Department of Water and Sanitation

Report No: P WMA 03/000/00/6923/1

WP11393

CROCODILE EAST WATER PROJECT (CEWP)

MODULE 1: TECHNICAL FEASIBILITY STUDY

Inception Report

June 2023

Final

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APPROVAL

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Report Title:	***Inception Report***
Author(s):	*Study Team*
Reviewer	*Lilene Louw & Evert Serfontein*
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DOCUMENT INDEX

This report forms part of the series of reports issued as part of the project Crocodile East Water Project (CEWP) Module 1: Technical Feasibility Study.

A document index is provided below.

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LIST OF ACRONYMS

CEWP	Crocodile East Water Project
CMF	Catchment Management Forum
COGTA	Cooperative Governance and Traditional Affairs
CAPEX	Capital Expenditure
CoM	City of Mbombela
DARDLEA	Department of Agriculture, Rural Development, Land and Environmental Affairs
DEDT	Department of Economic Development and Tourism
DFFE	Department of Forestry, Fisheries and the Environment
D: NWRP	(DWS) Directorate: Integrated Water Resource Planning
D: NWRP	(DWS) Directorate: National Water Resource Planning
D: SWRP	(DWS) Directorate: Strategic Water Resource Planning
D: WRDP	(DWS) Directorate: Water Resource Development Planning
DM	District Municipality
DOR	Drought Operating Rules
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EWR	Ecological Water Requirements
EME	Exempted Micro Enterprise
FS	Feasibility Study
FSL	Full Supply Level
RO: NWRI	(DWS) Regional Office: National Water Resources Infrastructure
GT	(DWS) Graduate Trainee
HDI	Historically Disadvantaged Individual
IDP	Integrated Development Plan

IIMA	Interim Inco-Maputo Agreement
IUCMA	Inkomati Usuthu Catchment Management Agency
IWAAS	Inkomati Water Availability Assessment Study
IWRP	Integrated Water Resources Planning
KOBWA	Komati Basin Water Authority
KWSAP	Komati Water Supply Augmentation Project
LM	Local Municipality
LNW	Lepelle Northern Water
MAR	Mean Annual Run-Off
MPTA	Mpumalanga Tourism and Park Agency
NOC	Non-Overspill Crest
NRW	Non-Revenue Water
OA	(DWS) Options Analysis
OPEX	Operational Expenditure
PPP	Public Private Partnership
PFS	Pre-Feasibility Study
PRIMA	Progressive Realisation of the IncoMaputo Agreement
PSP	Professional Service Provider
PMC	Project Management Committee
PMCM	Project Management Committee Meetings
PSC	Project Steering Committee
PSCM	Project Steering Committee Meetings
R	Rands
RBIG	Regional Bulk Infrastructure Grant
RQO	Resource Quality Objectives
SAWQG	South African Water Quality Guidelines
STOMSA	Stochastic Model of South Africa
SEF	Safety Evaluation Flood

ToR	Terms of Reference
TSG	Technical Support Group
V&V	Validation and Verification
VAT	Value Added Tax
WAAS	Water Availability Assessment Study
WARMS	Water Allocation and Registration Management System
WC/WDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WQ	Water Quality
WR2012	Water Resources of South Africa 2012
WRC	Water Research Commission
WRMF	Water Resources Management Framework
WRPM	Water Resources Planning Model
WRPS	(DWS) Water Resources Planning Systems
WRYM	Water Resources Yield Model
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSS	Water Supply System

LIST OF UNITS AND SYMBOLS

km	Kilometre
m	Metres
m³	Cubic Metres
m³/a	Cubic Metres per Annum
m³/s	Cubic Metres per Second
°	Degrees
’	Minutes
”	Seconds

GLOSSARY OF TERMS

Aquifer	An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt, or clay) from which groundwater can be abstracted.
Allocation	Water allocation refers to the volume of water that is authorised for abstractions by the regulator (DWS ,by means of a Water Use licence).
Catchment	The land area drained by a river and its tributaries.
Water requirement	A measure of the water needs of a water user or users, usually expressed in units of litres per capita per day (ℓ/c/d), million m^3/annum or Mega litres per day (Mℓ/day).
Demand reduction	Measures available to a Water Service Provider to reduce water demand and improve water use efficiency or through water restrictions.
Entitlement	A water entitlement is the general term used to describe water authorities (right to use) granted under the National *Water Act, No. 36 of 1998*. This can be either a water allocation, interim water allocation or a water licence.
Groundwater	Groundwater is the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water.
Reliable yield	The quantity of water that can be abstracted for a given use from a supply source or supply option with a specified degree of reliability (assurance of supply).
Reliability of supply	The probability of providing a specified water entitlement under given operating conditions for a specified period of time.
Supply option	A potential future water resource, defined as any location-specific change to water availability, infrastructure or reliable off-take that will result in the total available supply being increased or augmented.
Surface water	Surface water is water on the surface of the earth such as in a stream, river, dam, wetland or ocean.
Water balance	Numerical comparison of the water requirement with the available water or yield, for current and future planning years. It is usually provided in graphical form for ease of interpretation.

Yield	The average annual volume that can be drawn from a supply source or supply option to meet a specified requirement at a specified reliability. The volume is usually expressed as million m^3 per annum. Yield is always associated with some measure of probability of an occurrence of a reduced supply, expressed as either the risk of failure or the assurance of supply.

PREAMBLE

The Department of Water and Sanitation appointed iX engineers (Pty) Ltd for *WP11393: Crocodile East Water Project: Module 1: Technical Feasibility Study.*

The water of the Crocodile (East) River Catchment in Mpumalanga has been fully allocated, yet the water requirements, especially domestic water requirements, continue to grow. The system is under stress, and it cannot fully meet the environmental water requirements as well as the reliability / assurance of supply for both the agricultural and municipal water uses. The yield of the water resource will have to be increased by means of **additional storage**.

Taking cognisance of the above-mentioned and based on previous studies and investigations carried out in the past, the following **four proposed dams** within the **Crocodile (East) River Catchment** were recommended for further study as part of this Study (WP11393: Module 1: Technical Feasibility Study):

- Mountain View Dam on the Kaap River.
- Montrose Dam on the Crocodile East River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

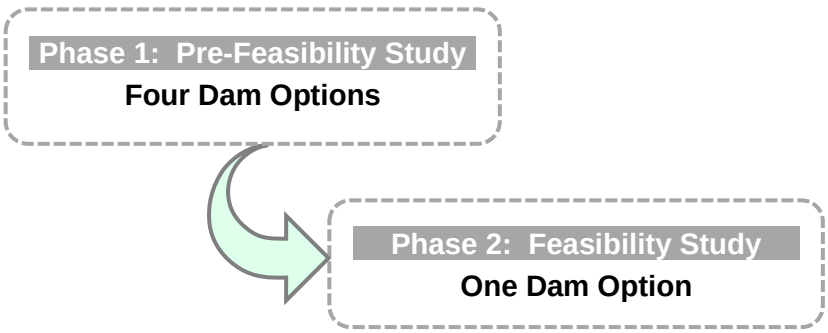
This Technical Feasibility Study will be undertaken in two separate phases, as follows:

Phase 1: Pre-Feasibility Study

The Pre-Feasibility Study (Phase 1) will be undertaken for the above-mentioned **four** proposed dams within the Crocodile (East) River Catchment

Phase 2: Feasibility Study

Under the Phase 1: Pre-Feasibility Study, **one** of the possible four dam options will be selected and recommended for further study and development to a **feasibility level** of detail in the Phase 2: Feasibility Study.



1 INTRODUCTION

1.1 Appointment of Professional Service Provider

iX engineers (Pty) Ltd was appointed by the Department of Water and Sanitation for *WP11393: Crocodile East Water Project: Module 1: Technical Feasibility Study.*

Service Level Agreement	The Service Level Agreement was prepared, signed by all parties, and concluded by 06 September 2022.
Purchase Order	The Purchase Order for the study was received from the Department of Water and Sanitation on 19 September 2022.

1.2 Inception Report

The Inception Report is the first deliverable for **WP11393: Crocodile East Water Project: Module 1: Technical Feasibility Study**.

The Inception Report provides an agreed understanding of the Scope of Work for the Study and confirms the composition of the Study Team, the manpower schedule, the work programme, the expenditure budget and the estimated cash flow. The report also serves as a first progress report on the Study and includes a review of the above items, with reference to the original Terms of Reference for the Study.

1.3 iX engineers Study Team

In order to provide the full scope of services as required by the DWS, the iX engineers team for this Study will consists of iX engineers (Pty) Ltd as the Lead Consultant, WRP Consulting Engineers (Pty) Ltd as a Sub-Consultant, as well as Independent Specialists.

The composition of the iX engineers Study Team is given below. The key expertise of the study team is also shown.

Lead Consultant:	
iX engineers	Project management, civil engineering infrastructure (pump stations, pipelines, conveyance systems), flood hydrology, dam hydraulics, cost estimates and engineering economic analysis, etc.
Sub-Consultant:	
WRP Consulting Engineers	Water demands, water resources, yield analyses, operating rules, etc.
Supporting Specialists:	
Henriette Anderson	Dam engineering
Louis Hattingh	
Tolmay Hopkins	Environmental assessments
Delana Louw	Ecological reserve and classification
Arno Otterman	Hydropower generation
Russel Aird	Demographics Socio-economic analysis
Gawie Steyn	Geotechnical / Materials investigation
Dawid Mouton	Geotechnical engineering
Prof Gerrit Basson	Sediment yield Water quality and limnology
Prof Andrzej Kijko	Geomorphologic and seismic investigation
Anelle Lötter	Public relations/Stakeholder engagement

2 BACKGROUND TO THE STUDY

2.1 Introduction

This section summarizes the work completed under previous studies and investigations (refer to Section 3 of this Report) and addresses how this Feasibility Study will complement and expand on the data and information previously gathered and collated.

2.2 Identification of Study

The water of the Crocodile (East) River Catchment in Mpumalanga has been fully allocated, yet the water requirements, especially domestic water requirements, continue to grow. The system is under stress, and it cannot fully meet the environmental water requirements as well as the reliability / assurance of supply for both the agricultural and municipal water uses.

The situation will worsen in the short term if water conservation and water demand management (WC/WDM) measures are not fully implemented. In the medium to long term, WC/WDM measures will not be sufficient to provide for the increase in domestic water requirement. The yield of the water resource will have to be increased by means of **additional storage**.

Both public and commercial sectors have requested development of **additional yield** through **storage** within the **Crocodile (East) River Catchment**. Due to the long lead-time required in developing new dams, the construction of an additional dam in the Crocodile River Catchment has to be investigated without delay.

Taking cognisance of the above-mentioned and based on previous studies and investigations carried out in the past, the following **four proposed dams** within the **Crocodile (East) River Catchment** were recommended for further study as part of this Study (WP11393: Module 1: Technical Feasibility Study):

- Mountain View Dam on the Kaap River.
- Montrose Dam on the Crocodile East River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

2.3 Study Area

The Crocodile (East) River Catchment in Mpumalanga is located in the north-east of the country and forms part of the larger Inkomati River Basin. The water of the Inkomati River Basin is shared between Mozambique, South Africa and Eswatini.

A map of the Study Area is included in **Figure 2-1**.

Engineering investigations and studies for the respective dams and associated infrastructure will **each** have their **specific focus** and **study area** and will also apply to dam access, advanced infrastructure for the dam and the possible relocation of services (roads, rail, etc).

However, with respect to the Water Resources task (water demands, yield analysis, future water balance, the development of short-term stochastic yield reliability curves, updating of the water resources planning model, etc) of the Study, the study area will cover the **whole** of the **Crocodile (East) River Catchment** (see **Figure 2-1**).

The Crocodile (East) River Catchment comprises of the following four tertiary catchments as indicated in **Figure 2-2**:

- Upper Crocodile Catchment (X21)
- Middle Crocodile Catchment (X22)
- Lower Crocodile Catchment (X24)
- Kaap Catchment (X23)

Important tributaries of the Crocodile River include the following:

- Kaap River
- Elands River
- Nels River
- White River

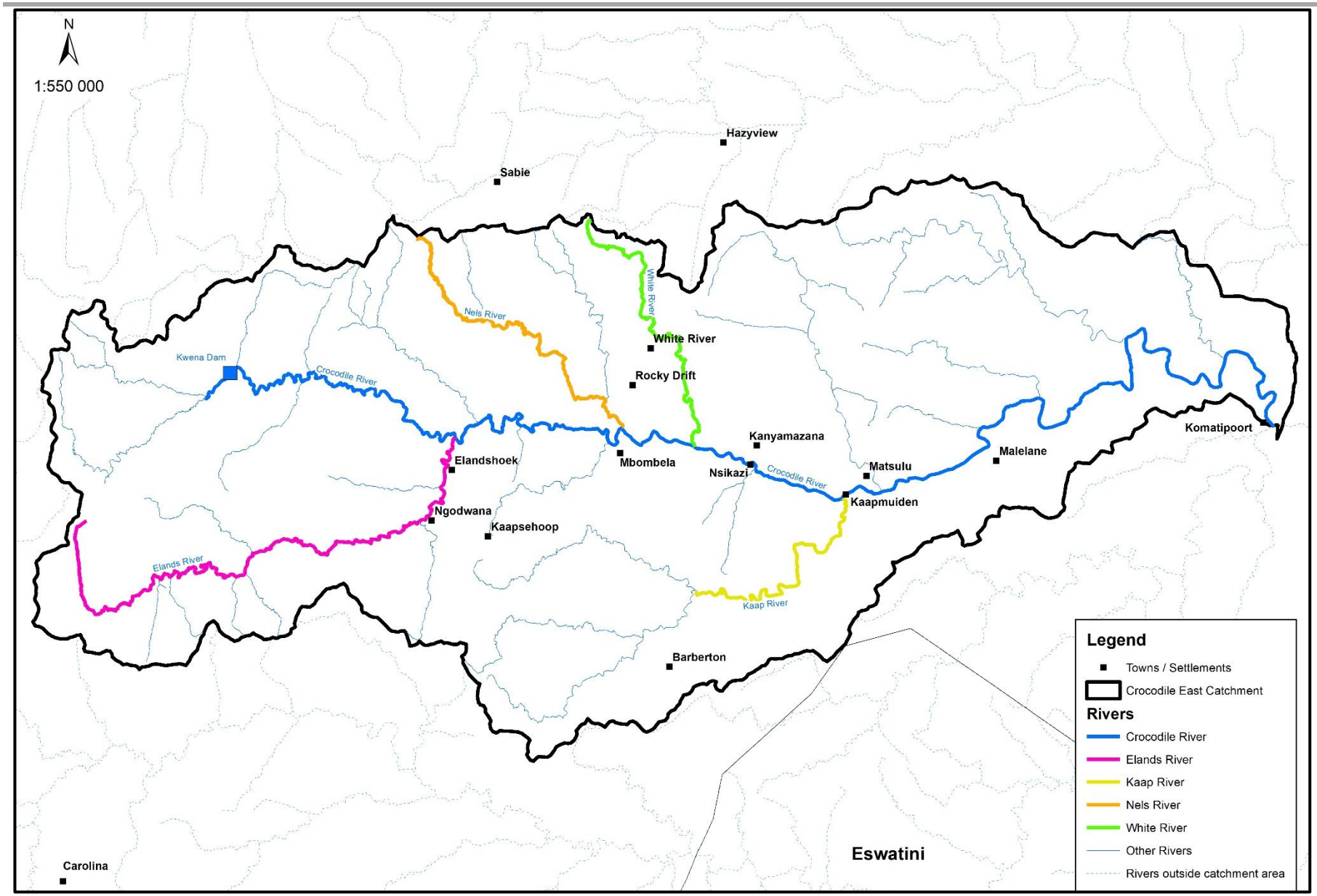


Figure 2-1: Crocodile River Catchment

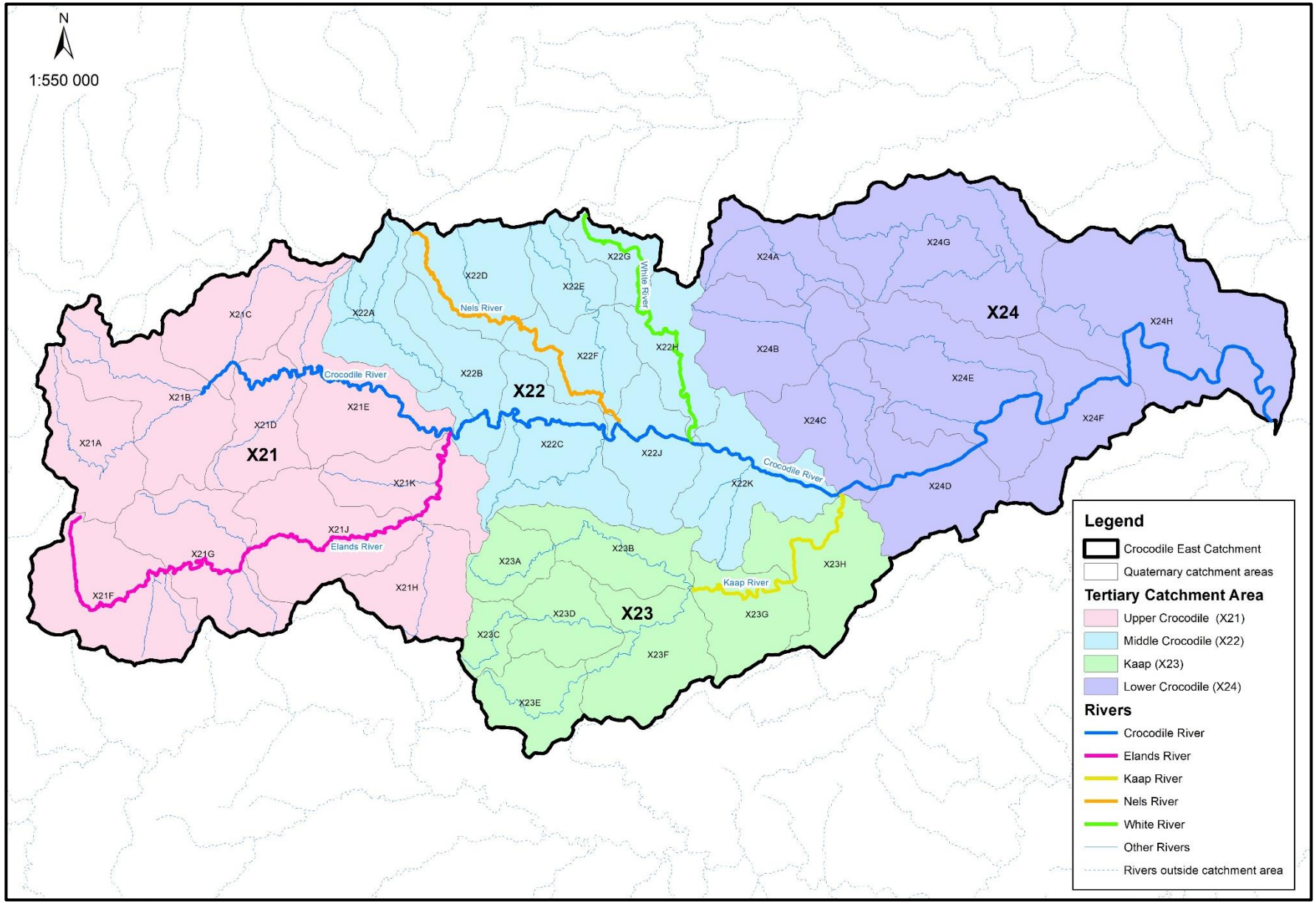


Figure 2-2: Crocodile East River: Tertiary Catchments

The following District and Local Municipalities fall within the Crocodile (East) River Catchment:

- Ehlanzeni District Municipality
  - Bushbuckridge Local Municipality
  - City of Mbombela Local Municipality
  - Nkomazi Local Municipality
  - Thaba Chweu Local Municipality
- Gert Sibande District Municipality
  - Chief Albert Luthuli Local Municipality
- Nkangala District Municipality
  - Emakhazeni Local Municipality

The Crocodile River Catchment is rural in nature, with agriculture being the main economic activity. The high rainfall escarpment catchments of the Upper and Middle Crocodile and Kaap catchments have significant areas of commercial forestry.

The Upper Crocodile Catchment is relatively undeveloped with small domestic and irrigation demands. The Middle Crocodile Catchment has large areas of controlled irrigation and urban demands in the Mbombela LM. The Kaap River Catchment is dominated in the lower eastern part by significant areas of controlled irrigation. Water is transferred into the Kaap River Catchment from the Lomati and Shiyalongubo dams for urban users (Umjindi Local Municipality which was disestablished and merged with Mbombela Local Municipality to establish the City of Mbombela Local Municipality) and agriculture (Louw's Creek Irrigation Board). The Lower Crocodile Catchment has large areas of controlled irrigation and smaller urban/domestic demands for the Nkomazi LM.

The only major dam in the catchment is the Kwena Dam in the Upper Crocodile River Catchment. The dam is approximately 60 km west of Mbombela on the main stem of the Crocodile East River or in the upper reaches of the Crocodile East Catchment. The dam is far from the water demand centers and therefore makes it difficult to regulate and manage water distribution to supply demands as required by the users.

2.4 Proposed Dams

Four proposed dams (listed below) will be investigated during the Pre-Feasibility Phase (Phase 1) of this Study. Only **one** will be selected and recommended for further study in the Feasibility Phase (Phase 2) of the Study. It is, however, possible that the second-best option could be taken forward at a later stage.

- Mountain View Dam on the Kaap River.
- Montrose Dam on the Crocodile East River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

The regional orientation of the **four proposed dam sites** is indicated in **Figure 2-3**.

A brief overview of the four proposed dams (DWA, 2008) is included in sub-sections 2.4.1 to 2.4.4 of this Report.

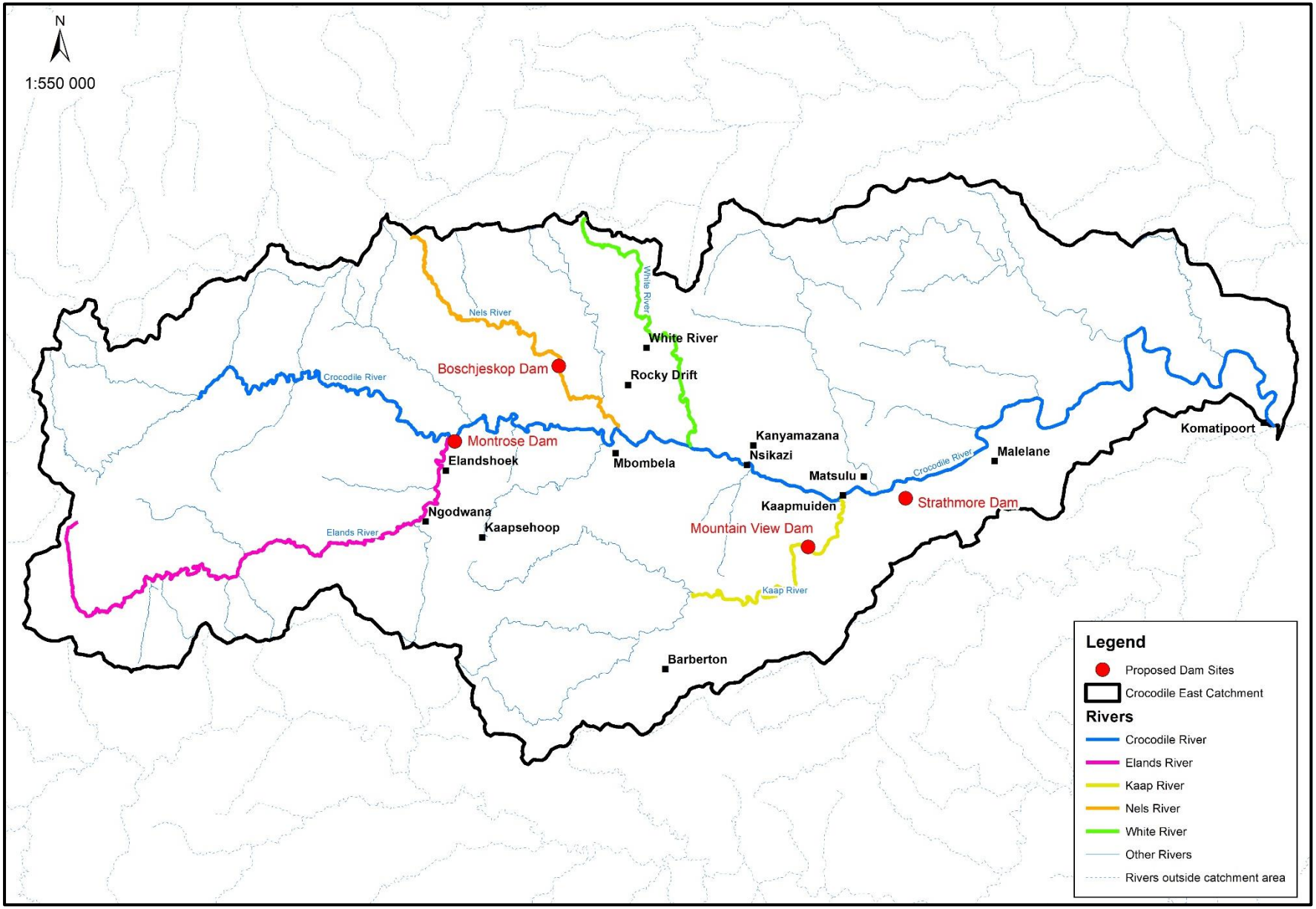


Figure 2-3: Regional Context of Four Proposed Dam Sites

2.4.1 Mountain View Dam

The proposed dam site is located near the end of a steeply sided valley on the Kaap River, some 10 km upstream of the confluence with the Crocodile River.

The approximate site co-ordinates of the proposed Mountain View Dam (see **Figure 2-4**) are: Latitude 25°36'45" and Longitude 31°16'15".

A roller compacted concrete arch dam with a central uncontrolled spillway provided with Robert's splitters discharging into a tail pond has been proposed. The dam can be up to 110 m high (to FSL). For a wall height between 77 and 87 m, the storage capacity of the dam will be between 155.3 and 229.2 million m^3 and the local yield between 25 and 34 million m^3/a.

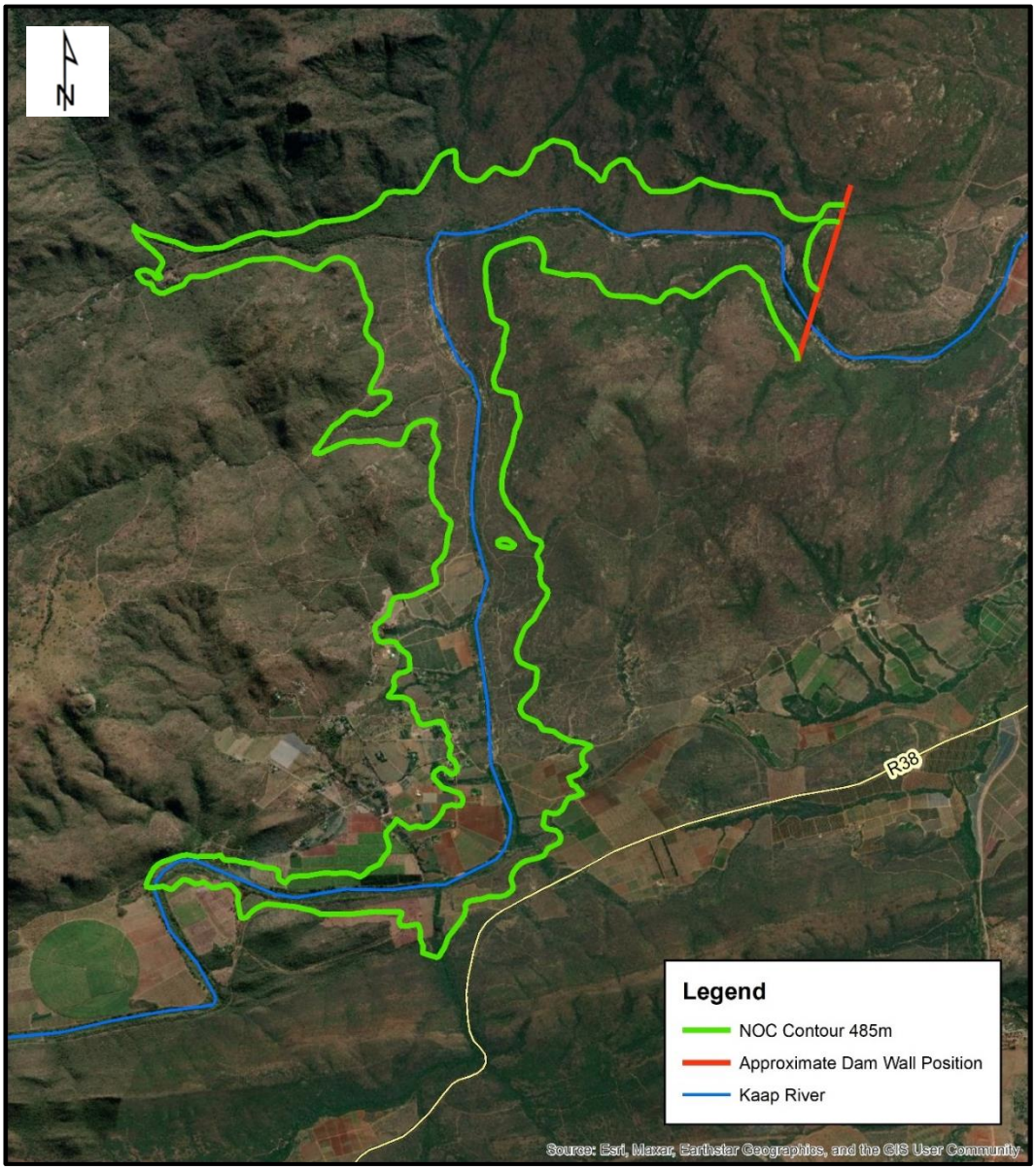


Figure 2-4: Mountain View Dam Site

2.4.2 Strathmore Off-Channel Dam

The proposed dam site is located on the southern side of the N4 national highway halfway between Kaapmuiden and Malelane. The dam is to be constructed in a range of hills aligned more-or-less east-west and parallel to the N4 highway. The dam will require at least two separate dam walls.

The approximate site co-ordinates of the proposed Strathmore Off-Channel Dam (see **Figure 2-5**) are :
Latitude 25°36'45" and Longitude 31°16'15".
The approximate site co-ordinates of the second wall are:
Latitude 25°32'07" and Longitude 31°25'31".

The absence of a visible rock outcrop at the western site implies an embankment dam is best suited. If a dam in excess of 35 m high is to be constructed, a third opening in the range of hills will be affected and a third dam will be necessary. A dam with a height of 32 to 42 m (to FSL) is envisaged. The storage capacity of the dam will vary between 59.1 and 113.8 million m^3. For a dam with a height of 22 to 32 m, the optimum yield will vary from 38.5 to 76.0 million m^3/a, for pumping rates of 1.43 to 4.44 m^3/s.

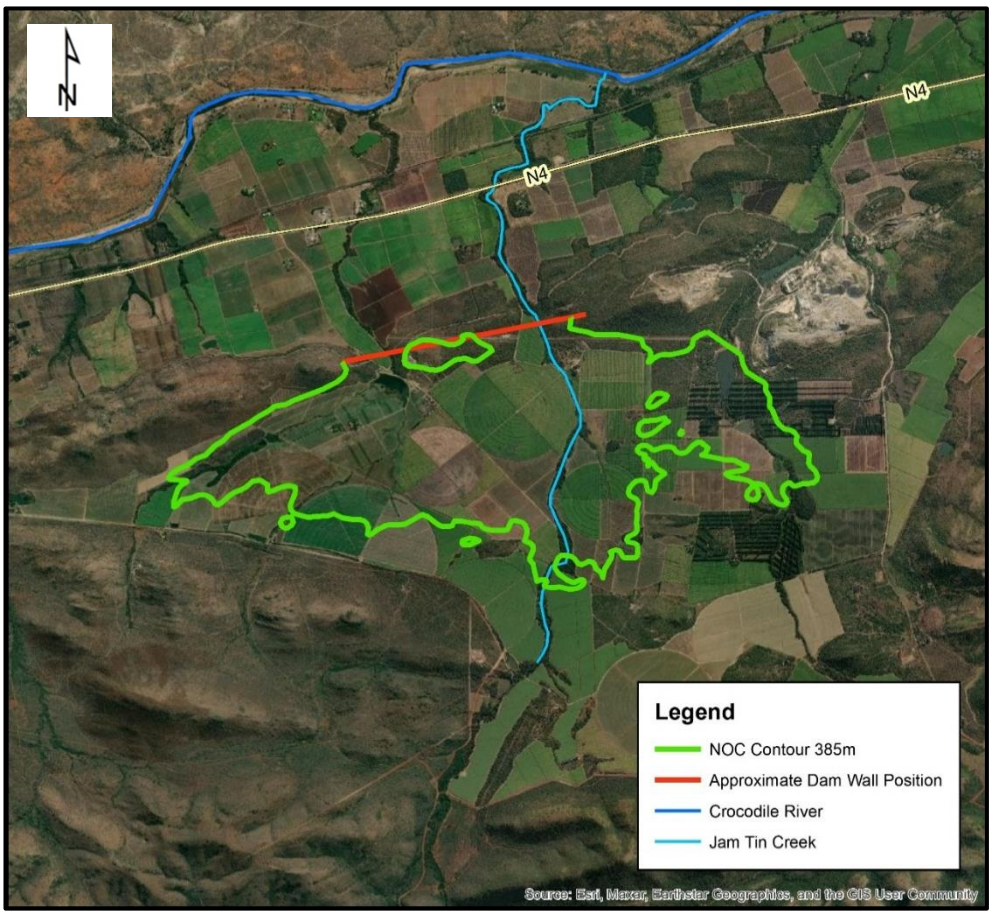


Figure 2-5: Strathmore Off-Channel Dam Site

2.4.3 Boschjeskop Dam

The proposed dam site is located 16 km to the north-west of Mbombela.

The approximate site co-ordinates of the proposed Boschjeskop Dam (see **Figure 2-6**) are: Latitude 25°21'07" and Longitude 30°52'21".

It has been proposed that an embankment dam be constructed in a valley of the Nels River. A central roller compacted concrete section is foreseen. The dam can be up to 70 m high (to FSL). For a dam 40 to 45 m high, the storage capacity of the dam will vary between 75.6 and 101.0 million m^3. For a dam height of 45 m, the local yield will be 19.5 million m^3/a.

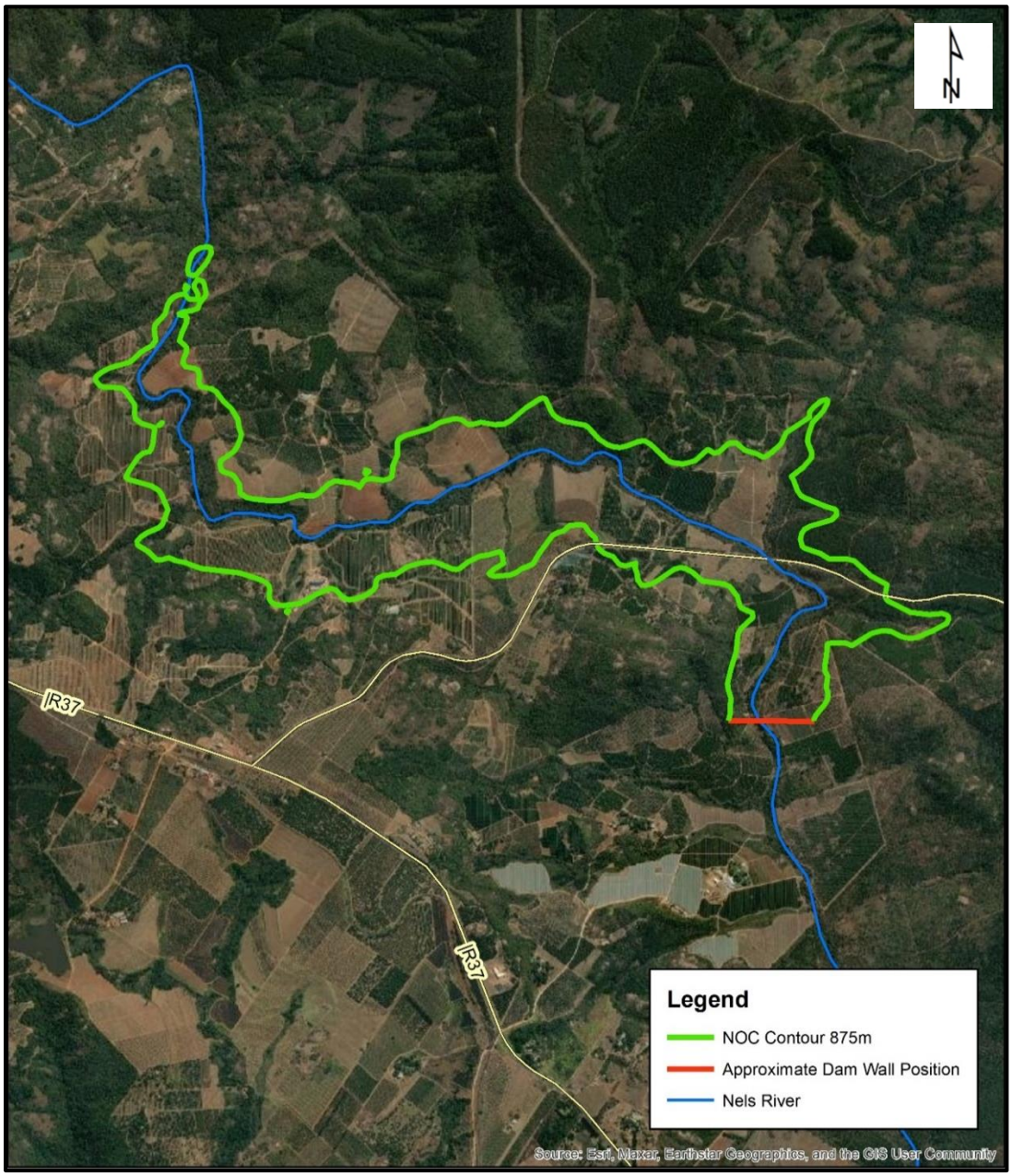


Figure 2-6: Boschjeskop Dam Site

2.4.4 Montrose Dam

The proposed dam is located in the Crocodile River some 2 km downstream of the confluence of the Elands and Crocodile rivers.

