FEASIBILITY STUDY FOR A LONG-TERM SOLUTION TO ADDRESS THE ACID MINE DRAINAGE ASSOCIATED WITH THE EAST, CENTRAL AND WEST RAND UNDERGROUND MINING BASINS

FOCUS GROUP MEETING

7 September 2012

Jurgo van Wyk
(Department of Water Affairs)

Objectives of Meeting Long-Term Feasibility Study

- Provide background
- Provide information regarding the Feasibility Study
- Listen to inputs from key stakeholders

DISCUSSION STRUCTURE

1. WHERE DO WE COME FROM?
2. WHERE ARE WE NOW?
3. WHERE ARE WE GOING?

WHERE DO WE COME FROM?

What is Acid Mine Drainage (AMD)?

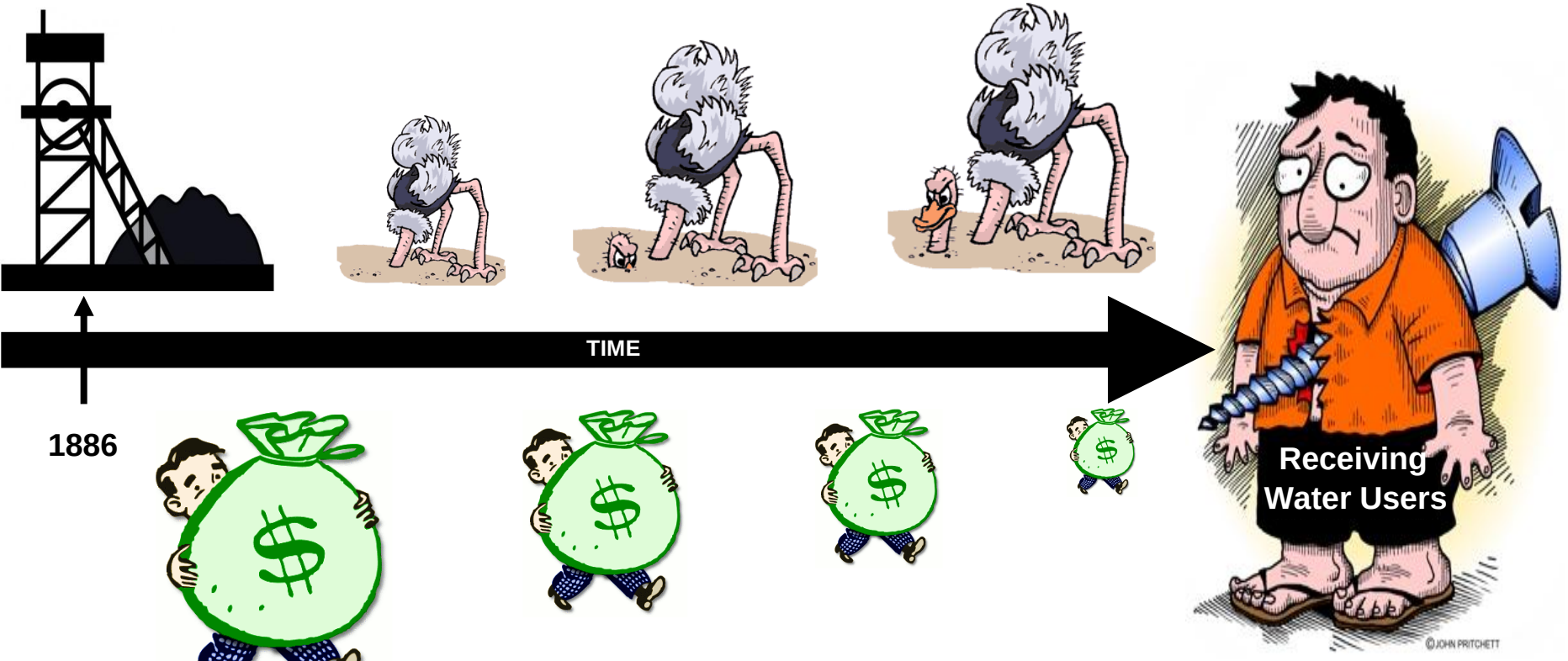
- Acid generation is caused by the exposure of rock containing sulphide minerals, most commonly iron pyrite (FeS_2), with air and water
- results in the production of highly acidic water;
- Contains elevated concentrations of sulphate (salt) and metals;
- AMD largely associated with gold & coal mining.

Decant from an abandoned shaft

AMD generation on surface

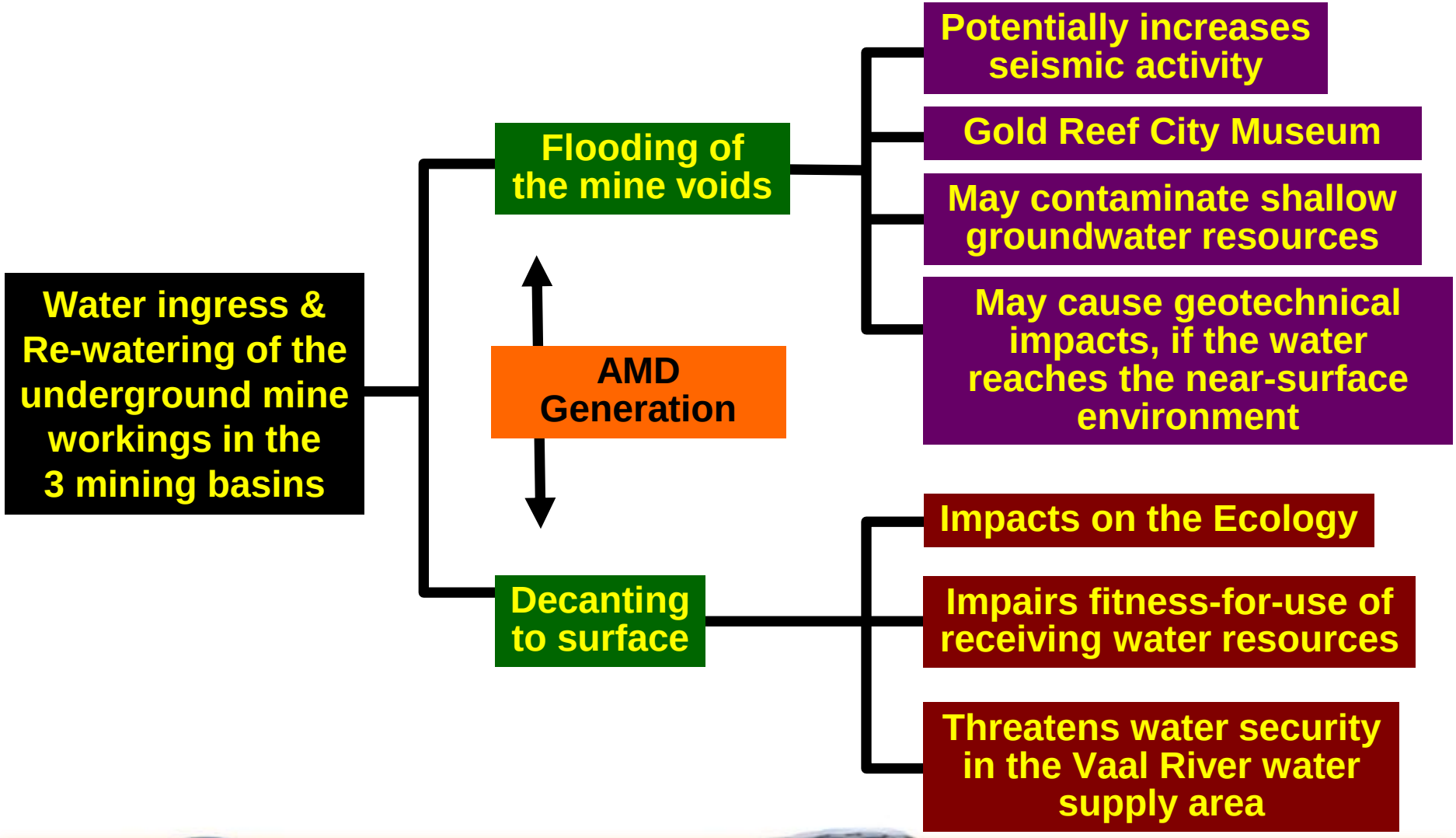
- **Generated on surface and underground;**
- **Seeps to surface streams and groundwater;**
- **Accumulates underground.**

Mining history



Public Perceptions & Concerns

The problem !!!



CAUSE → EFFECT (1) → EFFECT (2) - - - - - →

The Solution Proposed by the Mining Industry

In 2005 DWA directed the industry to develop a long term solution;

Mines responded with the "WUC" proposal:

- ➔ **Regional scale solution (ERB, CRB & WRB);**
- ➔ **CSIR ABC process for sulphate removal;**

Possible shortcomings:

- ➔ **Financial and economic model;**
- ➔ **Technology**
- ➔ **Process and Procedural requirements.**

1.8.2 ToE:AMD - Composition & ToR

Team of Experts:AMD

Terms of Reference

- **Risk Appraisal;**
- **Assessment & Collation of work done by various institutions to date;**
- **Assessment of available solutions and technologies;**
- **Viability and cost of critical short term interventions;**
- **Integrated lasting and sustainable medium and long-term solutions;**
- **Explore possible partnerships with private sector.**

▸CGS (Chair); ▸DMR; ▸ DWA; ▸DST; ▸Mintek; ▸CSIR; ▸WRC; ▸Universities

Recommendations approved by IMC: AMD

The 3 priority basins (Western, Central and East Rand Basins) should have implementation plans that include (9 February 2011):

- **pumping to maintain the underground mine water levels at least below ECL (short term);**
- **neutralisation of, and removal of heavy metals from AMD (short term);**
- **elimination of contribution to salinity in river systems (medium to long term);**
- **prevention of ingress;**
- **regular inspection & monitoring;**
- **ongoing assessment and management; and**
- **remediation to reduce AMD related impacts from other sources, such as from mine residue deposits.**

Some areas they felt needed revisiting include the liability of polluters and costing of implementation.

Directive to TCTA

- DWA appointed TCTA as Implementing Agent on 6 Apr 2011 to:
  - Install pumps for mine water extraction
  - Construction/ refurbishment of on-site treatment plants with option to refurbish existing plants
  - Convey treated water to nearby watercourse
  - Facilitate operation of pumps and treatment plants
- TCTA appointed PSPs to undertake Due Diligence on Wits AMD
- Due Diligence report finalized on 7 July 2011 - specified immediate and short-term solutions for Wits AMD

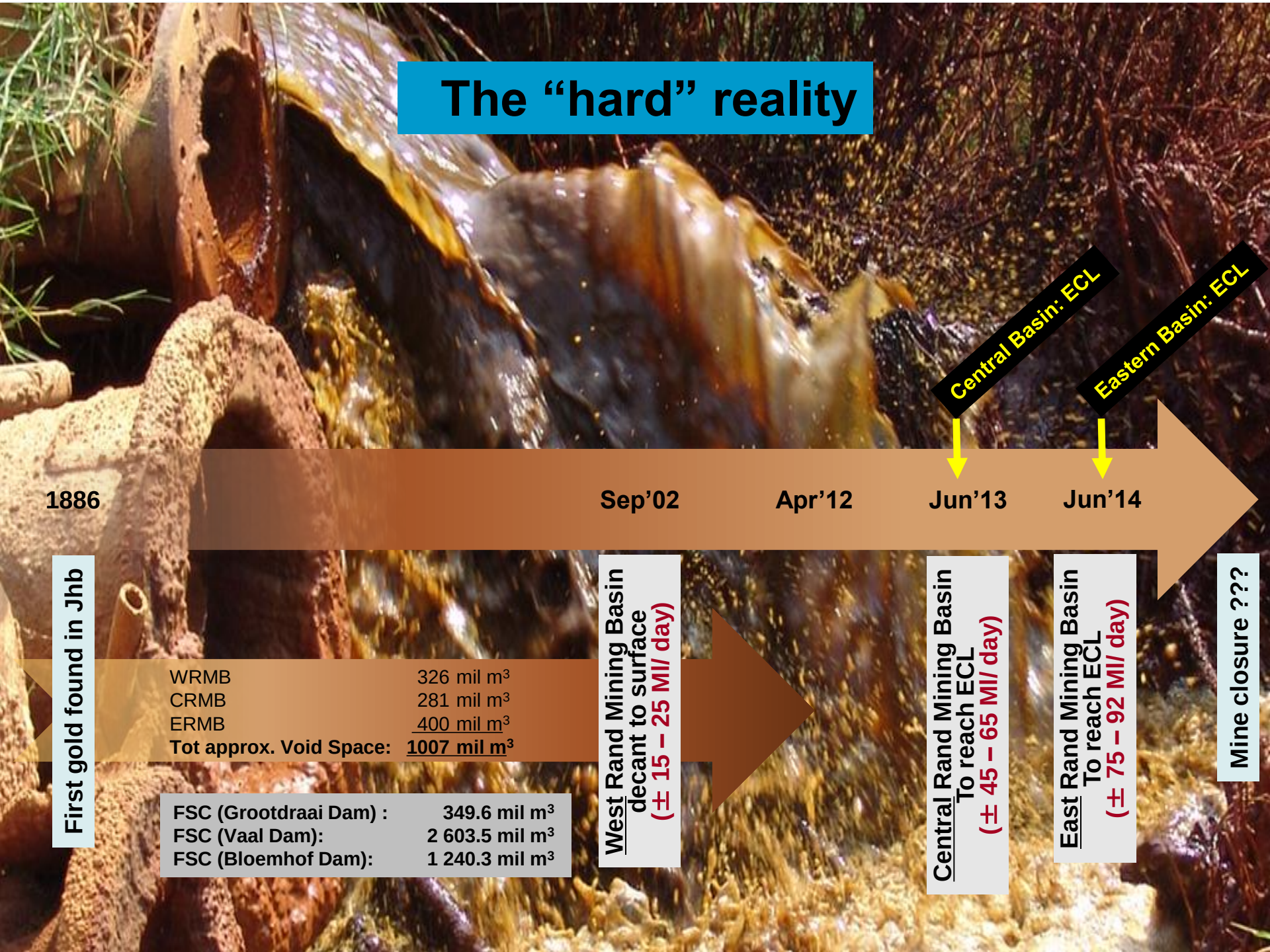
Immediate Solution

- Construction works nearing completion;
- Stage 1 commissioning of treatment plant commenced on 20 April 2012: increase treatment capacity from 12 to 24 Ml/day;
- Stage 2 commissioning by end-April 2012: achieve maximum capacity of ~35 Ml/day;
- Agreements with Rand Uranium (treatment plant) and Mogale Gold (sludge disposal) to be finalised.

Short-Term Solution

- Four (4) bids for short-term solution received by the TCTA;
- Evaluation of bids are finalized ;
- Based on current funding (R433 million), TCTA will recommend plausible options to DWA;
- Current funding limitations may imply a phased (modular) implementation of short-term solution;
- TCTA intend to award bid soon.

