Classification of significant water resources in the Crocodile West/Marico Water Management Area and the Mokolo and Matlabas catchments of the Limpopo WMA

# EWR Technical Task Group

Date: 22 April 2013
Venue: HC Bosman Living Museum terrain, Groot Marico
Time: 10:00

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

# Where are we in the technical process?

STUDY OBJECTIVES

- To determine the management class of significant water resources in the Mokolo Catchment (Limpopo WMA) and Crocodile (West) Marico WMA by co-ordinating and implementing the 7 step National Water Resource Classification System Process.

Step 1: Delineate the units of analysis and describe the status quo of the water resource or water resources;

Step 2: Link the socio-economic and ecological value and condition of the water resource or water resources;

Step 3: Quantify the ecological water requirements and changes in non-water quality ecosystem goods, services and attributes;

Step 4: Determine an ecologically sustainable base configuration scenario;

Step 5: Evaluate scenarios within the integrated water resource management process;

Step 6: Evaluate the scenarios with stakeholders; and

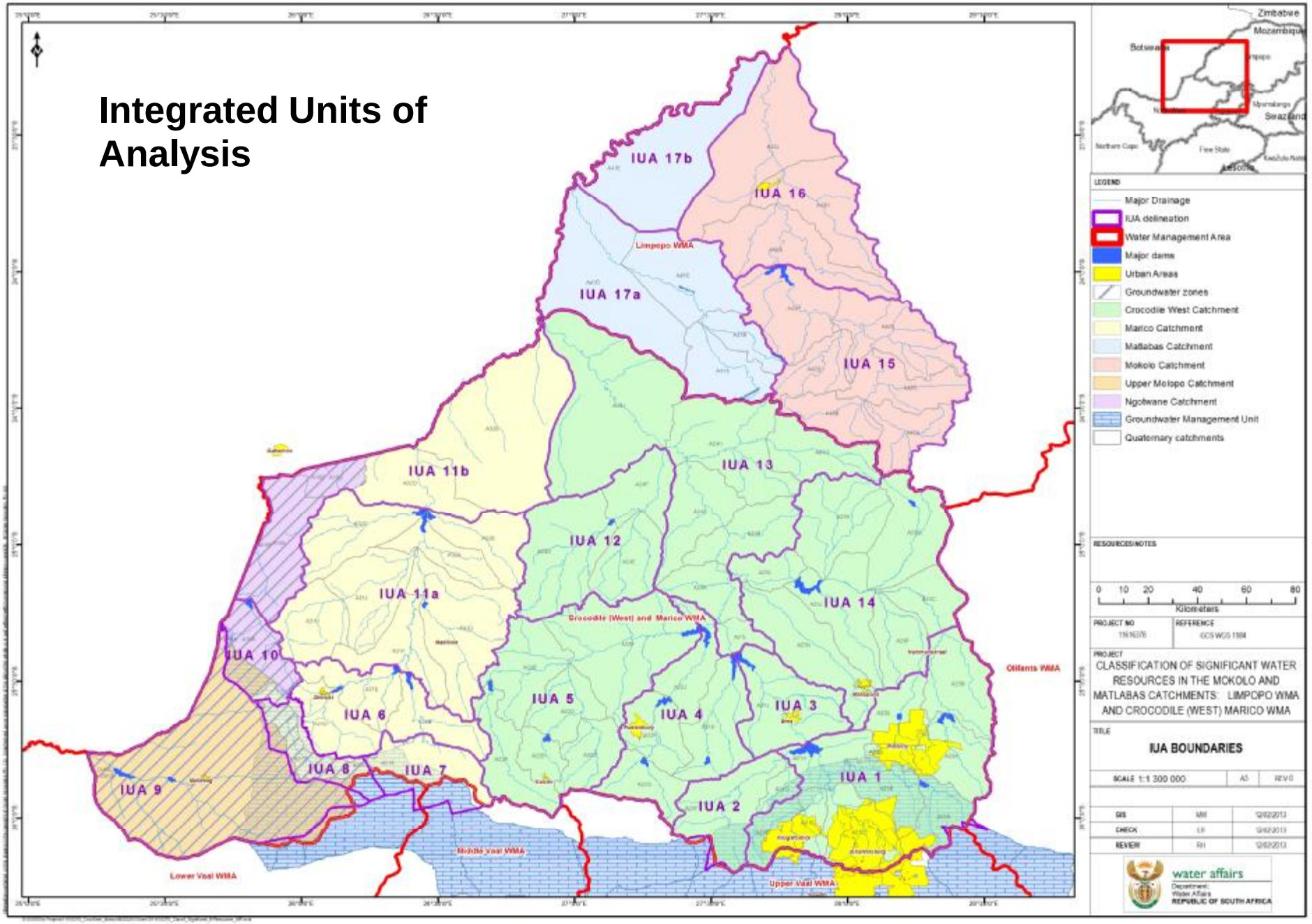
Step 7: Gazette and implement the class configuration

