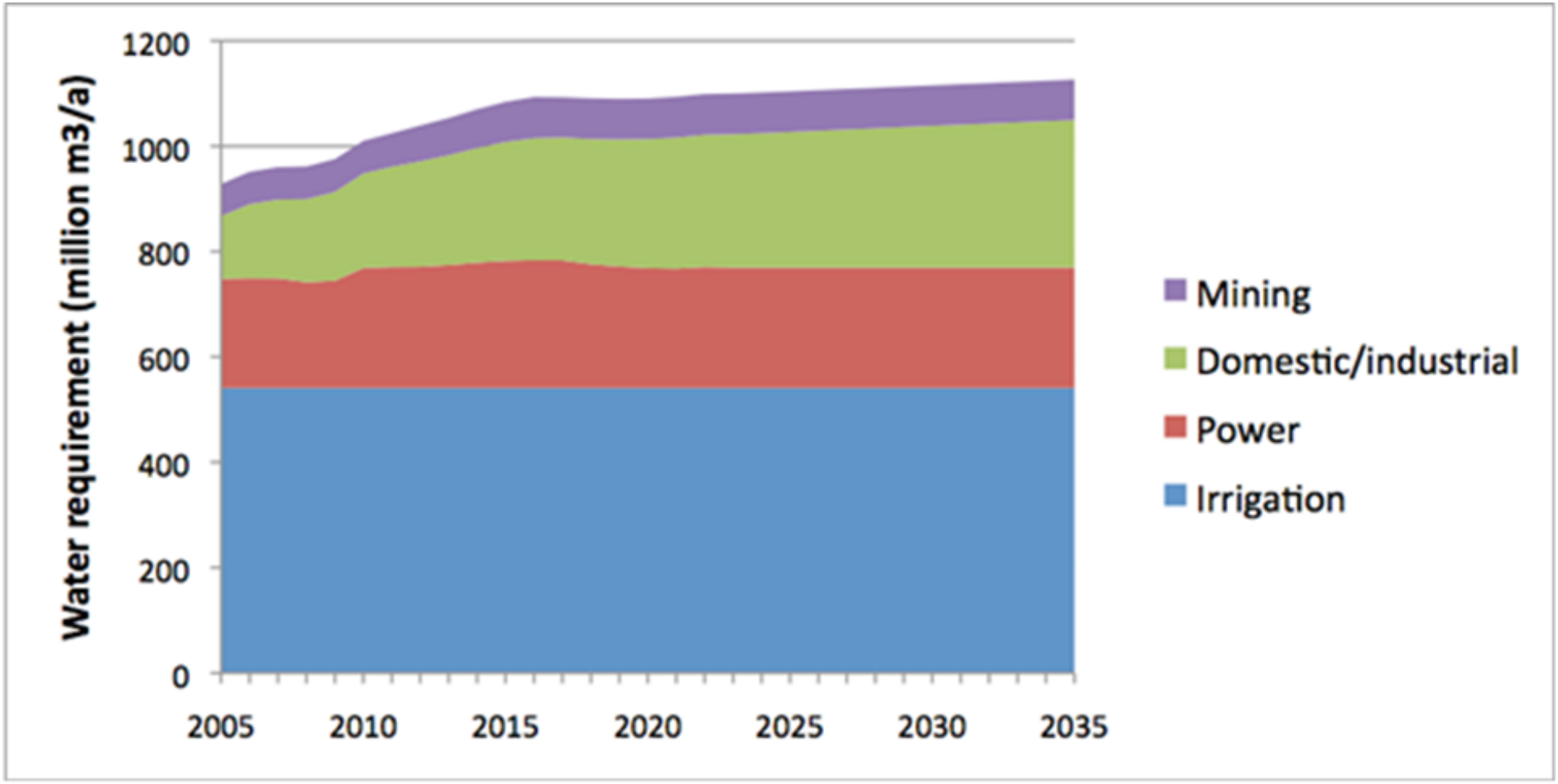
Mokopane's Water Requirement Projections



