

Framework for Groundwater Development and Management

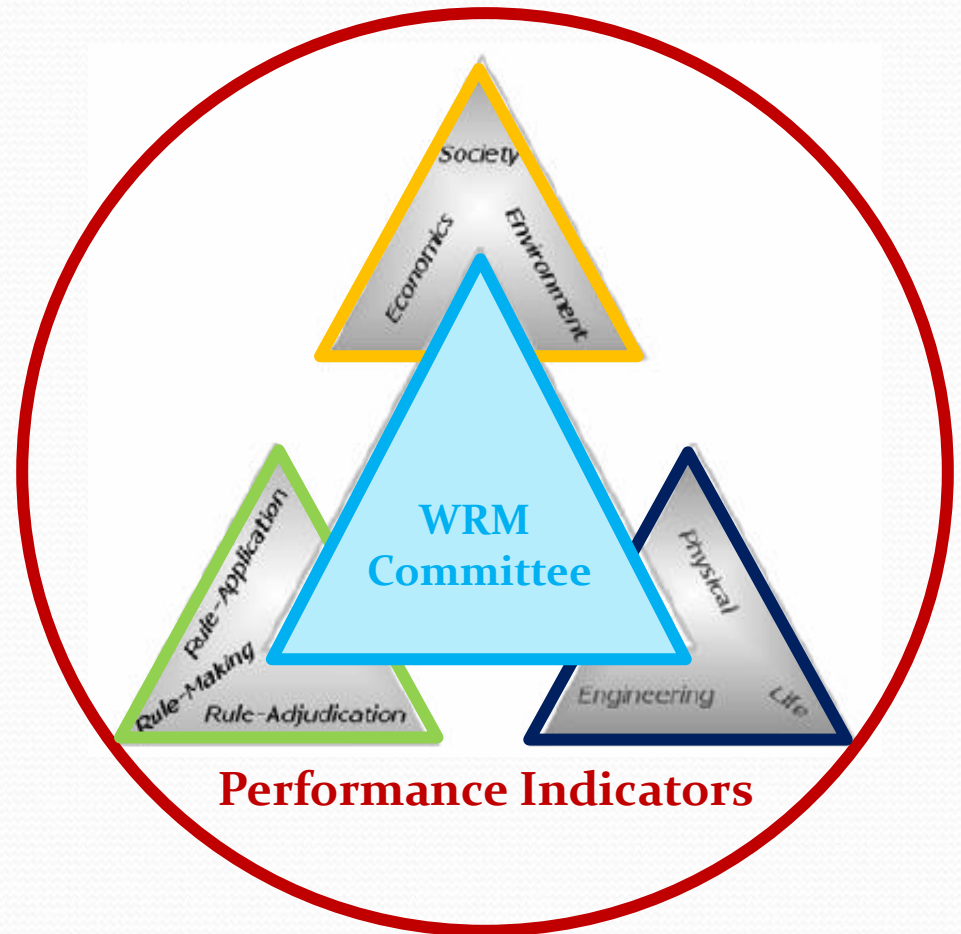
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22 November 2016

