water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Feasibility-level Cost and Implication Analysis Sub-Report

Support of the Water Reconciliation Strategy for the Algoa Water Supply System

March 2020
Revision: 1
Reference: 112546

Document control record

Document prepared by:

Aurecon South Africa (Pty) Ltd
1977/003711/07
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City
Cape Town
7441
PO Box 494
Cape Town
8000
South Africa

T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Feasibility-Level Cost and Implication Analysis				
Document ID		Unnumbered	**Project number**		112546	
File path		P:\Projects\112546 Algoa Recon Support\03 Prj Delivery\17 Reports\03 FEAS\05 Feas Level Cost & Impl Analysis\Feasibility-Level Cost And Implication Analysis (Final).docx				
Client		Department of Water and Sanitation	**Client contact**		Mr AJ Moore	
Rev	**Date**	**Revision details/status**	**Authors**		**Verifier**	**Approver**
0	13 March 2020	Draft	O Human M Wahl		S Kleynhans	E van der Berg
1	25 March 2020	Final			S Kleynhans	E van der Berg
Current Revision		**1**				

Approval			
Author signature		Approver signature	
Name	O Human	Name	Erik van der Berg
Title	Professional Engineer (Civil)	Title	Technical Director

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

DEPARTMENT OF WATER AND SANITATION

Directorates: National Water Resource Planning and Options Analysis

Support of the Water Reconciliation Strategy for the Algoa Water Supply System

Feasibility-Level Cost and Implication Analysis

Final: March 2020

Prepared by:

Aurecon South Africa (Pty) Ltd
P O Box 494
Cape Town, 8000
South Africa

Tel: 021 5265790
Fax: 086 5269500
E-mail: erik.vanderberg@aurecongroup.com

Prepared for:

Director: National Water Resource Planning,
Director: Options Analysis
Department of Water and Sanitation
Private Bag X313
Pretoria 0001
South Africa

Mr Tendayi Makombe (PE: NWRP, Central)
Tel: 012 336 8503
E-mail: makombet@dws.gov.za

Mr Tony Moore (CE: Options Analysis)
Tel: 012 336 8528
E-mail: mooret@dws.gov.za

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa 2020, *Feasibility-Level Cost and Implication Analysis*. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation
Directorates: National Water Resource Planning and Options Analysis

SUPPORT OF THE WATER RECONCILIATION STRATEGY FOR THE ALGOA WATER SUPPLY SYSTEM

APPROVAL

Title	:	Feasibility-Level Cost and Implication Analysis
Consultant	:	Aurecon South Africa (Pty) Ltd
Report status	:	Final
Date	:	March 2020

STUDY TEAM

Approved for Aurecon South Africa (Pty) Ltd:

.....

E VAN DER BERG
Technical Director

DEPARTMENT OF WATER AND SANITATION
Directorates National Water Resource Planning and Options Analysis

Approved for Department of Water and Sanitation:

.....

T MAKOMBE
PE: NWRP (Central)

.....

P MLILO
DIRECTOR: NWRP

.....

A J MOORE
CE: Options Analysis

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Feasibility-level Cost and Implication Analysis Sub-Report

Support of the Water Reconciliation Strategy for the Algoa Water Supply System

March 2020
Revision: 1
Reference: 112546

Document control record

Document prepared by:

Aurecon South Africa (Pty) Ltd
1977/003711/07
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City
Cape Town
7441
PO Box 494
Cape Town
8000
South Africa

T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Feasibility-Level Cost and Implication Analysis				
Document ID		Unnumbered	**Project number**		112546	
File path		P:\Projects\112546 Algoa Recon Support\03 Prj Delivery\17 Reports\03 FEAS\05 Feas Level Cost & Impl Analysis\Feasibility-Level Cost And Implication Analysis (Final).docx				
Client		Department of Water and Sanitation	**Client contact**		Mr AJ Moore	
Rev	**Date**	**Revision details/status**	**Authors**		**Verifier**	**Approver**
0	13 March 2020	Draft	O Human M Wahl		S Kleynhans	E van der Berg
1	25 March 2020	Final			S Kleynhans	E van der Berg
Current Revision		**1**				

Approval			
Author signature		Approver signature	
Name	O Human	Name	Erik van der Berg
Title	Professional Engineer (Civil)	Title	Technical Director

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

DEPARTMENT OF WATER AND SANITATION

Directorates: National Water Resource Planning and Options Analysis

Support of the Water Reconciliation Strategy for the Algoa Water Supply System

Feasibility-Level Cost and Implication Analysis

Final: March 2020

Prepared by:

Aurecon South Africa (Pty) Ltd
P O Box 494
Cape Town, 8000
South Africa

Tel: 021 5265790
Fax: 086 5269500
E-mail: erik.vanderberg@aurecongroup.com

Prepared for:

Director: National Water Resource Planning,
Director: Options Analysis
Department of Water and Sanitation
Private Bag X313
Pretoria 0001
South Africa

Mr Tendayi Makombe (PE: NWRP, Central)
Tel: 012 336 8503
E-mail: makombet@dws.gov.za

Mr Tony Moore (CE: Options Analysis)
Tel: 012 336 8528
E-mail: mooret@dws.gov.za

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa 2020, *Feasibility-Level Cost and Implication Analysis*. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation
Directorates: National Water Resource Planning and Options Analysis