# Objectives of the TTG

To interact with stakeholders on :

- Ecological Water Requirements;
- Wetlands in the study area;
- Groundwater interactions; and
- How the EWR data are used in the next steps of the classification process

# Integrated Units of Analysis



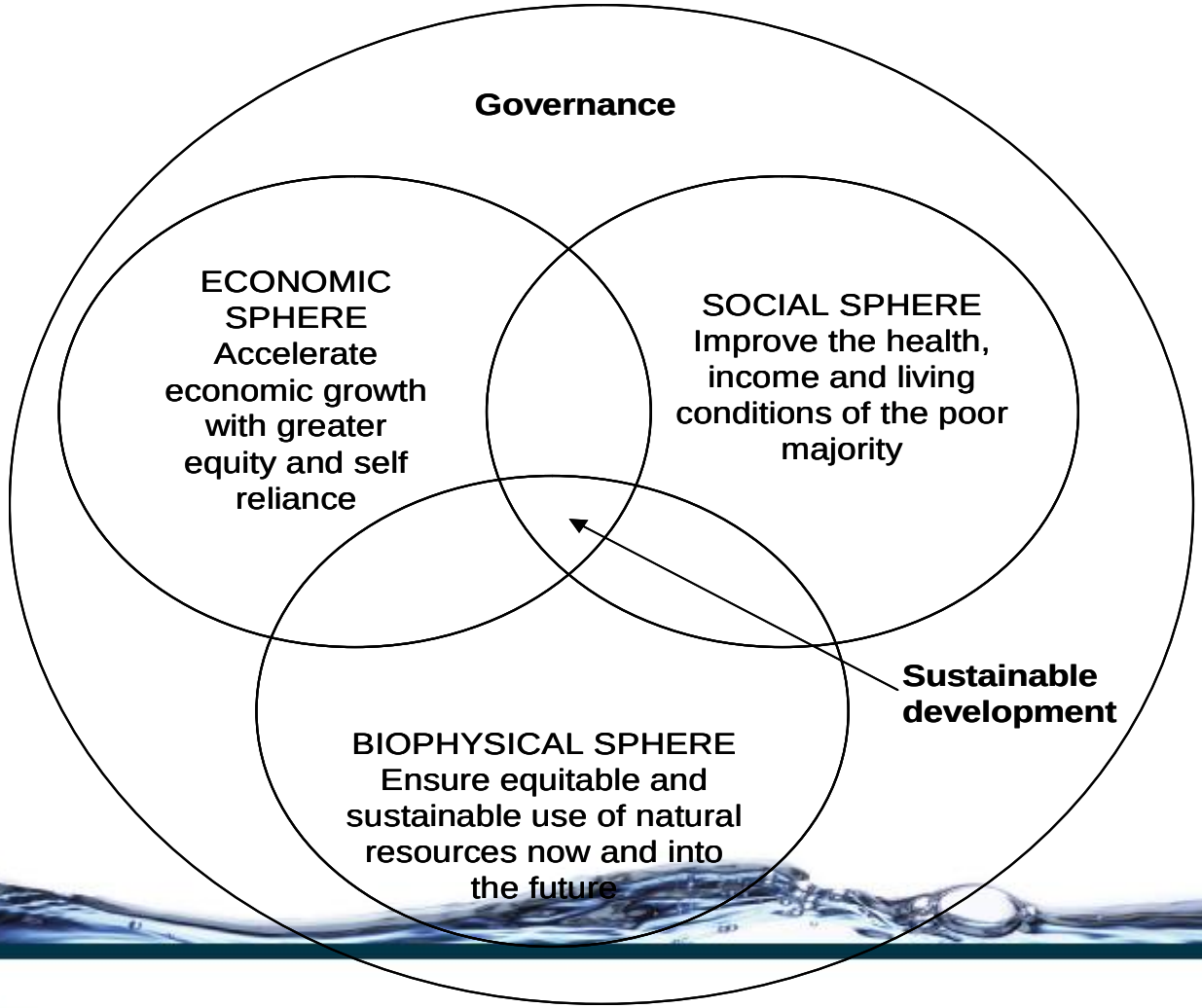
# Ecological Water Requirements (EWR)

