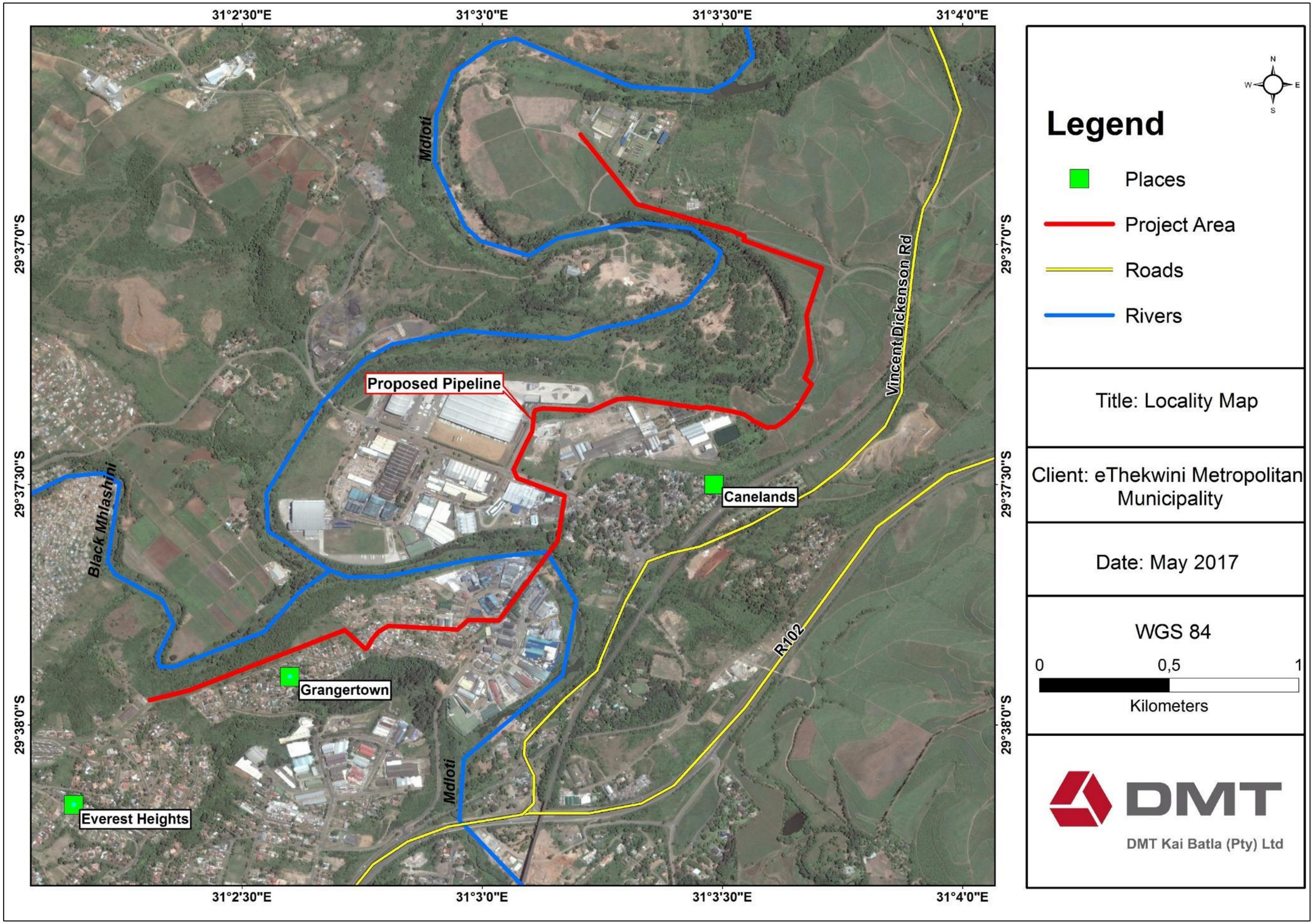
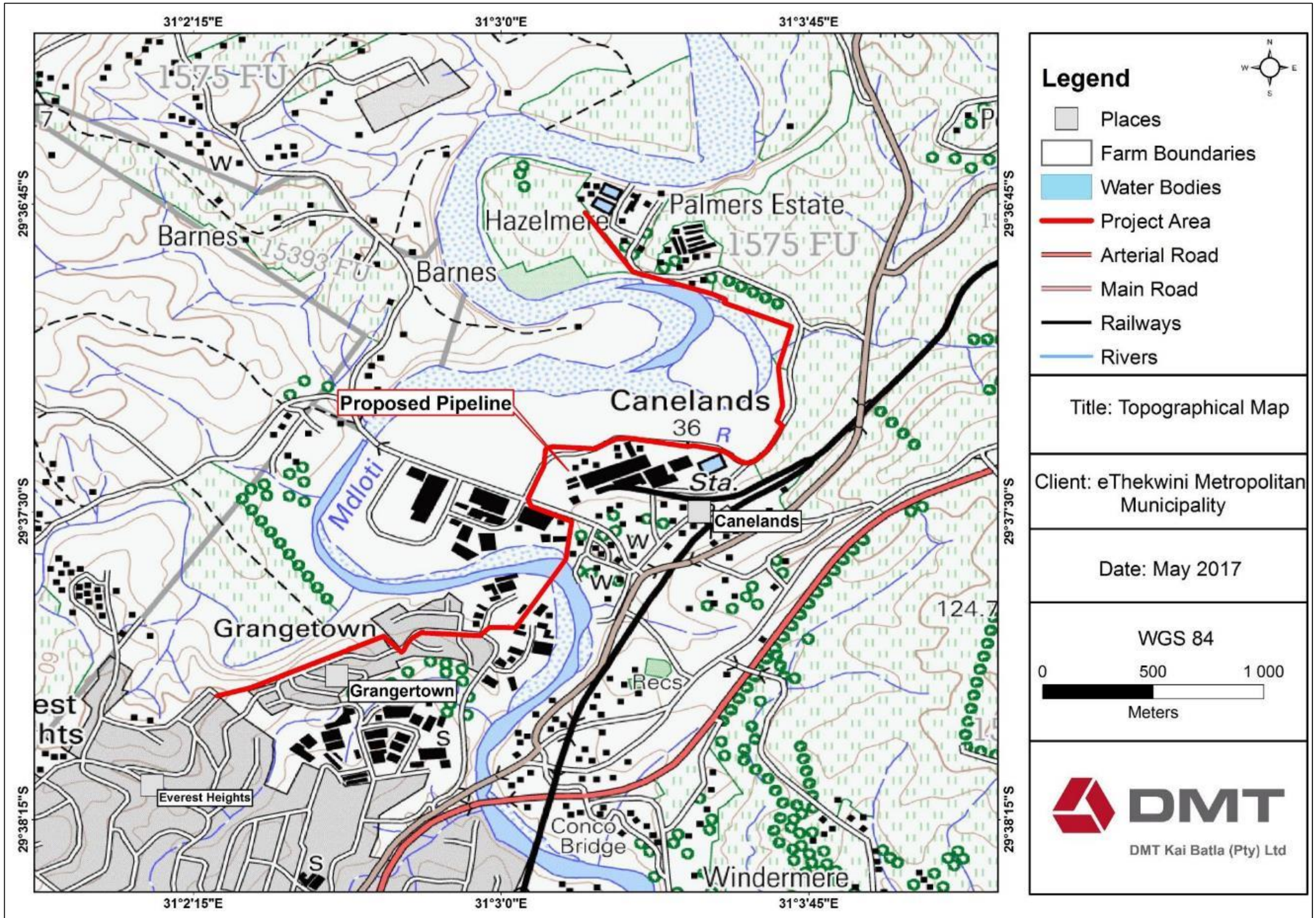
APPENDIX A: MAPS

DMT Kai Batla (Pty) Ltd



DMT Kai Batla (Pty) Ltd

DMT Kai Batla (Pty) Ltd



Legend

- Places
- Farm Boundaries
- Water Bodies
- Project Area
- Arterial Road
- Main Road
- Railways
- Rivers

