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

Final Reconciliation Strategy

Presentation of the report

23 March 2012

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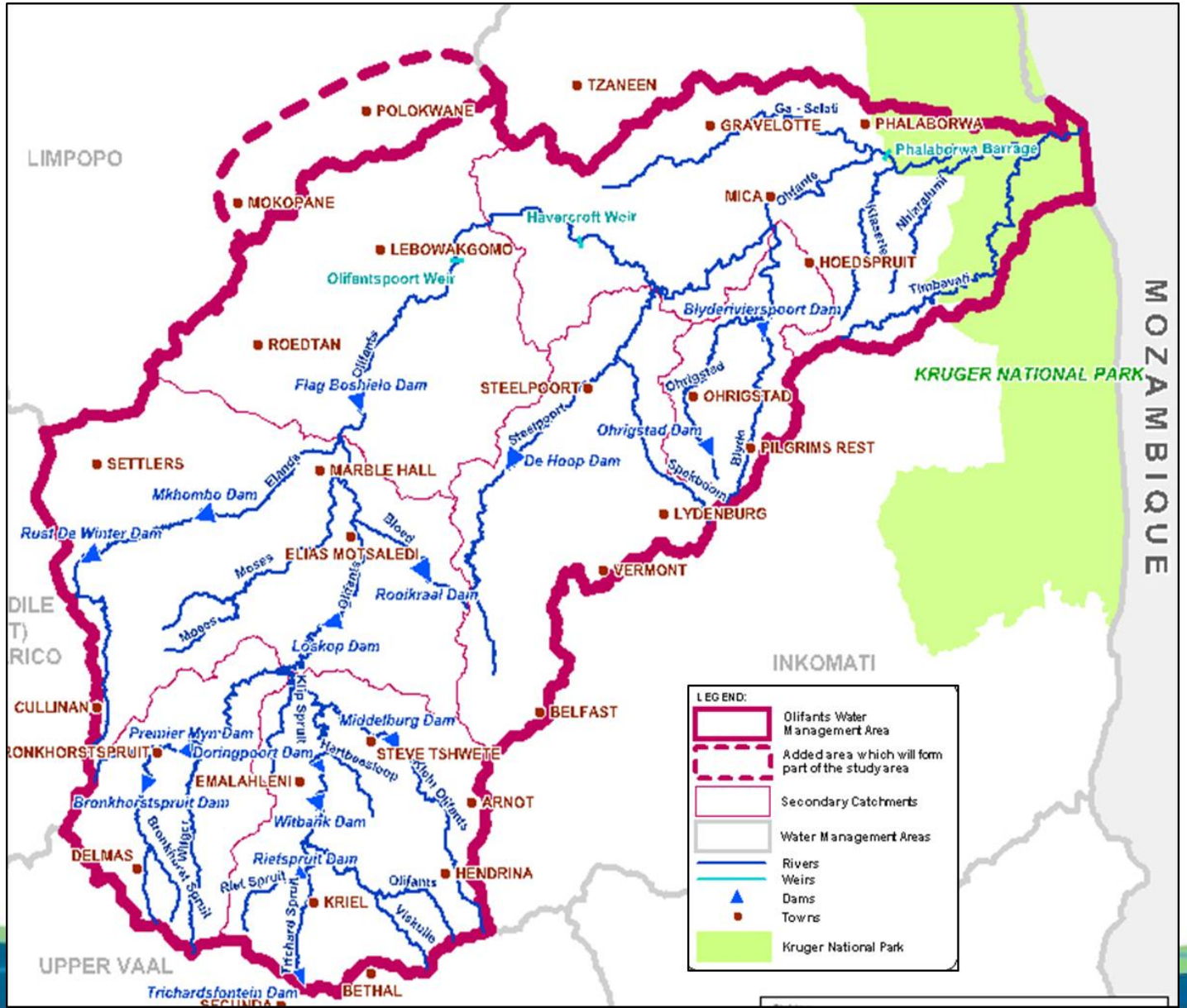
1 Introduction

- Purpose of study
- Objectives of the ORS
- Relation between the Preliminary and Final Reconciliation Strategies
- Report Structure

Study Area


TZANEEN
POLOKWANE
Ga - Selati
GRAVELOTTE
PHALABORWA
Phalaborwa Barrage
LIMPOPO
MOKOPANE
Havercroft Weir
MICA
Olifants
Klaserie
Nhlaralumi
LEBOWAKGOMO
Olifantspoort Weir
HOEDSPRUIT
Timbavati
Blyderivierspoort Dam
ROEDTAN
Olifants
Flag Boshielo Dam
STEELPOORT
Ohrigstad
OHRIGSTAD
KRUGER NATIONAL PARK
Steelpoort
Ohrigstad Dam
De Hoop Dam
Blyde
PILGRIMS REST
SETTLERS
Elands
MARBLE HALL
Mkhombo Dam
Spekboom
LYDENBURG
Rust De Winter Dam
Bloed
ELIAS MOTSALEDI
VERMONT
Moses
Olifants
Rooikraal Dam
Moses
Loskop Dam
INKOMATI
CULLINAN
Klip Spruit
Middelburg Dam
BELFAST
Premier Myn Dam
Hartbeesloop
Doringpoort Dam
STEVE TSHWETE
EMALAHLENI
Olifants
ARNOT
Bronkhorstspruit Dam
Witbank Dam
Bronkhorstspruit
DELMAS
Rietspruit Dam
HENDRINA
Riet Spruit
Olifants
KRIEL
Vaal
Trichard Sprui
Viskuile
UPPER VAAL
Trichardsfontein Dam
BETHAL
MOZAMBIQUE
LEGEND:
Olifants Water Management Area
Added area which will form part of the study area
Secondary Catchments
Water Management Areas
Rivers
Weirs
Dams
Towns
Kruger National Park

Study Objectives

1. To address growing water demands
2. To address serious water quality problems
3. To identify resource development options
4. To provide reconciliation interventions
   a) Structural
   b) Administrative / regulatory
5. To facilitate communication and strengthen the partnership between DWA and key stakeholders

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Objectives of the Olifants Reconciliation Strategy

- To meet legitimate current and future water requirements
- To recommend the most suitable interventions to balance the water requirements and water resources
- To identify responsible institutions and provide target dates for implementation of the strategy.

Relation between the Preliminary and Final Reconciliation Strategies

- Preliminary Strategy completed in Nov 2010 – Based on best information at that point in time
- Information gaps studied after Preliminary Strategy and covered in the Final Reconciliation Strategy:
  - Impact on the yield of the system as a result of the Reserve,
  - Groundwater availability,
  - Additional yield as a result of decant water from the coal mines,
  - Urban and rural water requirements,
  - Mining water requirements,
  - Extent of unlawful water use,
  - A more accurate estimate for WC/WDM savings in the irrigation sector,
  - A further reconciliation option, i.e. to transfer water into the Olifants Catchment from the Crocodile (West) System

Report Structure

- Situation in the basin is described, i.e. Reserve, current water use, projected water requirements, available water resources and water quality. A water balance is then provided.

- The water shortages emerging from this water balance are then addressed by identifying intervention measures and reviewing these.

- The strategy for reconciling the future water requirements with the available water and the optimum scenario of intervention options are then described.

- The report concludes with lists of risks and uncertainties, implementation arrangements and recommendations.

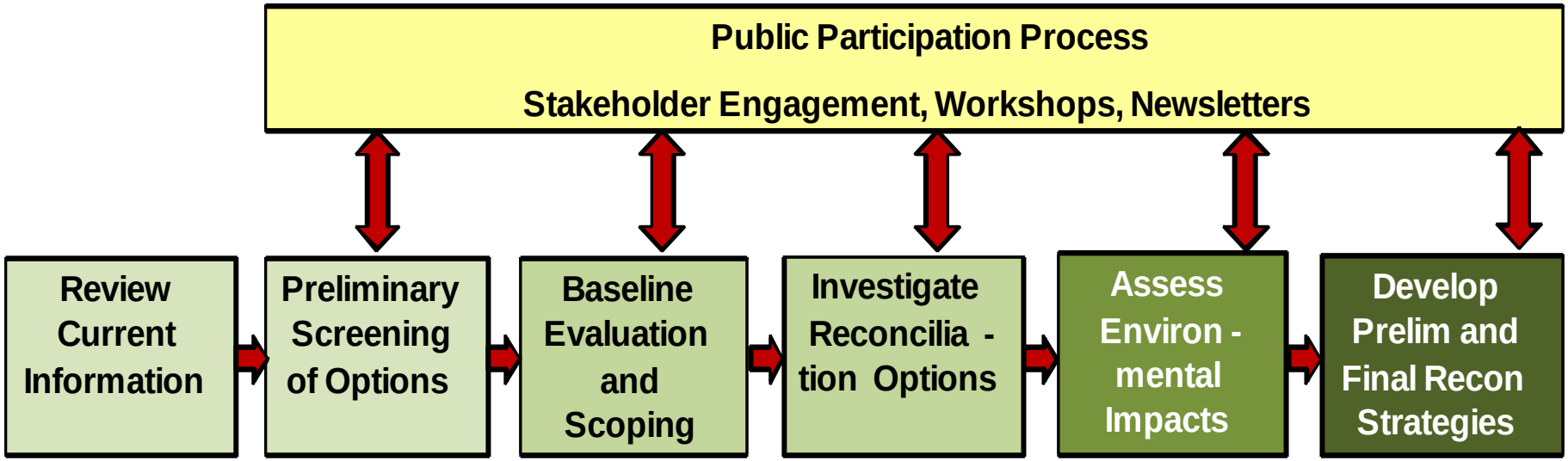
2 Overview of the study area and study procedure

- System description
- Study procedure

System Description

- The study area: Olifants River Catchment and its adjacent supply zones, Polokwane and Mogalakwena
- Several large dams located in the upper and middle reaches.
- The earlier dams were constructed to supply large irrigation schemes, while later dams were constructed to meet growing domestic, industrial and mining water requirements.
- A large number of water users who obtain their water from farm dams, and run-of-river abstraction
- Also a significant supply to irrigators and mines from groundwater.
- Water use for power generation in upper part transferred from neighbouring catchments
- Lower part of Olifants river flows through Kruger National Park (KNP) into Mozambique

Study Procedure



3 The Reserve

- Basic Human Needs component
- Ecological component
  - Previous EWR study done for the system
  - Ecological changes since previous determinations
  - Flood component of the Ecological Reserve
- Recommended Reserve Scenario

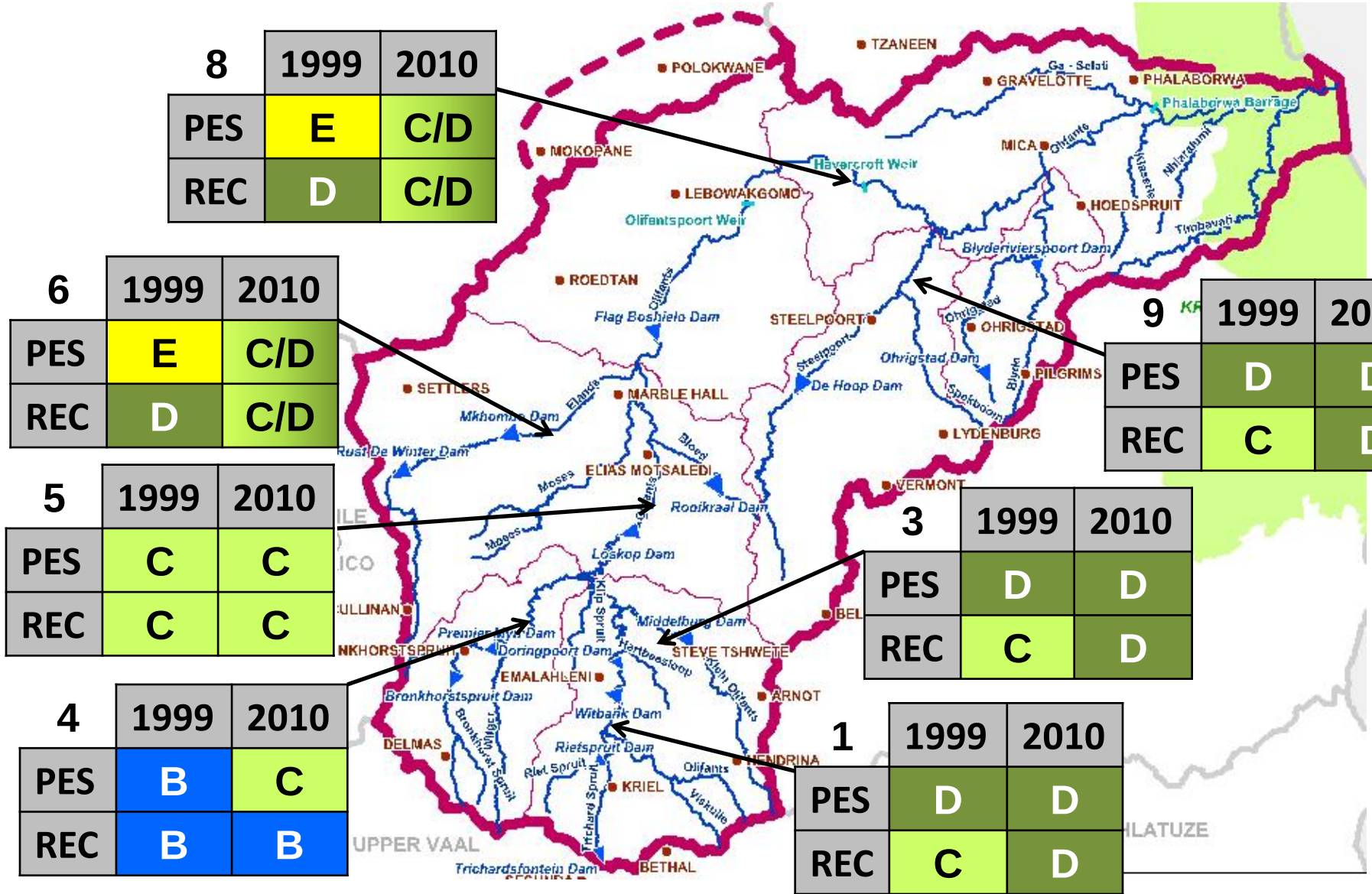
The Preliminary Ecological Reserve

- Comprehensive Reserve Study was undertaken – 1999
- Eco-classification was repeated in 2010 with main objective to check how the EWRs would be affected by the new classification procedure
- EWR determinations were not redone – EWR rule tables are still the same as in the 1999 study
- Rule tables that were developed for the ecological Reserve in 1999 study make provision for the release of small floods (freshets) from dams
- Floods were removed from rule tables
- Separate resource classification study is currently being undertaken by the Department. The Ecological Reserve values used in the Olifants Reconciliation Study are therefore seen as preliminary.

Comparison

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

Change In PES and REC



8	1999	2010
PES	E	C/D
REC	D	C/D

6	1999	2010
PES	E	C/D
REC	D	C/D

9	1999	2010
PES	D	D
REC	C	D

5	1999	2010
PES	C	C
REC	C	C

3	1999	2010
PES	D	D
REC	C	D

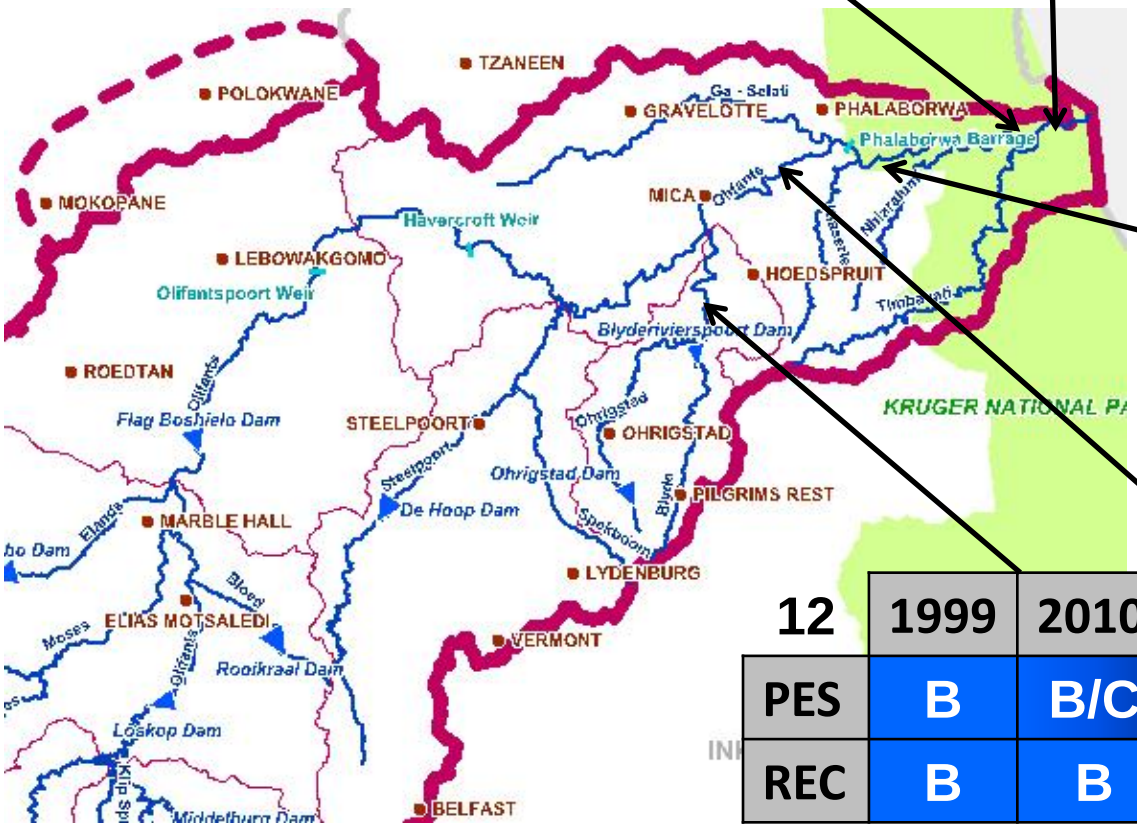
4	1999	2010
PES	B	C
REC	B	B

1	1999	2010
PES	D	D
REC	C	D

Reasons for changes 1999 to 2010

- Site 6 – Elands River
  - Fish and invetebrate during 2010 survey showed an improvement
  - Related to the change in operating rules for Mkhombo Dam
  - Flow releases from Mkhombo dam still varies over time and further improvement is possible
- Site 4 – Wilge River
  - Fish and invetebrate during 2010 survey showed a deterioration
  - Increased mining activities upstream
  - Saalklapspruit uptream is in a poor condition
- Site 8 – Olifants River
  - Fish and invetebrates haven't changed. Improvement as a result of methodology

Change In PES and REC *(Continued)*



16	1999	2010
PES	C	C
REC	C	B

17	1999	2010
PES	C	C
REC	C	B

15	1999	2010
PES	C	C
REC	B	B

13	1999	2010
PES	C	C
REC	C	C

12	1999	2010
PES	B	B/C
REC	B	B

Implications of Ecological Reserve on System Yield

Scenario	Implication on Yield Million m^3/a
Original implication according to 1999 study ecological classification	183
Implication according to revised eco-classification	221
After removal of floods Including De Hoop	157
Reserve implication used for this strategy	**157**

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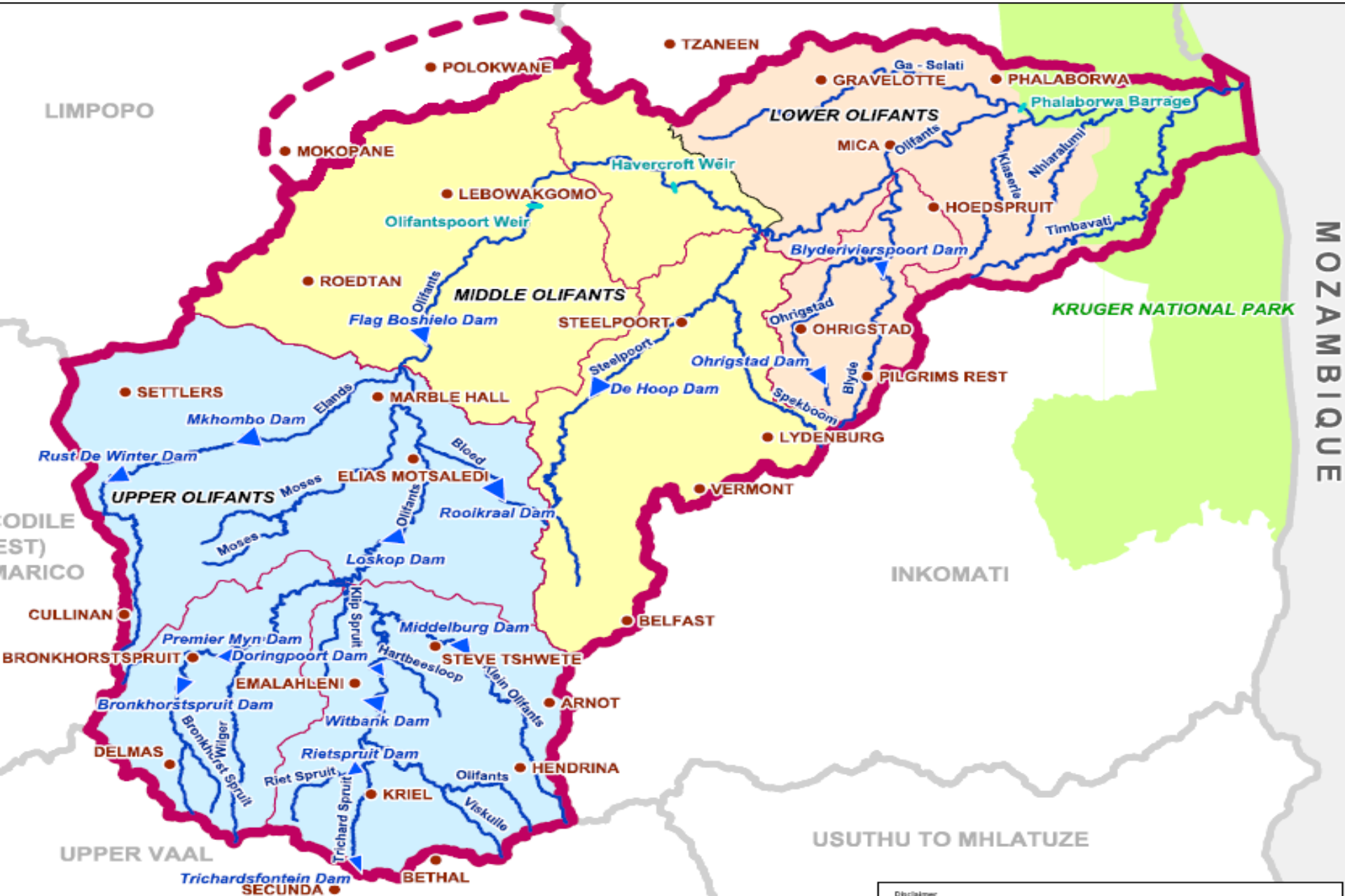
Original implication according to 1999 study ecological classification	183
Implication according to revised eco-classification	221
After removal of floods Including De Hoop	124 33 157
Reserve implication used for this strategy	**157**

4 Current Water Use And Projected Water Requirements

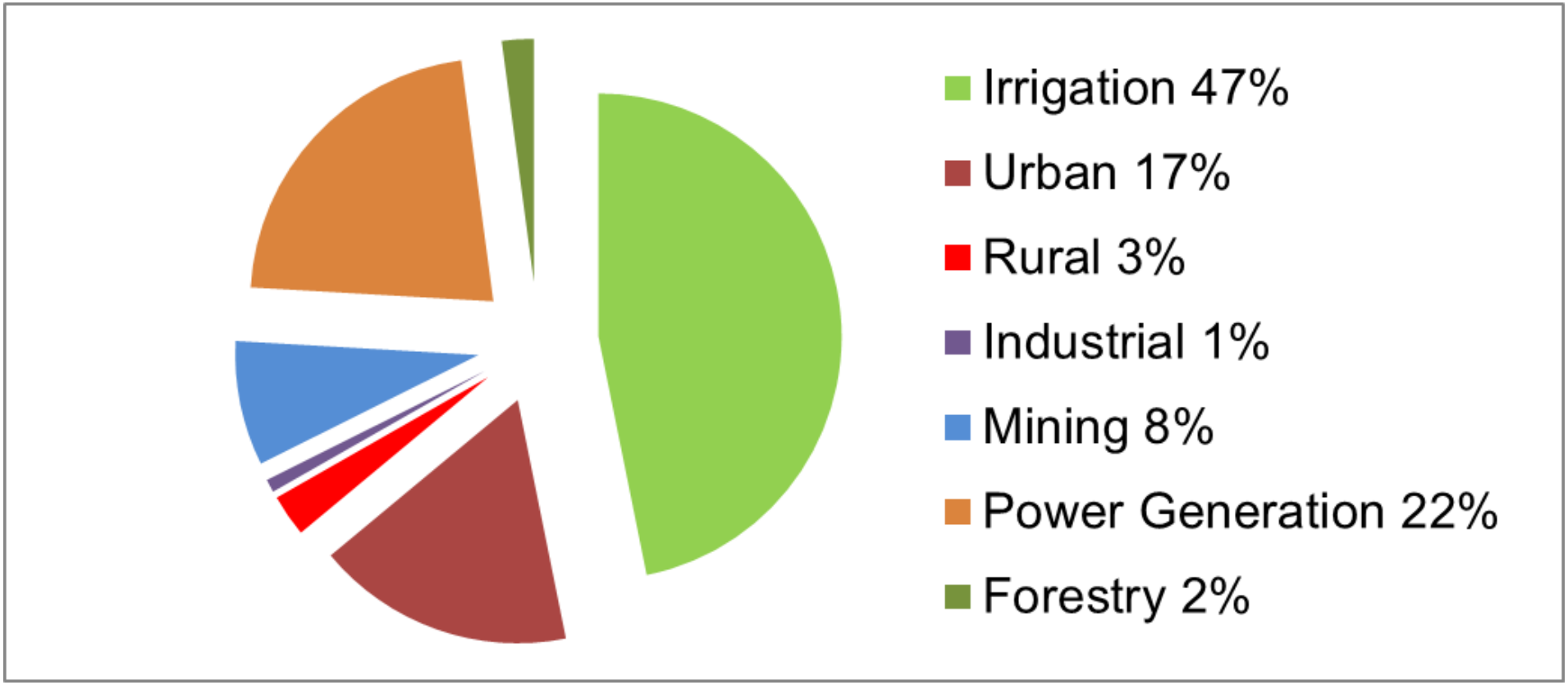
- Current water use
  - Irrigation
  - Urban and Rural
  - Industrial
  - Mining
  - Power Generation
  - Streamflow reduction
  - Invasive Alien Plants
- Projected future water requirements
  - (Sectors as above)
- Total High and Low scenario water requirements

The Three Water Management Zones



Current Water Use

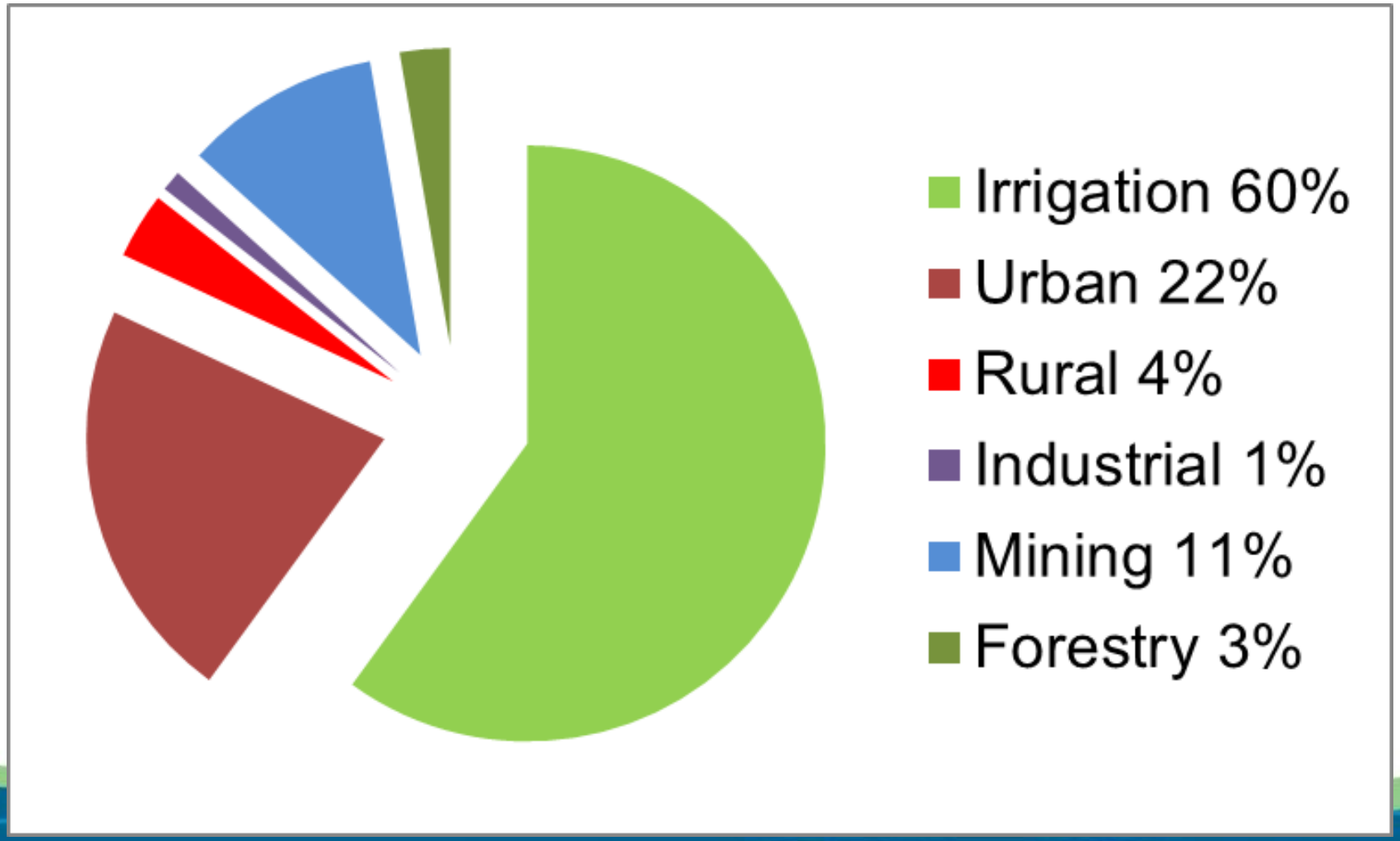
Total 1 038 million m^3/a



- All power generation water is transferred from other catchments

Current Water Use – Without Power Generation

Total 810 million m^3/a



Irrigation Water Use – Upper Olifants

Sub area	Controlled irrigation requirement		Diffuse irrigation requirement	Total irrigation requirement
	Average	1 in 50		
Witbank Dam	0		17.4	17.4
Middelburg dam	0		13.9	13.9
Bronkhorstspruit/Wilge Dam	0		20.2	20.2
Loskop Dam	0		15.9	15.9
Elands River	37.8	32.9	14.7	47.6
D/s of Loskop Dam	136.6	118.8	15.1	133.9
Total	**174.4**	**151.7**	**97.2**	**248.9**

Irrigation Water Use – Middle Olifants

Sub area	Controlled irrigation requirement		Diffuse irrigation requirement	Total irrigation requirement
	Average	1 in 50		
U/s of De Hoop Dam	0	0	14.7	14.7
D/s of De Hoop Dam	6.3	5.5	1.9	7.4
Spekboom (B42)	32.0	28.2	4.1	32.5
Olifants (B51)	0	0	6.9	6.9
Olifants (B52)	18.0	15.8	0.6	16.4
Olifants (B71)	0	0	3.2	3.2
Total	**56.3**	**49.5**	**31.4**	**81.1**

Irrigation Water Use – Lower Olifants

Sub area	Controlled irrigation requirement		Diffuse irrigation (use)	Total irrigation requirement
	Average	1 in 50		
Olifants/Selati (B72)	1.3	1.2	35.3	36.5
Blyde River (B60)	115.7	106.4	6.3	112.7
Olifants (B73)	2.0	1.8	0.3	2.1
Olifants (B71)	0.0	0.0	1.4	1.4
Total	**118.0**	**108.8**	**46.3**	**155.7**

Irrigation Water Use – Entire Catchment

- Upper Olifants – 249 million m^3/a
- Middle Olifants – 81 million m^3/a
- Lower Olifants – 156 million m^3/a

Total 486 million m^3/a

No growth in irrigation demand was assumed

Streamflow Reduction (SFR) Activities

- Forestry as an SFR activity has an impact on the yield of the system.
- Current estimates forestry are:

Sub-area	Area (km^2)	Streamflow reduction (million m^3/a)
Middle Olifants	91	3.5
Lower Olifants	186	18.9
TOTAL	**277**	**22.4**

- There are no plans to expand or reduce forestry in the Olifants River catchment.