The "hard" reality



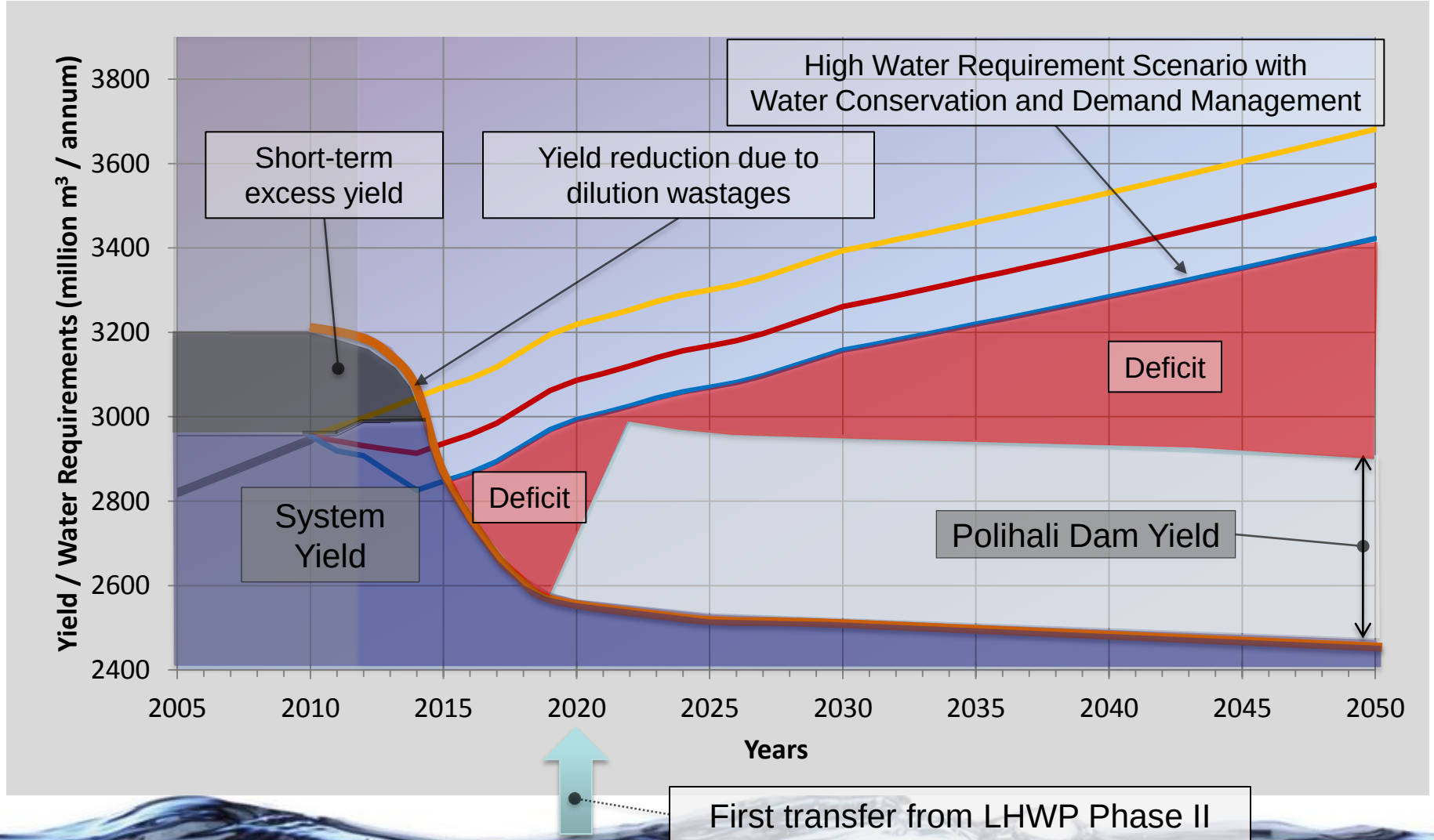
Vaal River Strategy

- **The Vaal River System supply water to 60% of economy and 45% of population.**
- **To ensure that sufficient water of good quality is available to supply the future requirements of the important area of the VRS a multi-pillar strategy is required:**

(1) Eradicate unlawful water use by 2013 (H. Smit);
(2) Reduction in water use by 15% through WC/ WDM (focus on loss-management) by 2015 (P. Herbst);
(3) Augmentation through LHWP#2 by 2020 (P. Pyke);
(4) Implementation of the IWQMS – Integrated WQM SSC (J.J. van Wyk);
(5) Re-use of treated "effluent" (1st: underground mine water return-flows; 2nd: WWTW return-flows) by 2014/ 15 (J.J. van Wyk);
(6) Plan yield replacement scheme in the Orange by 2034 (S. Rademeyer & P. Pyke)
(7) Manage uncertainties in Crocodile (West) and Olifants (S. Rademeyer); and
(8) Establish a Strategy Steering Committee to facilitate Strategy implementation co-ordination (S. Rademeyer);

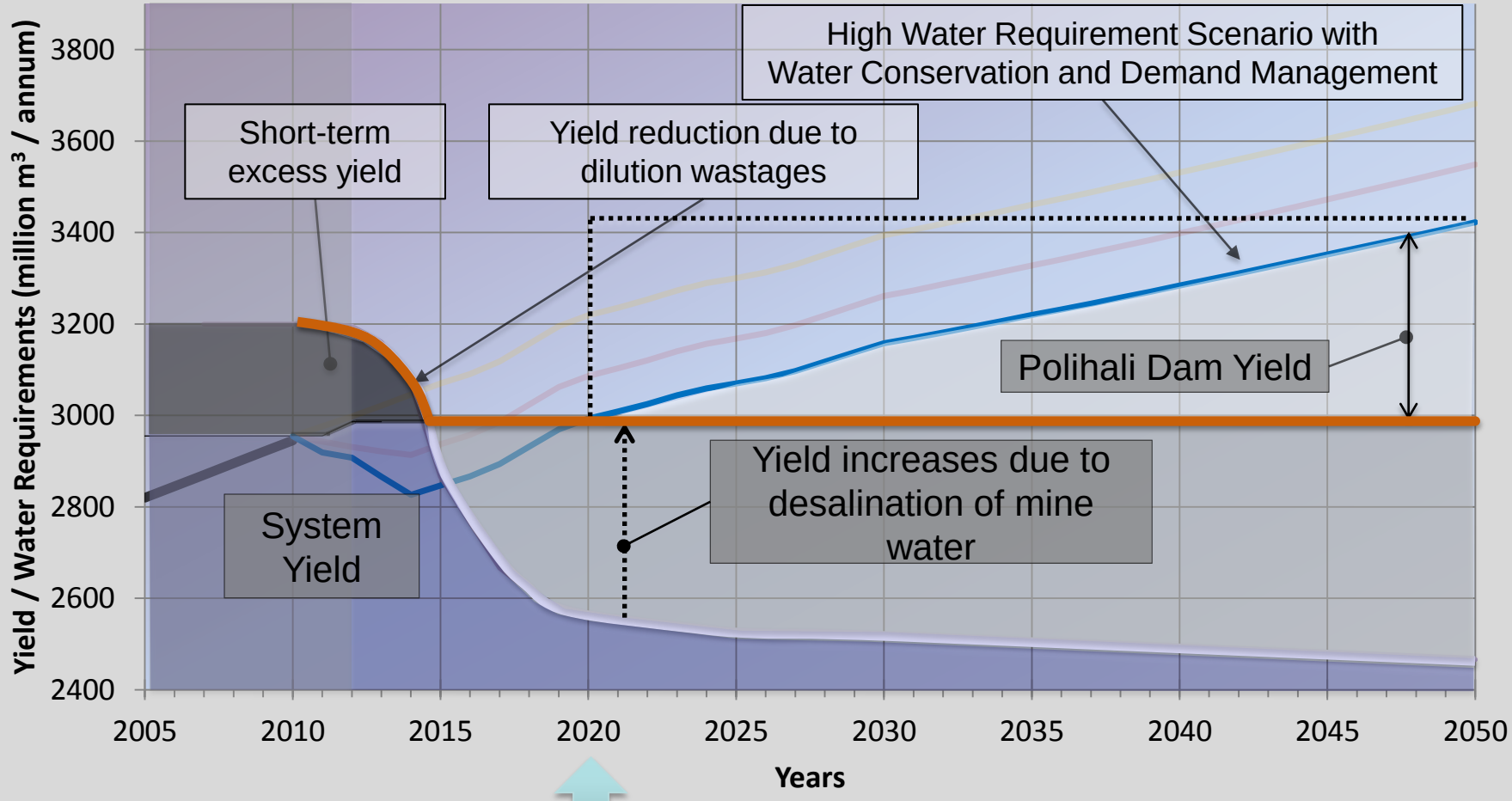
2.1.9 Vaal River system water balance: Short-Term

High with target WC/WDM	Mine Water: Neutralization and discharge	Unlawful removed

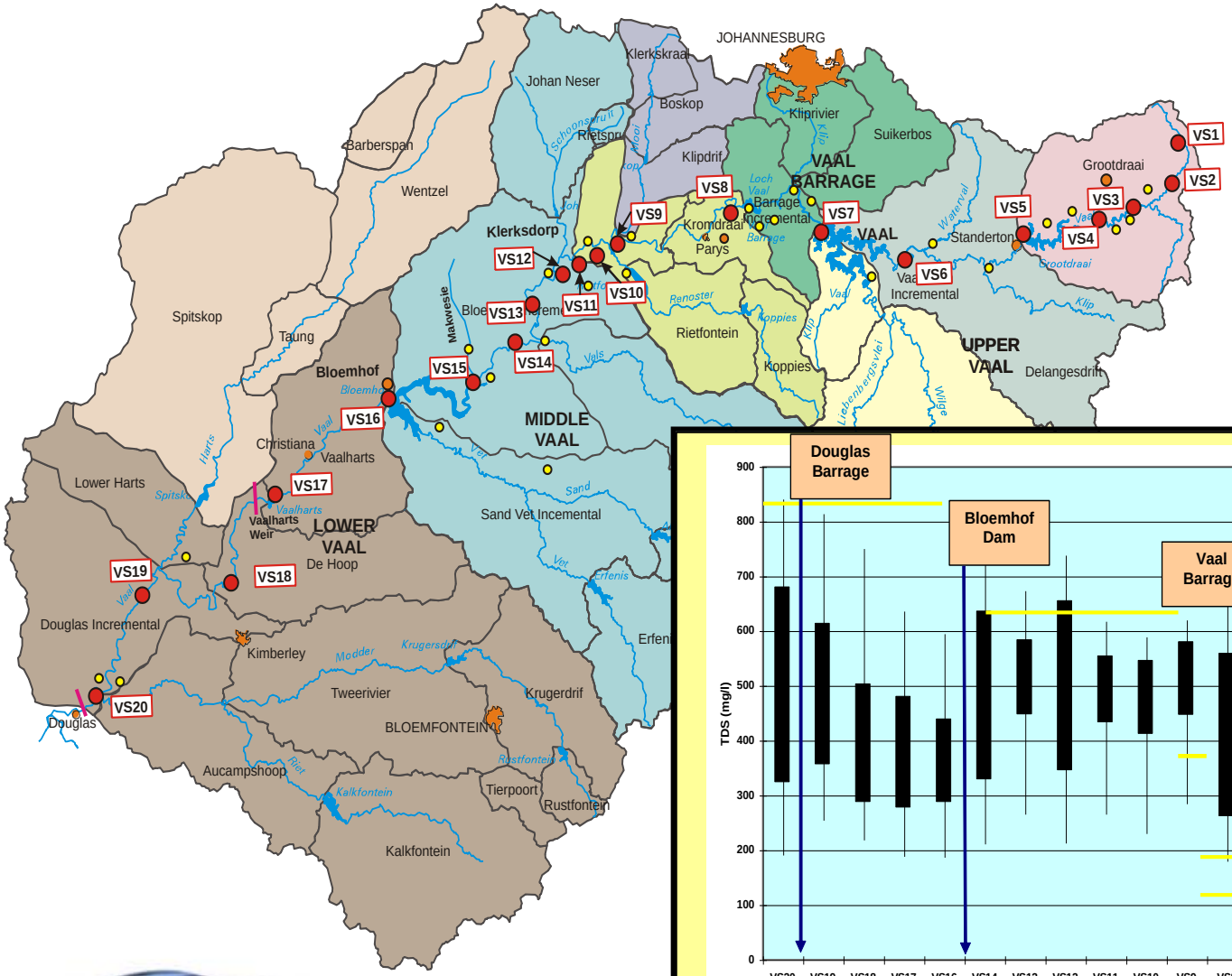


2.1.10 Vaal River system water balance: Long-Term

High with target WC/WDM	Mine Water: Desalination for urban use	Unlawful removed

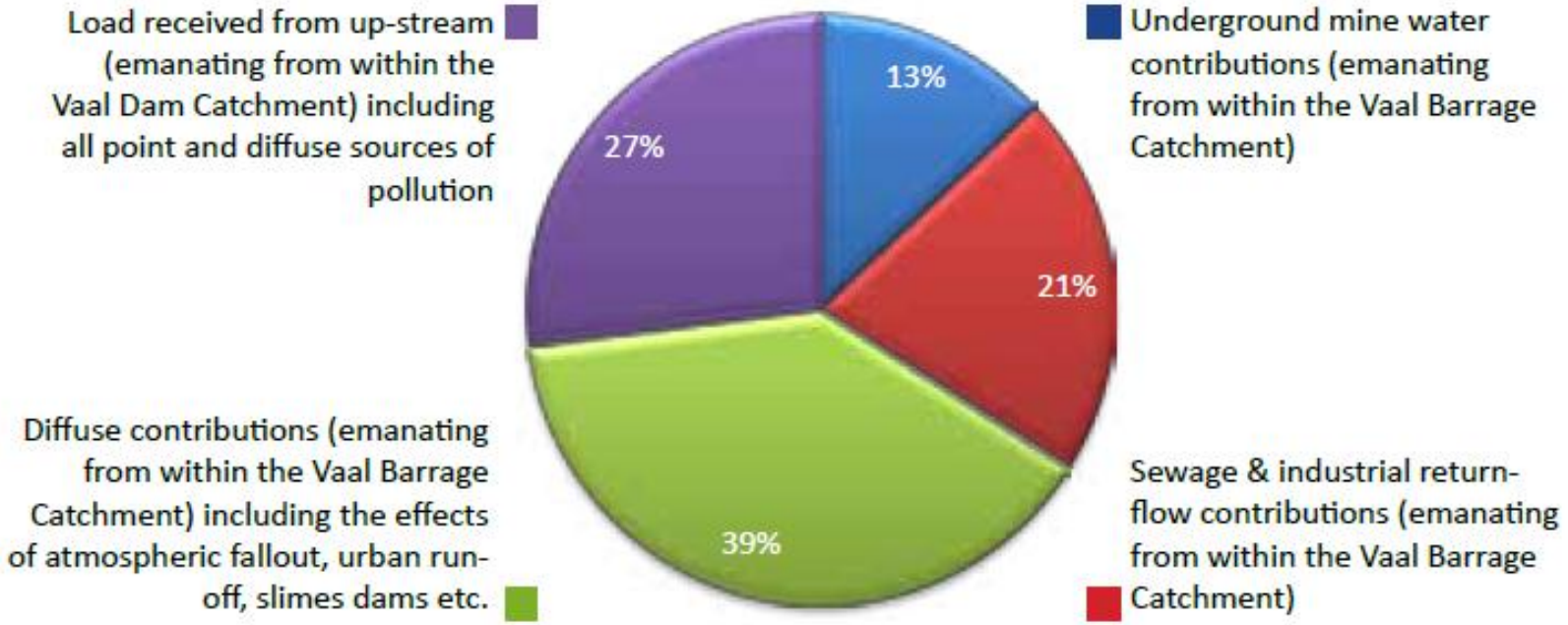


Salinity status: TDS (2006)