The approximate site co-ordinates of the proposed Montrose Dam (see **Figure 2-7**) are: Latitude 25°27'17" and Longitude 30°43'34".

Taking account of the deep soils on the right flank of the river, the Montrose Dam is conceived as a clay cored and roller compacted concrete gravity composite structure with a wall height of up to 100 m (to FSL). For a dam between 70 and 90 m high, the storage capacity of the dam will vary between 104.5 and 253.8 million m³. For a dam height of 90 m, the local yield will be 155 million m³/a.

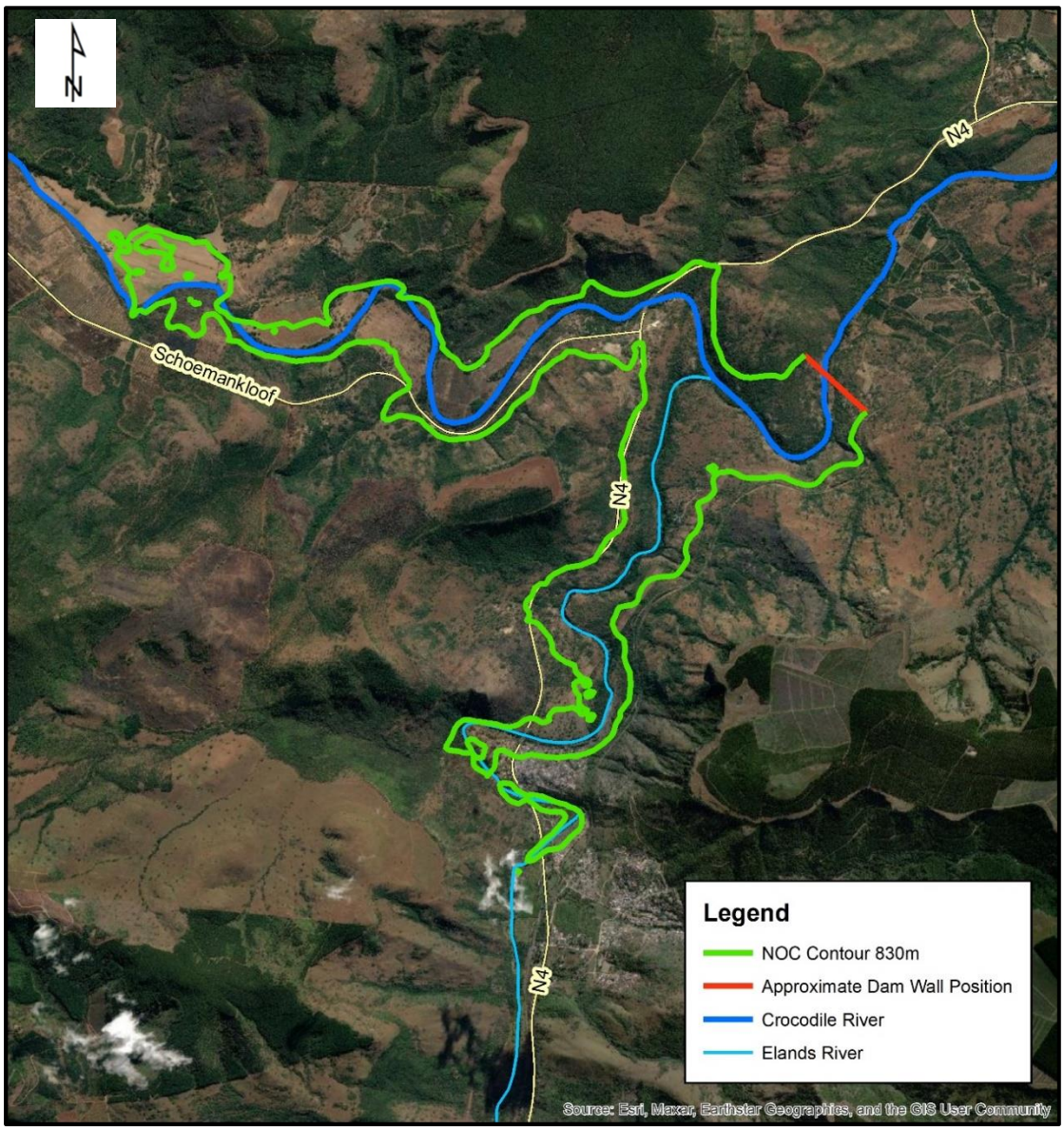


Figure 2-7: Montrose Dam Site

3 LITERATURE REVIEW

A sound understanding of the origins of the Study and previous studies and investigations that were completed, related to the Study, is essential for the Study.

The Terms of Reference highlighted the relevance of the following studies and investigations to this Study:

- Interim IncoMaputo Agreement (IIMA), Tripartite Technical Committee (TPTC) Mozambique, South Africa & Swaziland – August 2002.
- Inkomati Water Management Area Internal Strategic Perspective (ISP) PWMA 05/000/00/0303 – March 2004.
- Crocodile (East) River Development, Reconnaissance Study, PD Naidoo & Associates – September 2008.
- Inkomati Water Availability Assessment Study, Main Report (IWAAS) PWMA 05/X22/00/0808 – June 2009.
- Progressive Realisation of the IncoMaputo Agreement (PRIMA): Basin Management Alternatives and Feasibility Report: Part B: Inkomati River Basin, Report No: Implementation Activities and Action Plan (IAAP) 3 – April 2011.
- Inkomati Water Management Area: Modelling Support for Licensing Scenarios: Identification of Dam Sites on Crocodile River (East) – 1st Draft 2011.
- Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga.
- Development of Real-Time Operating Rules for the Crocodile River Catchment.
- Water Requirements and Availability Reconciliation Strategy for the Mbombela Local Municipality – February 2014.
- Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area – October 2020.

Some of the previous studies and investigations obtained to date are included in **Table 3-1**.

Table 3-1: Document and Data Register

Study Description & Report Title	Report No.	Client & Date	PSP
Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area			
Inception	P WMA 03/X22/00/6718	DWS 2021	BJ/IX/WRP Joint Venture
Economic Growth and Demographic Analysis	P WMA 03/X22/00/6818		
Water Requirements and Return Flows	P WMA 03/X22/00/6918		
Water Conservation and Water Demand Management	P WMA 03/X22/00/6718/4		
Water Resources Analysis	P WMA 03/X22/00/6718/5		
Infrastructure and Cost Assessment	P WMA 03/X22/00/6718/6		
Updated Reconciliation Strategy	P WMA 03/X22/00/6718/7		
Executive Summary: Updated Reconciliation Strategy			
Crocodile (East) River Development: Reconnaissance Study			
Reconnaissance Study – Final Report	PWMA 05/X22/00/0608	DWA 2008	PD Naidoo & Associates (Pty) Ltd
Reconnaissance Study – Final Report Volume 2			
Appendices			
Progressive Realisation of the IncoMaputo Agreement (PRIMA)			
PRIMA : IAAP 3 : Consultancy Services for Integrated Water Resources Management: **Phase 1**		Tripartite Technical Committee (TPTC) between Mozambique, South Africa and Swaziland 2010/2011	Aurecon
Phase 1: Inception Report	IAAP 3: 01 - 2010		
Data Base, Analytical Models and Decision Support System Report	IAAP 3: 02 - 2010		
Baseline Evaluation and Scoping Report	IAAP 3: 03 - 2010		
Basin Management and Development Alternatives and Feasibility Study Report	IAAP 3: 04 - 2010		

Study Description & Report Title	Report No.	Client & Date	PSP
PRIMA : IAAP 3 : Consultancy Services for Integrated Water Resources Management: **Phase 2**		Tripartite Technical Committee (TPTC) between Mozambique, South Africa and Swaziland 2010/2011	Aurecon
Phase 2: Inception Report	IAAP 3: 05 - 2011		
Evaluation and Selection of IWRM Scenarios Report	IAAP 3: 06 - 2011		
IWRM Plan for Maputo Basin	IAAP 3: 07 - 2011		
IWRM Plan for Inkomati Basin	IAAP 3: 08 - 2011		
Training Courses and Evaluation Report	IAAP 3: 09 - 2011		
Final Close-Out Report	IAAP 3: 10 - 2011		
Inkomati Water Availability Assessment Study (IWAAS)			
Main Report	PWMA 05/X22/00/0808	DWAF 2009	Water for Africa in association with SRK and CPH$_2$O
Water Requirements Volume 1 Water Requirements Volume 2: Assessment of Alien Vegetation	PWMA 05/X22/00/0908		
Ecological Water Requirements	PWMA 05/X22/00/1008		
Water Quality	PWMA 05/X22/00/1108		
Infrastructure and Operating Rules: Volume 1 Infrastructure and Operating Rules: Volume 2: Appendices	PWMA 05/X22/00/1208		
Rainfall Volume 1: Report Rainfall Volume 2: Appendices	PWMA 05/X22/00/1308		
Hydrology of Komati River Volume 1 Hydrology of Komati River Volume 2: Appendices	PWMA 05/X22/00/1408		
Hydrology of Crocodile River: Volume 1 Hydrology of Crocodile River: Volume 2: Appendices	PWMA 05/X22/00/1508		
Hydrology of Sabie River Volume 1 Hydrology of Sabie River Volume 2: Appendices	PWMA 05/X22/00/1608		

Study Description & Report Title	Report No.	Client & Date	PSP
Yield Modelling Volume 1 Yield Modelling Volume 2: Appendices	PWMA 05/X22/00/1708		
Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area			
Final Reconciliation Strategy	PWMA 05/X22/00/2012/6	DWA 2014	IWR Water Resources in association with Aurecon, SRK, Kayamandi & WRP
Joint Inkomati Basin Study			
Main Report	C14-99MRF P8491/08	Tripartite Permanent Technical Committee (TPTC) of the Kingdom of Swaziland, the Republic of Mozambique and the Republic of South Africa 2001	CONSULTEC Lda. from Mozambique and BKS ACRES from South Africa
Inkomati Water Management Area			
Water Resources Situation Assessment – Main Report	P05000/00/0101	DWAF 2003	Africon
Overview of Water Resources Availability and Utilisation	P WMA 05/000/00/0203	DWAF 2003	BKS (Pty) Ltd
Internal Strategic Perspective	P WMA 05/000/00/0303	DWAF 2004	Tlou & Matji (Pty) Ltd in association with Charles Sellick and Associates and Mohummad Mayet PrEng

4 SCOPE OF STUDY

4.1 Objective of Study

The objective of this Feasibility Study is to undertake and finalise the planning of a raw water supply scheme comprising a dam(s) and related conveyance infrastructure in the Crocodile (East) River Catchment. The proposed scheme configuration from a strategic water resource perspective, needs to provide a long-term regional water supply solution for the Crocodile (East) River Catchment. The work is to be done at a level of detail that will allow the proposed scheme to be ready for implementation in the shortest possible time upon the completion and conclusion of this Study.

4.2 Study Modules

In order to expedite the planning for a dam(s) in the Crocodile River Catchment, the Feasibility Study has been divided in two separate interactive and concurrently running modules, as follows:

- Module 1: Technical Feasibility Study
- Module 2: Environmental Impact Assessment

A PSP (Nemai Consulting) has been appointed by the DWS for the execution of Module 2: Environmental Impact Assessment for the Crocodile (East) Water Project (CEWP).

4.3 Scope of Study

The Technical Feasibility Study (Module 1) includes both pre-feasibility (Phase 1) and feasibility (Phase 2) work for a regional water supply solution for the Crocodile (East) River Catchment.

The technical feasibility module will consider water resource aspects, engineering investigations, project planning and scheduling, as well as implementation tasks, including the environmental and socio-economic impacts of the proposed project.

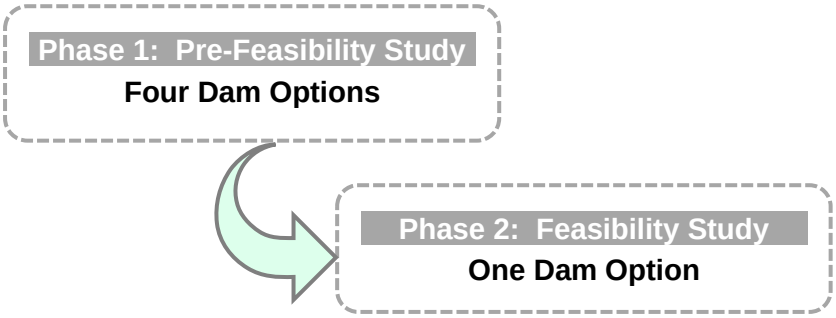
The co-ordination of activities and sharing of information between the two study modules (Module 1 and Module 2) will be essential for the successful execution of the CEWP. The Study Team will therefore work closely with DWS and the PSP for Module 2: Environmental Impact Assessment, to ensure work progresses smoothly and according to the Study programme.

5 STUDY APPROACH

5.1 Study Phases

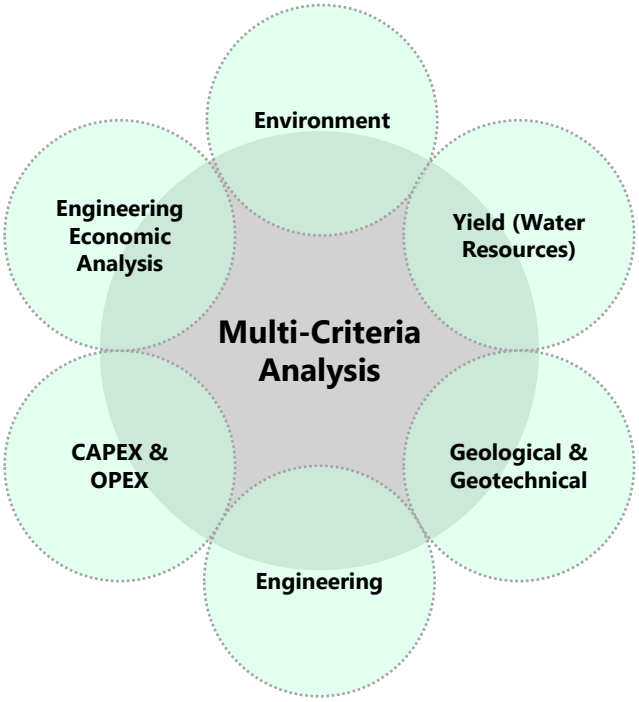
This Technical Feasibility Study will be undertaken in two separate phases, as follows:

- Phase 1: Pre-Feasibility Study, and
- Phase 2: Feasibility Study.



5.2 Phase 1: Pre-Feasibility Study

A long-term regional water supply solution for the Crocodile (East) River Catchment is required and taking cognizance of the significant water deficits in the Crocodile (East) River Catchment it is possible that the implementation of more than one dam will be required. Therefore, a ranking/scoring system (based on a multi-criteria decision matrix) rather than an elimination process will be adopted during the execution of the Pre-Feasibility Study. The decision to apply a ranking\scoring system was made after the Inception Meeting and site visits.



The Pre-Feasibility Study (Phase 1) will be undertaken including the following four proposed dams within the Crocodile (East) River Catchment:

- Mountain View Dam on the Kaap River.
- Montrose Dam on the Crocodile East River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

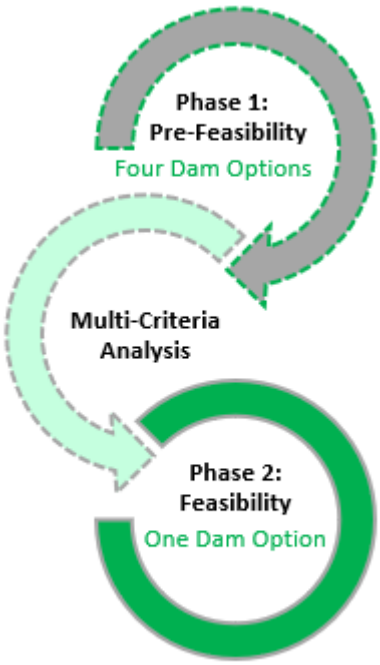
A multi-criteria decision matrix (ranking system) will be developed which will be applied to all four dams to enable a uniform comparison with the objective to identify the most feasible option (highest ranking/scoring). The criteria will typically include the following:

- Environmental impacts
- Yield analysis (Water Resources)
- Geological and geotechnical considerations
- Engineering (dam type, conveyance infrastructure, etc.)
- Capital expenditure (CAPEX) and operational expenditure (OPEX)
- Engineering economic analysis (Unit Reference Values)

For each of the above-mentioned criteria an appropriate ranking/scoring system (0 = worst, 5 = best) will be developed.

In the scoring system each of the criteria will be assigned the same weight in the determination of the aggregated merit score of each dam option.

The highest ranking/scoring dam option will be selected and recommended for further investigation and development at feasibility level.



5.3 Phase 2: Feasibility Study

During the Phase 1: Pre-Feasibility Study, **one** of the possible four dam options will be selected and recommended for further study and development to a **feasibility level** of detail in the Phase 2: Feasibility Study. The work will be done at a level of detail that will allow the proposed scheme to be ready for implementation in the shortest possible time upon the completion and conclusion of this Study.

5.4 Overview of Study Tasks

The proposed work has been structured and broken down into various tasks and subtasks. The tasks closely follow the scope of services and tasks as given in the ToR and therefor only shortened descriptions and requirements of the tasks are given. All of the project aspects and requirements will be addressed in the identified tasks.

The outcomes of the Study Inception (Kick-off) Meeting (Section 7 of this Report) and the site visits (included in **Appendix A**) did not necessitate any significant changes to the envisaged scope of work.

A list of the tasks that will be required to cover the full scope of work is included in **Table 5-1**, including the respective deliverables. Although the task numbering is sequential it does not necessarily imply that the tasks will be executed in this order, since some tasks will take place in parallel or will be informed by other tasks.

The detailed task descriptions, including the proposed approaches and methodologies, are respectively included in the following sections of this Report:

Section 6	**Project Management**
Section 7	**Phase 1: Pre-Feasibility Study**
Section 8	**Phase 2: Feasibility Study**

Table 5-1: Summary of Study Tasks and Deliverables

Task No.	Task Name	Deliverables
Project Management – Refer to Section 6		
	Project Co-ordination	a) Client and Stakeholder Engagement b) Public Relations: • Study Announcement • Stakeholder Communique • Stakeholder Database • Publishing on DWS Website • Meetings c) Project Management and Steering Committee Meetings: • Meeting Arrangements and Attendance • Agendas • Presentations • Minutes of Meetings d) Ad-hoc Tasks
	Project Planning and Monitoring	a) Project Programmes b) Progress Reports c) Financial Reports d) Invoices
	Information Management	Collaborative Sharepoint/One-Drive Site (cloud based)
	Risk Management	Risk Register
	Project Quality Assurance and Control	Quality Control System
	General Project Management	General Project Management
	Capacity Building and Training	a) Two one day workshops b) Secondment of three DWS interns / staff members to the Study Team
	Project Closure	c) Final Study Information (Data Pack)
Phase 1: Pre-Feasibility Study (Four Dam Options) – Refer to Section 7		
1.1	Study Inception	a) Inception Meeting: • Agenda • Presentation • Attendance Register • Minutes of Inception (Kick-off) Meeting b) Site Visits: • Arrangements for Site Visits • Landownership Information • Stakeholder Engagement (Communique) • Site Visit Itinerary • Attendance registers • Site Visit Report c) Inception Report

Task No.	Task Name	Deliverables
1.2	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	a) Downstream Ecological Consequences and Potential Impacts on the National Water Resource Class Report b) Chapter in the Pre-Feasibility Study Report
1.3	Perform/Review Historic Yield Analysis	a) Yield Analysis Report b) Chapter in the Pre-Feasibility Study Report
1.4	Environmental Screening and Identification of Fatal Flaws	a) Environmental Screening Report b) Chapter in the Pre-Feasibility Study Report
1.5	Perform/Review Geotechnical and Material Investigations	c) Geotechnical and Material Investigations Report d) Chapter in Pre-Feasibility Study Report
1.6	Engineering Investigation	Engineering Investigation Report
1.6.1	Topographical Survey and Mapping	a) Lidar DTM data, Contour and Orthophoto generation, Topographical detail mapping b) Chapter in Engineering Investigation Report c) Chapter in Pre-Feasibility Study Report
1.6.2	Proposed Scheme Configurations (Engineering Investigation)	a) Proposed Scheme Configurations Report b) Chapter in Engineering Investigation Report c) Chapter in the Pre-Feasibility Study Report
1.6.3	Engineering Economic Analysis	a) Engineering Economic Analysis Report b) Chapter in Engineering Investigation Report c) Chapter in Pre-Feasibility Study Report
1.7	Multi-Criteria Analysis	a) Multi-Criteria Analysis of Dam Options Report b) Chapter in Engineering Investigation Report c) Chapter in Pre-Feasibility Study Report
1.8	Pre-Feasibility Study Report	Pre-Feasibility Study Report
Phase 2: Feasibility Study (Recommended/Selected Dam Option) – <u>Refer to Section 8</u>		
2.1	Environmental Screening	a) Environmental Screening Report b) Chapter in the Feasibility Study Report
2.2	Water Resources	Water Resources Report
2.2.1	Determine Existing and Future Water Demands	a) Included in Water Resources Report b) Chapters in the Feasibility Study Report
2.2.2	Yield Analysis with the Water Resource Yield Model	
2.2.3	Future Water Balance for the Project	
2.2.4	Development of Short-term Stochastic Yield Reliability Curves	

Task No.	Task Name	Deliverables
2.2.5	Water Resources Planning Model	a) Final WRPM Schematic Diagram b) Electronic Copy of the Final WRPM c) Included in Water Resources Report d) Chapters in the Feasibility Study Report
2.2.6	Assessment of the Potential for Hydropower Generation at the Dam (Water Resources)	a) Hydropower Assessment Report b) Included in Water Resources Report c) Chapter in the Feasibility Study Report
2.3	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	a) Ecological Consequences of Dam Operational Scenarios Report b) Included in Water Resources Report c) Chapter in the Feasibility Study Report
2.4	Socio-Economic Impacts	a) Socio-Economic Impacts Report b) Chapter in the Feasibility Study Report
2.5	Engineering Investigation	Engineering Investigation Report
2.5.1	Topographical Surveys and Mapping	a) Lidar Survey Results and Physical Survey Data b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.2	Geological and Geotechnical Investigation	a) Geological and Geotechnical Investigation Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.3	Geomorphological and Seismic Investigation	a) Geomorphological and Seismic Investigation Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.4	Flood Studies	a) Flood Study Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.5	Feasibility Design of the Selected Scheme	a) Feasibility Design Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.6	Construction Programming and Costing	a) Construction Programming and Costing Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.7	Access and Advanced Infrastructure	a) Access and Advanced Infrastructure Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.8	Flood and Backwater Calculations for the Dam	a) Flood and Backwater Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report

Task No.	Task Name	Deliverables
2.5.9	Climatological Data for the Construction Site	a) Climatological Data Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.10	Water Quality and Limnology	a) Water Quality and Limnology Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.11	Sediment Yield and Sedimentation Investigation	a) Sediment Yield and Sedimentation Investigation Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.12	Land Requirements and Associated Costs	a) Land Requirements and Associated Costs Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.13	Assessment of the Potential for Hydropower Generation at the Dams (Engineering Investigation)	a) Hydropower Assessment Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.14	Costing (CAPEX and OPEX) of the Project	a) Cost Estimate (CAPEX and OPEX) Report b) Chapter in Engineering Investigation Report c) Chapter in the Feasibility Study Report
2.5.15	Engineering Economic Analysis	a) Engineering Economic Analysis Report b) Chapter in Cost Estimate Report c) Chapter in Engineering Investigation Report d) Chapter in the Feasibility Study Report
2.6	Implementation Actions	a) Project Implementation Programme b) Chapter in the Feasibility Study Report
2.7	Record of Implementation Decisions	Record of Decisions
2.8	Institutional, Financial and Operational Aspects	a) Institutional, Financial and Operational Aspects Report b) Chapter in the Feasibility Study Report
2.9	Feasibility Study Report	Feasibility Study Report

6 METHODOLOGY: PROJECT MANAGEMENT

In the sections below the approach and methodology for Project Management is included.

6.1 Project Co-ordination

To ensure that the study is completed successfully, co-ordination meetings will be conducted over the full study period. It is foreseen that most of the meetings will take place in the region (Mbombela) that will benefit from the CEWP.

The following separate structures / committees will be set up to deal with the Study management:

- Project Management Committee Meetings (PMCM)

These meetings will deal with the administration and management of the various study tasks / components of the project.

- Project Steering Committee Meetings (PSCM)

The steering committee will deal with strategic steering and co-ordination of the project and will facilitate communication and sharing of information at a higher level. Apart from DWS and the PSP, the meetings will include key role players from the Mbombela LM and representatives from relevant irrigation boards, WSA's , the IUCMA, local authorities, district municipalities and national, provincial and regional government.

The PSC will be supported by technical working groups, which will involve the various task leaders working together to ensure good communication and integrated planning of the project.

Project Management Committee meetings will take place in conjunction with the Project Steering Committee meetings. It is foreseen that the Project Management Committee meetings for Module 1 and Module 2 will be dealt with over one or two consecutive days in Mbombela.

The Study Team will provide all support services that will be required for the meetings.

The need for further public and ad-hoc meetings between parties relevant to each particular task of the programme to ensure that programme targets are met, will be identified. Such meetings will be arranged and convened through the DWS project manager. It is anticipated

that between 15 and 25 such meetings will be required to complete the Feasibility Study. It is anticipated that certain meetings will only be necessary at the end of the feasibility stage.

iX engineers will develop, or improve on, templates for reports that will be used for the project. The templates will ensure the standardizing of fonts, borders, spacing, etc and automating the table of content, indexes, references, tables, figures, captions, etc.

The iX engineers' team will maintain regular liaison between all parties involved in the implementation process and will facilitate interaction between the parties and the stakeholders.

- Public Relations

iX engineers will manage all public relations. The consultation process with the other stakeholders is critical for the successful and timeous execution of the project and therefore a specialist in Public Relations (PR), has been included in the iX engineers' Study Team. The PR will identify the key stakeholders and contact details will be obtained and maintained. In consultation with DWS a circular will be prepared to outline the objectives of the study and the role of each of the stakeholders. Interaction with each of the stakeholders will be documented.

A full stakeholder engagement and public relations process, where relevant representative stakeholders in the study will provide inputs into the Study, will be carried out to support the Study. The role of the Public Relations task manager will be a continuation of the role and functions implemented for the Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area, including the Crocodile Sabie River System Reconciliation Strategy which ended during the first half of 2021.

The following scope of services is foreseen for the Public Relations task for the Study.

- Communication and Liaison.
- Develop Stakeholder Database.
- Announce the Study.
- Public Relations Meetings.
- Publishing on the DWS website.

The above scope of services is detailed in Section 9 of this Report.

- Ad-hoc Tasks

The iX engineers' Study Team will carry out all ad-hoc tasks as requested. These ad-hoc tasks can be considered as actions required for project management, co-ordination and the facilitation during the execution of both the DWS project modules (Module 1 and Module 2). The scope of these ad-hoc tasks is stipulated in the ToR.

The Study Leader will be responsible for overall coordination, monitoring and performance control of the Study Team and will serve as the main link with DWS. The Study Team will be managed to ensure coordinated output towards key milestones.

Deliverables:	a) Client and Stakeholder Engagement b) Public Relations: • Study Announcement • Stakeholder Communique • Stakeholder Database • Publishing on DWS Website • Meetings c) Project Management and Steering Committee Meetings: • Meeting Arrangements and Attendance • Agendas • Presentations • Minutes of Meetings d) Ad-hoc Tasks

6.2 Project Planning and Monitoring

iX engineers will use project management tools and software such as Microsoft Projects to ensure that the project management tasks as stipulated in the ToR are carried out. A project planner and a cost controller have specifically been included in the Study Team to assist the Study Leader in managing the project.

A financial control system, comprising an interactive spreadsheet model, will be used to monitor and manage budget versus actual expenditure. Actual expenditure against budget will be correlated with percentage completion on tasks so that variances may be managed, and corrective action taken.

Invoicing will be deliverable based, supported by the relevant deliverables, progress reports and financial control documentation.

Deliverables:	Project Programmes, Progress Reports, Financial Reports and Invoices

6.3 Information Management

iX engineers will develop an information management plan to the requirements of the DWS as stipulated in the ToR. A collaborative Sharepoint/One-Drive site (cloud based) will be developed and access will be provided to the DWS' Project Manager and the iX engineers' Study Team. Signed off Study Reports will be made available on the official DWS website.

The Study Team working on the project will sign confidentiality clauses so that information, not meant for the public domain, will be protected.

Deliverables:	Collaborative Sharepoint Site Update DWS website (uploading of signed-off Study Reports)

6.4 Risk Management

The study risk management tasks will be carried out according to the requirements of the iX engineers' Risk Management Framework, which describes the risk management methodology adopted by iX engineers in accordance with the ISO 31000:2018 risk management standard. Refer to **Figure 6-1**.

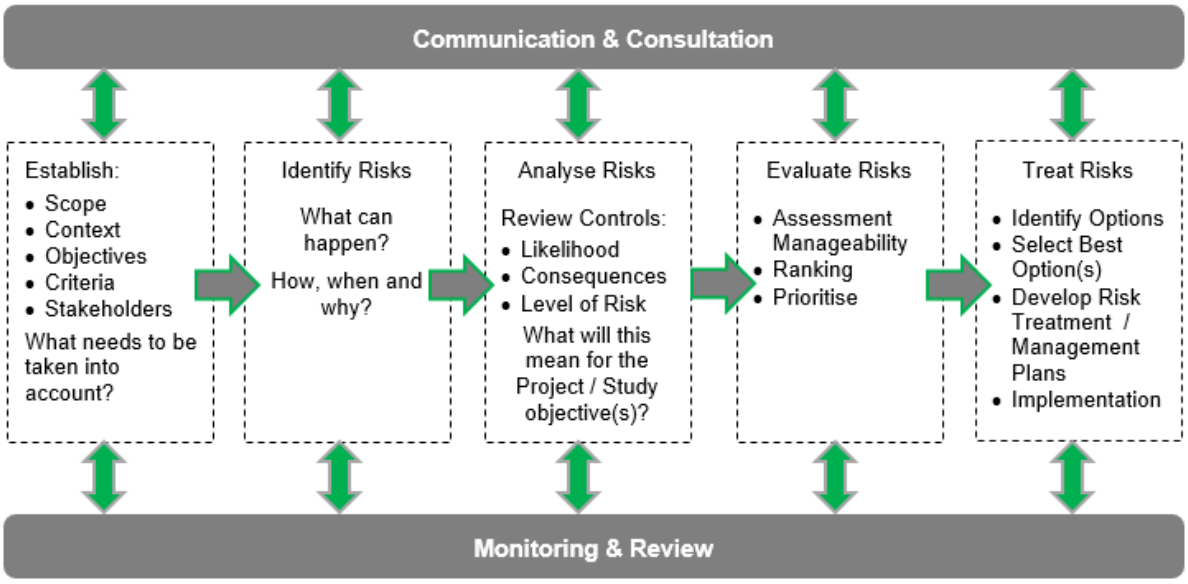


Figure 6-1: ISO31000:2018 Risk Management Standard

The following risk assessment tasks will typically be carried out:

- Assessment of risks and mitigation strategies over the life of the Study.
- Advise on an appropriate risk management strategy for the following potential risk categories: Political, technical, environmental, social, legal, demand/supply of water, operational, institutional, financial, and other identified issues.
- Develop a risk rating mechanism to determine the probability of occurrence of the potential risks and estimation of their impact, and
- Ensure stakeholder participation in the risk management process.

A proactive risk assessment process will be aimed at highlighting issues that may impact on the project budget, programme for implementation, quality of work or performance and the overall sustainability of the project. The risk assessment will be a formal process involving the Client, key stakeholders and the PSPs to ensure that a comprehensive set of real risks are identified and managed proactively. The resultant risk register will be maintained as a living document through the project to facilitate proactive management.

The risks will be assessed according to the severity of the potential impact, and the probability of occurrence thereof. A rating is calculated for each risk, being the product of the **Impact** and **Probability**. Rankings will be assessed based on **Table 6-1** below and should be agreed to by the Risk Management team.

Table 6-1: Proposed Risk Assessment Rankings

Impact Ranking	
Ranking	**Description (descriptors to be added to better define the impact)**
1	Ignore – event is negligible
2	Minor
3	Significant
4	Severe
5	Catastrophic

Probability (Likelihood) Ranking	
Ranking	**Description**
1	Adverse event will not occur
2	Highly unlikely that the event will occur
3	Event can occur
4	Highly likely that the event will occur
5	Adverse event will definitely occur

The identified risks with impacts, ratings and how they will be managed are then carried in the risk register with a format along the lines of that set out in **Table 6-2**.

Table 6-2: Proposed Format of Risk Register

Ref	Risk/ Issue	Cause	Impact	Inherent Risk Rating			Mitigation Measures (Risk Response)	Residual Risk Rating		
				Impact	Likelihood	Rating		Likelihood	Impact	Rating

Deliverable:	Risk Register

6.5 Project Quality Assurance and Control

CERTIFICATE OF REGISTRATION

This is to certify that:

IX ENGINEERS (PTY) LTD

Hillside Offices 277 The Hillside Street Menlo Park Pretoria 0081 SOUTH AFRICA
(Refer to Attachment to Certificate of Registration dated 22 September 2020 for additional certified sites)

operates a

QUALITY MANAGEMENT SYSTEM

which complies with the requirements of

ISO 9001:2015

for the following scope

The provision of project management, Civil ,Electrical and Mechanical engineering services, procurement of materials ,machinery or equipment and, construction management, pursuit of new business ,IT support , restoration expertise ,commissioning and specialist consulting and advisory services.

Scope Exclusions: None.

Certificate No: QMS42389

Issued: 22 September 2020 Originally Certified: 6 October 2016
Re-issue 1

Expires: 5 October 2023 Current Certification: 15 September 2020

Frank Camasta
Global Head of Technical Services
SAI Global Assurance

Certified System ISO 9001

JAS-ANZ

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SAI Global is appointed as the official certification body whereby iX engineers (Pty) Ltd achieved **ISO 9001:2015** certification in 2016. iX engineers have since strived to continually improve the system with the focus being on risks and project delivery.

Risk is a core driver for the quality control and quality assurance activities that will be undertaken. In line with the iX engineers vision our quality management system supports this through assessment and improvement. All assessment and quality control activity undertaken will reflect the complexity of the operation, level of risk, and performance history.

The objectives will be:

- To comply with contractual requirements.
- To comply with project/study goals established by the project/study sponsor and management team.
- To comply with all regulatory and governmental obligations and applicable codes, standards, and specifications.
- To ensure that interfaces are identified, and information requirements are met.
- All tasks and deliverables are quality assured as meeting specified requirements.
- Project/study processes are controlled, measured, monitored, analysed and continually improved.
- The ability to consistently supply outputs (deliverables) that meet applicable statutory, regulatory and project/study requirements can be demonstrated.
- Project processes are implemented that prevent nonconformity.
- Timely and effective corrective action is taken if nonconformity occurs.