Invasive Alien Plants

- Invasive Alien Plants (IAP) also reduces runoff and hence the yield available from the system.
- The impact of IAPs was considered in detail as part of this study, with new information from the Agricultural Research Council forming the basis of the areal extent of IAPs.
- The impact of these IAPs has been taken into account in determining the yields of dams.

Streamflow Reduction Activities

- Removing the IAPs will increase the yield of the system
- The increase is estimated at 21 million m^3/a

Sub-area	Streamflow reduction (million m^3/a)
Upper Olifants	12
Middle Olifants	3
Lower Olifants	6
TOTAL	**21**

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 demographic information from the All Towns became available during the course of the study and was the primary source of information for this Final Strategy.
- Low growth scenarios were derived from STATS SA
- High growth scenarios were based on:
  - Low growth in HIV/AIDS
  - High Immigration

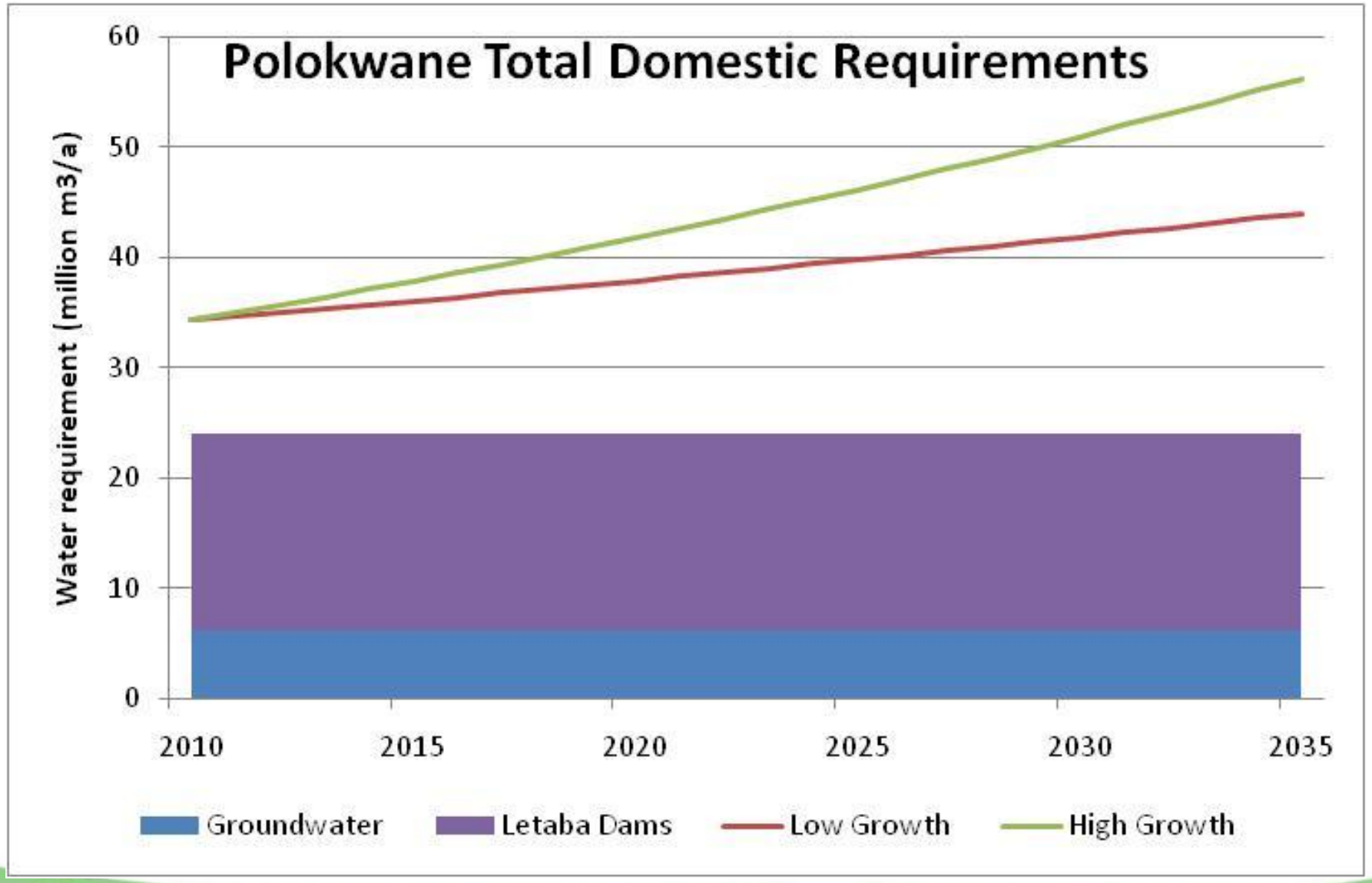
Further work done on future water requirements

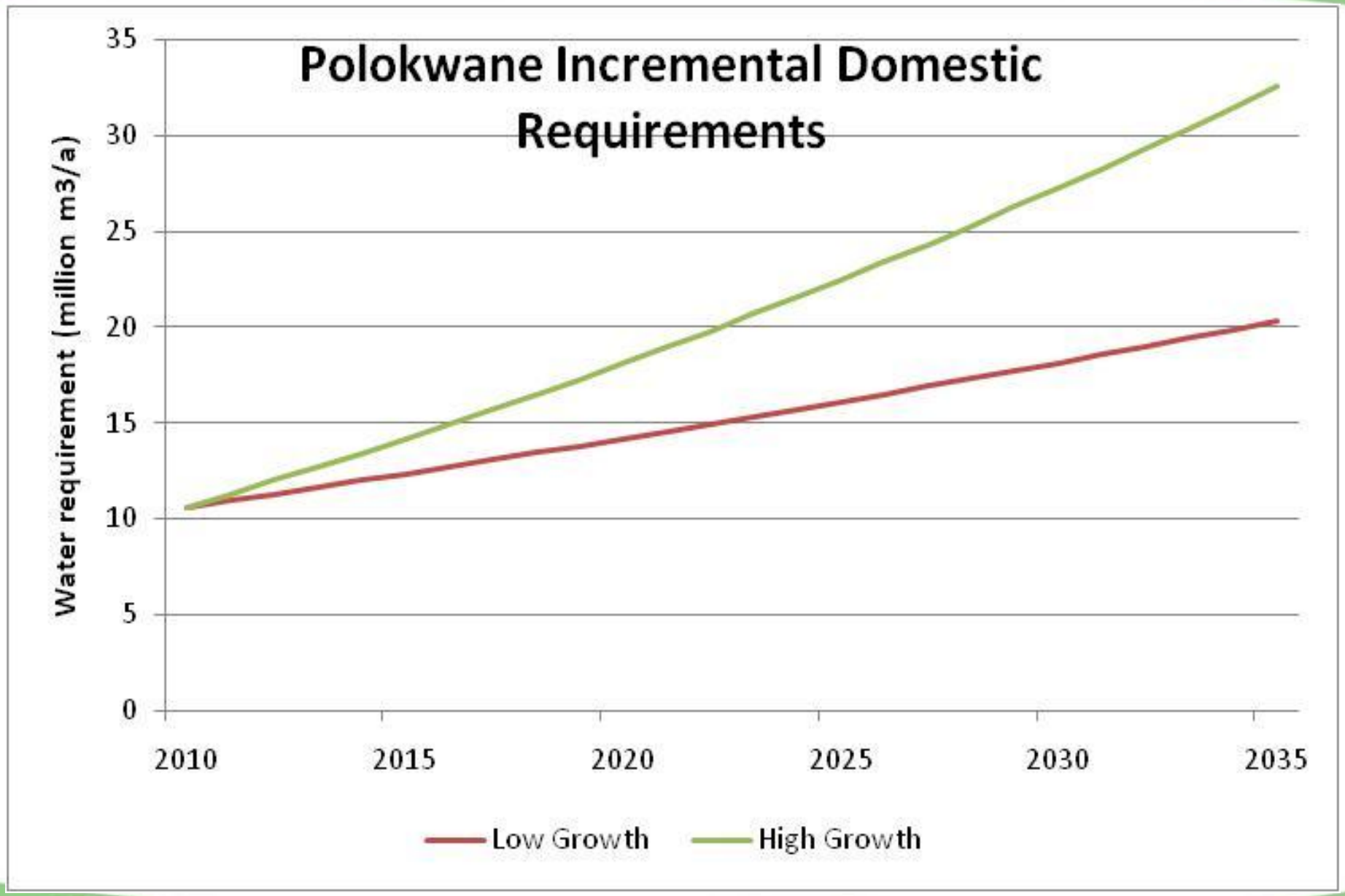
- Water use estimates from the All Towns studies were checked with recent actual abstraction data and the Water Services database - compared well, except for Polokwane and Mokopane
- Recent reports on Polokwane and Mokopane instead of All Towns were used as the main source of information on the current and future water requirements of these towns.
- The Water Services database was also used to estimate rural water use – compared well to All Towns Study data.

Further work done on future water requirements *(Continued)*

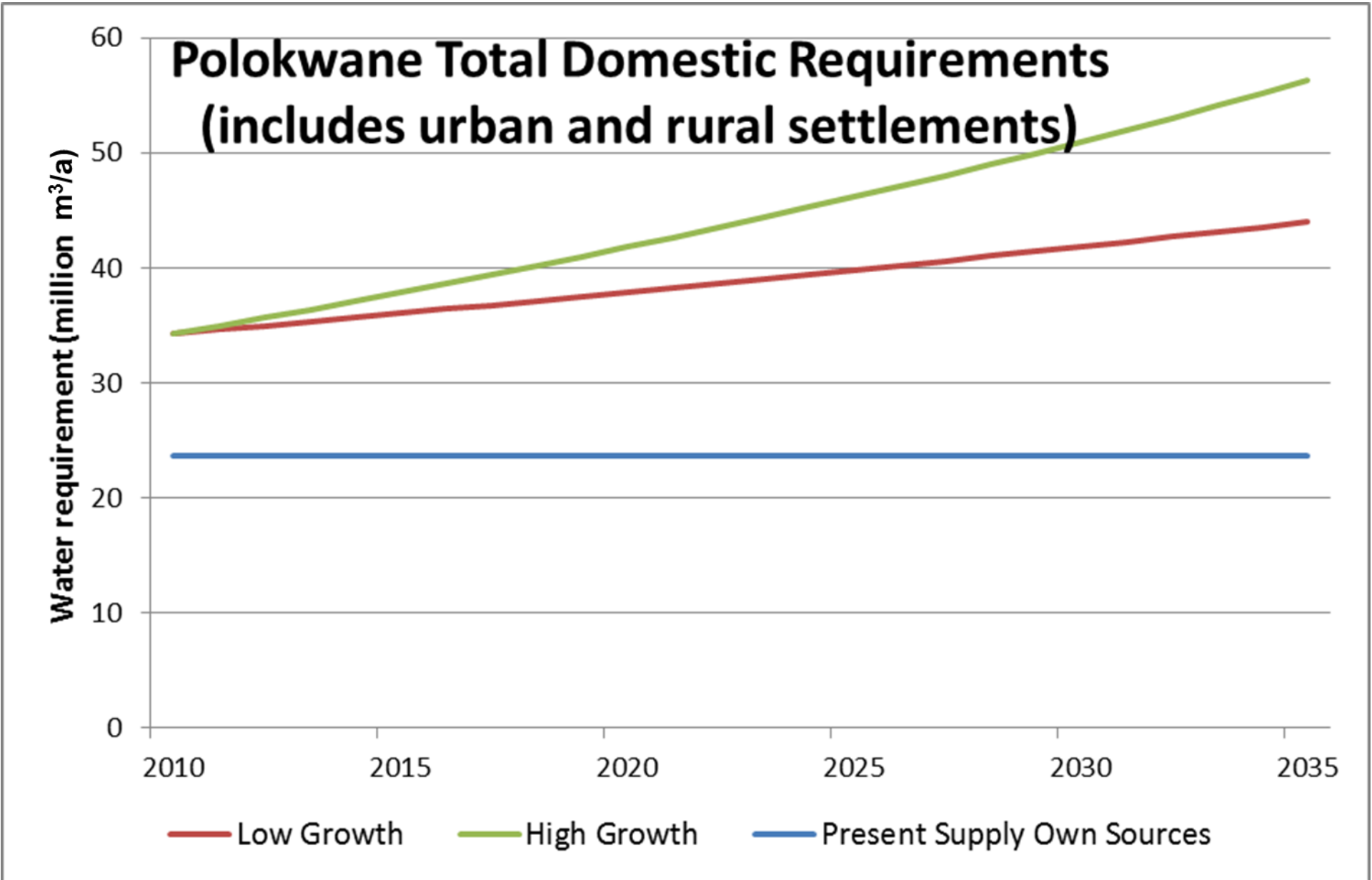
- The mining sectors have provided updated growth projections (up to 2032)
  - These projections are lower than assumed during the ORWRDP
  - Current mining water use was checked through telephonic enquiries and the WARMS database

Polokwane sub-balance

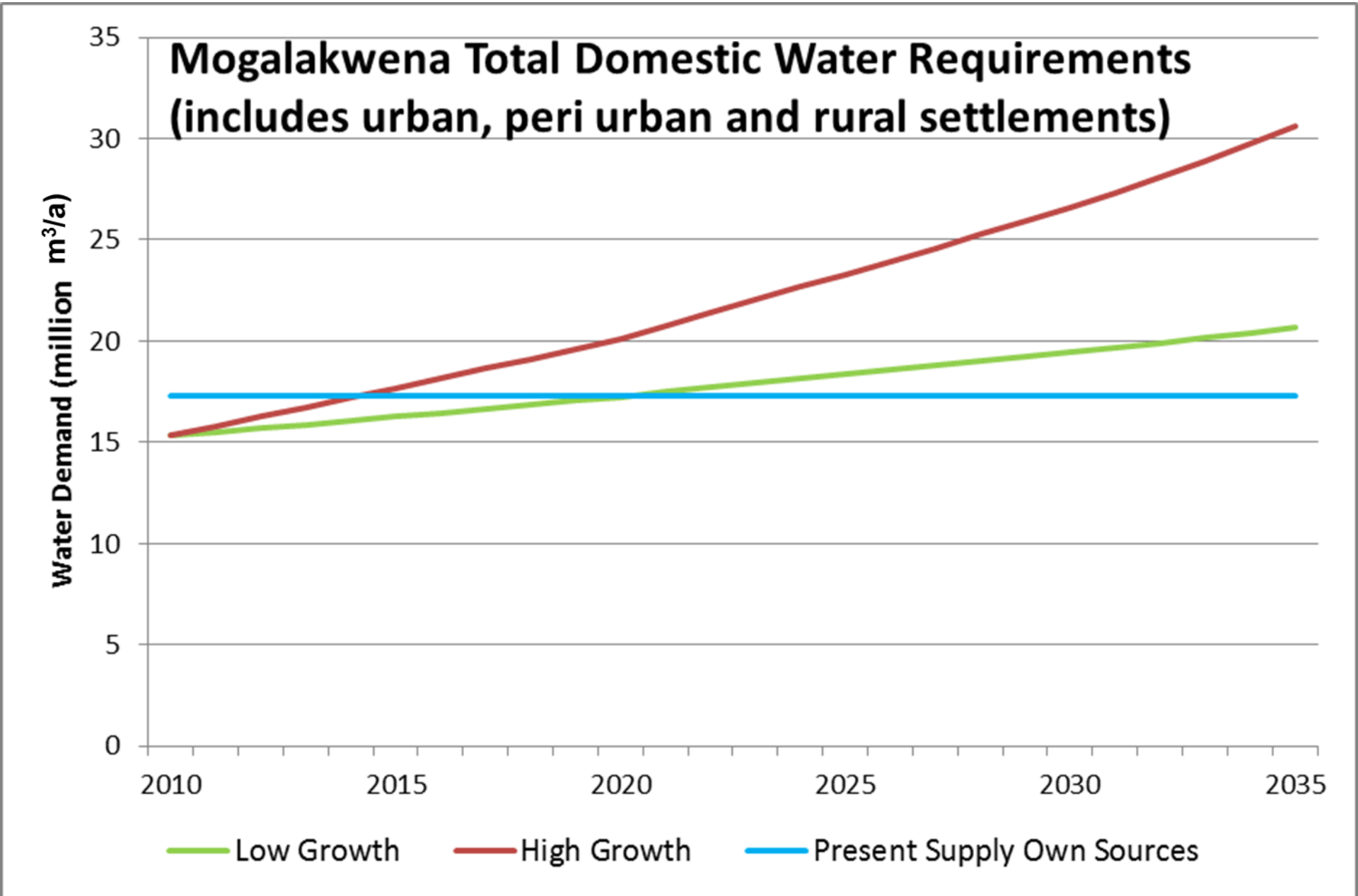



Polokwane Incremental Domestic Requirements
Water requirement (million m3/a)
35
30
25
20
15
10
5
0
2010
2015
2020
2025
2030
2035
Low Growth
High Growth

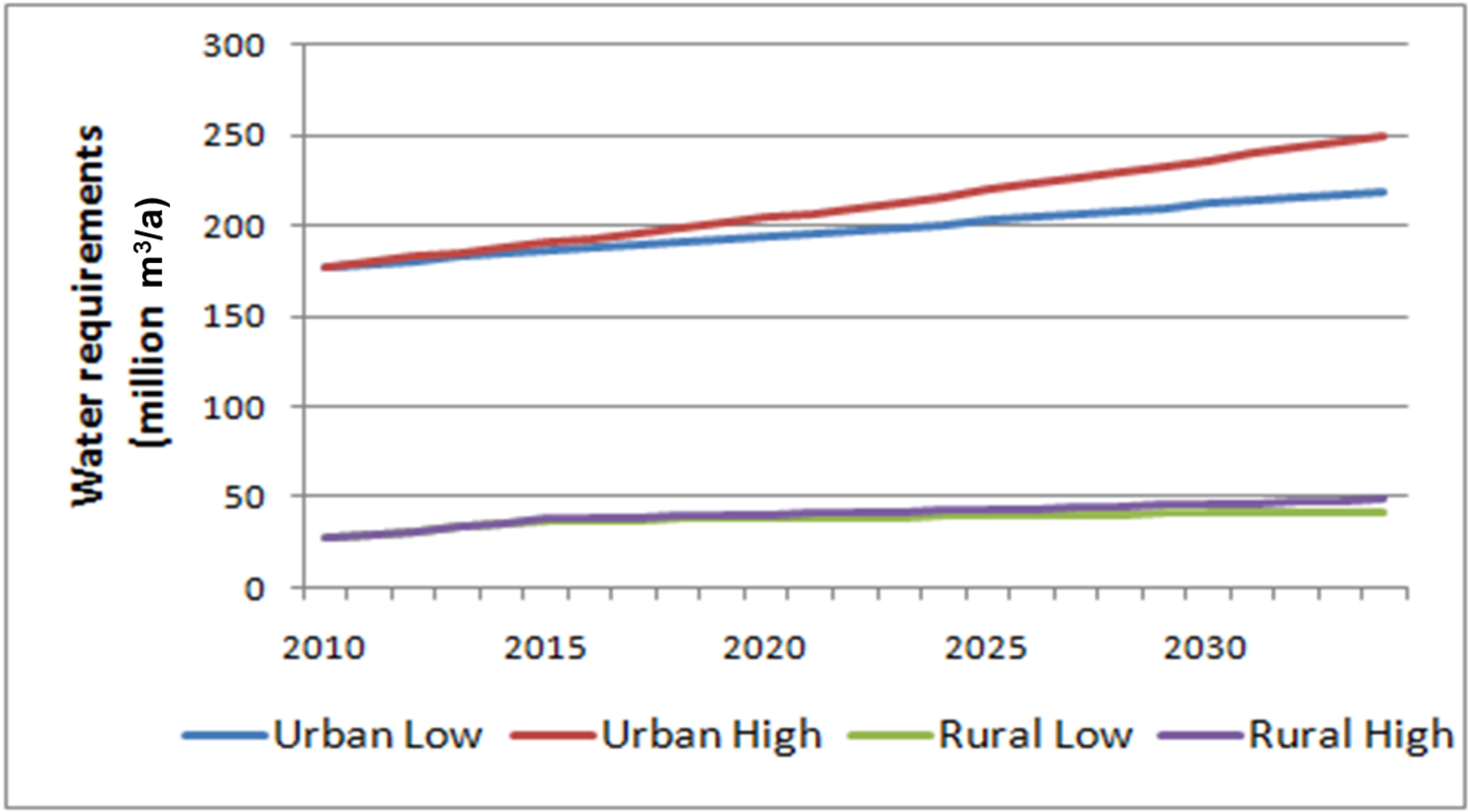
Polokwane


Polokwane Total Domestic Requirements
(includes urban and rural settlements)
Water requirement (million m³/a)
60
50
40
30
20
10
0
2010
2015
2020
2025
2030
2035
Low Growth
High Growth
Present Supply Own Sources

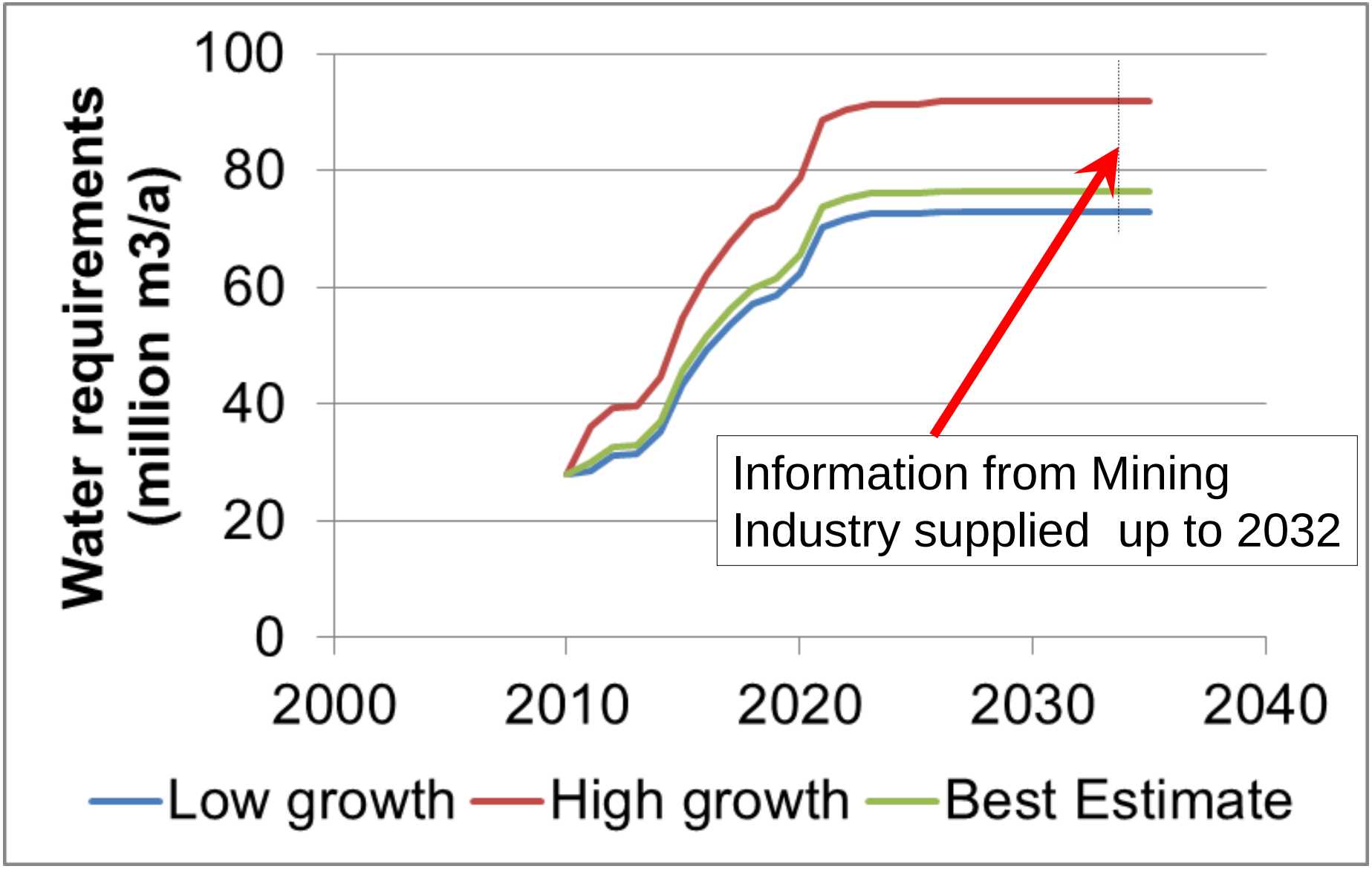
Mokopane


Mogalakwena Total Domestic Water Requirements
(includes urban, peri urban and rural settlements)
Water Demand (million m³/a)
35
30
25
20
15
10
5
0
2010
2015
2020
2025
2030
2035
Low Growth
High Growth
Present Supply Own Sources