Title: Topographical Map

Client: eThekwini Metropolitan Municipality

Date: May 2017

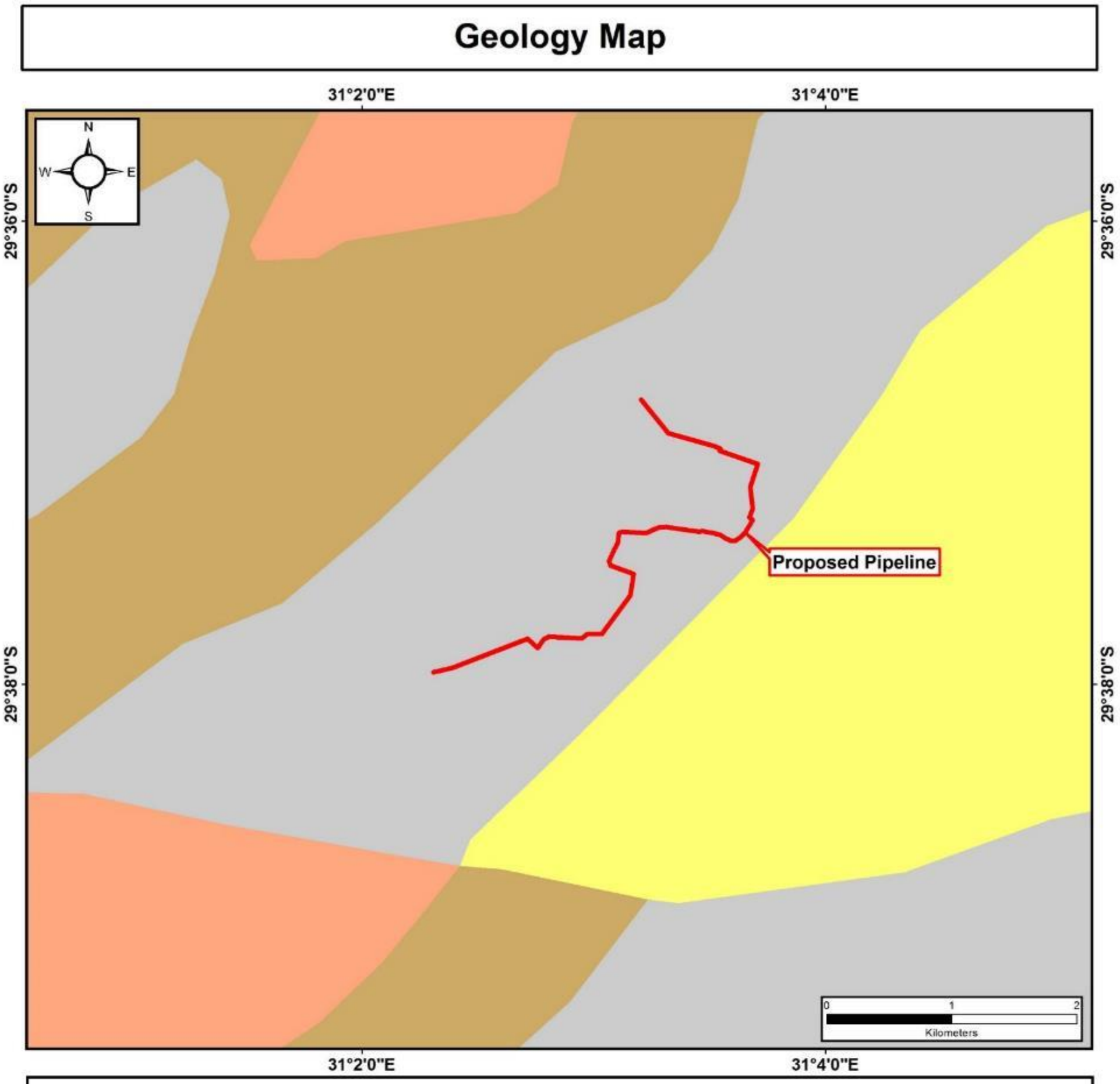
WGS 84

0 500 1 000

Meters

DMT Kai Batla (Pty) Ltd

Geology Map



Legend

Project Area

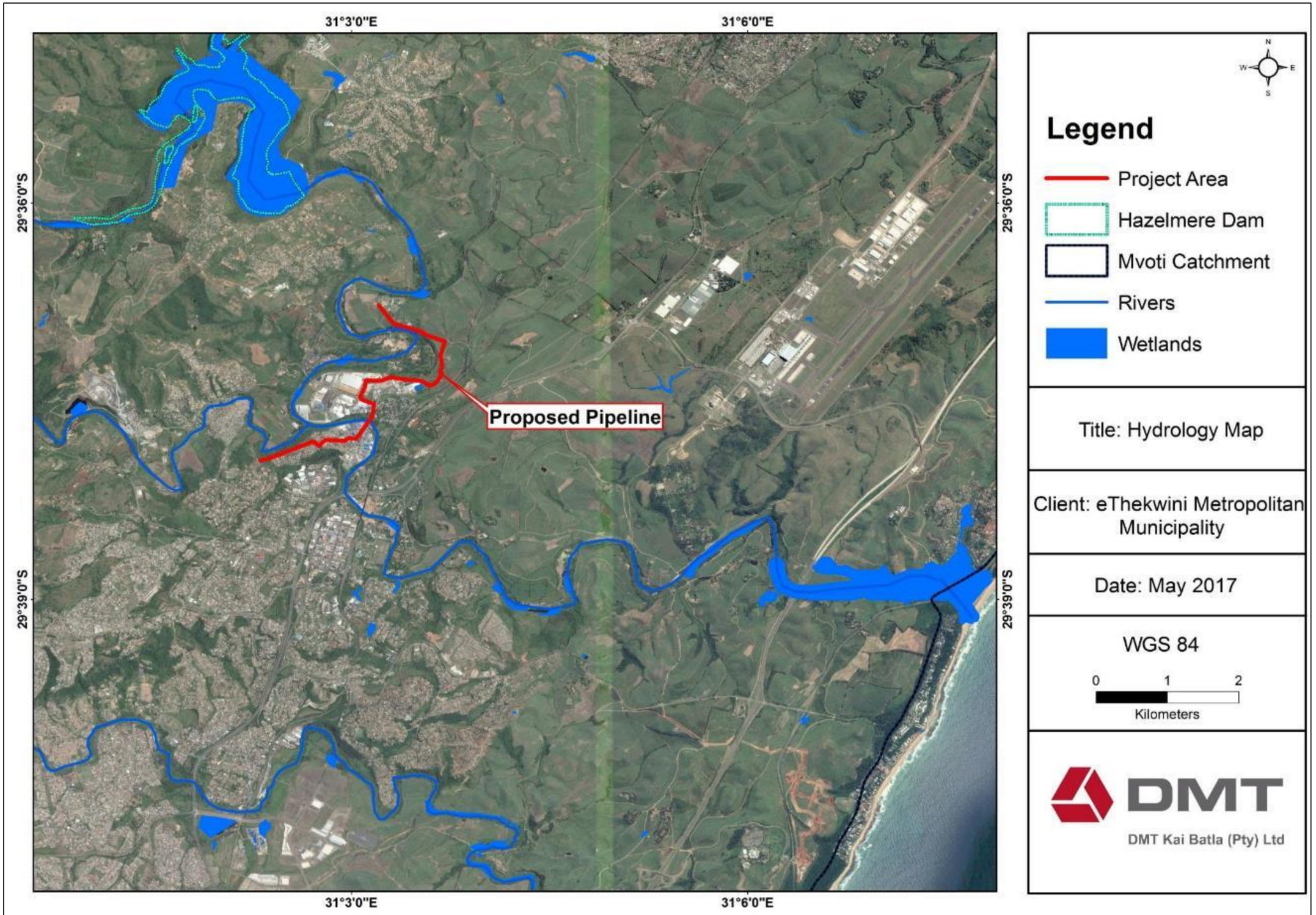
Geology Types

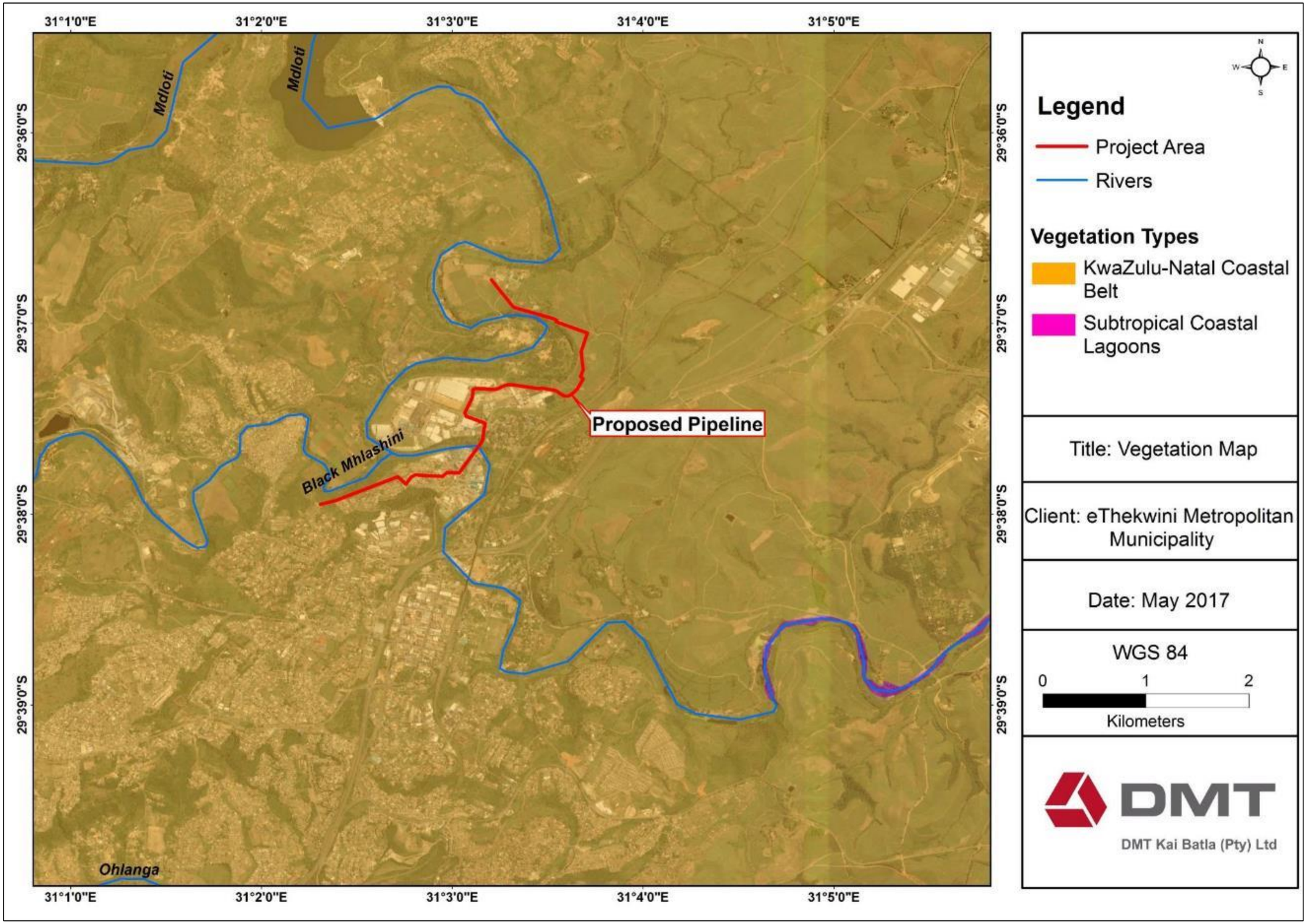
- Diamictite with varved shale, mudstone with dropstones and fluvioglacial gravel. **Dwyka Group**
- Fine- to coarse-grained sandstone, shale, coal seams. **Vryheid Fm.**
- Shale with thin siltstones and sandstones in the uppermost part. **Pietermaritzburg Fm.**
- Generally reddish, feldspathic and micaceous sandstone with subordinate quartz arenite, mudrock, granulestone and conglomerate. **Natal Group**

Ecca Group
Karoo Supergroup

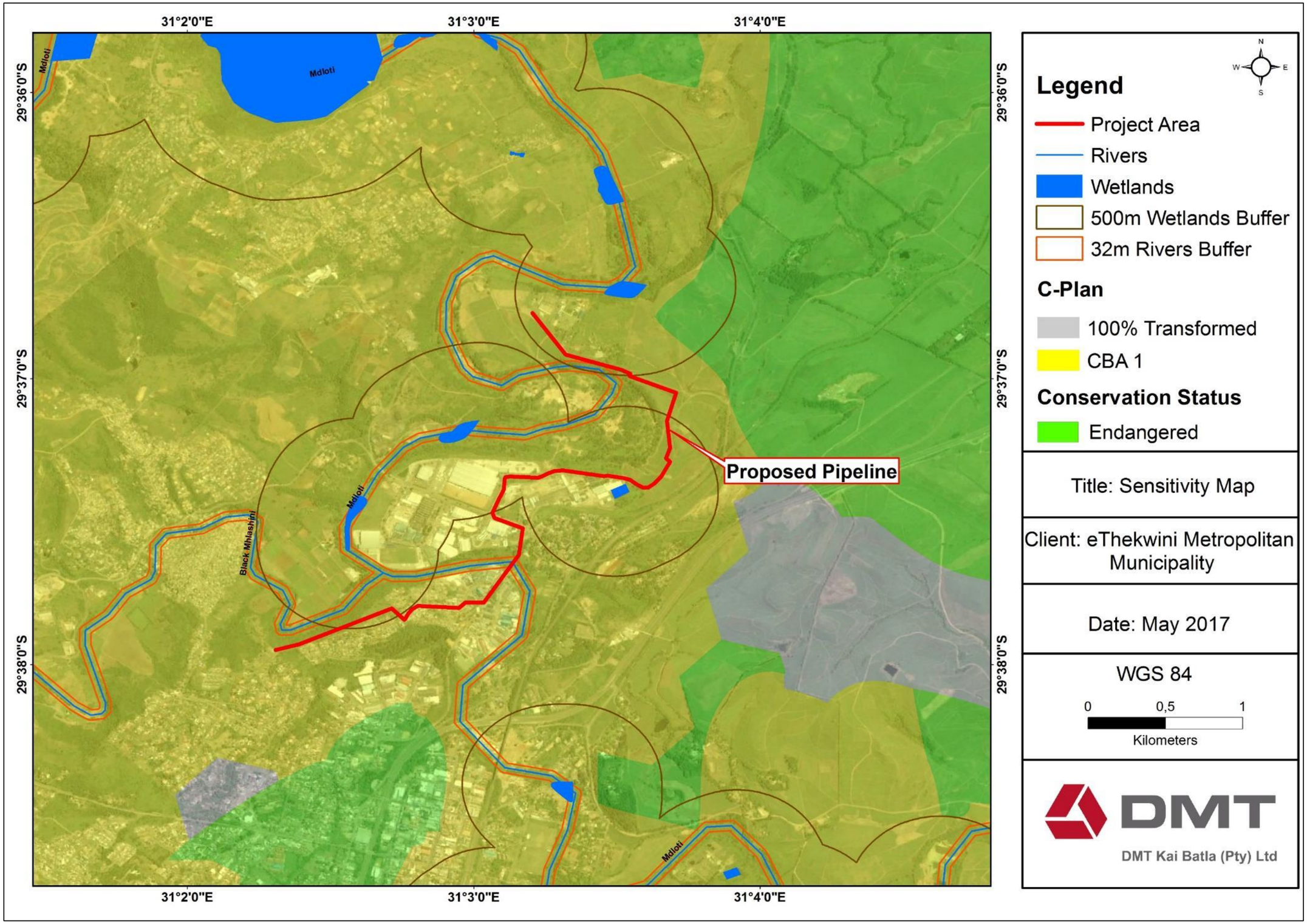
DMT
DMT Kai Batla (Pty) Ltd

DMT Kai Batla (Pty) Ltd




31°1'0"E
31°2'0"E
31°3'0"E
31°4'0"E
31°5'0"E
29°36'0"S
29°37'0"S
29°38'0"S
29°39'0"S
Mdloti
Mdloti
Black Mhlashini
Proposed Pipeline
Ohlanga
N
W
E
S
Legend
Project Area
Rivers
Vegetation Types
KwaZulu-Natal Coastal Belt
Subtropical Coastal Lagoons
Title: Vegetation Map
Client: eThekwini Metropolitan Municipality
Date: May 2017
WGS 84
0
1
2
Kilometers
DMT
DMT Kai Batla (Pty) Ltd

DMT Kai Batla (Pty) Ltd



Legend

- Project Area
- Rivers
- Wetlands
- 500m Wetlands Buffer
- 32m Rivers Buffer

C-Plan

- 100% Transformed
- CBA 1

Conservation Status

- Endangered

Title: Sensitivity Map

Client: eThekwini Metropolitan Municipality

Date: May 2017

WGS 84

0 0,5 1

Kilometers

DMT Kai Batla (Pty) Ltd

APPENDIX B: PHOTOGRAPHS

A site visit was undertaken by a representative from the EWS (i.e. Mr Alex Mahlambi) and Ms Samantha Moodley, the EAP from DMT-KB. A number of stops were made along the pipeline route- with the three compulsory stops being made at the beginning, middle and end of the route. As per communications with EWS personnel, the Applicant will be undertaking works within the pipeline servitude. This is to avoid any conflict with and potential damage to the Sasol methane pipeline which follows a similar route so to avoid damaging the Sasol pipes. Sasol will be consulted and will monitor their pipeline where construction is occurring when pipeline cross each other so as to ensure no damage to their pipeline. The photographs presented here depict observations made along the pipeline route.

Point 1: Start of the pipeline route, at the Hazelmere Water Treatment Works (WTW).

North-facing view from the Hazelmere WTW. From this perspective the natural and cultivated areas (i.e. cane farming land) surrounding the pipeline route can be seen.

East-facing view, showing the entrance to the WTW.

South-facing view, showing some of the cane farming land adjacent to the WTW.

West-facing view, showing the cane fam land and other cultivated land beyond that. The road visible here is used by farmers to access their properties. The road operations will be disrupted temporarily for the duration of the pipeline construction phase.

North-east view.

South-east view.

South- west view

North-west view

Point 2: One of the stops along the pipeline route

This image depicts a harvested sugar cane field. The white pegs (encircled) are Sasol pipeline markers. The new pipeline will cross beneath the road depicted in this image. It will run parallel to the Sasol pipeline with the 3m clearance between the two. As per comms. with the EWS, construction in this area will be done after the cane harvest so as to prevent any disruptions to the farming activities.

Areas showing vast sugar cane growth will be cleared during construction site preparation. It is anticipated that more than I hectare of vegetation will be cleared, and the EWS has included vegetation clearing activity in their environmental authorisation application.

Another view of the road running over the pipeline, in relation to the cane farming land.

In the conceptual phases, the EWS had considered attaching the new pipeline to the bridge depicted here. However, the structural integrity of bridge has been compromised over the years and the infrastructure damage is noted in a few areas. Hence this option was not favoured. The EWS is proposing the use of pipe jacking at this point.

Point 3: Location of the wetland crossing

This image depicts the damage to the piles at the existing bridge.

The Sasol pump station, located in the opposite direction to the bridge. At this point, the methane pipeline crosses the road before the bridge. Therefor the EWS pipeline does not cross paths with the Sasol pipeline.

The bridge crosses over the wetland identified along the pipeline route. There is dense vegetation in this area, typical of a wetland setting.

Image depicting the wetland identified along the pipeline route. There is dense vegetation surrounding the waterbody which limited the capturing of images from other points of the wetland.

A close up of the appearance of the water found in the wetland. From this image, it appears that the water body has been highly degraded over the years, especially considering its location in an industrial area.

Point 4: Middle point of the pipeline route; Canelands Industrial Park. Some of the properties in this area overlap with the pipeline servitude

North-facing view, showing a Shoprite warehouse in the background, located at the corner of Duiker and New Glasscow Roads

East-facing view, showing the Shoprite warehouse in the top right corner of the image. The new pipeline will be laid on this side if the road.

South-facing view; the image depicts a fenced-property in the industrial park. The white peg depicted here is an indication of the Sasol pipeline. The new pipeline crosses paths with the Sasol pipeline in this area.

West-facing view, depicting other businesses and properties in the industrial park, and one of the cross roads in the area. The traffic here will be temporarily affected by the pipeline construction activities.

North-east view

South-east view

South-west view

North-west view

Point 5: One of the stops along the pipeline route- at corner Spring Place and Estuary Drive. Canelands Industrial Park. Some of the properties in this area overlap with the pipeline servitude.

The yellow and red peg depicted here is an indication of the EWS pipeline location. The pipeline servitude overlaps with private property around this area.

White peg depicted here indicating where the Sasol pipeline is located in this area.

This is one of the points where EWS and Sasol pipeline cross path.

One of the thickets growing within the pipeline servitude. This vegetation will be cleared during site establishment.

This image depicts the existing pipe bridge with water and 2 sewage pipelines running across. Some of the locals use the bridge as a pass- as depicted here.

One of the water chambers (encircled) is located at this point.

Point 6: One of the points along the pipeline route where water leaks occur

There is dense vegetation around this area. This will be cleared during site establishment.

Another image depicting the dense vegetation.

Point 7: End of the pipeline at the Grange Reservoir. This area is predominantly residential and the pipeline development will affect the residents as it is on their verge.

North-facing view, depicting the wtare infrasrtucture at the resrvoir.

East-facing view, showing the steep terrain around the reservoir

South-facing view, showing the Sasol pipeline indicators. The two pipelines cross paths in this area.

West-facing view, showing the reservoir boundary on the left of the image. The pipeline runs beneath the roads depicted here.