Deliverable:	Quality Control System

6.6 General Project Management

Other project management tasks (resource and staff management, internal project management, internal design audit and squad checking sessions, etc), not specifically mentioned under the above project management tasks (Tasks 0.1 to 0.5), will be carried out in terms of the iX engineers' Project Management Approach.

Deliverable:	General Project Management

6.7 Capacity Building and Training

Provision will be made for capacity building and training of DWS officials or interns in the water resource planning process and / or project management and / or technical aspects, to be undertaken as part of this study. More details on our capacity building and training proposal are included in Section 9 of this report.

Deliverables:	Two one day Workshops Secondment of three DWS interns / staff members to the Study Team

6.8 Project Closure

The objective of this Task is to collect and transfer the final study information to DWS. All reports, agendas, presentations, minutes and records will be provided electronically to the Client.

Deliverable:	Final Study Information (Data Pack)

7 METHODOLOGY: PHASE 1: PRE-FEASIBILITY STUDY

The Pre-Feasibility Study (Phase 1) wil be undertaken for the following four proposed dams within the Crocodile (East) River Catchment:

- Mountain View Dam on the Kaap River.
- Montrose Dam on the Crocodile East River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

In the sections below the approach and methodology that will be followed with respect to work to be undertaken with respect to the Pre-Feasibility Study is included.

7.1 Task 1.1: Study Inception

Task 1.1.1: Study Inception Meeting

The Feasibility Study assignment was initiated by the Study Leader on receipt of confirmation that the iX engineer's Study Team had been selected to execute the project. The Study Inception (kick-off) Meeting was held on 04 October 2022. Attendees included representatives from DWS and the iX engineers' Study Team.

Deliverables:	Agenda, Presentation, Attendance Register and Minutes of Meeting.

Task 1.1.2: Data Collection and Review

The first task was to thoroughly review all work done in previous studies (list of previous reports consulted is shown in **Table 3-1**).

The review of the reports enabled the team members to appraise the information available and familiarise themselves with the findings from the previous studies so that they could reconsider or refine the proposals made in the original tender and compile the Inception Report.

Provision was made for a significant amount of start-up technical work as important reviews and preparatory work was required.

Deliverables:	List and Copies of previous relevant reports (Data Register).

Task 1.1.3: Site Visits

Visits to the four proposed dam sites (Montrose, Boschjeskop, Strathmore and Mountain View) were undertaken from 1 to 4 November 2022. Refer to **Appendix A** of this Report.

Deliverables:	Site Visit Report Site Visit Itinerary, Attendance Registers, Stakeholder Engagement (communique) and Landownership Information Chapter in the Pre-Feasibility Report

Task 1.1.4: Inception Report

On 21 and 24 November 2022, internal Study Team meetings were convened to facilitate a full understanding of the assignment.

During the Inception Phase the Study Team finalised the Scope of Work for the assignment, confirmed the composition of the Project Team, the manpower schedule, work programme, budget and cash flow.

Following the above tasks (Task No's 1.1.1 to 1.1.3) this Inception Report was compiled, which stipulates the scope of work for the Study, detailed description of the study tasks, the study programme and the study budget. The purpose of the Inception Report is to capture all work that will be necessary for the completion of the study.

The outcomes of the Study Inception Meeting and the site visits did not necessitate any significant changes to the envisaged scope of work.

Deliverable:	Inception Report

7.2 Task 1.2: Ecological Consequences in terms of the National Water Resource Class, the Target Ecological Category and the Reserve

Resource Quality Objectives (RQOs) have been gazetted with Water Resource Classification for this system. RQOs are set for flows, water quality, instream and riparian habitat and biota. During the Pre-Feasibility phase, an assessment will be made of the impacts of the proposed

dams on the downstream environment – specifically the ecological categories which represent the RQOs. The main objective will be to determine any fatal flaws and also to rank the options from the perspective of meeting the RQOs. During the Pre-Feasibility phase, the assumption will be made that the flow RQOs (EWRs) will be met from the proposed dam options. Further work on the flows and how to optimise yield while still ensuring that the RQOs are met will be the main focus of the Feasibility Phase.

While the EWRs may be met (the assumption being made), there are other impacts resulting from dams that may have an impact on the downstream environment such as the barrier effect, change in water quality, scour, sedimentation, provision of water for users combined with EWR releases (i.e., the potential operating system and manner of supply). The impacts will be described and then evaluated for water quality, geomorphology, riparian vegetation, fish and aquatic invertebrates. This will include the scale in terms of the longitudinal impact. The existing EcoStatus models will be used for the assessment to predict changes in Ecological categories (A to F) and to compare this to the gazetted RQOs. These results will also be converted to a severity rating to fit seamlessly into the EIA process and serve as contribution to the EIA.

Input required from the rest of the team by middle January 2023 will be the proposed locality of the dam sites and the proposed manner of operation (i.e., supply to users).

The tasks undertaken for Pre-feasibility is as follows:

Task 1.2.1: Compiling all Data for Relevant Dam Sites

Detailed previous work was undertaken at relevant EWR sites downstream of the proposed dams during the Reserve, National Water Resource Classification and PESEIS studies. Some of these dams were also broadly evaluated during those studies. The available work includes a range of models which have been set up to describe the baseline (Present Ecological State (PES)). These models will form the starting point for evaluation during this study. The team that will be assessing the work is that same team that has undertaken all these previous studies. The EcoStatus models (FRAI, MIRAI, PAI, GAI, VEGRAI, IHI, EIS, EcoStatus) will be sourced and all relevant information required will be obtained from the existing data basis. The existing relevant EWR sites will be selected for the assessment and evaluation.

Task 1.2.2: Consequences of Dams in terms of Positioning and Relevant Downstream Impacts

The objective of this task will focus on identifying fatal flaws. Where there are no fatal flows, the proposed dam sites will be ranked in terms of the impacts on the downstream ecological status of the dams. The assumption will be that all dams will supply an EWR and the assessment of the impact will be on other factors (as described previously) associated with the dams. A maximum of four dam sites will be assessed.

The first part of the task will be to identify the possible impacts and to design the evaluation and ranking system. The evaluation of the impacts will then be undertaken during a virtual specialist meeting.

The impacts of the proposed manner of dam operation, the barrier effect, the scale, potential for flood releases and flood mitigation, scouring and sedimentation will be assessed amongst others. The EcoStatus models will be applied and an assessment can be made whether there will be compliance with the RQOs and if not, how severe the impacts will be. This work will be used during the EIA assessment process.

Task 1.2.3: Reporting

The assessment of Task 1.2.2 will take place by means of liaison between the Specialists and virtual meetings as required. The results and outcomes will be documented in a report which will be summarised as a chapter for the Pre-Feasibility Report.

Deliverables:	Evaluation of Downstream Ecological Impacts of the Dam Options Report Chapter in the Pre-Feasibility Study Report

7.3 Task 1.3: Perform/Review Historic Yield Analysis

A historic yield analysis will be performed, using the latest hydrology, in order to determine yield versus supply capacity relationships for the four pre-feasibility dam options.

Deliverables:	Yield Analysis Report Chapter in the Pre-Feasibility Study Report

7.4 Task 1.4: Environmental Screening and Fatal Flaws

A desktop environmental assessment of the four dam options will be done using publicly available screening and data tools such as the Department of Department of Environment,

Forestry and Fisheries' National Environmental Screening Tool and the Mpumalanga Biodiversity Conservation Plan, as well as information from previous assessments. The objective will be to identify possible fatal flaws associated with the four dam options and allow ranking of the dam options as part of the multi-criteria analysis.

Deliverables:	Environmental Screening Report Chapter in the Pre-Feasibility Study Report

7.5 Task 1.5: Perform/Review (Pre-Feasibility) Geotechnical and Material Investigations

A preliminary (Pre-feasibility) geotechnical and material investigation for the four dam options will be performed/reviewed.

The results of previous geotechnical investigations will be reviewed to evaluate relevance and possible gaps/discrepancies in the data presented. Recommendations will be made regarding outstanding data and the scope for additional investigation(s) that will be required.

A walkover visit of each site has been performed during the inception phase. Visual observations were made of the site conditions to confirm the geotechnical/geological aspects. The potential dam sites will be ranked (from most to least suitable) according to the available geotechnical information.

The pre-feasibility geotechnical evaluation of the four potential dam sites will consist of a desk top study of all available geological and geotechnical information and additional information obtained during the site visits, combined with the available geotechnical information from previous studies. If deemed necessary, an additional site visit to a specific dam site may be undertaken to eliminate uncertainties or possible gaps in the available data.

Depending on the quality and relevance of the available data from the previous investigation(s), it will be decided on the requirements and scope (if any) for additional investigations at pre-feasibility level.

The scope of the geotechnical investigations for the dam site that will be investigated at feasibility level (as concluded in the pre-feasibility study) will be determined and this may include geophysical surveys, test pit excavations, rotary core drilling and laboratory testing of soil and rock samples.

The pre-feasibility geotechnical investigations and information data will be used in combination with all the other applicable parameters to rank the dam sites.

Following the completion of the multi-criteria analyses (refer to Task 1.7 in Section 7.7 below), additional pre-feasibility level geotechnical investigations may be performed on the two most favourable dam options. The scope and extent thereof will be determined when the dam sites are determined, and full supply levels determined. Such investigations can typically involve the following:

- Geophysical surveys at the dam site and potential rock quarry sites. Electrical Resistivity Tomography (ERT) will constitute the main investigation method, which will be augmented by seismic refraction surveys, possibly including Multichannel Analyses of Surface Waves (MASW), whereby shear wave velocities can be determined to depths of up to 30 m. Shear wave velocities can be used to determine Youngs Modulus of foundations.
- Test pitting in soil borrow areas to determine the soil profile and availability of earthfill for embankment construction. This will be combined with tactile soil profiling, representative soil sampling and laboratory testing.
- Test pitting in foundation footprint areas for embankments to determine the soil profile, depth to bedrock/impervious foundation material for core trench depth, foundation depths for embankment fills and the possible presence of problem soils. Representative soil samples can be taken for laboratory testing. Test pitting can also provide useful information in concrete wall sections to determine the depth and variations in the rock weathering profile, the presence of core stones and excavatability.

Results of the pre-feasibility level geotechnical investigation will be used to prepare the scope and specifications for the feasibility level study.

Deliverables:	Geotechnical and Material Investigations Report Chapter in the Pre-Feasibility Study Report

7.6 Task 1.6: Engineering Investigation

Task 1.6.1: Topographical Survey and Mapping

The available lidar survey and DTM will be collected from the Mbombela LM (Mountain View, Montrose, Boschjeskop and Strathmore dams).

The available lidar survey done by the City of Mbombela in 2019 unfortunately does not include the Boschjeskop Dam basin area and the lidar survey as required will be undertaken during the pre-feasibility phase. The lidar survey of 2019 is currently available for free, no

provision has therefore been made to acquire it from the City of Mbombela. It is also important to note that the available lidar survey also contains aerial photographs that will be accessed and used for example in the tasks for geological and geotechnical investigations.

Where existing surveys do not exist and are required for a dam, additional topographical surveys will be carried out during the feasibility phase of this Study. The surveys will be carried out to an elevation of about 15 m higher than the dam full supply level to allow for surcharge and for backwater for the Safety Evaluation Flood (SEF). Lidar surveys with georeferenced aerial photography will be carried out. Underwater surveys of the river, if water is deeper than say 1.0 m, will be carried out and spliced into the Lidar survey. Surveys will extend too at least 500 m downstream of the dam site for accurate tail water calculation. All existing structures such as bridges in the proposed reservoir will be surveyed. The surveys will be carried out to an accuracy of 50 mm in the vertical.

Survey outputs will comprise of:

- Lidar DTM data, Contour and Orthophoto generation
- Topographical Detail Mapping.

Deliverables:	Lidar DTM data, Contour and Orthophoto generation, Topographical Detail Mapping Chapter in Engineering Investigation Report Chapter in the Pre-Feasibility Study Report

Task 1.6.2: Proposed Scheme Configurations

Previous studies that investigated future water resource development options investigated several viable scheme configurations. Scheme configurations are required that will lead to a long-term water supply solution for the region and the Mbombela LM. The Mountain View, Montrose, Boschjeskop and Strathmore dam options will be investigated from an engineering perspective (dam type and height, including geotechnical and geological aspects) and possible environmental fatal flaws have been identified.

The previous studies that investigated future water resource development options identified a number of viable scheme configurations. These include the proposed Montrose Dam or proposed Mountain View Dam or the proposed Strathmore Dam plus/or the proposed Boschjeskop Dam.

From the results of these studies, it was evident that the proposed Montrose Dam option was significantly more expensive for a specific configuration (dam size and dam yield) than any of

the other options and was discarded from an economical point of view. Other options, for example, a smaller Mountain View Dam in combination with the Boschjeskop Dam, was not considered. Possible issues with the Strathmore Dam option were also flagged (mining development in its immediate vicinity, etc.).

However as required in the Terms of Reference these decisions/issues will be reviewed/confirmed during the pre-feasibility phase of this project. The results of the review will be captured in a report.

For the purposes of this review the dam engineering, geotechnical and geological experts will review all previous reports. Each of these sites will also be visited to confirm the assumptions made during previous studies. It is important to note that the level required for pre-feasibility geotechnical and geological investigations are based on available information as well as what are observed during site visits and based on the *Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options (VAPS) (DWAF, 1996)*.

It is important to note that none of the previous studies considered implementation of the EWR. In other words, the proposed outlet work layout did not consider such implementation. To determine the release requirements at the dams themselves, hydraulic modelling would be performed downstream of the dams to the EWR sites to determine the level of attenuation of the release hydrographs. It is also proposed to use the draft SANCOLD Guideline titled *Guideline for The Sizing of Dam Outlet Structures for Releasing Ecological Water Requirements from South African Dams (SANCOLD, 2020).*

Deliverables:	Proposed Scheme Configurations Report Chapter in Engineering Investigation Report Chapter in Pre-Feasibility Study Report

Task 1.6.3: Engineering Economic Analysis

An engineering economic analysis of the four dam options will be carried out. The dam options will be compared to each other based on Unit Reference Values (URV) and cost benefit analyses.

Any changes in the layouts of the proposed dams and configurations used in the previous studies will be costed using the methodology described in the *Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options. (VAPS) (DWAF, 1996)*. At this stage the only major chance in the

engineering economic analysis is the provision for the implementation of the EWR and its impact on the outlet works configurations. URV calculations will be performed that will serve as a basis for the engineering economic analysis.

Deliverables:	Engineering Economic Analysis Report Included in Engineering Investigation Report Chapter in Pre-Feasibility Study Report

7.7 Task 1.7: Multi-Criteria Analysis

Taking cognizance of the significant water deficits in the Crocodile (East) River Catchment it is possible that the implementation of **more than one dam** might be required. Therefore, a ranking/scoring system (based on a multi-criteria decision matrix) rather than an elimination process will be adopted during the execution of the Pre-Feasibility Study. Refer to Section 5.2 of this Report.

A multi-criteria decision matrix (ranking/scoring system) will be developed. This ranking decision matrix will be applied to all four dams to enable a uniform comparison to identify the most feasible option. The criteria will typically include the following:

- Environmental impacts
- Yield analysis (Water Resources)
- Geological aspects
- Engineering (dam type, conveyance infrastructure, etc.)
- Capital expenditure (CAPEX) and operational expenditure (OPEX)
- Engineering economic analysis (Unit Reference Values)

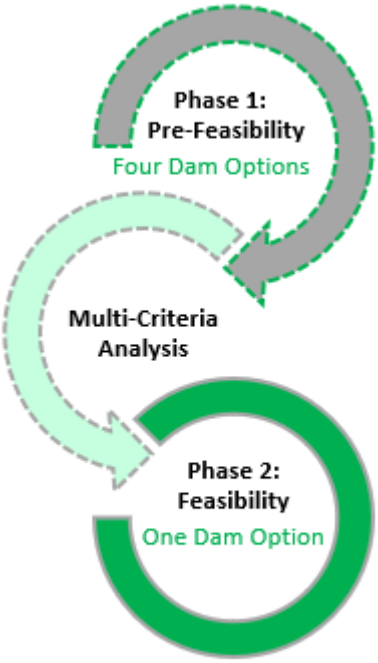
The highest ranking/scoring dam options will be selected and recommended for further investigation and development at feasibility level.

Deliverables:	Multi-Criteria Analysis of Dam Options Report Chapter in Engineering Investigation Report Chapter in Pre-Feasibility Study Report

7.8 Task 1.8: Pre-Feasibility Study Report

A report on the work undertaken during the Pre-feasibility stage will be prepared. The **purpose** of the Pre-Feasibility Study Report is to provide decision makers and key stakeholders a concise record for the Pre-Feasibility Study covering all the investigations, findings and recommendations. Each of the preceding tasks has one or more deliverables and the main findings, deliverables, conclusions and recommendations will be summarized and included into a single Pre-Feasibility Study Report.

The main **objective** of the Pre-Feasibility Report is to recommend **one** of the dam options considered in the Pre-Feasibility Study (Phase 1) for further study in the Feasibility Study (Phase 2).



Upon completions of Tasks 1.1 to 1.7 the multi-criteria decision matrix (ranking/scoring system) will be applied to all four dams to enable a uniform comparison with the objective to identify the most feasible option (highest ranking/scoring).

The highest ranking/scoring dam option will be selected and recommended for further investigation and development at feasibility level.

Deliverables:	Pre-Feasibility Study Report Other Task Reports as supporting documentation

8 METHODOLOGY: PHASE 2: FEASIBILITY STUDY

The Feasibility Study (Phase 2) wil be undertaken for the selected dam option within the Crocodile (East) River Catchment.

In the sections below the approach and methodology that will be followed with respect to work to be undertaken with respect to the Feasibility Study is included.

8.1 Task 2.1: Environmental Screening

Environmental Screening to be undertaken during the Feasibility Study will be done at a higher level of detail compared to the work done in the Pre-Feasibility Study. The screening will be based on relevant historic studies and information in the public domain. Information relevant to the project will be reviewed, including the Environmental Assessments conducted during the previous project stages. Salient environmental information will be assessed.

A desktop environmental screening will be performed for the selected dam option (and associated infrastructure) to identify sensitive environmental (biophysical) and attributes that may potentially be adversely affected. Socio-economic aspects will be considered as part of Task 2.4. Enviro-legal issues of concern will also be identified.

The primary output of the environmental screening task will be a high-level environmental risk assessment, which will include a fatal flaw analysis of the selected dam site, in terms of environmental criteria. A high level (qualitative) investigation will be conducted of the potential environmental implications of the proposed development and identification of aspects that requires assessment during the detailed Environmental Impact Assessment.

The screening output will be used by the EAP in the EIA study (Module 2). The aim of the work done by the PSP during the environmental screening process is therefore to ensure a smooth handing over and fast tracking of the EIA process (Module 2). The PSP will assist the DWS project manager with reviewing the work done by the EAP appointed for the EIA component of the project (Module 2). The PSP will assist with project management of the EIA study as required in the ToR. This will include the following:

- Management of EAP: assumed at an average of 8 hours per month over a 12 month period (assumed approximate timeframe for Module 2);
- Review of reports compiled by EAP: 60 hours over 12 month period.

Deliverables:	Environmental Screening Report Chapter in the Feasibility Study Report

8.2 Task 2.2: Water Resources

The Water Resources Task is divided into a number of sub-tasks, and further individual activities within those, as outlined in the following sub-sections of the report.

Some of the water resources assessment aspects requested in the Terms of Reference outlining the Study requirements have already been undertaken as part of the recently completed Mbombela Reconciliation Strategy Study. Furthermore, the Strategy Study has recently moved into a further Phase in which refinements, including the incorporation of the new hydrology developed by the IUCMA into the standard DWS models (WRYM and WRPM), has been undertaken.

For this Feasibility Study, it will be important to engage with the Reconciliation Strategy Study Team, in order to make use of the latest information and to reduce the amount of water resources modelling required for this Study. For the most part, the WRYM and WRPM has been configured as part of the Reconciliation Strategy Study and is ready for use as part of this Study. This includes updated hydrology prepared by the IUCMA.

The efforts involved with this Task will therefore be focused on scenario analyses and comparisons of the different dam options. The water resources team will support the dam engineers with decisions regarding yield for various options, as well as the impacts on downstream users.

Of importance to this system is the need to operate the new dam efficiently, in conjunction with the existing resources, i.e. Kwena Dam. This will extract the most yield from the system. The assessment of operating rules using the WRPM will be undertaken.

An outline of the approach that will be undertaken as part of the water resources assessment is as follows:

- Obtain the latest WRYM and WRPM from the Reconciliation Strategy Study Team.
- Configure the shortlisted Dam options into the models and determine yields of varying sizes using the WRYM.
- Configure the most likely dam option into the WRPM and determine operating rules and carry out a downstream user impact assessment.

- Support the EWR Team with scenario analyses relating to the Environmental Reserve.
- Support the Dam Engineers with yield analyses of various dam sizes, and
- Support the hydropower expert with hydrological flows and other required information relating to the hydropower assessment.

Deliverables:	Refer to Tasks 2.2.1 to 2.2.6 Water Resources Report for Feasibility Study Final WRPM Schematic Diagram Electronic Copy of the Final WRPM Chapters in the Feasibility Study Report

Task 2.2.1: Determine Existing and Future Water Demands

This Study will thus focus on firstly reviewing the Mbombela Reconciliation Strategy (DWS, 2021). All the current and future water demands, up to the year 2045, will be updated, as well as including the additional areas relating to the complete study area at the same level of detail. The demographics focus on smaller towns or groupings of towns and rural settlements and the objective of this task is to determine, update, and refine the existing and possible future size and distribution of the population and the economy. All existing documents and reports will be utilized wherever possible, and the latest available data at detailed settlements level will be obtained.

Information to be obtained to compile the demographic profile includes population, number of households, household size, income levels, etc. Of importance will be to obtain the latest population figures from all available sources in order to evaluate and reconcile the growth to determine the most accurate existing population figures. Information will also be obtained on historical trends in the area relating to birth and death rate, migration, urbanization, illegal migration, HIV and AIDS infection rates, Covid-19 deaths, etc.

All background information such as municipal documents (IDPs, SDFs, LEDs, Housing Sector plans, etc.) will be reviewed to determine current priorities of the municipalities with regard to social and economic developmental issues. Economic and demographic modelling will be undertaken (lowest geographical level) in order to facilitate later grouping of settlements. Key incumbents from various public service organizations will be consulted to augment information on current social and economic trends relevant to the study. Economic growth modelling will consider the potential of each of the areas, the spatial development framework and economic sector growth estimates to determine possible future economic growth by sector and possible spatial representation.

Task 2.2.2: Yield Analyses with the Water Resource Yield Model

Task 2.2.2.1: Configuration and Testing of the Network

The WRYM for the entire Crocodile Catchment, has been updated recently (as part of the Mbombela Reconciliation Strategy Implementation (DWS, 2021)) to a high level of resolution using the latest available land use. At the time of carrying out the Mbombela Reconciliation Strategy Implementation, a parallel study took place whereby the IUCMA updated and extended the hydrology till 2017 (hydro year). This hydrology has not yet been incorporated into the WRYM, however, this will take place as part of the recently initiated East Reconciliation Strategy Study (being undertaken by members of this proposed Study Team). Extensive testing of the model will be undertaken to ensure that the model is configured correctly and that the model appropriately represents the system.

Task 2.2.2.2: Compilation of Storage yield Curves

Storage–yield curves will be compiled for the dam and transformed into yield-cost curves. The yield analyses will take cognizance of all current water requirements that influence the yield of the CEWP. The yields utilized for compiling storage–yield curves will be limited to Historic Firm Yields (HFY's).

Task 2.2.2.3: Compilation of a User Priority Classification Table for Water Users

A priority classification table exists for the Crocodile East Catchment. This will be confirmed for all water users of water resources through a process of stakeholder involvement. The table shall reflect all the types of users encountered and will be categorized into different user sectors.

Task 2.2.2.4: Determine Historical Firm Yields

A HFY analyses for the selected dam shall be carried out. The yields shall be determined for the final live storage selected for the dam. The HFY's shall be calculated for the in-basin demands of the Crocodile East Catchment at 2020, 2030 and 2040 development levels. The HFY's shall be determined for two different cases, namely, Case 1: Full compliance with the Reserve and Case 2: No releases for the Ecological Reserve.

Task 2.2.2.5: Determine Long-term Stochastic Yields of the CEWP

Long-term stochastic yield (LSY) analyses will be undertaken for the final proposed scheme. The LSY's will be determined for the final live storages selected for the dam/s. The LSY's will

be calculated for the Medium Growth in-basin demands of the Crocodile Catchment at 2020, 2030 and 2040 development levels. The LSY's will be recorded for the 75.0, 90.0, 95.0, 98.0, 99.0 and 99.5 % assurances of supply.

Task 2.2.3: Future Water Balance for the Project

The LSY results and the determined water demands will be used to project annual water balances from 2020 to 2030 in order to get a preliminary indication of when augmentation of the CEWP will be required.

Task 2.2.4: Development of Short-term Stochastic Yield Reliability Curves

Short-term yield analyses will be conducted for the first phase of the CEWP and short-term yield reliability curves will be developed for each decision month as required by system users. These curves will be used for conducting analyses with the Water Resources Planning Model (WRPM).

Task 2.2.5: Water Resources Planning Model

The WRPM has been configured as part of the Mbombela Reconciliation Strategy Study, and this will be updated to incorporate the relevant aspects required for assessment in this Study, with the purpose of:

- Deriving final system operating rules.
- Deriving drought curtailment rules.
- Determining the timing of the next augmentation scheme.

Task 2.2.5.1: Configuration and Testing of the WRPM

The final WRPM schematic diagram representing the network with penalty structures will be compiled and included as part of the deliverable of this module. In configuring the model, the user priority classification tables applicable for each part of the Crocodile System will be used. Practical decision dates for the WRPM analyses will be proposed.

Before proceeding with any analyses, the WRPM configuration will be thoroughly tested to ensure that all aspects are functioning correctly and that the intended system operation is indeed simulating the model correctly.

An electronic copy of the final WRPM for the Crocodile East System, supported by the associated report, will be submitted to the DWS in the format required by the DWS. Electronic copies of the scenario run with the WRPM will also be made available to the DWS.

Task 2.2.5.2: Recording the Final Operating Rules Recommended for the CEWP

A write-up of the final operating rules recommended for the various phases of the CEWP will be carried out.

Task 2.2.6: Assessment of the Potential for Hydropower Generation at the Dams (Water Resources)

The potential of the CEWP to develop hydropower at the dam/s will be assessed. The power developed can then be either utilized to power project pumping stations or can be made available to the national grid.

Daily flow releases will be prepared for three future demand scenarios (Provisionally the years 2020, 230 and 2040). Assessment of the potential for hydropower generation and the characteristics of a typical hydropower plant (see Task 2.5.14) to suit the daily flow releases will be based on the daily flow releases. Typical energy and power duration curves for each month of the year and all months combined will be provided in the form of graphs and tables.

Based on the above, the economic viability of the CEWP's potential for the generation of hydropower will be assessed (see Task 2.5.15).

8.3 Task 2.3: Ecological Consequences in terms of the National Water Resource Class, the Target Ecological Category and the Reserve

A Classification and Resource Quality Objectives (RQOs) study which included the revision and update of the Ecological Water Requirements (EWR) determined during an Inkomati Reserve study undertaken 2007 to 2010, has been undertaken during 2013 to 2015. The EWRs (Ecological Reserve) was therefore gazetted under the National Water Act (Act 36 of 1998) as part of the National Water Resources Classification (Target Ecological Category and Reserve % of natural MAR) and as a component of the Resource Quality Objectives (Discharge (EWRs), quality and habitat requirements) to achieve the Target Ecological Category.

Task 2.3.1: Reporting

The Feasibility phase will focus on one selected dam site. From the Ecological Reserve, Classification and RQO perspective, the focus will be on evaluating a maximum of six operating scenarios to ensure the optimisation of the yield while still meeting the RQOs.

The same EcoStatus models will be used to assess the impacts of each operating scenario in a similar approach than for the Pre-feasibility study. Input can also be provided in terms of the flood releases. However, it must be noted that floods operating rules and the assessment of the size of floods that must be released to achieve a certain peak and velocity at the EWR as well as the attenuation affect will not be undertaken by the Reserve specialists. Input and recommendations only can be provided.

The input for this task required from the team will be the design of the six operating scenarios. This will be an interactive process between the yield modeller and the Reserve specialist. Timing of the Reserve work is therefore dependant on when the operating scenarios will be available.

Task 2.3.2: Preparation of Scenarios and Hydro-liaison

The first phase of this task will be to prepare the EWRs (gazetted flow RQOs) to cater for the fact that the natural hydrology has probably changed from when the EWR results have been produced. EWRs cannot be used within the yield/planning model if not based on the same hydrological model. Once this work has been undertaken, the design of the operating scenarios will be undertaken. This will be an interactive process.

Task 2.3.3: Consequences of Operating Scenarios, Ranking and Reporting

a) Once the operating scenarios are available, it will be supplied to the Reserve modeller who will populate the operating assessment model for use by the Reserve specialists.
b) A virtual evaluation will be undertaken by the relevant specialists using the EcoStatus models to predict the resulting Ecological Category for each scenario. These impacts will be ranked using existing models.
c) Task 2.3.3 will take place virtually. The results and outcomes will be documented in a report which will be summarised as a chapter for the Feasibility report.

Task 2.3.4: Flood Recommendations

Time will be set aside for input and liaison of the Flood Reserve Specialists with the relevant engineers on the team.

Deliverable:	Ecological Consequences of Operational Scenarios Report Chapter in Water Resources Report Chapter in the Feasibility Study Report

8.4 Task 2.4: Socio-Economic Impacts

A desktop assessment of the social environment at the proposed dam site will be undertaken, which will include identifying and mapping affected communities, existing structures (e.g., dwellings) and land uses that may be influenced. This will feed into a high-level socio-economic risk assessment, which will include a fatal flaw analysis.

All previous studies and information in the public domain will be obtained and relevant information reviewed. This will form part of the desktop assessment of the social environment at the selected dam site. This level of the evaluation process will essentially represent a "desktop" study, and information will largely be accessed from the following sources:

- Existing studies;
- Municipal documents and strategies;
- Satellite imagery;
- Eskom spot building counts; and
- Discussions with knowledgeable persons.

Based on the above information, a preliminary evaluation will be made with regard to the magnitude of the socio-economic impacts. If for any reason or a combination thereof the socio-economic impacts appear to be unacceptably high, the option will be labelled as fatally flawed. The output of the socio-economic task will be a high level social and economic risk assessment with a fatal flaw analysis of the selected dam site.

Deliverable:	Socio-Economic Impacts Report Chapter in the Feasibility Study Report

8.5 Task 2.5: Engineering Investigation

The Engineering Investigation Task is divided into several sub-tasks, and further individual activities within those, as outlined in the following sub-sections of the report.

An engineering investigation of the recommended site option (see Task 1.8) in the Pre-Feasibility Study will be carried out.

Deliverable:	Engineering Investigation Report for Feasibility Study (Refer to the following Tasks 2.5.1 to 2.5.15 below)

Task 2.5.1: Topographical Survey and Mapping

Provision has been made for a physical detail survey of the recommended dam site and its surrounds for the purposes of the feasibility phase of the study. As the lidar survey of 2019 is current available for free, no provision has been made to acquire it from the City of Mbombela. It is also important to note that the available lidar survey also contains aerial photographs that will be accessed and used for example in the tasks for geological and geotechnical investigations.

An additional detail topographical site survey will be carried out for the recommended site option. The surveys will be carried out to an elevation of say 15 m higher than the dam full supply level to allow for surcharge and for backwater for the Safety Evaluation Flood. Lidar surveys with georeferenced aerial photography will be carried out. Surveys will extend too at least 500 m downstream of the dam site for accurate backwater analyses.

Survey outputs will comprise of:

- Topographic Survey of dam wall area and downstream area and staking of dam wall centreline.
- Data Processing, Calculation, Report.

Deliverables:	Lidar Survey Data and Physical Survey Data Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.2: Geological and Geotechnical Investigations

A provisional sum amount that is not part of this Contract will be used for the geological and geotechnical investigations. The intention is that the funding for payment of this work will be provided by DWS by separate arrangement, as discussed in Section 13.9.

A detailed feasibility level geotechnical investigation of the site for the selected dam and conveyance infrastructure will inter alia consists of the following:

- Geophysical surveys will be conducted along the proposed dam centreline and at potential rock quarry sites to determine depth of weathering, presence of geological structures (dykes, faults, and contacts). A combination of electrical resistivity and seismic refraction surveys will be employed as a cost-efficient method to assist with the interpolation between boreholes and other data points.

- For the stability assessment of the dam basin slopes, critical basin slopes will be identified. The investigations will be concluded with stability analyses where required with suitable and appropriate recommendations on potential methods for slope stabilization. The water tightness of the basin will also be assessed for possible zones of leakage.

- Rotary cored drilling of boreholes, including SPT and water pressure tests to determine depth to, condition of and permeability of bedrock and overlying in situ materials at the dam site. This will be performed at the identified dam centreline and if anomalies are encountered, the drilling will be expanded in the upstream/downstream direction to identify the best location of the dam centreline according to the prevailing geological and geotechnical conditions, which may be influenced by faults/shear zones that may only be identified during the drilling operations and with the geophysical surveys. Borehole core samples of the in situ rock will be taken for laboratory tests to determine rock strength, deformation parameters and petrographic properties of the rock.

- Rotary cored drilling will be conducted at an identified hard rock quarry site to determine the weathering profile, type and quality of the rock and to provide representative cores samples for laboratory testing. Laboratory testing will include crushing strength tests, water absorption and other parameters as outlined in SANS1083. Petrographic analyses will be conducted specifically to identify the presence of deleterious minerals which may affect durability. The possible presence of strained quartz in granitic rocks will also be investigated for alkaline aggregate reactivity.

- The foundation investigations will typically involve geophysical surveys, rotary core drilling (if where needed after accessing the possible available drilling results), with water pressure (Lugeon) tests, pit and trench excavations, in situ permeability tests, petrographic analyses of rock core samples, compressive strength and deformation properties of rock cores, fault description and quantification, weathering resistance of rock, etc. (i.e. all the typical parameters required for the feasibility level design of a dam at the particular site). The results will be used to predict as accurately as possible excavation depths for the different dam types considered.

- Excavation of test pits with a TLB (where possible) at:

  - the dam site to identify foundation soils and collection of soil samples for testing to determine, soil types, permeability, shear strength, compressibility, compactability, as may be required.

- conveyance route to determine type of foundation soils, excavatability and taking of soil samples for tests to determine foundation conditions, usability of excavated soils for construction, etc.

- access roads to determine requirements for pavement layers, including the taking of soil samples for laboratory testing to determine grading and compaction characteristics (CBR).

These geotechnical investigations should be performed by suitably qualified and experienced service providers who will be sourced by following the official procurement processes. The requirements and standards for these investigations will be controlled by the appointed PSP and who will also closely supervise the investigations to ensure that all the required information will be obtained as required by the dam and infrastructure design teams. The data from the investigations will be collated, interpretated and contained in a complete geotechnical investigation report with suitable recommendations relevant to the designs.

The details of the materials investigation will be guided by the type of dam that will be considered. For an earthfill embankment dam, the materials investigation will focus on the identification of suitable semi-pervious (outer shell zones), impervious (clay core) and sand (filters and drains) material sources. All material sources will as far as it is possible and/or practical, be sourced from within the dam basin area. The engineering geologist will use existing geological data on the area, combined with air photo interpretation and on-site geological mapping to identify possible material sources for investigation. This will be followed by test pitting, with in situ soil profiling, taking of disturbed and undisturbed soil samples and appropriate laboratory testing to determine the relevant soil characteristics and parameters such as grading, Atterberg Limits, coefficient of permeability, shear strength, dispersivity and compaction characteristics (Standard Proctor maximum dry density, optimum moisture content). Rip-rap materials will be investigated as for hard rock sources.

For a concrete/rockfill dam the materials investigation will focus on the identification of hard rock sources (quarries). As above, the engineering geologist will identify possible hard rock quarry sources for investigation. This will be followed by rotary cored drilling, with core photography to determine RQD, the depth of weathering and quality of the in-situ rock and to obtain rock core samples for laboratory testing to determine Unconfined Compression Strength (UCS), elastic modulus, 10% FACT, ACV, flakiness index, etc. SANS 1083:2006 specifications will be used to determine suitability of materials for aggregate use. For rockfill, it may be required to perform trial blasts to investigate the blasting characteristics of the in-situ rock.

Sources of natural sand for fine concrete aggregate and filters are usually scarce, but will be investigated, otherwise such materials will have to be manufactured by the crushing of hard rock.