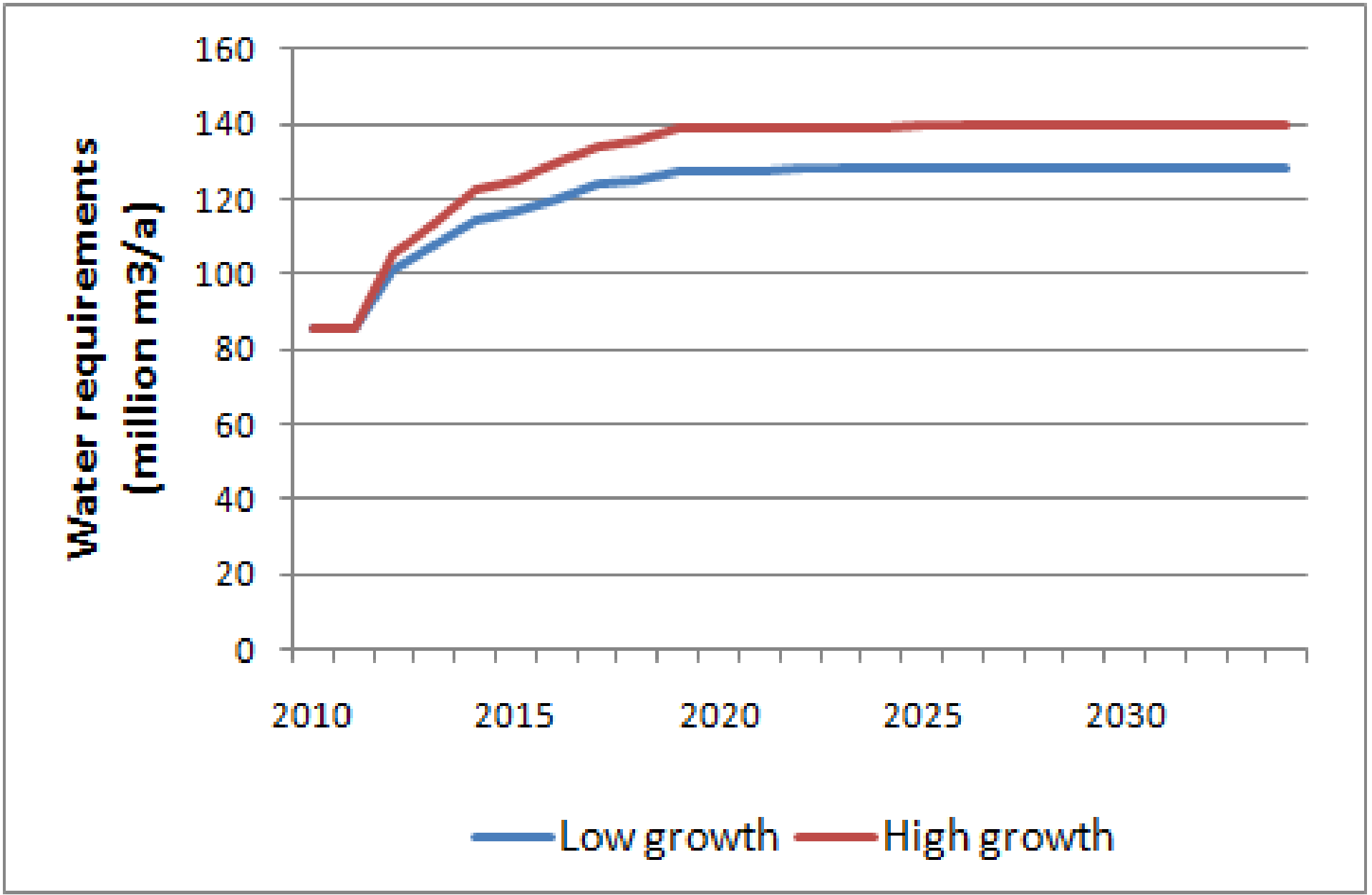
Urban And Rural Growth In Water Demand – Whole System



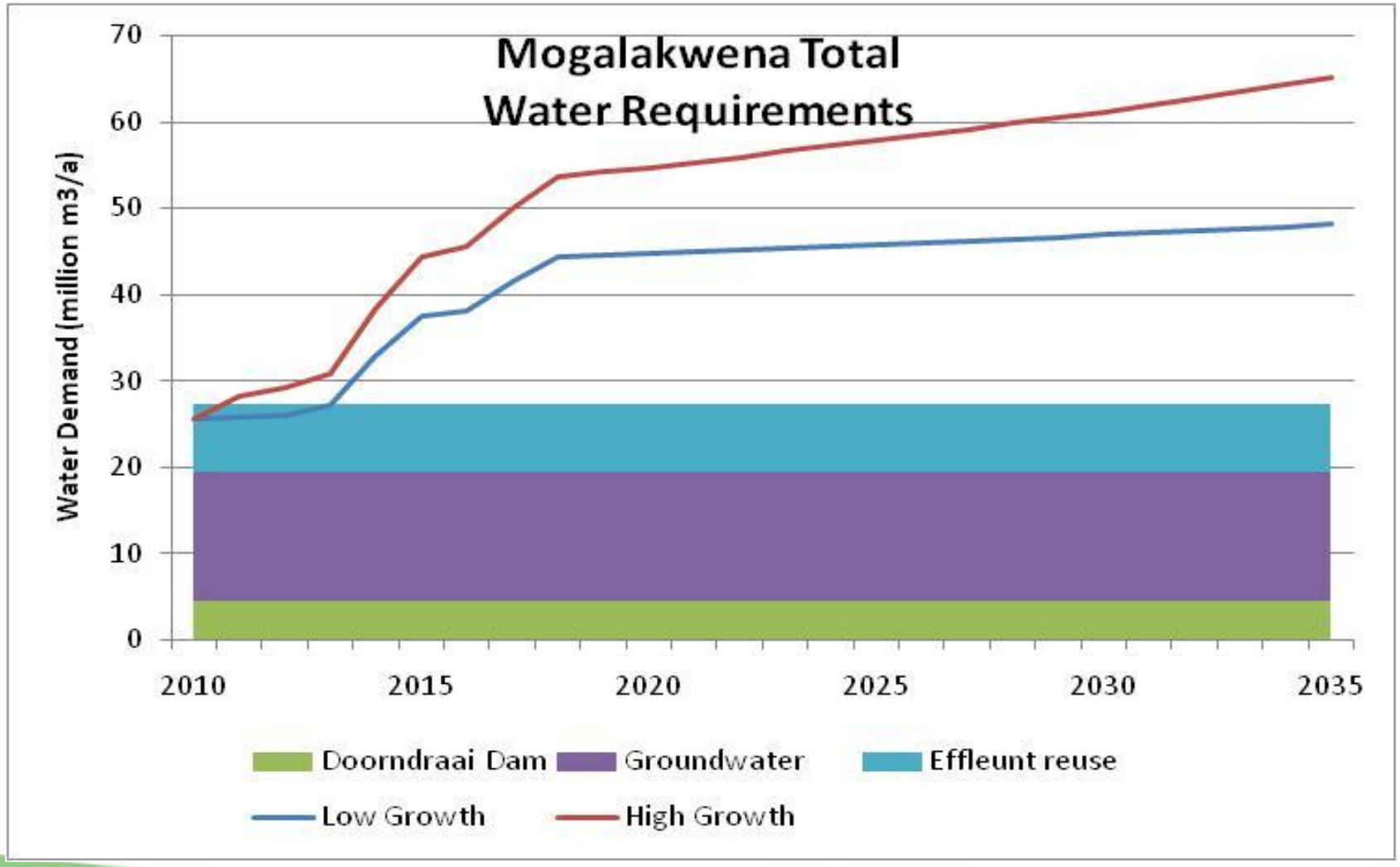
Mining requirements – Middle Olifants



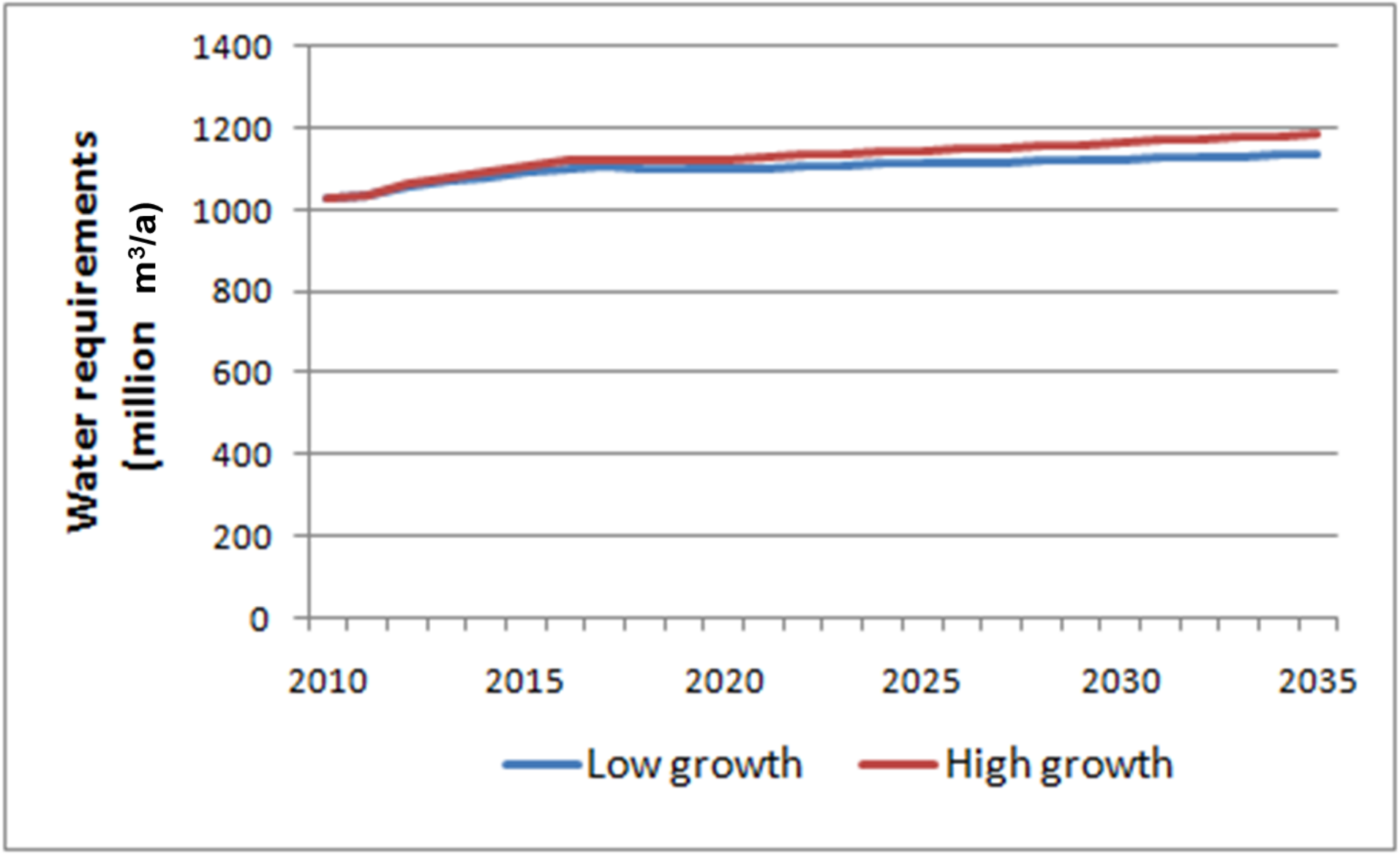
Mining requirements – Whole Catchment



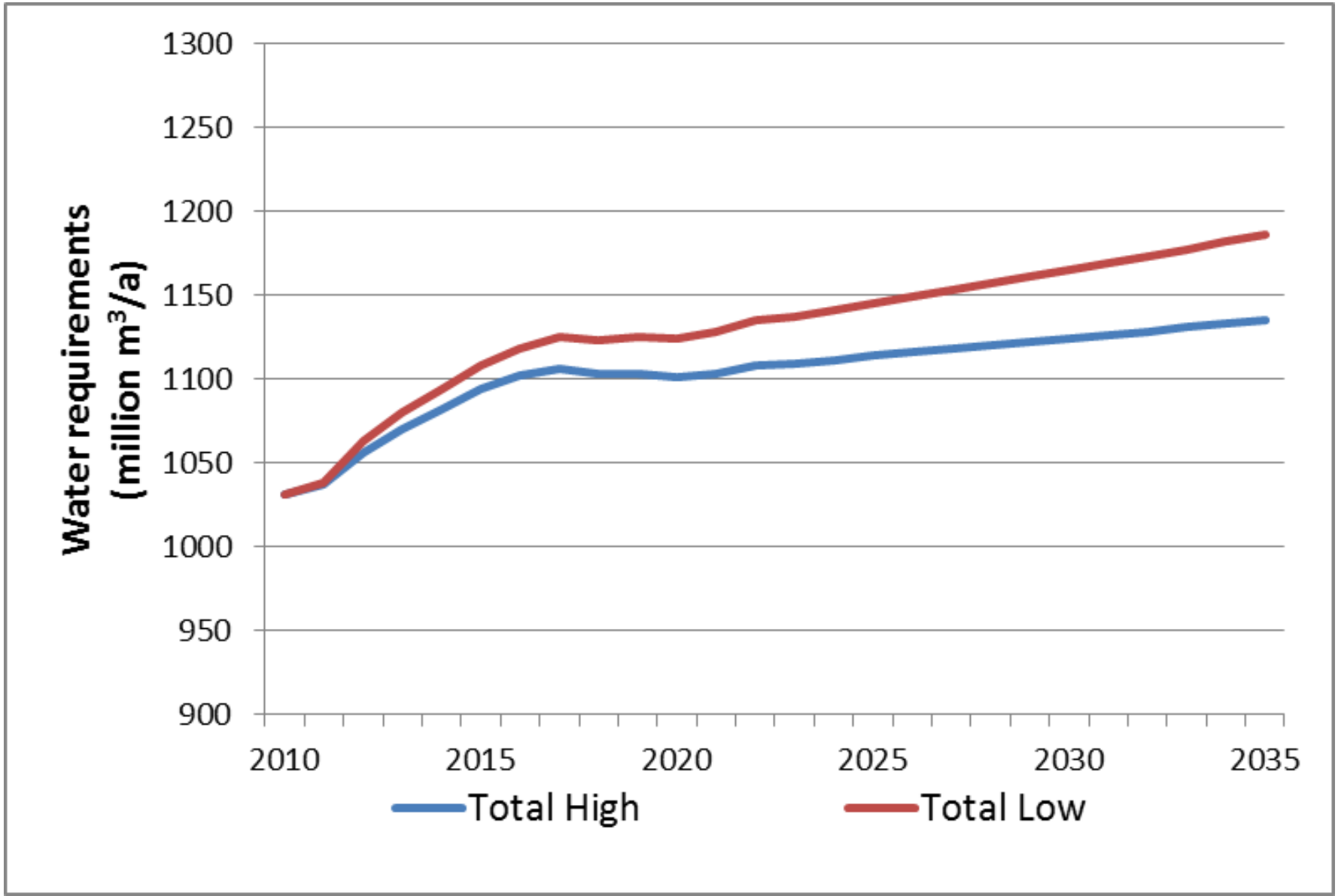
Mogalakwena sub-balance



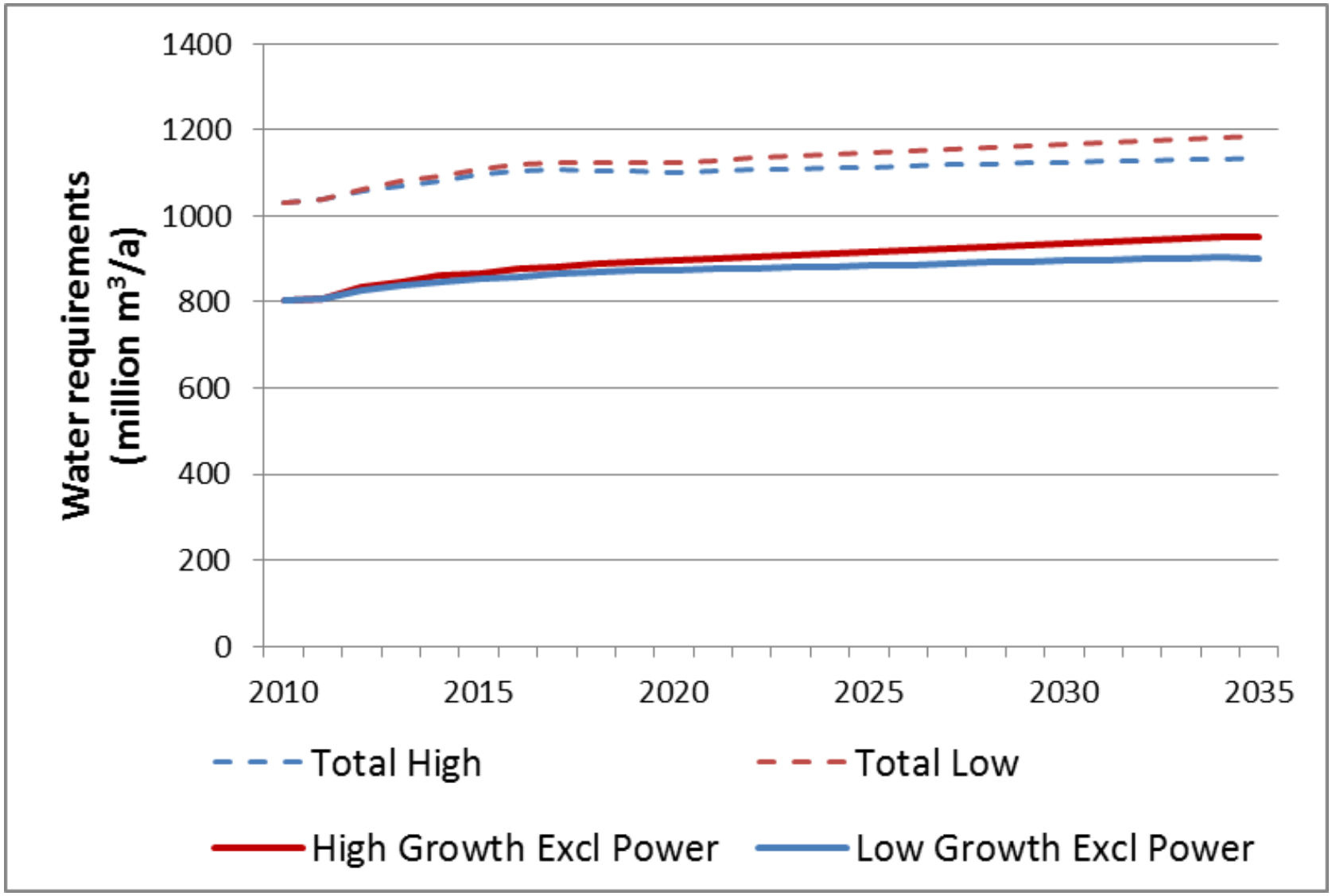
Total growth in water demand (all sectors)



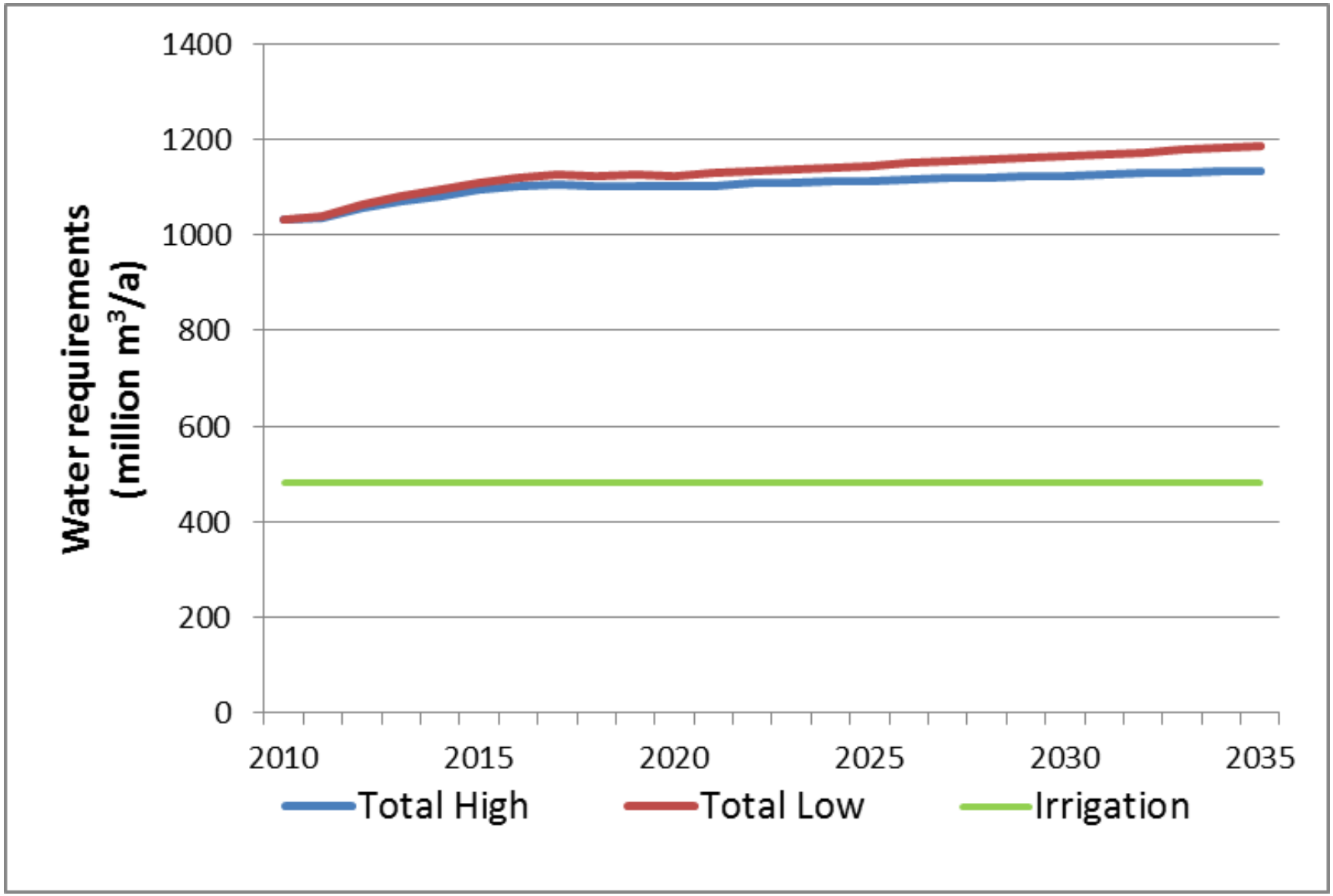
Total growth in water demand (all sectors)



Total growth in water demand (all sectors except Power Generation)



Total growth in water demand and Irrigation water demand



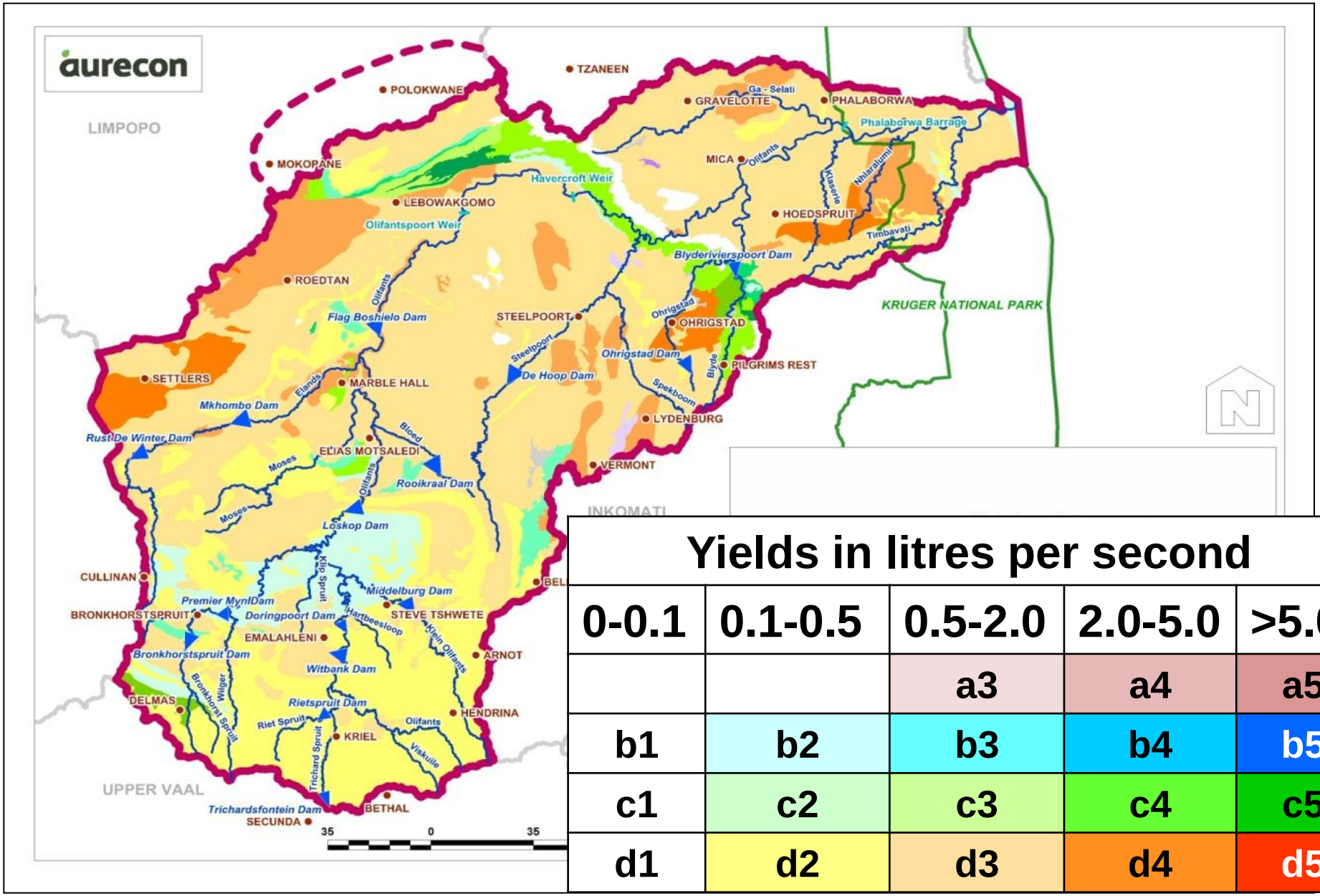
5 Water Resource Availability

- Groundwater
  - Geology and Geohydrology of the catchment
  - Groundwater use and potential
  - Further groundwater development options
  - Management of groundwater

Groundwater availability

- Available throughout the Olifants Catchment
- Varying in quantities, depending on hydrogeological characteristics of underlying formations
- Groundwater Yield Model (AGES, 2008) determined a potential total surplus of groundwater in the order of 70 million m^3/a within the Olifants River catchment
- Groundwater development in unstressed aquifers is encouraged

Hydrogeological yield map



Yields in litres per second				
0-0.1	0.1-0.5	0.5-2.0	2.0-5.0	>5.0
		a3	a4	a5
b1	b2	b3	b4	b5
c1	c2	c3	c4	c5
d1	d2	d3	d4	d5

Groundwater availability: Olifants River groundwater balance

- Estimated Recharge 860 million m³/a
- Estimate Evaporation Losses 500 million m³/a
- Community Water Supply 93 million m³/a
- Irrigation 72 million m³/a
- Estimate EWR 125 million m³/a

- POTENTIALLY AVAILABLE 70 million m³/a

(Source: Groundwater Yield Model (AGES, 2008))

Groundwater Availability Figures Used for this Strategy

- Groundwater potential - 70 million m^3/a
- Assumed that half of the potential can be exploited - 35 million m^3/a

Breakdown per management zone:

- Upper - 5 million m^3/a
- Middle - 15 million m^3/a
- Lower - 15 million m^3/a

5 Water Resource Availability (Cont'd)

- Surface water
  - Yield of large dams
  - Diffuse water resources
  - Transfers in
  - Other sources
  - Additional yield from decommissioned coal mines in the Upper Olifants zone
  - Summary of current and future water resources

Yield of large dams

Sub-area	1:50 year yield (million m^3/a)	Major dams (excluding farm dams and diffuse irrigation)
Upper Olifants	272	Loskop, Witbank, Wilge, Middelburg, Bronkhorstspruit, Rust De Winter, Mkhombo
Middle Olifants	176	Flag Boshielo, De Hoop*, Buffelskloof, Der Bruchen, Belfast, Lydenburg, Dap Naude, Ebenaezer, Doorndraai
Lower Olifants	199	Blyderivier, Origstad, Phalaborwa Barrage
TOTAL	**647**	

* Reserve for De Hoop Dam Subtracted

Diffuse Water Resources

Management Zone	I: 50y Yield of Farm Dams and Run-of-River (million m^3/a)
Upper Olifants	104
Middle Olifants	32
Lower Olifants	43
TOTAL	**179**

Transfers In

(All in million m^3/a)

Management Zone	Transfer in (million m^3/a)	Comment
Upper Olifants	228	From the Usuthu, Komati and Vaal for power generation
Middle Olifants	8	From the Letaba catchment
Lower Olifants	3	From Letaba catchment
TOTAL	**249**	

Current Groundwater

Management Zone	Source/Used by	Estimated Yields (million m^3/a)
Upper Olifants	Rural Coal mining	20
Middle Olifants, including Polokwane and Mokopane	Rural Sekukhune Polokwane Wellfields Wellfields near Mokopane Steelpoort mines Mokopane mines	35
Lower Olifants	Rural	3
Total		**58**

Available Yield (2010)

(All in million m^3/a)

Manage-ment Zone	Yield of major dams	Diffuse sources	Transfers In	Other Sources	Ground-water	Total
Upper Olifants	272	104	230	4	20	630
Middle Olifants	110	32	8	0	35	185
Lower Olifants	199	43	3	0	3	248
TOTAL	**581**	**179**	**241**	**4**	**58**	**1 063**