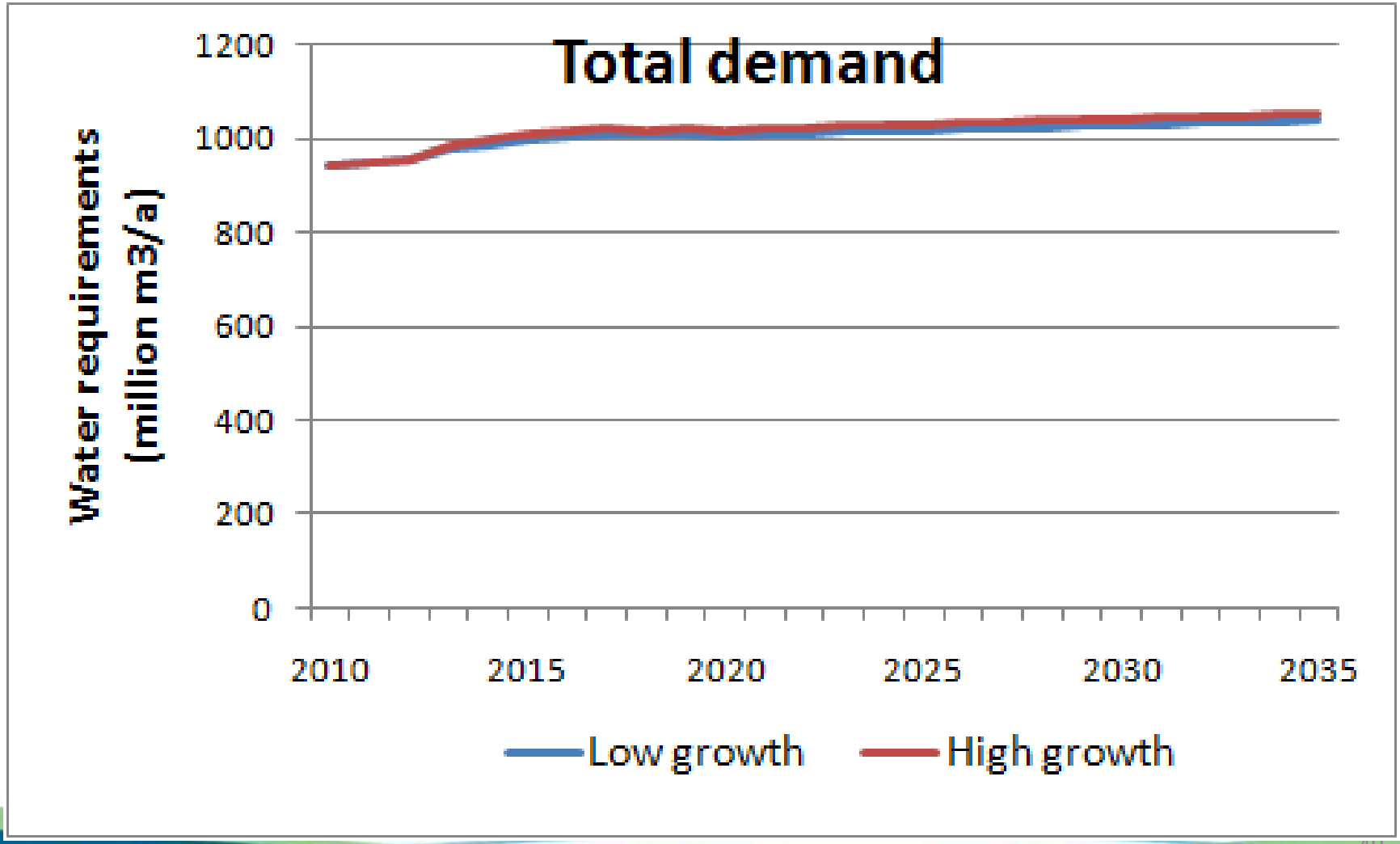
Total Urban and Rural Growth in Water Demand



High Growth Scenario as per Preliminary Reconciliation Strategy



Updated Total Growth in Water Demand (all sectors)



The Water Balance

Mr Stephen Mallory

Current Water Balance with No Interventions (2010 status quo)

As per Preliminary Strategy

Management Zone	Total Water Resource (million m³/a)	Water Requirement (million m³/a)	Minimum flow rule (million m³/a)	Water Balance (million m³/a)
Upper Olifants	618	612	0	6
Middle Olifants	128	156	0	(28)
Lower Olifants	202	218	18	(34)
Total	**948**	**986**	**18**	**(56)**

Excluding the additional yield of De Hoop Dam

Current Water Balance with No Interventions (2010 status quo)

As Recently Updated

Management Zone	Total Water Resource (million m³/a)	Water Require-ment (million m³/a)	Min flow rule (million m³/a)	Losses (million m³/a)	Water Balance (million m³/a)
Upper Olifants	622	609	0	0	13
Middle Olifants	131	118	19	0	(6)
Lower Olifants	245	212	0	5	28
Total	**998**	**939**	**19**	**5**	**35**

Excluding the additional yield of De Hoop Dam

Future Water Balance with No Interventions - As per Preliminary Strategy

2030 Water Balance in million m^3/a

Management Zone	Total Water Resource million m^3/a	Water Requirement million m^3/a	EWR million m^3/a	Water Balance million m^3/a
Upper Olifants	618	648	80	(110)
Middle Olifants	227	214	51	(38)
Lower Olifants	202	230	69	(97)
Total	**1 047**	**1 092**	**200**	**(245)**