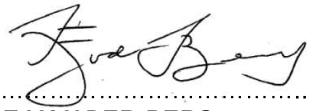
SUPPORT OF THE WATER RECONCILIATION STRATEGY FOR THE ALGOA WATER SUPPLY SYSTEM

APPROVAL

Title	:	Feasibility-Level Cost and Implication Analysis
Consultant	:	Aurecon South Africa (Pty) Ltd
Report status	:	Final
Date	:	March 2020

STUDY TEAM

Approved for Aurecon South Africa (Pty) Ltd:



……
E VAN DER BERG
Technical Director

DEPARTMENT OF WATER AND SANITATION
Directorates National Water Resource Planning and Options Analysis

Approved for Department of Water and Sanitation:

……
T MAKOMBE
PE: NWRP (Central)

……
P MLILO
DIRECTOR: NWRP

……
A J MOORE
CE: Options Analysis

Document Index

Reports that will be produced as part of this Study are indicated below.

Bold type indicates this Report.

Report Index	Report Number	Report Title
1		Inception
2		Water Requirements Chapter
3		Identifications of Options for Balancing Storage Chapter
4		Environmental Constraints Analysis
5	P WMA 15/N40/00/2517/1	Topographical Survey
7a	P WMA 07/N40/00/2619/2	Lower Coerney Dam Geotechnical Survey
7b	P WMA 07/N40/00/2619/1	Upper Scheepersvlakte Dam Geotechnical Survey
7c	P WMA 07/N40/00/2619/3	Lower Coerney Dam Supplementary Geotechnical Survey
8		Desktop assessment of short-listed options Chapter
9	P WMA 15/N40/00/2517/3	Options Analysis Report
10		Layout and Affected Land and Infrastructure
11		Feasibility-level engineering design - balancing dam
12		Feasibility-level engineering design - conveyance infrastructure
13		**Feasibility-level cost and implementation analysis**
14		Implementation Support
15	P WMA 15/N40/00/2517/4	Feasibility Study Report
16	P WMA 15/N40/00/2517/5	Stakeholder Participation: Feasibility Study

Executive Summary

Introduction

The objective of the Feasibility Component of the *Support of the Water Reconciliation Strategy for the Algoa Water Supply System* study is to:

- limit risks of shortfall in supply to the Nelson Mandela Bay Municipality (NMBM) and the Lower Sundays River Government Water Scheme (LSRGWS),
- remove potential operating system constraints for the sustainable delivery of bulk Orange River water supply to the LSRGWS and NMBM, for water requirements up to 2040, and
- limit operational risks to acceptable levels.

The existing Scheepersvlakte Balancing Dam is a balancing facility for water supply to the LSRWUA and the NMBM, and for emergency supply.

The focus of the investigation is on providing additional balancing storage in addition to the existing Scheepersvlakte Balancing Dam, which has lost storage due to siltation.

The main purpose of the proposed new balancing dam, at the Coerney site, is to eliminate the operational and balancing storage limitations imposed by Scheepersvlakte Dam.

Balancing dam feasibility level cost estimate

The costing and main design assumptions are discussed, concluding in the cost estimate for the construction of the balancing dam as well as the associated costs (access, electricity, etc.) and lastly the professional fees, as shown in **Table E1**.

Table E1: Balancing Dam cost (excluding 15% VAT)

No	Description	Amount, rounded (million)	
1	Construction cost	R	156.82
2	Preliminary and General Items (50%)	R	78.41
	Sub total	**R**	**235.24**
3	Access and electrical supply	R	2.75
	Sub total	**R**	**237.99**
4	Contingencies (25%)	R	59.50
	Total	**R**	**297.48**

The operation and maintenance costs are estimated as a percentage of the construction cost, divided into three categories: civil, mechanical and the dam. The cost of the river diversion, preliminary and general cost items and professional fees are excluded from the construction values below. The estimated annual operation and maintenance costs are as shown in **Table E2**.

Table E2: Dam Operation and Maintenance costs (excluding 15% VAT)

No	Description	Percentage	Construction Cost (million)		Annual Cost (million)	
1	Civil works	0.5%	R	89.653	R	0.448
2	Mechanical works	4.0%	R	18.750	R	0.750
3	Dam (embankment)	0.25%	R	78.564	R	0.196
Total			**R**	**186.967**	**R**	**1.394**

Conveyance infrastructure cost estimate

The costing and main design assumptions are discussed, concluding in the cost estimate for the construction of the conveyance infrastructure, as shown in **Table E3**.