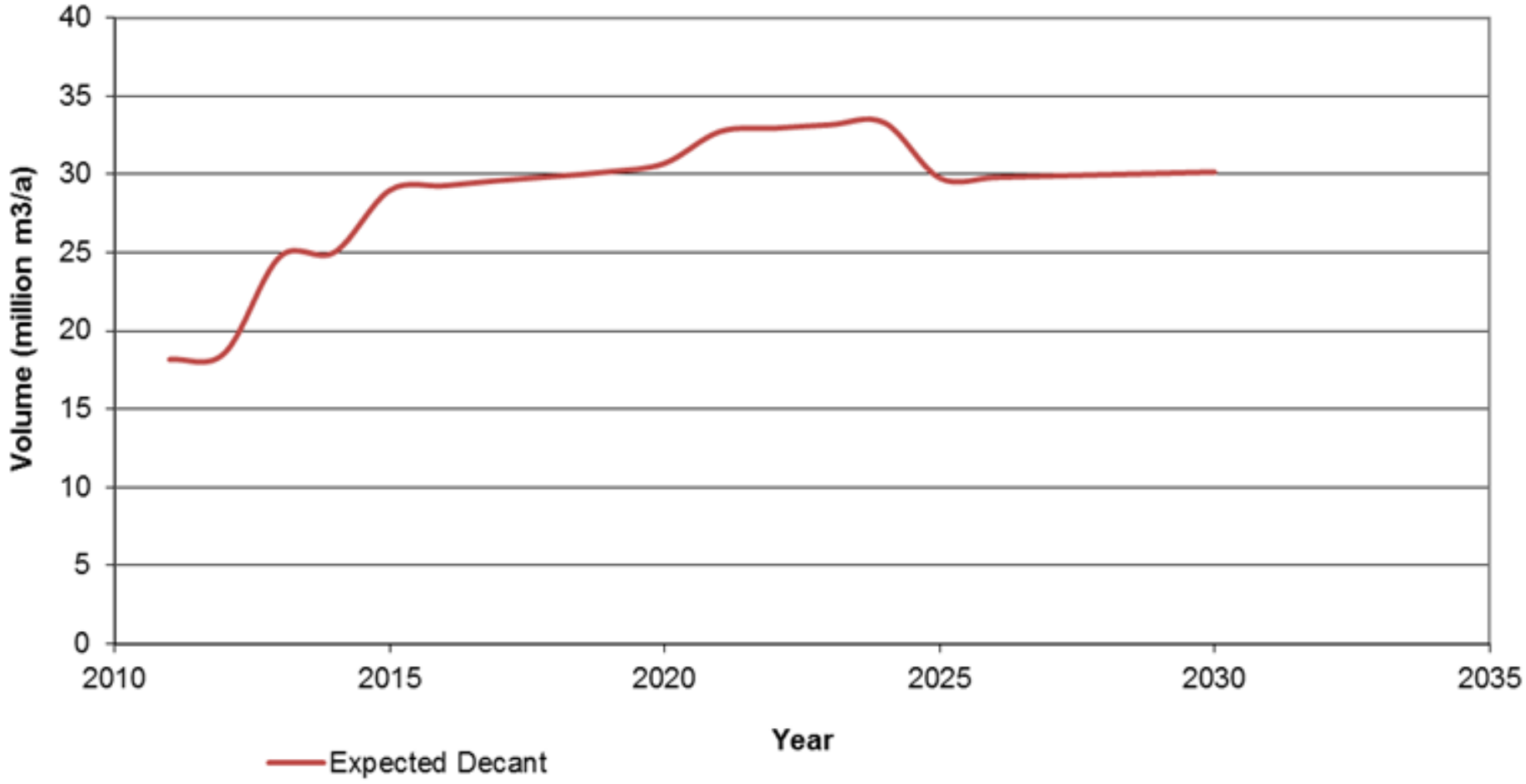
Other Sources: Additional yield from coal mine acid mine drainage

- Existing Treatment plant 9.1 million m^3/a – supply to eMalahleni - Witbank Dam Catchment
- Current additional yield as a result of this plant is approximately 4 million m^3/a
- The capacity of the eMalahleni plant is to be doubled to 18.2 million m^3/a
- 5.5 million m^3/a plant commissioned for decant water from the Optimum Mine – Middelburg Dam Catchment

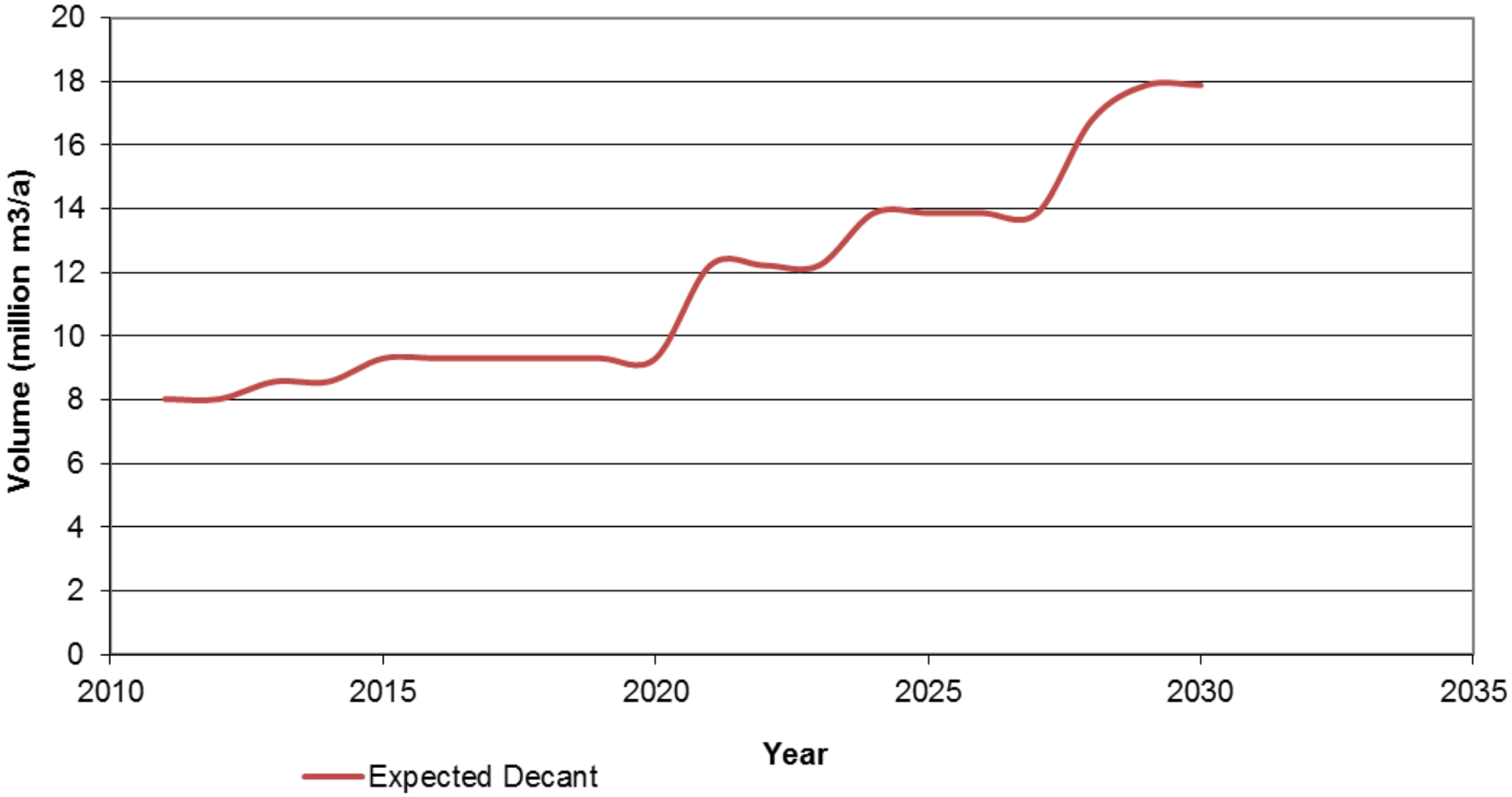
Future expected yields as result of coal mining activities

- In the near future, water from other coal mines will start to decant
- The expected additional yield was modelled by Golder Associates
- These are significant quantities of water (up to 22 million m^3/a in 2035)
- Water is however very acidic and has to be treated before use or discharge into rivers

Increase in yield as result of Mine Water Witbank Dam Catchment



Increase in yield as result of Mine Water Middelburg Dam Catchment



Latest information on yield of Phalaborwa Barrage

- The yield of the Phalaborwa 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

6 Water Quality

- Background
- Sources of pollution
- Actual water quality versus water quality objectives
  - Water assessment categories
  - Sampling sites used
  - Water quality situation in the Olifants River System
  - Trend Analysis

Water Quality

- Number of water quality concerns
- Primarily situated downstream and close to sources of pollution
- Localised water quality problems must be addressed by intensified CME and by reducing contamination at source
- The current quality of the water in the catchment is generally acceptable, but not for all users

Water Quality *(Continued)*

- The water quality does not affect the management or availability of the resource (dilution is not required)
- Treatment of AMD is essential to protect the water quality in the Loskop Dam catchment
- Immediate attention should be given to the upward trends, especially EC, CL- and SO_4

7 The Water Balance

- Current water balance with no interventions
- Future water balance with no interventions

Current Water Balance with no Interventions (2010 status quo)

(All in million m^3/a)

Manage-ment Zone	Total water resource	Water Require-ments	Minimum flow rule	Losses	Water Balance
Upper Olifants	630	609	0	0	21
Middle Olifants	185	187	(19)	0	(21)
Lower Olifants	248	220	(19)	(5)	4
Total	**1 063**	**1 016**	**(38)**	**(5)**	**4**

Note: Values in brackets are negative
De Hoop dam's yield excluded

Current Water Balance with De Hoop Dam (and EWR)

Manage-ment Zone	Total water resource	Water Require-ments	EWR impli-cations	Losses	Water Balance
Upper Olifants	630	609	(40)	0	(19)
Middle Olifants	284	187	(57)	0	40
Lower Olifants	248	220	(60)	(5)	(37)
Total	**1 162**	**1 016**	**(157)**	**(5)**	**(16)**

Note: Values in brackets are negative
De Hoop dam's yield included

Current Water Balance with De Hoop Dam (and EWR)

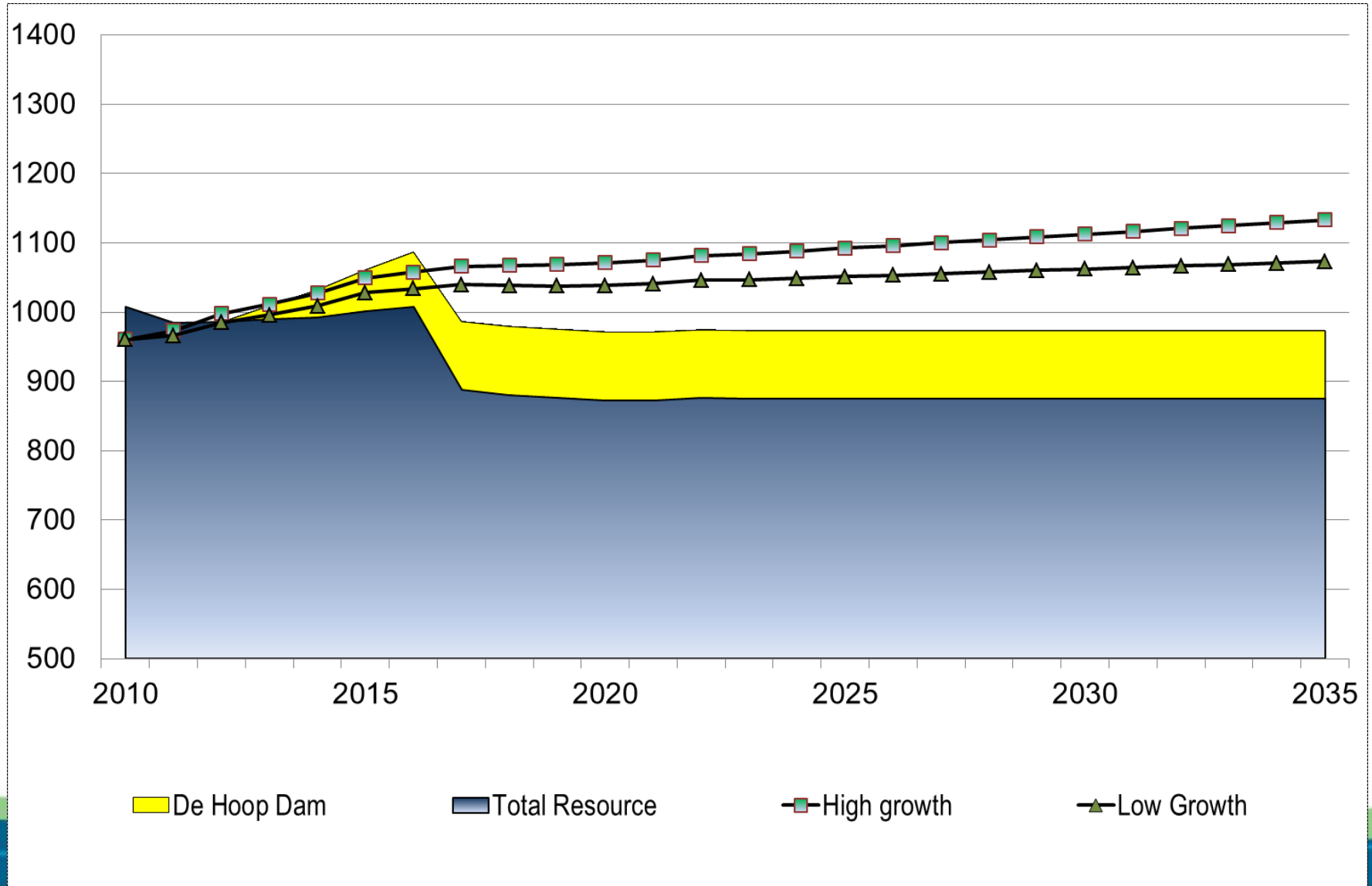
Manage-ment Zone	Total water resource	Water Require-ments	EWR impli-cations	Losses/ Gains	Water Balance
Upper Olifants	630	609	(40)	0	(19)
Middle Olifants	284*	187	(57)	0	40
Lower Olifants	248	220	(60)	(5) 40**	3
Total	**1 162**	**1 016**	**(157)**	**35**	**24**

Notes: Values in brackets are negative

* De Hoop dam's yield included

** Surplus from Middle

Projected Future Water Balance for the whole Olifants Catchment



8 Possible Intervention Scenarios

- Introduction
- Reconciliation options that will reduce water use or water requirements
  - Eliminating unlawful water use
  - Water conservation and water demand management
  - Reducing assurance of supply
  - Compulsory Licensing
  - Water trading

Note: Options in red are the recommended options

8 Possible Intervention Scenarios (continued)

- Reconciliation options that will increase water supply
  - Groundwater development
  - Transferring treated effluent from the East Rand
  - Transferring more water from Vaal Dam
  - Dam construction to increase yield through storage
  - Utilising AMD in the Upper Olifants
  - Reusing sewage effluent Polokwane & Mogalakwena
  - System operating rules
  - Rainfall enhancement
  - Removal of IAPs
  - Water transfer from the Crocodile (W) River System
  - Desalinisation of sea water

8 Possible Intervention Scenarios (continued)

- Considerations for selecting the most appropriate reconciliation options
  - Basis for water reconciliation
  - International obligations
  - Summary of the yield and cost information of the reconciliation options
  - Selection of reconciliation scenarios

Reconciliation Options

- Options that will reduce water requirements
- Options that will increase the water supply

Selection Process Followed

Considerations for selecting the most appropriate Reconciliation Options

Selection Criteria

- Fatal flaw
- Satisfy International obligations
- Political acceptability
- URV
  - Yield contribution / water requirement reduction
  - Capital cost of option
  - Operational cost of option
- Biophysical impacts
- Social impacts

Selection Criteria (Continued)

- Ease of implementation
- Capacity of implementing institution
- Time required to implement
- Risk
- Acceptability to users

Obligations Of The SA Government Towards Mozambique

- Treaty on the raising of Massingir Dam
  - SA/Portugal 1971
  - Portugal accepted that water in the Olifants would decrease
  - SA may not use water out of Massingir
- SA signatory to SADC Revised Protocol
  - May not cause harm to neighbouring state
  - States must exchange information

Environmental Screening Of Options

Environmental screening aims to:

- summarise any key environmental or social issues that should be taken into account when considering and comparing options;
- identify any environmental or social “fatal flaws” or “red flags” associated with any of the projects; and
- identify environmental authorisations that will be required for any of the projects.

Reconciliation options that can reduce water requirements

- Eliminating unlawful water use
- Water Conservation and Water Demand Management (WC/WDM) in the irrigation sector
- WC/WDM in the domestic water use sector
- WC/WDM in the mining sector
- Reducing assurances of supply
- Water trading
- Compulsory licensing (Conditions for application)

Selected reconciliation options that can reduce water requirements

Recommended Options:

- Elimination of unlawful water use
- WC/WDM in urban, irrigation and mining sectors
- Water trading

Unlawful water use

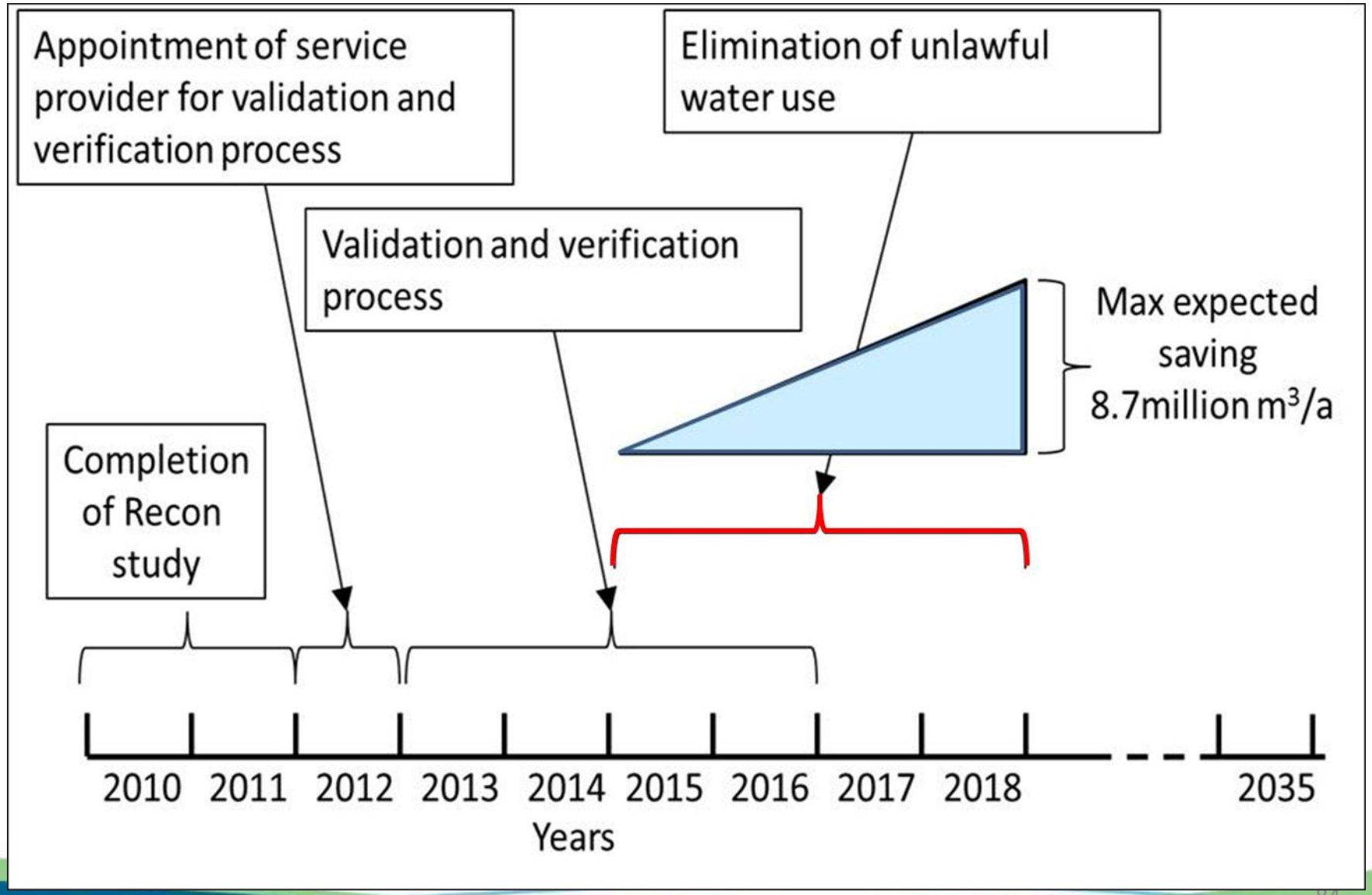
- Irrigation in 1998 – 488 km^2
- Irrigation in 2004 – 593 km^2

} (OWAAS Report)

- Increase 105 km^2
- Impact on yield - 17.4 million m^3/a
- Not all the increased irrigation can be regarded as unlawful
- Portion of impact can only be confirmed on completion of the Validation & Verification process
- Strategy accepted a conservative 50%, i.e. 8.7 million m^3/a

(Recommended)

Unlawful water use - Timing



WC/WDM – Irrigation Sector

- Improved Irrigation Systems – 19 million m^3/a
- Reduction in leaks on bulk conveyance systems - 16 million m^3/a
- Total expected savings - 35 million m^3/a (7.3% of total requirements)
- Phased in over 5 years
- These savings should be consolidated for re-allocation by administrative procedures, otherwise they will be used for horizontal expansion by the farmers
- Possible procedures
  - Link WCDM to Compulsory Licensing (takes too long)
  - Link to water trading **(Recommended)**

WC/WDM Urban Sector

- WC/WDM strategies were available for Emalahleni and Lebowakgomo
- Water savings for these two towns were extrapolated to the other towns
- Expected saving – 20 million m^3/a (11.3% of current urban requirements)
- Phased in over 5 years

(Recommended)

WC/WDM Mining Sector

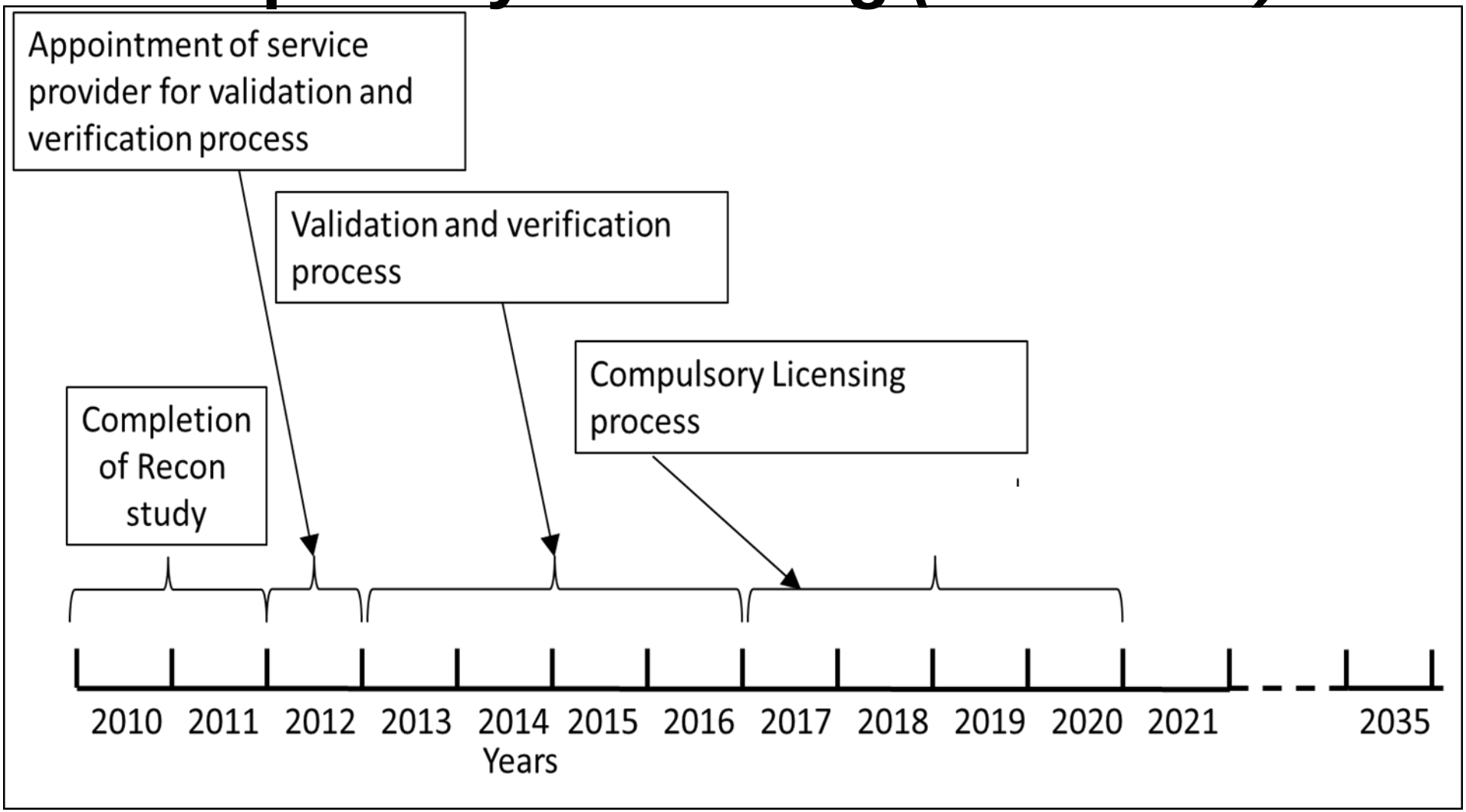
- Expected saving 5 million m^3/a (5.9% of current mining requirements)
- Processes of some mines need to be changed, therefore they need more time
- 10 year phasing period was adopted

(Recommended)

Compulsory Licensing

- It is proposed that Compulsory Licensing is regarded as a contingency measure, because:
  - Social consequences, e.g. economic prejudice and job losses must be considered
  - Timing problem
- Compulsory Licensing is used to correct imbalance
  - If you only reduce everyone's use by 10% then the social consequences will probably not be that significant.
  - It will however be time consuming and has risks because of appeals. **(Not Recommended now)**

Compulsory Licensing *(Continued)*

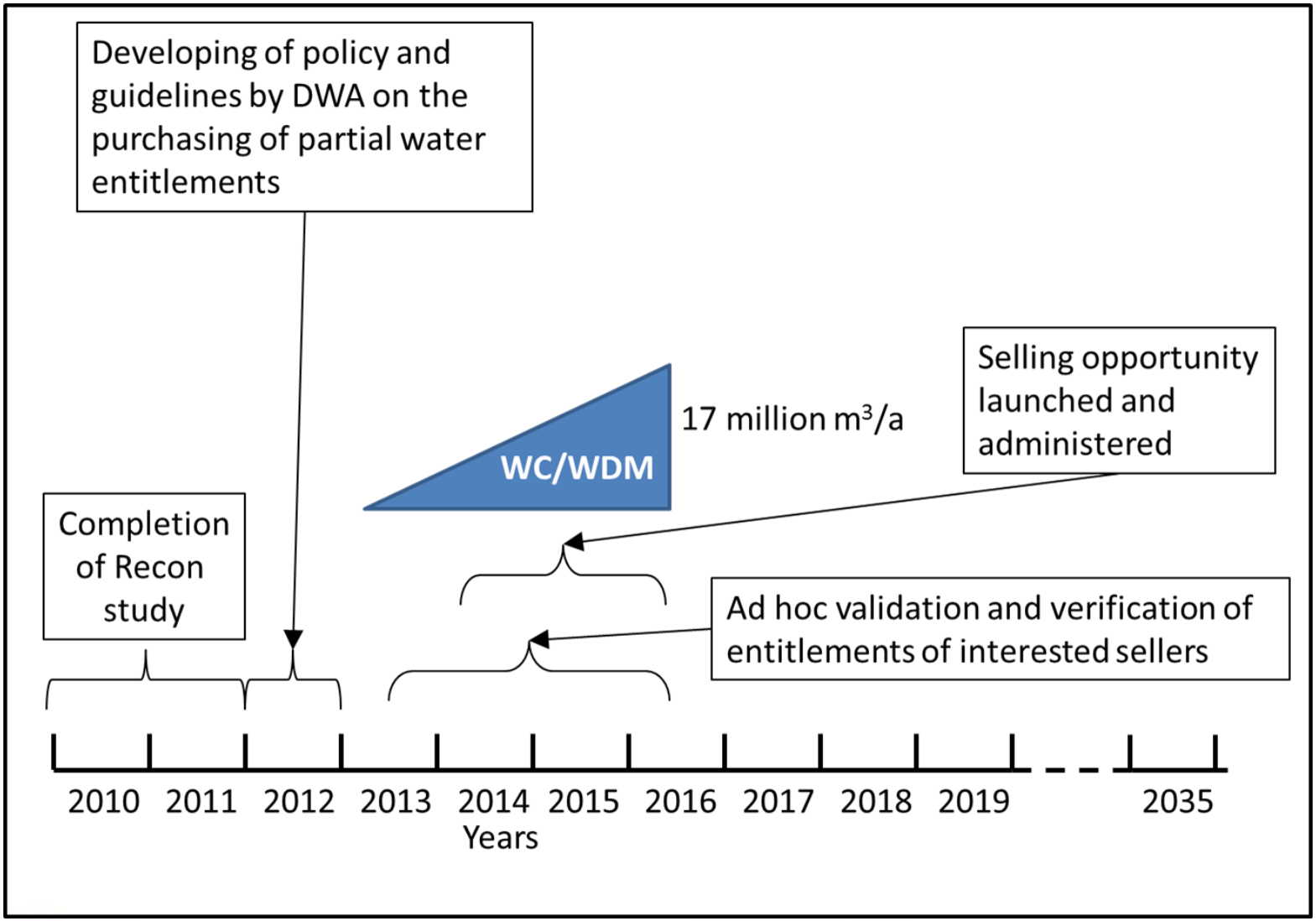


Water Trading

- Promising if linked to WC/WDM
- Irrigators are given an opportunity to offer their saved water for sale without suffering economic prejudice
- Funding could be obtained by either
  - Charging a levy on all water users in the catchment, or
  - Funds from the fiscus, recovered through water tariffs
- Policy and guidelines required to avoid misuse and social consequences.
- Strategy assumed that only half of the irrigation WC/WDM will be put on offer, i.e. 17.5 million m^3/a

(Recommended)

Water Trading – WC/WDM



Water Trading (Continued)

- Also possible to buy/sell full water entitlement
- Based on willing buyer/seller principle
- Should be well regulated as it could lead to severe social impacts and job losses.
- This is a definite option but it has not been factored into the reconciliation strategy as the willingness of buyers and sellers is uncertain

(Recommended , but is not as yet necessary – was regarded as a contingency measure and was not taken into account for the strategy)

Selected Reconciliation Options That Can Increase Water Supply

Recommended Options:

- Removal of Invasive Alien Plants
- Refinements to system operating rules
- Groundwater development
- Utilising AMD in the Upper Olifants zone
- Reusing sewage effluent in Polokwane and Mogalakwena