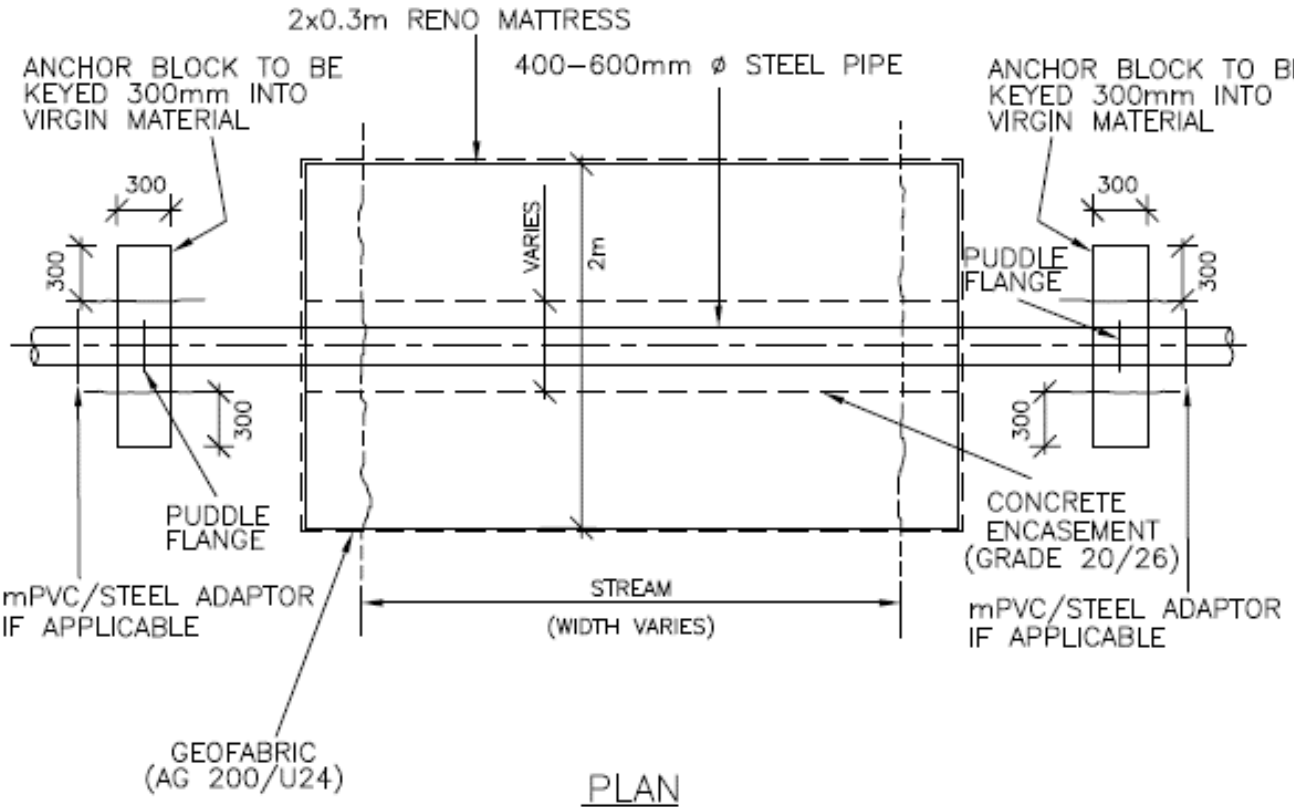
North-east facing view, showing the steep terrain around the reservoir.

South-east facing view, depicting the dense vegetation in the area.

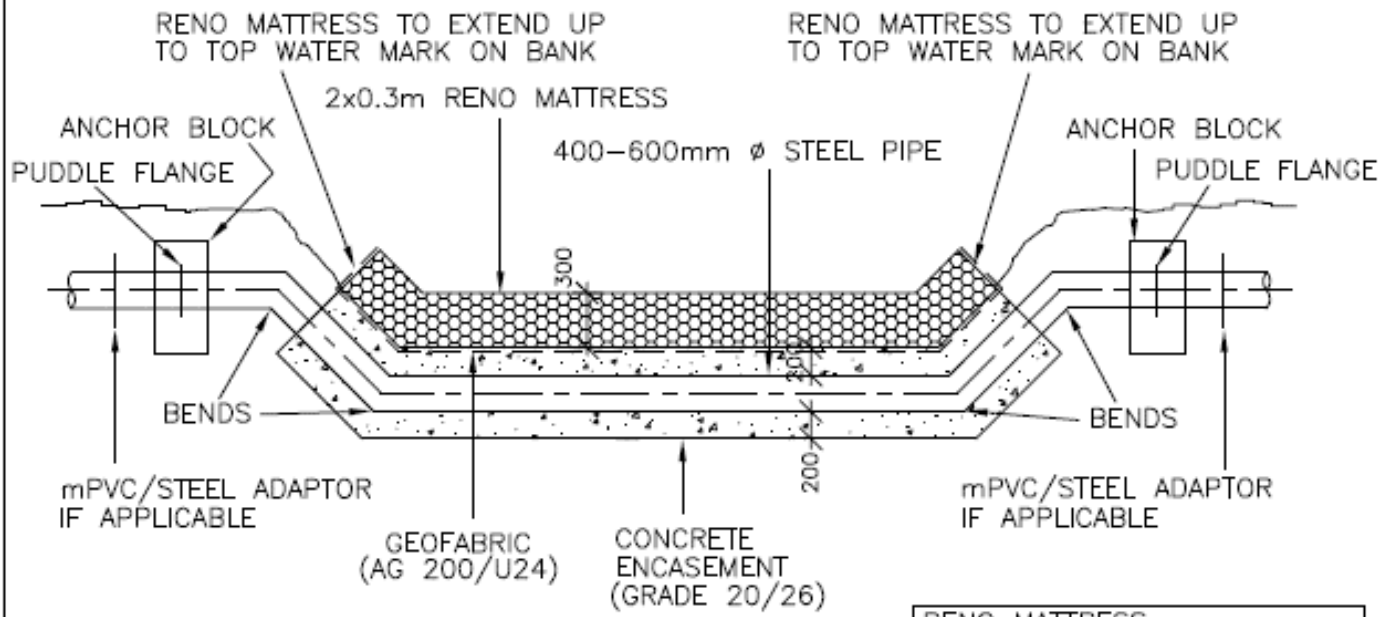
South-west facing view, depicting the location of the Sasol Pipeline in relation to the Grange reservoir.

North-west view, showing the reservoir infrastructure.

PPENDIX C: FACILITY ILLUSTRATION(S)



PLAN
N.T.S.



NOTE : BEFORE USING THIS DETAIL, PLEASE CHECK WITH THE MANAGER : WATER DESIGN THAT DETAIL IS APPLICABLE TO SITUATION.

SECTIONAL ELEVATION
N.T.S.

RENO MATTRESS:
DOUBLE TWISTED, HEXAGONAL 80mm WIRE MESH, 3.4mm O.D. FRAME WIRE, 2.7mm O.D. MESH WIRE. ALL WIRE TO BE MILD STEEL (SABS 1580–1993) & HOT–DIP GALVANISED TO (SABS 675–1993).

DURBAN METRO WATER SERVICES WATER DESIGN BRANCH

Drawn by : S.J.M.	DETAIL OF PROTECTION TO 400–600mmø PIPE CROSSING A STREAM	
Checked by :		
Date : JULY 1997		Executive Director: Durban Metro Water Services
Manager: Water Design		Plan No: ??

APPENDIX D: SPECIALIST REPORTS (INCLUDING TERMS OF REFERENCE)

RE-ROUTING OF THE RISING MAIN FROM HAZELMERE WATER TREATMENT WORKS TO GRANGE RESERVOIR IN VERULAM, ETHEKWINI MUNICIPALITY, KWAZULU-NATAL

Freshwater and Terrestrial Habitat Impact Assessment




Version: 1.0

Date: 8th September 2017

Eco-Pulse Environmental Consulting Services

Report No: EP325-01

Prepared for: **DMT Kai Batla (Pty) Ltd**
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Tel: 011 7814548 / Fax 086 545 2720 / 071 678 1951
Email: samantha.moodley@dmt-group.com

DMT Kai Batla (Pty) Ltd

Prepared by: **Eco-Pulse Environmental Consulting Services**
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eco-pulse
environmental consulting services

Suggested report citation:

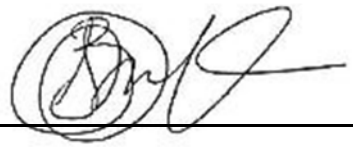
Eco-Pulse Consulting. 2017. Re-routing of the rising main from Hazelmere Water Treatment Works to Grange Reservoir in Verulam, eThekwini Municipality, KwaZulu-Natal: ***Freshwater and Terrestrial Habitat Impact Assessment Report***. Unpublished report prepared for DMT Kai Batla (Pty) Ltd. Report No. EP325-01. Version 1.0_8th September 2017.

SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following report has been prepared as per the requirements of Section 32 (3) of the NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (Act No. 107 OF 1998) ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS 2014 as per Government Notice No. 38282 GOVERNMENT GAZETTE, 4 DECEMBER 2014 (as amended) as well as the requirements of the Department of Water & Sanitation for Water Use Licensing and wetland/aquatic assessment, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017.

Document Title:	Re-routing of the rising main from Hazelmere Water Treatment Works to Grange Reservoir in Verulam, eThekwini Municipality, KwaZulu-Natal: ***Freshwater and Terrestrial Habitat Impact Assessment Report***.
Report No.	EP325-01
Version	1.0
Revision No.	0
Date:	08 September 2017
Report prepared by:	**Mr Brian Mafela** (BSc. Hons. Forest Resources & Wildlife Management) Candidate Natural Scientist (*Cand. Sci. Nat*.) (Ecological Science) SACNASP Registration Number: 100214/15
Internally Reviewed by:	**Mr Adam Teixeira-Leite** (BSc. Hons. Environmental Science) Professional Natural Scientist (*Pr. Sci. Nat*.) (Ecological Science) SACNASP Registration Number: 400332/13
Sign-off:	 **Mr Adam Teixeira-Leite** *Pr.Sci.Nat*.
Client:	DMT Kai Batla (Pty) Ltd on behalf of the eThekwini Municipality

I, **Brian Mafela**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Environmental Affairs (DEA) and Department of Water & Sanitation (DWS.

Signed:  Date: 08 September 2017

DETAILS OF PROJECT TEAM (ECO-PULSE)

The relevant experience of specialist team members from Eco-Pulse Consulting involved in the assessment and compilation of this report are briefly summarized below. *Curriculum Vitae's* of the specialist team are available on request.

Specialist	Role	Details
Adam Teixeira-Leite *Pr.Sci.Nat.* Senior Scientist	Project leader and Internal reviewer	Adam is a Senior Environmental Scientist at Eco-Pulse with a BSc. Honours degree in *Environmental Science: Earth Sciences*. He is a registered Professional Natural Scientist (Pr. Sci. Nat.) with 10 years' experience, having worked extensively on numerous specialist ecological assessment projects, both for wetland/aquatic and terrestrial (grasslands and forests) habitats and ecosystems in KZN, the Free State, Gauteng, Eastern Cape, Western Cape and Lesotho. He is also experienced in undertaking alien plant surveys and developing ecological rehabilitation and management plans and programmes.
Brian Mafela Environmental Scientist	Fieldwork & Lead author	Brian Mafela is an Environmental Scientist at Eco-Pulse with a BSc. Honours degree in Forest Resources and Wildlife Management. Brian is a registered Candidate Natural Scientist (*Cand. Sci. Nat.*) with over 3 years' experience in undertaking EIA processes, wetland and riparian assessments, vegetation assessments, identifying and evaluating impacts of developments on the environment and providing Best Management Practice (BMP) mitigation measures.
Ross van Deventer Environmental Scientist	Fieldwork, SASS5 assessment & Water Quality Analysis	Ross is an Environmental Scientist at Eco-Pulse and has an MSc (Environmental Science) with training in integrated environmental management along with specialist training in the field of water resource management and aquatic science. His specialised training is further complemented by experience gained in a number of wetland and riparian assessments. He is competent in the application of current best practice guidelines and assessments tools and is accredited in the application of the SASS5 bio-monitoring technique and competent in fish sampling and analysis.
Andrew Briggs Junior Environmental Scientist	Fieldwork & Providing assistance with reporting	Andrew is an Intern at Eco-Pulse with an MSc. Degree in Conservation Ecology. His thesis focused primarily on invertebrate and plant diversity in KZN watercourses. Andrew is currently involved in wetland delineation, riparian delineation, background research and undertaking wetland assessment using widely used WET-Management Series tools developed through the Water Research Commission.
Ryan Kok Intern	Fieldwork	Ryan Kok is an intern at Eco-Pulse with a BSc degree in Environmental Science; BSc Honours and MSc degree in Biological Sciences. Ryan has 3 years' experience in GIS and environmental niche modelling, with extensive field experience in monitoring and analysing species data. He also has experience in undertaking conservation planning and biodiversity assessments. Further gaining experience in the wetland and terrestrial habitats and ecosystems.

EXECUTIVE SUMMARY

This report sets out findings of a combined **Specialist Freshwater and Terrestrial Habitat Impact Assessment** for the proposed the proposed upgrade and re-routing of a 600mmØ rising main from Hazelmere Water Treatment Works to Grange Reservoir in Verulam, eThekwini Municipality, KwaZulu-Natal. Fieldwork to inform the assessment was undertaken over the course of a single day in late winter (August 2017) and the main findings of the assessments are summarised as follows:

A. Findings of the Specialist Freshwater Habitat Impact Assessment:

i. The study area is located within quaternary catchment **U30B**, which is drained primarily by the perennial uMdloti River, which drains in a south-easterly direction towards the South-Indian Ocean. The quaternary catchment forms part of the Mvoti to uMzimkhulu Water Management Area (WMA).

ii. A total of ten (10) definable watercourse units, including 6 wetland units and 4 river units, were mapped at a desktop level a 500m radius of the development (i.e. within the regulated area for water use) and then rated in terms of the potential to be significantly modified. Of the 10 watercourse units, 7 were identified as being likely to be significantly impacted by the proposed development including 5 wetland units and the Mdloti River itself. These watercourses were then assessed further.

iii. All wetlands were found to be in a heavily degraded state as indicated by PES ratings ranging between **largely modified ("D" PES category)** and **seriously modified ("E" PES category)**, largely as a result of intensive drainage and sugarcane cultivation within wetlands. The Mdloti River reach sampled attained a PES rating of **largely modified ("D" PES category)** which can be attributed to reduced flows caused by Hazelmere dam upstream, alteration of flow patterns, excavation and infilling, increased sediment deposition, IAP infestation and vegetation removal within the riparian zone.

iv. The assessment of wetland functioning revealed that all wetland units can be considered to be generally of low to moderately-low importance in delivering key regulating and supporting services, which is largely as a result of the transformation of wetland habitat caused by drainage and agriculture which has affected wetland condition and the capacity to supply ecosystem goods and services.

v. An assessment of the Ecological Importance and Sensitivity (EIS) of watercourses highlighted two wetland units W03-A and W03-B as well as the Mdloti River as being the most important and sensitive units with a rating of '**moderate**', whilst the remaining wetlands attained a rating of **moderately-low EIS** due to high levels of habitat degradation and the absence of sensitive aquatic habitat for supporting wetland biota.

vi. Future management of the freshwater wetlands associated with the project should be informed by the recommended management objectives for the water resource which, in the absence of classification, is generally based on the current status of the water resource

or PES and the EIS for the resources (DWAF, 2007). All watercourses were assigned a Recommended Ecological Category (REC) similar to their PES. This means that the Recommended Management Objective (RMO) for the watercourses affected by the project should be to **maintain current PES,** as per Table A, below.