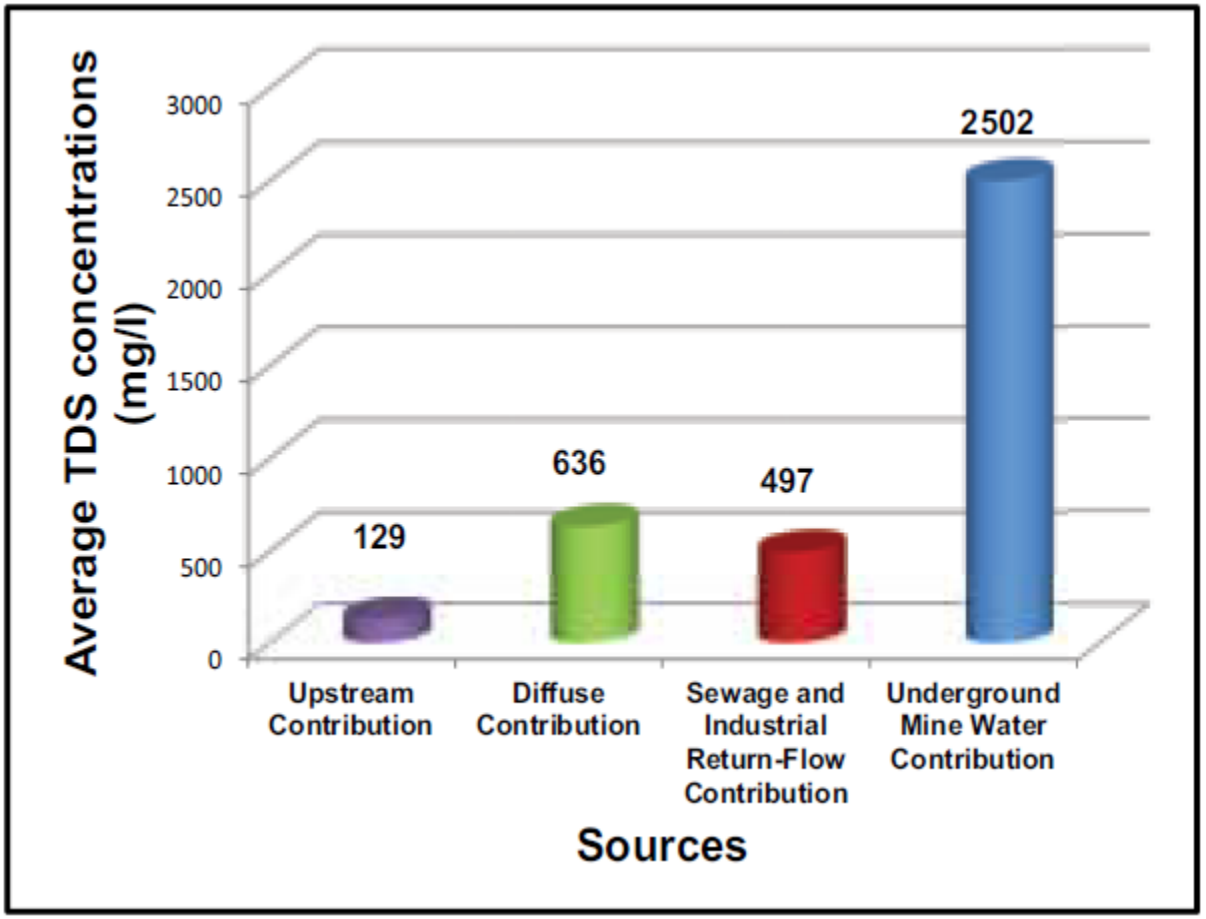


TDS Load Contributions

The approximated load contributions in TDS received in the Vaal Barrage reservoir under a "Short-Term Intervention" scenario, i.e. pumping and semi-treatment without salts removal (based on historic data: October 1995 to September 2004) is as follows:



TDS Concentrations



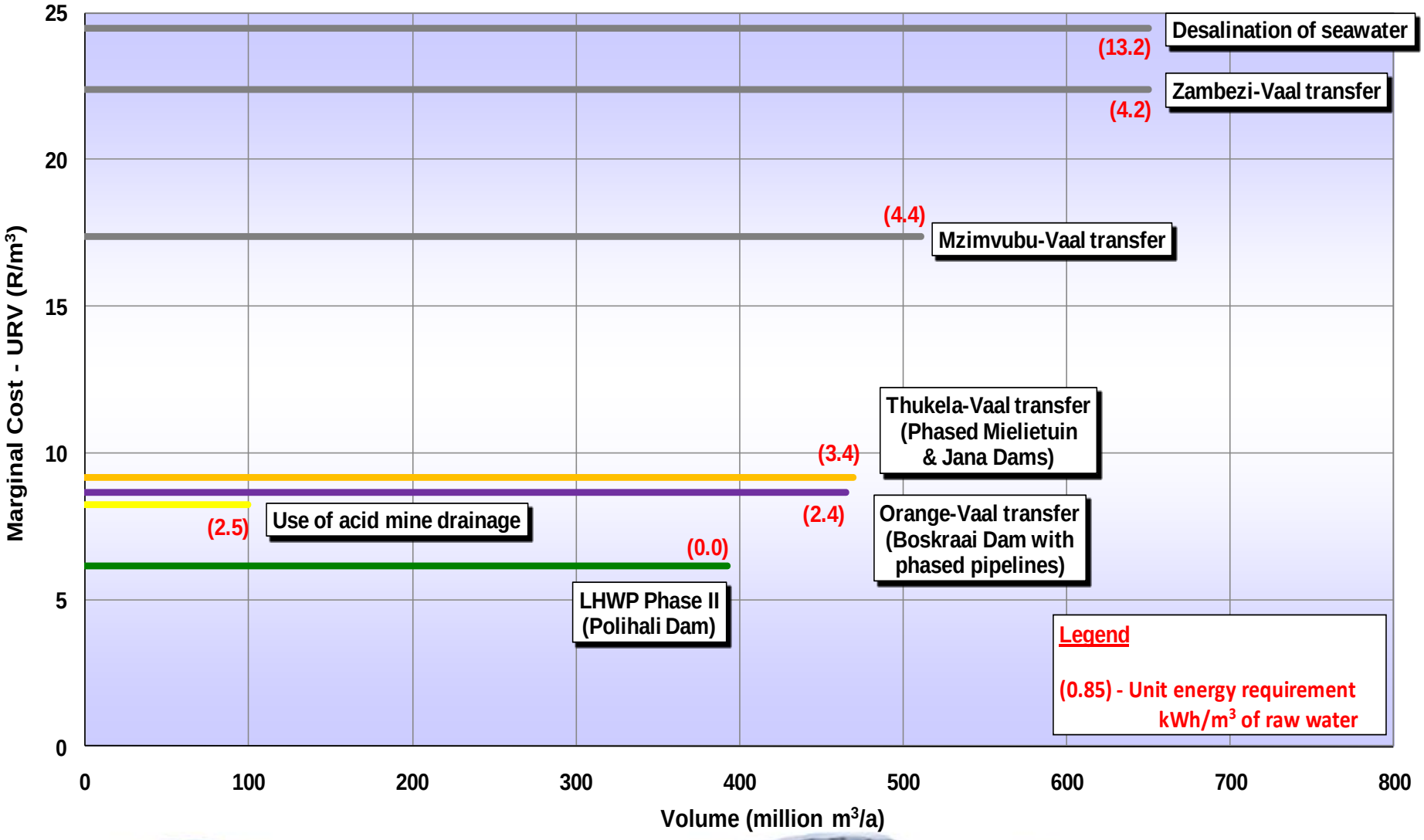
Note that although the percentage contribution of salts from mining is the lowest, the actual contribution in terms of salt concentration, is the highest.

Modeling results: Cascading TDS values

Point	Scenario		RWQOs:TDS 95%tile (mg/l)
	A	B	
Vaal Barrage	825	569	600
Midvaal off-take	748	622	600
Sedibeng off-take	859	648	600
Bloemhof Dam	813	602	750
Vaal Harts Weir	832	629	750
Klipspruit	1240	596	600
Suikerbosrand	1075	651	650

- **Scenario A (Interim) – Discharge of semi-treated AMD to the Vaal River system after neutralisation & metal removal; &**
- **Scenario B (Long run) – Desalination of underground mine water and re-use.**

2.1.11 Vaal River Augmentation Options



Important Dead-lines

Short-Term Emergency Works

- To stop decanting in WRMB.
- To protect the ECLs in CRMB (June/ July 2013); and
- To protect the ECLs in ERMB (June 2014).

Long-Term Solution

- To remove the mine water induced salt-loading (*i.e.* 2014/ 15)

WHERE ARE WE NOW?

Nothing beats good planning

FS:LTS to-

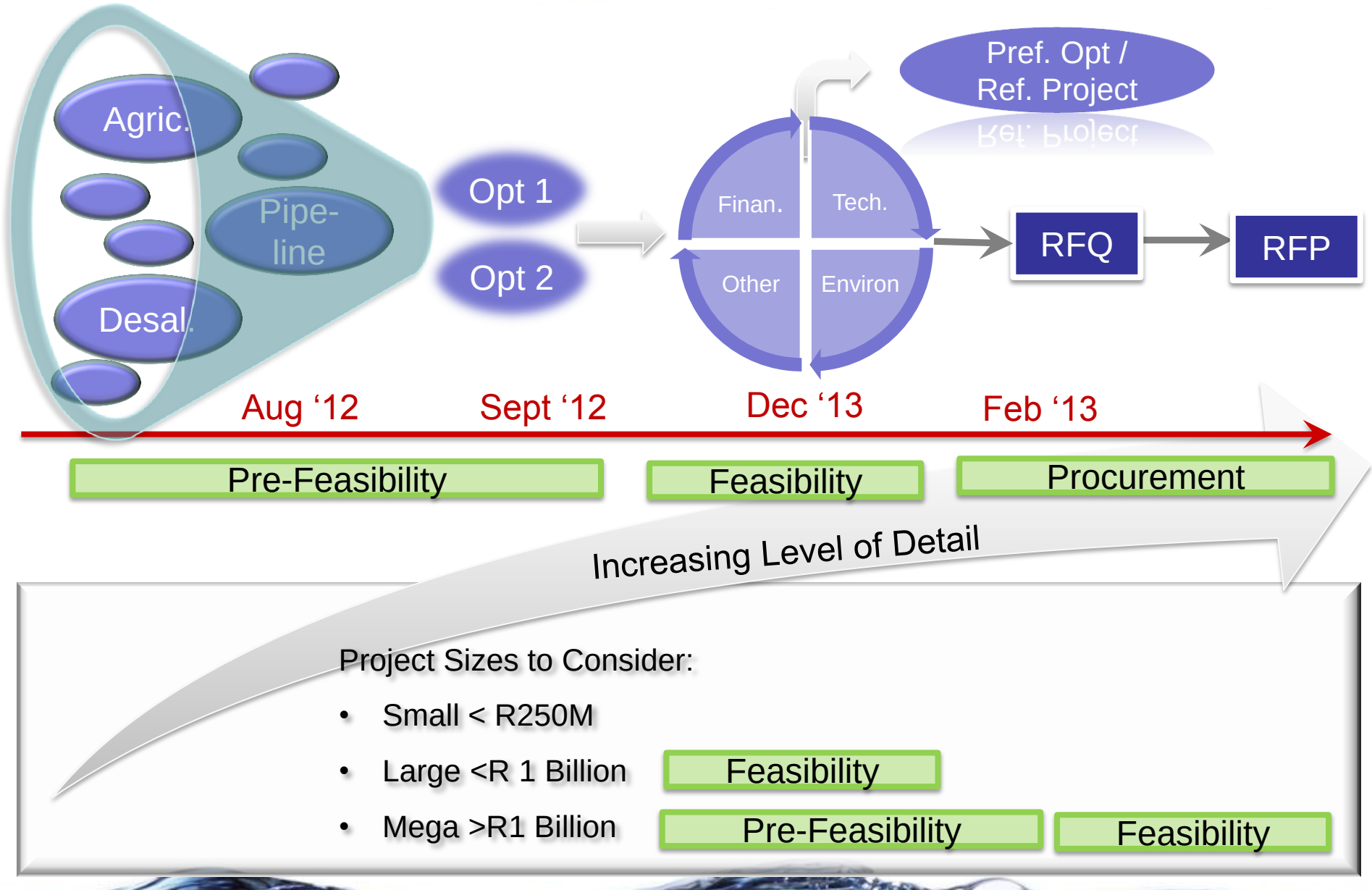
- **Consider all options and find the best solution;**
- **Follow a defensible process;**
- **Potentially facilitate public sector innovation;**
- **Address the waste “management” challenges;**
- **Protect the Tax payer and water user interest;**
- **Consider OPEX;**
- **Etc.**

Study Goal

- **Investigate and recommend a feasible long-term solution to the AMD problems emerging in the study area, in order to ensure long term water supply security and continuous fitness for use of Vaal River water.**

Study registered with National Treasury and needs to comply to the requirements to enable a possible PPP solution as well.