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

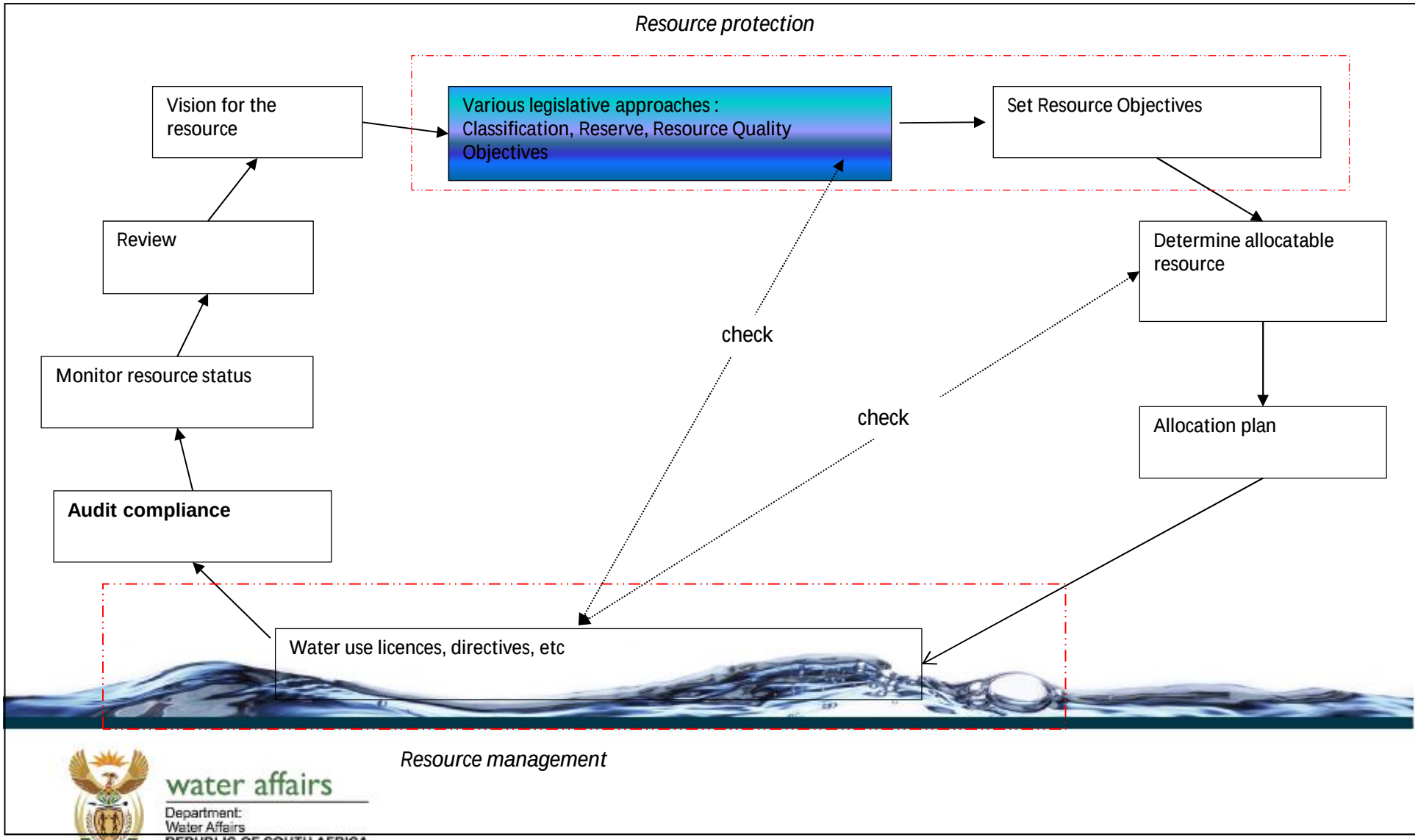
# Sustainability

- Global environmental crisis lead to1972 Stockholm UN Conference on Human Environment
- Resolving of the development versus environment on a mutually beneficial way
- Sustainable Development & Agenda 21:
  - Community and stakeholder participation
  - Sustainable resource management and development
  - Protection of quality of water resources and water supply
  - Integrated approaches to the development, management and use of water resources
- Definition: Development that meets the need of current generations without compromising the ability of future generations to meet their needs and aspirations

# Trifocal approach (MMSD, 2002)



# Link to IWRM




water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

# Resource protection

- Balancing the level of impact on the water resource for socio-economic development
- Efforts to maintain and improve the integrity of water resources and to sustain their capacity to provide goods and services
- Through concept of Ecological Water Requirements (EWR), environmental flows, instream flow requirements