Table E3: Conveyance infrastructure cost (excluding 15% VAT)

No	Description	Amount, rounded (million)
1	Kirkwood Canal off-take	R 1.87
2	Inlet/outlet to Coerney Dam	R 6.83
3	Main connecting pipeline	R 32.76
4	Tie-in to Nooitgedagt pipeline	R 1.28
5	Crossing of Middle Addo canal	R 0.81
6	Syphon under Sundays River	R 11.21
	Sub total (a)	**R 54.76**
7	Preliminary and General Items (50%)	R 27.38
	Sub total (b)	**R 82.14**
8	Contingencies (15%)	R 12.32
	Total	**R 94.46**

The operation and maintenance costs are estimated as a percentage of the construction cost, divided into two categories: civil and mechanical. The cost of contingencies is included, and the costs of the professional fees and preliminary and general items are excluded from the values below. The operation and maintenance costs for the conveyance infrastructure are shown in **Table E4.**

Table E4: Conveyance Infrastructure Operation and Maintenance Costs (excluding 15% VAT)

No	Description	Percentage	Construction Cost (Rand million)	Annual Cost (Rand million)
1	Civil works	0.5%	R 56.809	R 0.284
2	Mechanical works	4.0%	R 6.164	R 0.247
Total			**R 62.972**	**R 0.531**

Other miscellaneous project costs

The other project costs include land acquisition for the dam and pipeline, professional fees, which includes design, applications and licencing, etc. as shown in **Table E5**.

Table E5: Other miscellaneous costs (excluding 15% VAT)

No	Description	Amount (Rand million)
1	Land acquisition	R 21.950
2	Professional fees for dam (10% of construction cost)	R 29.748
3	Professional fees for conveyance infrastructure (10% of construction cost)	R 9.446
	Total	**R 61.144**

Total project cost

Total project costs are shown in **Table E6**.

Table E6: Total project costs

No	Description	Amount
1	Balancing dam	R 297 481 000
2	Conveyance infrastructure	R 94 456 000
3	Professional fees	R 39 194 000
	Value Added Tax (15%)	R 64 670 000
4	Land acquisition	R 21 950 000
	TOTAL (January 2020 prices)	**R 517 753 000**

The project cost estimate for commencement in 2025, with escalation of 6.5% per annum from the base year of 2020 is shown in **Table E7**.

Table E7: Total project costs (including 15% VAT)

Year	Escalation rate	Notes	Present cost	Future cost (Base year 2020)
2025	6.5%	Land acquisition + 40% Professional fees	R 39 979 240	R 54 775 000
2026	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 232 380 000
2027	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 247 485 000
2028	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 263 571 000
		TOTAL	**R 517 753 000**	**R 798 211 000**

Contents

Appendices

Tables

Abbreviations

DN	Nominal diameter
DWS	Department of Water and Sanitation
LSRGWS	Lower Sundays River Government Water Scheme
LSRWUA	Lower Sundays River Water User Association
masl	Metres above mean sea level
NMBM	Nelson Mandela Bay Municipality
NOC	Non-overspill crest
RDF	Recommended Design Flood
SEF	Safety Evaluation Flood
WTW	Water Treatment Works

1 Introduction and background

1.1 Study Objective

The objective of the Feasibility Component of the *Support of the Water Reconciliation Strategy for the Algoa Water Supply System* study is to:

- limit risks of shortfall in supply to the Nelson Mandela Bay Municipality (NMBM) and the Lower Sundays River Government Water Scheme (LSRGWS),
- remove potential operating system constraints for the sustainable delivery of bulk Orange River water supply to the LSRGWS and NMBM, for water requirements up to 2040, and
- limit operational risks to acceptable levels.

The focus of the investigation is on providing adequate balancing storage for supply to the NMBM, to limit risks of shortfall in supply.

1.2 Purpose of this Sub-report

The purpose of this sub-report is to describe the costing parameters, as well as the assumptions applicable to the feasibility design of the balancing dam and conveyance infrastructure in order to determine their respective construction, and operation and maintenance costs.

The content of this sub-report will form a Chapter/s of the Feasibility Design Report.

1.3 Background

Following the expected completion of the Nooitgedagt Water Treatment Works (WTW) Phase 3 in 2022, the WTW will have a maximum capacity of 210 Mℓ/day. The scheme has been designed to cater for peak/back-up supplies from the Nooitgedagt WTW at times when the older infrastructure, from sources to the west of Port Elizabeth, will be requiring maintenance or emergency repairs.

After investigation of a number of potential dam sites, as documented in the Options Analysis Report (DWS, 2019), the Lower Coerney Dam site was found to be the most favourable site

for the proposed new balancing dam and has been recommended for feasibility design. The proposed dam is referred to as 'Coerney Dam' in the sub-report and future reports, as there is no Upper Coerney Dam.

1.4 Content of this Report

The report is divided into three main parts, discussing the cost estimate of the:

- Coerney Dam,
- Conveyance infrastructure, and
- Other costs, which include legislative processes, professional fees and land acquisition.

Finally, the report concludes with a Project cost estimate, which combines the preceding cost estimates of the various components. The various chapters in this report and their content are briefly described hereunder.

Chapter 1: Introduction and background

Provides a brief introduction and background to the project and report.

Chapter 2: Coerney Dam cost estimate

Describes the main assumptions and parameters used in estimating a cost for the construction of the dam, as well as an estimate of the operation and maintenance costs.

Chapter 3: Conveyance infrastructure cost estimate

Describes the main assumptions and parameters used in estimating a cost for the construction of the conveyance infrastructure, including an estimate of the operation and maintenance costs.

Chapter 4: Other miscellaneous project costs

Describes the main assumptions and parameters used in estimating a cost for the other anticipated project costs, as well as an estimate of the operation and maintenance costs relating to the infrastructure aspects of the items covered in this section.