Removal of Invasive Alien Plants

- 21 million m^3/a of the yield are being taken up by IAPs – based on areas in OWAAS Report
- WfW teams are already busy removing IAPs
- Programme must be continued and intensified
- The strategy assumed that 50% of the 21 million m^3/a can be gained over the planning period of the study, i.e. 11.5 million m^3/a

(Recommended)

Refinements To System Operating Rules

- Loskop, Flag Boshielo, Witbank, Middelburg and De Hoop Dams should be operated as a system
- Better yields can be obtained by operating these dams conjunctively
- A separate study is required to work out the details

(Recommended but not included)

Rainfall Enhancement Through Cloud Seeding

- Experiments in the Vaal Catchment weren't very successful

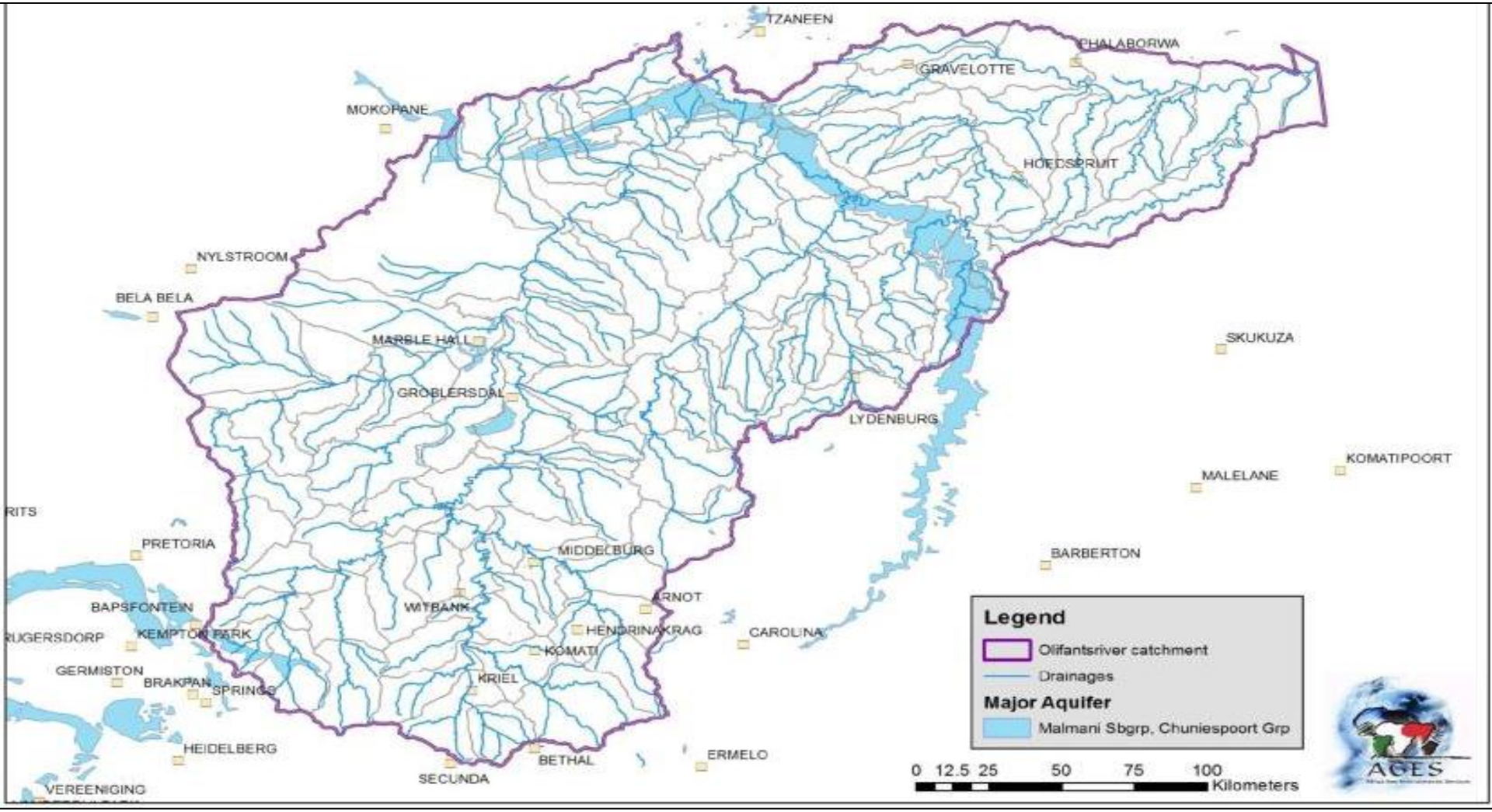
(Not Recommended)

Groundwater development

- Individual projects wherever groundwater is available (Recommended – allowed only 35 million m^3/a of the 70 million m^3/a potential)
- Possible regional water scheme with the Malmani dolomites as resource should be investigated
  - Impact of groundwater abstraction on surface water base flow
  - Possibility of artificial recharge with surface water where the Olifants River crosses the Malmani aquifer

  (Recommended)

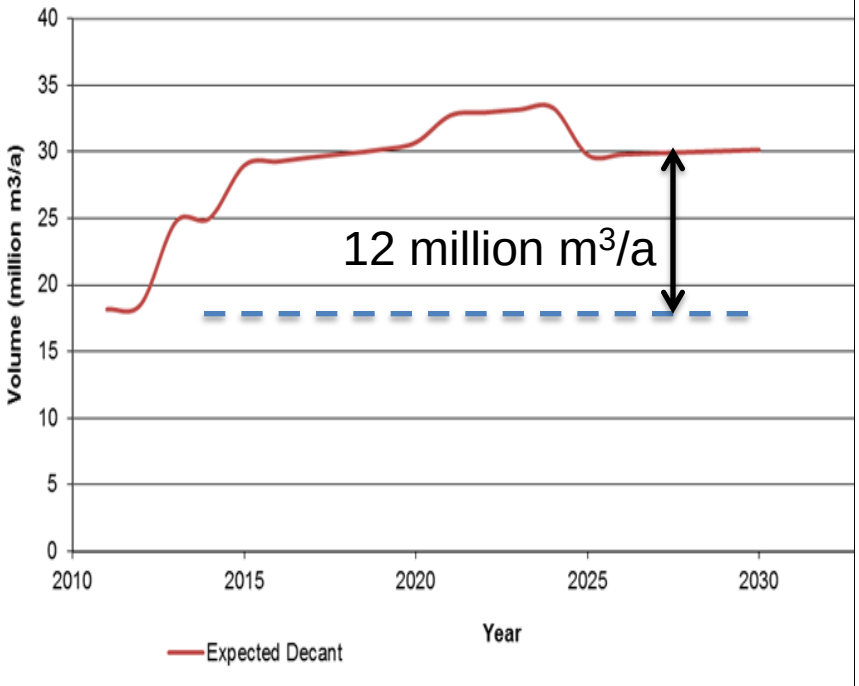
Groundwater availability: Olifants WMA Dolomitic Distribution



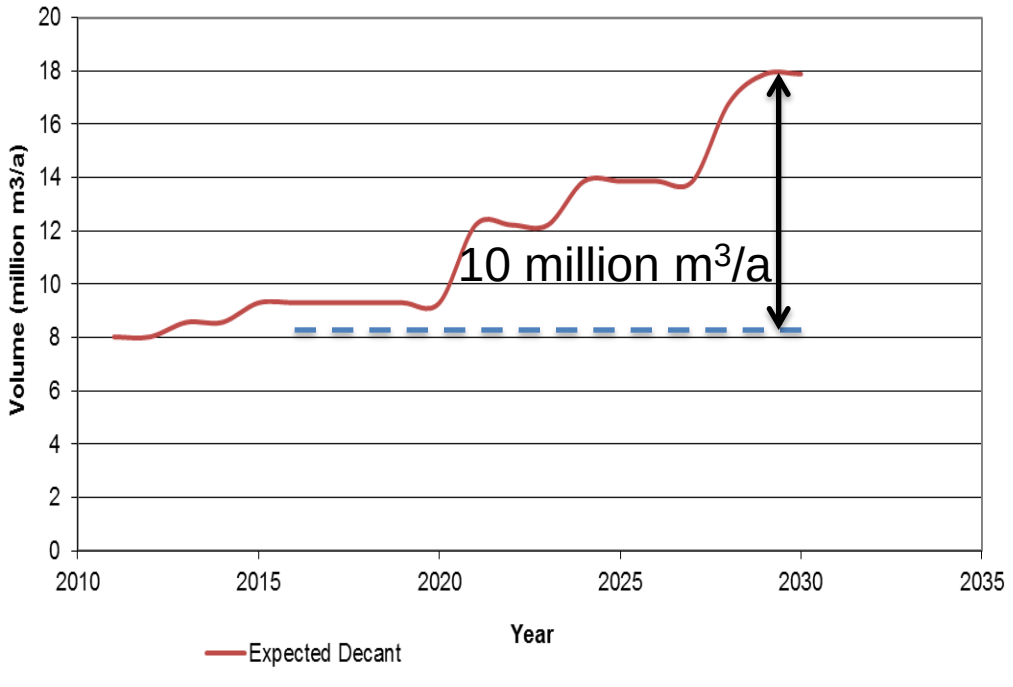
Utilising AMD In Upper Olifants

- Additional yield due to modified system in the Upper Olifants (increases to 22 million m^3/a in 30 years' time) (Recommended)

Witbank Dam Catchment



Middelburg Dam Catchment

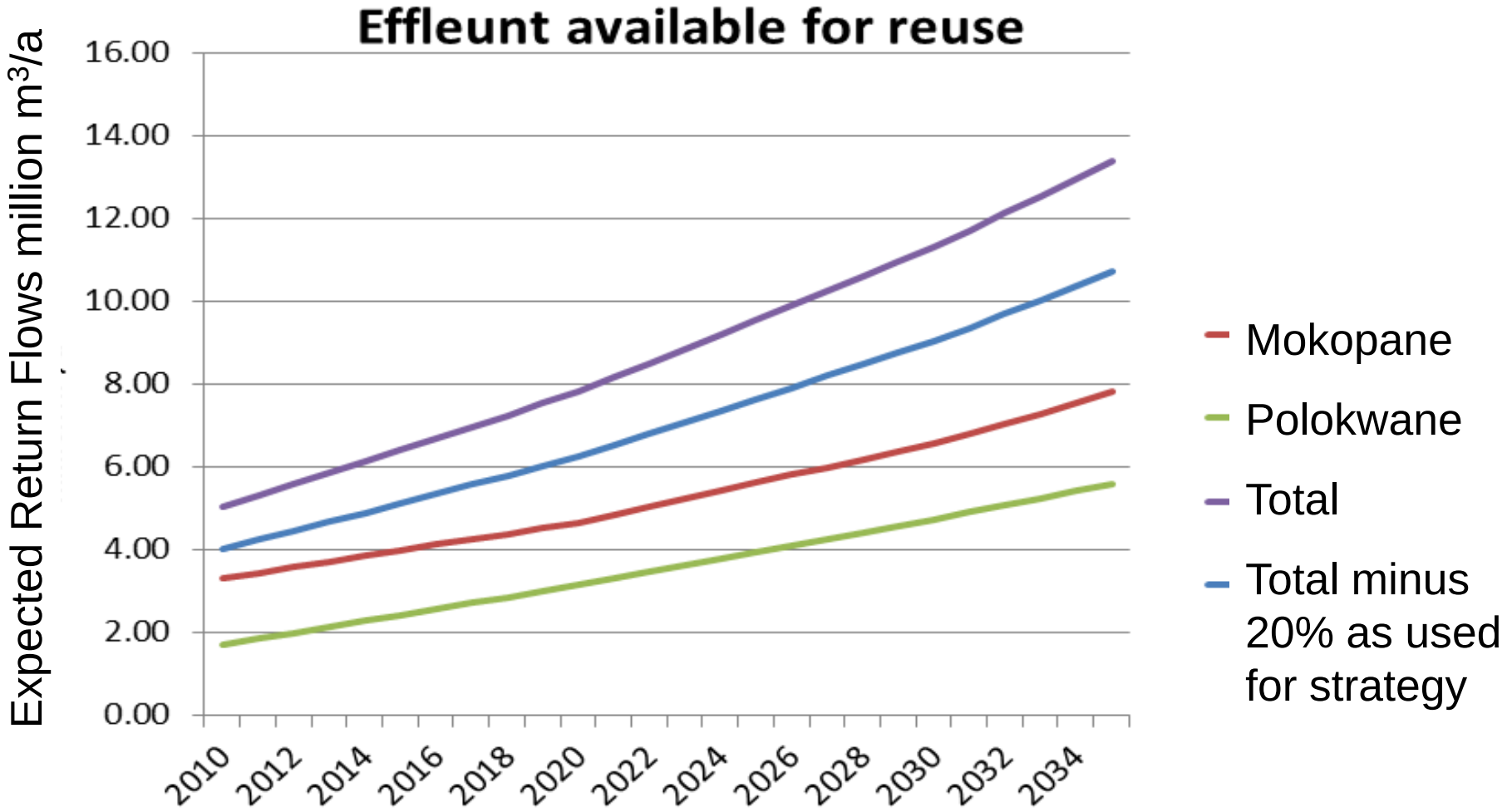


Reuse of Sewage Effluent – Polokwane and Mokopane

- Transfer water from Olifants Catchment can be reduced if Polokwane and Mokopane reuse their sewage effluent or make this water available to the mines
- Polokwane is already making 8 million m^3/a available
- Additional quantities can be reused
- Different from towns like Emalahleni and Steve Tshwete where sewage water remains in system and can be reused downstream

Recommended

Reuse of sewage effluent – Polokwane and Mokopane

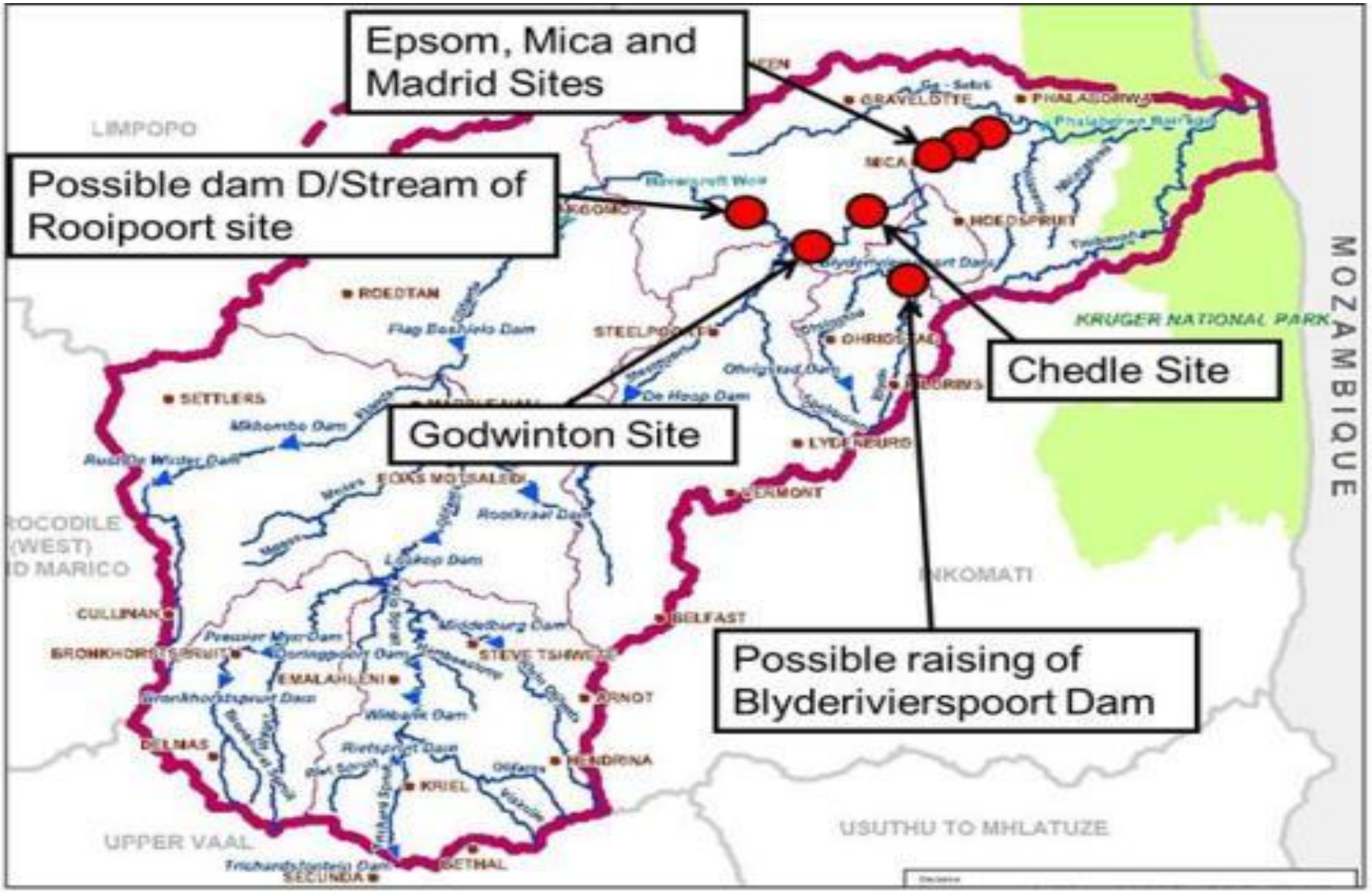


Infrastructure options in the Olifants Basin that can increase water supply (Continued)

Options considered, but not recommended:

- Raising of the Blyderivierspoort Dam (URV ≈ R1.0/m^3)
- A new dam in the Lower Olifants:
  - In Olifants Gorge (URV ≈ R 0.15 – R 0.20/m^3)
  - Other locations: (URV ≈ R1.60 to 1.70/m^3)
- Transferring treated effluent from the East Rand (URV ≈ R15.00/m^3)
- Transferring more water from Vaal Dam (URV ≈ R10.00/m^3)

Dam Sites Considered But Not recommended



Infrastructure options in the Olifants Basin that can increase water supply *(Continued)*

Options considered, but not recommended (Continued):

- Water transfer from the Crocodile (West) River System
- Desalination and transfer of seawater

Costs and URVs: Management Options

Option	Yield/Water Saving (million m^3/a)	Cost as NPV (R million)	URV (R/m^3)
Eliminating Unlawful Irrigation use	8.7	12	0.12
Removal of Alien Invasive Plants	15	120	0.76
WC/WDM: Urban	20	285	1.48
Water Trading	35	32	0.07
Compulsory Licensing	35	32	0.07

Costs and URVs: Development Options

Option	(million m^3/a)	Capital Cost(R million)	URV (R/m^3)
Rooipoort Dam	59	1 140	2.14
Dam in Olifants Gorge: • Godwinton • Chedle	 100 100	 132 200	 0.14 0.20
Dam in Lower Olifants: • Epsom • Madrid	 286 440	 4 820 8 800	 1.58 1.71
Raising of Blyderivierspoort Dam	110	2 977	2.99

Costs and URVs: Development Options (Cont.)

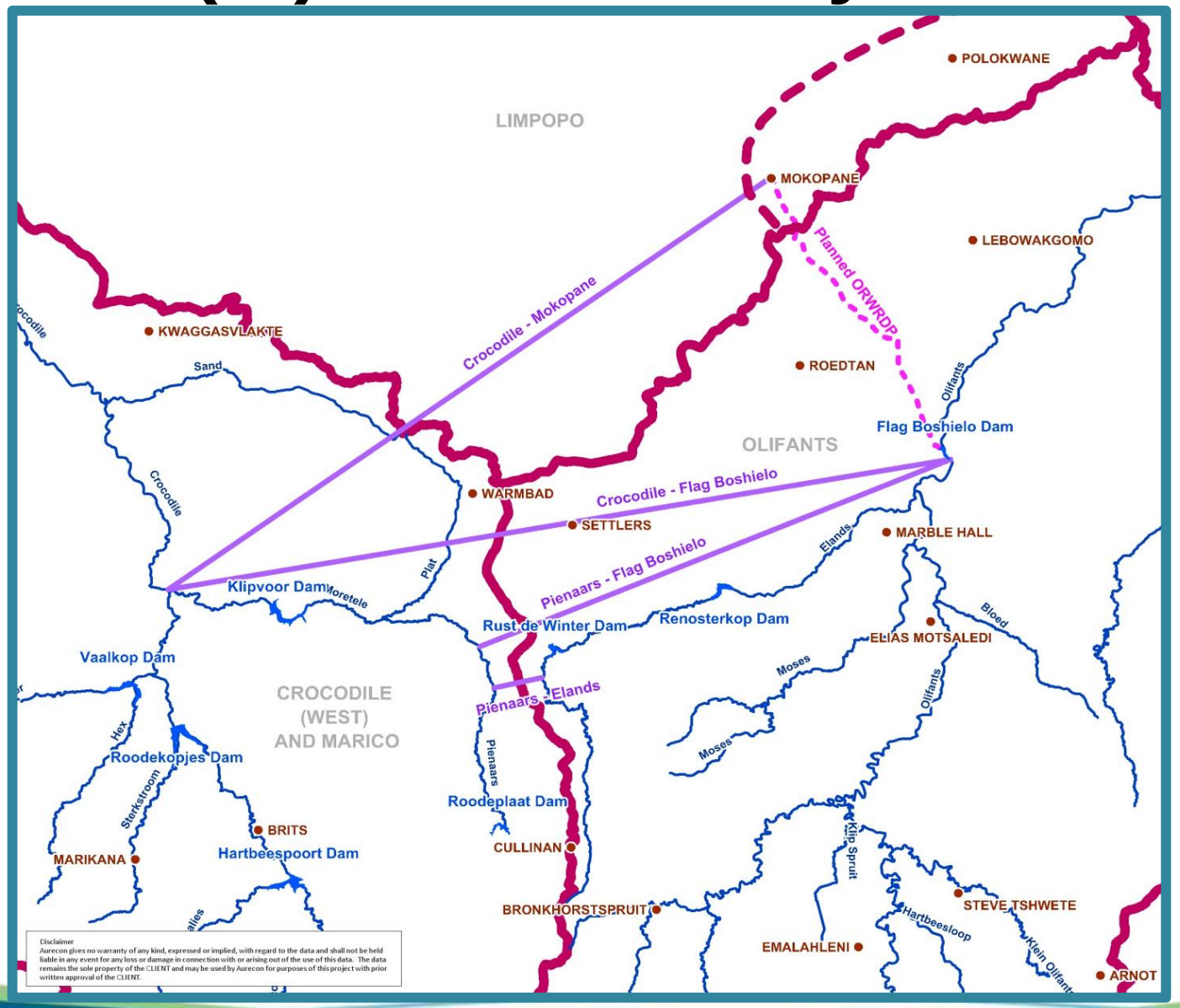
Option	Yield (million m^3/a)	Capital Cost (R million)	URV (R/m^3)
Transfer from ERWAT *	38.3	1 123	7.31
Transfer from Vaal Dam*	160	3 500	3.60
Transfer from Crocodile (West):			
• Pienaars – Flag Boshielo Dam	30	1 268	3.82
• Crocodile – Flag Boshielo Dam	60	3 926	6.43
• Crocodile – Mokopane	25	3 728	14.51
Raising from Massingir Dam	50	2 000	4.85
Desalination of Sea Water	100	12 970	44.45

* *Excludes cost of early augmentation of the Vaal System. (LHFP 2 (URV R6.14/m^3))*

Water Available from Crocodile (West) River Dams

Dam	2015 million m^3/a	2020 million m^3/a	2030 million m^3/a
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 $10^6 m^3$	Cost $x10^6$	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

9 Reconciling The Water Requirements With The Water Resource

- Introduction
- Whole Catchment
  - Selected reconciliation options
  - Water Demand/Water Supply Graphs
- Upper Olifants
  - Selected reconciliation options
  - Water Demand/Water Supply Graphs
  - Actions that need to be started as a matter of urgency

9 Reconciling The Water Requirements With The Water Resource (Cont'd)

- Middle Olifants
  - Distributing De Hoop Dam water
  - Selected reconciliation options
  - Water Demand/Water Supply Graphs
  - Split between Steelpoort River and Olifants River Main Stem
  - Actions that need to be started as a matter of urgency
- Lower Olifants
  - Present situation
  - Selected reconciliation options
  - Water Demand/Water Supply Graphs
  - Actions that need to be started as a matter of urgency

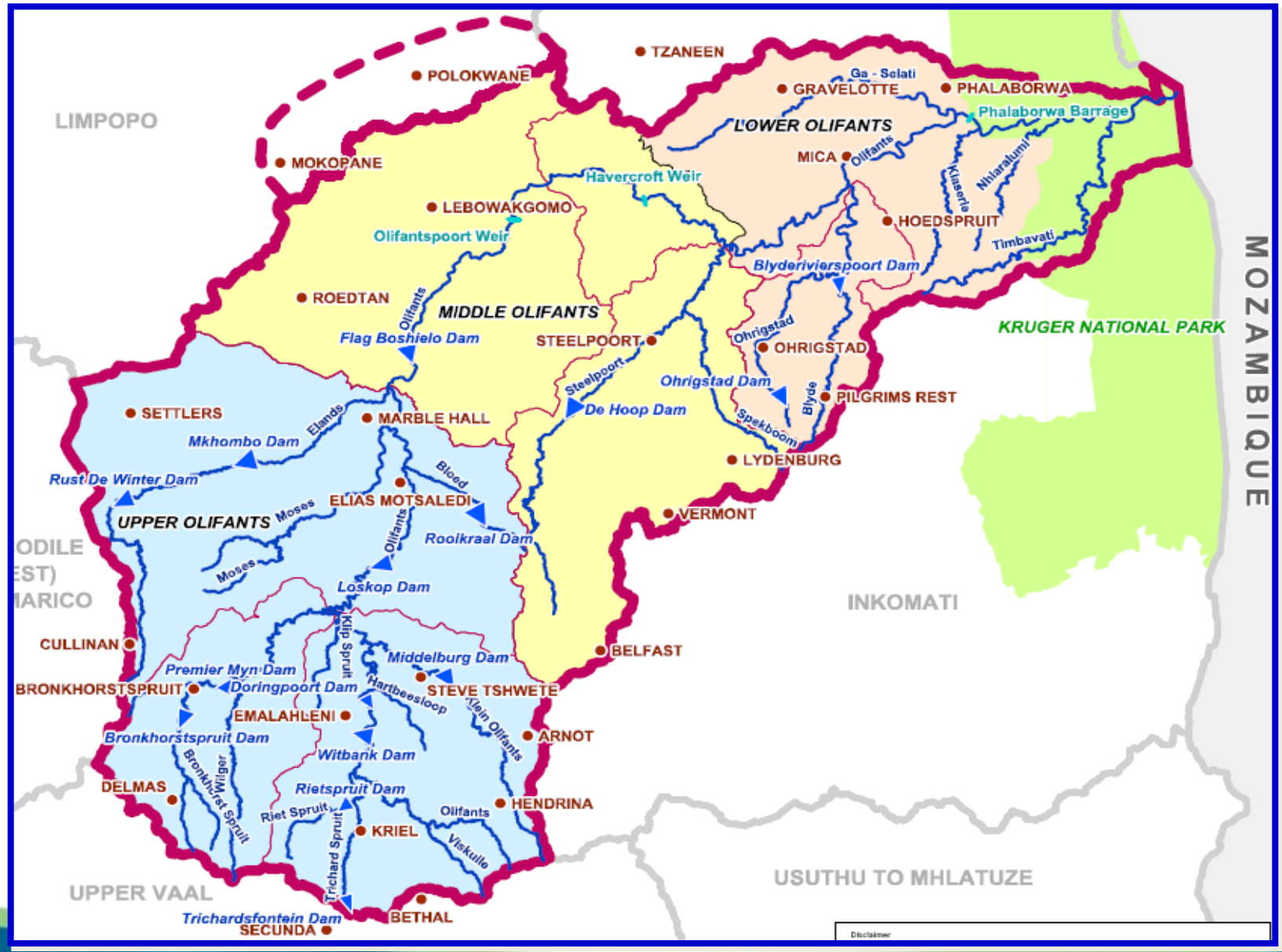
Basis for Water Reconciliation

- South Africa will meet its International Obligations.
- The Reserve is a priority
  - EWRs to meet the recommended ecological category will be maintained
  - The water for basic human needs will be supplied
- Unlawful water use will be eliminated
- Water for strategic users for the benefit of the country must receive priority before any other economic development

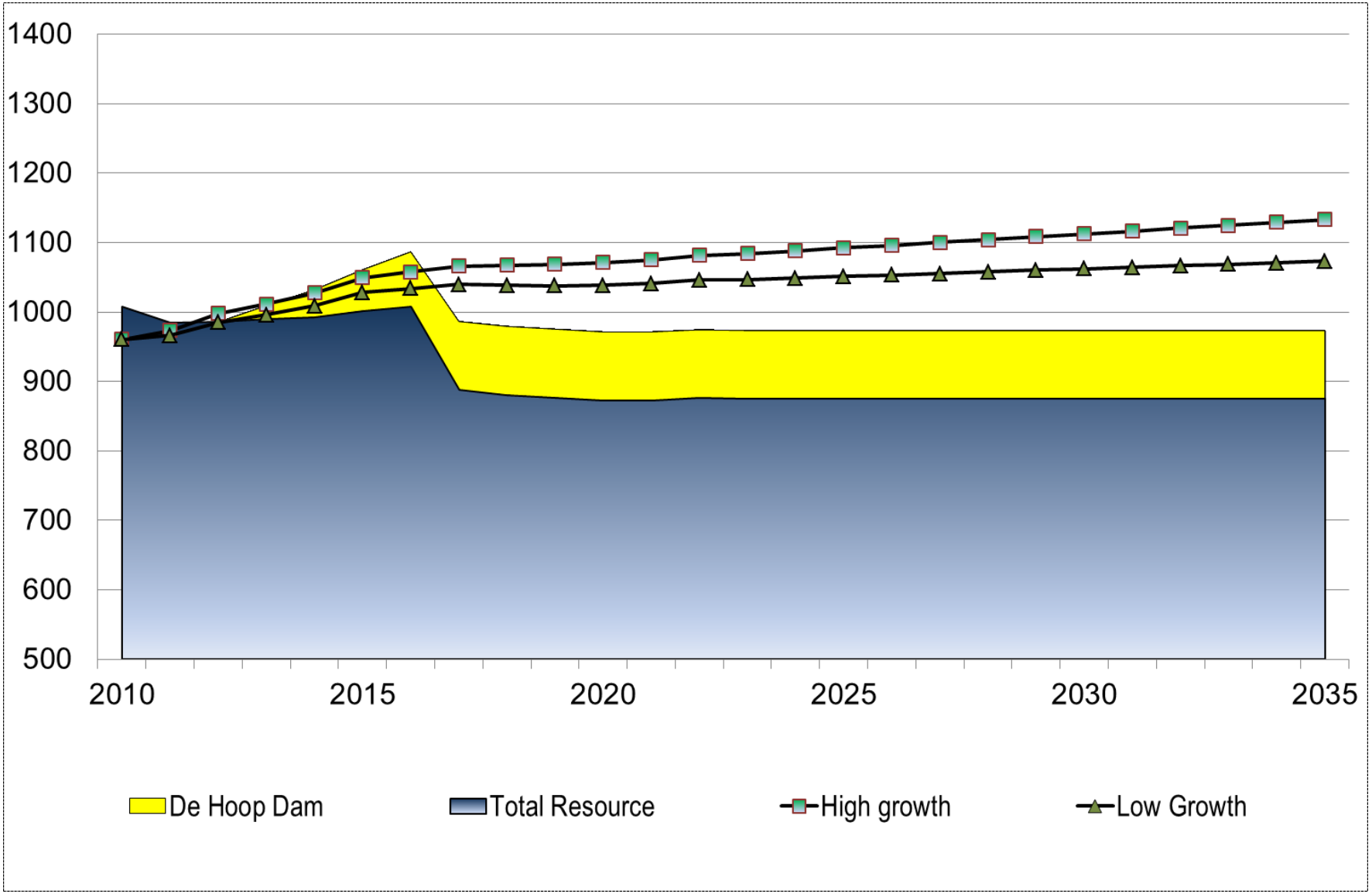
Basis for Water Reconciliation *(Continued)*

- Water for socio-economic development within the policy parameters of the government will be provided.
- There will be no increase in total water allocations for irrigation.
- No increase in forestry areas.