# What are Ecological Water Requirements?

- Water that is provided for the aquatic ecosystem to maintain it in a specific condition to support its direct and indirect uses (goods & services)
- Provide an indication of the volume, quality and timing of water required to maintain an ecosystem in this pre-defined condition
- These flows can be used to describe e.g. the pattern of flows required that will:
  - reduce the downstream impacts of development
  - rehabilitate systems impacted by past developments
  - allow calculation of the costs of compensating people downstream for such impacts
  - Allow informed decision-making

# Ecological Water Requirement Assessment

- It is a process to synthesize data to understand aquatic ecosystems and it's subsistence users by a multi-disciplinary group of specialists to evaluate the impacts of various development scenarios on the ecosystem regarding changes in flow, quality, habitat and biota
- Various methods available to undertake the process of EWRs for ecosystems

# Aquatic ecosystems

Different methods are available per ecosystem component:

- Rivers
- Wetlands/pans/lakes
- Groundwater
- Estuaries

# Specialist components

Rivers

- Fish
- Macro-invertebrates
- Vegetation
- Hydraulics
- Hydrology
- Physio-chemical
- Geomorphology

# Levels of EWR determination (1)

Desktop:

- Use available biological data to determine present state and existing coarse level hydrological data (monthly) to determine flow requirements
- No field surveys

Rapid:

- Use existing coarse-level hydrological data (monthly)
- Undertake field surveys for fish, macro-invertebrates, hydraulics cross-sectional profiling and measure discharge
- Use models to verify EWRs with cross-section, discharge and habitat availability

# Levels of EWR determination (2)

## Intermediate:

Takes longer, address the river of specific concern and usually require to collect new data during dry and post high flow season

Undertake field surveys for fish, macro-invertebrates, vegetation, geomorphology, hydraulics cross-sectional profiling and measure discharge, physio-chemical monitoring

Include a socio-economic component

## Comprehensive:

Takes longer, address the river of specific concern and usually require to collect new data with at least 3-4 surveys

Undertake field surveys for fish, macro-invertebrates, vegetation, geomorphology, hydraulics cross-sectional profiling and measure discharge, physio-chemical monitoring

Undertake detailed modeling

Include a socio-economic component

# Generic steps

**1. INITIATE STUDY**
Define study area
Select ecosystem components
Select study team

**2. DEFINE RESOURCE UNITS & SELECT SITES**

**3. FIELD SURVEYS & ASSESSMENTS**
Undertake specialist field surveys
Assess the present state and recommend future state

**4. QUANTIFICATION**
Quantify the ecological flows, including quality for present and future states

**5. ANALYSIS OF IMPACTS OF DEVELOPMENT SCENARIOS DETERMINE ECOLOGICAL & SOCIO-ECONOMIC CONSECQUENCES**

**5. DWA OPERATIONAL & MANAGEMENT CLASS DECISION-MAKING PROCESS**

**6. SELECT BEST DEVELOPMENT OPTION & DEVELOP A MONITORING PROGRAMME**

**8. IMPLEMENTATION PLAN**

# Resource Units

- Sections of river that have the same natural flow patterns, reactions to stress and biophysical and geographic features
- Each section has its own specification of EWRs
- The concept is to delineate the catchment into units which are relatively homogenous on an ecological basis
- Delineations could then be further resolved into smaller/larger reaches which are suited to management requirements
- The process for determining RUs considers a variety of factors, namely ecoregions, geomorphologic classification, water quality, land use, habitat integrity and physical system constraints

# Site Selection

- The sites are selected to provide as much information as possible about the variety of conditions in a river reach to relate the habitat to the site it represents
- The persons involved in site selection understand and are experienced with the use of sites in EWR studies
- A site must be selected for each Resource Unit
- Determining where possible sites are located in rugged and undisturbed surroundings can be a difficult, frustrating and a time-consuming process
- Google Earth is viewed by the site selection team to identify potential with access
- The final site is selected during the field visit

# Using Google Earth


water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

# Final site

# Criteria for site selection (1)

- **Locality of gauging weirs with good quality hydrological data**
- **The locality of the proposed developments**
- **The locality and characteristics of tributaries**
- **The reaches where social communities depend on a healthy river ecosystem**
- ***The accessibility and suitability of the sites for follow-up monitoring***
- **The habitat diversity for aquatic organisms; marginal and riparian vegetation**

# Criteria for site selection (2)

**The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially for low flows**

**An area or site that could be critical for ecosystem functioning. This is often a riffle which will stop flowing during periods of low or no flow. Cessation of flow constitutes a break in the functioning of the river. Those biota dependant on this habitat and/or on continuity of flow will be adversely affected**

**Pools are not considered as critical since they are still able to function as refuge habitats during periods of no flow**