Including the additional yield of De Hoop Dam

Future Water Balance with No Interventions - As per Preliminary Strategy

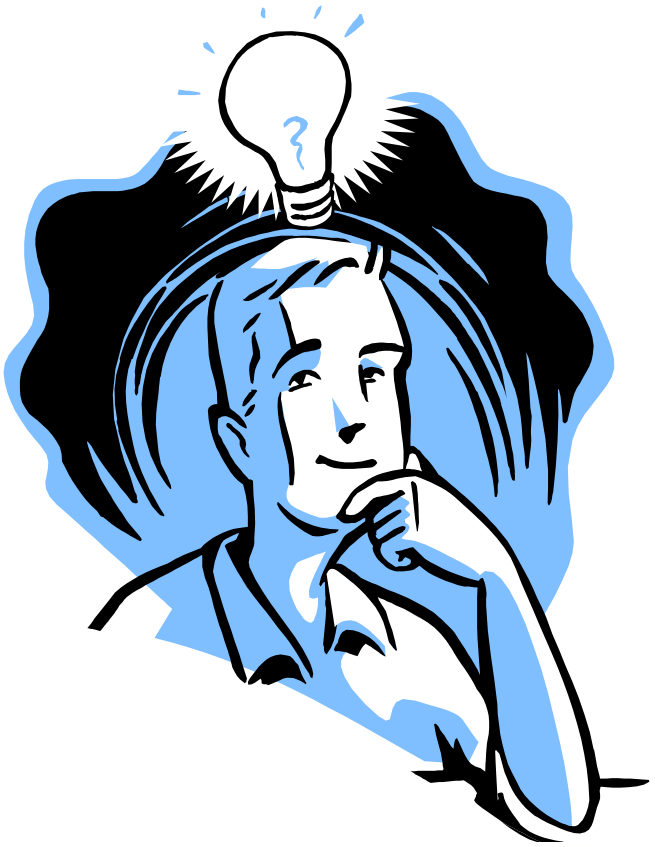
2030 Water Balance in million m^3/a

Management Zone	Total Water Resource million m^3/a	Water Requirement million m^3/a	EWR million m^3/a	Losses million m^3/a	Water Balance million m^3/a
Upper Olifants	634	624	40	0	(30)
Middle Olifants	230	200	32	0	(2)
Lower Olifants	245	226	60	5	(46)
Total	**1 109**	**1 050**	**132**	**5**	**(78)**

Including the additional yield of De Hoop Dam

Possible Reconciliation Options

Mr Johnny Beumer



Assumptions for Water Reconciliation

Assumption 1:
Reserve: Ecological status of the Olifants catchment needs to be maintained.

Assumption 2:
The EWRs must be met as soon as practical (Phased in over 8 years)

Assumption 3:
Water for strategic use for the benefit of the country (e.g. water supply to power stations) must receive priority above any other economic development

Assumptions for Water Reconciliation

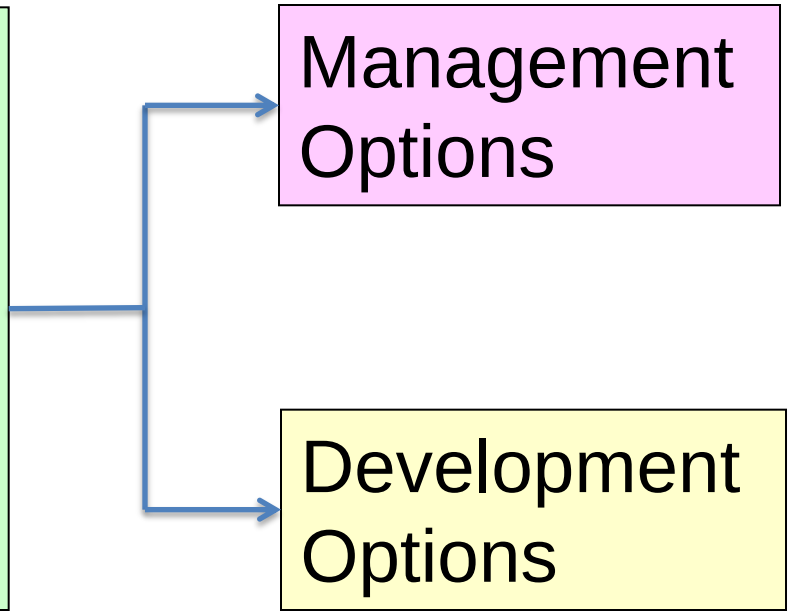
Assumption 4:
No further increase in total water allocation for irrigation
Assumption 5:
Water for economic growth within the policy parameters of the government will be provided

Basic Principles for Water Reconciliation

- Recognise South Africa's International Obligations in terms of the SADC Revised Protocol on Shared Water Courses (fair and equitable sharing of the water resource between South Africa and Mozambique)
- Ensure that water is used efficiently
- Eliminate all unlawful water use

Possible Intervention Options

- Options That Will Reduce Water Requirements
- Options That Will Increase the Water Supply



Options That Will Reduce Water Requirements

- Eliminating Unlawful Water Use
- Water Conservation and Demand Management
- Reducing Assurances of Supply
- Compulsory Licensing
- Compulsory Levy and Purchasing Water Entitlements
- Water Trading

Options That Can Increase Water Supply

- Groundwater Development
- Transferring Treated Effluent from the East Rand
- Transferring More Water From Vaal Dam
- Raising of the Blyderivierspoort Dam
- Possible New Dams at Rooipoort, in the Olifants River Gorge and in the Lower Olifants River
- Utilising Acid Mine Drainage in the Upper Olifants
- System Operating Rules

Options That Can Increase Water Supply (Continued)

- Rainfall Enhancement
- Rainwater Harvesting
- Removal of Invasive Alien Plants
- Water Transfer from the Crocodile (West) River System
- Artificial recharge of dolomite aquifer with surface water

Options Screened for Scenario Modeling

Possible Savings through Management Options

Option	Starting Year	Duration (Years)	% Saving Supply increase	Estimated Saving / Yield million m^3/a
WCDM Irrigation	2011	5	10%	28
WCDM Urban	2011	5	15%	25
WCDM Mining	2015	5	10%	8
Compulsory Licensing Irrigation	2015	4	See WCDM (10%)	See WCDM (28)
Operating Rules	2011	2	5%	47
Unlawful Water Use	2012	4	5%	25
Removal of IAPs	2011	8		15
			Total saving / yield	133

Unlawful Water Use

- No new water use licences have been issued to the irrigation sectors for many years
- Yet, according to the Verification and Validation study (DWAF, 2006), the irrigated area has increased since 1996 by approximately 300 km^2.