OPTIONS ANALYSIS



5x Focus Areas of the Feasibility Study

INTEGRATION

Technical Study

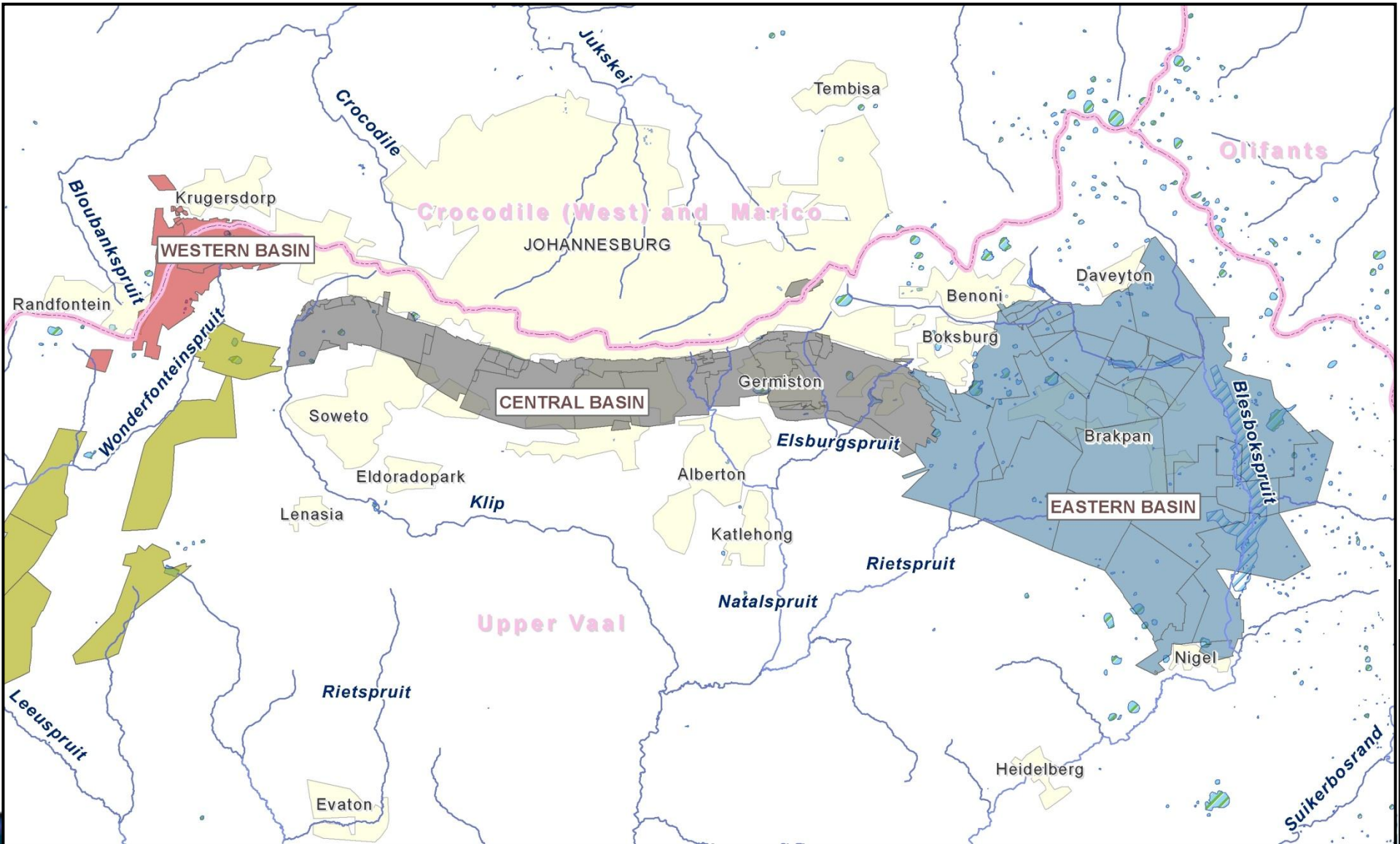
Legal Study

Institutional/ PPP Study

Finances & Economics Study

Key Stakeholder Participation

The Study Area



Study Governance Structure, Role of SSC and Communications Strategy

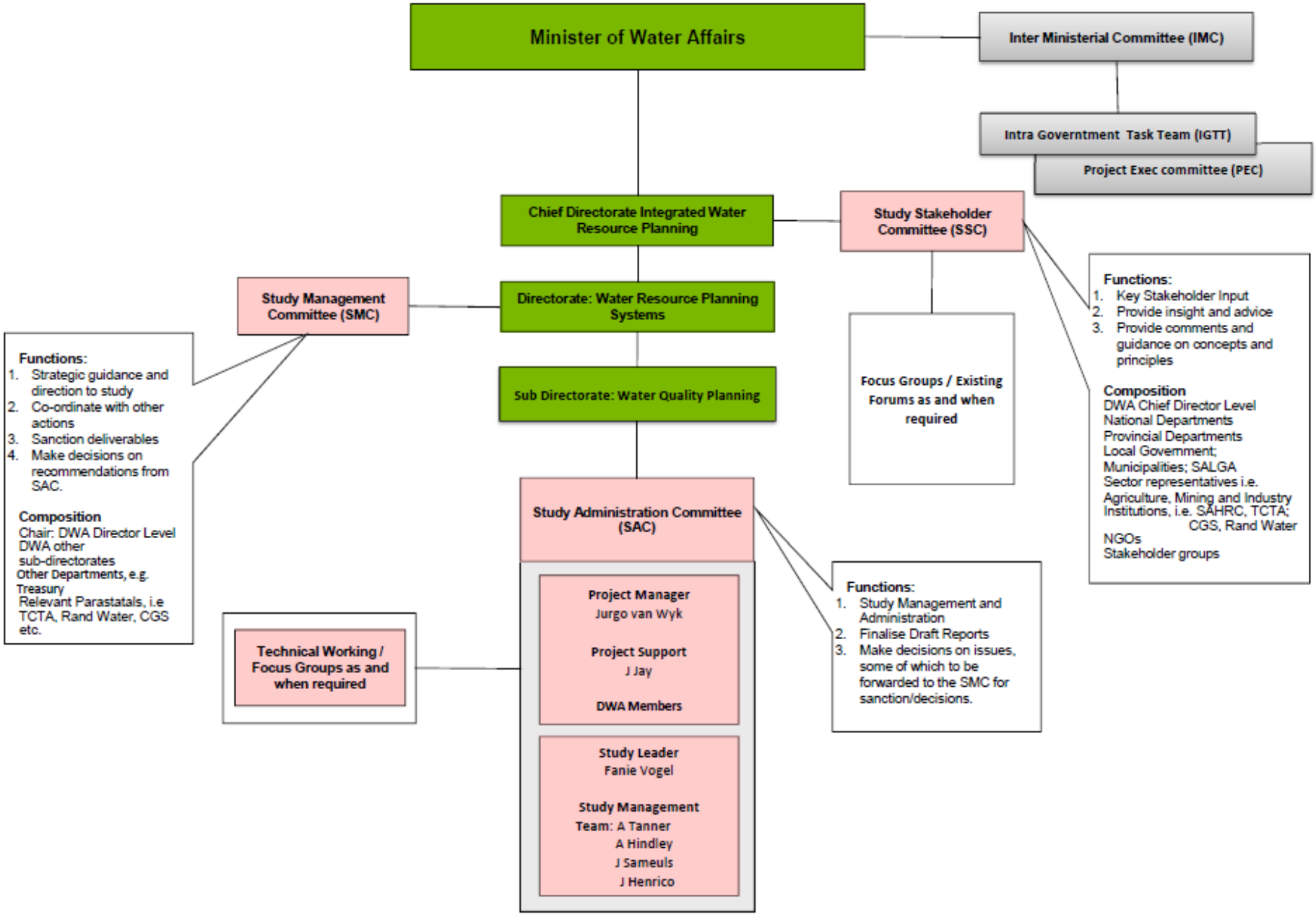
PSP: Multi-Disciplinary Consortium

- **Aurecon SA**
  - **Proxa**
- **SRK**
  - **Shango Solutions**
  - **Kaleo Consulting**
- **Turner & Townsend**
  - **Ledwaba Maswai**
  - **Ignis**
- **Specialist Individuals, comprising Engineers, Social & Environmental Specialists, Economists, Lawyers, Treatment Specialists, etc.**
- **103 members**

Management Structure

ACID MINE DRAINAGE FEASIBILITY STUDY (AMD)

Governance Structure



Key Stakeholder Engagement and Communication

- The Feasibility study to consider all options;
- Require technical input and expert advice;
- Focussed consultation on a technical level with key stakeholders and stakeholder sectors/ groups.
- Not an EIA or public consultation process yet.

Who are key stakeholders in this study?

Directly affected parties, those who have a high level of influence on the direction and success of AMD long-term initiatives, and those whose input is critical to the study

Key Stakeholder Engagement and Communication

- **Study Stakeholder 2 day w/shop May 2012**
- **Stakeholders Engaged to Date:**
  - **Government Departments**
  - **CSIR**
  - **CGS**
  - **NECSA**
  - **WRC**
  - **Rand Water**
  - **Municipalities**
  - **Universities e.g., Wits, NW, Tuks, TUT, FS etc.,**
  - **Experts: Frank Winde, Leslie Stoch, etc.**
  - **FSE**
- **DWA presentations to Catchment Forums and existing forums and structures,**
  - **E.g. Blesbokspruit Forum, Leeuspruit Forum, Western Basin Void Decant Technical Group, Vaal Dam Forum and Vaal Barrage Forum.**

Communication with wider Stakeholder Group

- **DWA website - will contain relevant information**
- **Newsletters**
  - **With standard text box for information/ feedback to stakeholders on the short-term interventions**
  - **Distribution:**
    - **DWA website & Electronically (email) to wider stakeholder database,**
  - **Newsletters**
- **Press releases**
  - **Distribute by DWA**
  - **Press releases:**
    - **March 2012 -Statement by Minister Edna Molewa at the AMD media briefing in Randfontein on 22 March 2012**
- **Frequently Asked Questions (FAQ) on DWA website**
- **Broad public participation to follow**

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FOCUS GROUP MEETING

7 September 2012

Andrew Tanner
(Aurecon)

5x Focus Areas of the Feasibility Study

INTEGRATION

Legal Study

Technical Study

Institutional/ PPP Study

Finances & Economics Study

Key Stakeholder Participation

WHERE ARE WE NOW?

WHERE ARE WE NOW?

Study Inception

Gathering Information

WHERE ARE WE NOW?

Legal Study

Current Status

- The draft “Legal Considerations for Apportionment of Liabilities Report” has been submitted to DWA during the last week of June.
- This is a confidential report
- Discussions with DWA on this matter are on-going

Legal Considerations for Apportionment of Liabilities (cont.…)

- The CGS' s alternative (technical/pragmatic) approaches on a apportioning liabilities is being considered and commented on by technical team members under this component.

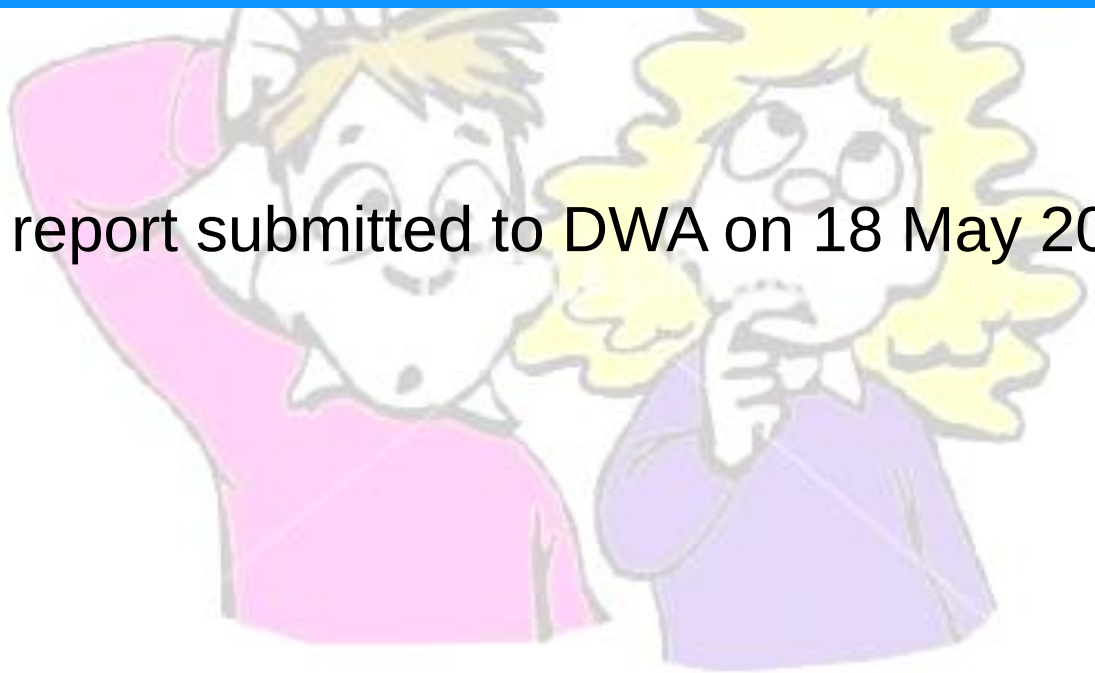
TECHNICAL DISCUSSION STRUCTURE

WHERE ARE WE NOW?

WHERE ARE WE GOING?

WHERE ARE WE NOW?