# Define ecological categories (1)

- Reference conditions:- i.e. those conditions that occur under natural conditions before anthropogenic impacts
- Present State or ecostatus:- the determination of the current state of the resource through rule-based models for the driver components and for the biological response
- Ecological Importance and Sensitivity (EIS): - the ecological importance is regarded as an expression of the water resource's ability to maintain the ecological diversity and functioning on local and wider scales. The ecological sensitivity refers to the river's ability to recover from disturbance

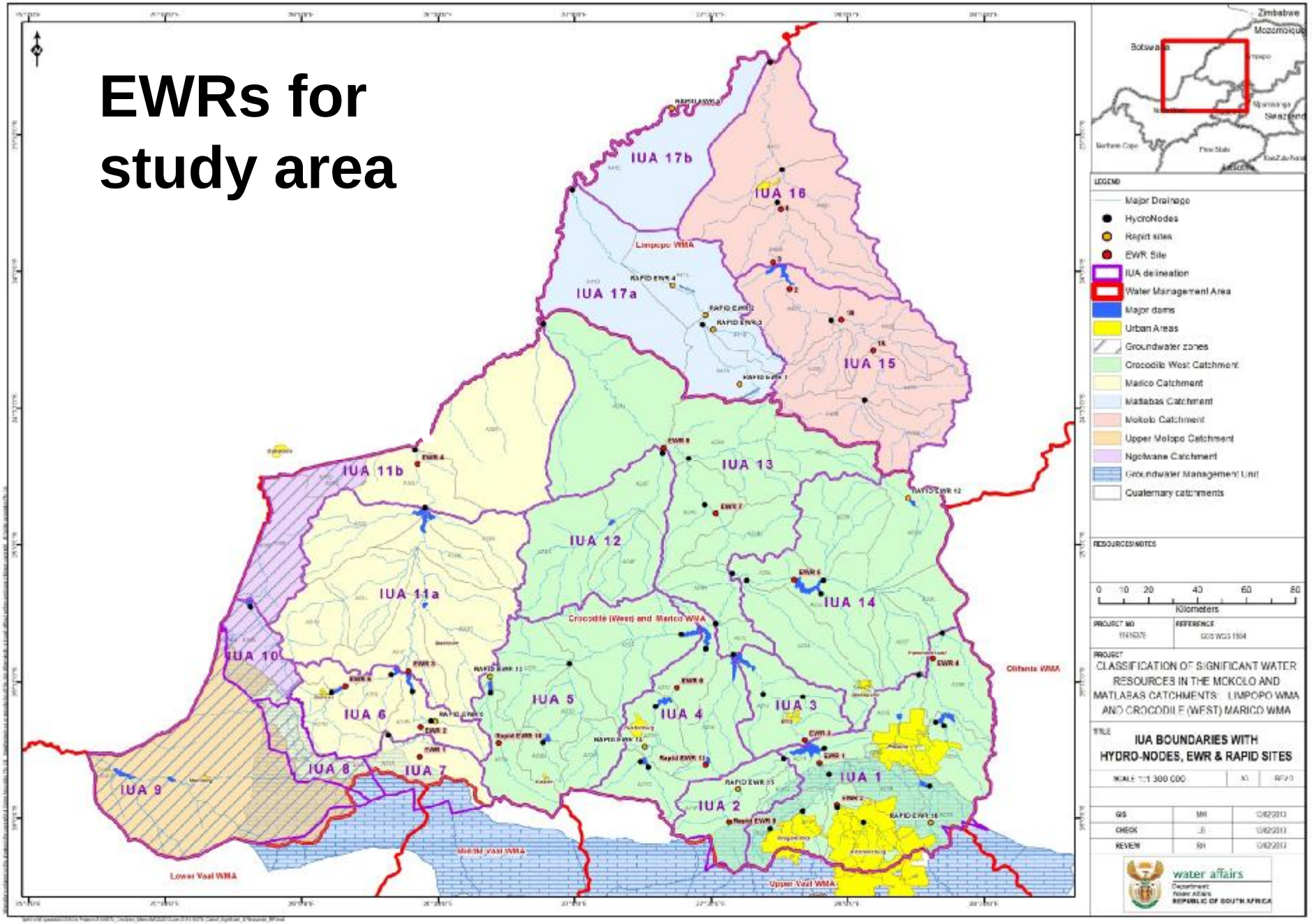
# Define ecological categories(2)

- Habitat Integrity (HI): - the Habitat Integrity evaluates the habitat integrity of both the instream and riparian components in the vicinity of the selected site
- Recommended Category: - the Present State and EIS is used in the decision on the RC as well as the feasibility to realistically be able to maintain or improve the current condition of the water resource
- Ecological Water Requirements: - The Desktop Reserve Model (DRM) (SPATSIM, version 2.12) is used to calculate the flow requirements (quantity) for the recommended category