Table A. REC and RMO for the delineated watercourse units based on their PES and EIS ratings.

Unit	HGM Type	PES	EIS	REC	RMO
W01	Channelled Valley-bottom Wetland	D: Poor	Moderately-low	D	*Maintain PES*
W02	Seep	D: Poor	Moderately-low	D	*Maintain PES*
W03-A & W03-B	Seep	E: Serious	Moderate	E	*Maintain PES*
W04-B	Seep	E: Serious	Moderately-low	E	*Maintain PES*
R01-A	Upper reach of the perennial Mdloti River	D: Poor	Moderate	D	*Maintain PES*
R01-B	Lower reach of the perennial Mdloti River	D: Poor	Moderate	D	*Maintain PES*

vii. Sensitive, vulnerable, highly dynamic or stressed ecosystems such as wetlands and rivers require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Possible activities, aspects (or stressors) and potential ecological risks identified for the project that could potentially manifest in impacts to the four drivers of wetland condition/functioning as defined by the DWS are likely to include the following:

a. General habitat disturbance and leading to the colonisation of adjacent wetland habitat by alien plants, weeds and other undesirable plant species *(low risk with mitigation);*

b. Risk of altered hydrology as a result of storm water management and infrastructure constructed across wetlands impeding and re-directing natural flows *(low risk with mitigation); and*

c. The risk of reduced water quality and the knock-on effects on wetland ecology (flora and fauna/biota) as a result of potential spills and pollution during construction *(low risk with mitigation).*

viii. Identified potential direct and indirect negative impacts linked with the development on the local freshwater/aquatic environment included (Table B):

Table B: Summary of the aquatic ecological impact significance assessment.

Impact Category	Construction phase impacts			Operational phase impacts	
	Poor mitigation	Good mitigation		Poor mitigation	Good mitigation
Destruction and modification of freshwater habitat	**Low**	Very Low		**Low**	Insignificant
Flow modification and erosion / sedimentation	**Low**	Very Low		**Low**	Very Low
Alteration of water quality	**Low**	Insignificant		Insignificant	Very Low
Overall (cumulative) Impact	**Low**	Very Low		**Low**	Very Low

Overall, the significance of the ultimate ecological consequences associated with the development construction and operational phases were assessed as being of '**Low' significance** under a 'poor/standard mitigation' scenario and can be easily mitigated/managed, which is likely to reduce significance to an overall '**Very Low' level** under a 'good/best practical mitigation' which is deemed acceptable from an aquatic ecological perspective. As such, no fatal flaws were identified for the various phases of the proposed development. Potential cumulative impacts associated with the project are also expected to be negligible as there will be no significant residual loss of aquatic habitat or functioning during both construction and operation where impacts are mitigated to acceptable levels and managed properly in accordance with the recommendations made in this report.

ix. Following a comprehensive evaluation of potential impacts a suite of mitigation measures were identified for implementation. These include planning and design mitigation measures aimed at primarily at avoiding adverse impact to watercourses, as well as construction and operational impacts aimed at reducing the impact of the proposed development on water resources. The reader is referred to Section 4.4 of the report for the details. Impact mitigation and management would be best achieved by incorporating the recommended environmental design, management & mitigation measures into an Environmental Management Programme (EMPr) for the site with appropriate rehabilitation and ecological monitoring recommendations also included.

x. A total of 7 watercourse crossings were identified for which a water use authorisation is required. A description of the applicable activities that are likely to constitute water uses is provided in the Table C below. Figure A shows the location of watercourse crossing which constitute water uses. The results of the DWS Risk Assessment tool indicate that the construction and operational activities of the proposed development qualify as a low risk activity because affected watercourses are highly degraded, lack sensitive habitats, lack conservation important aquatic biota and are therefore unlikely to be significantly modified as a result of the construction and operation of the proposed pipeline. This implies that **the proposed project qualifies for authorisation under the provisions of a General Authorisation (GA)**.

Table C. Water uses relevant to the proposed development.

No.	Water Uses[1]	Description	Unit ID	Length of crossing (m)	GPS Coordinates
1	Section 21 (c) & (i)	Construction of the pipeline across the	W01	12m	29°36'46.65"S

[1] ***Section 21(c): Impeding or diverting the flow of water in a watercourse:*** *This water use includes the temporary or permanent obstruction or hindrance to the flow of water into watercourse by structures built either fully or partially in or across a watercourse; or a temporary or permanent structure causing the flow of water to be re-routed in a watercourse for any purpose.*

Section 21(i): Altering the bed, banks, course or characteristics of a watercourse: *This water use relates to any change affecting the resource quality of the watercourse (the area within the riparian habitat or 1:100 year floodline, whichever is the greatest).*

No.	Water Uses[1]	Description	Unit ID	Length of crossing (m)	GPS Coordinates
		head the wetland unit.			31° 3'12.83"E
2	Section 21 (c) & (i)	Construction of the pipeline 25m below the toe of the wetland unit.	W02	N/A	29°36'57.46"S 31° 3'31.98"E
3	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit.	W03-A	200m	29°37'0.62"S 31° 3'38.96"E
4	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River.	W03-B	50m	29°37'3.59"S 31° 3'42.90"E
5	Section 21 (c) & (i)	Construction of the pipeline 44m from the edge of the river unit but within the 1:100 year floodline of the Mdloti River.	R01-A	N/A	29°37'9.76"S 31° 3'39.66"E
6	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River	W04-B	75m	29°37'20.04"S 31° 3'38.64"E
7	Section 21 (c) & (i)	Strapping of the pipeline to an existing pipe bridge & trenching of pipeline in the vicinity of the river unit and within the 1:100 year floodline of the Mdloti River.	R01-B	N/A	29°37'38.89"S 31° 3'8.39"E

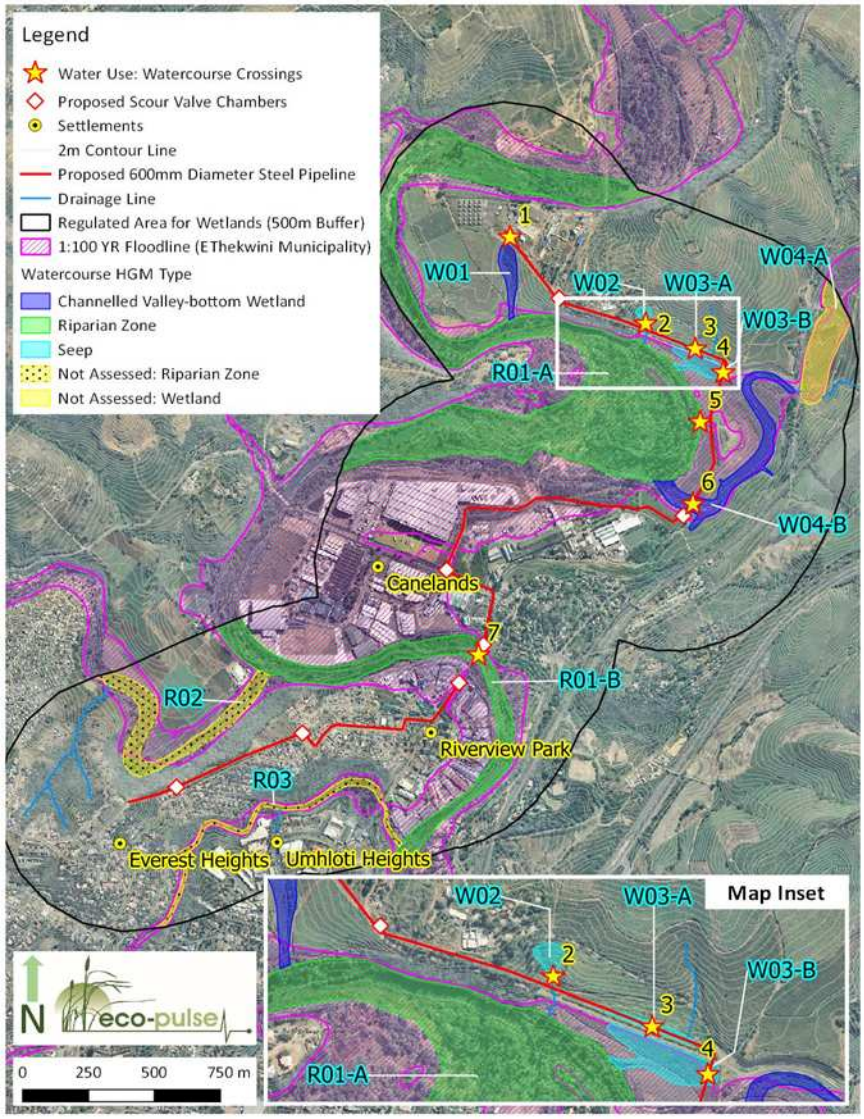


Figure A: Map showing watercourse crossings 1 – 7 which constitute Section 21 (c) and (i) water uses.

B. Findings of the Specialist Terrestrial Habitat Impact Assessment:

i. The study area is located in the summer rainfall region, on the eastern coast of KZN within the North-eastern Coastal Belt Ecoregion, with the provincial vegetation type being KwaZulu-Natal Coastal Belt Grassland (Critically Endangered). This vegetation is however no longer represented in the study area, as a result of transformation of the natural vegetation following decades of sugarcane cultivation and development along the floodplain of the Mdloti River.

ii. Following desktop mapping using colour imagery in GIS of the terrestrial vegetation/habitat along the pipeline development corridor, focused ground-truthing was undertaken in the field which resulted in the classification of four (4) distinct terrestrial vegetation communities, namely: **Primary Scarp Thicket** (sub-community 1 & 2), **Secondary Wooded Grassland**, **Mixed Alien Thicket** (sub-community 1 & 2) and ***Schinus terebinthifolius* Alien Thicket**. An additional two transformed units were also recorded, namely a **Sugarcane Plantation** and an **Urban Development** area. The spatial distribution and extent of the vegetation communities / units is shown in Figure B.

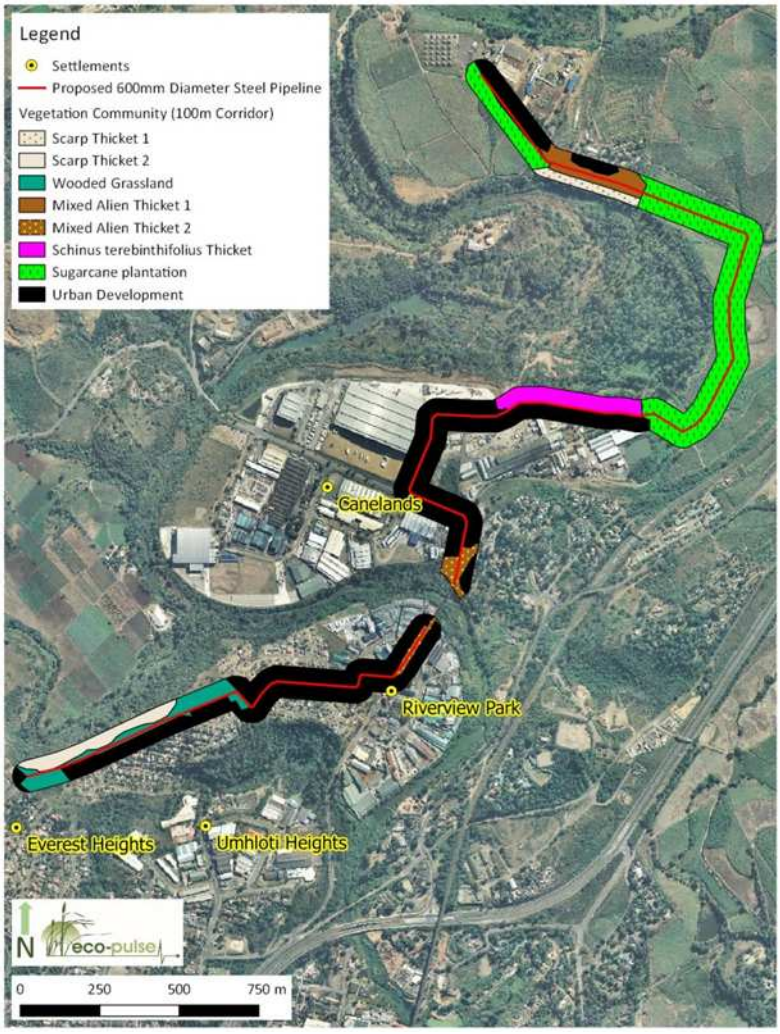


Figure B. Spatial distribution and extent of mapped terrestrial habitat/vegetation types within the development corridor assessed

iii. An assessment of vegetation/habitat Ecological Condition (EC) found that only the Scarp Thicket (sub-community 2) reflected a rating of **'moderately modified', with the remaining** . vegetation communities evaluated as either **'largely modified / degraded'** or **'seriously modified / secondary'**. Similarly, the Ecological Importance and Sensitivity (EIS) assessment revealed the Scarp Thicket (sub-community 2) as being the most notable with a rating of **'moderately EIS'** whilst other vegetation communities were assessed as being either **'low'** or **'moderately-low EIS'** (Table D).

Table D. Summary of the EC and EIS assessment results and size for each vegetation community.

Vegetation Community	Status	EC	EIS	Area (Ha)
Primary Scarp Thicket 1	Secondary Vegetation Community	Secondary (Seriously Modified)	**Moderately Low**	0.951
Primary Scarp Thicket 2	Primary Vegetation Community	Moderately-Modified	**Moderate**	1.947
Secondary Wooded Grassland	Partly Secondary Vegetation Community	Degraded (Largely Modified)	**Moderately Low**	2.888
Mixed Alien Thicket 1	Secondary Vegetation Community	Secondary (Seriously Modified)	**Low**	1.834
Mixed Alien Thicket 2	Partly Secondary Vegetation Community	Degraded (Largely Modified)	**Moderately Low**	1.59
***Schinus terebinthifolius* Alien Thicket**	Secondary Vegetation Community	Secondary (Seriously Modified)	**Low**	2.394
Sugarcane plantation	Transformed	Transformed	**N/A**	13.569
Urban Development	Transformed	Transformed	**Low**	22.41

iv. Identified potential direct and indirect negative impacts linked with the development on the local freshwater/aquatic environment included (Table E):

Table E: Summary of the terrestrial ecological impact significance assessment.