The goal of the materials investigation will be to prove the availability of at least 2 times the volume of material required to ensure sufficient reserves.

A submeter accuracy GIS system will be used to establish a material sources map to indicate the aerial extent of the material sources and haulage distances to the dam site.

No provision has been made for geotechnical work for conveyance systems, however, should the need arise for additional geotechnical work for possible conveyance systems, then the scope of this additional investigation will be determined during this study.

It is highly recommended that reputable, competent and specialist service providers be identified to conduct the physical investigations and laboratory work. A report will be prepared detailing the findings and outcomes of the geotechnical and materials investigations and providing recommendations.

A Request for Quotations (RFQ) for geotechnical and materials investigations will be prepared.

Deliverables:	Geotechnical and Materials Investigations Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.3: Geomorphological and Seismic Investigation

A seismic study will be undertaken at the selected dam site. All active faults within a 10 km radius of the dam sites and on the route of the conveyance system will be identified. Cognizance will be undertaken of the results during the feasibility design component of the study. The work will be undertaken by an experienced geomorphologist with proven experience in this type of investigation.

Deliverables:	Geomorphological and Seismic Investigations Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.4: Flood Studies

Inflow flood hydrographs will be developed and will be used for the preliminary spillway sizing and for the routing of floods through the dam.

Not only is the flood hydrology important from a dam safety point of view it is also extremely important for consideration during construction, especially the design of the river diversion and is one of the main inputs during the design of a dam. The available flood hydrology information (especially the flood hydrology analysis performed by the Department of Water and Sanitation) for dams in the catchment will be reviewed as these have proven in the past to provide useful insight.

The representative flood peaks and flood hydrographs will be determined using statistical analysis of the available flood information for the relevant rivers. To do the statistical analysis the relevant flow gauging records will be sourced from DWS and evaluated. Deterministic methods would be determined as a comparison. The SANCOLD guidelines for floods will be used as a baseline to determine the extreme flood events for design purposes. For construction purposes recommended monthly flood peaks for different probabilities of exceedance will be determined.

Deliverables:	Flood Study Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.5: Feasibility Design of the Selected Scheme

The object of this task is to optimise the selected scheme design to an appropriate detailed level to expedite the tender design phase during the implementation phase.

A phased approach will be followed for the feasibility design. High level concept designs for alternative dam wall types will be undertaken in close consultation with the Environmental and Geotechnical Teams after completion of the aforementioned tasks; with special focus on the geotechnical investigations, such as the availability and quality of construction materials, and nature of the foundations; for the required size of dam. The best three concept designs will be compared and the most cost-efficient concept design will then be selected for the feasibility design and optimised accordingly.

The Feasibility Design Report for the various components of the scheme will include where appropriate but not necessary be limited to the following:

- Sedimentation study for various possible dam sizes, using the most up-to-date information from river and dam measurements. In addition, a numerical model will be developed to establish the expected silt deposition pattern and to prove the effectiveness of any systems that might be required for silt evacuation.

- Dam wall, e.g., embankment/ conventional concrete/ RCC type dam wall design will be undertaken in compliance with dam safety requirements, considering all geological, geotechnical and materials information from Task 2.5.2. This will include applicable stability analyses. Foundation design for the selected type of dam wall and height, e.g., foundation grouting. In addition, where applicable for a RCC type dam wall, a preliminary thermal study will be completed to establish the RCC construction cooling requirements as appropriate for the RCC mix design, while a full construction site layout will be developed to facilitate the development of a realistic construction programme.

- Spillway design. The optimal spillway arrangement will be designed considering all engineering aspects, including flood hydrology information from Task 2.5.4, effective energy dissipation, erosion protection measures and impact of the design on the construction programme.

- Outlet works, including possible hydropower plant. Important considerations for the design of the outlet works are the operational requirements and the ecological water requirements. The layout of the outlet works will be designed also considering the construction programme where applicable for example for RCC type dams. With discharge information from the water resources study, the technical feasibility of including a hydropower facility will be evaluated and the most appropriate installed capacity and related works arrangement will be proposed (see Task 2.2.6).

- Intake works design also considering the sedimentation study.

- River diversion also to maintain optimal construction efficiency. Considering the characteristics of the site and the river and the anticipated construction programming requirements.

- Operation and maintenance design aspects.

- Monitoring and surveillance equipment during and after construction, e.g. seepage and the behaviour of the dam wall.
- Electricity requirements.
- Access roads.
- Realignment of services where impacted by the scheme.

The feasibility design will be prepared and presented in drawings to an adequate level to estimate the associated quantities, etc, for the cost estimation at this level of study.

The feasibility design will be prepared and presented in drawings to an adequate level to estimate the associated quantities, etc, for the cost estimation at this level of study.

Deliverables will include the following:

- Progress reports.
- Scope and specifications for survey requirements.
- Scope and specifications for geological, geotechnical and materials investigation requirements.
- Feasibility design drawings for dam and specifications.
- Design criteria memorandum for the Feasibility Study.

Deliverables:	Feasibility Design Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.6: Construction Programming and Costing

Different dam types require the development of a workable construction approach and methodologies. For example, significant outlet works and/or other features can sometimes lie on the critical path, compromising the speed benefits possible for certain types of dam, e.g. RCC construction. With the design for the recommended dam site optimized around ensuring the maximum possible construction efficiency, the construction programming will simply be an extension of the design and planning process.

For the feasibility design, the programme for the major construction activities will be based on an appropriate schedule of resources and this information will be used to develop an accurate cost estimate for project implementation from first principles. Fixed and time-based preliminary and general costs will be estimated on the basis of the establishment and resources anticipated for the construction and the associated figures will be compared with actual information from similar recent projects to ensure that the final estimated cost for project implementation is as accurate as possible. Site power requirements will be established on the basis of the capacities of the various fixed plant and site infrastructure. Other relevant infrastructure will be included in the programming and cost estimates, e.g., access road.

Also refer to Task 2.5.14: Costing (CAPEX and OPEX) of the Project.

Deliverables:	Construction Programming and Costing Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.7: Access and Advanced Infrastructure

Road access and housing infrastructure in support of the dam will be identified and designed to a feasibility level of detail. A needs analyses will be carried out and the designs will be in compliance with DWS Standards. If feasible a multi-purpose use will be considered.

This task comprises the following main activities for both the access road and housing infrastructure:

- Inception Stage
- DWS Requirements and Standards
- Information Collection
- Basic Planning Studies (township layouts and route planning)
- Surveys (done under Task 2.5.1)
- Material Testing (done under Task 2.5.2)
- Preliminary Geometric Designs
- Pavement Designs
- Township Services (water, sanitation and electricity)
- Drainage and Stormwater Design
- Design for Bulk Services (electricity and water supply mainly)

The task will be closely related to other tasks, in particular the dam design (as this will determine the housing requirements and transport requirements in particular during construction).

Regarding the housing infrastructure the following aspects will be consider during this task: location of the housing for construction i.e. one site, at the nearest town or a combination, option to convert the construction housing into other uses i.e. recreational facilities, community based facilities and/or other commercial uses. The route planning for the access road will require a certain level of detailed geometric design to accurately determine the amount of earthwork required (being an important cost item) and particular attention will be given to route selection considering the following aspects: design speed, design life and flood related aspects. Optimum use will be made of on-site materials to limit the importation of construction materials. This task will also identify innovative and sustainable technological options mainly related to housing, sanitation and energy / lighting options. The level of design detail and accuracy of the cost estimates will be in terms of the guideline for bankable feasibility studies. The housing infrastructure will be designed on a conceptual level, but a higher degree of design will be required for the high cost items such as bulk electricity and access roads will be done at feasibility level.

Deliverables:	Access and Advanced Infrastructure Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.8: Flood and Backwater Calculations for the Dam

The determination of backwater elevations will be required for the study. The backwater determinations will be carried out for the recommended dam. The purpose of the backwater determinations is to essentially establish the purchase line of the dam.

The backwater calculations will be carried out for the following conditions:

- High flood conditions (1:100 year return period flood event).
- The impact of a 50 year sediment deposition will be considered.
- The dam will be full when the high flood event occurs.

The backwater calculations will be carried out with the HEC-RAS modelling software. The software has the ability to perform two- dimensional (2D) hydrodynamic routing within the unsteady flow analysis component of HEC-RAS. The software is intended for calculating water surface profiles for steady gradually varied flow. The effects of various obstructions

(Bridges, culverts, weirs, and structures in the floodplain) can be considered in the computations. A digital terrain model (Grid xyz) will form the basic terrain model input for the backwater calculations.

Deliverables:	Flood and Backwater Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.9: Climatological Data for the Construction Site

It is anticipated that the project will be implemented shortly after the completion of the Feasibility Study. Arrangements will be made and put into place to gather detailed climatological information for the construction site of the dam.

Deliverables:	Climatological Data Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.10: Water Quality and Limnology

Water quality and limnology assessments will be undertaken according to best practices. The technical outputs of the assessments will be incorporated into the feasibility designs for the scheme.

The water quality and limnology task will comprise of the following components:

- An assessment (description) of the dam characteristics.
- A catchment assessment including land cover, land condition and extent of pollution.
- Identify and investigate possible future land use that can impact on water quality.
- A water quality assessment that will incorporate an assessment of the existing (current) water quality status and water quality monitoring.
- Assessment or prediction of the future water quality of the dam with respect to the following water quality parameters:
  - Nutrients and algae.
  - Turbidity, conductivity, dissolved salts and TDS.
  - Heavy metals and TOC (Total organic Carbon).
  - Microbiology (E coli).

- Water quality improvements and/or degradation.
- Thermal stratification.
- Impacts downstream of the dam on the aquatic environment.
- Possible recommendations for dam infrastructure and operations to overcome deteriorating water quality.
- Recommendations for water quality monitoring during the pre-construction phase and also during the construction and operational phases of the project.

The prediction of stratification patterns and hydrodynamics in the proposed dam will be based on empirical models unless additional detailed water quality modelling is requested or required.

On completion of the work, a full report covering the execution of the water quality and limnology task will be prepared. Conclusions and recommendations will be included in the report.

Deliverables:	Water Quality and Limnology Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.11: Sediment Yield and Sedimentation Investigation

A sediment yield assessment (50 year deposition) will be carried out for the proposed dam/s. The sediment deposition in all dams will be modelled since the deposited sediment will influence the backwater elevations, especially in the upper reaches of the dam basin.

A comprehensive sedimentation study will be undertaken for the various possible dam sizes, using the most up-to-date information from river and dam measurements. In addition, a numerical model will be developed to establish the expected silt deposition pattern and to prove the effectiveness of any systems that might be required for silt evacuation. The outlet works would also consider the results of sedimentation study.

Deliverables:	Sediment Yield and Sedimentation Investigation Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.12: Land Requirements and Associated Costs

The purchase/expropriation line around all the infrastructure of the scheme will be determined to establish the extent of servitudes required. Standard DWS' requirements will be adhered to in this regard. The names and contact details of all affected landowners will be established and the relevant cadastral details relating to the infrastructure, impoundment area and pipeline routes will be determined. Accurate costs for land purchase and servitude registration will be prepared and incorporated into the cost model.

Deliverables:	Land Requirements and Associated Costs Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.13: Assessment of the Potential for Hydropower Generation at the Dams (Engineering Investigation)

The potential of the CEWP to develop hydropower at the selected dam site will be assessed. The power developed can then be either utilized to power project pumping stations or can be made available to the national grid.

This will entail the following actions:

Hydropower Flows:

- Operation of the hydropower stations will predominantly be dictated by the dam water releases for the environmental and down-stream users, assessed by the water resource analysis, reserve determination, and demographic and economic tasks. These will also include international water treaties with Eswatini and Mozambique, and scenario planning to manage climate change and related potential variations in the hydrology.
- The appropriate development and hydrological scenarios will be set in consultation of the Client and the relevant study task teams.
- The water resource analysis and WRYM modelling will provide monthly flows of dam releases and dam spillages based on the projected demographic and economic growth in the study area for set planning horizons (2020, 2030 and 2040 or as agreed with the client). This will include the dam water level to inform the hydropower calculation across time and seasons.

- Daily water releases will be derived from the water resources analysis taking cognizance of environmental, legal (water treaty) and user requirements and their specific user hydrographs.

- This will be broken-down further into hourly release hydrographs best suited for power generation (peak electricity demand periods), dam outlet capacity and environment specific reserve needs.

Power Generation Potential:

- The Study Team will conduct conceptual designs of hydropower stations at selected dam sites, considering the best suited fit to dam outlets, topographic and geological considerations, flood protection, sedimentation and water quality, security, and connectivity to the Eskom and municipal electricity grids.

- The conceptual designs will include the necessary control valves and switchgear to operate the hydropower in accordance with the set dam release and dam spillage hydrographs, and to protect the electro-mechanical equipment in the hydropower stations.

- Modelling of hydropower generation at the varying hydrographs (in-day, daily and monthly) over the projected planning periods.

- Calculation of daily, monthly and annual electricity generation and revenue potential considering typical tariffs and wheeling costs of Eskom and the municipality.

Costing and Benefit Analysis of Hydropower:

- The study team will compile capital, operating and financing costs for the construction, operation, and maintenance of the hydropower plants at a conceptual design and feasibility study level, taking cognizance of typical construction, equipment and operating costs in the context of the location of the hydropower sites and related feed-in to the grid(s).

- First-order financial modelling and economic viability of the hydropower plants in consultation with the financial and economic modelling of the dams and related infrastructure.

- Determination of the financial viability and economic contribution to be expected from the hydropower sites. This will be done at feasibility study level of detail.

Presentation and Reporting:

- The task team will provide write-ups on the hydropower components in the feasibility study report and participate in the presentation of study findings to the Client and other stakeholders.
- The task team will also participate in the consultation meetings and workshops during the study term.

Key deliverables include:

- Power generation flow-duration curves
- Potential hourly flow and generating hydrographs
- Monthly and annual hydropower generation projections
- Financial viability assessment of hydropower sites
- Economic cost-benefit of hydropower sites

Deliverables:	Hydropower Assessment Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.14: Costing (CAPEX and OPEX) of the Project

An accurate cost model and Bill of Quantities for all components of the project infrastructure will be prepared. Typical bill items as given in the DWS Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options. (VAPS) (DWAF, 1996) will be used in the cost model and Bill of Quantities.

Cost items that will make up 80 % of the proposed construction cost will be developed from first principles considering the costs of labour, plant, material, energy and transport. The remaining items having a minor impact on the overall costs of the project will be based on cost for similar items for similar work in Southern Africa.

Deliverables:	Cost Estimate (CAPEX and OPEX) Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

Task 2.5.15: Engineering Economic Analysis

As one of the tasks of the Pre-feasibility Study, an engineering economic analysis of options will be required to select a dam or scheme which will then be further studied in the Feasibility Study. In the Feasibility Study, in determining the storage requirement for the dam, engineering economic analyses will be carried out to establish the most advantages dam size in terms of unit reference values (URV's). In the Feasibility Study, in optimizing the scheme configuration, engineering economic analyses will be carried out to establish the optimum scheme configuration.

Annual O & M costs will be calculated as a percentage of the capital cost of an infrastructure component. Different percentages will be used for the different components of the works (Dam, intake works, outlet works, civil works, mechanical and electrical works, pipelines, building work, etc). The recommendations made in the Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options (VAPS) (DWAF, 1996), with respect to the percentages of capital costs to be used as O & M costs, will be followed.

Annual energy costs will be based on a suitable Eskom tariff structure.

The economic life span of infrastructure components to be used in the engineering economic assessments will also be based on the recommendations given in the *Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options (VAPS) (DWAF, 1996).*

Deliverables:	Engineering Economic Analysis Report Chapter in Engineering Investigation Report Chapter in the Feasibility Study Report

8.6 Task 2.6: Implementation Actions

The task comprises the determination of the date that the project needs to be commissioned from a water resources perspective and subsequently preparing an implementation programme that will ensure that the project is indeed commissioned by the determined date.

The implementation programme will consider the following components:

- Tender design.
- Detail design.
- Tender documentation and procurement.
- Adjudication and award of the contract, and

- Estimated construction duration.
- Commissioning of dam and associated infrastructure.

Deliverables:	Project Implementation Programme Chapter in the Feasibility Study Report

8.7 Task 2.7: Record of Implementation Decisions

A Record of Implementation Decisions document will be prepared for the DWS, as stipulated in the ToR.

Deliverable:	Record of Implementation Decisions

8.8 Task 2.8: Institutional, Financial and Operational Aspects

Institutional, financial and operational aspects will be covered by the following tasks:

- Determine the project revenue from sales of water based on the DWS pricing strategy.
- Recommendations for the institutional arrangement for each funding option.
- Determination of the relationship between the various project participants who will have an ongoing role during the project lifecycle.
- Determine legal, administrative and financial arrangements and responsibilities, and
- Develop procedures for transfer of assets and resources to ensure sustainable technical operation and maintenance of the system.

Deliverables:	Institutional, Financial and Operational Aspects Report Chapter in the Feasibility Study Report

8.9 Task 2.9: Feasibility Study Report

A Project Summary Report (PSR) will be prepared. The report will not only cover technical aspects, but also environmental and other aspects dealt with outside of the Feasibility Study. Information on some of these aspects may only become available after the Feasibility Study, and therefore the PSR will only be preliminary report which may, or may not, have to be updated at a later stage. The PSR shall contain some concept drawings to illustrate the project area and some of the most important infrastructure.

Deliverable:	Feasibility Study Report

9 PUBLIC RELATIONS

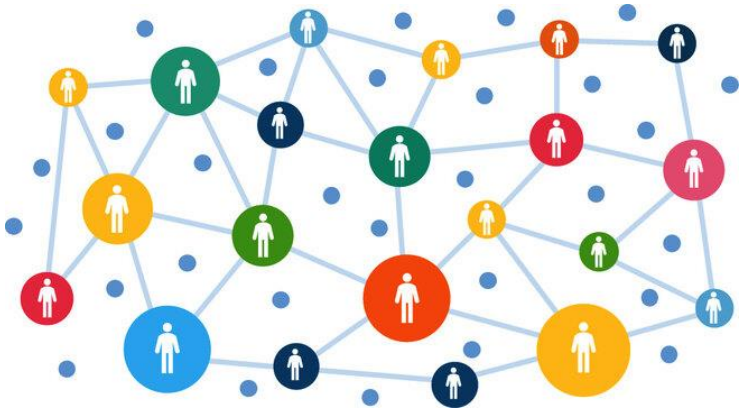
9.1 Public Relations

A full stakeholder engagement and public relations process, where relevant representative stakeholders in the study will provide inputs into the Study, will be carried out to support the Study.

The role of the Public Relations' Task Leader will be a continuation of the role and functions implemented for the *Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area*, including the *Crocodile Sabie River System Reconciliation Strategy* which ended during the first half of 2021.

The following scope of services is foreseen for the Public Relations task for the Study.

- Communication and Liaison.
- Develop Stakeholder Database.
- Announce the Study.
- PSC Meetings.
- Publishing on the DWS website.



The above scope of services is detailed below.

9.2 Scope of Services

9.2.1 Communication and Liaison

A stakeholder engagement or "public relations" process, where relevant representative stakeholders in the Study have inputs into the options investigated as part of the CEWP, will be carried out to support the Study. Principles for stakeholder engagement (e.g., providing stakeholders sufficient information and time to comment, etc.) will be followed throughout the duration of the Study.

It is important to remember that this Study is not taking place in isolation of other DWS projects. Many stakeholders in the study area have been and are involved in DWS initiatives and those

stakeholders should also be involved in this study as they can bring local knowledge and their experience to the table.

The approach to communication and liaison will be to announce the Study to a broad target audience and to invite them to attend a meeting. The Strategy Steering Committee (StraSC), which was established for the Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area, including the Crocodile Sabie River System Reconciliation Strategy, will be confirmed for this Study to ensure that members represent all required sectors for the CEWP. In this Study the Strategy Steering Committee (StraSC) is replaced with the Project Steering Committee (PSC).

It is envisaged that the Project Steering Committee will meet three times during the Study (over the 30-month period), at venues which will be arranged for by the PSP, to provide their guidance and comments on key deliverables of Module 1. It is assumed that the same group of stakeholders (PSC) will also be part of Module 2 when the EIA process will be implemented.

The main focus for the PSC during Module 1 will be to review and comment on the following deliverables which will be produced during the implementation of the Study:

- Inception Report (for stakeholders to ensure that the CEWP, Module 1 scope will meet their needs and for stakeholders to comment on the proposed plan of Study and its deliverables).
- Scheme configuration and options to be further investigated as part of the Pre-feasibility Study.
- Pre-Feasibility Report.
- Feasibility Report.

It is assumed that the PSP responsible for Module 2 will have further meetings with the PSC to engage with them on the deliverables to be produced as part of that study.

9.2.2 Stakeholder Database

A stakeholder database for the project is currently being developed in the project Inception Phase. The stakeholder database will consist of representatives of sectors of society and an electronic contact list will be developed and updated as the project unfolds during the 30-month study period. The stakeholder database will initially be based on the previously developed database for the study area and will include relevant representatives of the following sectors of society:

- National, provincial and local government as well as relevant government institutions.
- Conservation, environment, eco-tourism and NGOs.
- Agriculture and sub-sectors such as forestry, sugar, etc.
- Mining.
- Media, and
- Water resource management institutions (Irrigation Boards, Catchment Forums, etc).

Deliverable: Draft stakeholder database to be included as part of the Inception Report (refer to **Appendix B**). The database will be kept updated throughout the duration of the CEWP.

9.2.3 Project Announcement

A Background Information Document (BID) will be compiled and sent to everyone listed on the stakeholder database. The BID will include a summary of the Inception Report, e.g.:

- Scope of the Study.
- Study deliverables and associated plan for implementation and relevant timelines.
- How stakeholders can become involved and comment on the findings of the Study.

It is proposed that the 1st PSC meeting be held about three weeks after the distribution of the BID to stakeholders as part of the overall announcement of the CEWP.

Deliverable: Preparation and distribution of BID.

9.2.4 PSC Meetings

It is foreseen that three PSC meetings be held over the 30-month contract period. The meetings will be held to discuss and receive comments from stakeholders on the three main deliverables of the study as mentioned above. It is proposed that the meetings are held at the DWS offices in Mbombela. The PSP will make the necessary arrangements (e.g., compile and distribute an invitation, agenda and minutes of the meeting within three weeks after the meeting). A preparation meeting or dry-run will be held before each meeting with DWS to ensure that presentations are aligned to the audience and that the team (DWS and the PSP) is ready to respond to questions which may arise.

Deliverable: Arrange and conduct PSC meetings.

9.2.5 Availability of Reports for Comment

The PSP will provide electronic copies of documents for publishing on the DWS website. It is assumed that the DWS will be responsible for the publishing process on their own website. Where possible, documents will be provided via email to stakeholders before comments are required.

Deliverable: Preparation of documents for publishing on official DWS website.

10 CAPACITY BUILDING AND TRAINING

Capacity building and training are important components of the Study and will be key in the success of the Study and the sustainability of its outcomes. Members of the proposed Study Team have been involved in capacity building and training of client organizations before and can provide expert training in hydrology, water resources, civil engineering infrastructure design, engineering economic analysis, dam and geotechnical engineering and related fields.

The capacity building and training tasks component of the Study will comprise the following:

- *Development of a training framework*. This will be undertaken in parallel to the study inception task as outlined in the ToR. The framework will include training objectives, identified training needs, training methodologies, the identification of trainees and a detailed training programme.

- *Formal training courses*. Subject to the agreed training framework, it is anticipated that a formal (classroom style) training course will be hosted before and during the study tasks. Where possible, existing training material and practical training exercises will be used., with updates and additional material developed as required. It is assumed that DWS facilities will be available for this purpose that caters for IT support (projector, etc. Attendees will be expected to provide their own IT equipment (Personal computer or laptop, etc) for completing practical exercises. After each the course the PSP will submit a copy of the training material or training manual, as well as a training report. As an alternative, internet based (Teams) training can be considered. Note that in terms of the ToR, the Financial Proposal allows for two one-day workshops.

- *Ad-hoc training*. Subject to the agreed training framework, it is anticipated that nominated individuals will be seconded to the PSP for hands-on experience on the execution of selected tasks. The ToR allows for three interns/officials to be seconded for a period of eight months each. The secondment schedule will be drafted as part of the training framework. Note that, while efforts will be made to accommodate the availability and schedules of trainees, the timing and duration of secondments will be determined largely by the overall study schedule.

- *Training report*. A training report will be developed based on the process of selecting trainees, attendance of formal courses, schedule and milestones of secondments,

feedback of trainees, conclusions on the success of the training process based on feedback from the designated senior Client representatives and recommendations.

The *deliverables* of the Capacity Building and Training task will be the following:

- Training framework.
- Formal training courses.
- Training material.
- Training report.

As instructed in the ToR, provision has been made in the Financial Bid for the following capacity building and training requirements:

- Three interns/officials to be seconded to the PSP for a period of eight months each.
- The presentation of two one-day workshops.

11 STUDY TEAM

11.1 Study Management Team

The ***Study Management Team*** (**Kobus Bester (DWS), Lilene Louw (PSP) and Evert Serfontein (PSP)**) will be responsible for liaison with the Client, the general supervision of the Study and providing direction on all tasks. Their collective previous experience in reconciliation strategies and feasibility studies will ensure that they provide the necessary direction to the Study Team in undertaking the Study and enable efficient liaison with representatives of the Client. They will also be involved in some of the Technical Tasks.

11.2 Key Staff / Task Leaders

The proposed Key Staff/Task Leaders for the Study are included in **Table 11-1** below.

The Task Leaders will manage the various tasks and will be responsible for directing and coordinating the personnel working on each task, as well as ensuring technical precision and applicability. They will ensure that each task is completed within budget and on time, and to acceptable standards. Their responsibility is also to provide timeous and adequate warning of any problems encountered that could either delay the study or result in budget overruns.

Table 11-1: Proposed Key Staff / Task Leaders

Name	Qualifications	Project Position	Tasks
Lilene Louw	BSc Hons (Geohydrology) B Eng (Civil) N Dip Higher (Civil) NQF 5 & 7	Study Leader	• Client Liaison • Study Team Co-ordination • Project Management (budget, invoicing, programming, risk management, quality control, etc.) • Civil Engineering Infrastructure (pump stations, pipelines, conveyance systems), flood hydrology, dam hydraulics, etc.) • Cost estimates • Engineering Economic Analysis • Multi-Criteria Analysis
Evert Serfontein	BSc B Eng (Civil)	Deputy Study Leader	• Client Liaison • Study Team Co-ordination

Name	Qualifications	Project Position	Tasks
			• Project Management (budget, invoicing, programming, risk management, quality control, etc.) • Civil Engineering Infrastructure (pump stations, pipelines, conveyance systems), flood hydrology, dam hydraulics, etc.) • Cost estimates • Engineering Economic Analysis • Multi-Criteria Analysis
Caryn Seago	BSc Eng (Agric) MSc Eng (Agric)	Task Leader	Water Resources
Henriette Anderson	B Eng (Civil) M Eng (Civil) MBA	Task Leader	Dam Engineering
Louis Hattingh	B Eng (Civil) M Eng (Civil)	Task Leader	Dam Engineering
Tolmay Hopkins	BSc (Agric) Microbiology	Task Leader	Environmental Assessments
Delana Louw	BSc Hons (Nature Conservation)	Task Leader	Ecological Reserve
Gawie Steyn	BSc Hons (Applied Mathematics) MSc (Applied Mathematics) B Eng Hons (Civil)	Task Leader	Geotechnical Engineering
Dawid Mouton	BSc (Hons) Engineering Geology	Task Leader	Geological Investigation
Russell Aird	BSc Hons (Town and Regional Planning)	Task Leader	Demography and Socio-economics
Prof Andrzej Kijko	MSc (physics) PhD (Geophysics) DSc Geophysics	Task Leader	Geomorphologic and Seismic Analysis
Arno Otterman	BSc (Eng) (Agric) MSc (Eng) (Civil)	Task Leader	Hydropower assessments
Prof Gerrit Basson	B Eng Hons (Civil) M Eng PhD	Task Leader	• Sediment Yield, • Water Quality • Limnology, • Hydraulic Analysis
Anelle Lötter	N Dip (Journalism)	Task Leader	Public Relations

A Study Organogram for the project is included in **Figure 11-1**.

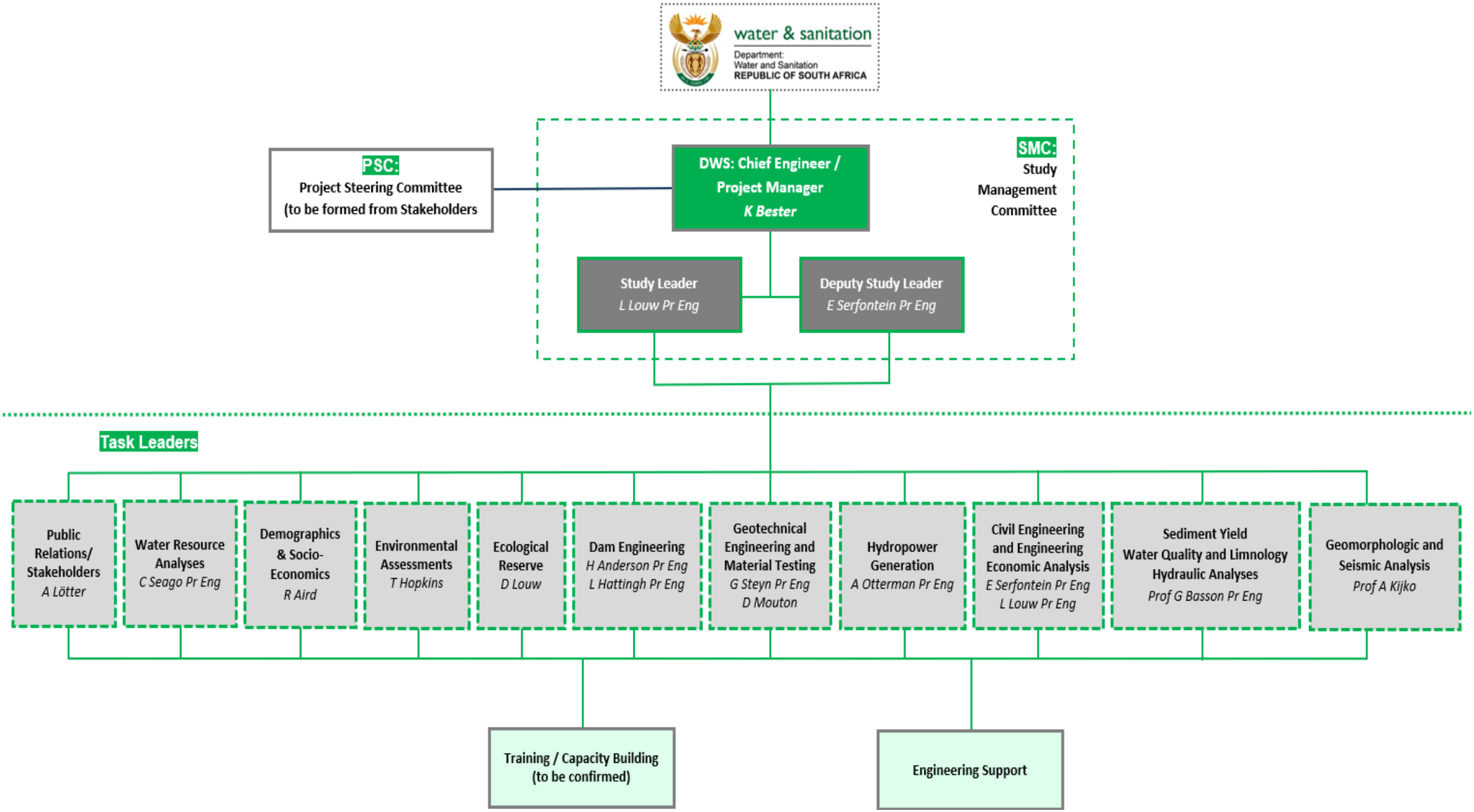


Figure 11-1: Study Organogram

12 STUDY PROGRAMME

12.1 Contractual Dates

The commencement date of the Study was when the Service Level Agreement was signed by the relevant parties, i.e. 6 September 2022. The Study Duration is 30 months (36 months maximum). A breakdown of the contractual dates is included in **Table 12-1** below.

Table 12-1: Contractual Dates for Technical Feasibility Study

	Start Date	End Date	Duration
Technical Feasibility Study	**6 September 2022**	**28 February 2025**	**30 Months (36 Months Max)**
Phase 1: Pre-Feasibility Study	6 September 2022	30 June 2023	10 Months
Phase 2: Feasibility Study	1 July 2023	28 February 2025	20 Months

12.2 Study Programme

A Study Programme for the execution of the Study is included in **Appendix C**. The work plan is based on the 30 month study period as given in the ToR.

13 STUDY BUDGET

13.1 Allocated Budget

The Professional Fees and Disbursement Costs for this Study are based on iX engineers' Financial Bid Document and as subsequently included in the signed Service Level Agreement (Contract between iX engineers and DWS for the Study).

The Professional Fees and Disbursement Cost estimates were calculated for a Study Period of 30 months and have been based on the estimated manhours to undertake the various tasks of the Study.

The Study will be **deliverable** based and therefore the costs to complete each deliverable have also been assessed and are presented in this Report. The amounts will be paid **proportionally** as **work progresses** satisfactorily.

A Deliverable Schedule is provided in **Table D-1** included in **Appendix D**

A summary of the approved Professional Fees and Disbursement Costs is provided in **Table 13-1** below.

Table 13-1: Summary of Study Budget

Cost Item	Cost (R)			% of Total
	(Excluding VAT)	15% VAT	(Including VAT)	
Professional Fees	R11,975,519.00	R1,796,327.85	R13,771,847.85	94.11%
Disbursement Costs	R750,000.00	R112,500.00	R862,500.00	5.89%
Total	**R12,725,519.00**	**R1,908,827.80**	**R14,634,346.85**	**100%**

A summarized cash flow projection is provided in **Table D-2** included in **Appendix D**.

Please Note:

The Professional Fees and Disbursement Costs indicated in this Report does not include amounts indicated as Provisional Sums in the ToR that will be allocated by the DWS for the following three tasks:

- Costs for a Sub-contractor to undertake the Ecological Reserve and Classification task, part of the Feasibility Study component of the Study.

- Costs for a Sub-contractor to undertake the Materials Investigation task, part of the Feasibility Study component of the Study.
- Costs for a Sub-contractor to undertake the Geotechnical Investigation task, part of the Feasibility Study component of the Study.