Chapter 5: Project cost estimate

Provides a total project implementation cost estimate for the dam, conveyance infrastructure and other associated project costs.

2 Coerney Dam cost estimate

The dimensions, assumptions and other factors affecting the costing of the various components of the balancing dam are discussed below.

2.1 Embankment materials

The proposed embankment dam design has typical embankment slopes of 1V:3H upstream and 1V:2H downstream. The dam has a crest length of 600 m and a crest width of 5 m. The lowest level at the valley bottom is 81.5 masl with a non-overspill crest (NOC) level of 102.0 masl, which results in a maximum wall height of 20.5 m.

As part of the site preparations, the topmost 0.3 m - 0.5 m of soil will need to be removed from the embankment footprint (4.3 ha) before placement of the embankment fill material. This topsoil should be stockpiled for use on disturbed areas.

The total embankment volumes are summarised in **Table 2-1**. The material for the embankment homogeneous fill zone will be excavated from within the dam basin, which is within normal free-haul distance of 1 km, and no allowance is thus made for overhaul. It has been assumed that the essential excavations from the spillway and discharge channel (approximately 94 000 m^3) will be used in the embankment construction, with no double handling of these materials.

Table 2-1: Embankment material quantities and sources

Zone	Volume	Source
Homogeneous fill	350 000	Dam basin
Upstream rip-rap	12 650	Imported
Sand and gravel filters	5 100	Imported
Rock toe drain	2 370	Imported

Materials, such as fine and coarse aggregate for concrete and sand for filters, were not found in the basin and will have to be imported from commercial sources. No project-specific borrow

areas were identified or investigated. The current costing makes allowance for their importation from commercial sources.

A few possible commercial sources for sand and coarse aggregates have been identified, but all are located some distances away from the Coerney Dam site. These are discussed in the *Feasibility-level Design: Balancing Dam Sub-Report* (DWS, 2020).

2.2 Foundation treatment

The 'groutability' of the weathered rocks encountered for the foundations of the dam core trench, outlet pipe encasement and outlet tower is uncertain.

No allowance has been made for consolidation or curtain grouting under the embankment. Some allowance is made for curtain grouting along the spillway overflow structure centreline.

Special mention should be made of the mudrock, which is susceptible to slaking. This rock will require immediate protection after exposure to prevent deterioration before construction/covering will commence. No allowance has been made for this.

2.3 Spillway

The spillway is excavated into the left abutment. The spillway overflow sill is an ogee-shaped mass gravity concrete overflow weir that is 6.35 m high and 50 m long. In general, the upper soils are underlain by weak bedrock that would be susceptible to erosion. It is thus required that the spillway side channel and discharge channel are lined with reinforced concrete. The side channel liner extends to the NOC, as it will also act as a retaining wall where the channel abuts to the embankment. The thickness of the liner is 0.4 m and the discharge channel is lined to the safety evaluation flood (SEF) flow depth of 1.7 m.

The discharge channel ends in a rectangular stilling basin. The basin is 20 m long with 6 m high side walls, which have a slight batter (1H:5V).

2.4 Inlet/Outlet works configuration

The outlet works of the dam will be located on the left abutment (eastern bank) of the valley. The pipe for supplying water to and from the dam will bifurcate into an inlet and outlet branch at the downstream outlet chamber, which is situated at the downstream toe of the embankment. The costing for this pipe, up to the start of the encasement, is described in Section 3, which addresses the conveyance infrastructure. The inlet/outlet pipes through the embankment have been included in the dam costing. The two stainless steel DN 1 m inlet/outlet pipes pass through the embankment, where they are encased in reinforced concrete.

2.5 Outlet tower

The inlet and outlet pipes will be connected to a circular (4 m internal diameter) reinforced concrete wet-well outlet tower. The tower is founded on a concrete base slab 1 m thick, extending 1.5 m past the wall perimeter. The walls are an average of 0.6 m thick. The tower is provided with two intake levels, which can be controlled with gates operated from the top of the tower. The tower will be accessed via a steel pedestrian space frame bridge with a mid-length column dividing the bridge into two spans.

The access bridge, intake gates, gantry and other mechanical equipment in the tower are accounted for with lump sum values.

2.6 Electrical supply requirements

There is currently no design for the electrical supply to the proposed dam location. It is presumed that the supply to the Scheepersvlakte Dam can be extended to the Coerney Dam site. A lump sum allowance has been made in the costing for this extension.

2.7 Access

There are some gravel tracks on either side of the valley of the proposed dam site. It is proposed that the track on the right abutment leading from Scheepersvlakte Dam be upgraded. An overall cost for access roads has been made on a per-kilometre rate and provision of 1.5 km of roads.

2.8 Instrumentation

A number of simple monitoring instruments were discussed and proposed in the feasibility design of the dam. A percentage allowance in the costing has been included to allow for these items.

2.9 River diversion

The river diversion strategy for the construction of Coerney Dam is relatively rudimentary due to the apparent absence of regular flow in the river channel. A lump sum provision has been made in the cost estimate to account for the provisions and risks associated with the river diversion to deal with water and floods. The estimate is a lump sum based on the size of the diversion embankment required and an all-in rate.

2.10 Construction cost estimate

A detailed cost estimate for the balancing dam is provided in **Appendix A**.