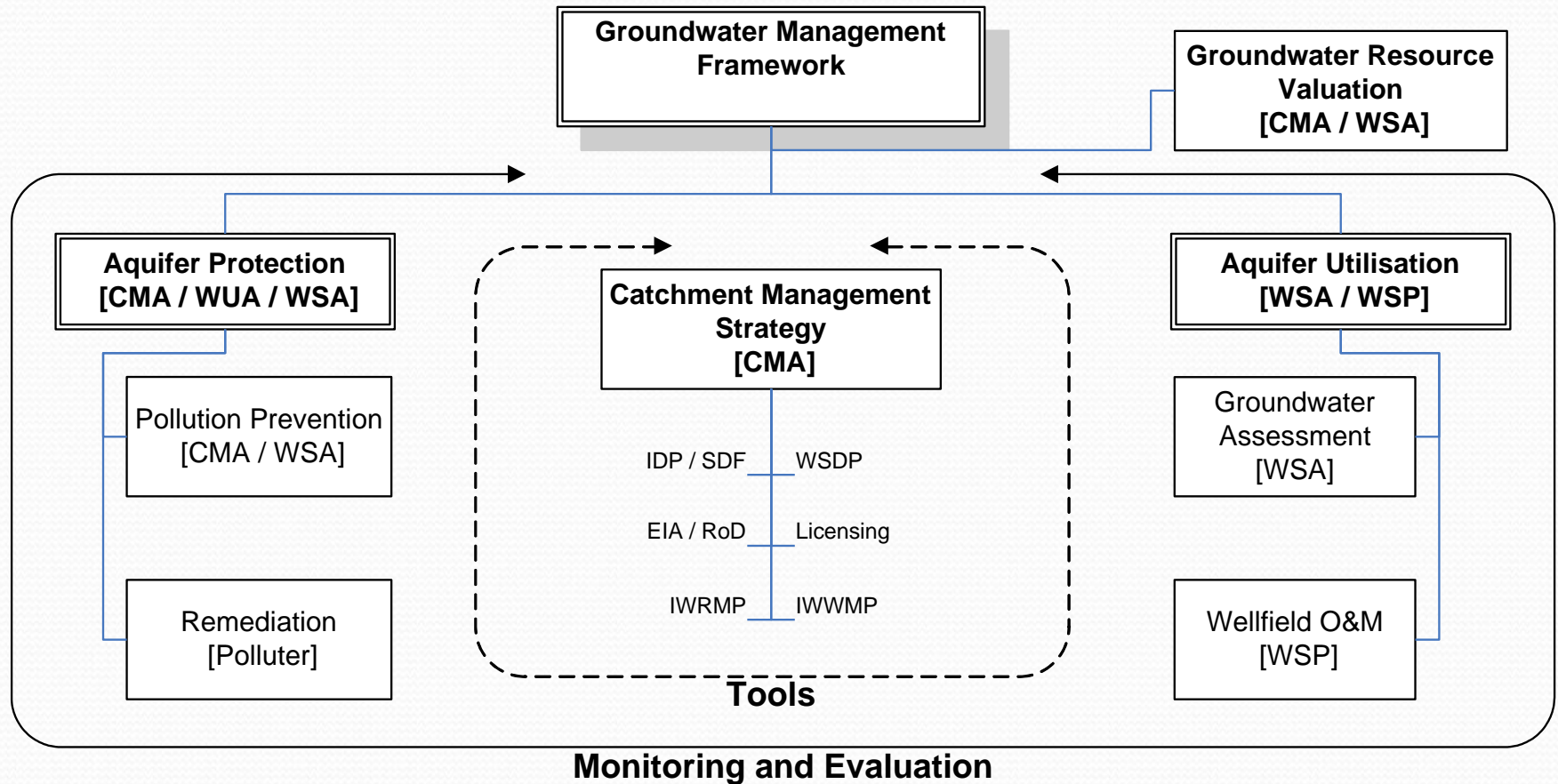


IWRM Governance Framework

- Based on Trialogue
 - **Government**
 - Water Institutions / Law
 - **Society**
 - Stakeholders / Users
 - **Science**
 - Monitoring / Consultant
 - **Interface**
 - WRM Committee
 - **Performance Indicators**



Groundwater Management Framework



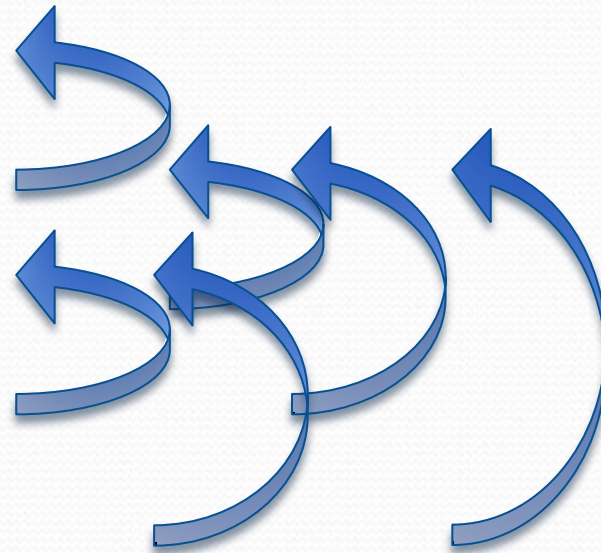
Legal Framework

- Access to land
- Servitude agreements
- Water Use Authorisation
- Reserve Determination
- Environmental Authorisation

Development Process



- Conceptualisation
- Reconnaissance
- Pre-feasibility
- Feasibility
- Design
- Construction
- Operation



Development Process

- Incremental Development
 - Plan and design whole scheme
 - Construct initial part of scheme
 - Add elements, when required

Vegter (2001)

- “Ecologically acceptable and sustainable groundwater exploitation evidently cannot be determined prior to the development of a groundwater resource. It is only through exploratory drilling and testing that the structure of a groundwater system and its spatially variable hydraulic parameters may be determined.” (Vegter, 2001, p. 38)
- Instead of attempting to determine an ecological reserve and a fixed sustainable yield of questionable substance, a flexible open-ended approach in understanding and managing these systems is essential ... “
(Vegter, 2001, p. 39)