13.2 Budget Allocations per Task

A breakdown of the proposed Professional Fees and Disbursement Costs for the identified tasks of the Study is provided in **Table 13-2.**

Table 13-2: Summary of Budget Allocation per Task

Task No.	Task Name	Amount			% of Total
		Excluding VAT	15% VAT	Including VAT	
Project Management					
	Project Management	R1,792,450.00	R268,867.50	R2,061,317.50	14.1%
Phase 1: Pre-Feasibility Study					
1.1	Study Inception	R591,350.00	R88,702.50	R680,052.50	4.6%
1.2	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	R488,000.00	R73,200.00	R561,200.00	3.8%
1.3	Perform/Review Historic Yield Analysis	R98,800.00	R14,820.00	R113,620.00	0.8%
1.4	Environmental Screening and Fatal Flaws	R161,500.00	R24,225.00	R185,725.00	1.3%
1.5	Perform/Review Geotechnical and Material Investigations	R85,800.00	R12,870.00	R98,670.00	0.7%
1.6	*Engineering Investigation*				
1.6.1	Topographical Survey and Mapping	Disbursement			
1.6.2	Proposed Scheme Configuration (Engineering Investigation)	R465,800.00	R69,870.00	R535,670.00	3.7%
1.6.3	Engineering Economic Analysis	R80,800.00	R12,120.00	R92,920.00	0.6%
1.7	Multi-Criteria Analysis	R20,800.00	R3,120.00	R23,920.00	0.2%
1.8	Pre-Feasibility Study Report	R78,000.00	R11,700.00	R89,700.00	0.6%
Phase 2: Feasibility Study					
2.1	Environmental Screening	R148,200.00	R22,230.00	R170,430.00	1.2%
2.2	*Water Resources*				
2.2.1	Determine Existing and Future Water Demands	R132,500.00	R19,875.00	R152,375.00	1.0%
2.2.2	Yield Analysis with the Water Resource Yield Model	R182,000.00	R27,300.00	R209,300.00	1.4%
2.2.3	Future Water Balance for the Project	R143,000.00	R21,450.00	R164,450.00	1.1%
2.2.4	Development of Short-term Stochastic Yield Reliability Curves	R143,000.00	R21,450.00	R164,450.00	1.1%
2.2.5	Water Resources Planning Model	R143,000.00	R21,450.00	R164,450.00	1.1%

Task No.	Task Name	Amount			% of Total
		Excluding VAT	15% VAT	Including VAT	
2.2.6	Assessment of the Potential for Hydropower Generation at the Dam (Water Resources)	R175,600.00	R26,340.00	R201,940.00	1.4%
2.3	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	Provisional Sum (Variation Order)			
2.4	Socio-Economic Impacts	R132,500.00	R19,875.00	R152,375.00	1.0%
2.5	*Engineering Investigation*				
2.5.1	Topographical Surveys and Mapping	Disbursement			
2.5.2	Geological and Geotechnical Investigations	R498,500.00	R74,775.00	R573,275.00	3.9%
2.5.3	Geomorphological and Seismic Investigations	R208,000.00	R31,200.00	R239,200.00	1.6%
2.5.4	Flood Studies	R74,200.00	R11,130.00	R85,330.00	0.6%
2.5.5	Feasibility Design of the Selected Scheme	R2,264,600.00	R339,690.00	R2,604,290.00	17.8%
2.5.6	Construction Programming and Costing	R738,400.00	R110,760.00	R849,160.00	5.8%
2.5.7	Access and Advanced Infrastructure	R351,000.00	R52,650.00	R403,650.00	2.8%
2.5.8	Flood and Backwater Calculations for the Dam	R152,200.00	R22,830.00	R175,030.00	1.2%
2.5.9	Climatological Data for the Construction Site	R43,600.00	R6,540.00	R50,140.00	0.3%
2.5.10	Water Quality and Limnology	R156,800.00	R23,520.00	R180,320.00	1.2%
2.5.11	Sediment Yield and Sedimentation Investigation	R808,919.00	R121,337.85	R930,256.85	6.4%
2.5.12	Land Requirements and Associated Costs	R61,000.00	R9,150.00	R70,150.00	0.5%
2.5.13	Assessment of the Potential for Hydropower Generation at the Dams (Engineering Investigation)	R175,600.00	R26,340.00	R201,940.00	1.4%
2.5.14	Costing (CAPEX and OPEX) of the Project	R72,800.00	R10,920.00	R83,720.00	0.6%
2.5.15	Engineering Economic Analysis	R208,000.00	R31,200.00	R239,200.00	1.6%
2.6	Implementation Actions	R234,000.00	R35,100.00	R269,100.00	1.8%
2.7	Record of Implementation Decisions	R234,000.00	R35,100.00	R269,100.00	1.8%
2.8	Institutional, Financial and Operational Aspects	R416,000.00	R62,400.00	R478,400.00	3.3%
2.9	Feasibility Study Report	R214,800.00	R32,220.00	R247,020.00	1.7%
Total Professional Fees		R11,975,519.00	R1,796,327.85	R13,771,846.85	94.1%
Disbursements		R750,000.00	R112,500.00	R862,500.00	5.9%
Total		**R12,725,519.00**	**R1,908,827.85**	**R14,634,346.85**	**100.0%**

13.3 Allocation of Professional Fees for Team Members

The total Professional Fees allocated to each team member is provided in **Table 13-3**.

Table 13-3: Summary of Professional Fees Allocation per Nominated Staff Member

Name	Study Position	Gender	Race	Hourly Rate (R/h)	Hours	Professional Fees			% of Total
						Excl VAT	15% VAT	Incl VAT	
Seago, C	Water Resources	female	white	1300	532	R691,600.00	R103,740.00	R795,340.00	5.8%
de Sousa, P	GIS	male	white	650	40	R26,000.00	R3,900.00	R29,900.00	0.2%
Swart, R	Graphics	female	white	650	60	R39,000.00	R5,850.00	R44,850.00	0.3%
Serfontein, E	Deputy Study Leader	male	white	1300	672	R873,600.00	R131,040.00	R1,004,640.00	7.3%
Scholtz, W	Technical	male	white	1300	51	R66,300.00	R9,945.00	R76,245.00	0.6%
Louw, L	Study Leader	female	white	1300	1416	R1,840,800.00	R276,120.00	R2,116,920.00	15.4%
Morgan, G	SHERQ	male	black	900	60	R54,000.00	R8,100.00	R62,100.00	0.5%
Mxhegwana, Z	Technical	female	black	400	80	R32,000.00	R4,800.00	R36,800.00	0.3%
Royston, J	Management Support	male	black	900	60	R54,000.00	R8,100.00	R62,100.00	0.5%
Kubheka, M	Management Support	female	black	500	60	R30,000.00	R4,500.00	R34,500.00	0.3%
Aird, R	Specialist: Demographics	male	white	1250	148	R185,000.00	R27,750.00	R212,750.00	1.5%
Lotter, A	Stakeholder Liaison	female	white	750	194	R145,500.00	R21,825.00	R167,325.00	1.2%
Hopkins, T	Environmental	female	white	950	435	R413,250.00	R61,987.50	R475,237.50	3.5%
Anderson, H	Dam Engineering	female	white	1300	872	R1,133,600.00	R170,040.00	R1,303,640.00	9.5%
Hattingh, L	Dam Engineering	male	white	1300	1220	R1,586,000.00	R237,900.00	R1,823,900.00	13.2%
Mouton, D	Geotechnical	male	white	1300	344	R447,200.00	R67,080.00	R514,280.00	3.7%
Steyn, G	Geotechnical	male	white	1300	206	R267,800.00	R40,170.00	R307,970.00	2.2%
Otterman, A	Hydropower	male	white	1300	200	R260,000.00	R39,000.00	R299,000.00	2.2%
Basson, G	Sediment	male	white	1900	471	R894,900.00	R134,235.00	R1,029,135.00	7.5%
Louw, D	Ecological Reserve	female	white	1100	192	R211,200.00	R31,680.00	R242,880.00	1.8%
Kijko, A	Geomorphological	male	white	1300	160	R208,000.00	R31,200.00	R239,200.00	1.7%
van Schoor, B	Pump Stations	male	white	900	280	R252,000.00	R37,800.00	R289,800.00	2.1%
van Staden, W	CAD/Drawings	male	white	725	792	R574,200.00	R86,130.00	R660,330.00	4.8%
Hydropower, S	Hydropower	male	white	950	96	R91,200.00	R13,680.00	R104,880.00	0.8%
Elges, H	Dam Engineering	male	white	1300	40	R52,000.00	R7,800.00	R59,800.00	0.4%
Scherman, P	EWR Quality	female	white	900	56	R50,400.00	R7,560.00	R57,960.00	0.4%
Mackenzie, J	EWR Riparian vegetation	male	white	800	112	R89,600.00	R13,440.00	R103,040.00	0.7%
Deacon, A	EWR Macroinvertebrates	male	white	700	56	R39,200.00	R5,880.00	R45,080.00	0.3%
Kotze, P	EWR Fish	male	white	800	56	R44,800.00	R6,720.00	R51,520.00	0.4%
Rowntree, K	EWR Fluvial Geomorphology	female	white	800	88	R70,400.00	R10,560.00	R80,960.00	0.6%
Sediment sup	Sediment Support	male	white	351	69	R24,219.00	R3,632.85	R27,851.85	0.2%
Ally, H	Limnology	male	black	1400	112	R156,800.00	R23,520.00	R180,320.00	1.3%
Moroaswi, L	Support: Demographics	female	black	450	200	R90,000.00	R13,500.00	R103,500.00	0.8%
Jacobs, E	Technical	male	white	900	140	R126,000.00	R18,900.00	R144,900.00	1.1%
Theron, M	CAD	female	white	425	120	R51,000.00	R7,650.00	R58,650.00	0.4%
Cat C Geotech	Geotechnical	male	white	750	129	R96,750.00	R14,512.50	R111,262.50	0.8%
Motaung, M	Mechanical Engineer	male	black	1300	208	R270,400.00	R40,560.00	R310,960.00	2.3%
Viljoen, P	Dam Construction Specialist	male	white	1300	336	R436,800.00	R65,520.00	R502,320.00	3.6%
Total					**10 363**	**R11,975,519.00**	**R1,796,327.85**	**R13,771,846.85**	**100.0%**
HDI Contribution									**44.5%**

Table E-1 included in **Appendix E** provides a schedule of the manhours for each team member as allocated to the various Study tasks.

13.4 Professional Fees for Participating Companies

Table 13-4 below provides a breakdown of the costs by Company (iX engineers with WRP Consulting Engineers as Sub-consultant) and by the Specialists seconded/sub-consulted to each Company. The Specialists linked with the two main Companies (iX engineers and WRP Consulting Engineers) are mostly from EMEs.

Table 13-4: Breakdown of Professional Fees For Participating Companies

Company	Hours	Professional fees (R)			% of Total
		Excl VAT	15% VAT	Incl VAT	
WRP Consulting Engineers	632	R756,600.00	R113,490.00	R870,090.00	6.32%
iX engineers	3731	R3,953,900.00	R593,085.00	R4,546,985.00	33.02%
WRP Sub–Consultants / Secondments	1833	R1,690,550.00	R253,582.50	R1,944,132.50	14.12%
iX Sub–Consultants / Secondments	4167	R5,574,469.00	R836,170.35	R6,410,639.35	46.55%
Total	**10 363**	**R11,975,519.00**	**R1,796,327.85**	**R13,771,846.85**	**100.00%**

13.5 HDI Involvement

The HDI participation rate on the Study is summarized in **Table 13-5**, on the basis of professional fees earned under the categories of black male and female, white female and male.

Table 13-5: HDI Participation Rate

Category	Professional Fees (R, incl. VAT)	% of Total
Black male	R615,480	4.5%
Black female	R174,800	1.3%
White Female	R5,343,763	38.8%
Sub-Total	**R6,134,043**	**44.5%**
White male	R7,637,804	55.5%
Total	**R13,771,847**	**100.0%**

13.6 Disbursements

The proposed disbursement costs for the Study are R 750 000.00 (excluding VAT) as a lump sum amount (as allowed for in the Financial Bid for the Study). Disbursements will be charged to the Client without mark-up and economy air travel will be used in all cases. The standard rates for car travel will be used and any other similar items will be agreed with the Client during the Study as appropriate. The proposed rates for printing and copying costs are summarized in **Table 13-6**.

Table 13-6: Proposed Rates for Printing and Copying Costs

No.	Description	Size	Rate (R, excl. VAT)
1	Printing only of original/master	A4	10.00
2	Duplicating: Black & white	A4	0.45
3	Duplicating: Black & white	A3	0.84
4	Duplicating: Colour	A4	7.70
5	Duplicating: Colour	A3	10.20
6	Transparencies: Black & white	A4	4.50
7	Transparencies: Colour	A4	14.95
8	Plan plotting: Paper: Black & white	A0	86.00
9	Plan plotting: Paper: Black & white	A1	75.00
10	Plan plotting: Paper: Black & white	A2	58.00
11	Plan plotting: Paper: Black & white	A3	40.00
12	Plan printing: Paper: Black & white	A0	86.00
13	Plan printing: Paper: Black & white	A1	75.00
14	Plan printing: Paper: Black & white	A2	58.00
15	Plan printing: Sepia	A0	58.00
16	Plan printing: Sepia	A1	52.00
17	Plan printing: Sepia	A2	40.00
18	Spiral binding with covers (per book)	A4	9.90
19	Creating of original CDs, including labels	-	85.00
20	Copies of CDs, including labels	-	22.00

The main disbursement costs will be for travelling to meetings, site visits and the acquisition of topographical surveys and aerial photographs.

13.7 Payment Method

The total Study fees and costs are given in **Table 13-1** above. The fees by task breakdown are included in **Table 13-2**. The conditions under which payment will be made for undertaking the work under each task are specified in the Contract (Service Level Agreement) between iX engineers and DWS for the Study.

A breakdown of the Study fees in terms of the payment conditions (Clauses 2.2.1 to 2.2.8 in the Contract (Service Level Agreement)), is given below:

- **Clause 2.2.1** of the Contract: Pre-feasibility Study. Total amount R 2 381 478.00, including VAT at 15 % (R 2 070 850, excluding VAT). The amount will be paid proportionally as work progresses satisfactorily. Final amount to be paid on receipt of approved deliverables, as contemplated in clause 4.3.1 of the Contract.

Task 1.1.1: Inception Meeting	R	37 950.00
Task 1.1.2: Data Collection and Review	R	89 600.00
Task 1.1.3: Site Visits	R	144 000.00
Task 1.1.4: Inception Report	R	319 800.00
Task 1.2: Ecological Consequences	R	488 000.00
Task 1.3: Historic Yield Analysis	R	98 800.00
Task 1.4: Environmental Screening	R	161 500.00
Task 1.5: Geotechnical and Materials Investigations	R	85 800.00
Task 1.6.1: Topographical Survey and Photography	R	0.00
Task 1.6.2: Proposed Scheme Configurations	R	465 800.00
Task 1.6.3: Engineering Economic Analysis	R	30 800.00
Task 1.7: Multi-Criteria Analysis	R	20 800.00
Task 1.8: Pre-Feasibility Report	R	78 000.00
Total (excluding VAT)		**R 2 070 850.00**

- **Clause 2.2.2** of the Contract: Environmental Screening. Total amount R 170 430, including VAT at 15 % (R 148 200, excluding VAT). The amount will be paid on receipt of approved reports for the Pre-feasibility and Feasibility stages of the Study, as contemplated in clause 4.3.2 of the Contract.

Task 2.1: Environmental Screening	R	148 200.00
Total (excluding VAT)		**R 148 200.00**

- **Clause 2.2.3** of the Contract: Project management, co-ordination, planning, monitoring, risk assessment, information management). Total amount R 2 061 318, including VAT (R 1 792 450, excluding VAT). The amount will be paid in monthly increments linked to actual progress achieved on receipt and approval of satisfactory interim progress reports, as contemplated in clause 4.3.3 of the Contract.

Project Management (PFS, month 1 – 5)	R 361 250.00
Project Management (PFS, month 6 – 10)	R 252 650 .00
Project Management (FS, month 11 – 30)	R 1 178 550.00
Total (excluding VAT)	**R 1 792 450.00**

- **Clause 2.2.4** of the Contract: Water Resources. Total amount R 1 411 280, including VAT at 15 % (R 1 227 200, excluding VAT). The amount will be paid in monthly increments linked to satisfactory and approved interim progress reports with respect to the deliverables, as contemplated in clause 4.3.4 of the Contract. Final amount to be paid on receipt of approved deliverables as contemplated in clause 4.3.4 of the Contract.

Task 2.2.1: Existing and Future Water Demands	R 132 500.00
Task 2.2.2: Yield Analysis with the Water Resource Yield Model	R 182 000.00
Task 2.2.3: Future Water Balance for the Project	R 143 000.00
Task 2.2.4: Short-Term Stochastic Yield Reliability Curves	R 143 000.00
Task 2.2.5: Water Resources Planning Model	R 143 000.00
Task 2.2.6: Potential for Hydropower (Water Resources)	R 175 600.00
Task 2.3: Ecological Consequences	R 0.00
Task 2.4: Socio-Economic Impacts	R 132 500.00
Task 2.5.13: Potential for Hydropower (Engineering)	R 175 600.00
Total (Excluding VAT)	**R 1 227 200.00**

- **Clause 2.2.5** of the Contract: Engineering Investigation. Total amount R 6 730 742, including VAT at 15 % (R 5 852 819, excluding VAT). The amount will be paid proportionally as work progresses satisfactorily. Final amount to be paid on receipt of approved deliverables (Engineering Investigation (Pre-feasibility) and Engineering Investigation (Feasibility)), as contemplated in clause 4.3.5 of the Contract.

Task 2.5.1: Topographical Surveys and Mapping	R	0.00
Task 2.5.2: Geological and Geotechnical Investigations	R	498 500.00
Task 2.5.3: Geomorphological and Seismic Investigations	R	208 000.00
Task 2.5.4: Flood Studies	R	74 200.00
Task 2.5.5: Feasibility Design of Selected Scheme	R	2 264 600.00
Task 2.5.6: Construction Programming and Costing	R	738 400.00
Task 2.5.7: Access and Advanced Infrastructure	R	351 000.00
Task 2.5.8: Flood and Backwater Calculations for the Dam	R	152 200.00
Task 2.5.9: Climatological Data for the Construction Site	R	43 600.00
Task 2.5.10: Water Quality and Limnology	R	156 800.00
Task 2.5.11: Sediment Yield and Sedimentation Investigation	R	808 919.00
Task 2.5.12: Land Requirements and Associated Costs	R	61 000.00
Task 2.5.13: Potential for Hydropower (Engineering Investigation) *(refer to Clause 2.2.4)*		
Task 2.5.14: Costing of the Project	R	72 800.00
Task 2.5.15: Engineering Economic Analysis	R	208 000.00
Task 2.9: Feasibility Study Report	R	214 800.00
Total (Excluding VAT)		**R 5 852 819.00**

- **Clause 2.2.6** of the Contract: Implementation Actions. Total amount R 538 200, including VAT at 15 % (R 468 000, excluding VAT). The amount will be paid proportionally as work progresses satisfactorily. Final amount to be paid on receipt of approved deliverable (Document on implementation actions), as contemplated in clause 4.3.6 of the Contract.

Task 2.6: Implementation Actions	R	234 000.00
Task 2.7: Record of Implementation Decisions	R	234 000.00
Total (excluding VAT)		**R 468 000.00**

- **Clause 2.2.7** of the Contract: Institutional, Financial and Operational Aspects. Total amount R 478 400, including VAT at 15 % (R 416 000, excluding VAT). The amount will be paid proportionally as work progresses satisfactorily. Final amount to be paid on receipt of approved deliverable (Report on institutional, financial, and operational aspects), as contemplated in clause 4.3.7 of the Contract.

Task 2.8: Institutional, Financial and Operational Aspects	R 416 000.00
Total (excluding VAT)	**R 416 000.00**

- **Clause 2.2.8** of the Contract: Disbursements. Total amount R 862 500, including VAT at 15 % (R 750 000, excluding VAT). Disbursements will be paid upon receipt of an invoice detailing the expenses incurred together with satisfactory proof detailing the deliverables and approval by DWS of disbursements incurred, as contemplated in clause 4.3.8 of the Contract.

Disbursements	R 750 000.00
Total (excluding VAT)	**R 750 000.00**

13.8 Cash Flow Projection

A cash flow projection for the Study is given in **Appendix D**. The projection is based on the 30-month study period and the payment method as given in Section 13.7 above. Each entry in the cash flow projection has a reference to the relevant clause in the Contract between iX engineers and DWS for the Study (Service Level Agreement), with respect to the method of payment for work undertaken on each task of the Study. These payment clauses are also provided in Section 13.7 of this report.

13.9 Provisional Sums

Payment for three of the tasks required under the Study were only allowed for as Provisional Sums in the Terms of Reference for the Study. However, the amounts that will be required for the Provisional Sums were not indicated in the Terms of Reference and were subsequently also not included in the Financial Bid for the Study. The intention is that the funding for payment of the three tasks will be provided by DWS by separate arrangement.

The relevant tasks are the following:

- Work by a Sub-contractor to undertake the Ecological Reserve and Classification task, part of the Feasibility Study component of the Study.

- Work by a Sub-contractor to undertake the Materials Investigation task, part of the Feasibility Study component of the Study.
- Work by a Sub-contractor to undertake the Geotechnical Investigation task, part of the Feasibility Study component of the Study.

The DWS indicated that the following options are available for funding of the Provisional Sums that will be required for the above three tasks:

- **Option 1:** Variation Order with respect to the Study Agreement.
- **Option 2:** Funding to be obtained by DWS from Treasury.
- **Option 3:** DWS to prepare a tender enquiry for the work.

14 DEVIATIONS FROM TOR AND STUDY ASSUMPTIONS

14.1 Deviations from Terms of Reference

The following deviations from the Terms of Reference have been made:

14.1.1 Ranking/Scoring System

A ranking/scoring system (based on a multi-criteria decision matrix) rather than an elimination process will be adopted during the execution of the Pre-Feasibility Study, which is a change to what was requested in the ToR.

The decision to apply a ranking\scoring system was made after the Inception Meeting and site visits.

14.2 Study Assumptions

The following Study assumptions have been made:

1. That the previous studies listed in the Inception Report and studies available at DWS will be made available to the PSP by DWS in good time for the purposes of this Study.

2. Based on the results of the updated Reconciliation Strategy Study for the Mbombela Municipal Area (DWS, 2021) that the Mountain View site is the most feasible site of the 4 sites investigated, it was assumed that during the Pre-Feasibility Study the results will be revisited, and the decisions previously taken will be documented using the following methodology:

    a) The Pre-Feasibility Study will comprise a desk top study of all available information together with site visits by the various specialists as described in the Inception Report.

    b) The four sites will be compared and ranked from most to least suitable to augment the water resource in the Crocodile East River System, in order to recommend only one site for the purposes of the feasibility design during the Feasibility Phase of this Study.

    c) Only a single concept design will be considered for each of the sites.

    d) The multi-criteria analyses that will be used for ranking of the four sites will include ecological impacts, incremental yields, unit reference values; to name a few.

3. A feasibility design will be conducted for the Mountain View Dam based on the results of previous investigations except if the Pre-Feasibility shows otherwise.

4. The scope and specifications for further geotechnical investigations will be determined during the early stage of the feasibility phase of the study for the recommended dam site.

5. The geotechnical investigations will be performed by suitably qualified and experienced service providers who will be sourced by following DWS procurement processes. The funding for this work will be provided by DWS by separate arrangement. However the requirements and standards will be controlled by the PSP who will also supervise the investigations to ensure that the information is obtained as required by the dam and other infrastructure design teams.

6. The Feasibility Study will optimise and finalise the feasibility design so that it can be ready for the detail design and implementation phase at the conclusion of this Study.

7. Environmental:

   a) Provision has been made for two updates of each report following review by the DWS.

   b) Assistance to the DWS for the EIA Phase (Module 2) has been assumed as follows:

      Management of EAP: assumed at an average of 8 hours per month over a 12 month period (assumed approximate timeframe for Module 2).

   c) Review of reports compiled by EAP: 60 hours over 12 month period. The following are excluded from the scope of work: attendance of public meetings and any specialist environmental assessments to determine environmental sensitivities.

15 STUDY REFERENCES

DWAF (1996) Vaal Augmentation Planning Study: Guidelines for the Preliminary Sizing, Costing and Engineering Economic Evaluation of Planning Options (VAPS).

JIBS (2001) Joint Inkomati Basin Study. Appendix 20: Existing Dams and Dam Investigations. Prepared by BKS ACRES & Consultec Consultores Associados, Lda. Prepared for the Tripartite Permanent Technical Committee.

DWA (2008) Crocodile (East) River Development: Reconnaissance Study, Report No. PWMA 05/X22/00/0608, compiled by PD Naidoo & Associates in 2008, for the Department of Water Affairs Directorate: Options Analysis, Pretoria, South Africa.

IWR (2013) Crocodile East Reconciliation: Dam Costing Report, compiled by Hattingh Anderson Associates CC in 2013, for the IWR Water Resources (Mr Stephen Mallory).

DWA (2014) Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area: Final Reconciliation Strategy, Report No. PWMA 05/X22/00/2012/6 compiled by Water for Africa (Pty) Ltd in association with Africon (Pty) Ltd, Water Geosciences and Charles Sellick and Associates in 2014, for the Department of Water Affairs Directorate: Water Resource Planning Systems, Pretoria, South Africa.

SANCOLD (2020) Guideline for The Sizing of Dam Outlet Structures for Releasing Ecological Water Requirements from South African Dams

DWS (2021) Department of Water and Sanitation, South Africa. Continuation of Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area, compiled by IX/BJ/WRP Joint Venture in February 2021, for the Department of Water and Sanitation Directorate: National Water Resource Planning, Pretoria, South Africa.

APPENDICES

Appendix A Site Visit Report

Department of Water and Sanitation

Report No: P WMA 03/000/00/6923/1/1

WP11393

CROCODILE EAST WATER PROJECT (CEWP)

MODULE 1: TECHNICAL FEASIBILITY STUDY

Site Visit Report

June 2023

Final

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

Published by

The Department of Water and Sanitation
Private Bag X313
PRETORIA, 0001
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APPROVAL

Project Name:	*Crocodile East Water Project (CEWP)* *Module 1: Technical Feasibility Study*
Report Title:	***Site Visit Report***
Author(s):	*Study Team*
Reviewer	*Lilene Louw & Evert Serfontein*
Client Report No.:	*P WMA 03/000/00/6923/1/1*
Contract Number:	*WP11393*
Consultant:	*iX engineers, supported by WRP Consulting Engineers & Specialists*
Status of Report:	*FINAL*
First Issue:	*June 2023*
Second Issue:	
Final Issue:	

Approved for the PSP by:

.....

Lilene Louw
Study Leader

.....

Evert Serfontein
Deputy Study Leader

Approved for the Department of Water and Sanitation by:

.....

Mr Kobus Bester
Chief Engineer:
Water Resource Development Planning (East)

.....

Ms Chriselna Fourie
Director:
Water Resource Development Planning

Prepared by:

iX engineers
Infrastructure Excellence

DOCUMENT INDEX

This report forms part of the series of reports issued as part of the project Crocodile East Water Project (CEWP) Module 1: Technical Feasibility Study.

A document index is provided below.

REPORT SERIES	REPORT TITLE	DWS REPORT No.
Phase 1: Pre-Feasibility Study		
1	Inception Report	P WMA 03/000/00/6923/1
	Site Visit Report (this report)	**P WMA 03/000/00/6923/1/1** Included as **Appendix A** in the Inception Report.
2	Evaluation of Downstream Ecological Impacts of the Dam Options Report	P WMA 03/000/00/6923/2
3	Yield Analysis Report	P WMA 03/000/00/6923/3
4	Environmental Screening Report	P WMA 03/000/00/6923/4
5	Geotechnical and Material Investigations Report	P WMA 03/000/00/6923/5
6	Engineering Investigation Report	P WMA 03/000/00/6923/6
7	Scheme Configurations Report	P WMA 03/000/00/6923/7
8	Engineering Economic Analysis Report	P WMA 03/000/00/6923/8
9	Multi-Criteria Analysis of Dam Options Report	P WMA 03/000/00/6923/9
10	Pre-Feasibility Study Report: Main Report	P WMA 03/000/00/6923/10
Phase 2: Feasibility Study		
11	Environmental Screening Report	P WMA 03/000/00/6923/11
12	Water Resources Report	P WMA 03/000/00/6923/12
13	Hydropower Assessment Report	P WMA 03/000/00/6923/13
14	Ecological Consequences of Operational Scenarios Report	P WMA 03/000/00/6923/14
15	Socio-Economic Impacts Report	P WMA 03/000/00/6923/15
16	Engineering Investigation Report	P WMA 03/000/00/6923/16

REPORT SERIES	REPORT TITLE	DWS REPORT No.
17	Geological and Geotechnical Investigations Report	P WMA 03/000/00/6923/17
18	Geomorphological and Seismic Investigations Report	P WMA 03/000/00/6923/18
19	Flood Study Report	P WMA 03/000/00/6923/19
20	Feasibility Design Report	P WMA 03/000/00/6923/20
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22	Access and Advanced Infrastructure Report	P WMA 03/000/00/6923/22
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25	Water Quality and Limnology Report	P WMA 03/000/00/6923/25
26	Sediment Yield and Sedimentation Investigation Report	P WMA 03/000/00/6923/26
27	Land Requirements and Associated Costs Report	P WMA 03/000/00/6923/27
28	Hydropower Assessment Report	P WMA 03/000/00/6923/28
29	Cost Estimate (CAPEX and OPEX) Report	P WMA 03/000/00/6923/29
30	Engineering Economic Analysis Report	P WMA 03/000/00/6923/30
31	Project Implementation Programme	P WMA 03/000/00/6923/31
32	Record of Implementation Decisions	P WMA 03/000/00/6923/32
33	Institutional, Financial and Operational Aspects Report	P WMA 03/000/00/6923/33
34	Feasibility Study Report: Main Report	P WMA 03/000/00/6923/34
35	Feasibility Study: Summary Report	P WMA 03/000/00/6923/35

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LIST OF ACRONYMS

CEWP	Crocodile East Water Project
CMF	Catchment Management Forum
D: NWRP	(DWS) Directorate: Integrated Water Resource Planning
D: NWRP	(DWS) Directorate: National Water Resource Planning
D: SWRP	(DWS) Directorate: Strategic Water Resource Planning
D: WRDP	(DWS) Directorate: Water Resource Development Planning
DWS	Department of Water and Sanitation
IUCMA	Inkomati Usuthu Catchment Management Agency
LM	Local Municipality
NOC	Non-Overspill Crest
OA	(DWS) Options Analysis
PFS	Pre-Feasibility Study

LIST OF UNITS AND SYMBOLS

km	Kilometre
m	Metres
°	Degrees
’	Minutes
”	Seconds

PREAMBLE

The Department of Water and Sanitation appointed iX engineers (Pty) Ltd for *WP11393: Crocodile East Water Project: Module 1: Technical Feasibility Study.*

The water of the Crocodile (East) River Catchment in Mpumalanga has been fully allocated, yet the water requirements, especially domestic water requirements, continue to grow. The system is under stress, and it cannot fully meet the environmental water requirements as well as the reliability / assurance of supply for both the agricultural and municipal water uses. The yield of the water resource will have to be increased by means of **additional storage**.

Taking cognisance of the above-mentioned and based on previous studies and investigations carried out in the past, the following **four proposed dams** within the **Crocodile (East) River Catchment** were recommended for further study as part of this Study (WP11393: Module 1: Technical Feasibility Study):

- Montrose Dam on the Crocodile East River.
- Mountain View Dam on the Kaap River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

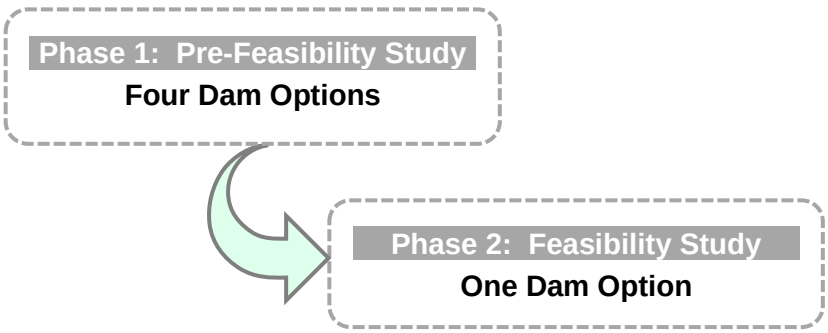
This Technical Feasibility Study will be undertaken in two separate phases, as follows:

Phase 1: Pre-Feasibility Study

The Pre-Feasibility Study (Phase 1) will be undertaken for the above-mentioned **four** proposed dams within the Crocodile (East) River Catchment

Phase 2: Feasibility Study

Under the Phase 1: Pre-Feasibility Study, **one** of the possible four dam options will be selected and recommended for further study and development to a **feasibility level** of detail in the Phase 2: Feasibility Study.



1 INTRODUCTION

1.1 Background to Study

The water of the Crocodile (East) River Catchment in Mpumalanga has been fully allocated, yet the water requirements, especially domestic water requirements, continue to grow. The system is under stress, and it cannot fully meet the environmental water requirements as well as the reliability / assurance of supply for both the agricultural and municipal water uses.

The situation will worsen in the short term if water conservation and water demand management (WC/WDM) measures are not fully implemented. In the medium to long term, WC/WDM measures will not be sufficient to provide for the increase in domestic water requirement. The yield of the water resource will have to be increased by means of **additional storage**.

Both public and commercial sectors have requested development of **additional yield** through **storage** within the **Crocodile (East) River Catchment**. Due to the long lead-time required in developing new dams, the construction of an additional dam in the Crocodile River Catchment has to be investigated without delay.

Taking cognisance of the above-mentioned and based on previous studies and investigations carried out in the past, the following **four proposed dams** within the **Crocodile (East) River Catchment** were recommended for further study as part of this Study (WP11393: Module 1: Technical Feasibility Study):

- Montrose Dam on the Crocodile East River.
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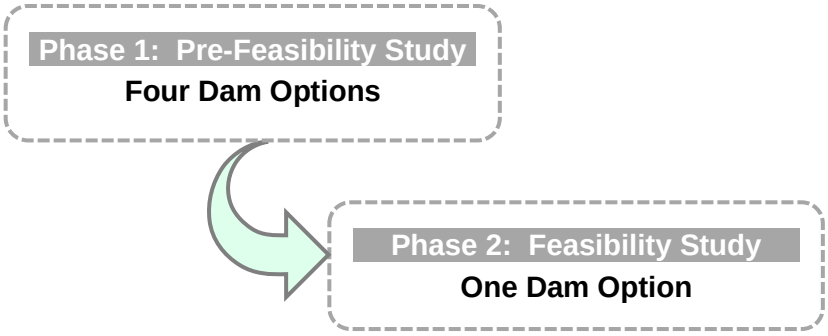

1.2 Study Area

The Crocodile (East) River Catchment in Mpumalanga is located in the north-east of the country and forms part of the larger Inkomati River Basin. The water of the Inkomati River Basin is shared between Mozambique, South Africa and Eswatini. A map of the Study Area is included in **Figure 1-1**.

Engineering investigations and studies for the respective dams and associated infrastructure will **each** have their **specific focus** and **study area** and will also apply to dam access, advanced infrastructure for the dam and the possible relocation of services (roads, rail, etc).

However, with respect to the Water Resources task (water demands, yield analysis, future water balance, the development of short-term stochastic yield reliability curves, updating of the water resources planning model, etc.) of the Study, the study area will cover the **whole** of the **Crocodile (East) River Catchment** (see **Figure 1-1**).