Impact Category	Construction phase impacts			Operational phase impacts	
	Poor mitigation	Good mitigation		Poor mitigation	Good mitigation
Direct physical destruction of flora and fauna	Low	Very Low		Very Low	Insignificant
Habitat Degradation & Fragmentation Impacts	Low	Very Low		Low	Insignificant
Pollution Impacts	Low	Insignificant		N/A	N/A
Indirect Ecological Disturbance & Nuisance Impacts	Very Low	Insignificant		N/A	N/A
Overall (cumulative) Impact	Low	Very Low		Low	Insignificant

Both construction and operational impacts are likely to be of very low to low significance due to the high level of degradation of remaining terrestrial vegetation communities, the absence of suitable habitat for supporting conservation important species and the fact that no residual loss of habitat/vegetation is likely to occur where area are rehabilitated appropriately following construction. All potential impacts can be easily mitigated and potentially be reduced to a very low impact or even insignificant impact significance.

v. Following a comprehensive evaluation of potential impacts a suite of mitigation measures were identified for implementation. These include construction and operational impacts aimed at reducing the impact of the proposed development on terrestrial resources. The reader is referred to Section 5.3 of the report for details. Impact mitigation and management would be best achieved by incorporating the recommended environmental design, management & mitigation measures into an Environmental Management Programme (EMPr).

vi. Three (3) protected plant species were identified within the study area including two (2) specially protected plant species under Schedule 12 of the Natal Nature Conservation Ordinance, No. 15 of 1974: *Aloe arborescens* and *Ledebouria sp*. (either *L. revoluta or L. floribunda*) and a single nationally protected tree: *Sclerocarya birrea* subsp. *caffra* under Section 15(1) of the National Forests Act. Specially protected plants require an Ordinary Permit from Ezemvelo KZN Wildlife whilst nationally protected trees require a licence in terms of protected trees from the Department of Agriculture, Forestry and Fisheries (DAFF) if they are to be handled in any manner (translocation, destruction, cutting down, pruning etc.). Basic information on all protected plants is provided in Table F.

Table F: Basic information on identified conservation-important plant species.

Botanical name	Common name	Plant type	Applicable legislation	Conservation status
Aloe arborescens	Krantz Aloe	Succulent shrub	Natal Nature Conservation Ordinance, No. 15 of 1974	Least Concern / **Specially protected in KZN**
Ledebouria sp. (either L. revoluta or L. floribunda)	N/A	Herb		
Sclerocarya birrea subsp. caffra	Marula tree	Tree	National Forest Act	Least Concern **Nationally Protected Tree**

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Biodiversity	The wide variety of plant and animal species occurring in their natural environment (habitats). The term encompasses different ecosystems, landscapes, communities, populations and genes as well as the ecological and evolutionary processes that allow these elements of biodiversity to persist over time.
Catchment	The area where water from atmospheric precipitation becomes concentrated and drains downslope into a river, lake or wetland. The term includes all land surface, streams, rivers and lakes between the source and where the water enters the ocean.
Conservation	The safeguarding of biodiversity and its processes (often referred to as Biodiversity Conservation).
Delineation	Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.
Ecosystem	An ecosystem is essentially a working natural system, maintained by internal ecological processes, relationships and interactions between the biotic (plants & animals) and the non-living or abiotic environment (e.g. soil, atmosphere). Ecosystems can operate at different scales, from very small (e.g. a small wetland pan) to large landscapes (e.g. an entire water catchment area).
Ecosystem Goods and Services	The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota.
Erosion (gully)	Erosion is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations. While erosion is a natural process, human activities have dramatically increased the rate at which erosion is occurring globally. Erosion gullies are erosive channels formed by the action of concentrated surface runoff.
Function/functioning/ functional	Used here to describe natural systems working or operating in a healthy way, opposed to dysfunctional, which means working poorly or in an unhealthy way.
Habitat	The general features of an area inhabited by animal or plant which are essential to its survival (i.e. the natural "home" of a plant or animal species).
Hydric status	A classification of plants according to occurrence in wetlands and can be useful in determining whether the habitat at a site is wetland/riparian based on the hydric status of dominant species occurring.
Indigenous	Naturally occurring or "native" to a broad area, such as South Africa in this context.
Invasive alien species	Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.
Mitigate/Mitigation	Mitigating impacts refers to reactive practical actions that minimize or reduce in situ impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).
Riparian habitat / Riparian area / Riparian zone	Includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas (National Water Act).
Risk	A prediction of the likelihood and impact of an outcome; usually referring to the likelihood of a variation from the intended outcome.
Soil Mottles/ Mottling	Soil mottling is a feature of hydromorphic (wet) soils and common to wetland areas. Mottles

	refer to secondary soil colours not associated with soil compositional properties that usually develop when soils are frequently wet for long periods of time. In water-logged soils, anaerobic (oxygen deficient) conditions generally causes redoximorphic soil features such as red mottles to develop. Lithochromic mottles on the other hand are a type of mottling associated with variations of colour due to weathering of parent materials.
Threat Status	Threat status (of a species or community type) is a simple but highly integrated indicator of vulnerability. It contains information about past loss (of numbers and / or habitat), the number and intensity of threats, and current prospects as indicated by recent population growth or decline. Any one of these metrics could be used to measure vulnerability. One much used example of a threat status classification system is the IUCN Red List of Threatened Species (BBOP, 2009).
Threatened ecosystem	In the context of this document, refers to Critically Endangered, Endangered and Vulnerable ecosystems.
Transformation (habitat loss)	Refers to the destruction and clearing an area of its indigenous vegetation, resulting in loss of natural habitat. In many instances, this can and has led to the partial or complete breakdown of natural ecological processes.
Watercourse	Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).
Wetland	Refers to land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil (NWA, 1998).
Wetland Type	This is a combination between wetland vegetation group and Level 4 of the National Wetland Classification System, which describes the Landform of the wetland.
Wetland Vegetation Group	Broad wetland vegetation groupings reflect differences in regional context such as geology, soils and climate, which in turn affect the ecological characteristics and functionality of wetlands.

LIST OF ABBREVIATIONS/ACRONYMS

CBA	Critical Biodiversity Area
CR	Critically Endangered (threat status)
DEA	Department of Environmental Affairs (formerly DEAT)
DWS	Department of Water and Sanitation (formerly DWA/F)
EA	Environmental Authorisation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment: EIA regulations promulgated under section 24(5) of NEMA
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EN	Endangered (threat status)
FEPA	Freshwater Ecosystem Priority Area
GA	General Authorisation
GIS	Geographical Information Systems
GPS	Global Positioning System
HGM	Hydro-Geomorphic (unit)
IAPs	Invasive Alien Plants
IHI	Index of Habitat Integrity
KZN	KwaZulu-Natal

LT	Least Threatened (threat status)
NEMA	National Environmental Management Act No.107 of 1998
NFEPA	National Freshwater Ecosystem Priority Areas, identified to meet national freshwater conservation targets (CSIR, 2011)
NT	Near Threatened (threat status)
NWA	National Water Act No.36 of 1998
PES	Present Ecological State, referring to the current state or condition of an environmental resource in terms of its characteristics and reflecting change from its reference condition.
SANBI	South African National Biodiversity Institute
VU	Vulnerable (threat status)
WULA	Water Use Licence Application

1 INTRODUCTION

1.1 Project Locality and Background

EThekwini Water and Sanitation (EWS) are proposing to upgrade the existing rising main water pipeline between Hazelmere Water Treatment Works (WTW) and Grange Reservoir, situated in the town of Verulam, within the eThekwini Municipality, KwaZulu-Natal (Figure 1). The upgrading of the pipeline constitutes a Listed Activity in terms of the National Environmental Management Act, 1998 (NEMA) and also constitutes a Water Use in terms of the National Water Act, 1998 (NWA) and therefore will require Environmental Authorisation and Water Use Authorisation, respectively. In order to fulfil this legislative requirement, EWS appointed DMT Kai-Batla (Pty) Ltd as the independent Environmental Assessment Practitioner (EAP) and tasked them with undertaking a Basic Assessment (BA) and Water Use Licence Application (WULA) to fulfil the legislative conditions for the project. Eco-Pulse Environmental Consulting Services ('Eco-Pulse') was subsequently appointed by DMT to undertaken a Freshwater and Terrestrial Habitat Impact Assessment to inform the BA and WULA.

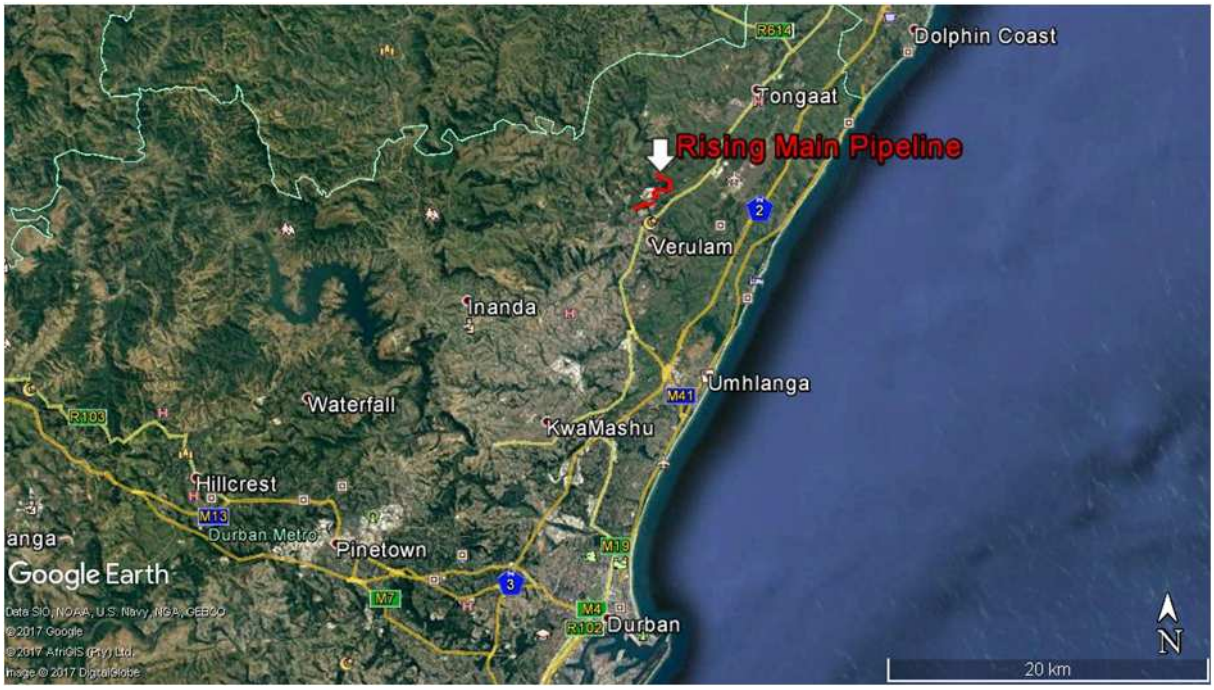


Figure 1 Google Earth™ map showing the rising main pipeline route (in red) on the outskirts of the town of Verulam, eThekwini, KZN.

1.2 Description of the Proposed Development

The proposed development involves an upgrade to the existing 375mm (Ø) Constant Inside Diameter (CID) AC rising main between Hazelmere Water Treatment Works (Hazelmere WTW) and Grange Reservoir to a 600mm (diameter) (Ø) steel pipeline (Figure 2). The new steel pipeline will run within the servitude of the existing AC rising main. The upgraded pipeline will be fitted with air valve chambers and scour valve chambers positioned at crests and troughs, respectively.

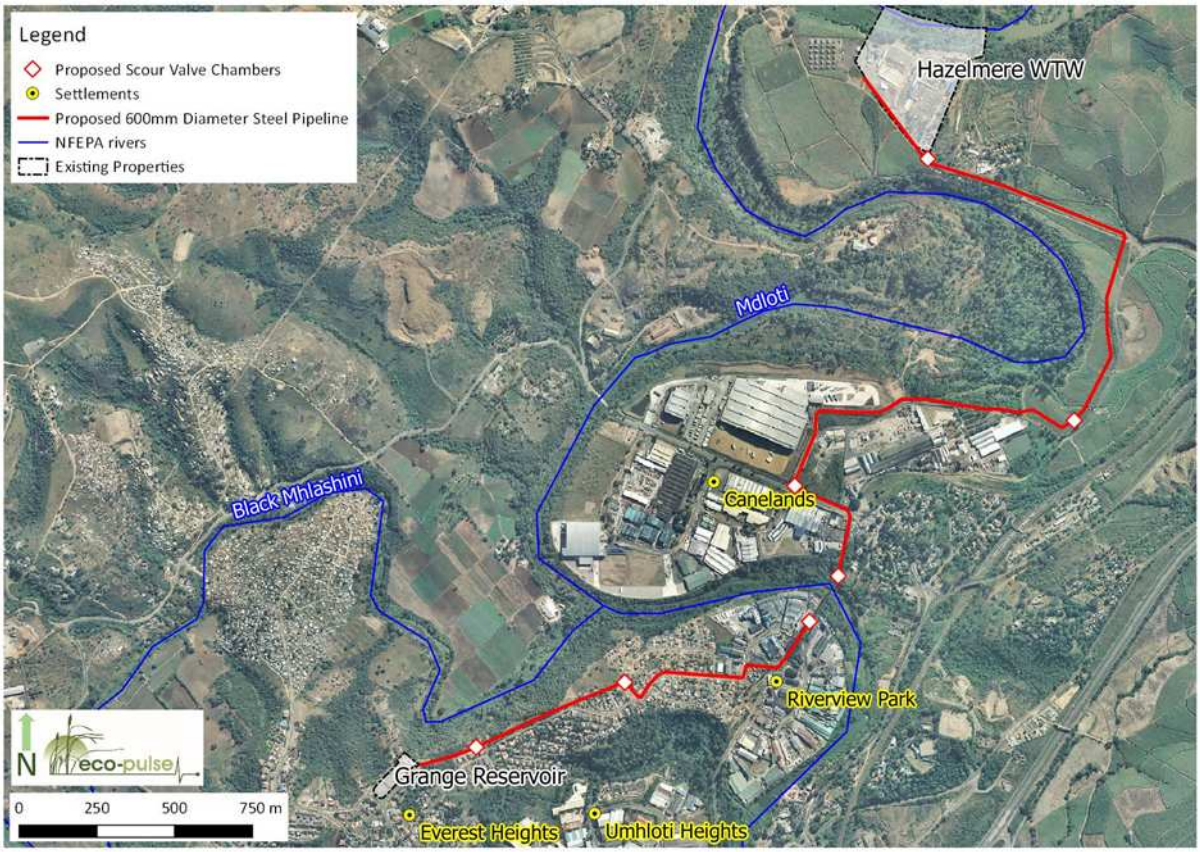


Figure 2 Map showing the rising main pipeline route (in 'red').