Component 4.1: Assessment of the Current Status of the Management of AMD

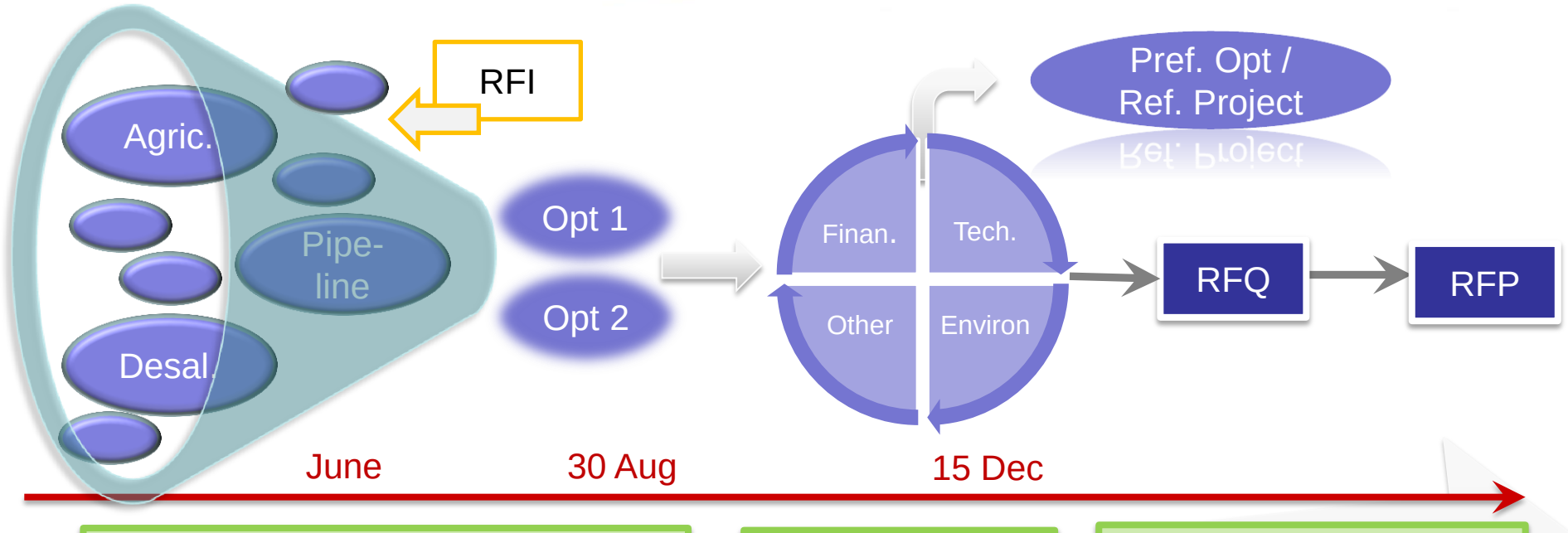


- Draft report submitted to DWA on 18 May 2012

Findings to Date

- The current status was reviewed under the following headings:
  - Existing and planned (STI) infrastructure
  - Current and planned treatment of AMD
  - Environmental aspects
  - Procurement strategies
- The STI does have implications for LTS and the costs of alternatives are being evaluated

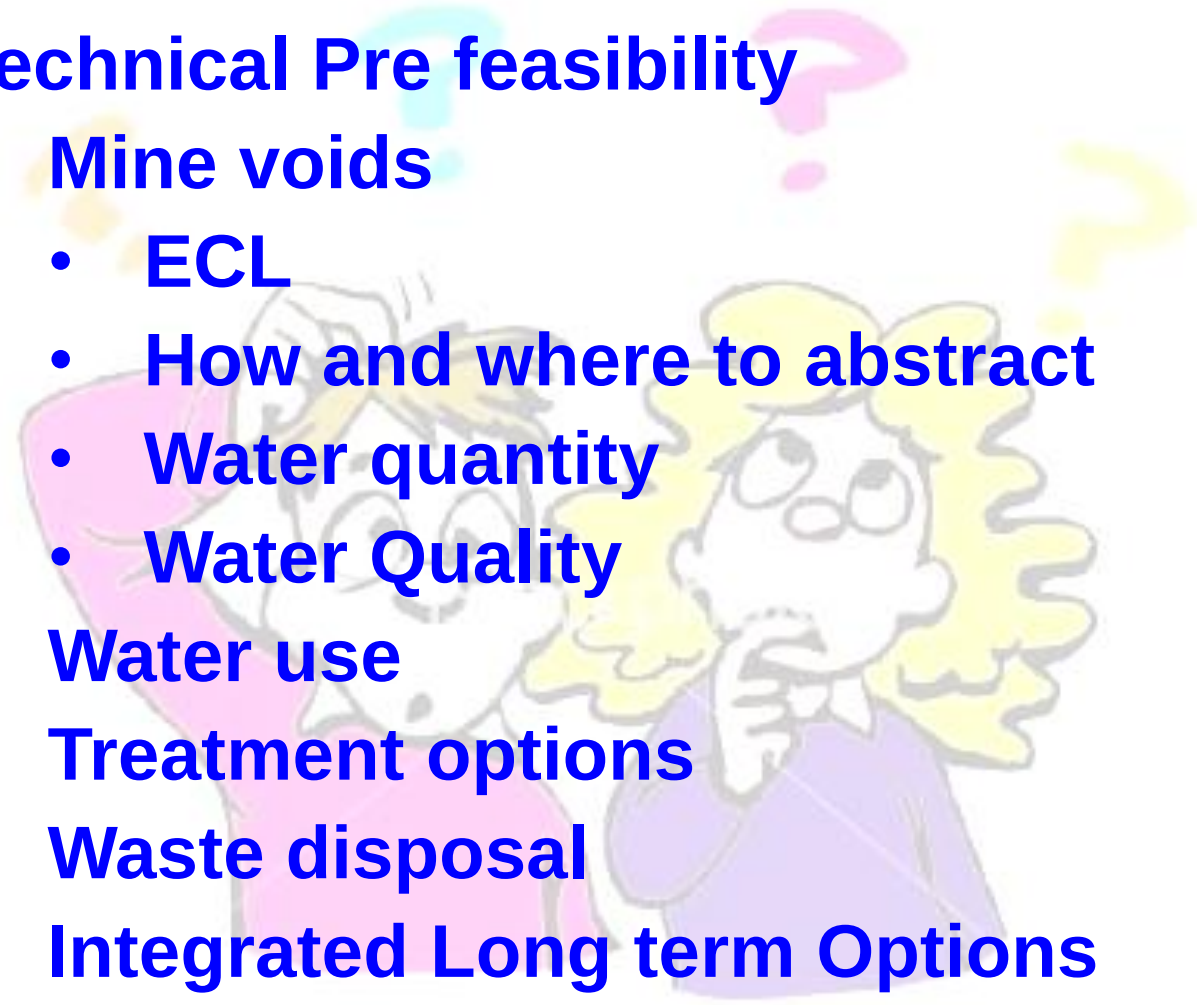
OPTIONS ANALYSIS



Project Sizes to Consider:

- Small < R250M
- Large <R 1 Billion — Feasibility
- Mega >R1 Billion — Pre-Feasibility, Feasibility

WHERE ARE WE NOW?



Technical Pre feasibility

- **Mine voids**
  - **ECL**
  - **How and where to abstract**
  - **Water quantity**
  - **Water Quality**
- **Water use**
- **Treatment options**
- **Waste disposal**
- **Integrated Long term Options**

WHERE ARE WE NOW?

- MINE VOIDS

Current Mine Water Status in Wits Basins

Basin	Mine water level (metres below surface) [mbs]	Environmental critical level (ECL) (mbs)	Est. date to ECL
Eastern	June 2012= 538	314	Jun 2014
Central	June 2012= 322	174	Jun-Jul 2013
Western	At surface	160	ECL currently breached resulting in surface decant

ECL – The highest level that mine water can be allowed to rise in the mine void before adverse environmental impacts can be detected

Water Quantity and Quality of Mine Voids

- 1st Draft Report submitted on 16 May 2012
- Comments received and report discussed with DWA on 22 June 2012
- Additional analyses carried out
- 2nd Draft Report issued on 22 August
- Now available to SSC members on the project Web Portal

Findings to Date

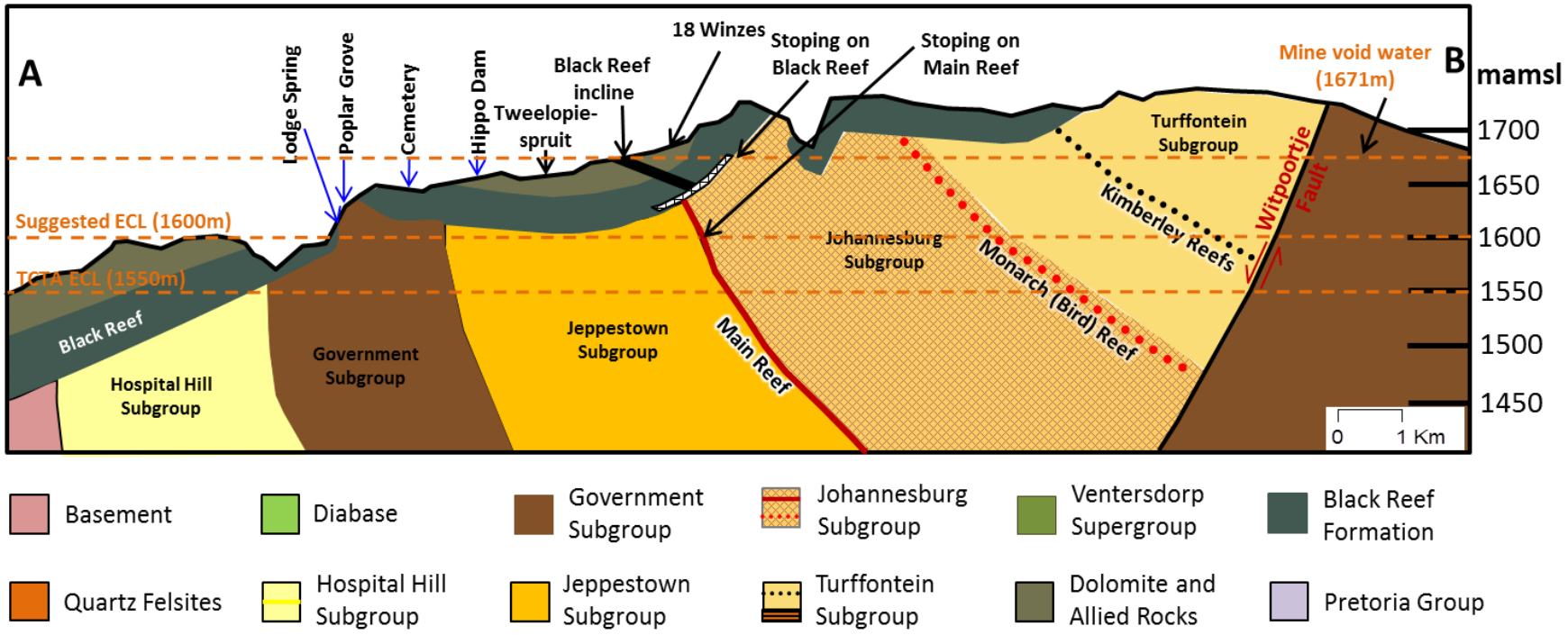
Water Quantity and Quality of Mine Voids

Western Basin:

- ECL Objectives
  - Protection of Cradle of Humankind Dolomites and Tweelopies Spruit
  - Reverse hydraulic gradient towards mine void

Water Quantity and Quality of Mine Voids

Western Basin



Water Quantity and Quality of Mine Voids

Western Basin (cont…):

ECL Strategy

- Lower level slowly to 1600 m amsl and maintain for sufficient time to empty storage in dolomitic aquifer
- **Monitor** in Cradle of Human Kind and Tweeloopies Spruit during dewatering
- Lower to 1550 m amsl (TCTA recommendation) if no improvement to Tweelopies catchment or problems in Cradle of Human Kind

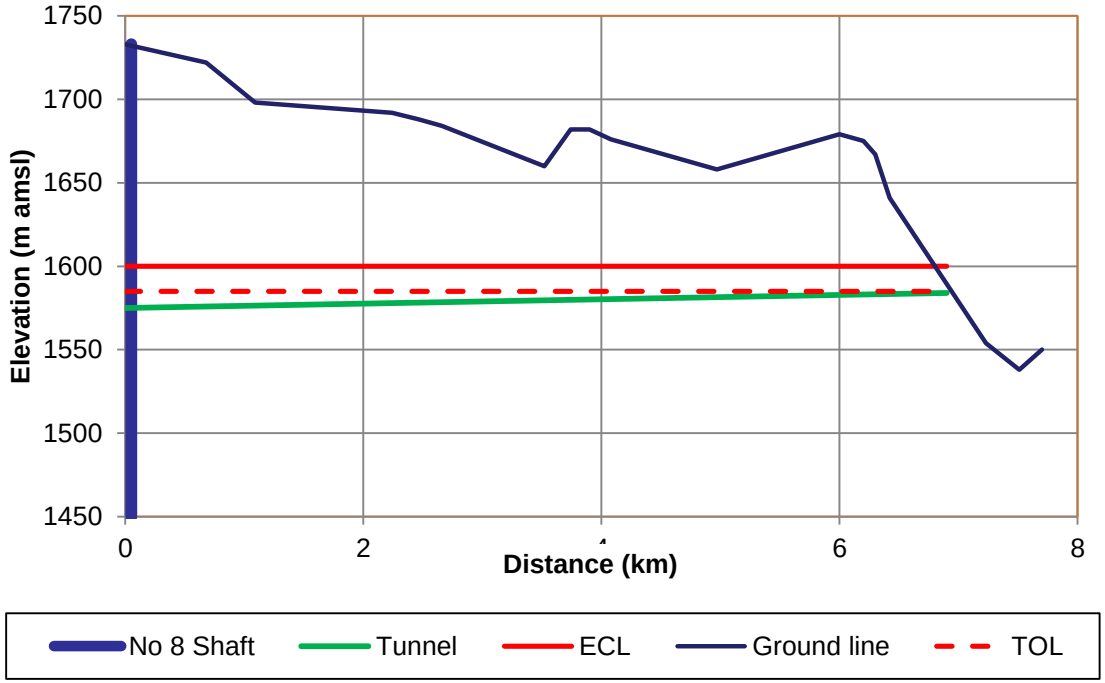
Water Quantity and Quality of Mine Voids

Western Basin (cont.…):

Abstraction Strategy

- Rand Uranium Shaft #8 (TCTA selection) due to proven good connection
- Passive drainage by tunnel connected to void (possible longer term solution)

Western Basin Tunnel Option



Average Flow 23 Ml/d

Assumed Eskom Tariff Increases	
2013	25 %
2014-2027	13 %
Thereafter (CPI)	6 %

Length	Cost	Savings	
(km)	(R mil)	Head (m)	Elec. NPV (R.mil)
6.9	276	180/130	148/114
NPV for 50 years			

Water Quantity and Quality of Mine Voids

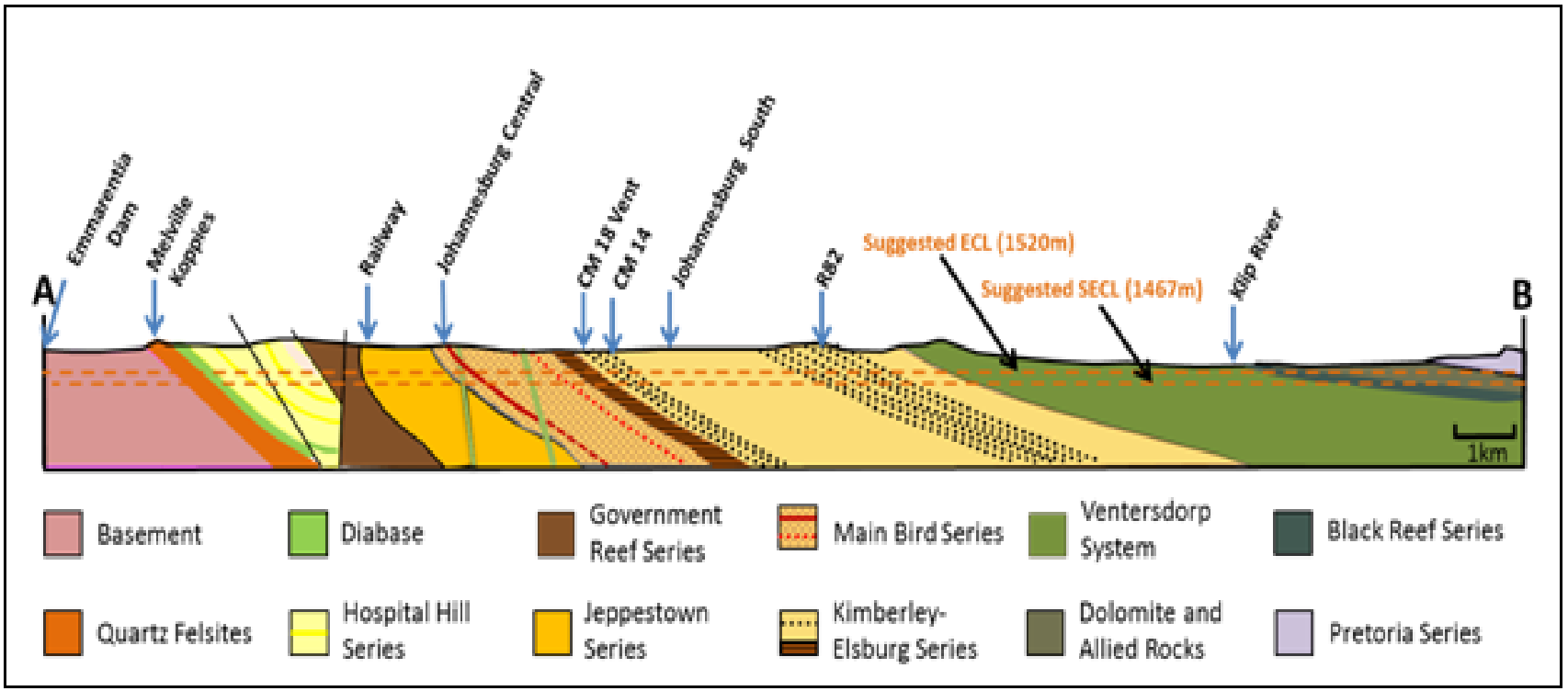
Central Basin:

ECL Objectives

- Protect shallow aquifers
- Maintain ECL at 1520 m amsl, 100m below surface
- Plug GRC shaft or move museum

Water Quantity and Quality of Mine Voids

Central Basin



Water Quantity and Quality of Mine Voids

Central Basin:

SECL Objective 1

- To protect Gold Reef City tourist facility at 1480 m amsl
- Adopt level of 1474 m amsl (TCTA 1467)

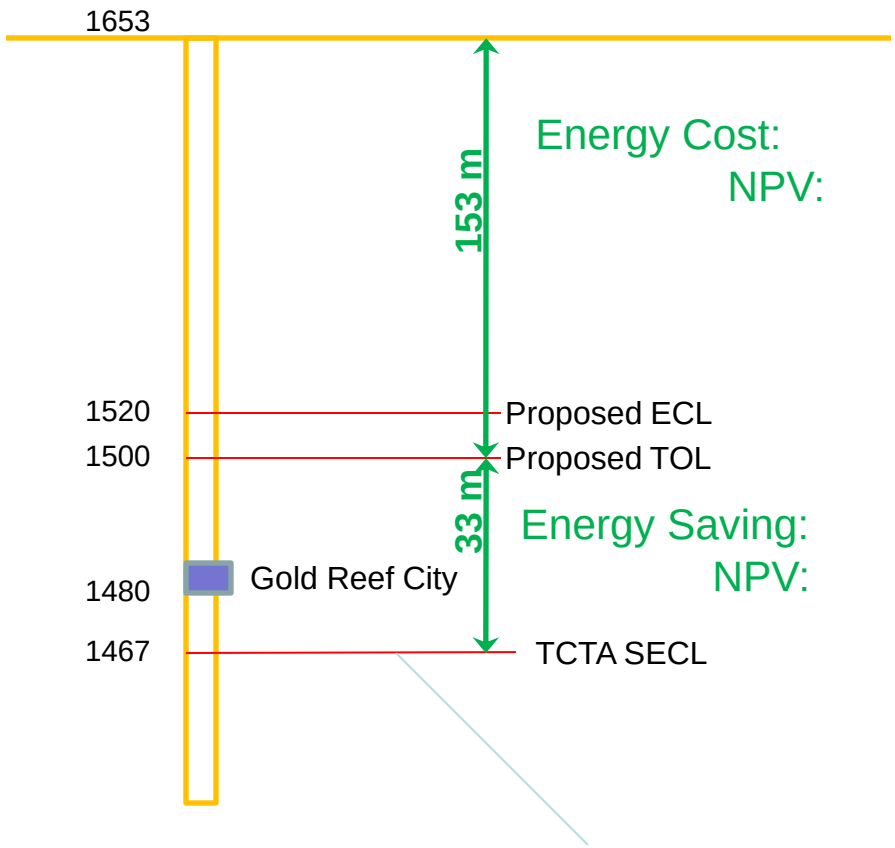
SECL Objective 2

- Allow Mining
- Maintain level +- 400m below surface as long as necessary

Water Quantity and Quality of Mine Voids

Central Basin

Average pump rate 46 Ml/day



Energy Cost: R 8.2 million / annum
NPV: R 130 million

Energy Saving: R 2.5 million / annum
NPV: R 27 million

Water Quantity and Quality of Mine Voids

Central Basin:

Recommendation

- **Maintain at level for mining or at 1467 m amsl initially.**
- **If GRC shaft has been plugged**
  - **Slowly allow level to rise and Monitor**

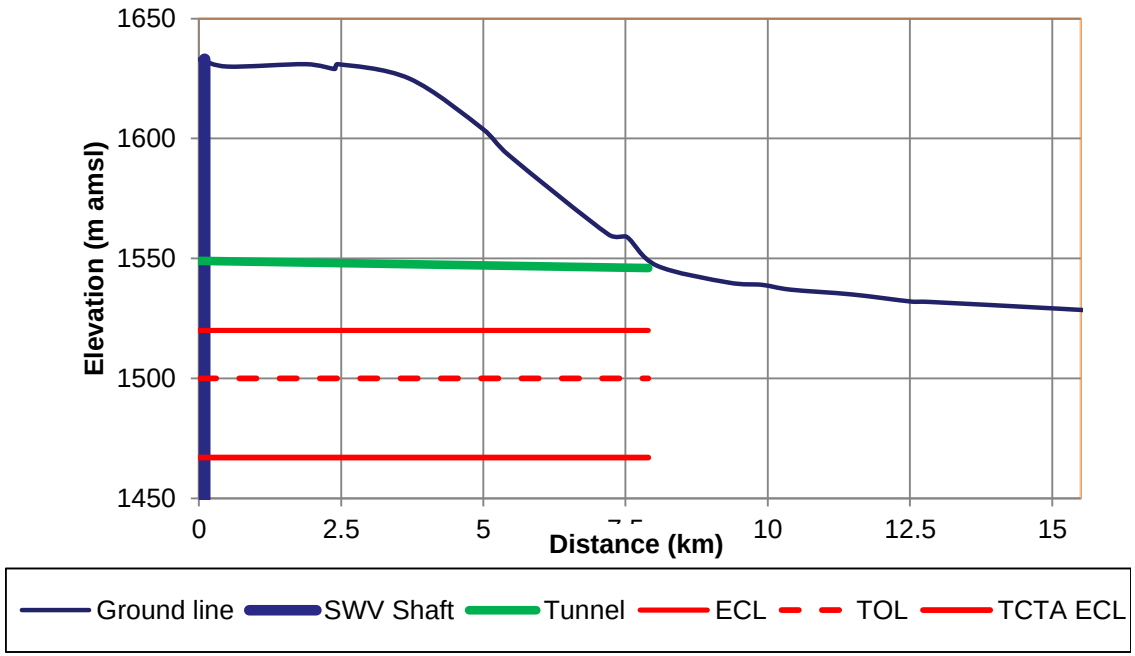
Water Quantity and Quality of Mine Voids

Central Basin (cont…):

Abstraction options

- South West Vertical (SWV) shaft recommended by TCTA. Deep and limited connectivity
- Considering additional abstraction from:
  - several declines (more connection at shallow depths)
  - passive drainage via tunnel or
  - abstraction boreholes targeting mine void/declines at shallower depths

Central Basin Tunnel from SWV Shaft



Capacity 46 Ml/d

Assumed Eskom Tariff Increases	
2013	25 %
2014-2027	13 %
Thereafter (CPI)	6 %

Length	Cost	Savings	
(km)	(R mil)	Head (m)	Elec. NPV (R.mil)
7.5	300	206/150	300/230
NPV for 50 years			

Water Quantity and Quality of Mine Voids

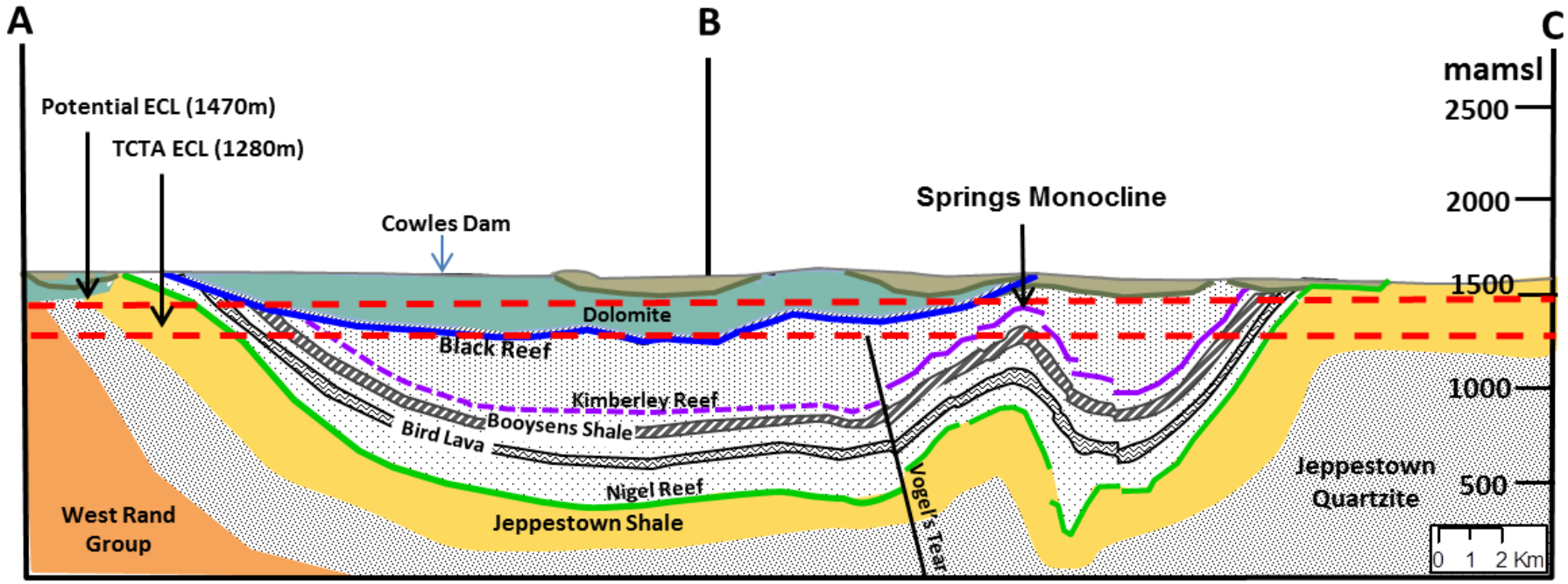
Eastern Basin:

ECL Objective:- Protect dolomitic Aquifer

- Set at 1280 m amsl suggested by TCTA to protect dolomites.
- Can consider raising ECL to 1470 m amsl - 70m below surface (hydraulic gradient still towards void) and separated by Green Sill, if adequate monitoring
- Monitoring of ground water quality will be essential
- **Slowly allow level to rise and Monitor Water Quality**

Water Quantity and Quality of Mine Voids

Eastern Basin



Water Quantity and Quality of Mine Voids

Eastern Basin (cont…):

Abstraction points

- Grootvlei #3 recommended by TCTA (1280 m amsl) but recirculation to void - known ingress point
- Shafts at lower elevations could reduce pumping by 20 m head difference
  - E.g. Marievale
- Boreholes into void could be considered

Water Quantity and Quality of Mine Voids

Summary of ECL and Pumping Rate

Basin	TCTA ECL mamsl	This Study ECL mamsl	Approx. Average Pumping Rates (TCTA) (Ml/day)		Proposed Pump Capacity and Rate (this study) (Ml/day)	
			Volume	Range	Capacity	Rate
Western	1550	1600	27	23-35	40	23
Central	1467	1520/1474	57	34-84	50	46
Eastern	1280	1470	82	38-110	100	80

Water Quantity and Quality of Mine Voids

Water Chemistry

Water Quality Parameter	Units	TCTA Report			This Report		
		Basin			Basin		
		Western (95th percentile)	Central (95th percentile)	Eastern (flooded condition)	Western (95th percentile)	Central (95th percentile)	Eastern (95th percentile)
pH*	-	3.4-4.0#	2.3	5#	3	3.2	7.1
TDS	mg/ℓ	7174	7700	5500	5388	3888	4248
Conductivity	mS/m	548	730	450	426	354	367
Calcium (Ca)	mg/ℓ	461	580	550	823	483	421
Magnesium (Mg)	mg/ℓ	345	380	230	-	161	165
Sodium (Na)	mg/ℓ	139	150	325	243	185	264
Sulphate (SO_4)	mg/ℓ	4556	5200	3275	3410	2464	2581
Chloride (Cl)	mg/ℓ	65	260	260	-	69	253
Acidity/Alkalinity	mg/ℓ	2560**	2425**	750**	1255+	125##	541##
Iron (Fe)	mg/ℓ	933	1,000	370	799	177	206
Aluminium (Al)	mg/ℓ	54	50	1	-	44	2
Manganese (Mn)	mg/ℓ	312	60	10	114	20	6
Uranium (U)	mg/ℓ	0.2	-	-	0.1	0.2	0.5

*5th percentile #Assumed 5th percentiles **Acidity - Calculated $CaCO_3$ +Acidity mg/l ##Alkalinity mg/l $CaCO_3$ All units as quoted in source documents

WHERE ARE WE NOW?

Discussion

- Western basin
- Central basin
- Eastern basin

WHERE ARE WE GOING?

What can we do with the water?

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Objective
  - Assess options to eliminate or suitably reduce the salt loadings on the Vaal System from underground AMD.

- Scope
  - Options for direct use of neutralized water
  - Assess alternative uses for desalinated water.

Options for Discharge, Delivery and Disposal of Treated Water & Waste Products

- Interim First Draft report issued to DWA 5 September, (without RW Inputs)
  - Need more inputs from and discussions with Rand Water to complete report

Findings to Date

- Two Water Quality Streams
  - Neutralised water
  - Desalinated water

Findings to Date

- Direct use of neutralized water
  - Mines
  - Agriculture
  - Industry

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for Direct Use of Neutralized Water
  - Direct supply to agriculture.
    - Pipe or canal supply from neutralization plant to distribute some or all of the water.
    - There are salt tolerant crops.
    - Requires careful management and crop rotation.
    - Salts build up in the soil.
    - All salts are not removed from the system.
    - Not sustainable as a Long-Term Solution??