# Description of Ecological Categories

| Percentage | Category | Description |
|---|---|---|
| >89 | A | Unimpaired; community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality |
| 80-89 | B | Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged |
| 60-79 | C | Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged |
| 40-59 | D | Fair – Largely impaired; fewer families present then expected, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred |
| 20-39 | E | Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred |
| <20 | F | Very poor – Critically impaired; few aquatic families present. If high densities of organisms, then dominated by a few taxa. Only tolerant organisms present |

# EWRs for study area



# Summary of EWR results (Crocodile West 1)

| EWR Site number | Quaternary catchment | River | Coordinates | PES | EIS | REC | Level of determination |
|---|---|---|---|---|---|---|---|
| CROC_1 | A21H | Crocodile | S 25.8004<br>E 27.896 | D | Moderate | D | Intermediate |
| CROC_2 | A21C | Jukskei | S 25.9539<br>E 27.9621 | E | Moderate | D | Intermediate |
| CROC_3 | A21J | Crocodile | S 25.7168<br>E 27.8431 | C/D | High | C/D | Intermediate |
| CROC_4 | A23B | Pienaars | S 25.4155<br>E 28.312 | C | High | C | Intermediate |
| CROC_5 | A23J | Pienaars/ Moretele | S 25.12657<br>E 27.80457 | D | High | C | Intermediate |
| CROC_6 | A22J | Hex | S 25.5214<br>E 27.3749 | D | Moderate | D | Intermediate |
| CROC_7 | A24C | Crocodile | S 24.88661<br>E 27.51743 | D | Moderate | D | Intermediate |
| CROC_8 | A24H | Crocodile | S 24.64476<br>E 27.32569 | C | Moderate | C | Intermediate |

# Summary of EWR results (Crocodile West 2)

| EWR Site number | Quaternary catchment | River | Coordinates | PES | EIS | REC | Level of determination |
|---|---|---|---|---|---|---|---|
| CROC_9 | A21F | Magalies | S 26.01689<br>E 27.56581 | B | Very high | B | Rapid III |
| CROC_10 | A22A | Elands | S 25.72655<br>E 26.72044 | C | High | B/C | Rapid III |
| CROC_11 | A21K | Sterkstroom | S 25.80739<br>E 27.4784 | C | High | C | Rapid III |
| CROC_12 | A23G | Buffels | S 24.8304<br>E 28.2224 | B/C | Moderate | B/C | Rapid III |
| CROC_13 | A22E | Elands | S25.48108<br>E 26.69039 | C | Low | C | Rapid III |
| CROC_14 | A22H | Waterkloofspruit | S25.7414<br>E 27.2568 | B/C | Low | B/C | Rapid III |
| CROC_15 | A21F | Magalies | S 25.8969<br>E 27.5982 | C/D | Low | C/D | Rapid III |
| CROC_16 | A21A | Rietvlei | S 26.01885<br>E 28.30442 | C | Low | C | Rapid III |

# Summary of EWR results (Marico)

| EWR Site number | Quaternary catchment | River | Coordinates | PES | EIS | REC | Level of determination |
|---|---|---|---|---|---|---|---|
| MAR_1 | A31A | Kaaloog-se-Loop | S 25.777<br>E 26.433 | B | Very high | B | Intermediate |
| MAR_2 | A31B | Groot Marico | S 25.669<br>E 26.435 | B | Very high | B | Intermediate |
| MAR_3 | A31F | Groot Marico | S 25.461<br>E 26.392 | C/D | High | C/D | Intermediate |
| MAR_4 | A32D | Groot Marico | S 24.706<br>E 26.424 | C | High | C | Intermediate |
| MAR_5 | A31E | Klein Marico | S 25.516<br>E 26.159 | C | Moderate | C | Rapid III |
| MAR_6 | A31B | Polkadraaispruit | S 25.64697<br>E 26.48928 | B/C | Moderate | B/C | Rapid III |

# Summary of EWR results (Mokolo)

| EWR site | Quatenary catchment | River: Site name | Coordinates | PES | EIS | REC | Level of determination |
|---|---|---|---|---|---|---|---|
| 1a | A42C | Mokolo: Vaalwater | S24 17.362 E28 05.544 | C/D | High | B/C | Intermediate |
| 1b | A42E | Mokolo: Tobacco | S24 10.697 E27 58.661 | B/C | High | B | Intermediate |
| 2 | A42F | Mokolo: Ka'ingo | S24 03.897 E27 47.230 | B/C | Very high | B | Intermediate |
| 3 | A42G | Mokolo: Gorge | S23 58.080 E27 43.614 | B/C | Very high | B | Intermediate |
| 4 | A42G | Mokolo: Malalatau | S23 46.272 E27 45.315 | C | Very high | B | Intermediate |