Whole Catchment



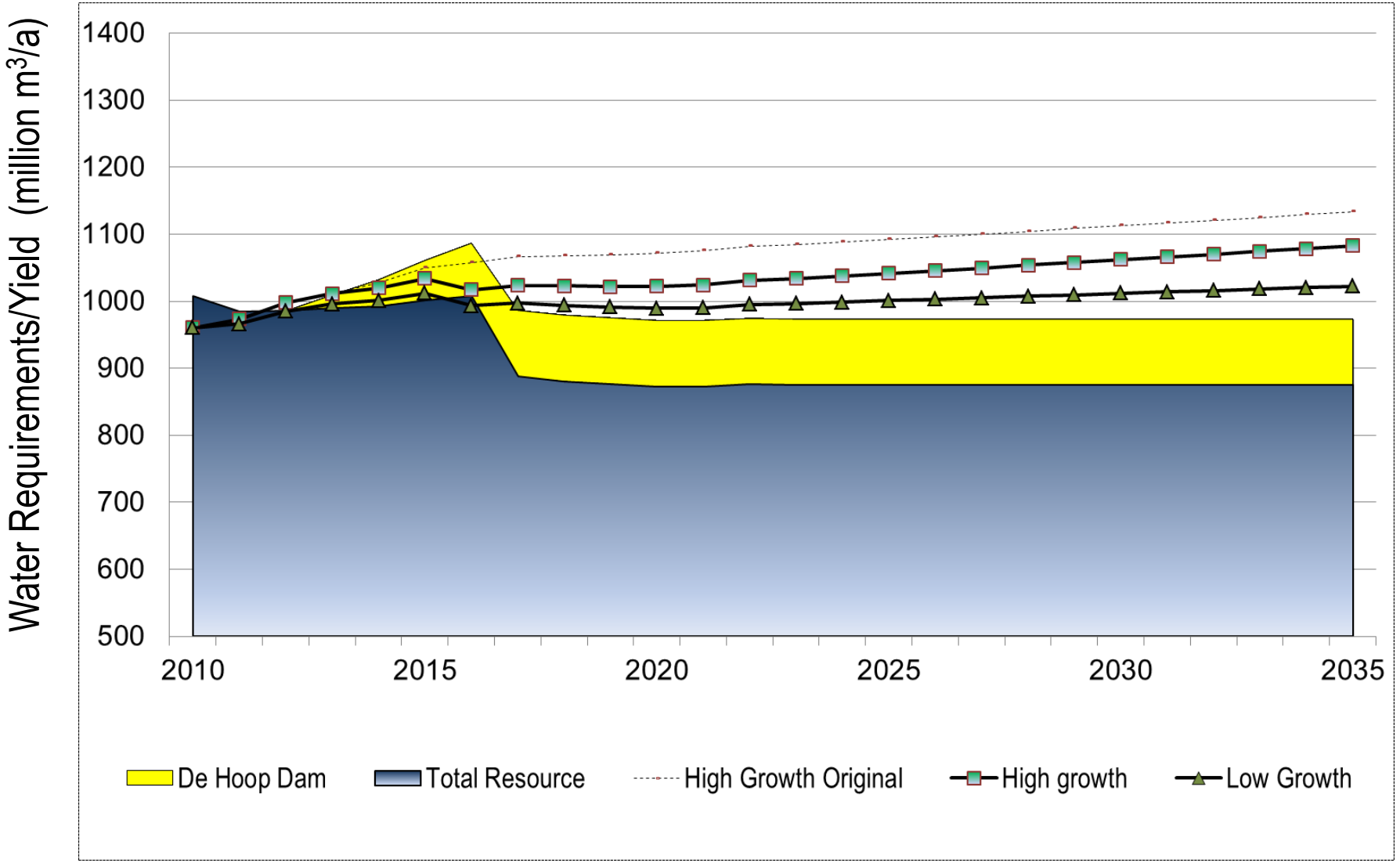
Whole catchment: Current situation, with De Hoop Dam and EWRs operationalized in 2016



Whole Catchment: Selected options that will reduce water requirements

Envisaged Intervention	Exp Δ saving million m^3/a	Exp Date Opera-tional	Time to Full Saving (Y)
WC/WDM for irrigation and savings offered to purchase	17	2013	5
WC/WDM Urban	19.8	2013	5
WC/WDM Mining	5	2013	10
Eliminating unlawful water use	8.5	2015	5

Whole Catchment: Effect of implementing selected reconciliation options that will reduce the water requirements

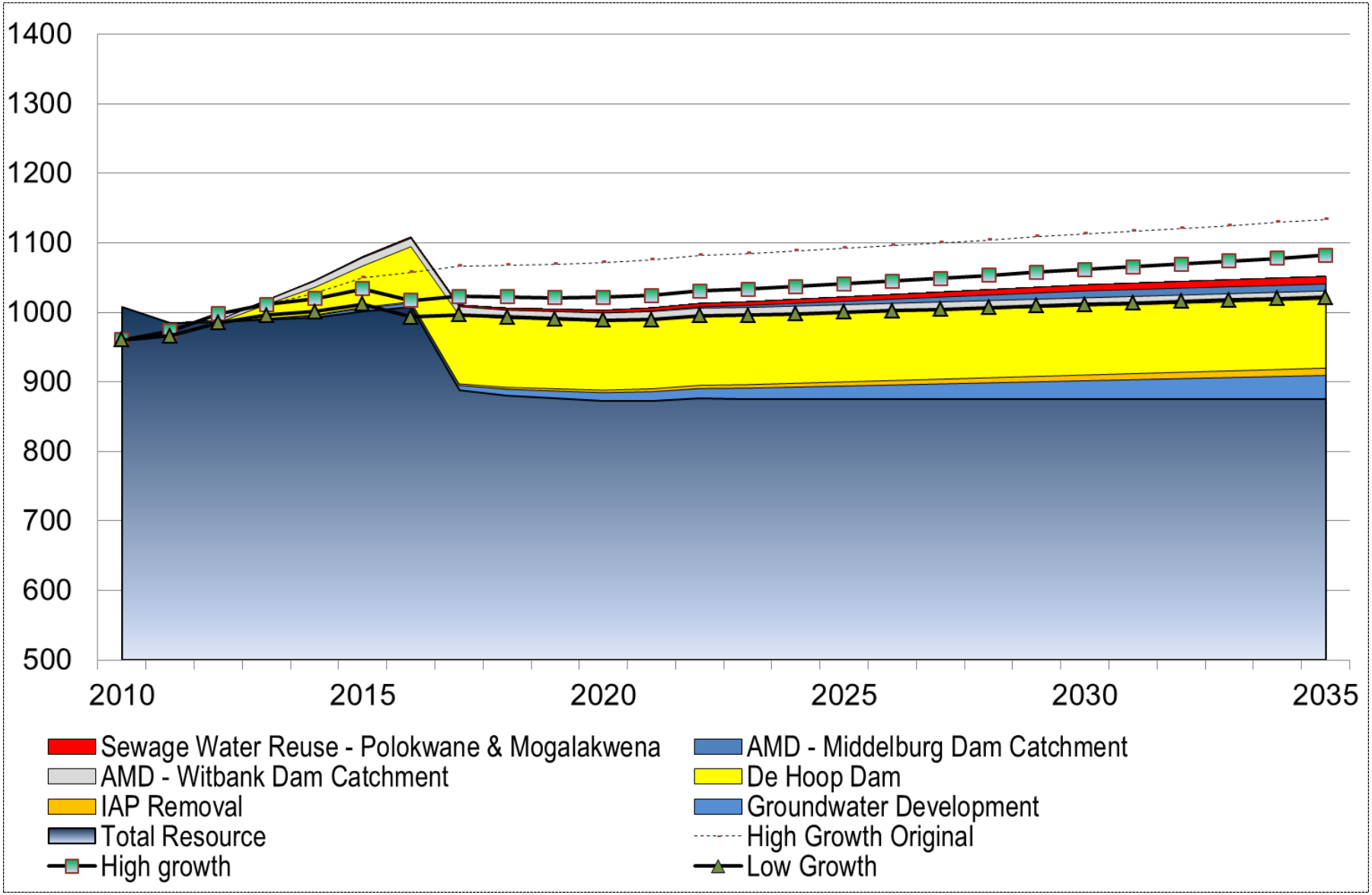


Whole Catchment: Selected options that will increase the water supply

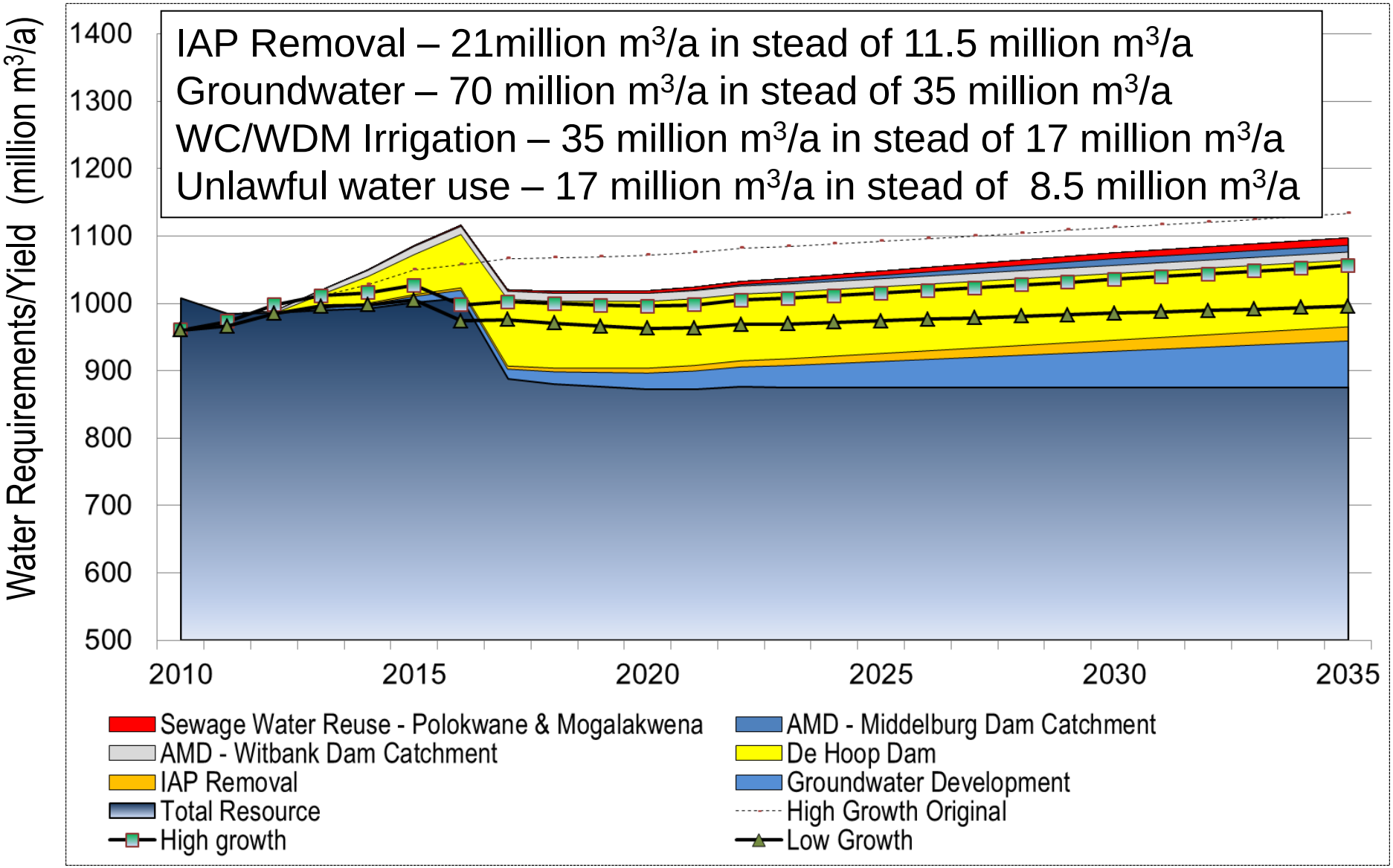
Envisaged Intervention	Exp Δ saving million m^3/a	Exp Date Opera-tional	Time to Full Yield (Y)
Removal of IAPs	10.5	2010	25
Groundwater development	35	2012	23
Treatment of decanting water from coal mines in Witbank Dam catchment	12	2012	20*
Treatment of decanting water from coal mines in Middelburg Dam catchment	10	2020	2030*
Sewage water reuse – Polokwane and Mogalakwena	11	2012	23

* Not linear.

Whole Catchment: Added effect of implementing selected reconciliation options that will increase the water supply

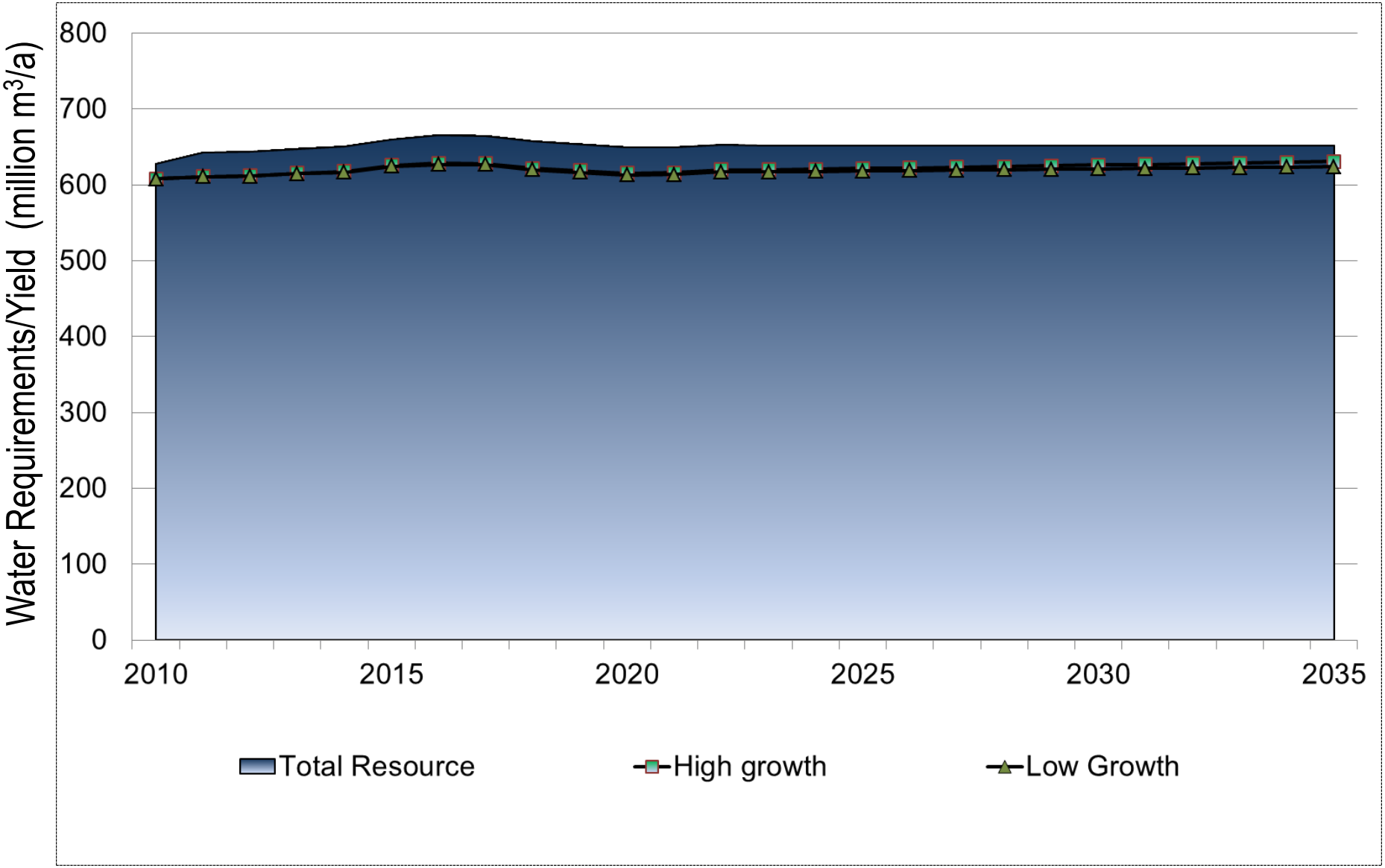


Whole Catchment: Consider reconciliation options less conservative than in the strategy

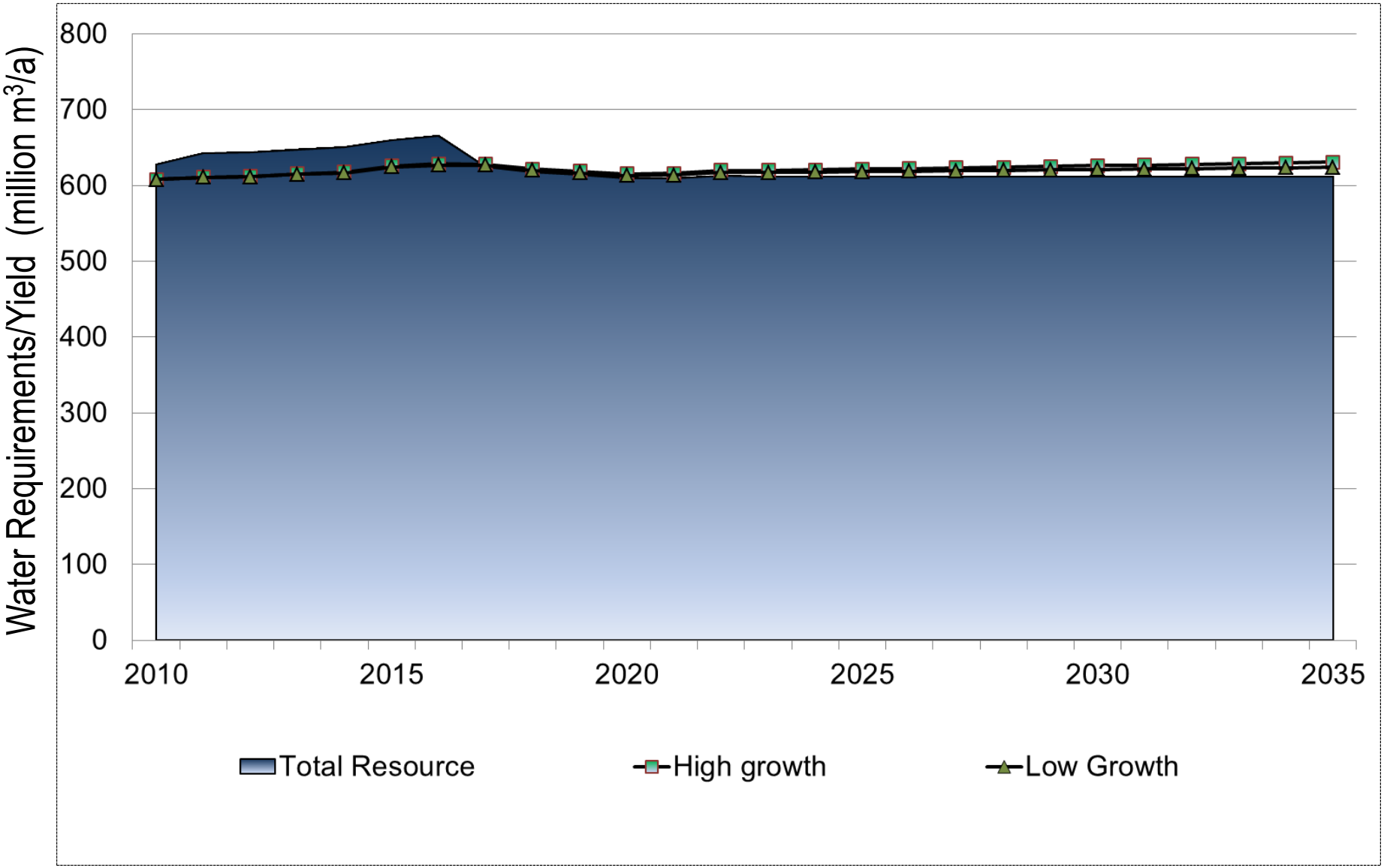


Upper Olifants Management Zone

Upper Olifants – Current situation with no reconciliation options , nor EWR operationalised



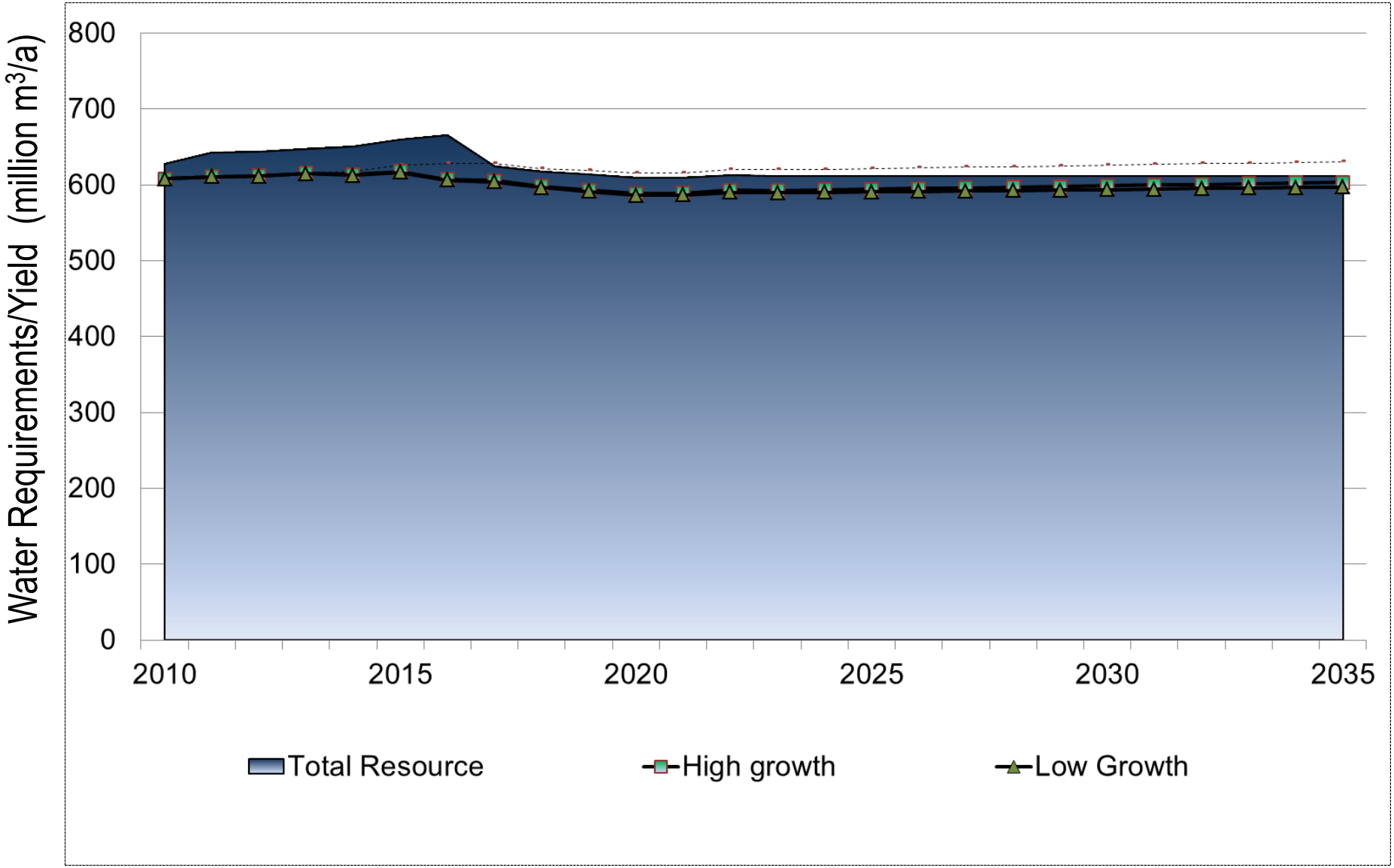
Upper Olifants – Current situation, no reconciliation options and EWR operationalised in 2016



Upper Olifants: Selected reconciliation options that will reduce water requirements

Envisaged Intervention	Esp. Δ saving million m^3/a	Exp Date Opera-tional	Time to Full Saving (Y)
WC/WDM for irrigation and savings offered to purchase	8.8	2013	5
WC/WDM Urban	10.5	2013	5
WC/WDM Mining	1.5	2013	10
Eliminating unlawful water use	6.4	2015	5

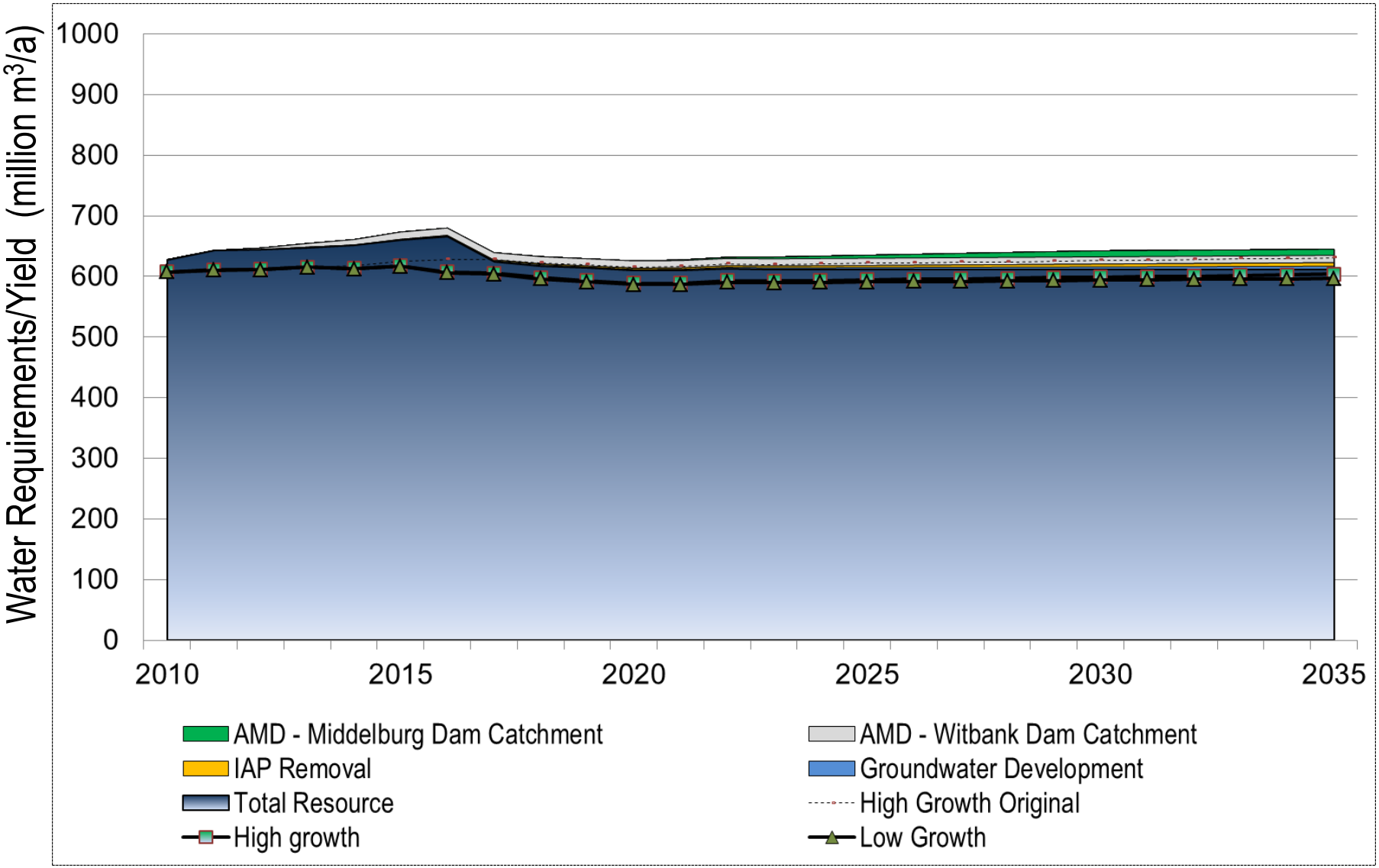
Upper Olifants: Effect of implementing selected reconciliation options that will reduce the water requirements