The Crocodile (East) River Catchment comprises of the following four tertiary catchments as indicated in **Figure 1-2**:

- Upper Crocodile Catchment (X21)
- Middle Crocodile Catchment (X22)
- Lower Crocodile Catchment (X24)
- Kaap Catchment (X23)

Important tributaries of the Crocodile River include the following:

- Kaap River
- Elands River
- Nels River
- White Rive

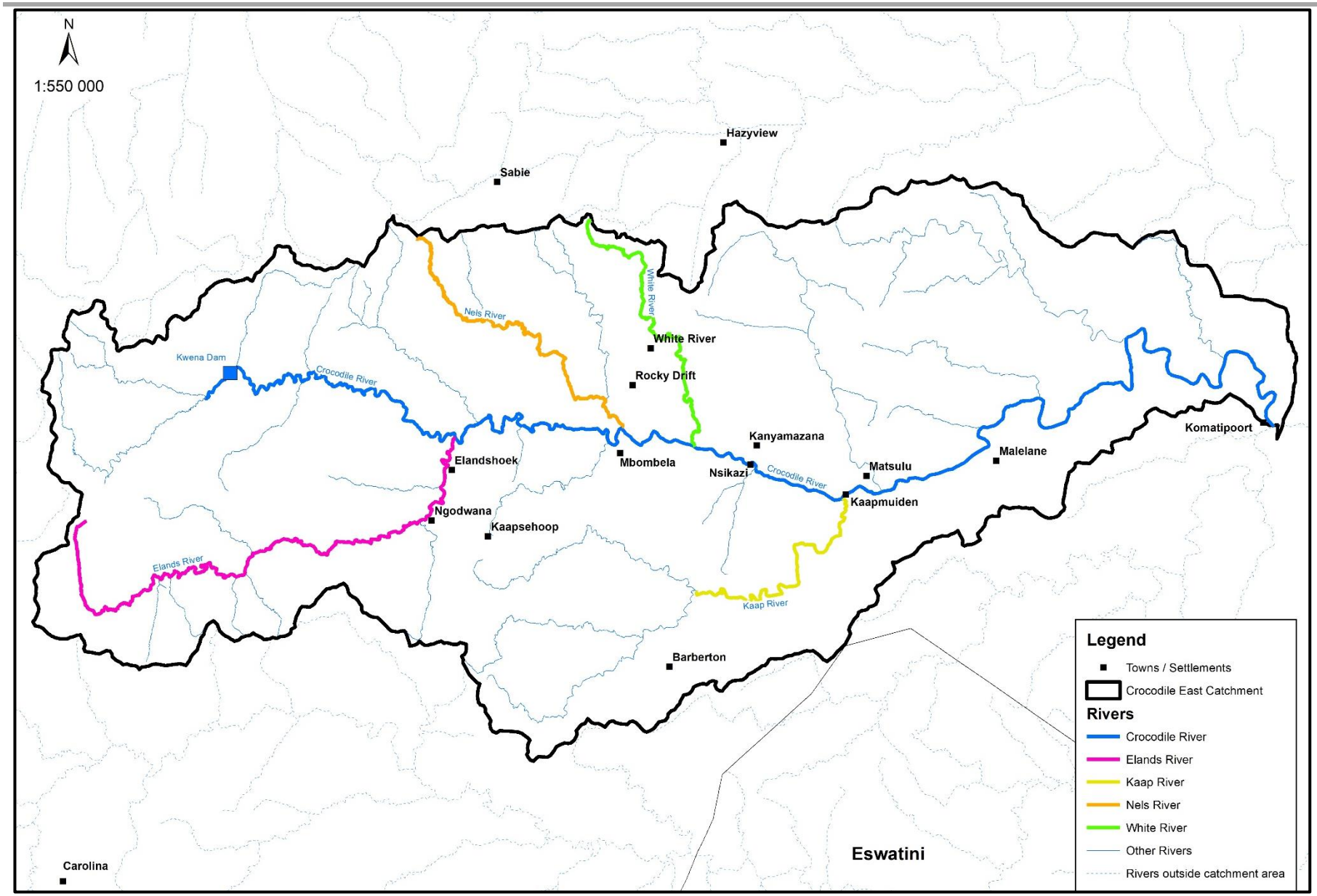

Figure 1-1: Crocodile River Catchment

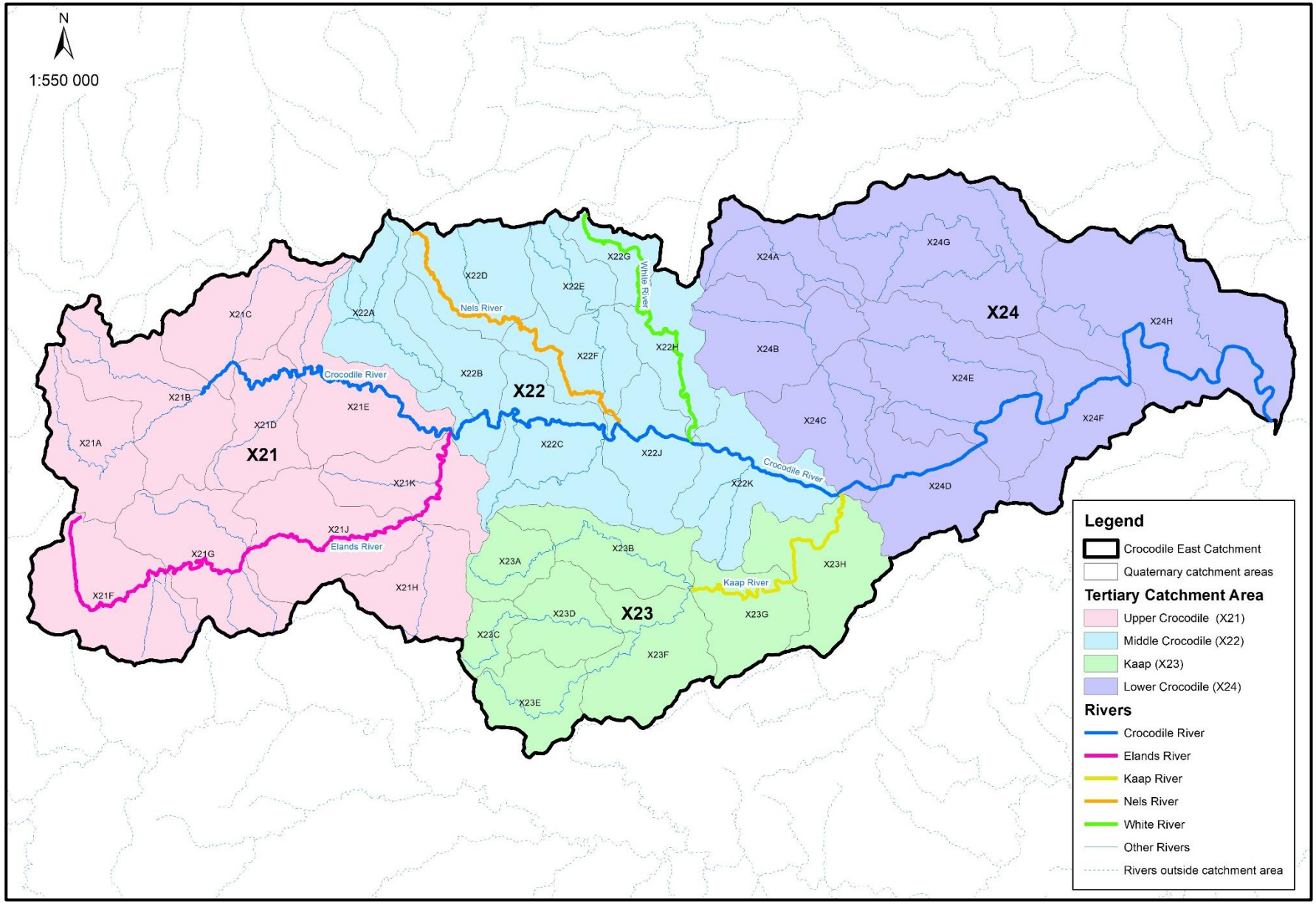

Figure 1-2: Crocodile East River: Tertiary Catchments

The following District and Local Municipalities fall within the Crocodile (East) River Catchment:

- Ehlanzeni District Municipality
  - Bushbuckridge Local Municipality
  - City of Mbombela Local Municipality
  - Nkomazi Local Municipality
  - Thaba Chweu Local Municipality
- Gert Sibande District Municipality
  - Chief Albert Luthuli Local Municipality
- Nkangala District Municipality
  - Emakhazeni Local Municipality

The Crocodile River Catchment is rural in nature, with agriculture being the main economic activity. The high rainfall escarpment catchments of the Upper and Middle Crocodile and Kaap catchments have significant areas of commercial forestry.

The Upper Crocodile Catchment is relatively undeveloped with small domestic and irrigation demands. The Middle Crocodile Catchment has large areas of controlled irrigation and urban demands in the Mbombela LM. The Kaap River Catchment is dominated in the lower eastern part by significant areas of controlled irrigation. Water is transferred into the Kaap River Catchment from the Lomati and Shiyalongubo dams for urban users (Umjindi Local Municipality which was disestablished and merged with Mbombela Local Municipality to establish the City of Mbombela Local Municipality) and agriculture (Louw's Creek Irrigation Board). The Lower Crocodile Catchment has large areas of controlled irrigation and smaller urban/domestic demands for the Nkomazi LM.

The only major dam in the catchment is the Kwena Dam in the Upper Crocodile River Catchment. The dam is approximately 60 km west of Mbombela on the main stem of the Crocodile East River or in the upper reaches of the Crocodile East Catchment. The dam is far from the water demand centers and therefore makes it difficult to regulate and manage water distribution to supply demands as required by the users.

1.3 Proposed Dams

Four proposed dams (listed below) will be investigated during the Pre-Feasibility Phase (Phase 1) of this Study. Only **one** will be selected and recommended for further study in the Feasibility Phase (Phase 2) of the Study. It is, however, possible that the second-best option could be taken forward at a later stage.

- Montrose Dam on the Crocodile East River.
- Mountain View Dam on the Kaap River.
- Boschjeskop Dam on the Nels River.
- Strathmore Off-Channel Storage Dam, near the confluence of the Kaap and Crocodile Rivers.

The regional orientation of the **four proposed dam sites** is indicated in **Figure 1-3**.

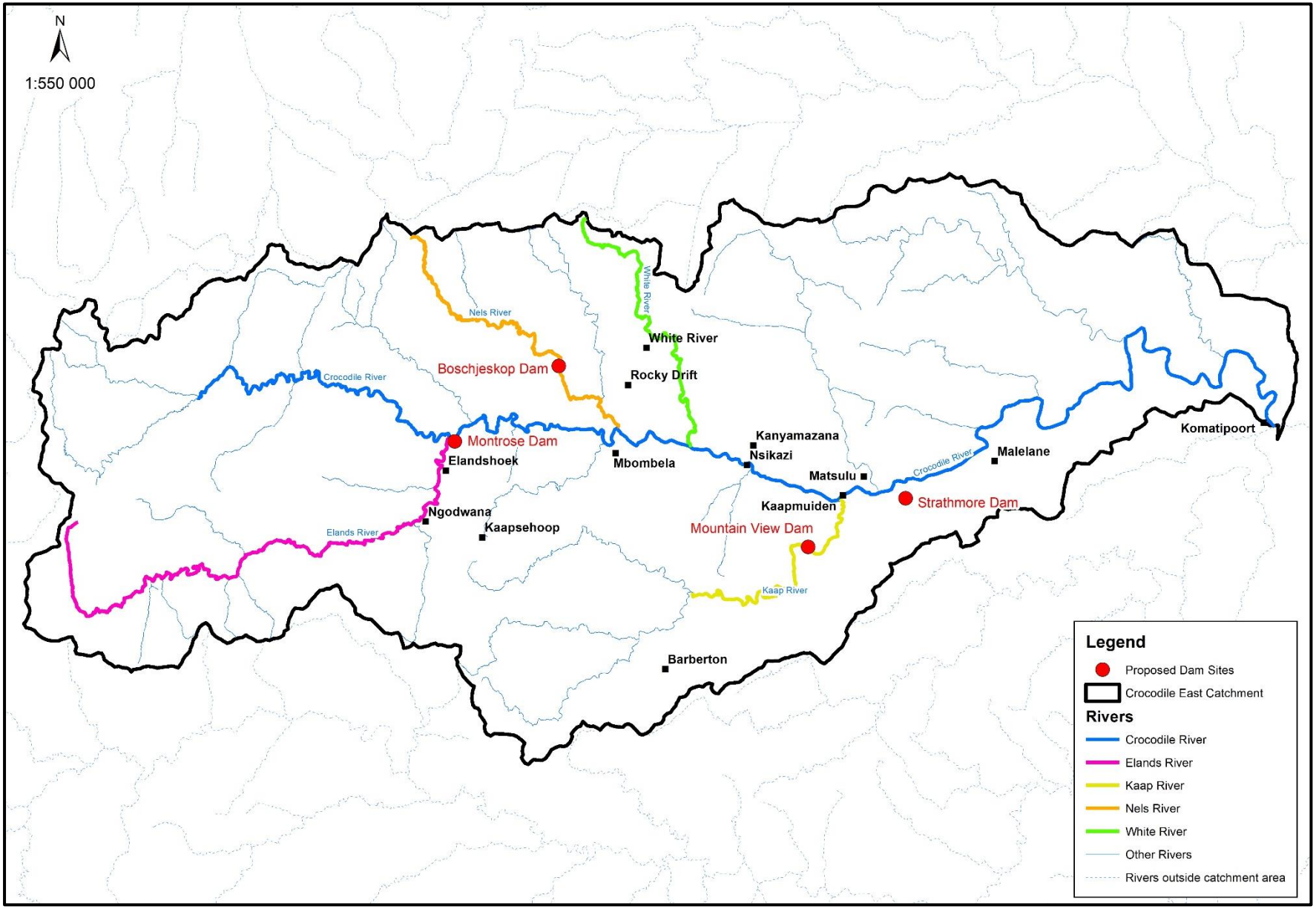

Figure 1-3: Regional Context of Four Proposed Dam Sites

2 OVERVIEW OF SITE VISITS

2.1 Site Visit Itinerary

Site visits of the four proposed dam sites (Montrose, Mountain View, Boschjeskop and Strathmore) were conducted from 1 to 4 November 2022.

Attendees included representatives from the following organisations:

- DWS: Mr Kobus Bester (DWS study manager for the project, D:WRDP), Mr Silo Kheva (DWS, D:WRDP (Mpumalanga)) and other DWS staff that will be involved in the Study or that have an interest in the Study.
- iX engineers' Study Team
- IUCMA (Dr Tendai Sawunyama)
- Irrigation Boards
- Community Trust
- Landowners

Attendance Registers of the site visits of the dam sites are included in **Appendix A**.

The site visits presented an opportunity for the iX engineers' Study Team and others to familiarize themselves with the proposed dam sites and to obtain an overall and preliminary assessment of the sites from an engineering, geological and geotechnical, environmental and social perspective.

Photographs of some of the participants at the various dam sites are included below.


You are entering the
Croc River Conservancy.
This is private property.
Trespassers WILL be prosecuted.
Lena yindzawo lengakavunyelwa
kutsi kungene noma
ngabe ngubani.

An Itinerary for the site visits is included in **Table 2-1**.

Table 2-1: Site Visit Itinerary

Date	Time	Description
1 Nov 2022	**07:00**	**Depart from Pretoria**
	12:45	**Meet at Assembly Point 1:** Google Maps Co-ordinates: -25.42886 30.75477 (refer to map) Google Earth Co-ordinates: 25°25'44.01"S 30°45'16.78"E (see kmz file)
	12:45 - 13:00	Depart and travel as a Group to Montrose Dam site
	13:00 - 17:00	**Montrose Dam Site Visit:** · *Proposed Dam Wall Site and Dam Basin Area*
	±17:00	**Depart and Travel to Mbombela**
		Stay Overnight: Mbombela
2 Nov 2022	07:30	**Meet at Assembly Point 2:** Google Maps Co-ordinates: -25.47349 30.96795 (refer to map) Google Earth Co-ordinates: 25°28'25.38"S 30°58'4.53"E (see kmz file) (Nelspruit Crossing, parking area in front of Woolworths)
	07:30 – 08:30	Depart and travel as a Group to Mountain View Dam site
	08:30 - 17:00	**Mountain View Dam Site Visit:** · *Proposed Dam Wall Site and Dam Basin Area*
	±17:00	**Depart and Travel to Mbombela**
		Stay Overnight: Mbombela
3 Nov 2022	07:30	**Meet at Assembly Point 2:** Google Maps Co-ordinates: -25.47349 30.96795 (refer to map) Google Earth Co-ordinates: 25°28'25.38"S 30°58'4.53"(see kmz file) (Nelspruit Crossing, parking area in front of Woolworths)
	07:30 – 08:00	Depart and travel as a Group to Boschjeskop Dam site
	08:00 – 11:45	**Boschjeskop Dam Site Visit:** · *Proposed Dam Wall Site and Dam Basin Area*
	11:45 - 13:00	Depart and travel as a Group to Strathmore Dam site
	13:00 – 13:30	*Meet with Mr Mosa Chirwa the Chairperson of the Libuyile Community Trust. Mr Chirwa will travel with the team to meet the Chief – TL Dlamini. After the visit to the Chief, the team will be able to visit the land*.
	13:30 - 17:30	**Strathmore Dam Site Visit:** · *Proposed Dam Wall Site and Dam Basin Area*
	±17:30	**Depart and Travel to Mbombela**
		Stay Overnight: Mbombela

Date	Time	Description
4 Nov 2022	**07:30**	**Depart from Mbombela**
	11:30	**Arrive at Pretoria**
		Some of the Team Members may want to stay behind to visit some areas upstream or downstream of these proposed sites again, but not alone.

2.2 Brief Overview of Site Visits

The following sections provide a brief overview of the site visits undertaken to the respective dam sites.

2.2.1 Montrose Dam Site

The Montrose Dam site was visited on 1 November 2022.

The proposed dam is located in the Crocodile River some 2 km downstream of the confluence of the Elands and Crocodile rivers.

The approximate site co-ordinates of the proposed Montrose Dam (see **Figure 2-1**) are: Latitude 25°27'17" and Longitude 30°43'34".

Access was gained to the right flank via the Rivulets gravel road which eventually follows the railway track in a southern direction. The site is situated on the Crocodile River. It was accessed from the right flank on the farm of Loraine Dickens.

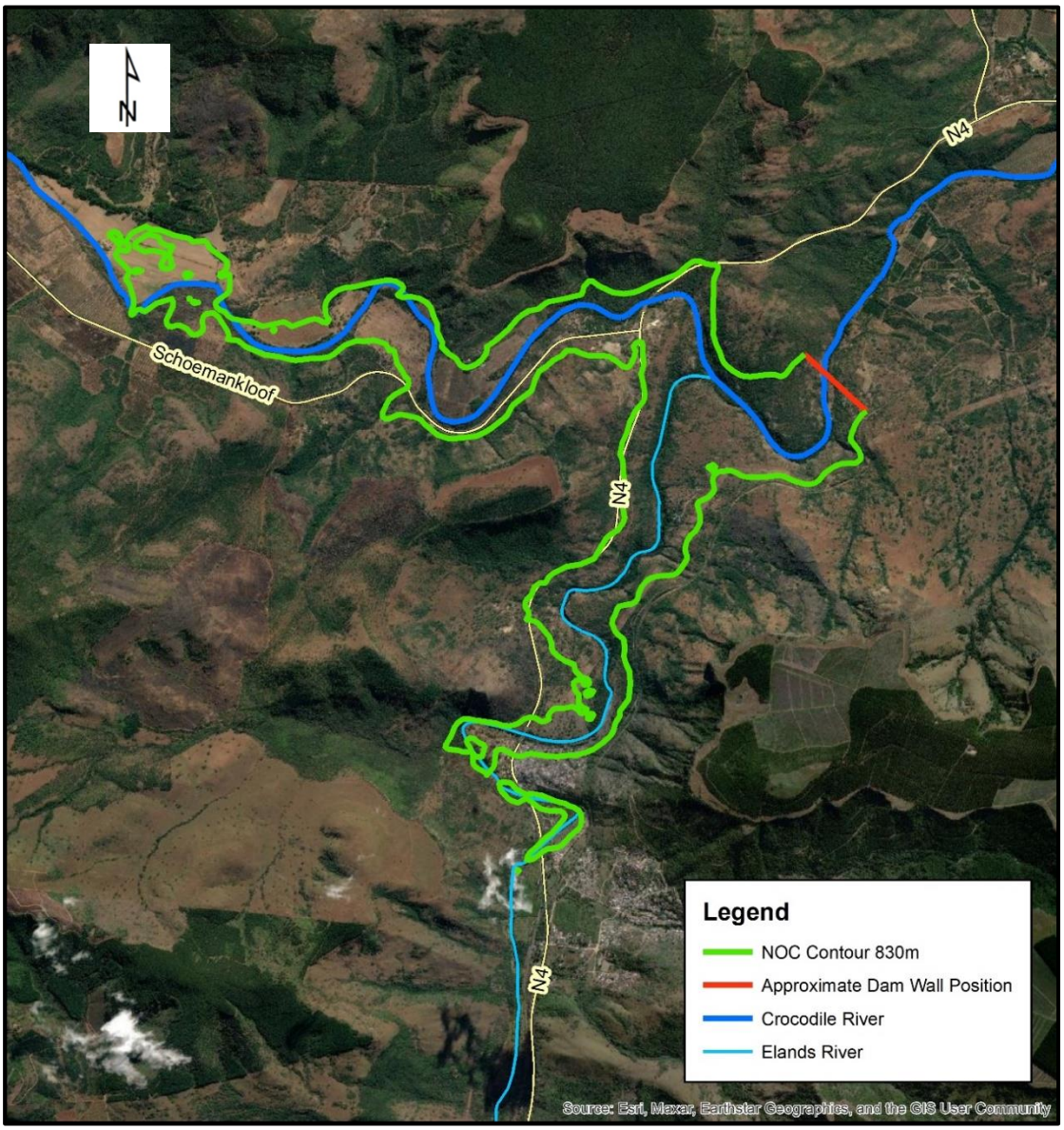

Figure 2-1: Montrose Dam Site

The dam site has an asymmetrical shape with the right flank significantly flatter than the left flank. Whilst vehicle access is possible from the right flank, the left flank access is difficult without any paths or tracks noticeable. It will be difficult to establish drilling equipment on the steep left flank. Widespread granite rock outcrops were however observed on the left flank.

The right flank has scattered granite rock outcrops and the rock weathering profile is clearly very irregular. The river section comprises a wide (approximately 50 m) alluvial terrace on the right bank with no rock outcrops visible in the river channel and rest of the river section.

Engineering geological investigations at Montrose will have to comprise a combination of geophysical surveys (electric resistivity on the flanks and seismic refraction in the river section) before drilling be commenced. The main objective of the geophysical surveys would be to identify the best location for a dam site in terms of founding. Potentially suitable area for a rock quarry was identified on the right flank approximately 600 m downstream of the Elands River confluence.

2.2.2 Mountain View Dam Site

The Mountain View Dam site was visited on 2 November 2022.

The Mountain View Dam site is situated on the Kaap River approximately 10 km south-west of Kaapmuiden and near the end of a steeply sided valley on the Kaap River (±)10 km upstream of the confluence with the Crocodile River.

The approximate site co-ordinates of the proposed Mountain View Dam (see **Figure 2-2**) are: Latitude 25°36'45" and Longitude 31°16'15".

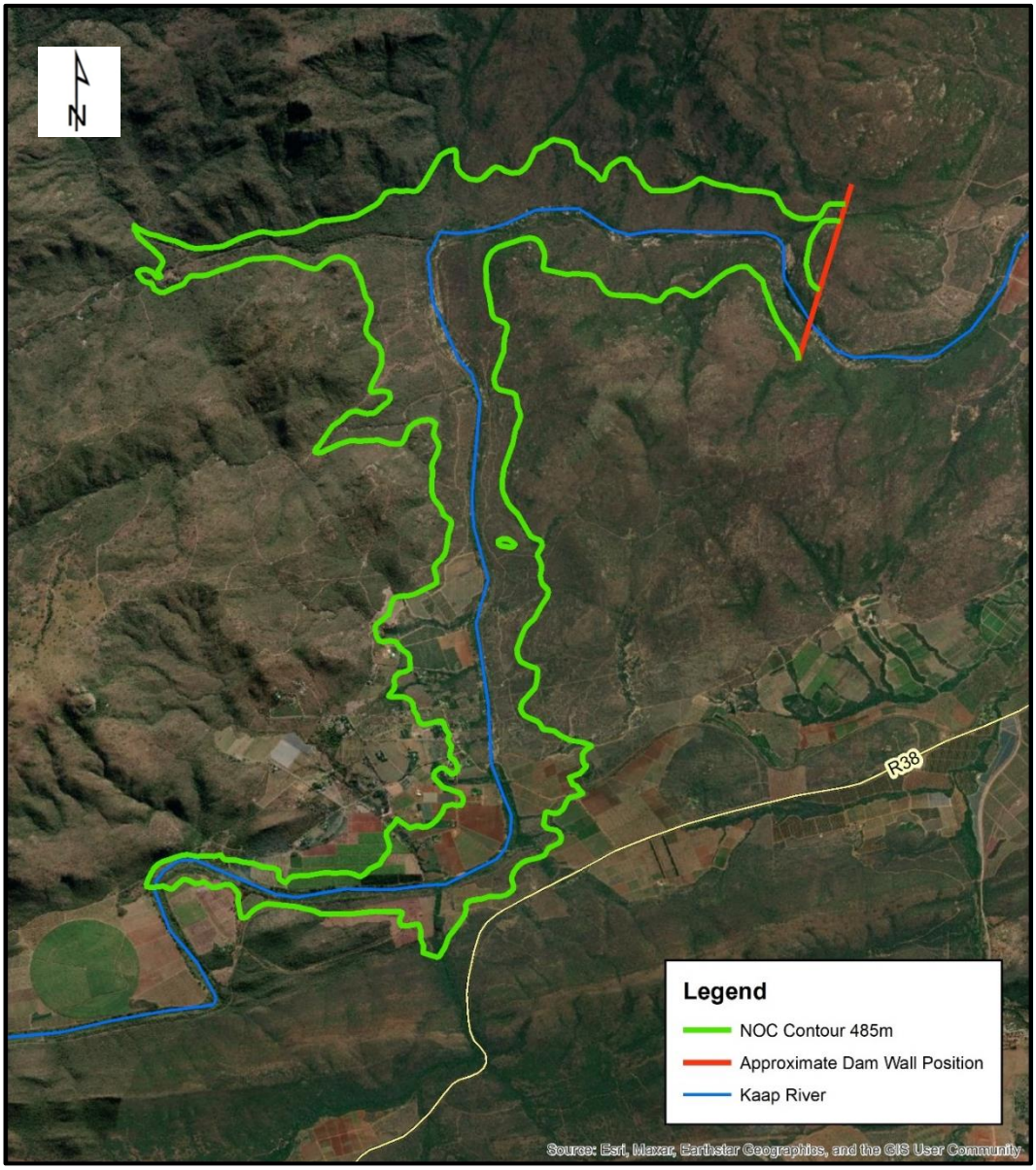

Figure 2-2: Mountain View Dam Site

Access was gained via the Esperado Road which turns off from the R38 Road to Barberton approximately 9.3 km from the N4. Access could be gained using a farm track that leads to the canal offtake on the left river bank, approximately 170 m below the small existing weir. Access to the upper left was possible by means of an existing track that was constructed as part of the exploration drilling programme in the nineteen seventies. The track extends all the way to the saddle on the upper left flank. Access to the upper left flank is reasonably easy, but the majority of the flank is steep and rugged with limited access for drilling equipment. It was confirmed during the site visit that the presence of the saddle is associated with a set of east-west striking dolerite dykes, possibly associated with faulting.

Water in the weir dams up within the river channel section for a distance of about 640 m where a very prominent granite rock outcrop forms an impressive continuous rock outcrop in the river section of approximately 250 m x 90 m, at the upstream end of the prominent gorge. Due to the presence of the weir and widespread water upstream of it, access for geophysical surveys and drilling operations is deemed very difficult.

The right flank is very steep and characterised by virtually continuous rock outcrops, giving rise to near-vertical rock cliff faces in places. The closest existing farm track to the upper parts of the right flank is more than 1 km. The right flank is not accessible for geophysical surveys except at the upper portions. The same goes for drilling.

Widespread rock in the dam basin offers several rock quarry site opportunities, particularly on the right flank.

The reservoir area contains steep valley slope of more than 1V:2H in places and reservoir slope stability will have to be investigated as part of the feasibility level studies.

2.2.3 Boschjeskop Dam Site

The Boschjeskop Dam site took place on 3 November 2022.

The proposed dam site is located 16 km to the north-west of Mbombela.

The approximate site co-ordinates of the proposed Boschjeskop Dam (see **Figure 2-3**) are: Latitude 25°21'07" and Longitude 30°52'21".

Access to the site is relatively easy via a secondary gravel road that turns off from the R37 heading northwards from Mbombela to Sabie.

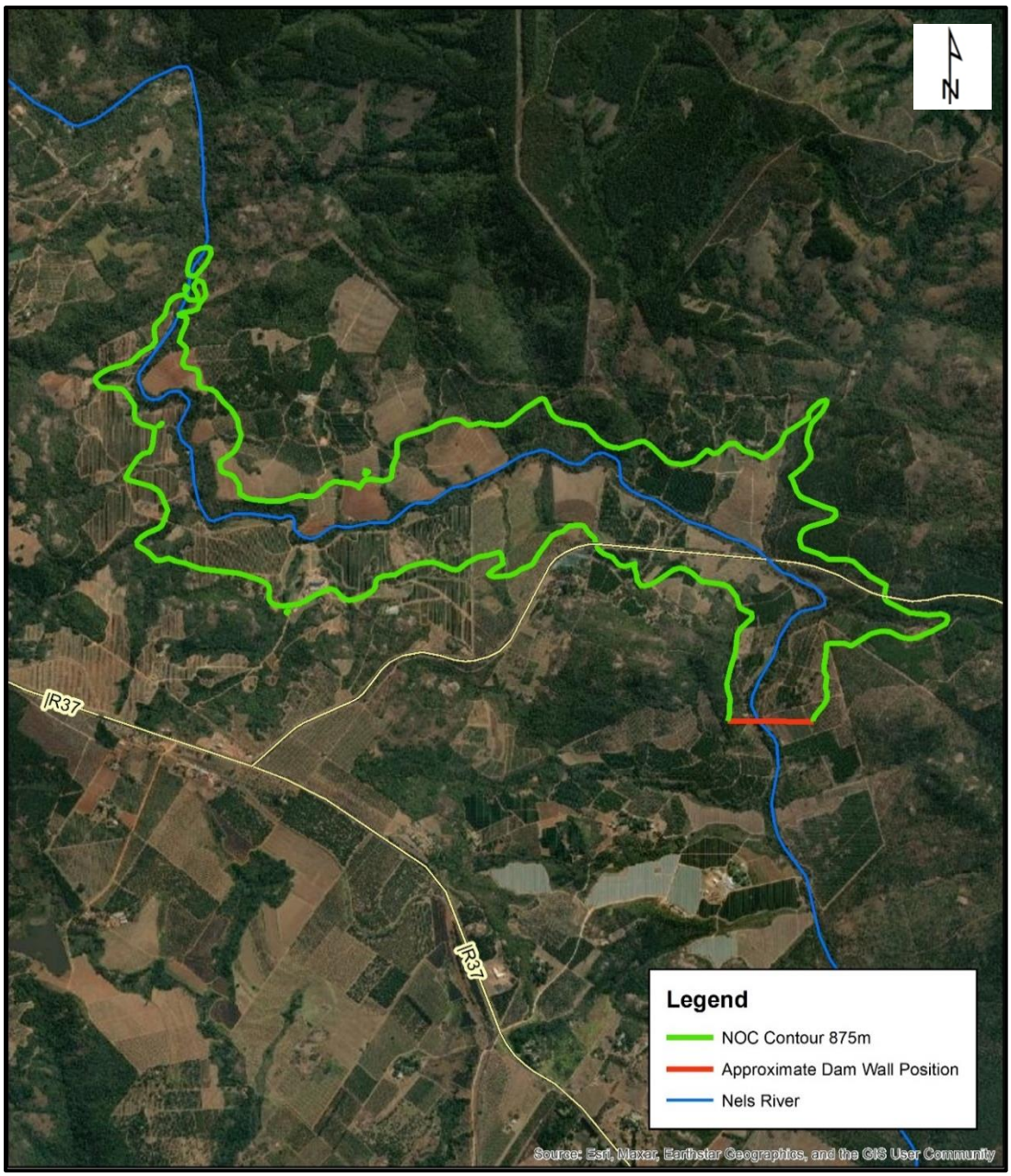

Figure 2-3: Boschjeskop Dam Site

The site has an asymmetrical shape with a steeper right flank that is covered by scattered granite gneiss outcrop. A distinct north-south striking shear zone intersects the upper right flank. This feature is easily recognised by widespread pegmatite and vein quartz which also form somewhat of a ridge.

The river section is densely vegetated mostly by large indigenous trees, but contains scattered prominent granite gneiss rock outcrops. Irregular rock profile is expected in the river section although mostly shallow rock.

The flat left flank is covered by a well-developed clayey sand surface layer (hillwash) underlain by deeply weathered granite.

Access to the entire site is good. Extensive use of geophysical surveys will be required to delineate the concrete spillway option. Earth embankment wall will be required for the flat right flank. The hillwash and residual granitic soils has a large distribution in the dam basin which should be well suited for embankment construction.

2.2.4 Strathmore Dam Site

The proposed dam site is located on the southern side of the N4 national highway halfway between Kaapmuiden and Malelane. The dam is to be constructed in a range of hills aligned more-or-less east-west and parallel to the N4 highway. The dam will require at least two separate dam walls.

The approximate site co-ordinates of the proposed Strathmore Off-Channel Dam (see **Figure 2-4**) are :

Latitude 25°36'45" and Longitude 31°16'15".

The approximate site co-ordinates of the second wall are:
Latitude 25°32'07" and Longitude 31°25'31".

Access to the site is easy via farm access road from the N4 road which occurs approximately 1.5 km north of the dam site.

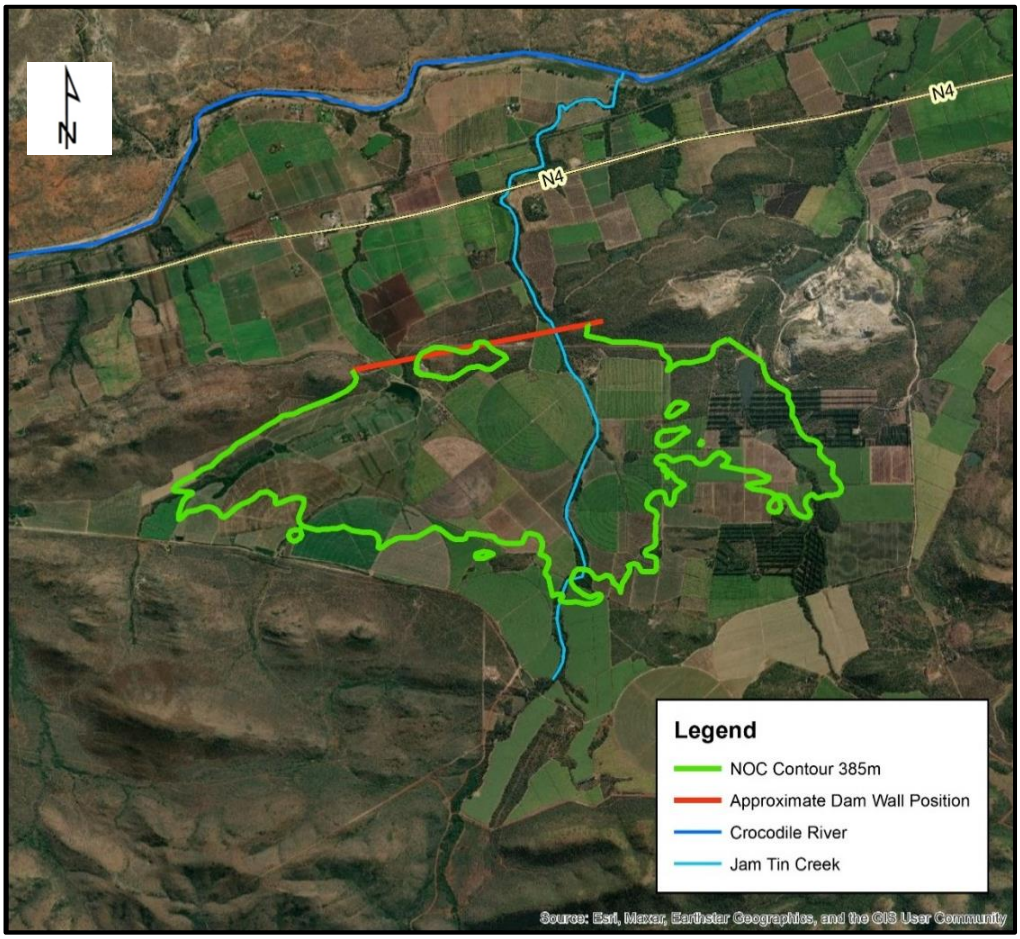

Figure 2-4: Strathmore Off-Channel Dam Site

Strathmore Dam Site is an off-channel dam straddling two north-flowing streams. These are separated by a low hill which forms part of a distinct almost east-west striking low hill range that is associated with the ancient so-called green belt rocks of the Swazian Group. These comprise highly metamorphosed rocks such as amphibolite and schist. A third stream flows northwards along the far eastern portion of the reservoir (Salt Creek) which will also require a saddle dam pending the reservoir level.

The entire reservoir area is under cultivation, mostly sugar cane.

The dam sites positions are not well defined and generally lack distinct rock outcrop, although some areas of shallow rock are expected. The rock mass is generally closely jointed and possibly highly pervious. Extensive foundation grouting is foreseen to render relatively impervious foundations.

A large magnesite mine is situated to the north-east of the dam. The presence of the old mining pits/mine concession area will limit the reservoir level. The possible leakage of reservoir water into the mine pit will have to be assessed.

Geotechnical foundations for this dam site will require geophysical surveys combined with rotary cored drilling particularly to determine rock mass permeability and grouting requirements. The presence of the nearby active mine will require further investigations of the extent and depths of the mine pits, mining lease boundaries and future mine extension planning. Large reserves of clayey soils are present in the basin for embankment construction.

Two of the dam sites may be affected by existing syphons and canal system.