Growth in Irrigation Use according to recent OWAAS study

Dam	Irrigated area (km2)	
	1998	2004
Bronkhorstspruit	42.6	75.5
Middelburg	34.1	45.7
Witbank	41.7	55.6
Loskop	1.6	3.0
Flag Boshielo	177.7	192.2
De Hoop	13.7	22.8
B41&B42 (remainder)	52.1	53.4
Blyderivier	74.3	75.1
Palaborwa Barrage (B50&B70)	50.6	70.0
Total	**488.4**	**593.3**

Yield Analysis to Determine the Impact of Unlawful Water Use

- A yield analysis was carried out to determine the increase in yield assuming the removal of unlawful use.
- Increased areas within irrigation boards were assumed to be lawful if the total area (within the irrigation board) is within the allocated area.

Dam	Yield (million m^3/a)		
	Yield	Yield as result of reduced irrigation	Increase in yield
Bronkhorstspruit	11.0	18.3	7.3
Middelburg	5.8	7.9	2.1
Witbank	23.0	24.0	1.0
Loskop	110	113	3.0
Rust de Winter	9.8	9.8	0.0
Mkombo	3.2	3.2	0.0
Flag Boshielo	27.8	27.8	0.0
De Hoop	65	69	4.0
Belfast	5.7	5.7	0.0
Der Bruchen	8.3	8.3	0.0
Buffelskloof	14.7	14.7	0.0
Lydenburg	2.5	2.5	0.0
Blyderivier	60.0	60.0	0.0
Origstad	18.9	18.9	0.0
Palaborwa Barrage	34.7	34.7	0.0
Total	**400.4**	**417.8**	**17.4**

Further Considerations for Unlawful Water Use

- Much of the area upstream of Flag Boshielo falls within a Government Water Control Area (In terms of the old Water Act).
- I.t.o proclamation published in Government Gazette 4018 (Sept 1973), each property with this GWCA was limited to 20ha of irrigation.
- If this proclamation still holds under the NWA of 1998, then much of the irrigation upstream of Loskop Dam could be deemed to be unlawful.

Further Considerations for Unlawful Water Use (Continued)

- Quantifying the unlawful area will however be a complicated and time consuming task due to the large number of sub-divisions since 1973.
- It is recommended that this be undertaken as part of the ongoing verfication of water use in the Olifants WMA.

Further Work on Water Conservation and Demand Management

- Sources of information
  - All Towns study
  - Interviews
  - Business plans (Lepelle North)
  - DWA studies by D: Water Use Efficiency
    - Emahlaleni
    - Lebowakgoma
    - Irrigation sector
    - Eskom

Conclusions On WCDM

- Large scope for water use savings in the urban and rural sectors, notably:
  - Emalahleni (50% Unaccounted for)
  - Western Highveld (50% Unaccounted for)
  - Lebowakgomo (45% Unaccounted for)
- Some scope for savings in the irrigation sectors, but a strategy is needed to harness the savings for other use.
- Scope for savings in the power generation sector, but these savings will be very costly.