# Summary of EWR results (Matlabas)

| EWR site | Quaternary catchment | River: Site name | Coordinates | PES | EIS | REC | Level of determination |
|---|---|---|---|---|---|---|---|
| MAT_1 | A41A | Matlabas Zyn Kloof | -24.41203; 27.60324 | B | Very High | A | Rapid III |
| MAT_2 | A41B | Matlabas Haarlem East (A4H004) | -24.160138; 27.47971 | B/C | - | B/C | Rapid III |
| MAT_3 | A41B | Mamba River Bridge | -24.2127; 27.50718 | B/C | - | B/C | Rapid III |
| MAT_4 | A41C | Matlabas Phofu | -24.05159; 27.35922 | C | - | C | Rapid II |

# Detail results: Kaaloog-se-Loop

# Information available

| Component | Data availability | Confidence |
|---|---|---|
| **Hydrology** | No gauging weir (A3H004 was closed in 1931 and could not be used).<br>Simulated monthly flows (natural and present) for the period 1920 – 2006 were available. | 4 |
| **Physico-chemical** | Data was available from a monitoring point (188041) at the bridge on Kaaloog se , but not enough data to run TEACHA.<br>Reference water quality data was available from A2H036 at Steenbokfontein on the in the catchment. | 2 |
| **Geomorphology** | The sediment clues were surveyed and a sediment size analysis was conducted. | 3 |
| **Riparian vegetation** | Historical data (River Health Programme, 2005 & Mucina and Rutherford, 2006) and recent data (surveys) available for the EWR site on Kaaloog-se-Loop. | 3 |
| **Fish** | Fair amount of historical and recent data available for the upper | 4 |
| **Macroinvertebrates** | Two SASS5 surveys were undertaken to determine PES: 2007/10 and 2008/07. Ms. Hermien Roux (DACE) has good historical data for this site due to the fact that it is one of her regular monitoring sites. | 4 |

## Ecological Importance & Sensitivity

- The Ecological Importance and Sensitivity (EIS) for this site is rated as Very high
- Occurrence of *Barbus Motebensis* and unique taxa associated with dolomitic eyes at the site that are sensitive to water quantity and quality changes
- The species richness is very high with more than 45 macroinvertebrate families present
- This reach of the river has been identified as a national priority for conservation.

# Present State and reasons

| | PES | Causes | Sources | F[1]/NF[2] |
|---|---|---|---|---|
| **Hydrology** | A/B | Decreased low flows | Irrigation abstraction upstream | F |
| **Physico-chemical** | A/B | Increased nutrients and decreased in pH and alkalinity | Irrigation and mining activities upstream | F |
| **Geomorphology** | B/C | Narrowing of active channel and undercutting of sedimentation features | Reduced flows | F |
| | | Smothering of interstitial spaces | Increased silt from quarries and dirt roads | NF |
| | | Trampling by cattle | Antrophogenic influences | NF |
| **Riparian Vegetation** | B | Introduction of exotic species (limited) | Antrophogenic influences | NF |
| | | Limited overgrazing | Antrophogenic influences | NF |
| **Fish** | B | Decreased low flows | Irrigation abstraction upstream | F |
| **Inverts** | A | Near natural system | Irrigation abstraction upstream | F |