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for Direct Use of Neutralized Water (cont.…)
  - Direct supply to mines:
    - Pipe or canal to operations that can accept this saline water
    - Processing of mine dumps, etc.
    - Other process that can accept saline water?
    - Salts combined with dump material in a slurry
    - Slurry reprocessed
    - Waste product “stored”?
      - Slimes dam, etc.

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for Direct Use of Neutralized Water (cont.…)
  - Direct supply to mines:
    - Salts are not removed from the system
      - Will eventually re-enter the resource unless run off is contained and permanently “stored”.

These options may defer the problem but may pose long term risks.

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for Direct Use of Neutralized Water (cont.…)
  - Direct supply to Industry:
    - Pipe (or canal) to industries that will accept saline water:
      - Will not use the salt in their process
      - Will treat to get acceptable water
      - Disposal of salt will be a risk to the water resource and environment

Findings to Date

Direct use of neutralized water

- Use of Neutralised Water is not a recommended LTS since majority of the salt remains in the system.
- May buy some time if carefully managed.

Findings to Date

- Alternative use of Neutralised and Desalinated Water
  - Rivers
  - Potable
  - Industry

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for use of neutralized and desalinated water – each discussed in the following presentations, by basin:
  - Potable Water:
    - Treated to SANS 241 (minimum)
    - Other higher standards may required
  - Industrial Users:
    - Salts removed to acceptable concentrations
    - May be to SANS 241

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Options for use of neutralized and desalinated water – each discussed in the following presentations, by basin (cont.…):
  - Discharge to Rivers:
    - RWQO
    - Downstream Users
    - Environment

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Desalinated Water - Discharge to Rivers

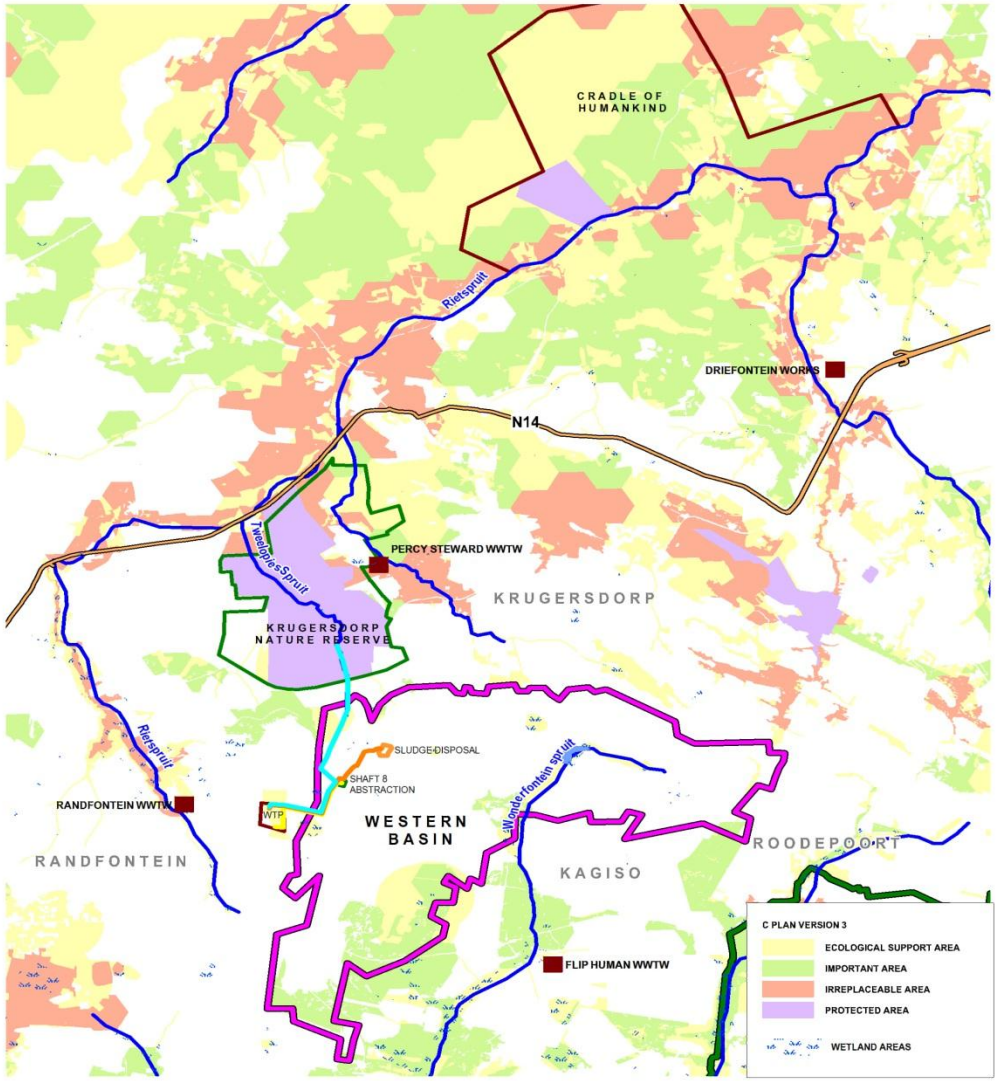
- Objective

  Provide guidance on the discharge of desalinated acid mine drainage by considering Water User Quality Requirements for the affected basins.

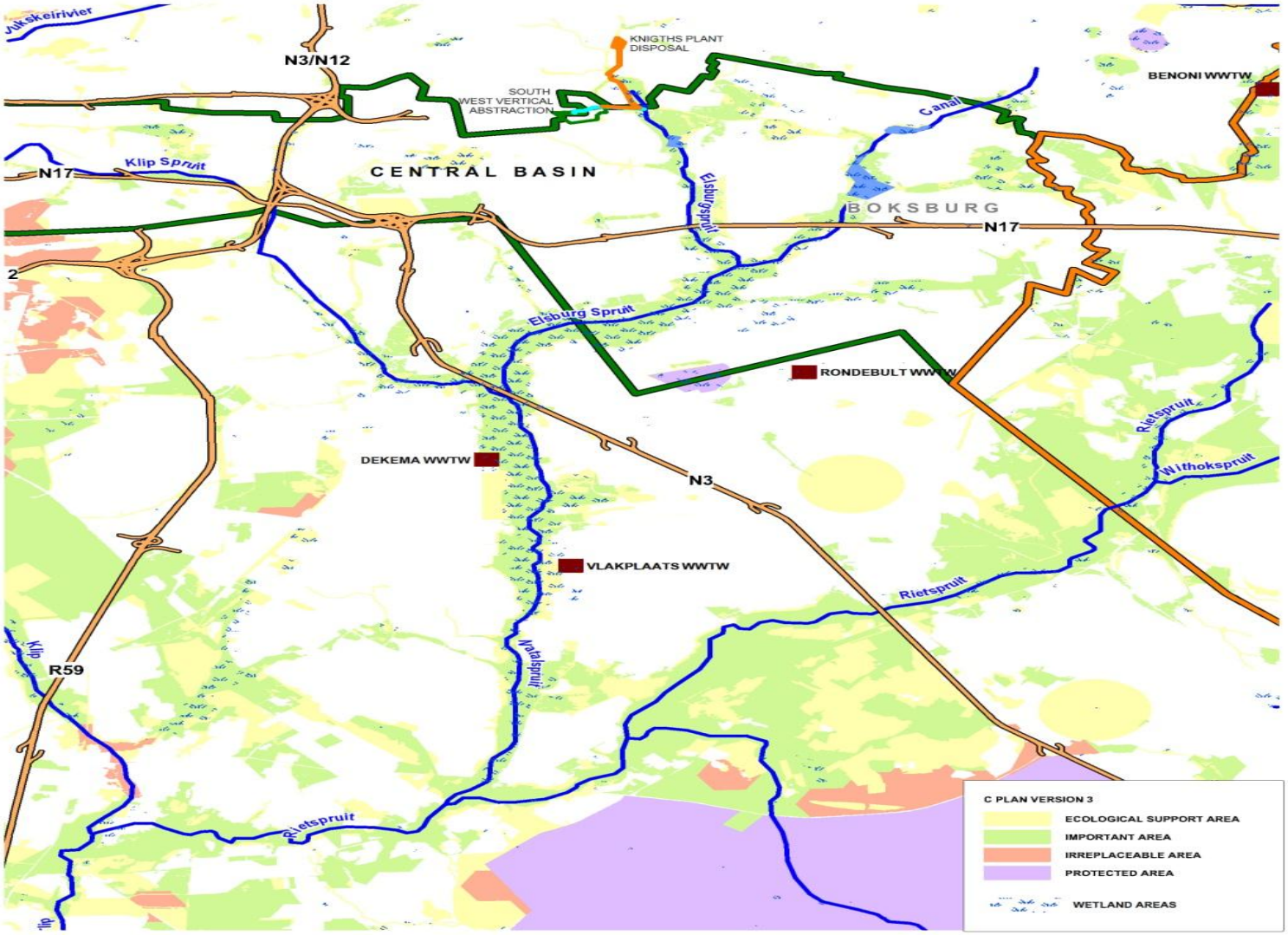
Resource Water Quality Objective

- RWQO is the water quality component of the Resource Quality Objectives (RQOs).
  - **numeric or descriptive in-stream** (or in-aquifer) water quality objectives
  - finer resolution (spatial or temporal) than RQOs
- Water requirements
  - Domestic, Agriculture, Recreational, Aquatic, Industrial
- Levels
  - Target, Acceptable, Tolerable, Unacceptable
- Vaal River Reconciliation Study

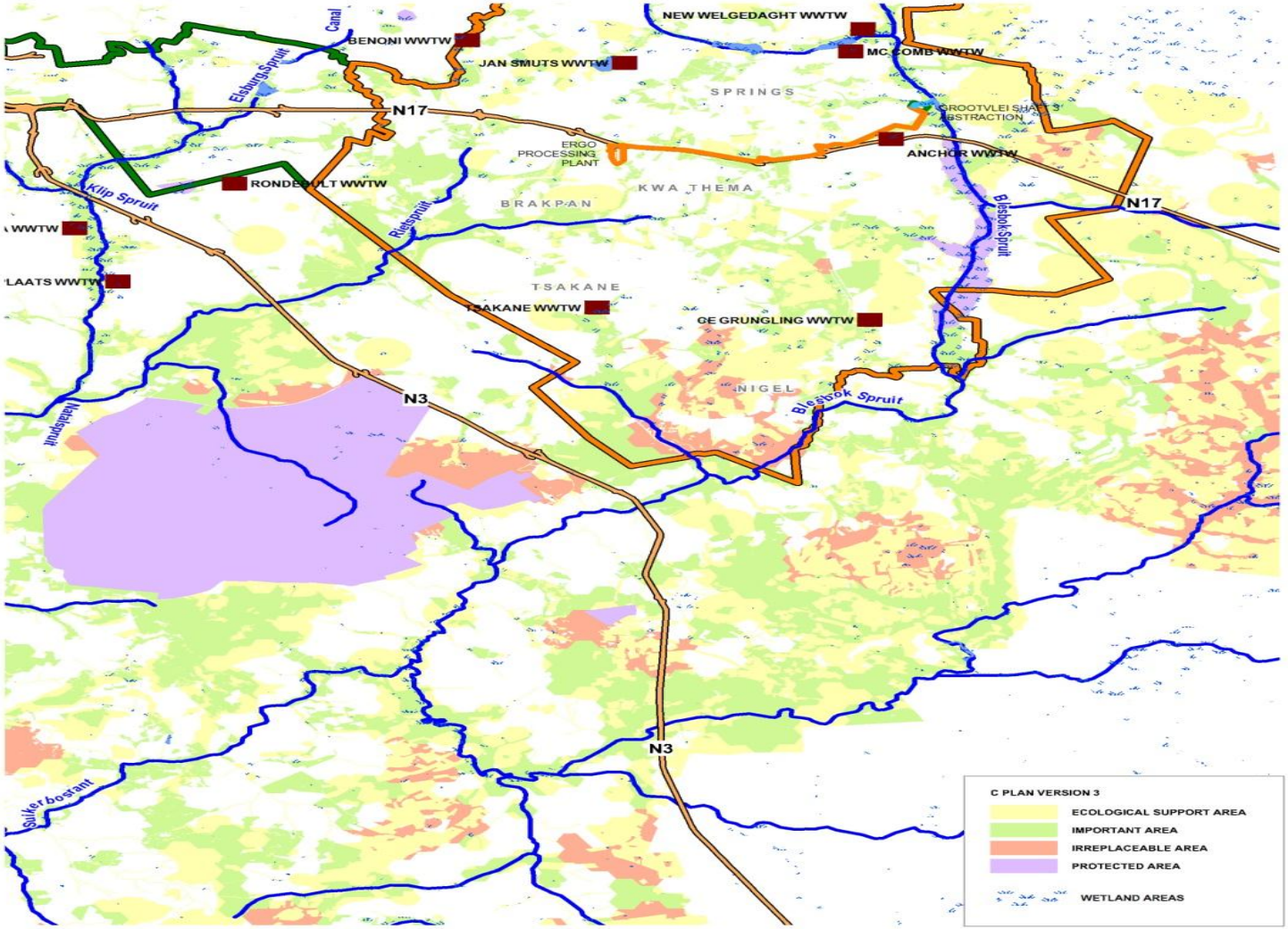
Western Basin



Central Basin



Eastern Basin



Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Desalinated Water
  - Potable Use
  - Industrial Use

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Potable Use
  - If desalinated the drinking water quality standards can be achieved
  - Rand Water is considered as the primary stakeholder, as the mine water treatment facilities fall within their area of supply and jurisdiction
  - Other stakeholders to be considered are Johannesburg Water, Magalies Water and municipalities such as Ekurhuleni Metropolitan Municipality
  - Rand Water have major concerns about the public's reaction if desalinated water is proposed for potable use

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

- Industrial Use
  - Rand Water have a number of existing and potential customers who will probably take treated mine water for industrial purposes
  - Other users (industries and mines) can be considered

Options to eliminate (or suitably reduce) Underground Mine Water induced Salt Loading on the Vaal River System

Water Quality of Neutralized vs. Desalinated Water for Industrial Use

WQ Parameter	Units	Neutralized (HDS)	Desalinated (RO): SANS 241
Sulphate	mg/l	< 2 400	< 250
Chloride	mg/l		< 300
pH		> 6 to < 9	> 5 to < 9.7
Iron	mg/l	< 1	< 0.3
Aluminium	mg/l	< 1	< 0.3
Manganese	mg/l	< 3	< 0.1
Uranium	mg/l	< 0.05	< 0.015

WHERE ARE WE GOING?

How can we treat the AMD?