Upper Olifants: Selected reconciliation options that will increase the water supply

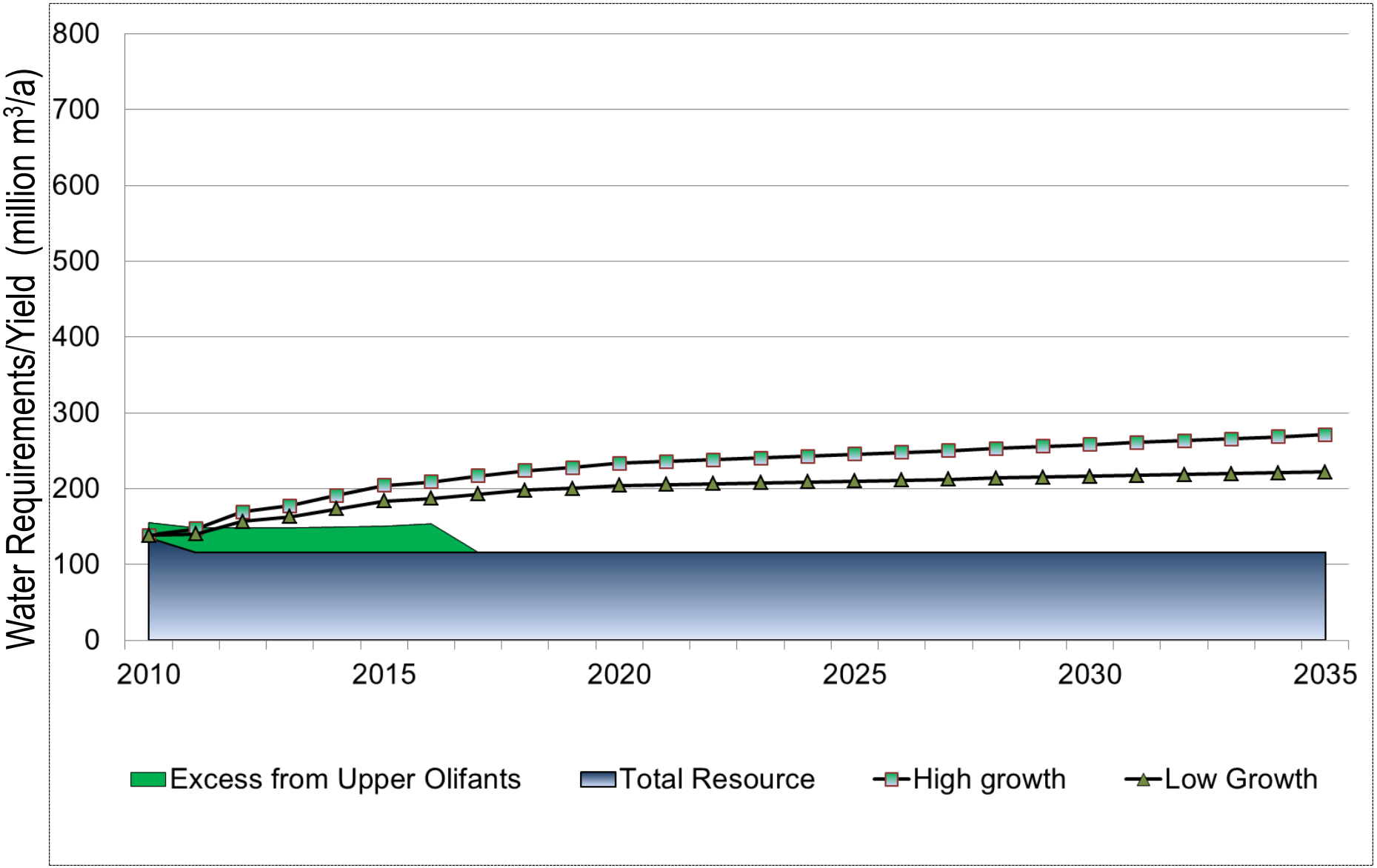
Envisaged Intervention	Exp ∆ saving million m^3/a	Exp Date Opera-tional	Time to Full Yield (Y)
Groundwater development	5	2012	23
Water reuse – from coal mines in Witbank Dam Catchment	12	2011	5
Water reuse – from coal mines in Middelburg Dam Catchment	10	2020	10
IAP removals	5.9	2012	23

Upper Olifants: Added effect of implementing selected reconciliation options that will increase the water supply

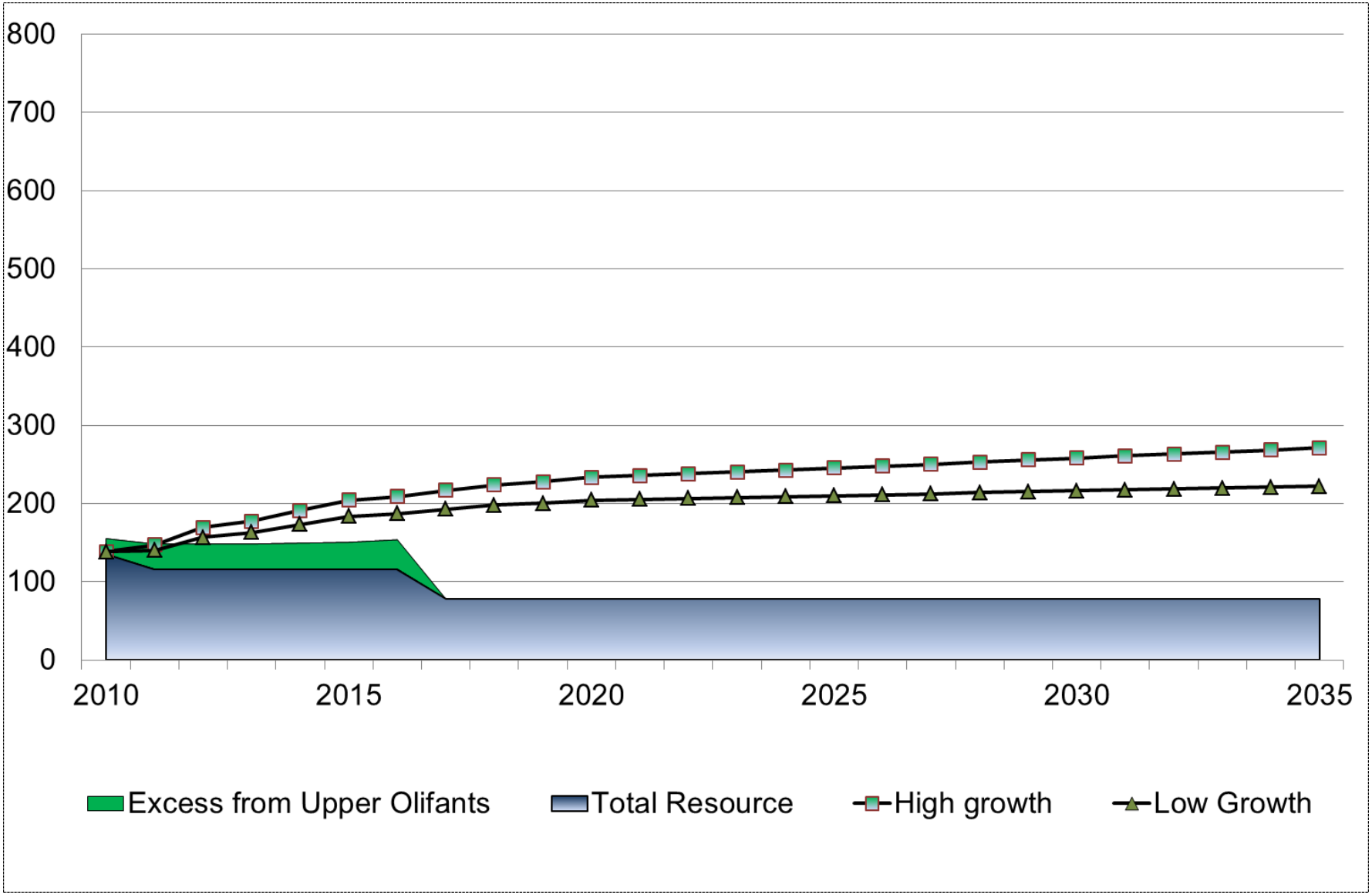


Middle Olifants Management Zone

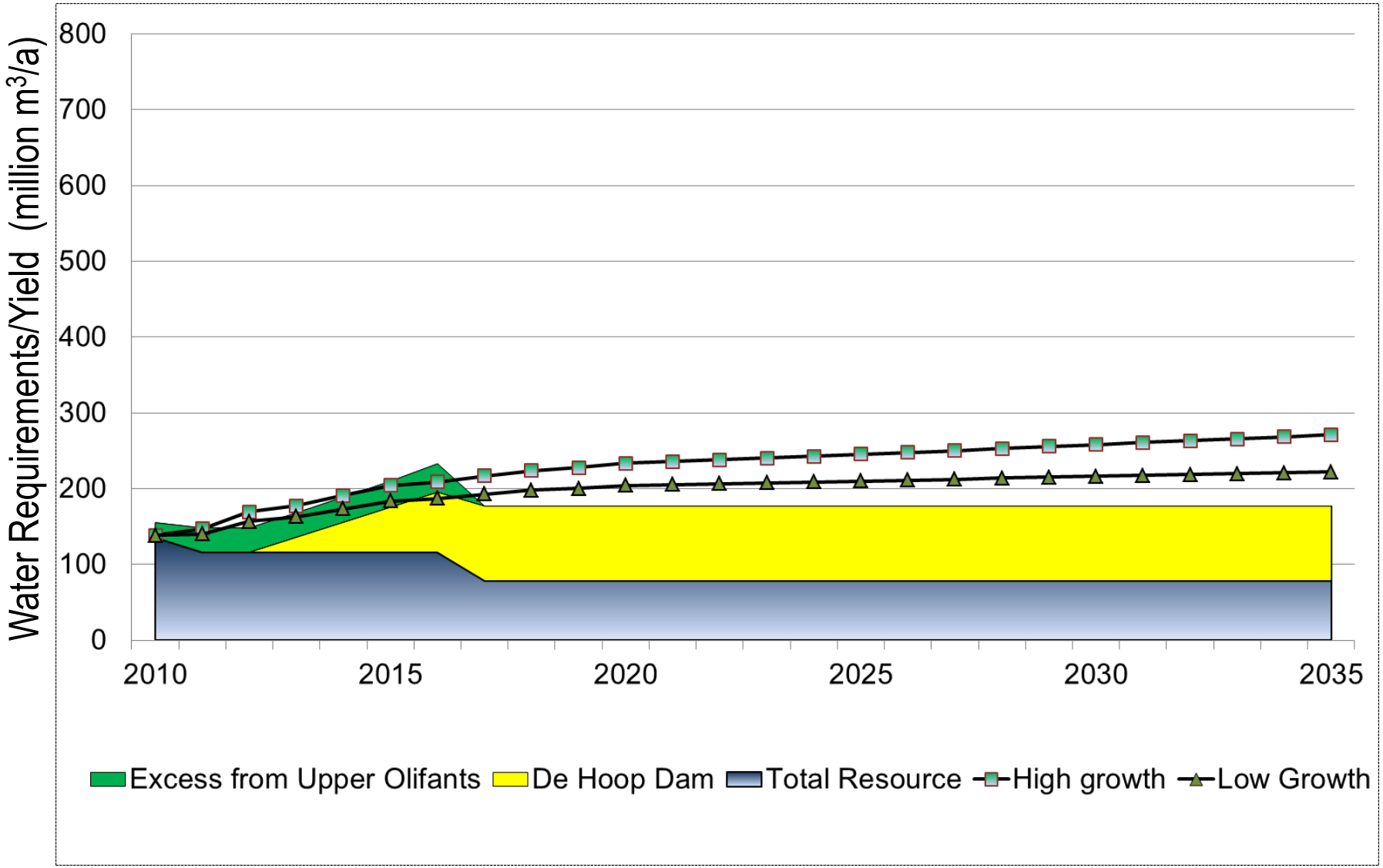
Middle Olifants – Current situation, no reconciliation options implemented, neither EWR not operationalised



Middle Olifants – Current situation, no reconciliation options implemented and EWR operationalised from 2016



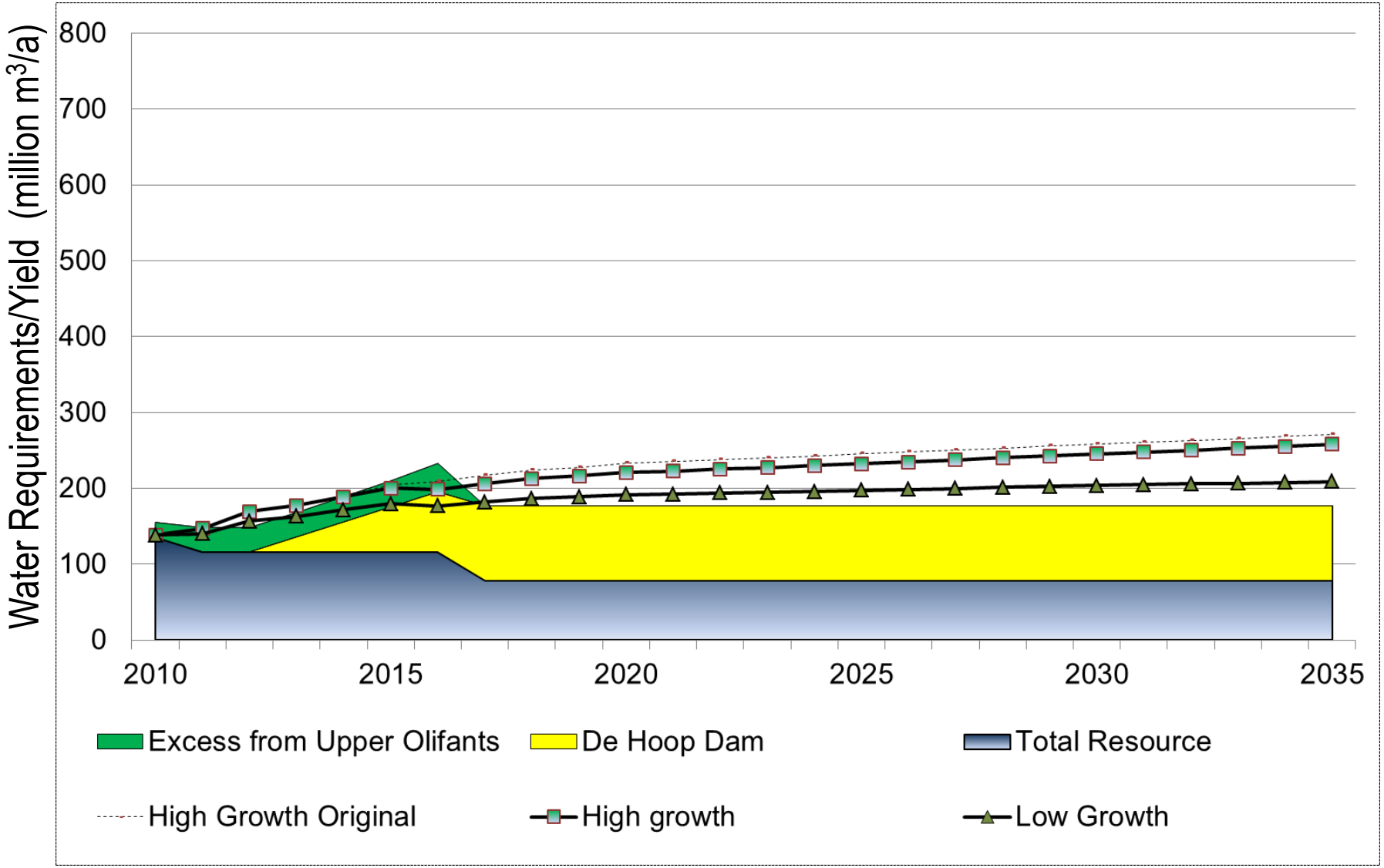
Middle Olifants – Effect of commissioning De Hoop Dam, no reconciliation options implemented and EWR operationalised from 2016



Middle Olifants: Selected reconciliation options that will reduce water requirements

Envisaged Intervention	Exp ∆ saving million m^3/a	Exp Date Opera-tional	Time to Full Saving (Y)
WC/WDM for irrigation and savings offered for purchase	2.8	2013	5
WC/WDM Urban	6.4	2013	5
WC/WDM Mining	1.6	2013	10
Eliminating unlawful water use	2.1	2015	5

Middle Olifants: Effect of selected reconciliation options that will reduce the water requirements

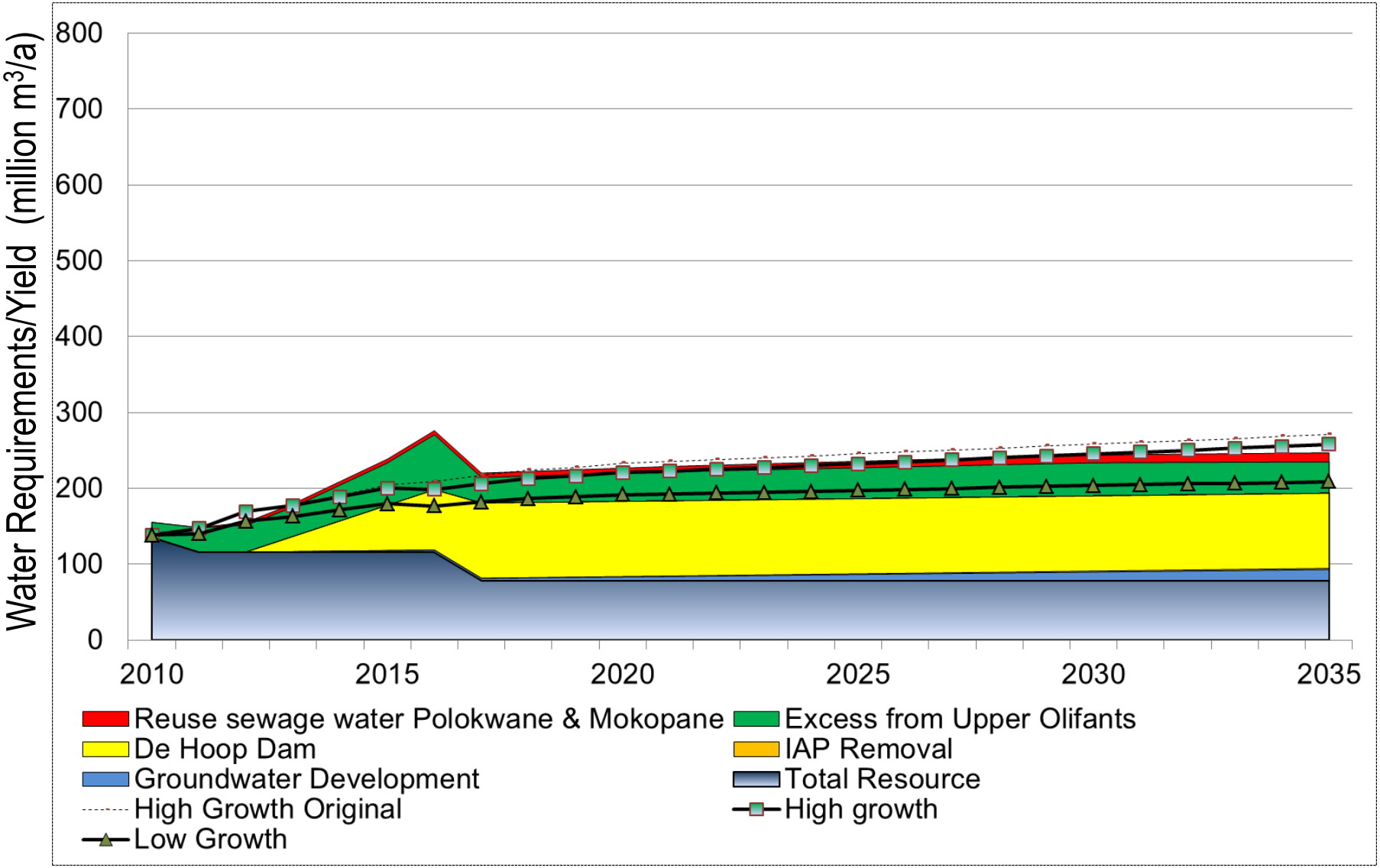


Middle Olifants: Selected reconciliation options that will increase the water supply

Envisaged Intervention	Exp Δ saving million m^3/a	Exp Date Opera-tional	Time to Full Yield (Y)
De Hoop Dam	99	2012	5
Groundwater development	15	2012	23
IAP removals	1.6	2012	23
Increased excess flow from Upper Olifants Management Zone	Varies*	2012	5
Reuse sewage water in Polokwane and Mogalakwena	11	From 2012	23

* Not linear. Excess from Upper Olifants plotted on graph of Middle Olifants

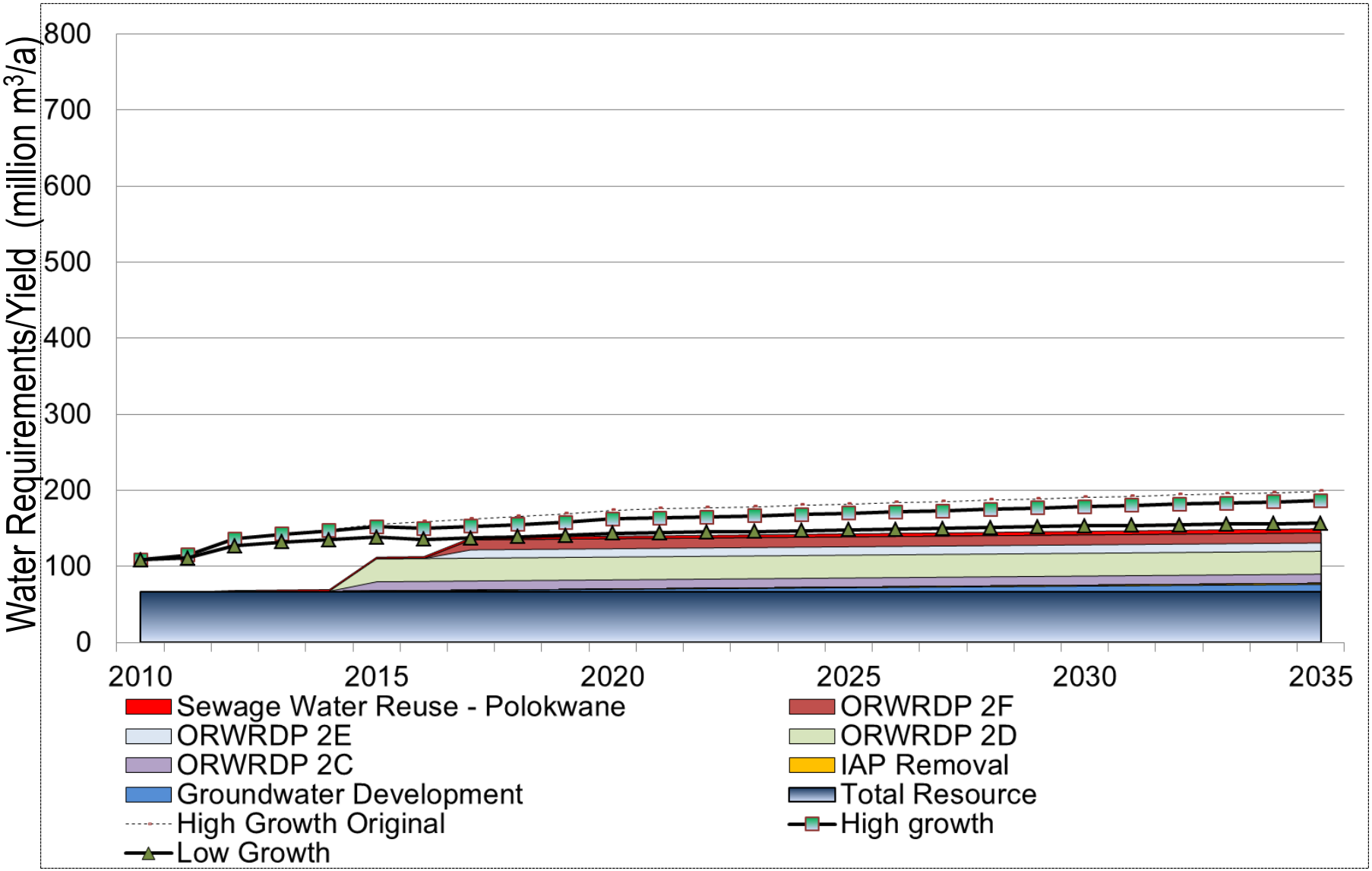
Middle Olifants: Added effect of selected reconciliation options that will increase the water supply



Concerns On Middle Olifants

- Will there be enough water available from the Steelpoort Sub-catchment to supply all the demands in the Middle Olifants as envisaged in the ORWRDP ?
- With the proposed ORWRDP Phase 2B (pipeline to Mokopane from Flag Boshielo Dam), will there be water shortages in Flag Boshielo Dam and Olifants River Main Stem in the Middle Olifants?