Table 2-2 shows a summary of the costs for the various components and types of work discussed above.

Table 2-2: Cost estimate summary for the balancing dam (excluding VAT)

No	Description	Amount (to nearest 1000)
1	Clearing	R 195 000
2	River diversion	R 10 000 000
3	Excavations	R 20 262 000
4	Drilling and grouting	R 677 000
5	Embankment fill materials	R 41 717 000
6	Concrete works	R 52 570 000
7	Mechanical Items	R 22 525 000
8	Miscellaneous	R 8 877 000
	Sub total	**R 156 823 000**
9	Preliminary and General Items (50%)	R 78 412 000
10	Access and electrical supply	R 2 750 000
11	Contingencies (25%)	R 59 496 000
	Total	**R 297 481 000**

2.11 Operation and maintenance costs

The operation and maintenance costs of the various dam components have been included as an annual cost, based on a percentage of the construction value.

The components are divided into three sections.

- Civil works, which includes the concrete spillway, intake tower and access bridge, the access roads and pipelines.
- The mechanical works, which includes hoisting equipment, valves and gates.
- The dam, which includes the embankment and dam basin.

A simple annual cost estimate for the three categories has been determined, based on a percentage of the construction value. The construction value used includes 25% contingencies and excludes the cost of the river diversion and the 50% preliminary and general charge items. The operation and maintenance costs for the dam, based on the above, are shown in

Table 2-3.

Table 2-3: Operation and maintenance costs for the balancing dam (excluding VAT)

No	Description	Percentage	Construction value (rounded to nearest 1000)	Annual Amount (rounded to nearest 1000)
1	Civil works	0.5%	R 89 653 000	R 448 000
2	Mechanical works	4.0%	R 18 750 000	R 750 000
3	Dam (embankment)	0.25%	R 78 564 000	R 196 000
Total			**R 186 967 000**	**R 1 394 000**

3 Conveyance infrastructure cost estimate

3.1 New offtake at Kirkwood primary canal

The new offtake from the Kirkwood primary canal comprises a 1.5 m wide adjustable weir, which will allow for regulating of the flow that can be discharged from the canal to the WTW or to the Coerney Dam. The weir level will be adjusted by means of a manually operated sluice gate, which will allow water to discharge from the canal into a wet well. Water will be piped from the wet well through a magnetic flow meter. The display from the flow meter will be positioned next to the adjustable sluice gate, which will allow the weir to be adjusted to discharge a certain flow.

3.2 Inlet/outlet to proposed Coerney Dam

The proposed dam will be supplied from the Kirkwood primary canal through a DN 1400 pipeline, which will also be used to transfer water to the tie-in point on the existing Nooitgedagt WTW pipeline.

The pipe for supplying water to and from the dam will bifurcate into an inlet and outlet branch at the outlet chamber, which is situated at the downstream toe of the embankment. The inlet branch will have an isolation valve for shutting off supply when the dam is full. The outlet branch will be fitted with a non-return valve and an isolation valve, both upstream and downstream. The non-return valve will ensure that water can be 'automatically' supplied from the dam in the event where the inlet has been shut to avoid spilling of the dam when it is full. The isolation valves will ensure that the non-return valve can be serviced while the inlet pipe remains in operation.

The inlet and outlet pipe branches will reduce from DN 1400 to DN 1200 at the bifurcation and reduce from DN 1200 to DN 1000 after the cross connection, which is before passing through the embankment in a concrete encasement.

3.3 New connecting pipework

A DN 1400 steel pipeline is required between the Kirkwood primary canal offtake and the proposed Coerney Dam, as well as from the proposed dam to a tie-in point on the existing DN 1400 pipeline supplying the Nooitgedagt WTW.

The total length of the two steel pipelines is approximately 2 950 m. Based on the limited geotechnical information available, and assuming that the pipes would be manufactured from Grade X52 steel, a 10 mm wall thickness would be required.

3.4 Tie in to existing Nooitgedagt supply pipeline

A connection is required to the existing 1400 mm diameter Nooitgedagt WTW supply pipeline. This connection needs to be located downstream of the existing cross connection on the Scheepersvlakte pipeline as well as downstream of the high point in the existing supply line.

The tie-in will comprise a 1400 mm x 1400 mm equal tee that will be cut into the existing pipeline. The branch of the tee will be fitted with an isolation valve to close the Coerney Dam's supply should maintenance be required on this pipeline.

3.5 Crossing of the Middle Addo Canal

The proposed pipeline will need to cross the Middle Addo canal twice. It is recommended that the pipeline be installed over the canal in order not to impact the integrity or operation of the canal, and to facilitate easier maintenance, if required. The 1400 mm diameter steel pipe will serve as the pipe bridge with concrete supports on either side of the canal. An air valve will have to be installed at the high point created by the canal crossing. The air valve will also serve as an access point into the pipeline for maintenance purposes.

3.6 Syphon under Sundays River

An additional syphon under the Sundays River on the existing Nooitgedagt WTW supply pipeline is recommended to:

- reduce the risk of supply failure in the event of damage to the existing syphon; and
- to mitigate the risk of the new balancing storage being located on the opposite side of the river, relative to the WTW.