APPENDICES

Appendix A Site Visit Attendance Registers

ATTENDANCE AND DISTRIBUTION LIST

SITE VISIT : MONTROSE DAM SITE

DATE : 1 NOVEMBER 2022

Name	Representing	Contact Details	Signature
E van As	Poplar Creek Farm	082-881 0592	
D van Rensburg	Poplar Creek farm	083 680 1023	
Silo Khewa	DWS	0663024058	
Bernard Chirwa	DWS	080 95 64 65 96	
GEDION SIZIBA	DWS	0656931826	
[illegible]	[illegible]	078 455 5286	
[illegible]	DWS	012 336 7670	
[illegible]	DWS	012 336 8160	
T. Mbili	DWS	012 336 8231	
S. Mamba	DWS	063 697 4588	
E Serfontein	iX	082 495 4815	
Lilene Louw	iX engineers	083 227 1692	
Kobus Beeter	DWS		

ATTENDANCE AND DISTRIBUTION LIST

SITE VISIT : BOSCHJESKOP DAM SITE

DATE : 3 NOVEMBER 2022

Name	Representing	Contact Details	Signature
J. PRETORIUS	Mooimaak	0835078997	
LP Marais	Nelspruit	083 264 5455	
JS Marais	"	0839408107	
Tolway Hopkins	IX Engineers	0828082693	
GEDION SIZIBA	DWS	0636931826	
Sakhile Mamba	DWS	0636974388	
Norman Chaka	SAFCOL	0788035410	
Bernard Chirenda	DWS	060 560 6960	
Thandekile Mbili	DWS	0781359140	
Khuthalo Tshindi	DWS	012 336 8160	
Kennedy Mandaga	DWS	012 336 7670	
OSCAR Martin	IX	082 585 8376	
Gawie Steyn	IX	0825658375	
Henriette Andersen	IX	0828074375	
J. WOLMARANS	DUNORA	0825576194	
AUD BERGH	SAPPI KRAFTEN SAWMILLS	0834008507	
J. Nesserman	Muell estates	0825423952	
A van Wyk	SAFCOL	078 8010487	
J. BARNARD	HIGHLAND NIGHT (FARMER)	0829457563	
E Serfontein	IX	082 495 4815	
Lilene Louw	iX engineers	083 227 1692	
Kobus Bester	DWS		

ATTENDANCE AND DISTRIBUTION LIST

SITE VISIT : MOUNTAIN VIEW DAM SITE

DATE : 2 NOVEMBER 2022

Name	Representing	Contact Details	Signature
DAWIE VAN SCHALKWYK	JINDILLI FARMS	066 680 9175 / 073 168 2780	
Johan St Leusburg	F J Botha Trust	0694043861 / 0825323156	
James van Merwe	Lake Kamo Irr. Board.	0825799020	
Marié le Roux	Kaapriver Majors	072 916 9256	
Stefan Lamprecht	Masfyn	slamprecht@masnya.co.za 0637073016	
SIPHO MASHINGA	LUCMA	072 810 5928	
Tolmay Hopkins	iX	0828082698	
David Morton	iX	0825658376	
Gavin Steyn	iX	0825658375	
Ewart Serfontein	iX	0824354815	
Charles Venter	Klipriversberg	0828781060	
Tendai Sawunyama	LUCMA	0826093043	
Silo Khoza	DWS	0663024058	
Bernard Chisendo	DWS	060 564 3696	
Tennocky Mandiya	DWS	082 005 9644	
Daniel Venter	Chairman Kaap River	0836797536	
Matthews Phoma	Morgenpoort	0825534065	
C Beale	"	0837058194	FJI
D.J. Bosman	OWNER	082 455 1752	
Thandekile Mbili	DWS	0731359140	
Vhutshilo Tshivhidzo	DWS	0123368160	
Eserfontein	iX	0824954815	
Lilone Louw	iX engineers	083 227 1692	
Kobus Bester	DWS		

ATTENDANCE AND DISTRIBUTION LIST

SITE VISIT : STRATHMORE DAM SITE

DATE : 3 NOVEMBER 2022

Name	Representing	Contact Details	Signature
R. Radley	Radley Landgoed	082 388 3643	
O. Mouton	IX	0825658578	
H ANDERSON	IX	0828074335	
MM CHIRWA	LIBERTY CC CONS	0721127870	
GEDION SZIBA	DWS	0636931826	
Benard Chirende	DWS	060 360 5696	
Kennedy Mundye	DWS	0823367670	
Tumay Hoffmann	IX	0828082693	
E Serfontein	IX	0824954815	
J.M MYAMBI	LIBERTY CONSULT	0824539244	
S.B Mamba	DWS	0636974388	
T. Mbili	DWS	0731359140	
Shiondi N	DWS	0711433 1785	
Tsepo Sangwane	Libcro	0794369802 tsangwane@cbl.co.za	
E Serfontein	IX	0824954815	
Lilene Law	IX engineers	083 227 1692	
Kobus Bester	DWS		

Appendix B Stakeholder Database

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE							
Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
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Mr	Pieter	Viljoen	DWS:				ViljoenP2@dws.gov.za
Mr	Mohlapa	Sekoele	DWS				SekoeleM@dws.gov.za
Mr	Benard	Chirende	DWS: NWRP				chirendeb@dws.gov.za
Mr	Beason	Mwaka	DWS: WRPS	Systems Operator	(012) 336 8188	082 807 6621	mwakab@dws.gov.za
Mr	Celiwe	Ntuli	DWS HO: WRPS	Scientific Manager	(012) 336 7618	082 885 1942	ntulic@dws.gov.za
Mr	Patrick	Mlilo	DWS HO: NWRP		(012) 336 1199	082 611 7293	Mlilop@dws.gov.za
Mr	Kennedy	Mandaza	DWS HO: NWRPS			082 600 5964	mandazak@dws.gov.za
	S	Naicker	DWS		(012) 336 8171	063 501 0114	naickers@dws.gov.za
Mr	Kobus	Bester	DWS		(012) 336 8071		besterk@dws.gov.za
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Mr	Sakhile	Mamba	DWS		(012) 336 7481		mambas2@dws.gov.za mndawenis@dws.gov.za
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	Khumbuzile	Moyo	DWS		(012) 336 8293		moyoK@dws.gov.za
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Mr	Richard	Martin	DWS		(012) 336 8072		martinr@dws.gov.za
Ms	Barbara	Weston	DWS HO: RDM	Deputy Director	(012) 336 8221		westonb@dwa.gov.za westonb@dws.gov.za
	Sindi	Mthimkhulu	DWS Swaziland		+268 2404 8032/3	+268 7605 3623	smthimkhulu@yahoo.com
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Mr	Ustathi	Bofilatos	DWS	Director	(012) 336 7562	082 8837 871	Bofilatose@dws.gov.za
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Mr	Fikile	Guma	DWS MP	Director	(013) 759 7311	081 030 9070	gumaf@dws.gov.za
Ms	Ayanda	Ngcobo	DWS				NgcoboA2@dws.gov.za
		Mlaudzi	DWS Mpumalanga region	Regional Acting Head		082 327 5886	mlzudzim@dws.gov.za
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Mr	Gedion	Siziba	DWS				sizibag@dws.gov.za
Mr	Sydney	Nkuna	DWS Mpumalanga region			082 317 6784	Nkunas2@dws.gov.za
Ms	Joyce	Machaba	DWS				machabaj@dws.gov.za
	Thami	Veleko	DWS				Velekot@dws.gov.za
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Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
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Inkomati Usuthu Catchment Management Agency (IUCMA)							
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Mr	Andrew	Mbalathi	IUCMA				mbhalatia@iucma.co.za
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Mr	Sampie	Shabangu	IUCMA				shabangus@iucma.co.za
Department of Forestry, Fisheries and the Environment (DFFE)							
	Jackie	Jay	DFFE				jjay@dffe.gov.za
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Ms	Venessa	Matukana	DFFE				VMatukana@dffe.gov.za
	Mashudu	Mposi	DFFE				mmposi@mpg.gov.za
Mpumalanga Provincial Government							
Office of the Premier							
Ms	Refilwe	Mtshweni-Tsipane		Premier: Mpumalanga			
Mr	George Mthethwa	Mthethwa		Provincial Government's Spokesperson	(013) 766 2242	083 302 2774	gpmthethwa@mpg.gov.za wnkuna@mpg.gov.za nfjdlamini@mpg.gov.za
Mr	Makhukhu	Mampuru		Director-General	(013) 766 2121		dg@mpg.gov.za;jmarakala@mpg.gov.za
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Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA)							
Mr	Marius	van Rooyen	DARDLEA			081 425 2930	mvanrooyen.agric@gmail.com
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	Aubrey	Sibuyi	DARDLEA			072 420 7933	asibuyi1977@gmail.com
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Mr	Ephraim	Mojolefa	DRDLR		(017) 826 4363	076 423 6302	etmojolefa@ruraldevelopment.gov.za
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Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
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Mr	Frans	Krige	MTPA (Mpumalanga Tourism)				frans.krige@mtpa.co.za
Mr	Mervyn	Lotter	MTPA (Mpumalanga Tourism)				mervyn.lotter@gmail.com
	Komila	Knarasoo	MTPA (Mpumalanga Tourism)				komilla.knarasoo@mtpa.co.za
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	Lindelwa	Sengwayo	DEDT	PA/Secretary: Office of the HOD			ltsengwayo@mpg.gov.za
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	J.D.	Mdluli	DEDT	Director: Tourism Development			jdmdluli@mpg.gov.za
Local Government							
Ehlanzeni District Municipality							
	Dolphon	Malokela	Ehlanzeni DM	General Manager: Technical Services	(013) 759 8500		council@ehlanzeni.gov.za info@ehlanzeni.org.za
Dr	N.P.	Mahlalela	Ehlanzeni DM	Municipal Manager	(013) 759 8500		
	J	Sidell	Ehlanzeni DM	Executive Mayor	(013) 759 8500		
Bushbuckridge Local Municipality							
	Mpho	Makhavhu	Bushbuckridge LM	Technical Director: Resource Planning	(013) 0650983		MakhavhuM@bushbuckridge.gov.za
	T.D.	Chavane	Bushbuckridge LM	Manager: Integrated Development Plan		079 874 3324	chavaned@bushbuckridge.gov.za
	S	Mgiba	Bushbuckridge LM	PS to Municipal Manager		079 874 3359	mgibas@bushbuckridge.gov.za
Mr	Thys	Venter	Bushbuckridge LM	Superintendent: Water and Sewerage	(013) 712 8800	072 180 1941	thys.venter@mbombela.gov.za
Mr	Emmanuel	Mashava	Bushbuckridge LM	Technical Services	(013) 799 1851/57	072 190 8892	emashava@gmail.com mashavaE@bushbuckridge.gov.za
City of Mbombela (CoM)							
Mr	Theo	Botha	City of Mbombela	Resource Planning			theo.botha@mbombela.gov.za
	Koena	Moabelo	City of Mbombela	Resource Planning			Koena.Moabelo@mbombela.gov.za
Ms	Linda	Zulu	City of Mbombela		(013) 759 9189	082 458 1275	linda.zulu@mbombela.gov.za
Mr	Peter	Morata	City of Mbombela				peter.morata@mbombela.gov.za

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Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
Nkomazi Local Municipality							
Cllr	P.P.	Magagul	Nkomazi LM	Executive Mayor	(013) 790-0245		call.center@nkomazi.gov.za
Mr	X.T.	Mabila	Nkomazi LM	Municipal Manager			
Thaba Chweu Local Municipality							
Cllr	M.F.	Nkadimeng	Thaba Chweu LM	Executive Mayor			enquiries@tclm.gov.za
	Africa	Ngomane	Thaba Chweu LM			082 700 8090	xikaya09@gmail.com
	S.L.	Manqele	Thaba Chweu LM	Director: Technical and Engineering Services	(013) 235 7300		
	C	Nkuna		Community Services and Safety		063 250 5381	
Gert Sibande District Municipality							
	Habile	Cijimpi Absenia	Gert Sibande DM	Municipal Manager			jabum@gsibande.gov.za tshidip@gsibande.gov.za tshiamom@gsibande.gov.za
	TD (Dan)	Hlanyane	Gert Sibande DM	Licensing Authority	(017) 801 7000	017 801 7000	Dan.Hlanyane@gsibande.gov.za records@gsibande.gov.za
	Magagula	Lindokuhle	Gert Sibande DM		(017) 801 7177 /	067 408 7579	LindokuhleM@gsibande.gov.za
	Tebogo	Mogakabe	Gert Sibande DM	Environmental Management	(017) 801 7000 (017) 811 1207		TebogoM@gsibande.gov.za records@gsibande.gov.za
	Mthembu	Bulelwa	Gert Sibande DM	Community and Social Services: Air Quality Officer		074 435 4313	BulelwaS@gsibande.gov.za
Chief Albert Luthuli Local Municipality (Carolina)							
Mr	Ephraim	Thabethe	Chief Albert Luthuli LM	Municipal Manager		061 619 4813	mm@albertluthuli.gov.za
Mr	Daniel	Nkosi	Chief Albert Luthuli LM	Executive Mayor			info@chiefalbertluthulinews.co.za
Nkangala District Municipality							
Mr	M.M.	Skosana	Nkangala DM	Nkangala District Municipal Manager			skosanamm@nkangaladm.gov.za matoaneT@nkangaladm.gov.za nkosinm@nkangaladm.gov.za ngwenyann@nkangaladm.gov.za standeral@nkangaladm.gov.za
Cllr	A.B.	Nkwanya	Nkangala DM	Speaker			silandasn@nkangaladm.gov.za
Ms	Susan	Silinda	Nkangala DM	PA to the Speaker			silandasn@nkangaladm.gov.za
Mr	Vusi	Mahlangu	Nkangala DM	Environmental Manager			mahlangumv@nkangaladm.gov.za
Mr	Ntekele	Risimate	Nkangala DM	Water Management			ntekelefr@nkangaladm.gov.za
Mr	A.G .	Zimbwa	Nkangala DM	Manager:Technical Services			technicalservices@nkangaladm.gov.za social@nkangaldm.gov.za

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE							
Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
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					(013) 253 7600		municipality@emakhazenilm.co.za
	Decia	Matumba	SALGA		(013) 752 1200	081 722 9221	dmatumba@salga.org.za
Interest Groups							
Agriculture / Forestry							
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Mr	Bennie	Van Zyl	TLU				hb@tlu.co.za
Business and Industry							
Mr	Louis	Klapprott	Sembocorp:Silulumanzi		(013) 752 6839	083 269 0928	Louis.Klapprott@silulumanzi.com
Mr	Andile	Mbatha	SAPPI				Andile.mbatha@sappi.com
Mr	Benjamin	Olivier	SAPPI				Benjamin.olivier@sappi.com
Mr	Tony	Mitchell	SAPPI		(033) 3476600		tony.mitchell@sappi.com
Mr	Patrick	Maringa	SAPPI				Patrick.Maringa@sappi.com
Ms	Louise	Van Wyk	SAPPI - Ngodwana Mill		(013) 734 6111		Louise.VanWyk@sappi.com Jabu.Tlou@sappi.com.
Mr	Andre	Beegte	Mpumalanga Wetland Forum			084 240 2264	abeegte@environment.gov.za
Mr	Adie	Erasmus	Mpumalanga Wetland Forum: Secretary			083 271-8260	adie@cleanstreamsa.co.za
Mr	Philani	Mngomezulu	Mpumalanga Water Caucus			076 783 1037	zakesmkhonza77@gmail.com
Mr	Nohlanhla	Mngomezulu	Mpumalanga Water Caucus			078 293 1221	Nonhlanhlamngomezulu6@gmail.com
Ms	Vanessa	Matukana	Working for Water			082 359 3473	vmatukana@environment.gov.za
Mr	Werner	Roux	Working for Water			082 469 4341	Wroux@dffe.gov.za
Mr	Jeremia	Mathebula	Emerging farmer's Rep			082 353 2726	jeremiam@vodamail.co.za
Mr	Eddie	Ridelll	SanParks				edriddell@gmail.com wwfsabiewaterstewardship@gmail.com
Mr	Jacques	Venter	SanParks				jacques.venter@sanparks.org
Mr	Nick	Theron	SanParks - Kruger2canyons				nicktheron@kruger2canyons.org
Ms	Sharon	Pollard	AWARD				sharon@award.org.za
Mr	Mpho	Makhavhu	Rand Water			076 985 1710	mmakhavh@randwater.co.za
Mr	Stephen	Mallory	Crocodile Catchment Operations Forum				stephen@waterresources.co.za
Ms	Nancy	Job	SANBI				n.job@sanbi.org.za

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE							
Title	**Name**	**Surname**	**Organisation**	**Position**	**Tel No.**	**Cell No.**	**Email**
Mr	Theunis	Steyn					theunis@kmls.co.za
Ms	Debbie	Turner	White River Irrigation Conservation Board				wrvcb@outlook.com
Ms	Nancy	O'Farrel	Crocodile River Main Irrigation Board				nancy@rmputter.co.za
Mr	Walter	Walter	RCL Foods				Walter.Visser@rclfoods.com

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE						
Landowners						
Farm Name	**Farm No**	**Farm Portion**	**Owner 1**	**Owner 2**	**Contact No.**	**Email**
Montrose Dam Site						
Belmont	571	RE/571	Shavanda Holdings Pty Ltd	Jackman Michael John (Gail)	082 352 6170	jackman@mweb.co.za
Belmont	571	2/571	Lorraine Dicker	Lorraine Dicker	083 637 0939	dickerlorraine54@gmail.com
Montrose	574	574	Q C K Lezmin 4915 Pty Ltd	Cobus Joubert	083 227 2415	morne@joubertenseuns.co.za
Elandshoek	302	RE/19/302	Mashobotho Communal Prop Assoc			
Lindenau	303	RE/303	Lindenau Beleggings Pty Ltd			
Lindenau	303	2/303	Sibonelo Communal Property Assoc		082 453 5941	
Lindenau	303	4/303	Transnet Ltd	enquiries@transnet.net	011 308 3000	
Montrose	290	RE/2/290	Mokey Mountain Trading 189 Pty Ltd			
Montrose	290	RE/4/290	MH Guest Farm Pty Ltd	Petro	074 873 0779	mhguestfarm@gmail.com
Mooifontein	292	8/292	Malewu Communal Prop Assoc			
Elandshoek	302	RE/18/302	Mashobotho Communal Prop Assoc			
Mooifontein	292	3/292	Poplar Creek Farm Pty Ltd	Dawie Janse van Rensburg	083 680 1023 079 664 0649	admin@poplarcreek.co.za gm@poplarcreek.co.za
Sappi	307	307	Sappi Manufacturing Pty Ltd	Sappi Prop Co Pty Ltd		
Mooifontein	292	2/292	Poplar Creek Farm Pty Ltd	Dawie Janse van Rensburg	083 680 1023 079 664 0649	admin@poplarcreek.co.za gm@poplarcreek.co.za
Lindenau	303	1/303	Transnet Ltd		(011) 308 3000	enquiries@transnet.net
Mooifontein	292	1/292	Poplar Creek Farm Pty Ltd	Dawie Janse van Rensburg	083 680 1023 079 664 0649	admin@poplarcreek.co.za gm@poplarcreek.co.za
Elandshoek	302	RE/13/302	A B Snyman Eiendomme CC			
Lindenau	303	12/303	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Lindenau	303	11/303	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Montrose	573	RE/573	Q C K Lezmin 4915 Pty Ltd	Cobus Joubert	083 227 2415	morne@joubertenseuns.co.za
Belmont	571	1/571	Lorraine Dicker	Lorraine Dicker	083 637 0939	dickerlorraine54@gmail.com
Montrose	290	12/290	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Montrose	290	11/290	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Montrose	290	14/290	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Montrose	573	1/573	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Elandshoek	302	24/302	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Elandshoek	302	RE/7/302	Mashobotho Communal Prop Assoc			
Elandshoek	302	21/302	South African National Roads Agency Ltd	Victoria Bota	(012) 844 8031	BotaV@nra.co.za
Berlin	446	RE/446	Republiek van Suid-Afrika (Safcol)	Norman Khoza	078 803 5410	norman@safcol.co.za
Belmont	569	Belmont 569 JT	Sjoko Lodge Cc			013 733 4000

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE						
Landowners						
Farm Name	**Farm No**	**Farm Portion**	**Owner 1**	**Owner 2**	**Contact No.**	**Email**
Boschjeskop Dam Site						
Boschjeskop	250	R/3/250	Mooimaak Beleggings CC	Johan Pretorius	083 507 8997	j.j.p@lantic.net
Boschjeskop	250	22/250	Mooimaak Beleggings CC	Johan Pretorius	083 507 8997	j.j.p@lantic.net
Boschjeskop	250	51/250	Aproflo Pty Ltd	New Owner: Johan Barnard Previous Owner: Warrick Diesel	082 945 7563	barnardj@secunda.co.za 458diesel@gmail.com
Doornkraal	244	2/244	Republic of South Africa (Safcol)	Norman Khoza	078 803 5410	norman@safcol.co.za
Doornkraal	244	5/244	Donora Trust	Johan vd Merwe	082 557 6199	alpine@lantic.net
Boschjeskop	250	27/250	Roses Macadamia Shamba Farm CC	Lee Rose	076 230 7597	roses.shamba@gmail.com
Boschjeskop	250	19/250	Roses Macadamia Shamba Farm CC	Lee Rose	076 230 7597	roses.shamba@gmail.com
Boschjeskop	250	25/250	Nelsrif Boerdery Pty Ltd	Louis Marais Louis (jnr)	082 893 1518 083 269 5455	finansies@nelsrifboerdery.com louis.marais@nelsrifboerdery.com
No Data		28/250	Vzyl / Meul Estates / Roses Macadamia Shamba	Van Zyl Mantelo	082 454 2570	
Boschjeskop	250	5/250	Republic of South Africa (Safcol)	Norman Khoza	078 803 5410	norman@safcol.co.za
Boschjeskop	250	17/250	Muell Estates Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	8/250	M T O Forestry Pty Ltd	Stephen Gresse Cristoff Gresse	060 582 3104 065 607 1740	christoff@mto.co.za
Boschjeskop	250	26/250	Roses Macadamia Shamba Farm CC	Lee Rose	076 230 7597	roses.shamba@gmail.com
Boschjeskop	250	R/2/250	Shakoaneng Community Trust	Josephine Mashego	082 706 1683	
Boschjeskop	250	4/250	Republic of South Africa (Safcol)	Norman Khoza	078 803 5410	norman@safcol.co.za
Boschjeskop	250	33/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	32/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	30/250	Joubert & Joubert Landgoed CC	Henning Joubert	082 430 4966	henning@jjboerderye.co.za
Boschjeskop	250	34/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	35/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	31/250	Joubert & Joubert Landgoed CC	Henning Joubert	082 430 4966	henning@jjboerderye.co.za
Boschjeskop	250	36/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za
Boschjeskop	250	RE/250	K2014091900 Pty Ltd	Johan Wasserman	082 542 3952	management@muellestates.co.za

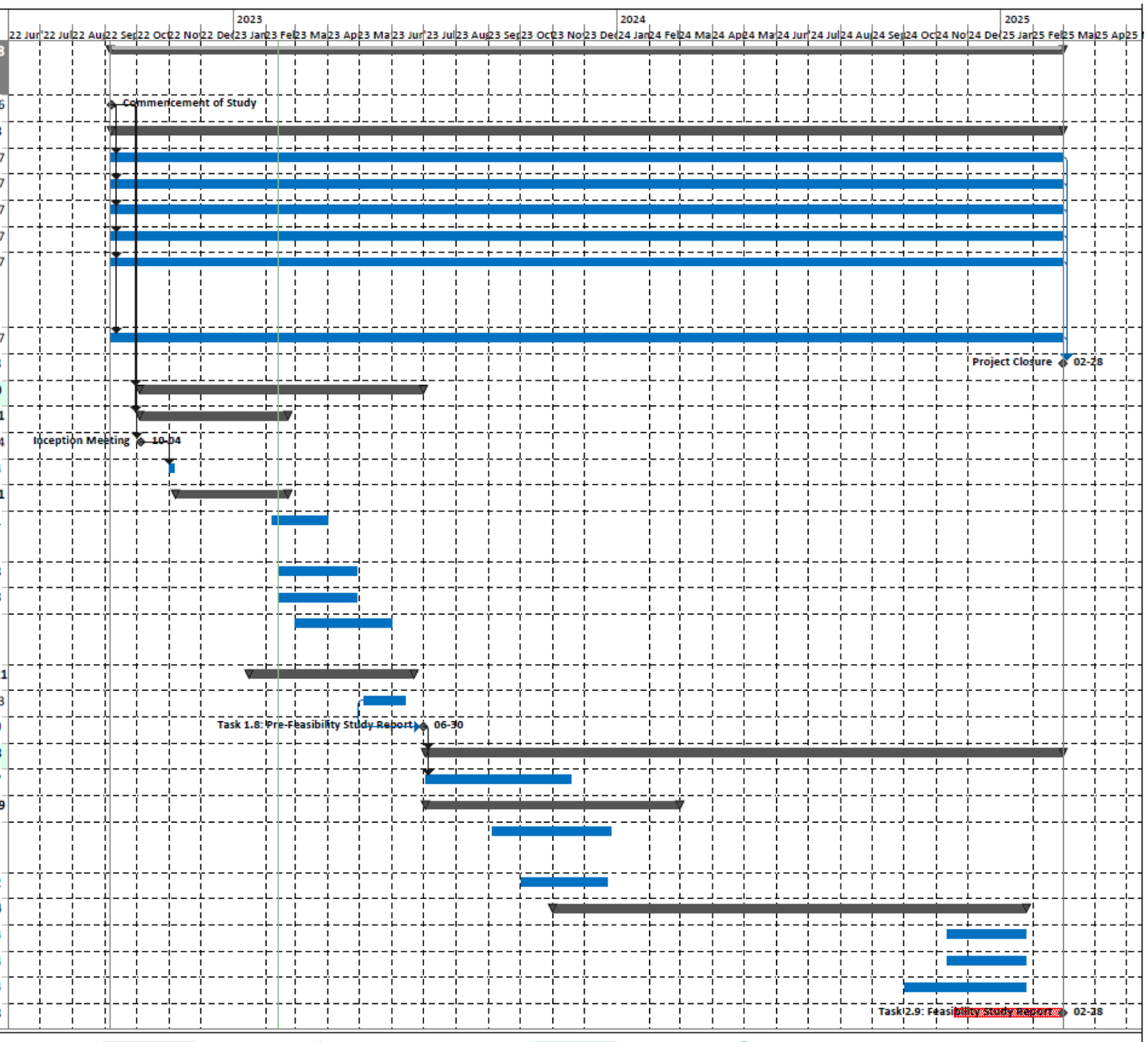
WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE						
Landowners						
Farm Name	**Farm No**	**Farm Portion**	**Owner 1**	**Owner 2**	**Contact No.**	**Email**
Mountain View Dam Site						
Mountain View	250	250	Danie Bosman Trust	Dr Danie Bosman	(013) 752 5251 082 455 1752	drbosman@mweb.co.za
Eureka Station	285	285	Transnet Ltd		(011) 308 3000	enquiries@transnet.net e-mail: enquiries@transnet.net
Oxo	224	224	Nelspruit Combined Butcheries Pty Ltd	Rudolph en Hester Sweitzer	(013) 752 4551 083 679 0702	admin@farmersmeats.co.za
Karline	269	Karline 269 JU	Dortannion Farm Pty Ltd	Deon van der Schyff	083 988 8639	gjvanderschyff@gmail.com
Lovedale	277	8/277	Venter Sjoerdtje Elizabeth	Daniel Venter Gustaf Venter	083 679 7536	daniel@siyalima.co.za
Lovedale	277	12/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za
Lovedale	277	14/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za
Lovedale	277	15/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za
Lovedale	277	18/277	Martin Bruwer Familie Trust	Justin van Straaten	076 512 9124	martinbruwer.boerdery@gmail.com
Lovedale	277	20/277	Little Swift Inv 67 Pty Ltd	Johan Venter	083 629 0665	jventer@ttslimpopo.co.za
Lovedale	277	23/277	Kleingeluk Vars Produkte CC	Bertie Venter	082 440 6979	venter.bertie@gmail.com
Lovedale	277	25/277	Bruin Tyrone Roque De	Kobus de Bruin	082 451 9062	siyayaveg@gmail.com
Klipriviersberg	225	225	Klipren Beleggings Pty Ltd	Charles Venter	(013) 753 2705 082 878 1060	Charles@cvgroup.co.za
Perl	278	1/278	Perl Trust	Gustav van Staden	083 633 5388	gustav@siyalima.co.za
Lovedale	277	3/277	Perl Trust	Gustav van Staden	083 633 5388	gustav@siyalima.co.za
Lovedale	277	4/277	Laeveld Oliemeule Pty Ltd	Riaan van Wyk	081 452 4287	riaan@3baard.com riaan@interafricagroup.com
Lovedale	277	5/277	Whiteman Johannes Andreas	Andre Whiteman	079 884 7954	a.whiteman.jnr@gmail.com
Lovedale	277	7/277	Venter Sjoerdtje Elizabeth	Daniel Venter	083 679 7536	daniel@siyalima.co.za
Eureka Station	285	285	Transnet Ltd		(011) 308 3000	enquiries@transnet.net
Lovedale	277	47/277	Ukuzinikela Group Pty Ltd	Riaan van Wyk	081 452 4287	riaan@3baard.com riaan@interafricagroup.com
Stonehaven	227	227	Elangeni Boerdery Pty Ltd			
Koedoeskraal	276	276	Koedoeskamp Boerdery CC	Matthys Swanepoel	082 390 1000	info@mac-nificent.co.za
Lovedale	277	11/277	Magam Kayalikude	MAGAM COLANI REGINA	072 551 9019	kayalikugem11@gmail.com
Lovedale	277	13/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za
Koedoeskraal	276	4/276	Morgan Creek Prop 400 Pty (*)	Christo Bester	083 305 8194	bester_c@mweb.co.za
Lovedale	277	6/277	Merwe John Phillip Van Der	John vd Merwe	079 699 6381	john@bushcolour.co.za
Lovedale	277	45/277	Honeybird Nest Holdings Pty Ltd	Delpina Rister	076 190 8530	delph.rister@gmail.com
Lovedale	277	9/277	Venter Sjoerdtje Elizabeth	Daniel Venter	083 679 7536	daniel@siyalima.co.za
Lovedale	277	16/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE						
Landowners						
Farm Name	**Farm No**	**Farm Portion**	**Owner 1**	**Owner 2**	**Contact No.**	**Email**
Mountain View Dam Site						
Lovedale	277	19/277	Martin Bruwer Familie Trust	Justin	076 512 9124	martinbruwer.boerdery@gmail.com
Lovedale	277	22/277	Opperman Jacobus Johannes	Bouwer	082 448 1291	bouwer777@icloud.com
Lovedale	277	24/277	Huyssteen Anna Elizabeth Margarete Van	Johan van der Merwe	083 286 9847	jpcontractor@mweb.co.za
Lovedale	277	26/277	Dominietto Adriane	Adri	084 604 5241	nelspruit.lcrcad@saps.gov.za
Lovedale	277	21/277	Han Han Trust	Johan Grobler	082 899 7898	johan@spoormpu.co.za
Lovedale	277	27/277	J C Family Trust	Ian Macoly	082 600 8070	No email address - phone him
Lovedale	277	46/277	Botha Sarel Jacobus	Sarel Botha	078 023 5610	elsiebotha54@gmail.com
Lovedale	277	2/277	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za
Lovedale	277	10/277	F J Botha Trust	Johan van Rensburg	082 532 3156	johan@siyalima.co.za
Lovedale	277	17/277	Leon Venter Familie Trust	Riaan van Wyk	081 452 4287	riaan@3baard.com riaan@interafricagroup.com
Bushbuck Hill	251	251	F R Boerdery CC	Barend van Rensburg	082 806 4885	barend@rensberg.co.za
Hillsowen	249	3/249	F R BOERDERY CC	Barend van Rensburg	082 806 4885	barend@rensberg.co.za
Naudes Rust	272	2/272	Dortannion Farm Pty Ltd	Pieter Whiteman	073 166 6501	dortan@soft.co.za

WP11393: CROCODILE EAST WATER PROJECT (CEWP) - DRAFT STAKEHOLDER DATABASE						
Landowners						
Farm Name	**Farm No**	**Farm Portion**	**Owner 1**	**Owner 2**	**Contact No.**	**Email**
Strathmore						
Strathmore	214	58/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
Strathmore	214	173/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
Strathmore	214	57/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
Strathmore	214	37/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
Strathmore	214	50/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
Strathmore	214	RE/1/214	Radley Landgoed Pty Ltd	Renald Radley	082 388 3640 (013) 790 0466	renald@radleylg.co.za info@radleylg.co.za
Strathmore	214	125/214	Libuyile Community Trust	Mosa Chirwa (Chairman in 2021: Libuyile Community Trust)	072 112 7870	chirwamosam@gmail.com lomafa@me.com
JU	655	RE/655	Blue Cloud Inv 73 Pty Ltd			

Appendix C Study Programme

ID	WBS	Task Name	Duration	Start	Finish
0	**0**	**WP11393: CROCODILE EAST WATER PROJECT MODULE 1: TECHNICAL FEASIBILITY STUDY**	**31,05 mons**	**Tue 22-09-06**	**Fri 25-02-28**
1	1	Commencement of Study	1 day	Tue 22-09-06	Tue 22-09-06
2	**2**	**Project Management**	**31 mons**	**Wed 22-09-07**	**Fri 25-02-28**
3	2.1	Meetings: Project Management Committee (PMC) (Admin/Technic	30,95 mons	Wed 22-09-07	Thu 25-02-27
4	2.2	Meetings: Project Steering Committee (PSC)	30,95 mons	Wed 22-09-07	Thu 25-02-27
5	2.3	Public Relations Meetings	30,95 mons	Wed 22-09-07	Thu 25-02-27
6	2.4	Ad-hoc Meetings	30,95 mons	Wed 22-09-07	Thu 25-02-27
7	2.5	Project Coordination, Planning and Monitoring, Information Management, Risk Management, QA & Control, General Project Management	30,95 mons	Wed 22-09-07	Thu 25-02-27
8	2.6	Capacity Building and Training (2 No one day Workshops)	30,95 mons	Wed 22-09-07	Thu 25-02-27
9	2.7	Project Closure	0 mons	Fri 25-02-28	Fri 25-02-28
10	**3**	**Phase 1: Pre-Feasibility Study**	**9,05 mons**	**Tue 22-10-04**	**Fri 23-06-30**
11	**3.1**	**Task 1.1: Study Inception**	**4,4 mons**	**Tue 22-10-04**	**Tue 23-02-21**
12	3.1.1	Inception Meeting	0,05 mons	Tue 22-10-04	Tue 22-10-04
13	3.1.2	Site Visits	0,2 mons	Tue 22-11-01	Fri 22-11-04
14	**3.1.3**	**Inception Report**	**3,2 mons**	**Mon 22-11-07**	**Tue 23-02-21**
20	3.2	Task 1.2: Ecological Consequences ito the National Water Resource Class, etc	1,95 mons	Tue 23-02-07	Fri 23-03-31
21	3.3	Task 1.3: Perform/Review Historic Yield Analysis	2,7 mons	Tue 23-02-14	Fri 23-04-28
22	3.4	Task 1.4: Environmental Screening and Fatal Flaws	2,7 mons	Tue 23-02-14	Fri 23-04-28
23	3.5	Task 1.5: Perform/Review (Pre-Feasibility) Geotechnical and Materials Investigation	3,3 mons	Wed 23-03-01	Wed 23-05-31
24	**3.6**	**Task 1.6: Engineering Investigation**	**5,65 mons**	**Mon 23-01-16**	**Wed 23-06-21**
28	3.7	Task 1.7: Multi-Criteria Analysis	1,4 mons	Fri 23-05-05	Tue 23-06-13
29	3.8	Task 1.8: Pre-Feasibility Study Report	1,85 mons	Thu 23-05-11	Fri 23-06-30
30	**4**	**Phase 2: Feasibility Study**	**21 mons**	**Mon 23-07-03**	**Fri 25-02-28**
31	4.1	Task 2.1: Environmental Screening	5 mons	Mon 23-07-03	Fri 23-11-17
32	**4.2**	**Task 2.2: Water Resources**	**8,7 mons**	**Mon 23-07-03**	**Thu 24-02-29**
39	4.3	Task 2.3: Ecological Consequences ito the National Water Resource Class, etc	4,05 mons	Mon 23-09-04	Mon 23-12-25
40	4.4	Task 2.4: Socio-Economic Impacts	3 mons	Mon 23-10-02	Fri 23-12-22
41	**4.5**	**Task 2.5: Engineering Investigation**	**15,4 mons**	**Wed 23-11-01**	**Fri 25-01-24**
57	4.6	Task 2.6: Implementation Actions	2 mons	Mon 24-11-11	Fri 25-01-24
58	4.7	Task 2.7: Record of Implementation Decisions	2 mons	Mon 24-11-11	Fri 25-01-24
59	4.8	Task 2.8: Institutional, Financial and Operational Aspects	3,45 mons	Tue 24-10-01	Fri 25-01-24
60	4.9	Task 2.9: Feasibility Study Report	3 mons	Mon 24-11-18	Fri 25-02-28



Project: WP11393: CROCODILE EAST WATER PROJEC
Date: Mon 23-02-13

Task · Milestone · External Tasks · Inactive Milestone · Duration-only · Start-only · Progress
Critcal Task · Summary · External Milestone · Inactive Summary · Manual Summary Rollup · Finish-only · Manual Progress
Split · Project Summary · Inactive Task · Manual Task · Manual Summary · Deadline