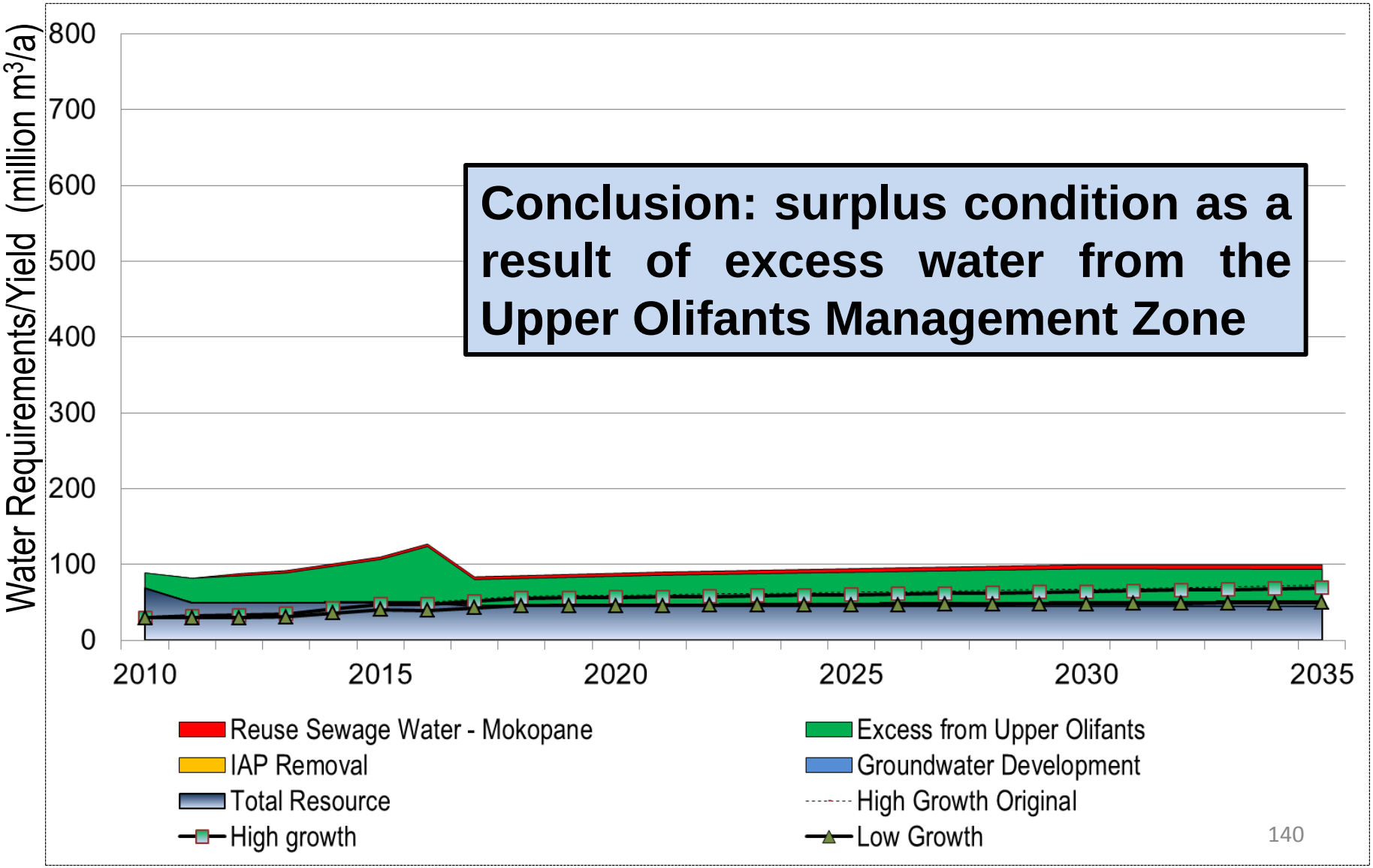
Steelpoort River: Water demands of all ORWRDP water users and supply capability of ORWRDP Phases 2C – 2F (Supply from De Hoop Dam)



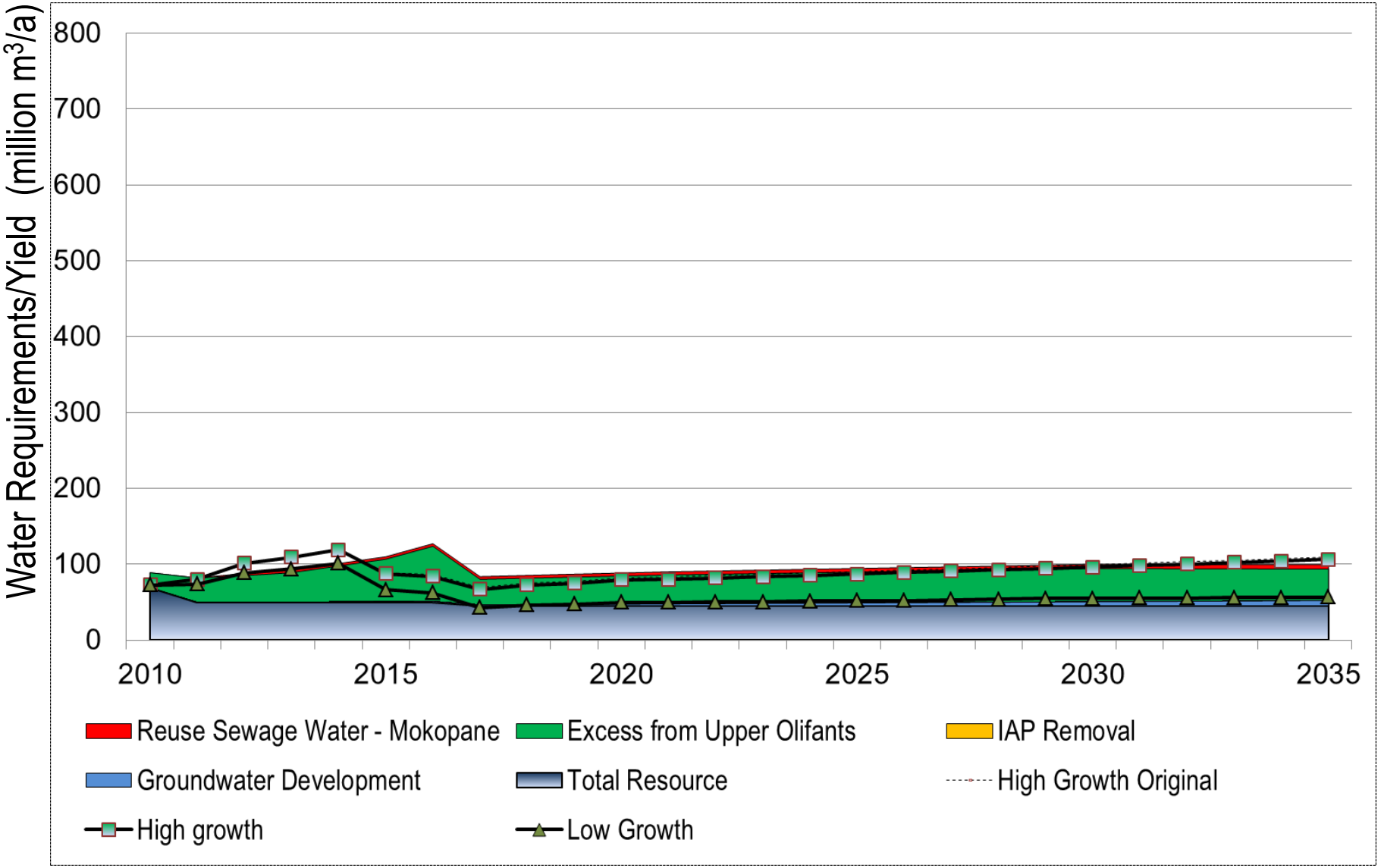
Conclusion – Supply from De Hoop Dam

- All water requirements earmarked for supply from De Hoop Dam cannot be met
- Flag Boshielo Dam must continue to supply water to certain areas
- Question: Will there then be shortfalls on the Olifants Main Stem in the Middle Olifants Management Zone?

Middle Olifants River Main Stem: Water requirements of Mokopane and Middle Olifants water users that cannot be reached from De Hoop Dam



Middle Olifants River Main Stem: Water requirements that cannot be met from De Hoop Dam, added to Flag Boshielo Dam

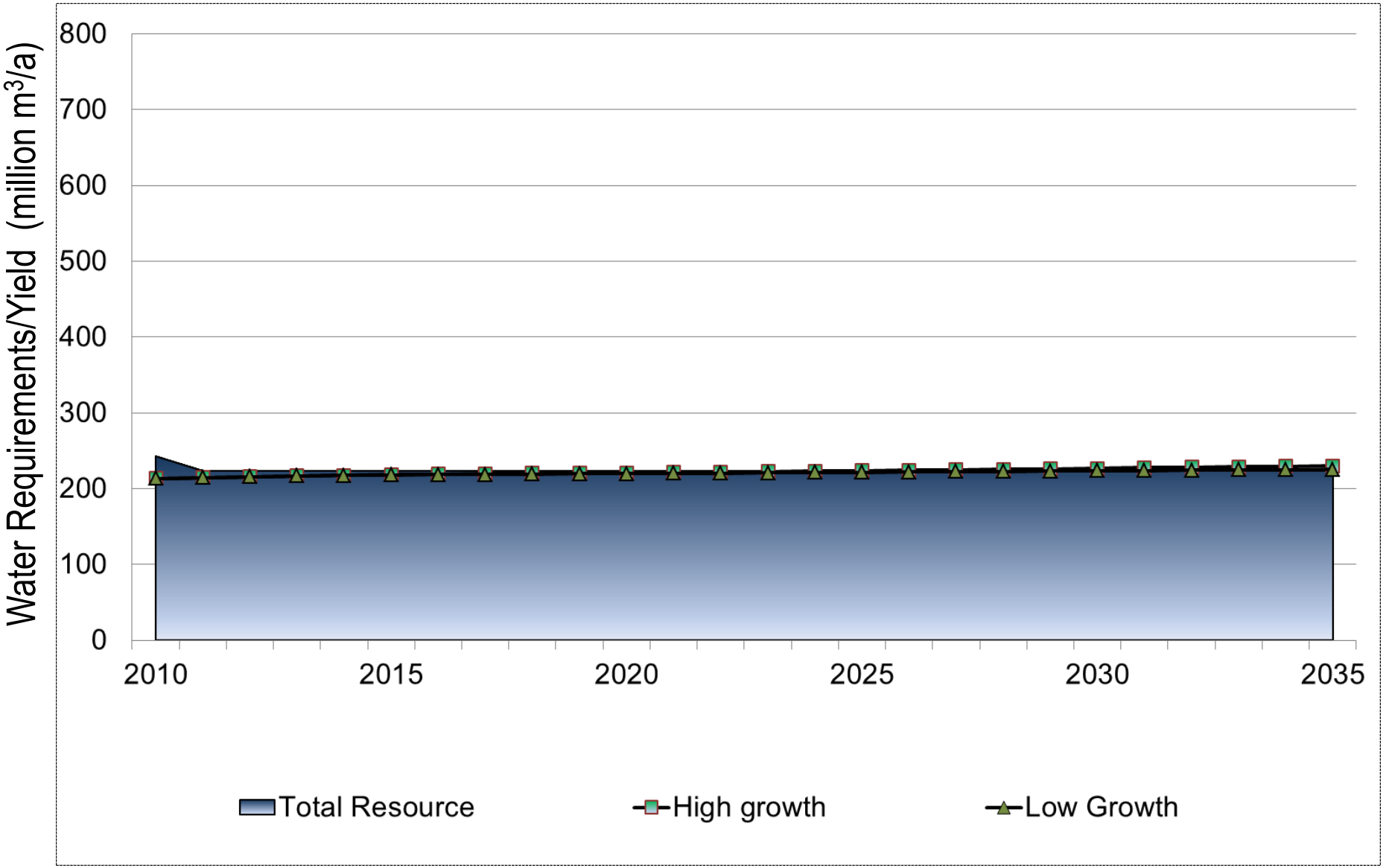


Conclusions Middle Olifants

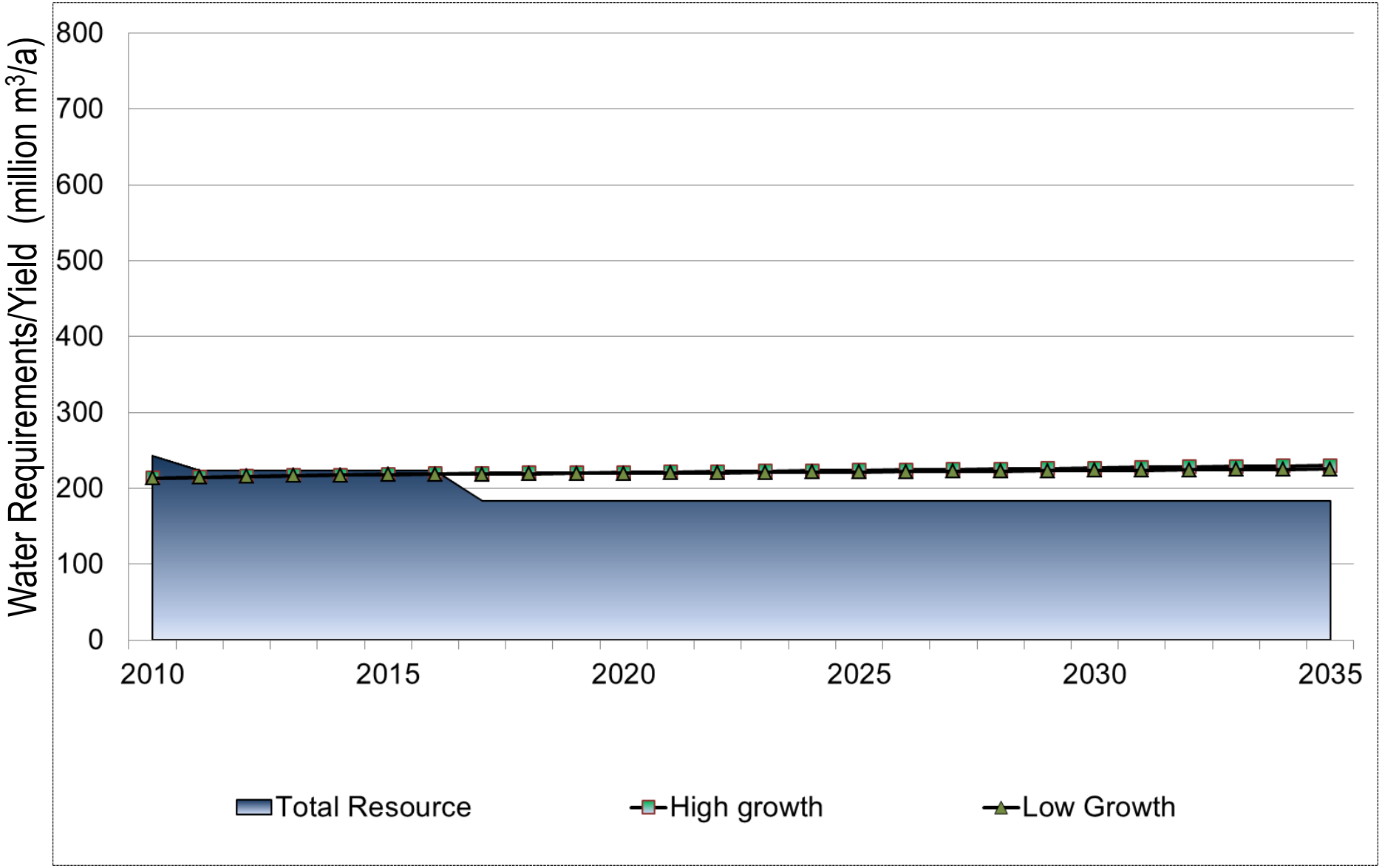
- Slight deficits can be expected during the period 2012 to 2014 (As a result of the difference in assumed linear 5y for De Hoop Dam for reaching its full yield and the expected completion dates of the ORWRDP Phases 2C-2F)
- The early deficits will not necessarily occur (modelling based on 1:50 y chance of failure). If required they can possibly be resolved through the temporary transfers of water entitlements (water trading).

Lower Olifants Management Zone

Lower Olifants – Current situation, no reconciliation options implemented, and EWR not operationalised



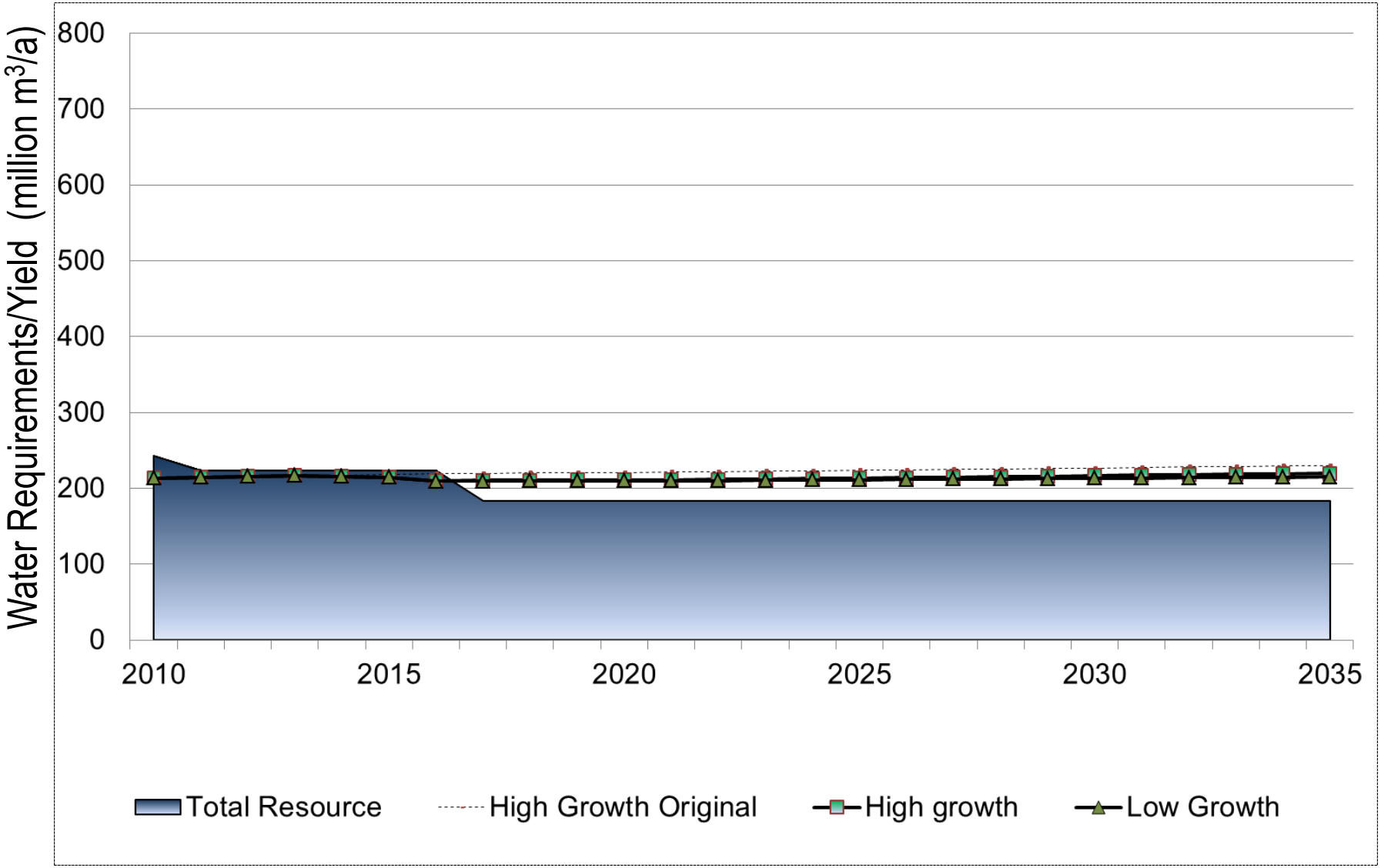
Lower Olifants – No reconciliation options implemented and EWR operationalised as from 2016



Lower Olifants: Selected reconciliation options that will reduce water requirements

Envisaged Intervention	Exp ∆ saving million m^3/a	Exp Date Opera-tional	Time to Full Saving (Y)
WC/WDM for irrigation and savings offered to purchase	5.4	2013	5
WC/WDM Urban	3.1	2013	5
WC/WDM Mining	1.8	2013	10

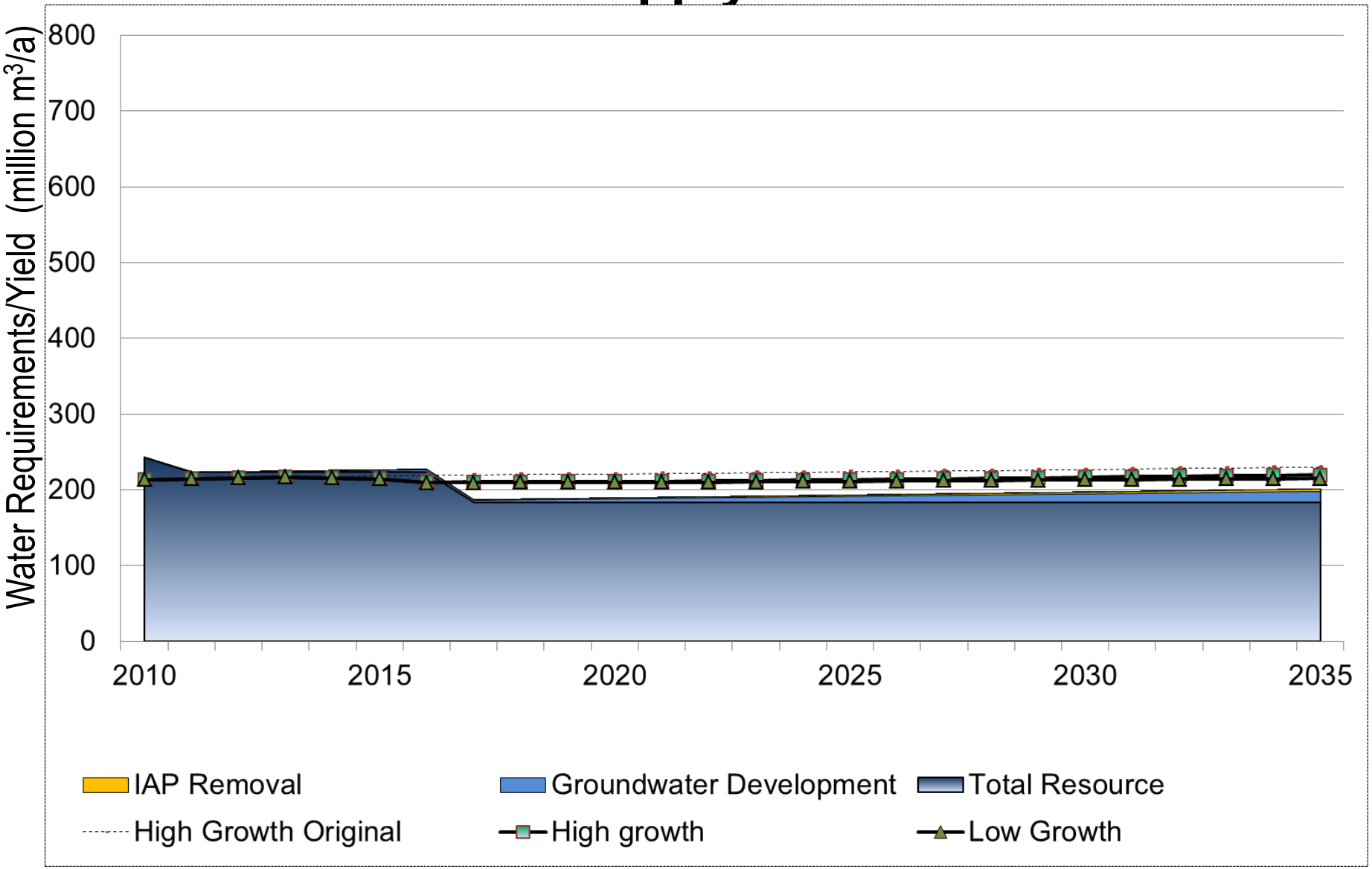
Lower Olifants: Effect of implementing selected reconciliation options that will reduce the water requirements



Lower Olifants: Selected reconciliation options that will increase the water supply

Envisaged Intervention	Exp ∆ saving million m^3/a	Exp Date Opera-tional	Time to Full Yield (Y)
Groundwater development	15	2012	23
IAP removals	3	2012	23

Lower Olifants: Added effect of selected reconciliation options that will increase the water supply



Conclusions Lower Olifants

- The deficit is however so small (in the order of 20 million m^3/a) that an additional dam cannot be justified
- It is recommended that the real situation is monitored and if necessary, that irrigation water be purchased (water trading option)
- The irrigation boards should identify those farmers who are currently not utilizing their water entitlements and these farmers can then be approached first.

10 The Reconciliation Strategy In A Nutshell

The following is envisaged for the Olifants catchment for the next 25 years:

i. The Reserve needs to be operationalized as soon as practical. It is expected that this will be achieved in 2016 as De Hoop Dam reaches its full yield potential.
ii. Water required to supply the current and future social and economic activities in the Olifants catchment will have to come from the catchment's local resources, except for the power stations within the catchment.
iii. Water to power stations will continue to be supplied from the Usuthu, Komati and Vaal systems.
iv. Water required by the Polokwane and Mokopane supply areas will be augmented from the Olifants catchment.

The Reconciliation Strategy In A Nutshell (Continued)

v. Water requirements can be balanced by availability through the implementation of the following measures:
   - Eliminating unlawful water use. The target date for the majority of transgressions to be addressed is 2018, after which compliance monitoring and enforcement will remain an on-going activity.
   - Introducing water conservation and water demand management (WC/WDM) in all sectors. Full water savings need to be achieved within five years in the irrigation and urban water use sectors, and within 10 years in the mining sector.

The Reconciliation Strategy In A Nutshell (Continued)

v. Water requirements can be balanced by availability through the implementation of the following measures:
   - The introduction of a mechanism whereby water saved through water use efficiency (WUE) measures, especially in agriculture, can be traded back into the market. This means that water users will be in a position to sell their water savings, and not necessarily use this water to expand horizontally.
   - The treatment of acid mine drainage water to an acceptable standard, either for immediate direct use or before it is allowed to decant into the river system.

The Reconciliation Strategy In A Nutshell (Continued)

v. Water requirements can be balanced by availability through the implementation of the following measures:
   - Invasive alien plants must be removed. Working for Water programmes must be accelerated to ensure that at least 50% of infested areas, plus all new growth, is eradicated by 2035.
   - Groundwater resources must be developed as a priority. The Malmani dolomites must be investigated as a possible resource for a regional water supply scheme.
   - Return flows from Polokwane and Mokopane should be reused by the urban or mining sector.

The Reconciliation Strategy In A Nutshell (Continued)

vi. All above measures lean more towards management interventions rather than development interventions. An orchestrated effort is necessary to ensure that objectives are achieved. If these implementation measures are not successful as assumed, in spite of the fact that the assumed measures are conservative, the water will have to be reallocated to other use by means of compulsory licensing or by buying out water entitlements in respect of low value irrigation.

11 Risks And Uncertainties

9 Risks and uncertainties are listed in the strategy report. A few crucial ones are listed below.

- Extent of unlawful water use. Best estimates will have to suffice until V&V process is complete
- Success of purchasing WC/WDM savings is difficult to predict. A well structured policy is urgently needed.
- Cooperation of WMIs, Local Authorities and mining companies
- Successful implementation of the strategy holds a significant risk if the establishment of the CMA is further delayed

12 Implementation Arrangements

Role of NWRP in DWA:

- DWA is the trustee of the country's water resources
- Are facilitating the process of water reconciliation planning

Implementation responsibility:

- All water users, water user institutions, and water related management institutions

Implementation Arrangements (Continued)

Implementing institutions:

- DWA Regions
- CMA
- ESKOM
- Mines
- Industries
- Municipalities
- Water Boards
- Irrigation Boards and Water User Associations
- Nature conservation institutions (e.g. SA National Parks)

Institutional Responsibilities

Intervention	Actions Required	Primary Responsibility	Target Date
Addressing Unlawful Irrigation Use (Compliance Monitoring and Enforcement)	Validation and Verification	DWA Regions, later CMA	End 2016
	Directives to unlawful water users	DWA Regions, later CMA	End 2018
	Legal action where needed	DWA Legal Services. Will later assist CMA	End 2018
	Maintenance of lawful water use in controlled areas	IBs, WUAs for CMA	Ongoing

Institutional Responsibilities *(Continued)*

Intervention	Actions Required	Primary Responsibility	Target Date
WC/WDM in the irrigation sector (in-field measures)	Improved systems	Irrigators	End 2016
	Repair leakages	Irrigators	
	Improved scheduling	Irrigators	
	Seal lei dams	Irrigators or IBs on behalf of irrigators	
WC/WDM in the irrigation sector (addressing canal/pipe leaks)	Accelerated programmes for refurbishing and replacing worn-out conveyance systems	IBs, WUAs	End 2016

Institutional Responsibilities *(Continued)*

Intervention	Actions Required	Primary Responsi-bility	Target Date
Water Trading – WC/WDM linked to the purchase of water savings	Develop policy & guidelines	DWA HO	End 2012
	Launch of WC/WDM initiative and water trading process	DWA HO, DWA Regions, later CMA	Beginning 2013
	Validation & verification	DWA Regions, later CMA	2013 - 2015 Deal with application cases first
	Administer water trading	DWA Regions, assisted by DWA : HO	2013 - 2015

Institutional Responsibilities *(Continued)*

Intervention	Actions Required	Primary Responsibility	Target Date
WC/WDM Urban	E.g. pressure Management, leak detection & repairs	WSPs (DMs, LMs, WBs, WUAs), Industries	End 2016 for WSP with plans End 2017 for those that need to do planning
	Public awareness (e.g. In-formative billing, retrofitting of water saving devices)	DWA, WSPs and public	
	Water Pricing	DWA (to ensure pricing is in line with Pricing Strategy)	

Institutional Responsibilities *(Continued)*

Inter-vention	Actions Required	Primary Responsibility	Target Date
WC/WDM Mining	Process adaptations for enabling water recycling and water reuse	Mine owners, operators and industries	End 2021
	Retrofitting water saving devices	Mine owners, operators and industries	End 2016

Institutional Responsibilities (Continued)

Intervention	Actions Required	Primary Responsibility	Target Date
Removal of IAPs	Removal of plants	WfW Teams	Ongoing – Removal must be faster than the growth of IAPs. Reduce IAPs by at least 50% over 23y
	Rehabilitate land and re-establish indigenous vegetation	WfW Teams	
	Follow ups and maintenance	WfW Teams	

Institutional Responsibilities *(Continued)*

Intervention	Actions Required	Primary Responsibility	Target Date
Operationa-lising of the Reserve	Complete Water Resource Classification	DWA HO	End 2012
	Establish flow monitoring network	DWA Regions, IBs, WUAs, WBs	End 2015
	Establish operating rules	DWA Regions, IBs, WUAs, WBs	End 2015
	Monitor and adjust	DWA Regions, IBs & WUAs, WBs	Beginning of 2016

Institutional Responsibilities *(Continued)*

Intervention	Actions Required	Primary Responsibility	Target Date
Groundwater Development	Borehole siting	DMs, LMs, Water Boards, mine companies, industries, private individuals	Ongoing from 2012
	Drilling		
	Infrastructure development		
AMD Treatment	Feasibility Study	Mine companies	2015 for AMD in Witbank Dam Catchment 2020 for AMD in Middelburg Dam Catchment
	Design		
	Tenders		
	Construction		

Funding

Capital required for:

- AMD treatment plants (Private and DWA)
- Groundwater development (Private, municipal & DWA)
- Refurbishment of irrigation canals (Private and/or DWA)

Funding options:

- Fiscus
- Off budget – e.g. TCTA

Operational budget required for:

- Management options

13 Recommendations Towards Implementation

- All Management options (except compulsory licensing) to reduce water requirements must be implemented asap
- The WC/WDM in irrigation sector should be linked to water trading
- A policy and guideline document on purchase of partial water entitlements must be produced in 2012
- The V & V process must be resumed asap. Various interventions are dependent on this process.
- The establishment of a CMA must be accelerated
- Impacts of all interventions must be continuously monitored

Recommendations Towards Implementation (Continued)

- Strategic groundwater development in unstressed aquifers must continue
- Groundwater in stressed aquifers must be managed and regulated better

Recommendations For Further Work

- Possible regional groundwater scheme with the Malmani dolomites as resource should be investigated
  - Impact of groundwater abstraction on surface water base flow
  - Possibility of artificial recharge with surface water
- Operating rules for operating Loskop Dam, Flag Boshielo Dam, Middelburg Dam, Witbank Dam and De Hoop Dam as a system must be developed and implemented

Recommendations For Further Work (Continued)

- The current Study Steering Committee should be transformed into a Strategy Steering Committee
- The following issues need attention in the follow up Maintenance Study
  - Estimated Groundwater use only include use for municipal, rural and mining. Irrigation with groundwater should also be factored in.
  - River transmission losses should be investigated
  - Current environmental releases of 19 million m^3/a out of Flag Boshielo Dam and Phalaborwa Barrage: It must be ascertained that this value hasn't been double counted

Recommendations For Further Work (Continued)

- The following issues need attention in the follow up Maintenance Study (Continued)
  - The late water requirement inputs of Tshwane Metro and by the Industrial Development Corporation (via Hatch) must be investigated and it must be determined whether the Reconciliation Strategy underestimated the water requirements.

Discussion