The additional syphon under the Sundays River will be concrete encased. The top of the reinforced pipe encasement should be below riverbed level. The length of the encasement is assumed to be approximately 105 m (the same as the existing pipeline).

An air valve chamber and a scour valve chamber will have to be installed, and tie-ins made into the existing pipeline. The air valve will also serve as an access point into the new pipeline for maintenance purposes. The tie-ins will comprise 1400 mm x 1400 mm equal tees that will be cut into the existing pipeline and installed on the new syphon pipeline. Isolating valves will be provided so that the new syphon can be isolated, as it will only be used if the existing syphon is damaged or when maintenance is required.

3.7 Construction cost estimate

A detailed cost estimate of the required conveyance infrastructure is provided in **Appendix B**. **Table 3-1** provides a summary of the costs for the various components and types of work discussed above.

Table 3-1: Cost estimate summary for the conveyance infrastructure (excluding VAT)

No	Description	Amount (to nearest 1000)	
1	Kirkwood Canal off-take	R	1 873 000
2	Inlet/outlet to Coerney Dam	R	6 831 000
3	Main connecting pipeline	R	32 760 000
4	Tie-in to Nooitgedagt pipeline	R	1 277 000
5	Crossing of Middle Addo canal	R	812 000
6	Syphon under Sundays River	R	11 205 000
	Sub total (a)	**R**	**54 759 000**
7	Preliminary and General Items (50%)	R	27 379 000
	Sub total (b)	**R**	**82 138 000**
8	Contingencies (15%)	R	12 321 000
	Total	**R**	**94 458 000**

3.8 Operation and maintenance costs

The operation and maintenance costs (**Table 3-2**) of the various conveyance infrastructure components have been included as an annual cost based on a percentage of the construction value.

The components are divided into two sections.

- Civil works, which includes the pipelines and all concrete work at tie-ins and chambers,
- The mechanical works, which includes valves and gates.

A simple annual cost estimate for the two categories has been determined, based on a percentage of the construction value. The construction value used includes 15% contingencies and excludes the 50% preliminary and general charge items.

Table 3-2: Operation and maintenance costs for the conveyance infrastructure (excluding VAT)

No	Description	Percentage	Construction value (rounded to nearest 1000)	Annual Amount (rounded to nearest 1000)
1	Civil works	0.5%	R 56 809 000	R 284 000
2	Mechanical works	4.0%	R 6 164 000	R 247 000
Total			**R 62 972 000**	**R 531 000**

4 Other miscellaneous project costs

4.1 Land acquisition

The surface area required for the dam wall and spillway is 4.4 ha. The surface area covered by the basin when at the recommended design flood (RDF) water level is 80.1 ha. This equates to a total area of 84.5 ha. Assuming that it is undeveloped irrigable land, at a cost of R 250 000 per hectare, the cost of land acquisition amounts to R 21 250 000.

The surface area for the 1860 m long pipeline, including a 15 m wide servitude, is 2.8 ha. Thus, the estimated cost of land acquisition for conveyance infrastructure, at a cost of R 250 000 per hectare, amounts to R 700 000.

4.2 Professional fees

An allowance of 10% of the construction cost has been included to account for professional fees for engineering services, site supervision, dam safety requirements, environmental compliance and other specialist requirements.

4.3 Cost estimate

Other miscellaneous project costs are summarised in **Table 4-1**.

Table 4-1: Other miscellaneous project costs (excluding VAT)

No	Description	Amount	
1	Land acquisition	R	21 950 000
2	Professional fees for dam (10% of construction cost)	R	29 748 000
3	Professional fees for conveyance infrastructure (10% of construction cost)	R	9 446 000
	Total	**R**	**61 144 000**

5 Project cost estimate

The cost estimate for the construction of the balancing dam, the conveyance infrastructure, other miscellaneous costs, professional fees and land acquisition costs have been discussed in the preceding sections. **Table 5-1** shows a summary of the total cost estimate.

Table 5-1: Project cost estimate

No	Description	Amount
1	Balancing dam	R 297 481 000
2	Conveyance infrastructure	R 94 456 000
3	Professional fees	R 39 194 000
	Value Added Tax (15%)	R 64 670 000
4	Land acquisition	R 21 950 000
	TOTAL (January 2020 prices)	**R 517 753 000**

The project cost estimate for commencement in 2025 with escalation of 6.5% from the base year of 2020 is shown in **Table 5-2**.

Table 5-2: Project cost estimate with escalation

Year	Escalation rate	Notes	Present cost	Future cost (Base year 2020)
2025	6.5%	Land acquisition + 40% Professional fees	R 39 979 240	R 54 775 000
2026	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 232 380 000
2027	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 247 485 000
2028	6.5%	33% Construction value + 20% Professional fees	R 159 257 903	R 263 571 000
		TOTAL	**R 517 753 000**	**R 798 211 000**

References

Department of Water and Sanitation, South Africa 2017, Environmental Constraints Analysis. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation, South Africa 2017, Identification of Options for Balancing Storage. Prepared by Aurecon South Africa (Pty) Ltd with AfriCoast Consulting Engineer's assistance as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation, South Africa 2018, Desktop Assessment of Short-Listed Options. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation, South Africa 2018. Coerney Dam Contour Survey (EC 003/2018). Survey Services: Southern Operations (National Water Resource Infrastructure).