Level of Study	Product / Decision	Data collection	Confidence	Scale
Conceptualisation	Inception / Planning Report	Expert evaluation of existing data	50 %	1:500 000 to 1:250 000
Reconnaissance	ID Target Areas Recommendation for and prioritisation of monitoring	Primarily desktop work with limited fieldwork and data collection, as required, (e.g. Hydrocensus) 1 st order water balance model	60 %	~ 1:250 000
Pre-feasibility	Environmental monitoring and assessment ID Target Sites	Geological and ecological mapping Installation of monitoring infrastructure and ongoing monitoring of relevant processes Re-calibrate water balance model	70 %	1:100 000 to 1: 50 000
Feasibility	Exploration Yield estimation License & EIA application Feasibility Report	Site survey, borehole siting Drilling and testing of exploration boreholes Regional groundwater modeling Invest in collecting all relevant input for design purposes	80 %	1: 50 000 to 1: 10 000
Options Analysis	Options Analysis Report	Comparison of different options for water supply, based on feasibility studies	80 %	
Design *	Wellfield design and implementation Operating rules	Design all components of the scheme Wellfield model	90 %	1: 1 000 to 1:10 000
Operation & Maintenance *	Operation & Maintenance	Ongoing monitoring	95 %	

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Conceptualisation

- Defining the need for investigation
- ID of groundwater potential
- ID of type of scheme
 - Abstraction borehole / wellfield
 - Artificial recharge / ASR
- ID of required investigations

➤ Inception Report

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Reconnaissance

- Desktop analysis of maps and data
- ID of preferred aquifers
- 1st order water balance model
- ID of groundwater target areas
- Initial field verification (hydrocensus)
- Recommendations for monitoring

➤ **Scoping Report**

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Pre-feasibility

- Geological and ecological mapping
- Establishment of monitoring network
- Collection of monitoring data
- Testing of existing boreholes
- Update water balance model
- ID of groundwater target sites

➤ Target Generation Report

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Feasibility

- Detailed mapping and borehole siting
- Drilling of exploration boreholes
- Testing of exploration boreholes
- Expansion of monitoring network
- Ongoing monitoring
- Borehole / aquifer yield estimation

➤ Drilling and Testing Report

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Feasibility (cont.)

- Groundwater / surface water sampling
 - Chemical & biological analysis
 - Isotope analysis
- Regional groundwater model
 - Aquifer yield analysis
 - Input to wellfield design

➤ Groundwater Modeling Report

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Feasibility (cont.)

- Environmental Impact Assessment
 - BAR or EIA
- Reserve Determination
 - Level of confidence
 - Resource Quality Objectives
- Water Use Licence Application

➤ EIA RoD & WULA

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Wellfield Design

- ID of production borehole sites
- Operational philosophy
- Design of production boreholes
 - Depth, diameter
 - Construction details
 - Wellheads

➤ Preliminary Design Report

Wellfield Design (cont.)

- Wellfield model
- Update preliminary design
- Design of connection pipelines
- Design of transmission pipeline
- Design of water treatment works

➤ Final Design & Tender Document

Level of Study

Conceptualisation

Reconnaissance

Pre-feasibility

Feasibility

Options Analysis

Design *

Operation & Maintenance *

Wellfield Construction

- Tender process
 - Drilling
 - Civil works
 - Mechanical and electrical works
- Construction
- Testing and commissioning

➤ Commissioning Report

Level of Study

Conceptualisation

Reconnaissance

Pre-feasibility

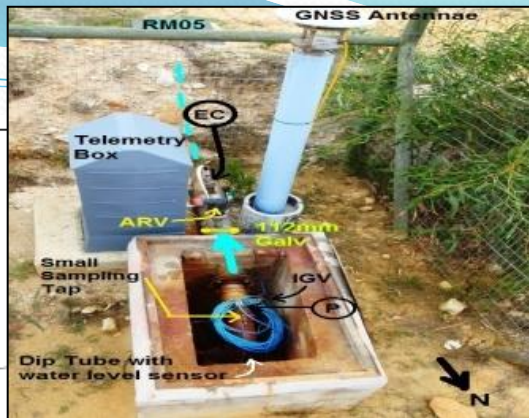
Feasibility

Options Analysis

Design *

Operation & Maintenance *

Level of Study



Feasibility



Options Analysis



Design *

Operation & Maintenance *

Level of Study
Conceptualisation
Reconnaissance
Pre-feasibility
Feasibility
Options Analysis
Design *
Operation & Maintenance *

Wellfield Operation

- Operating Rules
 - Standard conditions
 - Drought conditions
 - Conjunctive use
 - Maintenance Plan
 - Monitoring
- Operation and Maintenance Manual

Discussion