1.3 Scope of Work

The scope of work involved undertaking (i) a Freshwater Habitat Impact Assessment and (ii) a Terrestrial Habitat Impact Assessment. A combined report has been compiled that documents the methods and findings of both assessments.

Freshwater Habitat Impact Assessment:

- Desktop mapping and undertaking an impact potential assessment for all watercourses (includes rivers, riparian areas and wetlands) within the regulated area for wetlands (500m buffer of the proposed pipeline) to inform field assessments.
- Desktop contextualisation of the site based on existing spatial information for the study area and based on the assessor's experience in the region/locality, including:
    - Desktop review of available information and biomonitoring/reserve studies for the Mdloti River;
    - Ezemvelo KZN Wildlife's Terrestrial Systematic Conservation Plan (CPLAN, 2010);
    - Ezemvelo KZN Wildlife's Provincial Vegetation Map (2012);
    - Data from the Strategic Environmental Assessment of the Province (EKZNW, 2010);
    - National Freshwater Ecosystem Priority Areas (NFEPAs) (CSIR, 2011);
    - Provincial Wetland Map (EKZNW, 2011); and
    - Local/regional biodiversity conservation planning information (where available).

- Identification and delineation of the outer boundary of wetlands/riparian areas within 32m of the proposed pipeline upgrade according to the approach, methods and techniques contained in '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (DWAF, 2005). This includes sampling and analysis of soil morphology, vegetation and topographic indicators used in wetland delineation. *Note that for wetlands that are not within the activity footprint but are within 500 m of the proposed development, it is only necessary to assess the wetland if the proposed activity will impact on one of the four main wetland drivers, viz. habitat, biota, flow and water quality.*
- Classification of watercourse units using the latest *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al.,* 2013).
- Undertaking a site visit to gather field data necessary to assess wetland/riverine integrity and functioning (PES/EIS) for those wetlands/rivers that are likely to be impacted or trigger Section 21 (c) and/or Water Use.
- Undertaking the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment for watercourse units likely to be impacted (based on the desktop risk/screening assessment and field investigations), involving:
    - Aquatic vegetation and habitat survey;
    - Identification and mapping of the geographic location of any aquatic species of conservation concern (rare/protected plants and trees);
    - WET-Health level 1 rapid assessment (Macfarlane et al., 2008) to establish the Present Ecological State (PES) of the wetlands;
    - Assessment of the importance of the wetlands in providing ecosystem goods and services according to the principles found in the revised WET-EcoServices assessment tool (Kotze et al., 2009);
    - Aquatic habitat condition assessment for instream and riparian areas using the Index of Habitat Integrity at a rapid level 1 level of application (Kleynhans & Louw, 1996); and
    - Rating of the Ecological Importance and Sensitivity (EIS) of the wetlands and rivers using recognized methods, namely the Resource Directed Measures EIS tools (Kleynhans, 1999; Duthie, 1999) and the WET-EIS tool (Rountree, *in prep*.).
- Development of a freshwater habitat sensitivity map for the site, including the location of sensitive freshwater habitat and vegetation types, protected aquatic plants and any recommended development layout recommendations with motivation to be provided.
- Identification and description of the various direct and indirect aquatic ecological impacts for the various phases of the project, including a broad comment on the cumulative ecological impacts likely to arise from the project on the broader region (where applicable).
- Provision of recommendations for managing and mitigating aquatic ecological impacts, including a conceptual level wetland management and rehabilitation plan as an Annexure to the main report.
- Identification of key impacts that should be monitored and recommendation of simple guidelines/methods for ecological monitoring.

- Application of the "DWS Risk Assessment Matrix" at a project level, as detailed in the General Authorisation in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (C) or Section 21 (I), as contained in Government Gazette No. 40229, 26 August 2016 and contained within the DWS document titled 'Section 21(c) and (i) Risk-based assessment and authorization, October 2014, Edition 2'.
- Description of any assumptions made and any uncertainties or gaps in knowledge, as well as identifying the need for any future specialist inputs should these be deemed relevant to the project.
- Reporting: preparing a combined Specialist Freshwater Wetland and Aquatic Assessment Report, including all relevant maps and supporting information. *This report complies with the relevant requirements for specialist reports contained in Appendix 6 of the NEMA: EIA Regulations (August, 2014) as well as the requirements of the Department of Water & Sanitation for Water Use Licensing, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017*.

Terrestrial Habitat Impact Assessment:

Given the high level of vegetation community transformation and infrastructure development, the ecologist from Eco-Pulse opted to conduct a rapid/high-level assessment of the terrestrial vegetation and habitat along the pipeline route as follows:

- Desktop contextualisation of the site based on available provincial, regional and local conservation planning information including:
    - Ezemvelo KZN Wildlife's Terrestrial Systematic Conservation Plan (CPLAN, 2010 & 2016);
    - Ezemvelo KZN Wildlife's Provincial Vegetation Map (2012);
    - Data from the Strategic Environmental Assessment of the Province (EKZNW, 2010);
    - National Vegetation Types (Mucina & Rutherford, 2006); and
    - eThekwini Municipality's D'MOSS and CPLAN layers.
- Desktop identification of species of conservation concern (flora/fauna) potentially occurring on the property based on available species records for the region (i.e. SANBI's online threatened species database: PRECIS and EKZNW's CPLAN) and considering the habitat preferences of these species in light of the habitat represented at the site.
- Desktop mapping of untransformed terrestrial vegetation and habitat in the immediate vicinity of the proposed development footprint.
- Visiting the site to undertake the following:
    - Rapid field survey of vegetation and habitat along transects across the untransformed terrestrial habitat types identified to be investigated (includes species identification and status, relative abundance of different species, identification of pioneer and alien plant species and description of habitat and vegetation type and ecological condition rating).

  - Identification and mapping of the geographic location of any terrestrial species of conservation concern (rare/protected plants and trees) noted during the site assessment.
- Comparison of the vegetation found on the site with reference vegetation type, where applicable.
- Provision of an ecological sensitivity map for the site, including the location of sensitive habitat/vegetation types, protected plants and any recommended terrestrial biodiversity buffer zones (development set-backs).
- Identification and description of the various direct and indirect impacts to terrestrial vegetation and habitat for the various phases of the development project (includes construction and operation), including a broad comment on the cumulative ecological impacts likely to arise from the project on the broader region (where applicable).
- Providing recommendations for managing and mitigating ecological impacts for the various project phases.
- Discussion of any permit/licensing requirements for threatened and protected plant species.
- Description of any assumptions made and any uncertainties or gaps in knowledge, as well as identification of the need for any future specialist inputs (such as detailed faunal assessments) if relevant to the project.

1.4 Key Definitions and Concepts

Under Section 1(1)(xxiv) of the National Water Act (Act No. 36 of 1998) (NWA), a 'watercourse' is defined as:

a) a **river** or **spring**;
b) a **natural channel** in which water flows regularly or intermittently;
c) a **wetland, lake or dam** into which, or from which, water flows; and
d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

This assessment focuses on the assessment of all natural watercourses and their associated habitats / ecosystems likely to be measurably affected by the proposed development, focussing specifically on wetlands, streams and rivers. For the purposes of this assessment, wetlands, streams and rivers are defined as follows:

- **Wetlands** are areas that have water on the surface or within the root zone for extended periods throughout the year such that anaerobic soil conditions develop which favour the growth and regeneration of hydrophytic vegetation (plants which are adapted to saturated and anaerobic soil conditions). In terms of Section 1 of the NWA, wetlands are legally defined as: (1) "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

- **Rivers and streams** are natural channels that are permanent, seasonal or temporary conduits of freshwater. In terms of ecological habitats, rivers and streams comprise in-stream aquatic habitat and riparian habitat. Generally, riparian zones mark the outer edge of stream and river systems. Streams and rivers are differentiated in terms of channel dimensions and generally fall within the broad category of rivers / riverine ecosystems in this report.
- **Instream habitat** is the aquatic habitat (or alluvial in the case of intermittent / ephemeral watercourses) within the active channel that includes the water column, river bed and the inundated active channel margins, and associated vegetation. In terms of Section 1 of the NWA, instream habitat is legally defined as habitat that includes "…the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse."
- A **riparian zone** is a habitat, comprising bare soil, rock and/or vegetation that is: (i) associated with a watercourse; (ii) commonly characterised by alluvial soils; and (iii) inundated or flooded to an extent and with a frequency sufficient to support vegetation species with a composition and physical structure distinct from those of adjacent land areas (DWAF, 2005). In terms of Section 1 of the NWA, riparian habitat is legally defined as: 'habitat that "…includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."

1.5 Conservation and Functional Importance of Aquatic and Terrestrial Ecosystems and Biodiversity

The term 'biodiversity' is used to describe the wide variety of plant and animal species occurring in their natural environment or 'habitat'. Biodiversity encompasses not only all living things, but also the series of interactions that sustain them, which are termed 'ecological processes'. South Africa ranks as the third most biologically diverse country in the world, based on an index of species diversity and endemism, and is one of twelve (12) "mega-diverse" countries which collectively contain more than two-thirds of global biodiversity (Endangered Wildlife Trust and DEA *et al.,* 2013). South Africa's biodiversity is considered important for the following reasons:

- It provides an important basis for economic growth and development;
- Keeping our biodiversity intact is vital for ensuring the on-going provision of ecosystem services that are if benefit to society, including the provision of clean air, water, food, medicine and fibre;
- The role of biodiversity in combating climate change is also well recognised and further emphasises the key role that biodiversity management plays on a global scale (Driver *et al.,* 2012);
- It plays an important role in addressing South Africa's priorities of sustainable rural communities, service delivery and job creation; and

- Biodiversity forms the foundation of ecological infrastructure (ecosystems or habitats which deliver the ecosystem services that underpin economic and social development and are increasingly recognised as having market value).

We need to be mindful of the fact that without the integrity of our natural systems, there will be no sustained long-term economic growth or life (DEA *et al.,* 2013). Pressures and threats to biodiversity are increasing globally and the continuous decline in biodiversity loss may have damaging consequences in terms of local opportunity cost such as the production of clean water, carbon storage to counteract global warming, etc. The loss of biodiversity puts aspects of the economy, wellbeing and quality of life at risk, and reduces long-term socio-economic options for future generations. The need to sustain biodiversity is directly or indirectly referred to in a number of Acts, with the most important being the National Environmental Management: Biodiversity Act No. 10 of 2004 (NEM: BA). In terms of NEM: BA, sustainable development requires the consideration of all relevant factors including disturbance of ecosystems and loss of biodiversity, both of which should be avoided or, if that is not possible, should be minimized and remedied. Given the limited resources available for biodiversity management and conservation in South Africa, as well as the need for development, efforts to manage and conserve biodiversity need to be strategic, focused and support the notion of sustainable development.

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries (Driver *et al*., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage, and are often referred to as the "kidneys" and "arteries" of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel *et al*., 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa's most scare natural resource) and are important in providing additional biophysical, social, cultural, economic and aesthetic services (Nel *et al*., 2013). The health of our rivers and wetlands is measured by the diversity and health of the species we share these resources with. Healthy river ecosystems can increase resilience to the impacts of climate change, by allowing ecosystems and species to adapt as naturally as possible to the changes and by buffering human settlements and activities from the impacts of extreme weather events (Nel *et al*., 2013). Freshwater ecosystems are likely to be particularly hard hit by rising temperatures and shifting rainfall patterns, and yet healthy, intact freshwater ecosystems are vital for maintaining resilience to climate change and mitigating its impact on human wellbeing by helping to maintain a consistent supply of water and for reducing flood risk and mitigating the impact of flash floods. We therefore need to be mindful of the fact that without the integrity of our natural river systems, there will be no sustained long-term economic growth or life (DEA *et al.,* 2013).

Freshwater ecosystems, including rivers and wetlands, are also particularly vulnerable to anthropogenic or human activities, which can often lead to irreversible damage or longer term, gradual/cumulative changes to freshwater resources and associated aquatic ecosystems. Since channelled systems such as rivers, streams and drainage lines are generally located at the lowest point in the landscape; they

are often the "receivers" of wastes, sediment and pollutants transported via surface water runoff as well as subsurface water movement (Driver *et al*., 2011). This combined with the strong connectivity of freshwater ecosystems, means that they are highly susceptible to upstream, downstream and upland impacts, including changes to water quality and quantity as well as changes to aquatic habitat & biota (Driver *et al*., 2011). South Africa's freshwater ecosystems have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work shows that 60% of our river ecosystems are threatened and 23% are critically endangered. The situation for wetlands is even worse: 65% of our wetland types are threatened, and 48% are critically endangered (Driver *et al*., 2011*)*. Recent studies reveal that less than one third of South Africa's main rivers are considered to be in an ecologically 'natural' state, with the principal threat to freshwater systems being human activities, including river regulation, followed by catchment transformation (Rivers-Moore & Goodman, 2009). South Africa's freshwater fauna also display high levels of threat: at least one third of freshwater fish indigenous to South Africa are reported as threatened, and a recent southern African study on the conservation status of major freshwater-dependent taxonomic groups (fishes, molluscs, dragonflies, crabs and vascular plants) reported far higher levels of threat in South Africa than in the rest of the region (Darwall *et al*., 2009). Clearly, urgent attention is required to ensure that representative natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations to come. The degradation of South African rivers and wetlands s is a concern now recognized by Government as requiring urgent action and the protection of freshwater resources, including rivers and wetlands, is considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

1.6 Overview of Relevant Environmental Legislation

The link between ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore *et al.,* 2007). In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection of freshwater resources in the country. Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been included below:.

South African Constitution 108 of 1996	This includes the right to have the environment protected through legislative or other means.
National Environmental Management Act 107 of 1998	This is a fundamentally important piece of legislation and effectively promotes sustainable development and entrenches principles such as the 'precautionary approach', 'polluter pays', and requires responsibility for impacts to be taken throughout the life cycle of a project.
Environmental Impact Assessment (EIA) Regulations	New regulations have been promulgated in terms of Chapter 5 of NEMA and were published on 4 December 2014 in Government Notice No. R. 32828. In addition, listing notices (GN 983-985) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	This Act imposes 'duty of care' on all landowners, to ensure that water resources are not polluted. The following Clause in terms of the National Water Act is applicable in this case:

	19 (1) "*An owner of land, a person in control of land or a person who occupies or uses the land on which (a) any activity or process is or was performed or undertaken; which causes, has caused or likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring*" Chapter 4 of the National Water Act is of particular relevance to wetlands and addresses the use of water and stipulates the various types of Licenced and un-licenced entitlements to the use water. Water use is defined very broadly in the Act and effectively requires that any activities with a potential impact on wetlands (within a distance of 500m upstream or downstream of a wetland) be authorized.
General Authorisations (GAs)	These have been promulgated under the National Water Act and were published under GNR 398 of 26 March 2004. Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a Licence which should be obtained from the Department of Water and Sanitation (DWS).
National Environmental Management: Biodiversity Act No. 10 of 2004	The intention of this Act is to protect species and ecosystems and promote the sustainable use of indigenous biological resources. It addresses aspects such as protection of threatened ecosystems and imposes a duty of care relating to listed invasive alien plants.
Conservation of Agricultural Resources Act 43 of 1967	The intention of this Act is to control the over-utilization of South Africa's natural agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.