Department of Water and Sanitation, South Africa 2018. Scheepersvlakte Contour and Detail Survey Report (EC026/2018). Survey Services: Southern Operations (National Water Resource Infrastructure).

Department of Water and Sanitation, South Africa 2020, Feasibility-Level Engineering Design: Balancing Dam Sub-Report. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Department of Water and Sanitation, South Africa 2020, Feasibility-Level Engineering Design: Conveyance Infrastructure Sub-Report. Prepared by Aurecon South Africa (Pty) Ltd as part of the Support of the Water Reconciliation Strategy for the Algoa Water Supply System.

Appendix A: Cost estimate for the balancing dam

EARTHFILL DAM COST MODEL

Spillway on left abutment

27-Mar-20

Proposed Lower Coerney : 4.7 Mm3 gross storage capacity

Lower Coerney Dam Costing v 18 - Spillway 50 m - Left abutment V5.xlsx

Max wall height (m)=	20 m
NOCL=	RL 102.0 m
FSL=	RL 98.2 m
Crest width (m)=	5 m

No	DESCRIPTION	UNIT	RATE Jan 20 Rand	QUANTITY	AMOUNT Rounded to nearest 1000 Rand, Excl VAT
1	**Clearing (d)**				
	(a) sparse	ha	25 000	0.0	0
	(b) bush	ha	35 000	2.2	76 000
	(c) trees	ha	55 000	2.2	119 000
2	**River diversion**	Sum	10 000 000		10 000 000
3	**Excavation (d)**				
	(a) Bulk				
	(i) all materials	m³	80	136 674	10 934 000
	(ii) extra over for rock	m³	400	13 667	5 467 000
	(b) Confined				
	(i) all materials	m³	200	8 928	1 786 000
	(ii) extra over for rock	m³	600	893	536 000
	(c) Preparation of solum				
	(i) all materials	m²	35	36 201	1 267 000
	(ii) extra over for rock	m²	150	1 810	272 000
4	**Drilling & Grouting (d)**				
	(a) Curtain grouting	m drill	1 500	376	563 000
	(b) Consolidation grouting	m drill	1 500	76	114 000
	(c) Slurry trench - fill	m3		0	0
5	**Embankment (d)**				
	(a) Earthfill	m³	110	238 173	26 199 000
	(b) Filters	m³	700	5 096	3 567 000
	(c) Rip rap	m³	800	10 084	8 067 000
	(d) Overhaul beyond 1km (one way)	m³km	10	0	0
	(e) Toe drain	m³	600	4 745	2 847 000
	(f) Spillway channel protection with reno	m³	3 000	346	1 037 000
6	**Concrete Works (c)**				
	(a) Formwork				
	(i) gang formed	m²	675	6 661	4 496 000
	(ii) intricate	m²	850	10 905	9 270 000
	(b) Concrete				
	(i) mass	m³	2 700	8 538	23 052 000
	(ii) structural	m³	3 000	900	2 700 000
	(c) Reinforcing	t	16 500	791	13 052 000
7	**Mechanical Items**				
	(a) Valves & gates (m)	No	2 000 000	5	10 000 000
	(b) Cranes & hoists (m)	Sum	5 000 000		5 000 000
	(c) Structural steelwork (c)	Sum	2 000 000		2 000 000
	(d) Outlet pipe (SS316) (c)	m	15 000	368	5 525 000
	SUB-TOTAL				147 946 000

Proposed Lower Coerney : 4.7 Mm3 gross storage capacity

No	DESCRIPTION	UNIT	RATE Jan 20 Rand	QUANTITY	AMOUNT Rounded to nearest 1000 Rand, Excl VAT
8	**Miscellaneous** (% of 1-9) (c)	%	6		8 877 000
	SUB TOTAL A				156 823 000
9	**Preliminary & General** (% of sub-total A)	%	50		78 412 000
10	**Preliminary works**				
	(a) Access road (construction and maintenance, 3yr) (c)	km	1 500 000	1.50	2 250 000
	(b) Electrical supply to site (c)	Sum	500 000		500 000
	SUB TOTAL B				237 985 000
11	**Contingencies** (% of sub total B)	%	25		59 496 000
	SUB TOTAL C (CONSTRUCTION COST)				**R 297 481 000**
12	**Professional fees** (% of sub total C)	%	10		29 748 000
	SUB TOTAL D				327 229 000
	VAT 15%				49 084 000
	TOTAL CONSTRUCTION PHASE COST				**R 376 313 000**
13	**Cost of relocations**	Sum	0		0
14	**Cost of land acquisition**				
	(a) Irrigated	ha	1 000 000	0.0	0
	(b) Dryland farming	ha	600 000	0.0	0
	(c) Undeveloped	ha	250 000	85.0	21 250 000
	(d) Homesteads	No	0		0
	TOTAL PROJECT COST (as at Jan 2020)				**R 397 563 000**
	(Rounded to nearest R 100 000)				**R 397 600 000**