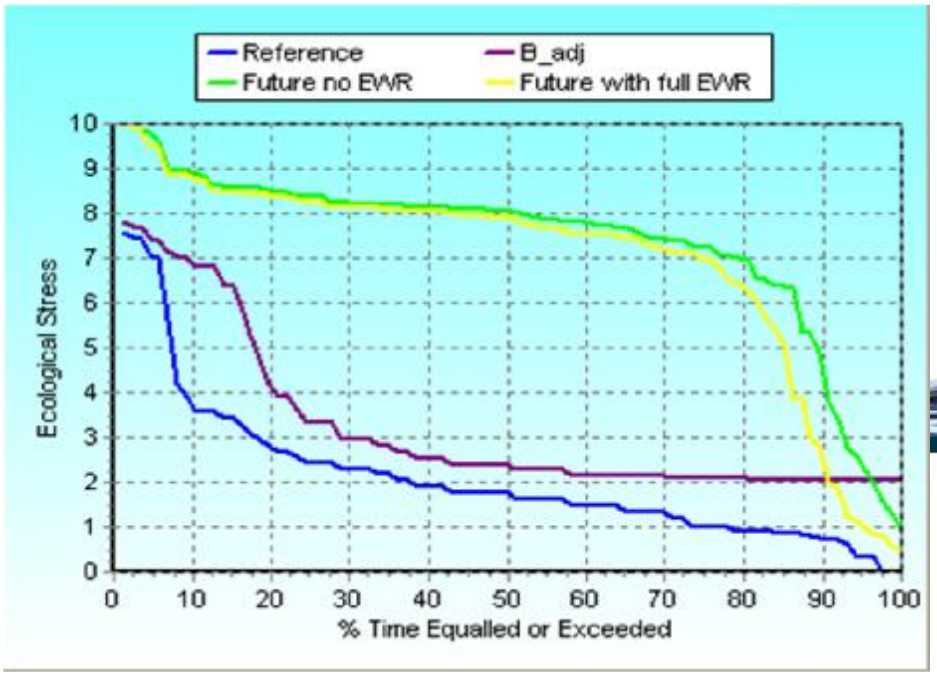
# Ecostatus, Recommended category

| Driver component | PES & REC category | Trend | AEC Down |
|---|---|---|---|
| Hydrology | A/B | Stable | B/C |
| Water quality | A/B | Negative | B/C |
| Geomorphology | B/C | Negative | C |
| **Response component** | **PES & REC category** | **Trend** | **AEC Down** |
| Fish | B | Stable | C |
| Macroinvertebrates | A | Stable | B |
| Instream EC | A/B | Stable | C |
| Riparian vegetation | B | Stable | B |
| **Ecostatus** | **B** | **Stable** | **B/C** |
| **Recommended Ecological Category** | | | **B** |
| **Confidence in results** | | | **Medium** |

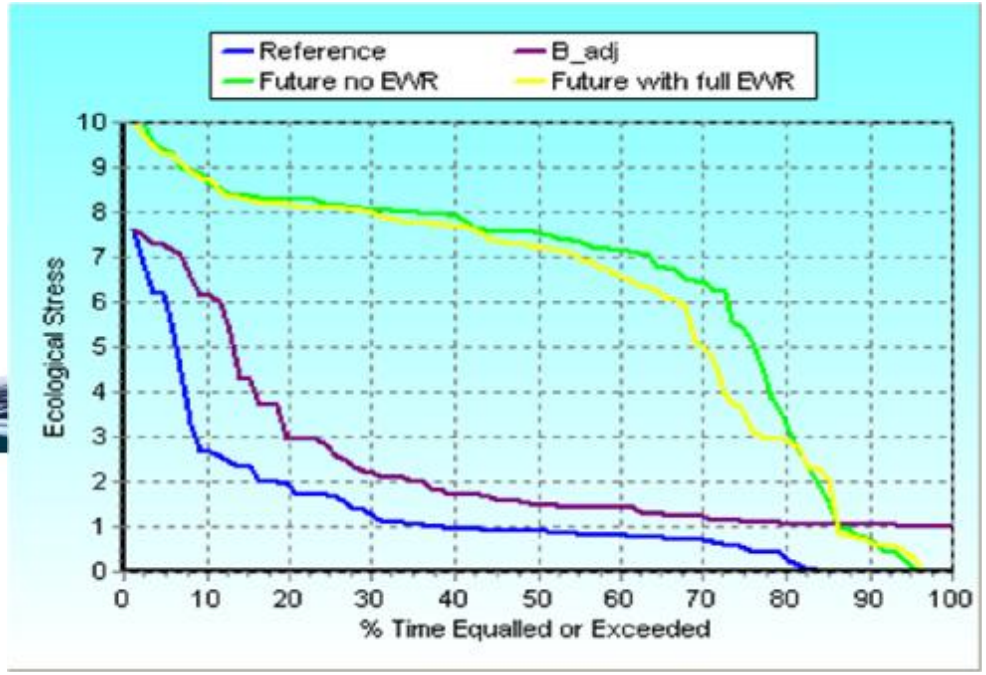
# Ecological Water Requirements (1)

- Approach used: Habitat Flow Stressor Response
- Separate requirements for wet and dry season
- Dry and wet season stress duration curves for EWR site
- Integrate these requirements with flood requirements

**Dry season – September**




**Wet season – February**



# Ecological Water Requirements (2)

Final Ecological Water Requirements determined by using the Desktop Reserve Model within SPATSIM

| Reference MAR | REC | Units | Total EWR | Maintenance Low flow | Maintenance High flow | Drought Low flow |
|---|---|---|---|---|---|---|
| 10.54 | B | $Mm^3/a$ | 8.043 | 8.037 | 0.006 | 5.227 |
| | | % | 76.32 | 76.26 | 0.06 | 49.6 |

# Questions