Other pieces of legislation that may also be of some relevance to wetlands/rivers include:

- The National Forests Act No. 84 of 1998;
- The Natural Heritage Resources Act No. 25 of 1999;
- The National Environmental Management: Protected Areas Act No. 57 of 2003;
- Minerals and Petroleum Resources Development Act No. 28 of 2002;
- Nature and Environmental Conservation Ordinance No. 19 of 1974; and
- The Mountain Catchments Areas Act No. 62 of 1970.

In addition, terrestrial ecosystems, their relevant species, vegetation, habitats and biodiversity in general are governed in South Africa by the following legislation:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- National Environmental Management Act No. 107 of 1998 (NEMA) inclusive of all amendments;
- National Environmental Management: Biodiversity Act No. 10 of 2004 (NEM: BA);
- Conservation of Agricultural Resources (Act No. 43 of 1983 (CARA);
- National Forests Act No. 84 of 1998 (NFA);
- Nature Conservation Ordinance (No. 19 of 1974); and
- Decree No. 9 (Environmental Conservation) of 1992.

2 APPROACH AND METHODS

2.1 Data Sources Consulted

The following data sources and GIS spatial information listed in Table 1 was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 1. Data sources and GIS information consulted to inform the freshwater and terrestrial habitat assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
2015 Colour aerial photography	Desktop mapping of drainage network and vegetation/habitat	eThekwini Municipality
Latest Google Earth ™ imagery	To supplement available aerial photography where needed	Google Earth™ On-line
1: 50 000 Relief Line (2m Elevation Contours GIS Coverage)	Desktop mapping of drainage network and wetlands	eThekwini Municipality
1:50 000 River Line (GIS Coverage)	Highlight potential onsite and local rivers and wetlands and map local drainage network	eThekwini Municipality
DWA Eco-regions (GIS Coverage)	Understand the regional biophysical context in which water resources within the study area occur	DWA (2005)
EThekwini Geology	*Understand regional geomorphology controlling the physical environment*	eThekwini Municipality
NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential onsite and local rivers and wetlands	CSIR (2011)
NFEPA: River, wetland and estuarine FEPAs (GIS Coverage)	Shows location of national aquatic ecosystems conservation priorities	CSIR (2011)
NFEPA: Wetland Vegetation Groups (GIS Coverage)	Wetland vegetation type and threat status	CSIR (2011)
National Biodiversity Assessment - Threatened Ecosystems (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2011)
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation and its national threat status*	Mucina & Rutherford (2006)
KwaZulu-Natal Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation and its provincial threat status*	Scott-Shaw and Escott (2011)
KZN Aquatic Systematic Conservation Plan (GIS Coverage)	*Determination of provincial freshwater conservation priorities*	EKZNW (2007)
Durban Metropolitan Open Space System (D'MOSS) (GIS Coverage)	*Location and extent of open space systems and ecological corridors*	eThekwini Municipality 2011
KZN Terrestrial Conservation Plan (GIS Coverage)	*Identification of fauna, flora and ecosystems of conservation importance.*	EKZNW (2010)
KZN Systematic Conservation Assessments (SCAs) (GIS Coverage)	*Identification of fauna, flora and ecosystems of conservation importance.*	EKZNW (2016)
SANBI's PRECIS (National Herbarium Pretoria Computerized Information System) (electronic database)	Determination of conservation important plant species	http://posa.sanbi.org
SANBI On-line threatened species database	*Assessment of threatened plant species potentially occurring on site*	SANBI on-line database
Second Southern African Bird Atlas Project (SABAP2) (electronic database)	Determination of conservation important birds	SABAP2, 2017
Red Data Books (Data Lists of Plants, Mammals, Reptiles and Amphibians)	Determination of conservation important plants, mammals, reptiles and amphibians	Various sources
Animal Demography unit online resources	Determination of conservation important birds	ADU online, 2017

2.2 Approach and Methods for the Freshwater Habitat Impact Assessment

2.2.1 *Approach to the assessment*

The general approach to the freshwater (wetland/aquatic) habitat assessment was based on the proposed framework for wetland assessment proposed in the Water Research Commission's (WRC) report titled: '*Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition*' (Ollis *et al.*, 2014) (Figure 3).

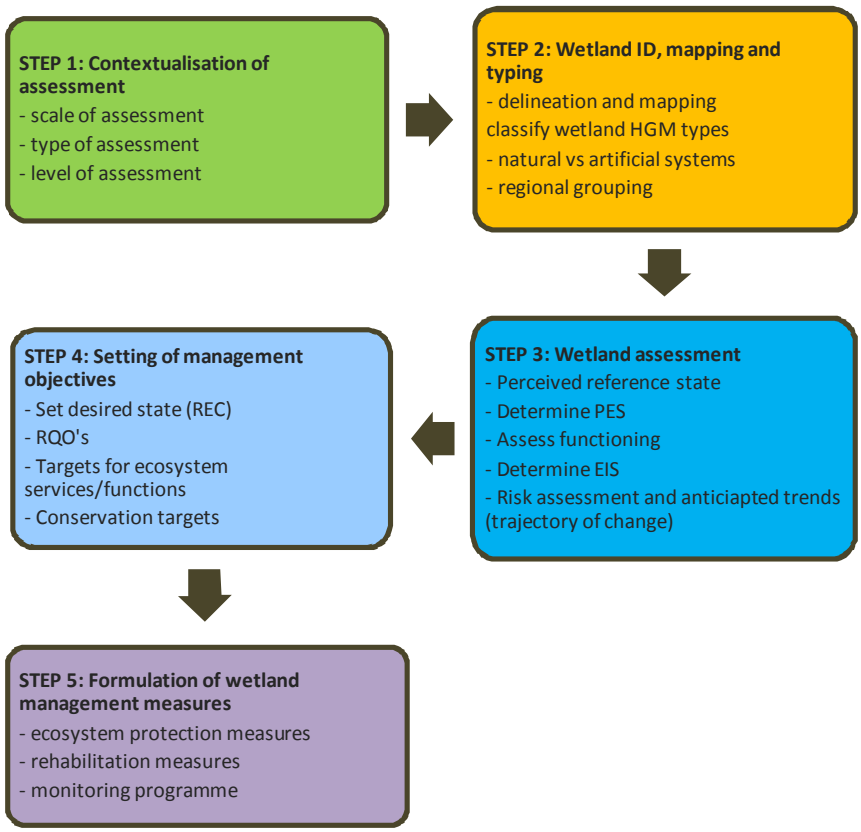


Figure 3 Proposed decision-support framework for wetland assessment in SA (after Ollis et al., 2014).

2.2.2 Desktop Mapping

The desktop delineation of all watercourses (rivers / riparian zones and wetlands) within 500m of the proposed development / activities was undertaken by analysing available 2m contour lines and colour aerial photography supplemented by Google Earth™ imagery where more up to date imagery was needed. Digitization and mapping was undertaken using QGIS 2.18 GIS software. All of the mapped watercourses were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems / habitat). This was undertaken based on aerial photographic analysis and professional experience in working in the region. Please note that the desktop map was updated as part of the finalisation of the assessment to include the detailed delineation of the units occurring within the study area.

2.2.3 'Impact Potential' Screening Assessment

Following the desktop identification and mapping exercise, watercourses were assigned preliminary 'likelihood of impact' ratings based on the likelihood that activities associated with the proposed development will result in measurable direct or indirect changes to the mapped watercourse units within 500m of the proposed development. The 'impact potential' ratings were refined following the completion of the field work. Each watercourse unit was ascribed a qualitative 'impact potential' rating according to the ratings and descriptions provided in Table 2, below.

Table 2. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
Definite / Probable	These resources are likely to require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within the footprint** of the proposed development activity and will definitely be impacted by the project; and/or ➢ resources located **within 15m upstream and/or upslope** of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located **within 15m or downslope** of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located downstream within the following parameters: o **within 15m downstream** of a low risk development; o **within 50m downstream** of a moderate risk development; and/or o **within 100m downstream** of a high risk development e.g. mining large industrial land uses.
Likely	These resources may require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within 32m but greater than 15m upstream, upslope or downslope** of the proposed development; and/or ➢ resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. This is generally resources located downstream within the following parameters: o **within 32m downstream** of a low risk development; o **within 100m downstream** of a moderate risk development; and/or o **within 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Unlikely	These resources are unlikely to require impact assessment or Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or ➢ resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: o **greater than 32m downstream** of a low risk development; o **greater than 100m downstream** of a moderate risk development; and/or o **greater than 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
None	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located within another adjacent sub-catchment and which will not be impacted by the development in any way, shape or form.

2.2.4 Baseline Wetland/Aquatic Assessment

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section. The assessments undertaken as part of this study are listed in Table 3 below along with the relevant published guidelines and assessment tools / methods / protocols utilised. A more comprehensive description of the methods listed below are included in **Annexure A**.

Table 3. Summary of methods used in the assessment of delineated water resource units.

Method/Technique		Reference for Methods/Tools Used	Annexure
Wetland/riparian area delineation		➢ *A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005)*	**A1**
Classification of water resources (rivers & wetlands)		➢ *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (SANBI, 2014)* ➢ *Classification system for channelled watercourses (Eco-Pulse, 2013)*	**A2**
Wetlands	**Wetland condition/PES**	➢ *WET-Health assessment tool (Macfarlane et al., 2008)*	**A3**
	Wetland Functional Importance	➢ *WET-Ecoservices assessment tool (Kotze et al., 2009)*	**A4**
	Wetland Ecological Importance & Sensitivity (EIS)	➢ *Wetland EIS tool (Eco-Pulse, 2017)*	**A5**
Rivers	**SASS5 derived water quality**	➢ *SASS5 - South African Scoring System, Version 5 (Dickens and Graham, 2002)*	**A6**
	Water chemistry	➢ *Water chemistry sampling and laboratory analysis*	**A7**
	Fish sampling	➢ *Specialist fish sampling*	**A8**
	River condition/PES	➢ *IHI (Index of Habitat Integrity) tool (Kleynhans, 1996)*	**A9**
	River Ecological Importance & Sensitivity (EIS)	➢ *River EIS tool (Eco-Pulse, 2017).*	**A10**

2.2.5 Impact Assessment

While details of specific impacts will vary according to the site and development activity, aquatic / freshwater ecosystem impacts can typically be grouped into the following three (3) categories based on distinct impact-causing activities, ecosystem components and impact pathways:

1. **Direct habitat loss and modification impacts** – This impact type refers to the direct physical destruction and/or disturbance of freshwater habitat by human activities like vegetation / habitat clearing (stripping / grubbing), surface reshaping / alteration, earthworks (i.e. excavation and infilling) and flooding. This impact also includes the resultant impacts to ecosystem condition and ecosystem services but does not include the indirect hydrological, geomorphological and ecological impacts of such activities like flow modification, erosion and sedimentation and associated downstream habitat degradation.

2. **Indirect flow modification, erosion and/or sedimentation impacts** – This impact type refers to all of the indirect impacts resulting from and associated with human activities that alter wetland hydrological and geomorphological (erosion and sedimentation) processes and structures like: (i) direct physical habitat modification; (ii) catchment and buffer zone land cover modification and transformation (e.g. vegetation clearing, surface hardening, stormwater management and

cultivation); and (iii) flow regulation, abstraction and controlled discharges. This impact also includes the resultant impacts to ecosystem condition and ecosystem services.

3. **Water pollution impacts** – This impact refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within watercourses and the associated ecological impacts. In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems and for current uses, domestic and agricultural.

Each of the above impact groups were described and qualitatively rated in terms of the following impact characteristics / aspects based on professional opinion:

- Stressor characteristics.
- Impacts to ecosystem PES (functioning).
- Impact to the supply of ecosystem services.

An impact assessment was then carried out using the above mentioned categories and then contextualised in terms of the following ultimate consequences or end-points (i.e. impacts to resources of known societal value) in line with the National Wetland Offset Guidelines (SANBI & DWS, 2014), namely:

(i) **Impacts to water resource supply and quality**: This addresses impacts to the quantity and quality of water provided by water resources. Such impacts may be the result of more direct impacts like abstraction, regulation and/or return discharges, and/or the result of freshwater ecosystem loss or degradation that affects the ability of watercourses to provide supporting regulating and supporting services.

(ii) **Impacts to ecosystem and habitat conservation (ecosystem biodiversity):** This deals specifically with impacts to quality and condition of habitat and the ability to meet conservation targets for freshwater ecosystems. This therefore accounts for the loss or change in freshwater habitat, which is particularly important for highly threatened ecosystem types.

(iii) **Impacts to species of conservation concern (species biodiversity)**: This addresses impacts on freshwater biota, with a particular emphasis on species or populations of conservation concern and the ability to meet species conservation targets.

(iv) **Impacts to local communities**: This deals with impacts to local communities reliant on freshwater ecosystem goods and services, specifically impacts to provisioning (e.g. water supply & cultivated foods) and cultural services (e.g. cultural significance or recreational values) of direct value to local users and consequences for human health, safety and livelihood support.

The approach to impact conceptualisation is depicted by the diagram in Figure 4.

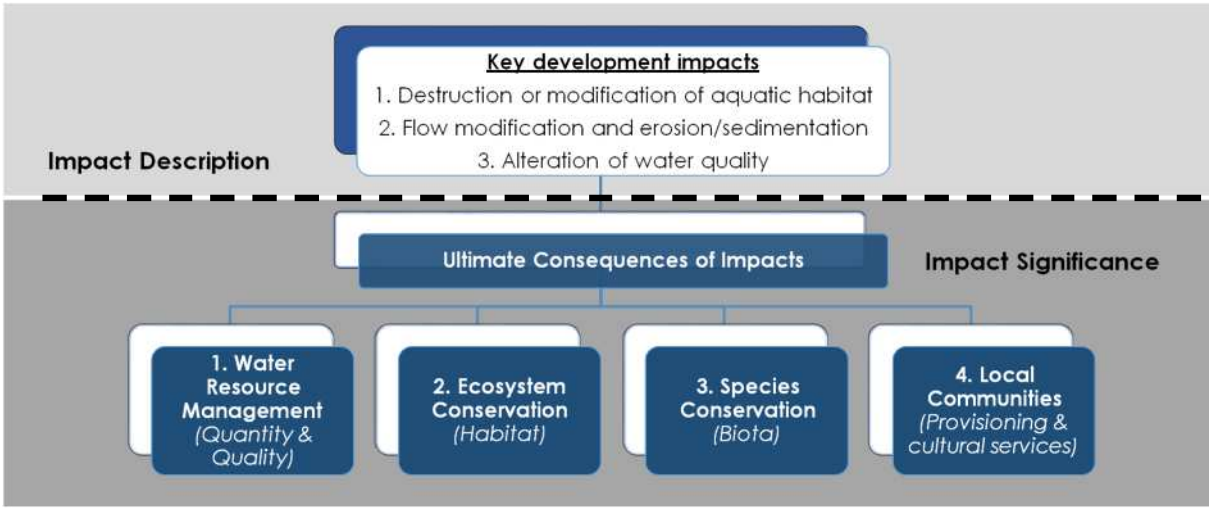


Figure 4 Diagram illustrating how the impact assessment framework is conceptualized.