NOTE

(c) included in Civil maintenance cost

(m) included in Mechanical maintenance cost

(d) included in Dam maintenance cost

Appendix B: Cost estimate for the conveyance infrastructure

CONVEYANCE INFRASTRUCTURE COST

25-Mar-20

No	DESCRIPTION	UNIT	RATE Jan 20 Rand	QUANTITY	AMOUNT (Excl VAT) Rand
1	**Steel pipelines**				
	a) DN 1000	m	12 000	10	120 000
	b) DN 1400	m	19 200	1700	32 640 000
2	**Tie-in to Nooitgedagt**				
	a) DN1400 Butterfly valve*	No	500 000	1	500 000
	b) DN1400 Equal tee	No	250 000	1	250 000
	c) DN1400 Restrained Flange Adaptor	No	50 000	1	50 000
	d) DN1400 Puddle Pipe Plain Ended, 1760	No	80 000	1	80 000
	e) DN1400 Puddle Pipe Flanged one end, 2260	No	90 000	1	90 000
	f) Cut and remove existing, plus joint repairs	Sum	150 000		150 000
	g) Chamber (28m3)	Sum	156 800		156 800
3	**Coerney Dam Inlet/Outlet Chamber**				
	a) DN 1200 90 Bend	No	115 000	1	115 000
	b) DN 1200 22.5 Bend	No	80 500	2	161 000
	c) DN 1200 NRV - PN 16	No	2 400 000	1	2 400 000
	d) DN 1200 Butterfly valve*	No	427 000	3	1 281 000
	e) Flanges	No	80 000	10	800 000
	f) DN 150 AV*	No	13 600	2	27 200
	g) DN 150 RSV*	No	4 650	2	9 300
	h) DN 1400 x DN1200 Reducer	No	150 000	1	150 000
	i) DN 1200 x DN1000 Reducer	No	130 000	2	260 000
	j) DN 1200 Restrained Flange Adaptor	No	40 000	2	80 000
	k) DN 1200 Flanged Equal tee	No	187 500	3	562 500
	l) DN 1200 Puddle pipe, 2685	No	60 000	1	60 000
	m) DN 1200 Puddle pipe, 4570	No	75 000	1	75 000
	n) DN 1200 Puddle pipe, 1800	No	55 000	1	55 000
	o) DN 1000 Puddle pipe, 2385	No	50 000	1	50 000
	p) DN 1000 Puddle pipe, 885	No	45 000	1	45 000
	q) Chamber (50m3)	Sum	700 000		700 000
4	**Middle Addo Canal Crossing**				
	a) DN 1400 45° Bends	No	103 500	4	414 000
	b) Concrete plinths	No	56 000	5	280 000
	c) DN 150 AV*	No	13 600	1	13 600
	d) DN 150 RSV*	No	4 650	1	4 650
	e) Support brackets, etc.	Sum	100 000		100 000
5	**Syphon Sundays River**				
	a) DN1400	m	19 200	150	2 880 000
	b) Concrete Encasement	m^3	2 800	600	1 680 000
	c) Chambers	No	500 000	2	1 000 000
	d) DN 150 AV*	No	13 600	1	13 600
	e) DN 150 RSV*	No	4 650	1	4 650
	f) DN 200 SV*	No	15 000	1	15 000
	g) DN 1400 x DN 200 Tee	No	60 000	1	60 000
	h) Spare DN 1400 Pipes	m	19 200	60	1 152 000
	i) Allowance for river diversion / coffer dam	Sum	1 500 000		1 500 000
	j) DN 1400 isolating valves*	No	500 000	4	2 000 000
	k) DN 1400 x DN 1400 equal tee	No	250 000	2	500 000
	l) Cut into existing pipe and repair	No	150 000	2	300 000
	m) Bends	Sum	100 000		100 000

No	DESCRIPTION	UNIT	RATE Jan 20 Rand	QUANTITY	AMOUNT (Excl VAT) Rand
6	**Kirkwood Canal**				
	a) Weir Chamber (20m3)	Sum	224 000		224 000
	b) Flowmeter Chamber (41m3)	Sum	459 200		459 200
	c) DN 1200 flowmeter*	No	300 000	1	300 000
	d) DN 1200 restrained flange adaptor	No	40 000	1	40 000
	e) Sluice Gate*	No	400 000	1	400 000
	f) DN 1400 x DN 1200 Reducer	No	150 000	1	150 000
	g) DN 1200 Puddle pipe, flanged one end, 3600	No	100 000	1	100 000
	h) Break and repair existing canal	Sum	80 000		80 000
	i) DN 1200 Puddle pipe, flanged one end, 6000	No	120 000	1	120 000
	SUB-TOTAL A				54 758 500
	Preliminary & General (% of sub-total A)	%	50		27 379 250
	SUB TOTAL B				82 137 750
	Contingencies (% of sub total B)	%	15		12 320 663
	SUB TOTAL C				94 458 413
	Professional fees (% of sub total C)	%	10		9 445 841
	SUB TOTAL D				103 904 254
	VAT 15%				15 585 638
	TOTAL CONSTRUCTION COST				**R 119 489 892**
	(Rounded to nearest R 100 000)				**R 119 500 000**

* Items included in mechanical works for operation and maintenance

Aurecon South Africa (Pty) Ltd
1977/003711/07
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City
Cape Town
7441
PO Box 494
Cape Town
8000
South Africa
T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W aurecongroup.com