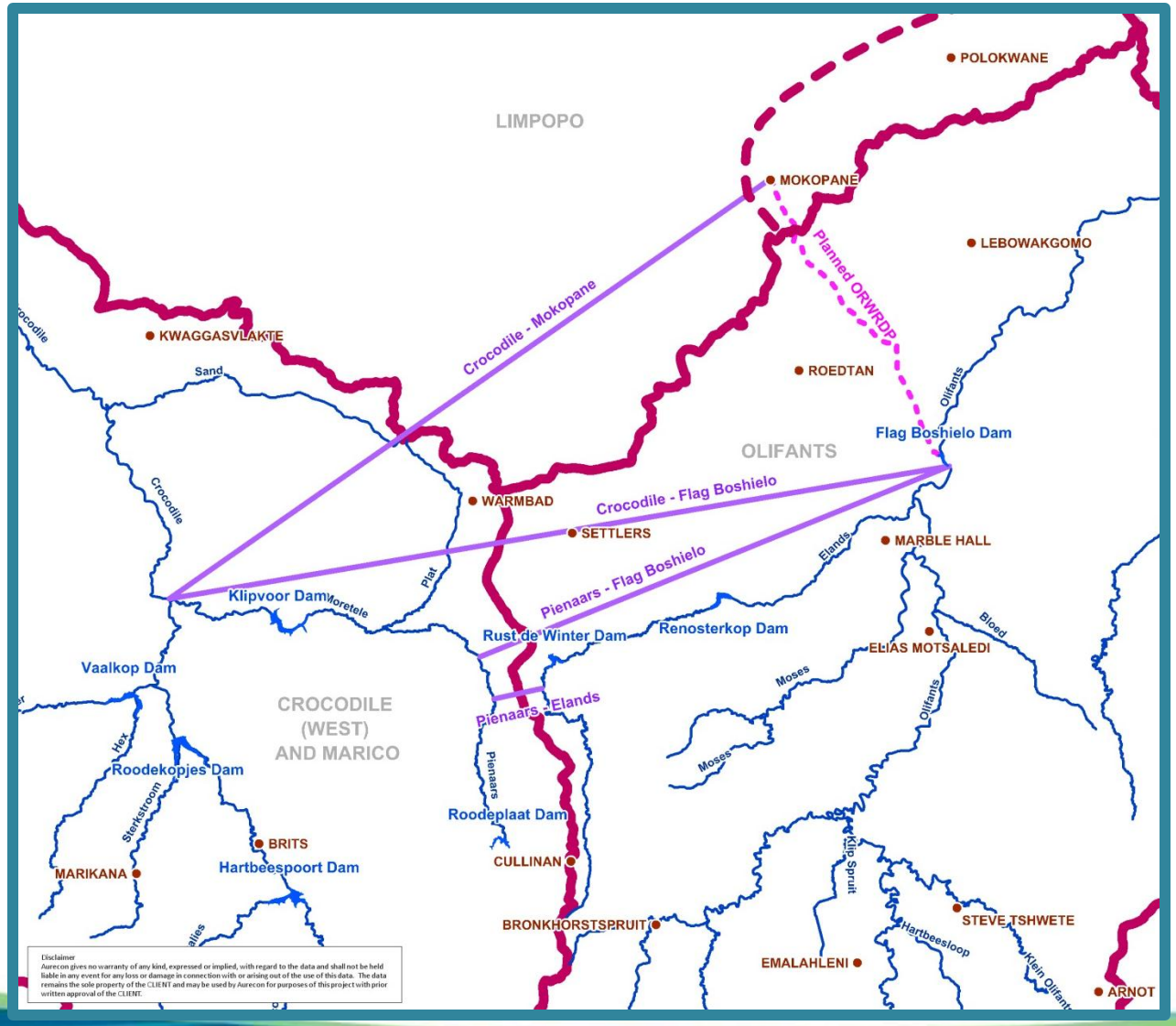
Achievable Savings With WCDM

Sector	Current Water Requirements 10^6 m^3/a	Estimated Savings 10^6 m^3/a	Comments
Urban	105.4	19.8	Achievable
Rural	40.3	8.2	Problematic
Irrigation	508		
- Improved irrigation systems		34	Requires willing buyer/seller
- Improved conveyances		16	Very costly
Power generation	228	27.3	Very costly
Mining	73.5	7	
Industrial	8.4	~0	
Total	**963**	**112**	

Water Available from Crocodile (West) River Dams ($x10^6 m^3/a$)

Dam	2015	2020	2030
Roodeplaat dam	26,5	36,0	33,0
Hartebeespoort dam	24,0	29,0	58,5
Klipvoor Dam	0	4,7	17,0
Source: BKS, Support to the Mokolo-Crocodile WAP Team (Draft)			

Croc (W) Transfer - Layout Plan



Cost of Crocodile (W) Transfer Options

Transfer Option	Supply ($x10^6 m^3$)	Cost (R x $x10^6$)	URV (R/m^3)
Pienaars - Elands	30/15	213	1,57
Pienaars – Flag boshielo dam	30	1 268	3,82
Crocodile – Flag boshielo	60	3 926	6,43
Crocodile - Mokopane	40	2 877	7,51

Options That Can Bring Short-Term Relief

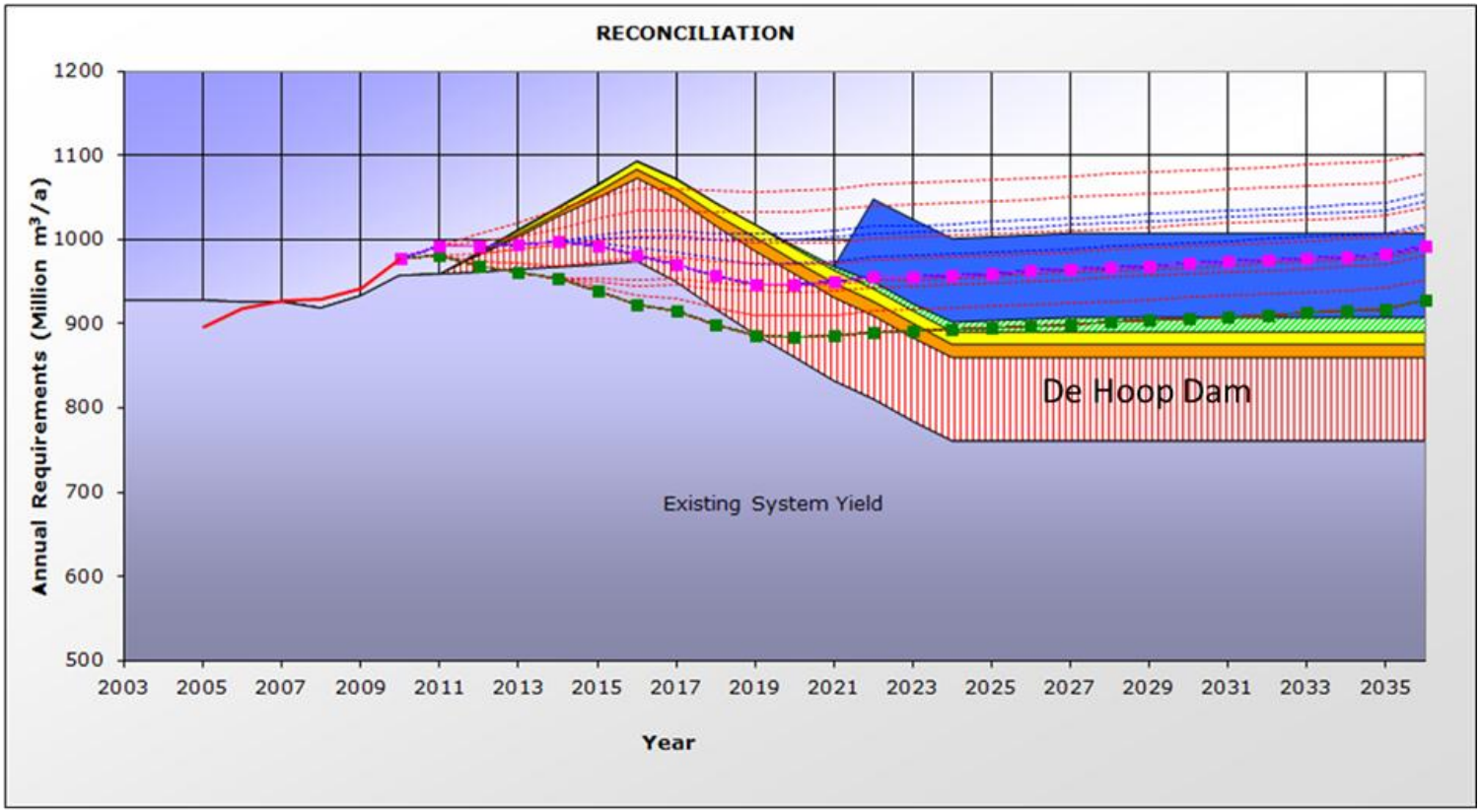
- Eliminating Unlawful Water Use
- Integrated System Operating Rules
- WCDM for the Domestic / Industrial Sector
- Groundwater Development
- Rainwater Harvesting
- Water Trading
- Removing Invasive Alien Plants