Appendix D Cash Flow

Table D-1: Deliverable Schedule

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
Pre-Feasibility Study: Inception (Month 1 - 5)							
2		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	90,312.50	15,843.10
2	1.1.1	PFS: Study Inception Meeting	2.2.1	Inception Meeting	Agenda, presentation, attendance register, minutes	37,950.00	250.00
2	1.1.2	PFS: Data collection and review	2.2.1	Review of all work done in previous studies	List and copies of previous relevant reports (Data register)	89,600.00	
3	1.1.3	PFS: Site visits	2.2.1	Site visits (four dams)	Attendance registers, site visit itinerary, etc	144,000.00	30,280.00
3		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	90,312.50	15,843.10
4	1.1.4	PFS: Inception Report (Draft)	2.2.1	Inception Report	Draft Inception Report	199,475.00	
4		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Co-ordination, management	90,312.50	15,843.10
5	1.1.4	PFS: Inception Report (Final)	2.2.1	Inception Report	Final Inception Report	120,325.00	
5		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	90,312.50	15,843.10
5	1.6.1	PFS: Topographical survey and aerial photography	2.2.1	Survey information, aerial photography	Lidar DTM data, topographical mapping, photographs	0.00	129,920.00
Pre-Feasibility Study: (Month 6 - 10)							
6		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	32,530.00	15,843.10
6		PFS: Management	2.2.3	Public Meeting 1	Arrange venue, invitations, agenda, minutes, presentations	90,000.00	25,000.00
6	1.6.1	PFS: Topographical survey and aerial photography	2.2.1	Survey information, aerial photography	Lidar DTM data, topographical mapping, photographs	0.00	50,080.00
6	1.6.2	PFS: Proposed scheme configurations	2.2.1	Proposed scheme configurations	Report / chapter in PFS Report	0.00	
6	1.3	PFS: Perform/Review historic yield analysis	2.2.1	Yield analysis	Report / chapter in PFS Report	32,933.33	
6	1.4	PFS: Environmental screening and fatal flaws	2.2.1	Screening and fatal flaws	Report / chapter in PFS Report	53,833.33	
6	1.2	PFS: Ecological consequences	2.2.1	Existing Reserve Impact Assessment	Report / chapter in PFS Report	162,666.67	
7		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	32,530.00	15,843.10
7	1.2	PFS: Ecological consequences	2.2.1	Existing Reserve Impact Assessment	Report / chapter in PFS Report	162,666.67	
7	1.4	PFS: Environmental screening and fatal flaws	2.2.1	Screening and fatal flaws	Report / chapter in PFS Report	53,833.33	
7	1.5	PFS: Perform/Review geotechnical and materials investigations	2.2.1	Perform/Review geotechnical and materials investigation	Report / chapter in PFS Report	0.00	
7	1.6.1	PFS: Topographical survey and aerial photography	2.2.1	Survey information, aerial photography	Lidar DTM data, topographical mapping, photographs	0.00	
7	1.6.2	PFS: Proposed scheme configurations	2.2.1	Proposed scheme configurations	Report / chapter in PFS Report	232,900.00	
7	1.3	PFS: Perform/review historic yield analysis	2.2.1	Project management, meeting	Report / chapter in PFS Report	32,933.33	
8		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	32,530.00	15,843.10
8	1.2	PFS: Ecological consequences	2.2.1	Existing Reserve Impact Assessment	Report / chapter in PFS Report	162,666.67	
8	1.5	PFS: Geotechnical and materials investigations	2.2.1	Geotechnical and materials investigation	Report / chapter in PFS Report	42,900.00	
8	1.4	PFS: Environmental screening and fatal flaws	2.2.1	Environmental screening	Report / chapter in PFS Report	53,833.34	
8	1.6.3	PFS: Engineering economic analysis	2.2.1	Lifecycle costs, URV's	Report / chapter in PFS Report	0.00	
8	1.6.2	PFS: Proposed scheme configurations	2.2.1	Proposed scheme configurations	Report / chapter in PFS Report	232,900.00	

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
8	1.6.1	PFS: Topographical survey and aerial photography	2.2.1	Survey information, aerial photography	Lidar DTM data, topographical mapping, photographs	0.00	
8	1.3	PFS: Perform/review historic yield analysis	2.2.1	Project management, meeting	Report / chapter in PFS Report	32,933.33	
9		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	32,530.00	15,843.10
9	1.5	PFS: Geotechnical and materials investigations	2.2.1	Geotechnical and materials investigation	Report / chapter in PFS Report	42,900.00	
9	1.6.3	PFS: Engineering economic analysis	2.2.1	Lifecycle costs, URV's	Report / chapter in PFS Report	0.00	
9	1.7	PFS: Multi-criteria analysis	2.2.1	Multi-criteria matrix	Report / chapter in PFS Report	0.00	
9	1.8	PFS: Pre-Feasibility Report	2.2.1	Pre-Feasibility Report with recommended option	Pre-Feasibility Report (Draft)	39,000.00	
10		PFS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	32,530.00	15,843.10
10	1.6.3	PFS: Engineering economic analysis	2.2.1	Lifecycle costs, URV's	Report / chapter in PFS Report	50,800.00	
10	1.7	PFS: Multi-criteria analysis	2.2.1	Multi-criteria matrix	Report / chapter in PFS Report	50,800.00	
10	1.8	PFS: Pre-Feasibility Report	2.2.1	Pre-Feasibility Report with recommended option	Pre-Feasibility Report (Final)	39,000.00	
Feasibility Study (Month 11 - 30)							
11		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
11	2.1	FS: Environmental screening and fatal flaws	2.2.2	Environmental screening	Report / chapter in FS Report	29,640.00	
11	2.2.1	FS: Determine existing and future water demands	2.2.4	Water demands	Chapter in Water Resources Report	33,125.00	
11		PFS: Management	2.2.3	Public Meeting 2	Arrange venue, invitations, agenda, minutes, presentations	113,200.00	25,000.00
12		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
12	2.1	FS: Environmental screening and fatal flaws	2.2.2	Environmental screening	Report / chapter in FS Report	29,640.00	
12	2.2.1	FS: Determine existing and future water demands	2.2.4	Water demands	Chapter in Water Resources Report	33,125.00	
13		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
13	2.1	FS: Environmental screening and fatal flaws	2.2.2	Environmental screening	Report / chapter in FS Report	29,640.00	
13	2.3	FS: Ecological consequences ito the NWR Class	2.2.4	Determine the ecological consequences	Report / Chapter in FS Report	0.00	
13	2.2.1	FS: Determine existing and future water demands	2.2.4	Water demands	Chapter in Water Resources Report	33,125.00	
14		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
14	2.1	FS: Environmental screening and fatal flaws	2.2.2	Environmental screening	Report / chapter in FS Report	29,640.00	
14	2.3	FS: Ecological consequences ito the NWR Class	2.2.4	Determine the ecological consequences	Report / chapter in FS Report	0.00	
14	2.4	FS: Socio-economic aspects	2.2.4	Socio-economic aspects	Report / chapter in FS Report	44,166.67	
14	2.2.1	FS: Determine existing and future water demands	2.2.4	Water demands	Chapter in Water Resources Report	33,125.00	
14	2.2.2	FS: Yield analysis with the water resources yield model	2.2.4	Yield analysis	Chapter in Water Resources Report	91,000.00	
15		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
15	2.1	FS: Environmental screening and fatal flaws	2.2.2	Environmental screening	Report / chapter in FS Report	29,640.00	
15	2.2.2	FS: Yield analysis with the water resources yield model	2.2.4	Yield analysis	Chapter in Water Resources Report	91,000.00	
15	2.3	FS: Ecological consequences ito the NWR Class	2.2.4	Determine the ecological consequences	Report / chapter in FS Report	0.00	

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
15	2.4	FS: Socio-economic aspects	2.2.4	Socio-economic aspects	Report / chapter in FS Report	44,166.67	
15	2.2.4	FS: Develop short-term stochastic yield reliability curves	2.2.4	Yield reliability curves	Report / chapter in FS Report	0.00	
15	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	99,700.00	
15	2.2.5	FS: Water resources planning model	2.2.4	Planning model	Chapter in Water Resources Report	0.00	
15	2.2.3	FS: Future water balance for the project	2.2.4	Water balance	Chapter in Water Resources Report	143,000.00	
16		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
16	2.2.4	FS: Develop short-term stochastic yield reliability curves	2.2.4	Yield reliability curves	Chapter in Water Resources Report	71,500.00	
16	2.2.5	FS: Water resources planning model	2.2.4	Planning model	Chapter in Water Resources Report	47,666.67	
16	2.3	FS: Ecological consequences ito the NWR Class	2.2.4	Determine the ecological consequences	Report / chapter in FS Report	0.00	
16	2.4	FS: Socio-economic aspects	2.2.4	Socio-economic aspects	Report / chapter in FS Report	44,166.67	
16	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	99,700.00	
16	2.5.1	FS: Topo surveys and mapping	2.2.5	Surveys	Lidar DTM data, topographical mapping, photographs	0.00	
17		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
17	2.2.4	FS: Develop short-term stochastic yield reliability curves	2.2.4	Yield reliability curves	Chapter in Water Resources Report	71,500.00	
17	2.2.5	FS: Water resources planning model	2.2.4	Planning model	Chapter in Water Resources Report	47,666.67	
17	2.2.6	FS: Assessment for the potential for hydropower (Water resources)	2.2.4	Assessment for the potential for hydropower	Chapter in Water Resources Report	87,800.00	
17	2.5.1	FS: Topo surveys and mapping	2.2.5	Surveys	Lidar DTM data, topographical mapping, photographs	0.00	
17	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	99,700.00	
17	2.5.3	FS: Geomorphological and seismic investigation	2.2.5	Geomorphological and seismic investigation	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	
17	2.5.4	FS: Flood studies	2.2.5	Flood studies & dam runoffs	Report / chapter in Engineering Investigation Report / chapter in FS Report	24,733.33	
17	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	0.00	
18		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
18	2.2.5	FS: Water resources planning model	2.2.4	Planning model	Chapter in Water Resources Report	47,666.67	
18	2.2.6	FS: Assessment for the potential for hydropower (Water resources)	2.2.4	Assessment for the potential for hydropower	Chapter in Water Resources Report	87,800.00	
18	2.5.1	FS: Topo surveys and mapping	2.2.5	Surveys	Lidar DTM data, topographical mapping, photographs	0.00	
18	2.5.3	FS: Geomorphological and seismic investigation	2.2.5	Geomorphological and seismic investigation	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	
18	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	99,700.00	
18	2.5.4	FS: Flood studies	2.2.5	Flood studies & dam runoffs	Report / chapter in Engineering Investigation Report / chapter in FS Report	24,733.33	

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
18	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	0.00	
19		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
19	2.5.1	FS: Topo surveys and mapping	2.2.5	Surveys	Chapter in Water Resources Report	0.00	
19	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	99,700.00	
19	2.5.3	FS: Geomorphological and seismic investigation	2.2.5	Geomorphological and seismic investigation	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	
19	2.5.4	FS: Flood studies	2.2.5	Flood studies & dam runoffs	Report / chapter in Engineering Investigation Report / chapter in FS Report	24,733.33	
19	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	0.00	
20		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
20		PFS: Management	2.2.3	Public Meeting 3	Arrange venue, invitations, agenda, minutes, presentations	113,200.00	25,000.00
20	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
20	2.5.4	FS: Flood studies	2.2.5	Flood studies & dam runoffs	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
20	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
21		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
21	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
21	2.5.4	FS: Flood studies	2.2.5	Flood Studies & dam runoffs	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
21	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
21	2.5.6	FS: Construction programming and costing	2.2.5	Construction cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
21	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
22		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
22	2.5.2	FS: Geological and geotechnical investigations	2.2.5	Geological and geotechnical investigations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
22	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
22	2.5.6	FS: Construction programming and costing	2.2.5	Construction cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
22	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
23		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
23	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	

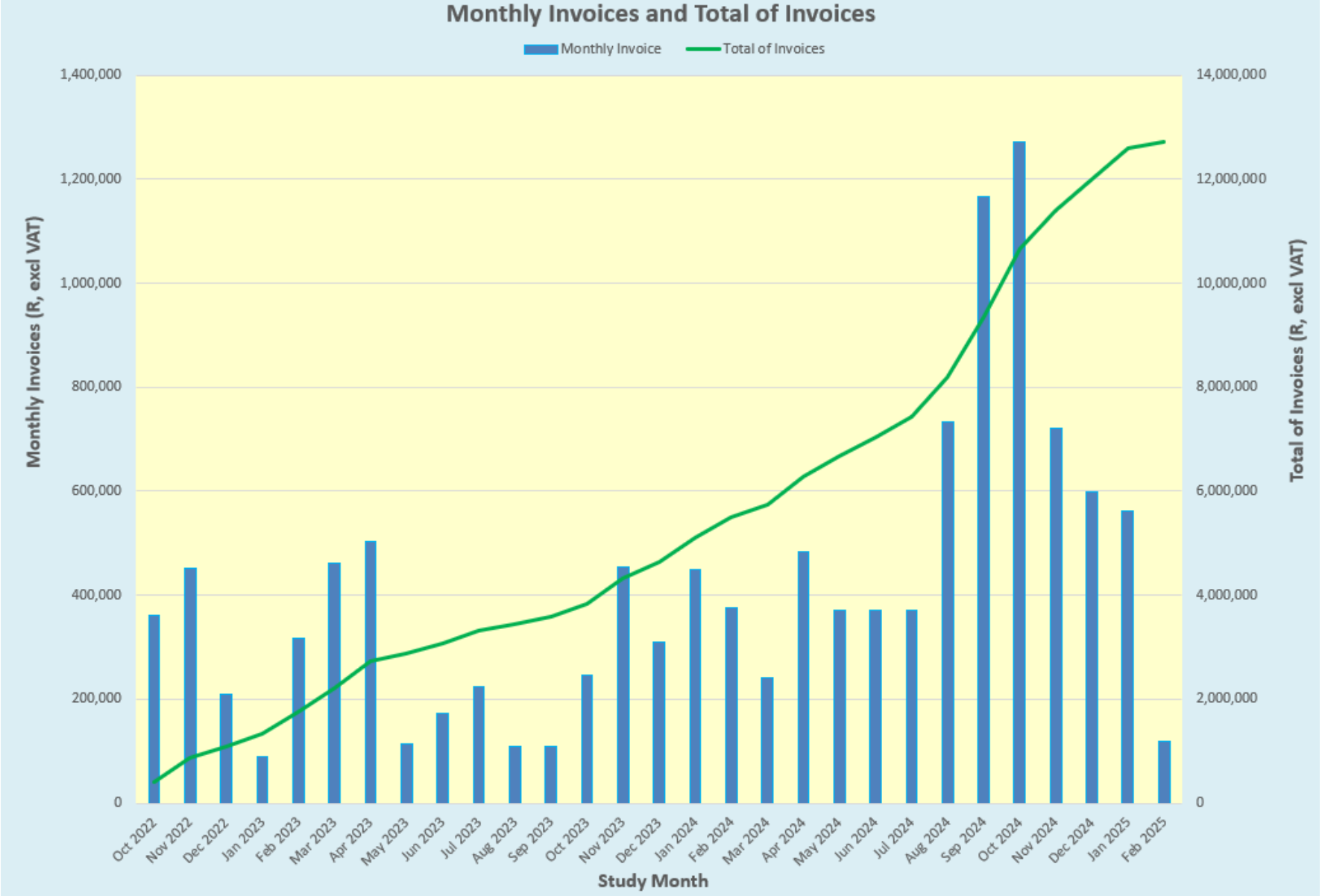
Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
23	2.5.6	FS: Construction programming and costing	2.2.5	Cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
23	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
23	2.5.8	FS: Flood and backwater calculations for the dam	2.2.5	Backwater calculations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
23	2.5.9	FS: Climatological data for the construction site	2.2.5	Climatological data	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
23	2.5.10	FS: Water quality and limnology	2.2.5	Water quality and limnology	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
24		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
24	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report / Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
24	2.5.6	FS: Construction programming and costing	2.2.5	Construction cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	246,133.33	
24	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	117,000.00	
24	2.5.8	FS: Flood and backwater calculations for the dam	2.2.5	Backwater calculations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
24	2.5.9	FS: Climatological data for the construction site	2.2.5	Climatological data	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
24	2.5.10	FS: Water quality and limnology	2.2.5	Water quality and limnology	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
24	2.5.13	FS: Assessment for the potential for hydropower (Engineering)	2.2.4	Potential for hydropower	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
24	2.5.11	FS: Sediment yield and sedimentation investigation	2.2.5	Sediment yield	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
25		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
25	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report/ Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
25	2.5.6	FS: Construction programming and costing	2.2.5	Cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	246,133.33	
25	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	117,000.00	
25	2.5.8	FS: Flood and backwater calculations for the dam	2.2.5	Backwater calculations	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
25	2.5.9	FS: Climatological data for the construction site	2.2.5	Climatological data	Report / chapter in Engineering Investigation Report / chapter in FS Report	21,800.00	
25	2.5.10	FS: Water quality and limnology	2.2.5	Water quality and limnology	Report / chapter in Engineering Investigation Report / chapter in FS Report	52,266.67	
25	2.5.13	FS: Assessment for the potential for hydropower (Engineering)	2.2.4	Potential for hydropower	Report / chapter in Engineering Investigation Report / chapter in FS Report	87,800.00	
25	2.5.14	FS: Costing (CAPEX and OPEX) of the project	2.2.5	Project costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
25	2.5.11	FS: Sediment yield and sedimentation investigation	2.2.5	Sediment yield	Report / chapter in Engineering Investigation Report / chapter in FS Report	269,639.67	
26		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
26	2.8	FS: Institutional, financial and operational aspects	2.2.7	Institutional, financial and operational aspects	Report / chapter in FS Report	0.00	
26	2.5.5	FS: Feasibility design of the selected scheme	2.2.5	Feasibility design of the dam alternatives	Report/ Chapter in Engineering Investigation Report/Chapter in FS Report	323,514.29	
26	2.5.6	FS: Construction programming and costing	2.2.5	Construction cost estimates	Report / chapter in Engineering Investigation Report / chapter in FS Report	246,133.33	
26	2.5.7	FS: Access and advanced infrastructure	2.2.5	Access and advanced infrastructure	Report / chapter in Engineering Investigation Report / chapter in FS Report	117,000.00	
26	2.5.8	FS: Flood and backwater calculations for the dam	2.2.5	Backwater calculations	Report / chapter in Engineering Investigation Report / chapter in FS Report	76,100.00	
26	2.5.9	FS: Climatological data for the construction site	2.2.5	Climatological data	Report / chapter in Engineering Investigation Report / chapter in FS Report	21,800.00	
26	2.5.10	FS: Water quality and limnology	2.2.5	Water quality and limnology	Report / chapter in Engineering Investigation Report / chapter in FS Report	52,266.67	
26	2.5.11	FS: Sediment yield and sedimentation investigation	2.2.5	Sediment yield	Report / chapter in Engineering Investigation Report / chapter in FS Report	269,639.67	
26	2.5.12	FS: Land requirements and associated costs	2.2.5	Land requirements and costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	30,500.00	
26	2.5.13	FS: Assessment for the potential for hydropower (Engineering)	2.2.4	Potential for hydropower	Report / chapter in Engineering Investigation Report / chapter in FS Report	87,800.00	
26	2.5.14	FS: Costing (CAPEX and OPEX) of the project	2.2.5	Project costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
26	2.5.15	FS: Engineering economic analysis	2.2.5	Economics, URVs, Costing	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
27		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
27	2.6	FS: Implementation actions	2.2.6	Implementation actions	Implementation programme / Chapter in FS Report	0.00	
27	2.7	FS: Record of implementation decisions	2.2.6	Record of implementation decisions	Record of decisions	0.00	
27	2.8	FS: Institutional, financial and operational aspects	2.2.7	Institutional, financial and operational aspects	Report / chapter in Engineering Investigation Report / chapter in FS Report	138,666.67	
27	2.5.8	FS: Flood and backwater calculations for the dam	2.2.5	Backwater calculations	Report / chapter in Engineering Investigation Report / chapter in FS Report	76,100.00	
27	2.5.10	FS: Water quality and limnology	2.2.5	Water quality and limnology	Report / chapter in Engineering Investigation Report / chapter in FS Report	52,266.67	
27	2.5.11	FS: Sediment yield and sedimentation investigation	2.2.5	Sediment yield	Report / chapter in Engineering Investigation Report / chapter in FS Report	269,639.67	
27	2.5.12	FS: Land requirements and associated costs	2.2.5	Land requirements and costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	30,500.00	
27	2.5.13	FS: Assessment for the potential for hydropower (Engineering)	2.2.4	Potential for hydropower	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
27	2.5.14	FS: Costing (CAPEX and OPEX) of the project	2.2.5	Project costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	36,400.00	
27	2.5.15	FS: Engineering economic analysis	2.2.5	Economics, URVs, Costing	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	
28		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
28	2.5.14	FS: Costing (CAPEX and OPEX) of the project	2.2.5	Project costs	Report / chapter in Engineering Investigation Report / chapter in FS Report	36,400.00	
28	2.5.15	FS: Engineering economic analysis	2.2.5	Economics, URVs, Costing	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	

Study Month	Task No	Abbreviated Task Name	Contract Reference	Sub Task Deliverable	Type of Deliverable	Fees (excl VAT)	Disbursements (excl VAT)
28	2.6	FS: Implementation actions	2.2.6	Implementation actions	Implementation programme / Chapter in FS Report	117,000.00	
28	2.7	FS: Record of implementation decisions	2.2.6	Record of implementation decisions	Record of decisions	117,000.00	
28	2.8	FS: Institutional, financial and operational aspects	2.2.7	Institutional, financial and operational aspects	Report / chapter in Engineering Investigation Report / chapter in FS Report	138,666.67	
28	2.9	FS: Feasibility Study Report	2.2.5	Feasibility Study Report	Feasibility Study Report (Draft)	71,600.00	
29		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
29	2.5.15	FS: Engineering economic analysis	2.2.5	Economics, URVs, Costing	Report / chapter in Engineering Investigation Report / chapter in FS Report	69,333.33	
29	2.6	FS: Implementation actions	2.2.6	Implementation actions	Implementation programme / Chapter in FS Report	117,000.00	
29	2.7	FS: Record of implementation decisions	2.2.6	Record of implementation decisions	Record of decisions	117,000.00	
29	2.8	FS: Institutional, financial and operational aspects	2.2.7	Institutional, financial and operational aspects	Report / chapter in Engineering Investigation Report / chapter in FS Report	138,666.67	
29	2.9	FS: Feasibility Study Report	2.2.5	Feasibility Study Report	Feasibility Study Report (Draft)	71,600.00	
30		FS: Management	2.2.3	Project coordination & management, QA, risk management, etc	Management, agenda, minutes, presentation	47,607.50	15,843.10
30	2.8	FS: Institutional, financial and operational aspects	2.2.7	Institutional, financial and operational aspects	Report / chapter in Engineering Investigation Report / chapter in FS Report	0.00	
30	2.9	FS: Feasibility Study Report	2.2.5	Feasibility Study Report	Feasibility Study Report (Final)	71,600.00	5,020.00
Total						**11,975,519.00**	**750,000.00**

Table D-2: Summary of Cash Flow

Month	Study Month	Manhours Cost	Disbursements	Total	Total Accumulative
Oct 2022	2	361,862.50	46,373.10	408,235.60	408,235.60
Nov 2022	3	451,287.50	15,843.10	467,130.60	875,366.21
Dec 2022	4	210,637.50	15,843.10	226,480.60	1,101,846.81
Jan 2023	5	90,312.50	145,763.10	236,075.60	1,337,922.41
Feb 2023	6	318,130.00	90,923.10	409,053.10	1,746,975.52
Mar 2023	7	461,030.00	15,843.10	476,873.10	2,223,848.62
Apr 2023	8	503,930.00	15,843.10	519,773.10	2,743,621.72
May 2023	9	114,430.00	15,843.10	130,273.10	2,873,894.83
Jun 2023	10	173,130.00	15,843.10	188,973.10	3,062,867.93
Jul 2023	11	223,572.50	40,843.10	264,415.60	3,327,283.53
Aug 2023	12	110,372.50	15,843.10	126,215.60	3,453,499.14
Sep 2023	13	110,372.50	15,843.10	126,215.60	3,579,714.74
Oct 2023	14	245,539.17	15,843.10	261,382.27	3,841,097.01
Nov 2023	15	455,114.17	15,843.10	470,957.27	4,312,054.28
Dec 2023	16	310,640.83	15,843.10	326,483.94	4,638,538.22
Jan 2024	17	448,340.83	15,843.10	464,183.94	5,102,722.16
Feb 2024	18	376,840.83	15,843.10	392,683.94	5,495,406.09
Mar 2024	19	241,374.17	15,843.10	257,217.27	5,752,623.36
Apr 2024	20	484,321.79	40,843.10	525,164.89	6,277,788.25
May 2024	21	371,121.79	15,843.10	386,964.89	6,664,753.14
Jun 2024	22	371,121.79	15,843.10	386,964.89	7,051,718.03
Jul 2024	23	371,121.79	15,843.10	386,964.89	7,438,682.92
Aug 2024	24	734,255.12	15,843.10	750,098.22	8,188,781.14
Sep 2024	25	1,165,761.45	15,843.10	1,181,604.56	9,370,385.70
Oct 2024	26	1,272,361.45	15,843.10	1,288,204.56	10,658,590.25
Nov 2024	27	720,513.83	15,843.10	736,356.94	11,394,947.19
Dec 2024	28	597,607.50	15,843.10	613,450.60	12,008,397.79
Jan 2025	29	561,207.50	15,843.10	577,050.60	12,585,448.40
Feb 2025	30	119,207.50	20,863.10	140,070.60	12,725,519.00
		11,975,519.00	**750,000.00**	**12,725,519.00**	


Monthly Invoices and Total of Invoices
Monthly Invoice
Total of Invoices
Monthly Invoices (R, excl VAT)
Total of Invoices (R, excl VAT)
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Oct 2022
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Nov 2024
Dec 2024
Jan 2025
Feb 2025
Study Month

Appendix E Summary of Team Member Manhours per Study Task

Table E-1: Summary of Team Member Manhours per Study Task

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
Project Management					
	Project Management				
		Seago, C	32	R1,300.00	R41,600.00
		Serfontein, E	120	R1,300.00	R156,000.00
		Scholtz, W	51	R1,300.00	R66,300.00
		Louw, L	720	R1,300.00	R936,000.00
		Morgan, G	60	R900.00	R54,000.00
		Royston, J	60	R900.00	R54,000.00
		Kubheka, M	60	R500.00	R30,000.00
		Aird, R	8	R1,250.00	R10,000.00
		Lotter, A	194	R750.00	R145,500.00
		Hopkins, T	39	R950.00	R37,050.00
		Anderson, H	64	R1,300.00	R83,200.00
		Hattingh, L	108	R1,300.00	R140,400.00
		Mouton, D	8	R1,300.00	R10,400.00
		Steyn, G	8	R1,300.00	R10,400.00
		Louw, D	16	R1,100.00	R17,600.00
Project Management (Pre-Feasibility and Feasibility Study) TOTAL					**R1,792,450.00**
Phase 1: Pre-Feasibility Study					
1.1	Study Inception				
		Seago, C	0	R1,300.00	R0.00
		Serfontein, E	48	R1,300.00	R62,400.00
		Louw, L	48	R1,300.00	R62,400.00
		Mxhegwana, Z	40	R400.00	R16,000.00
		Anderson, H	8	R1,300.00	R10,400.00
		Hattingh, L	20	R1,300.00	R26,000.00
		Basson, G	58	R1,900.00	R110,200.00
		Mouton, D	90	R1,300.00	R117,000.00
		Steyn, G	54	R1,300.00	R70,200.00
		Geotech Support	19	R750.00	R14,250.00
		Hopkins, T	70	R950.00	R66,500.00
		van Schoor, B	40	R900.00	R36,000.00
	Sub-Total				**R591,350.00**

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
1.2	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve				
		Louw, D	176	R1,100.00	R193,600.00
		Sherman, P	56	R900.00	R50,400.00
		Mackenzie, J	112	R800.00	R89,600.00
		Deacon, A	56	R700.00	R39,200.00
		Kotze, P	56	R800.00	R44,800.00
		Rowntree, K	88	R800.00	R70,400.00
	Sub-Total				**R488,000.00**
1.3	Perform/Review Historic Yield Analysis	Seago, C	56	R1,300.00	R72,800.00
		de Sousa, P	20	R650.00	R13,000.00
		Swart, R	20	R650.00	R13,000.00
	Sub-Total				**R98,800.00**
1.4	Environmental Screening and Fatal Flaws				
		Hopkins, T	170	R950.00	R161,500.00
	Sub-Total				**R161,500.00**
1.5	Perform/Review Geotechnical and Material Investigations				
		Mouton, D	40	R1,300.00	R52,000.00
		Steyn, G	26	R1,300.00	R33,800.00
	Sub-Total				**R85,800.00**
1.6	Engineering Investigation				
1.6.1	Topographical Survey and Mapping	**Disbursement**			
	Sub-Total				**R0.00**
1.6.2	Scheme Configurations (Engineering Investigation)				
		Anderson, H	120	R1,300.00	R156,000.00
		Hattingh, L	200	R1,300.00	R260,000.00
		Motaung, M	16	R1,300.00	R20,800.00
		van Staden, W	40	R725.00	R29,000.00
	Sub-Total				**R465,800.00**
1.6.3	Engineering Economic Analysis				
		Louw, L	16	R1,300.00	R20,800.00
		Serfontein, E	16	R1,300.00	R20,800.00
		van Schoor, B	40	R900.00	R36,000.00
		Mxhegwana, Z	8	R400.00	R3,200.00
	Sub-Total				**R80,800.00**
1.7	Multi-Criteria Analysis				

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
		Louw, L	8	R1,300.00	R10,400.00
		Serfontein, E	8	R1,300.00	R10,400.00
	Sub-Total				**R20,800.00**
1.8	Pre-Feasibility Study Report				
		Louw, L	24	R1,300.00	R31,200.00
		Serfontein, E	24	R1,300.00	R31,200.00
		Seago, C	4	R1,300.00	R5,200.00
		Hattingh, L	4	R1,300.00	R5,200.00
		Mouton, D	4	R1,300.00	R5,200.00
	Sub-Total				**R78,000.00**
	Phase 1: Pre-Feasibility Study TOTAL				**R2,070,850.00**
Phase 2: Feasibility Study					
2.1	Environmental Screening				
		Hopkins, T	156	R950.00	R148,200.00
	Sub-Total				**R148,200.00**
2.2	Water Resources				
2.2.1	Determine Existing and Future Water Demands				
		Aird, R	70	R1,250.00	R87,500.00
		Moroaswi, L	100	R450.00	R45,000.00
	Sub-Total				**R132,500.00**
2.2.2	Yield Analysis with the Water Resource Yield Model				
		Seago, C	110	R1,300.00	R143,000.00
		de Sousa, P	20	R650.00	R13,000.00
		Swart, R	40	R650.00	R26,000.00
	Sub-Total				**R182,000.00**
2.2.3	Future Water Balance for the Project				
		Seago, C	110	R1,300.00	R143,000.00
	Sub-Total				**R143,000.00**
2.2.4	Development of Short-term Stochastic Yield Reliability Curves				
		Seago, C	110	R1,300.00	R143,000.00
	Sub-Total				**R143,000.00**
2.2.5	Water Resources Planning Model				
		Seago, C	110	R1,300.00	R143,000.00
	Sub-Total				**R143,000.00**
2.2.6	Assessment of the Potential for Hydropower Generation at the Dam (Water Resources)				

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
		Otterman, A	100	R1,300.00	R130,000.00
		Support	48	R950.00	R45,600.00
	Sub-Total				**R175,600.00**
2.3	Ecological Consequences in Terms of the National Water Resource Class, the Target Ecological Category and the Reserve	**1. Provisional Sum** **2. Refer to Task** 1.2			
	Sub-Total				**R0.00**
2.4	Socio-Economic Impacts				
		Aird, R	70	R1,250.00	R87,500.00
		Moroaswi, L	100	R450.00	R45,000.00
	Sub-Total				**R132,500.00**
2.5	Engineering Investigation				
2.5.1	Topographical Surveys and Mapping	**Disbursement**			
	Sub-Total				**R0.00**
2.5.2	Geological and Geotechnical Investigations				
		Mouton, D	202	R1,300.00	R262,600.00
		Steyn, G	118	R1,300.00	R153,400.00
		Support	110	R750.00	R82,500.00
	Sub-Total				**R498,500.00**
2.5.3	Geomorphological and Seismic Investigations				
		Kikjo, A	160	R1,300.00	R208,000.00
	Sub-Total				**R208,000.00**
2.5.4	Flood Studies				
		Louw, L	8	R1,300.00	R10,400.00
		Serfontein, E	8	R1,300.00	R10,400.00
		van Schoor, B	40	R900.00	R36,000.00
		van Staden, W	24	R725.00	R17,400.00
	Sub-Total				**R74,200.00**
2.5.5	Feasibility Design of Selected Scheme				
		Anderson, H	510	R1,300.00	R663,000.00
		Hattingh, L	666	R1,300.00	R865,800.00
		Elges, H	40	R1,300.00	R52,000.00
		Viljoen, P	252	R1,300.00	R327,600.00
		Motaung, M	100	R1,300.00	R130,000.00
		van Staden, W	312	R725.00	R226,200.00
	Sub-Total				**R2,264,600.00**
2.5.6	Construction Programming and Costing				
		Anderson, H	170	R1,300.00	R221,000.00
		Hattingh, L	222	R1,300.00	R288,600.00

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
		Viljoen, P	84	R1,300.00	R109,200.00
		Motaung, M	92	R1,300.00	R119,600.00
	Sub-Total				**R738,400.00**
2.5.7	Access and Advanced Infrastructure				
		Jacobs, E	140	R900.00	R126,000.00
		Theron, M	120	R425.00	R51,000.00
		van Staden, W	240	R725.00	R174,000.00
	Sub-Total				**R351,000.00**
2.5.8	Flood and Backwater Calculations for the Dam				
		Louw, L	8	R1,300.00	R10,400.00
		Serfontein, E	16	R1,300.00	R20,800.00
		van Schoor, B	88	R900.00	R79,200.00
		van Staden, W	40	R725.00	R29,000.00
		Mxhegwana, Z	32	R400.00	R12,800.00
	Sub-Total				**R152,200.00**
2.5.9	Climatological Data for the Construction Site				
		Louw, L	8	R1,300.00	R10,400.00
		van Schoor, B	24	R900.00	R21,600.00
		van Staden, W	16	R725.00	R11,600.00
	Sub-Total				**R43,600.00**
2.5.10	Water Quality and Limnology				
		Ally, H	112	R1,400.00	R156,800.00
	Sub-Total				**R156,800.00**
2.5.11	Sediment Yield and Sedimentation Investigation				
		Basson, G	413	R1,900.00	R784,700.00
		Support	69	R351.00	R24,219.00
	Sub-Total				**R808,919.00**
2.5.12	Land Requirements and Associated Costs				
		Louw, L	8	R1,300.00	R10,400.00
		van Schoor, B	24	R900.00	R21,600.00
		van Staden, W	40	R725.00	R29,000.00
	Sub-Total				**R61,000.00**
2.5.13	Assessment of the Potential for Hydropower Generation at the Dams (Engineering Investigation)				
		Otterman, A	100	R1,300.00	R130,000.00

Task No.	Task Name	Name	Man-hours	Hourly Rate (R/h)	Costs (R)
		Support	48	R950.00	R45,600.00
	Sub-Total				**R175,600.00**
2.5.14	Costing (CAPEX and OPEX) of the Project				
		Louw, L	40	R1,300.00	R52,000.00
		Serfontein, E	16	R1,300.00	R20,800.00
	Sub-Total				**R72,800.00**
2.5.15	Engineering Economic Analysis				
		Louw, L	72	R1,300.00	R93,600.00
		Serfontein, E	88	R1,300.00	R114,400.00
	Sub-Total				**R208,000.00**
2.6	Implementation Actions				
		Louw, L	100	R1,300.00	R130,000.00
		Serfontein, E	80	R1,300.00	R104,000.00
	Sub-Total				**R234,000.00**
2.7	Record of Implementation Decisions				
		Louw, L	100	R1,300.00	R130,000.00
		Serfontein, E	80	R1,300.00	R104,000.00
	Sub-Total				**R234,000.00**
2.8	Institutional, Financial and Operational Aspects				
		Louw, L	160	R1,300.00	R208,000.00
		Serfontein, E	160	R1,300.00	R208,000.00
	Sub-Total				**R416,000.00**
2.9	Feasibility Study Report				
		Louw, L	80	R1,300.00	R104,000.00
		Serfontein, E	24	R1,300.00	R31,200.00
		van Schoor, B	24	R900.00	R21,600.00
		van Staden, W	80	R725.00	R58,000.00
	Sub-Total				**R214,800.00**
Phase 2: Feasibility Study TOTAL					**R8,112,219.00**
TOTAL PROFESSIONAL FEES (excluding VAT)					**R11,975,519.00**