Component 4.4:
Assessment of Treatment Technologies

- Draft report issued to DWA on 30 August 2012

Alternative Treatment Processes and the Implications

Classification of technology

- Pre-treatment
  - HDS
- Physical Processes
  - Conventional RO (following HDS)
  - Alternative RO (no HDS pre-treatment)
  - Electro-coagulation
  - Electro-coagulation & Electro-precipitation
- Chemical processes
  - ABC-process
  - SAVMIN process
- Biological processes
  - Biosure
  - Paques

Alternative Treatment Processes and the Implications

Factors affecting the selection process:

- Quality of raw AMD
- Quality required of treated AMD
- Waste products produced
  - Mass of waste
  - Volume of waste
  - Properties of waste
  - Value of waste products
- State of development of technology
- Complexity of process and operation
- Risk evaluation
  - Environmental impact
  - Health factors
  - Impact of failures
    - Recovery times
    - Danger to public

TECHNOLOGY OPTIONS

SUMMARY OF AMD TREATMENT TECHNOLOGIES

ACID NEUTRALIZATION	METALS REMOVAL	REMOVAL OF SALTS	REMOVAL OF SPECIFIC POLLUTANTS
Limestone ($CaCO_3$)	Precipitation as Hydroxides	Physical Desalination (Reverse Osmosis)	Radio- active nuclides Precipitation Ion Exchange
Lime ($Ca(OH)_2$)	Precipitation as Carbonates	Biological Sulphate Removal	Cyanide Removal Chemical Oxidation Biological Oxidation Complexation
Sodium based alkali ($NaOH$, Na_2CO_3)	Precipitation as Sulphides	Chemical Precipitation (ABC, SAVMIN)	
Biological Sulphate Reduction	Wetlands, Oxidation Ponds	Ion Exchange	Arsenic Removal Chemical Oxidation Reduction Biological Oxidation Adsorption
Ammonia		Passive Treatment Wetlands, Irrigation	
Wetlands, anoxic drains			Molybdenum Removal Iron Adsorption

Short-term Intervention Process shown in yellow

Alternative Treatment Processes, Products & Possible Locations

Classification of AMD Treatment Technologies

Classification	Development	Risk level	Comments
Embryonic	Laboratory Scale Simulations	Very high	• Chemical principles are evaluated and proven • No secondary effects are simulated • Limited design info available
Innovative	Pilot Plant Simulations	Moderately high	• Proven chemical principles are applied on a larger scale • Limited simulation of secondary effects depending on the size of the pilot plant • Design parameters are being determined. • Risk that not all parameters are identified
Proven	Being used in practice	Moderate	• Has ben used in Practice for extended period to treat at least 10Ml/d

Alternative Treatment Processes and the Implications

- Discussion
  - HDS and Conventional RO (CRO) are only “proven” technology
  - HDS produces large quantities of waste with disposal challenge
  - CRO produces gypsum sludge
  - All other processes are innovative and require further research or testing to be proven

Alternative Treatment Processes and the Implications

- Discussion (continued)
  - Processes that reduce the waste should receive preference for further investigation
  - Alternative RO produces re-usable metals and gypsum (as claimed by the supplier)
  - Biological processes can produce metal sulphides and elemental sulphur in biological processes

Alternative Treatment Processes and the Implications

- Discussion (continued)
  - Biological processes need to be placed where the carbon source is
  - Biological processes require tertiary treatment to achieve potable standards

WHERE ARE WE GOING?

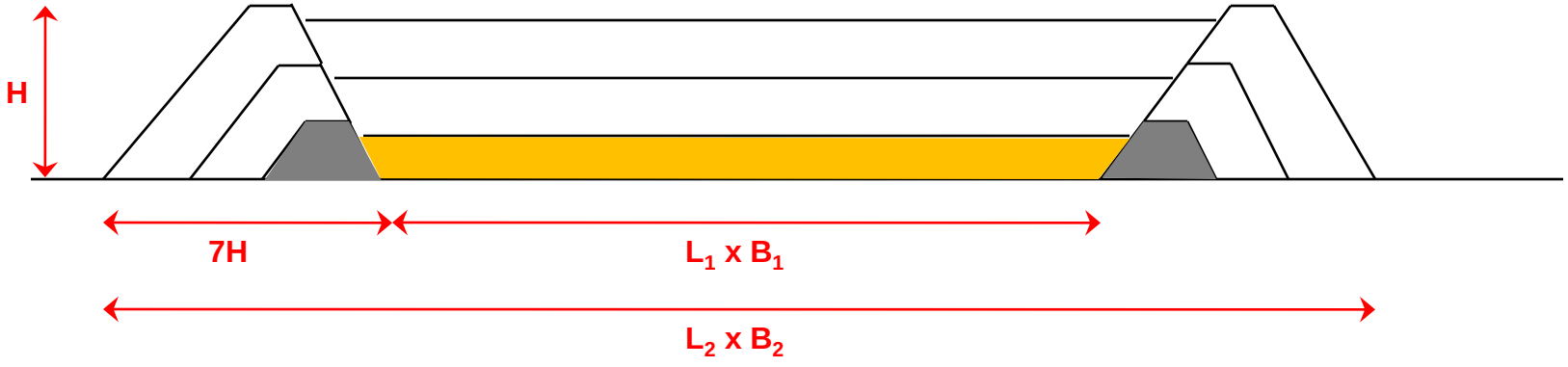
What can we do with the waste products?

Image showing discharges into CPS Pit

HDS Sludge Storage Facilities (SSFs)

Basin	AMD (Ml/d)	H (m)	L_2 (m)	B_2 (m)	NPV (R.mil)	URV (R/m^3)
Western	23	22	735	590	959	7.27
Central	46	38	1030	630	1152	4.35
Eastern	80	32	1200	800	1946	4.24

Size and NPV for 50 years



WHERE ARE WE GOING?

What are the possible Options for Abstraction, treatment, water use and waste management?

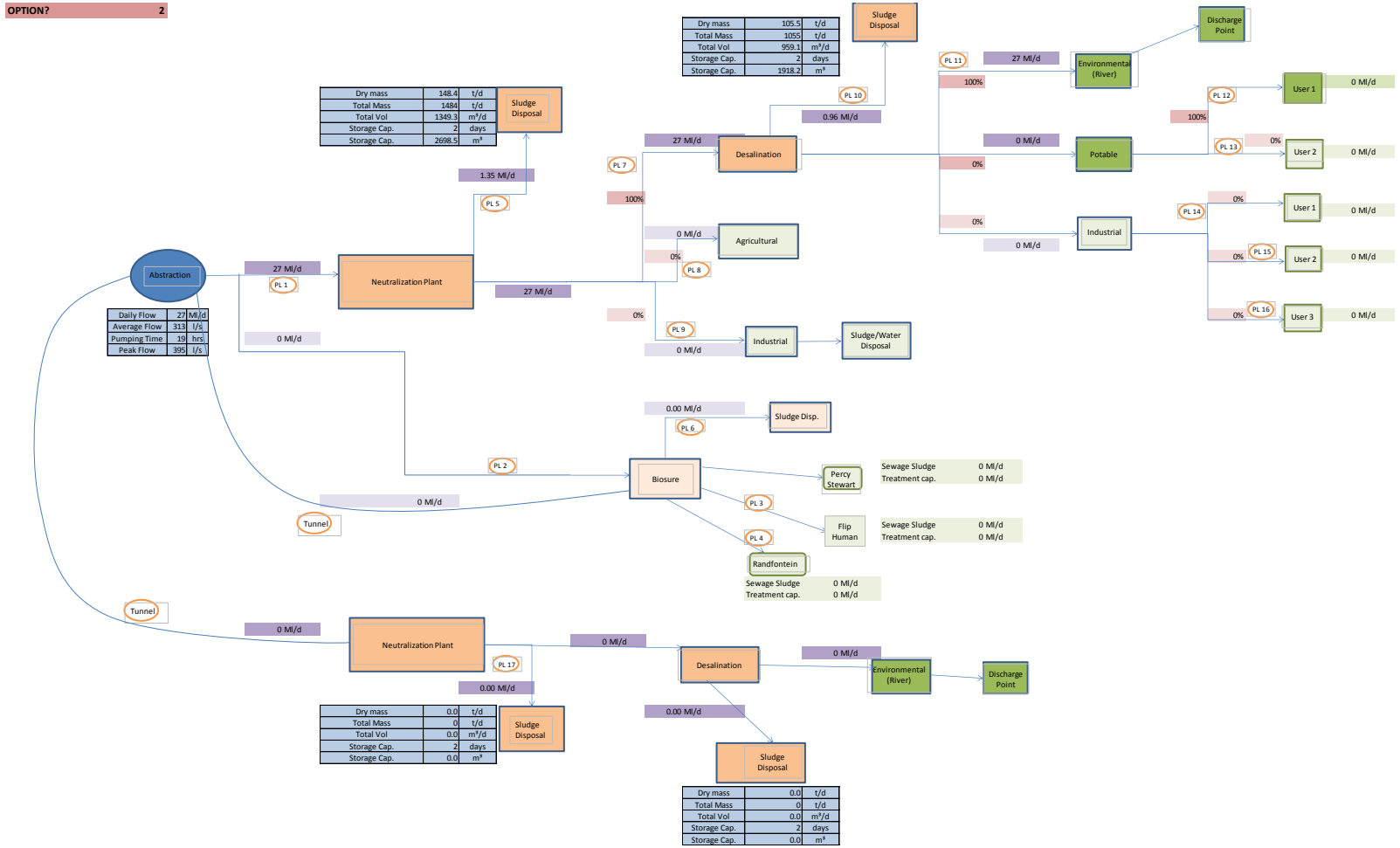
TECHNICAL OPTIONS UNDER CONSIDERATION INCLUDE

- **Potential raising of the ECLs (with monitoring) to levels that are still deemed "safe";**
- **Tunnels (Western and Central Basins);**
- **Connectivity limitation between sub-basins and the need for multiple abstraction regimes;**
- **Alternative pumping locations taking account of preferential flow-paths within the mine voids and the associated impacts on WQ;**
- **Innovative treatment technologies;**
- **Waste discharge options- an important challenge;**
- **Management and use of treated water; etc.**

Current Status

- Flow Diagram Model has been developed for all 3 Basins
- Costing Models are in an advanced stage of development (URV Method) for all 3 Basins

Typical Flow Diagram Model



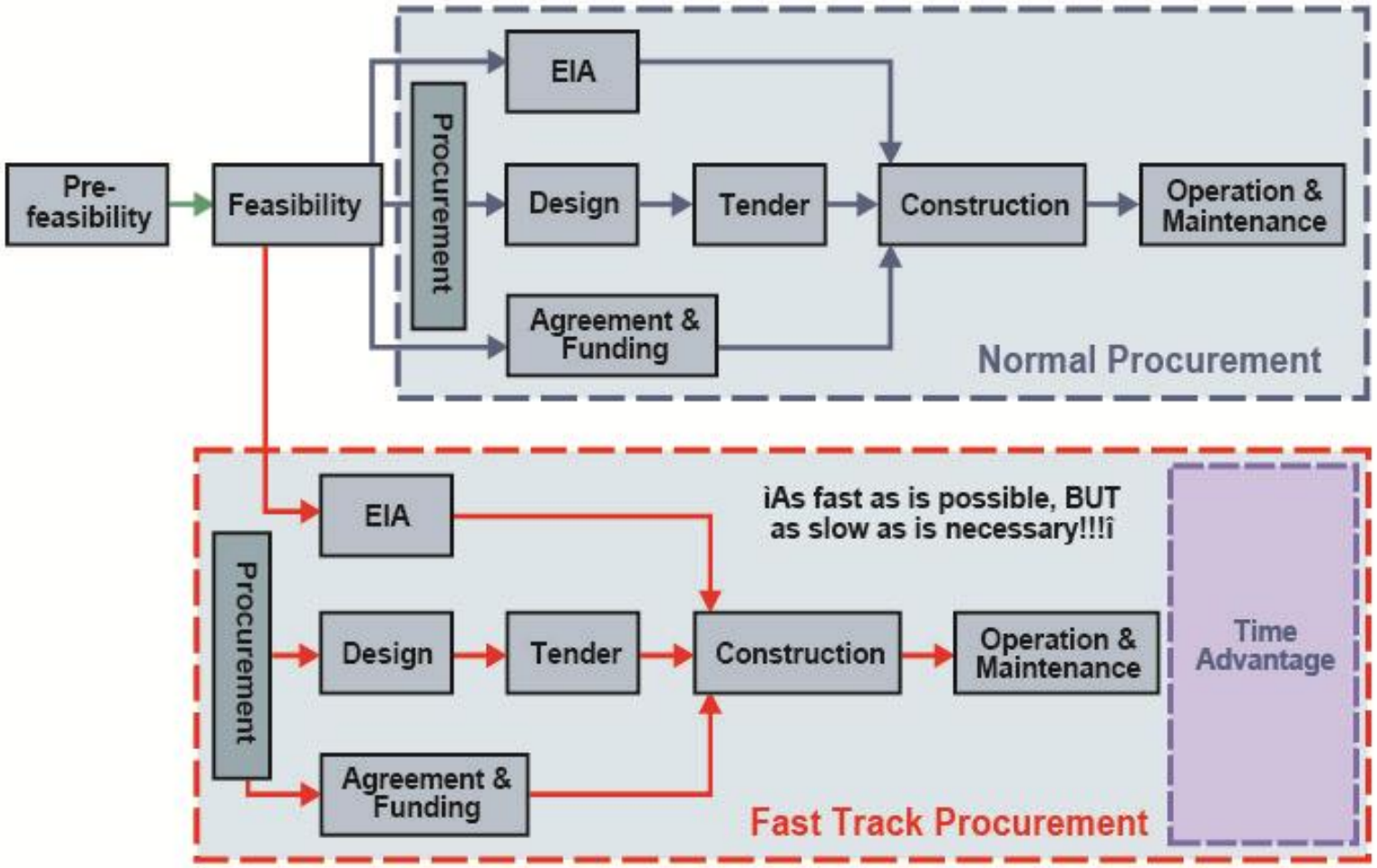
WHAT ARE THE MAIN CONCERNS/CHALLENGES?

Implementation of the Long Term Solution

Key Study Program Dates

- **Contract start date:** **30 Jan. 2012**
- **Inception Report:**
  - **Possible Scope Changes:** **Mid-May 2012**
- **Pre feasibility Draft report:** **End-Sept 2012**
- **Feasibility Draft:** **End-Nov. 2012**
- **Approvals and Final Reports:** **Feb. 2013**
- **Contract end date :** **28 Feb. 2013**

Fast tracking the process



Implementation Programme-Comparisons

	Possible Commissioning Dates	
Process	Normal Process (Low Risk)	Fastest Process (High Risk)
Conventional Procurement	September 2017	May 2017
DBOM or PPP Procurement	July 2018	Aug 2015

Contributions

OPTIONS FOR CONSIDERATION

- **Technical**
  - Abstraction points
  - Water delivery
  - Waste disposal
  - Implementation
- **Legal**
  - Who contributes what?

OPTIONS FOR CONSIDERATION

- **Institutional**
  - Who operates and maintain?
- **Financial and Economics**
  - Funding
  - Cost recovery

Contact Details

http://www.dwa.gov.za/Projects/AMDFSLTS

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amdsainfo@aurecongroup.com

(as per the news letter)

CLOSURE