Reconciliation Scenarios

Scenario1:

- The high water requirements projection.
- The screened management options implemented
- The full Reserve phased in over a period of 8 years
- Groundwater development options phased in over the next 16 years.
- De Hoop Dam commissioned in 2012.
- Godwinton Dam commissioned in 2020 (yield 100 million m^3).

Scenario 1: Management interventions plus Godwinton Dam



Legend:

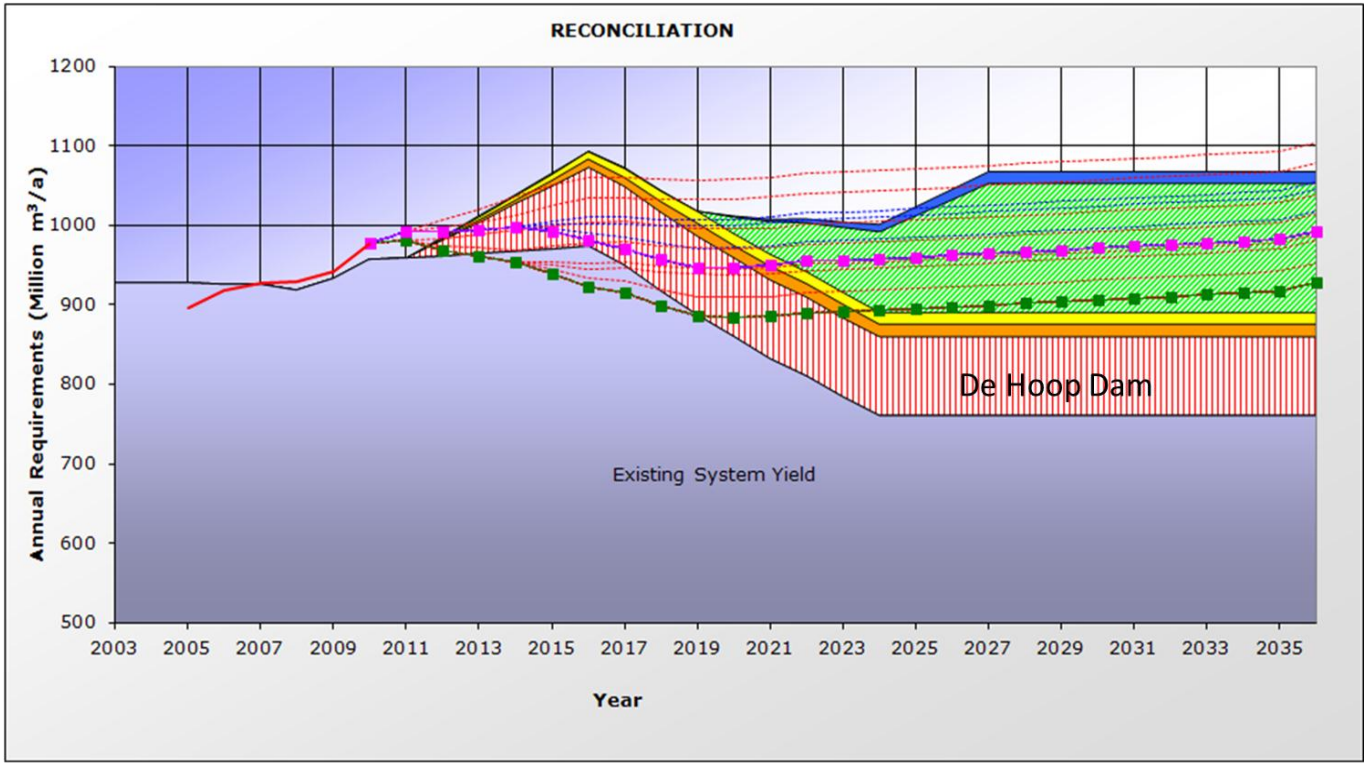
- Existing System Yield
- De Hoop Dam
- \+ Groundwater Develpment
- IAP Removals
- Godwinton Dam
- Water Requirements (High Scenario)
- Water Requirements (Low Scenario)
- Dotted lines depict where the water requirement curves would Have run without each of the management options

Reconciliation Scenarios (Cont.)

Scenario 2:

- Same as Scenario 1 except the water transfer from Vaal Dam instead of the Godwinton Dam

Scenario 2: Management interventions plus Transfer from Vaal Dam



Legend:

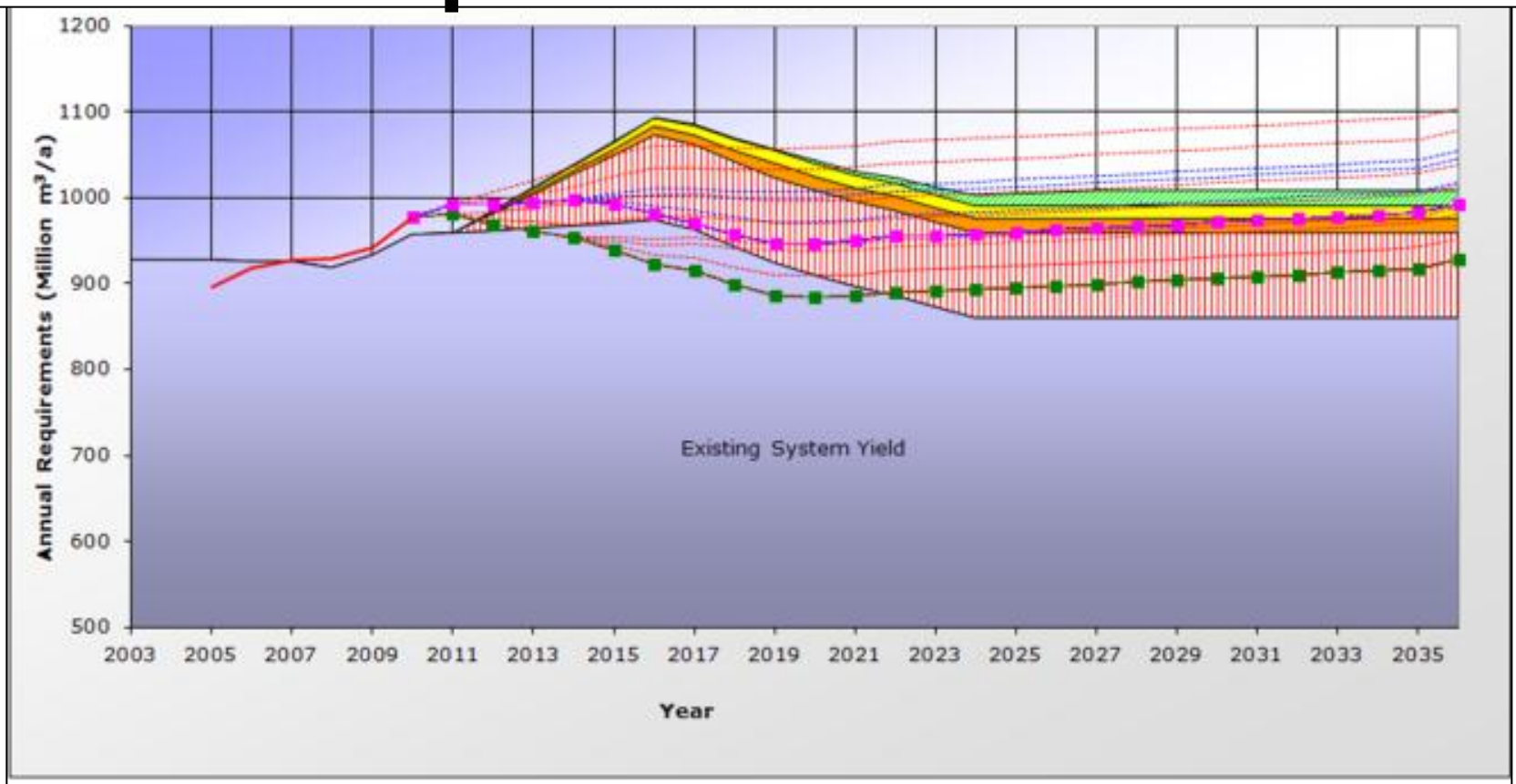
- Existing System Yield
- De Hoop Dam
- \+ Groundwater Develpment
- IAP Removals
- Vaal Transfer
- Water Requirements (High Scenario)
- Water Requirements (Low Scenario)
- Dotted lines depict where the water requirement curves would Have run without each of the management options

Reconciliation Scenarios (Cont.)

Scenario 3: Assess the sensitivity of the water balance to the Reserve

- The high water requirements projection.
- Halve the effect of the implementation of the Reserve on the yield
- The screened management options implemented
- Groundwater development options phased in over the next 16 years.
- No dam or transfer option.

Scenario 3 – Reduced Reserve Impact and No dam

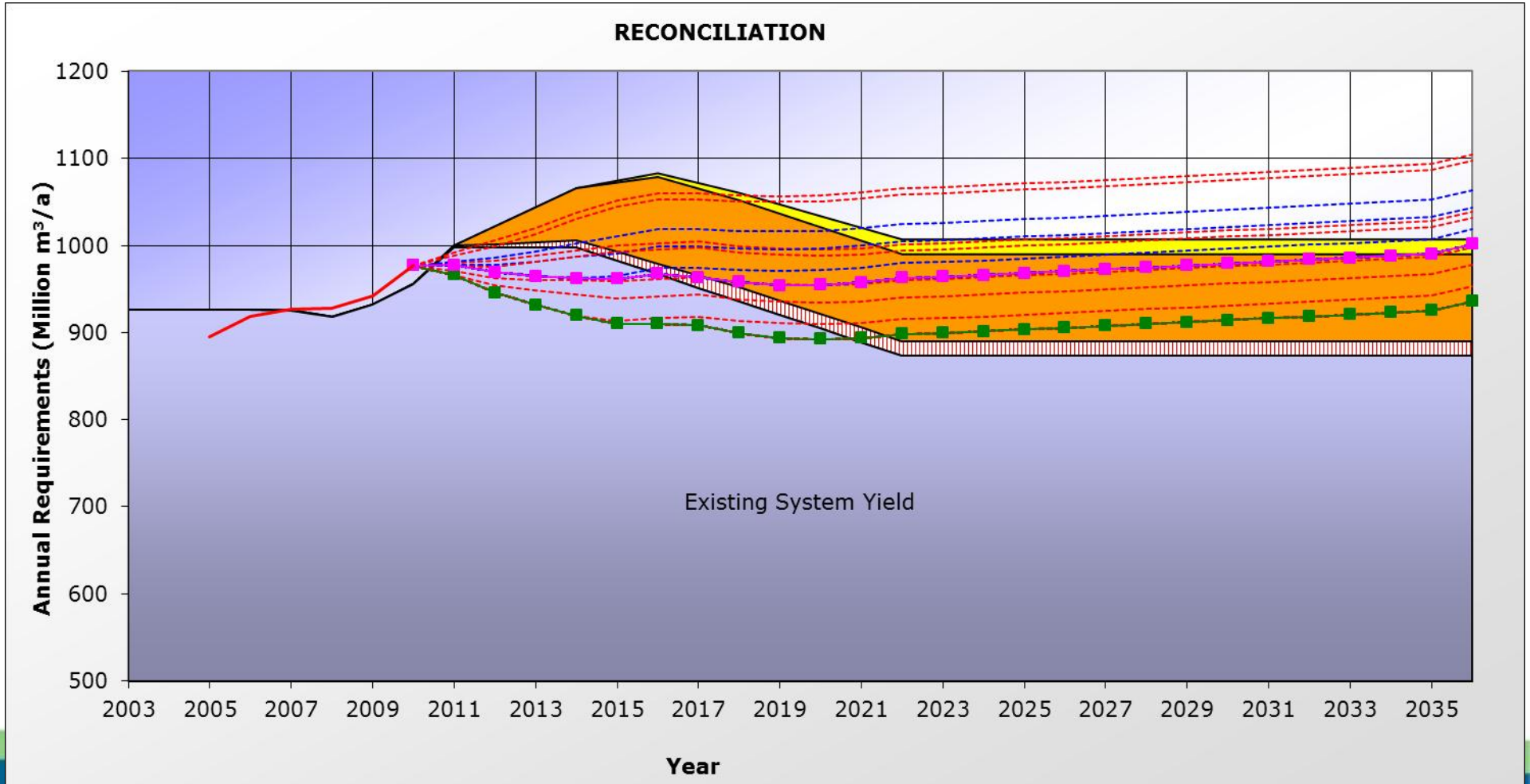


Legend:

- Existing System Yield
- IAP Removals
- De Hoop Dam
- \+ Groundwater Development

Scenario 3 With Updated Data

Reserve implemented for Cat B in KNP and phased in from 2015



Provisional Recommendations for the Final Strategy

- The uncertainties need to be investigated further
  - Unlawful Water Use
  - Ecological Reserve (Surface and groundwater)
  - River Losses
  - Increased yield from coal mines
  - Realistic savings with Water Conservation and Water Demand Management, System Operating Rules, etc.
  - Extent of Invasive Alien Plants

Provisional Recommendations of the Final Strategy (Continued)

- A thorough investigation into the Reserve – 1999 study should be updated using improved methodologies
- All the possible management options to reduce water requirements should be implemented .
- The validation and verification process should be accelerated.
- Groundwater development in unstressed sub-catchments must be encouraged.

Provisional Recommendations of the Final Strategy (Continued)

- Bulk water abstraction from the Malmani aquifer where it crosses the Olifants River must be investigated together with the possibility of artificial recharge with surface water.
- A possible water transfer from the Crocodile (West) system should be investigated further at pre-feasibility level
- Water trading should be encouraged

Provisional Recommendations of the Final Strategy (Continued)

- Geohydrological study needs to be done to study the interaction between groundwater and surface water more accurately in the escarpment dolomite aquifer
- The impacts of all interventions must be continuously monitored.

Thank You:

Discussion

Slides possibly required if questions go in that direction

Irrigation Expansion

- Huge growth in irrigation use – despite the fact that no new water use licences have been issued for many years
- Some of this expansion might be unlawful

Catchment	Irrigation Area (km2)	
	1996	2004
Upstream of Loskop dam	121	234
B30 (Elands, Moses, Olifants	440	519
B40 (Steelpoort)	41	76
B50 (Olifants)	67	84
B60 (Blyde)	92	129
B70 (Olifants, Selati)	67	97
TOTAL	**828**	**1139**

Possible Dam Sites