The impact assessment was undertaken for the following mitigation scenarios only:

- **Realistic 'Poor' Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of standard construction and operational phase mitigation measures. In terms of implementation success, this scenario assumes a realistic / likely poor implementation scenario based on the author's experience with such developments. It is important to note that it is our experience in similar development settings that contractor compliance with construction Environmental Management Programmes (EMPr) is poor and that operational maintenance is poor.
- **Realistic 'Good' Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of the construction and operational phase mitigation measure recommended by the author. In terms of implementation success, this scenario assumes a realistic best case scenario for implementation based on the author's experience with such developments.

A comprehensive description of the impact significance assessment method employed is included in **Annexure A11.**

2.2.6 DWS Risk Assessment

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorisation of Section 21(c2) and 21(i3) water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does

[2] 21(c): Impeding or diverting the flow of water in a watercourse

[3] 21(i): Altering the bed, banks, course or characteristics of a watercourse

not apply to the following activities:

- Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area'[4] of a watercourse where the Risk Class is **Medium or High.**
- Where any other water use as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.
- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 c and I water use Risk Assessment Protocol') was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD

whereby:

CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION

and

LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risk stressors[5] associated with each of the three impact groups / types considered were:

1. **Direct habitat loss and modification impacts** – Physical disturbance.
2. **Indirect flow modification, erosion and/or sedimentation impacts** – Erosive surface runoff, sediment and increased and/or reduced water inputs.
3. **Water pollution impacts** – Chemical, organic and biological pollutants.

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool.

It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of

[4] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

i. The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.
ii. In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).
iii. A 500m radius from the delineated boundary of any wetland or pan.

[5] *A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact (USA EPA - https://www.epa.gov/risk/about-risk-assessment#whatisrisk).*

risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses to inform WUL requirements for the proposed development.

2.3 Approach and Methods for Terrestrial Assessments

2.3.1 Field Survey

The field survey was undertaken over a period of one day on the 23rd August 2017 (late winter season). The survey entailed a site walkover within the study corridor defined as the area within a 100m study corridor. Vegetation sampling was focused within the study corridor. The following information was collected in the field:

- Qualitative plant species composition. Where plant species could not be identified, samples and photographs were taken to confirm at a later stage using available taxonomic keys and species identification guides.
- Qualitative species abundance.
- Species of conservation concern.
- Observable onsite impacts.
- Distinct vegetation boundaries.
- Vegetation structure.

Please note that sampling involved visual /qualitative assessments and no formal vegetation plots were undertaken. Furthermore, no formal faunal sampling or searches were undertaken, and faunal features like dens, spoor[6] and skat[7] were recorded if observed but were not sought out.

All sampling points were recorded using a handheld GPS device.

2.3.2 Species of Conservation Concern Potential Occurrence (POC) Assessment

Species of conservation concern are species that have a high conservation importance in terms of preserving South Africa's high biological diversity and generally include rare and threatened species. This category also includes those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient - Insufficient Information (DDD). South African conservation agencies use the internationally endorsed IUCN Red List Categories and Criteria to determine the conservation status of biota, which are published in various Red Lists for specific orders of animals and plants. SA uses a revised system of the IUCN criteria (Figure 5).

[6] *Spoor is a track of an animal e.g. print made by hooves.*

[7] *Skat is animal droppings.*

Identification of conservation important species is important in order to ensure protection of flora and fauna. A description of the different South African Red List categories is provided in Table 4.

Species of conservation concern refer to species of flora (plants) and fauna (animals) that have a high conservation importance in terms of preserving South Africa's high biological diversity and include threatened species that have been classified as 'at high risk of extinction in the wild'. If a subpopulation of a species of conservation concern is found to occur on a proposed development site, it would be one indicator that development activities could result in significant loss of biodiversity, bearing in mind that loss of subpopulations of these species will either increase their extinction risk or may in fact contribute to their extinction (see Figure 5). A description of the different SANBI categories of species of conservation concern is provided in Table 4.

Table 4. South African Red List Categories for species of conservation significance (after SANBI, on-line at http://redlist.sanbi.org/eiaguidelines.php).

Status	Category	Description
SPECIES OF CONSERVATION CONCERN	**Critically Endangered, Possibly Extinct (CR PE)**	Possibly Extinct is a special tag associated with the category Critically Endangered, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered
	Critically Endangered (CR)	A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
	Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
	Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
	Near Threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.
	Critically Rare	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
	Rare	A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.
	Declining	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.
	Data Deficient - Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
OTHER	**Data Deficient - Taxonomically Problematic (DDT)**	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.
	Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

Status	Category	Description
	Not Evaluated (NE)	A species is Not Evaluated when it has not been evaluated against the criteria. The national Red List of South African plants is a comprehensive assessment of all South African indigenous plants, and therefore all species are assessed and given a national Red List status. However, some species included in Plants of southern Africa: an online checklist are species that do not qualify for national listing because they are naturalized exotics, hybrids (natural or cultivated), or synonyms. These species are given the status Not Evaluated and the reasons why they have not been assessed are included in the assessment justification.

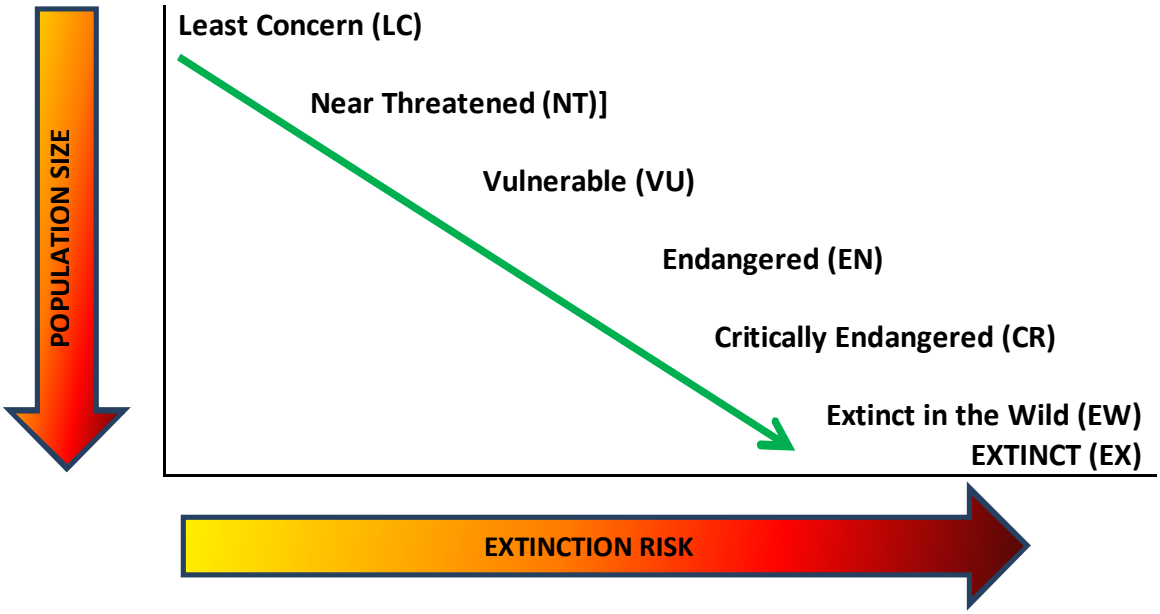


Figure 5 Graph showing the relationship between population size and extinction risk, distinguishing between the various species threat statuses (after SANBI, 2010).

A number of existing species databases (EKZNW), publications and field guides were used to assess the **Potential Occurrence (POC**) of Red Data (Threatened/Protected) flora and fauna species for the study area and development site, with following parameters were then used to assess the probability of occurrence:

1. **Species range**: Species often have specific geographical/altitudinal ranges in which they occur or are restricted to and the location of the project area in relation to these distributional ranges was evaluated based on available information.
2. **Habitat requirements**: Most Red Data animals have very specific habitat requirements/preferences and the presence/absence of these habitat characteristics in the study area was evaluated.
3. **Habitat status:** Often a high level of habitat degradation in a specific habitat will negate the presence of Red Species which are typically sensitive to disturbance; hence the status or ecological condition/suitability of available habitat in the area was assessed.

4. **Habitat connectivity**: Movement between areas for breeding and feeding forms an essential part of the life-cycle and persistence of many species. Isolated/patchy habitats are generally not well-suited for harboring threatened species; however, this is not always the case. Connectivity of the study area to surrounding habitat and the adequacy of these linkages were evaluated.

The habitat requirements/preferences for each plant/animal t species of conservation concern was thus reviewed (based on available literature) and was compared with the habitat occurring at the site (initially based on imagery which was then verified through site visits) in order to estimate the likelihood of these species occurring on the target property (as per the assessment matrix in Table 5, below).

Table 5. Generic matrix used for the estimation and rating of flora/fauna species potential occurrence based on known habitat requirements/preferences and ranges.

		SPECIES HABITAT REQUIREMENTS/PREFERENCES			
		Fully met	**Largely met**	**Partially met**	**Not met**
		Natural condition	**Fair condition**	**Poor-Fair condition**	**Poor condition/ Transformed**
SPECIES DISTRIBUTION/RANGE	**Habitat occurs within known species geographic/altitudinal range**	Highly probable	Possible	Unlikely	Highly unlikely or Improbable
	Habitat occurs on the edge of known species geographic/altitudinal range	Possible	Possible	Unlikely	Highly unlikely or Improbable
	Habitat occurs outside of known species geographic/altitudinal range	Unlikely	Unlikely	Highly unlikely or Improbable	Highly unlikely or Improbable

2.3.3 Assessment of Ecological Condition for Terrestrial Vegetation/Habitat

Vegetation communities / habitat units defined for the study area were assessed qualitatively in terms of their ecological condition. Ecological condition is defined as a measure of modification relative to a reference state in terms of species structure and composition. Below is a description of ecological condition classes (Table 6).

Table 6. Description and indicators of Ecological Condition classes.

Condition Class	Description	Indicators
Largely Intact	Unmodified, largely natural.	• High native flora composition (80 – 100%). • Structural characteristics resemble that of reference plant communities. • Low to no disturbances. • Low to no weed and / or IAP infestation.
Transitional	Habitats where natural disturbance regimes have changed resulting in a change to structural characteristics (e.g. wooded grassland to thicket communities).	• Substantial increase in woody cover relative to reference communities. • High structural change. • Generally low to no disturbances. • Generally low to no weed and IAP infestation.
Moderately Modified	A moderate change in species composition and vegetation structure has occurred in response to anthropogenic impacts.	• Moderate native flora composition (50 – 80%). • Moderate change in structural characteristics (e.g. moderate increase / decrease in woody plants) resemble that of reference plant communities.

		• Moderate disturbances. • Moderate weed and / or IAP infestation.
Largely Modified / Degraded	A large to serious change in species composition and vegetation structure has occurred in response to anthropogenic impacts.	• Low native flora composition (0 – 50%). • Major change in structural characteristics relative to reference plant communities. • High disturbance. • Moderate to high weed and / or IAP infestation.
Seriously Modified / Secondary	A vegetation community that replaces original vegetation after severe disturbance (such as cultivation or clearing) or severe cumulative impacts such as overgrazing or over-burning over a long period of time.	• Vegetation comprised of few species, with one or a few dominant. • Moderate to high abundance of weeds and IAPs. • Contour ridges or other evidence of soil disturbance evident.
Transformed	Non-vegetated areas owing to past and present human activities. A few indigenous species may be present.	• Present cultivated lands (crops, forestry etc.). • Development land (Houses, Roads etc.)

2.3.4 Assessment of Ecological Importance and Sensitivity

The ecological importance of the vegetation community refers to the ability of the ecological entity to: (i) meet conservation targets for conservation important flora and faunal species i.e. biodiversity maintenance value; and (ii) provide for the maintenance of biodiversity features. The importance of each vegetation community was therefore based on (i) whether it is representative of threatened habitat (condition), (ii) whether it provides habitat for species of conservation concern, (iii) rarity, diversity and uniqueness of flora and habitat and (iv) it's importance in terms of conservation planning.

Sensitivity refers to both the intensity and likelihood of change in key aspects as a result of changes to key ecosystem drivers. The more sensitive a system, the more likely and more intense the changes with a change in drivers (Table 7). High sensitivity systems are those often characterised by with high diversity, specifically sensitive species (intolerant species), small patch size and/or low area to perimeter ratio and/or are located in areas sensitive to change e.g. located on highly erodible soils or steep slopes. In terms of species, sensitive species are those with narrow tolerance ranges and that cannot withstand elevated levels of disturbance. Low sensitivity systems are often those characterised by low diversity, high levels of modification and can withstand elevated disturbance regimes. Low sensitivity species are typically generalist and opportunistic species that have wide tolerances ranges. The sensitivity of each vegetation community was therefore assessed qualitatively based on the following aspects:

- Diversity and intactness / condition.
- Presence of sensitive species.
- Presence of sensitive habitats (i.e. to sediment and water quality changes).
- Community / habitat patch size and shape (perimeter to area ratio).
- Soil erodibility.
- Slope.

Table 7. Descriptions of the EIS ratings.

EIS Rating	Description(s)
High	Vegetation community with features are considered ecologically important and sensitive on a national or even international level.
Moderately-High	Vegetation community with features are considered to be ecologically important and

EIS Rating	Description(s)
	sensitive at a regional scale.
Moderate	Vegetation community with features are considered to be ecologically important and sensitive at a local scale.
Moderately-Low	Vegetation community with features are regarded as somewhat ecologically important and sensitive at a local scale.
Low	Vegetation community with features have a very low ecological importance and sensitivity at any scale.

2.4 Assumptions, Limitations and Gaps in the Information Presented

The following limitations and assumptions apply to the freshwater and terrestrial habitat impact assessment undertaken:

2.4.1 General assumptions & limitations

- This report deals exclusively with a defined area and the extent and nature of freshwater/aquatic and terrestrial habitat and ecosystems in that area.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the Province at the time of the assessment.
- All field assessments were limited to day-time assessments.

2.4.2 Sampling limitations & assumptions

- Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of freshwater ecosystems, it is important to note that the current extent and classification is reported on here.
- Infield soil sampling and vegetation observations were only undertaken a strategic sampling points within the habitats likely to be negatively affected. Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.
- The wetland boundary was identified and classified along a transitional gradient from saturated through to terrestrial soils which makes it difficult to identify the exact boundary of the wetland. The boundaries mapped in this specialist report therefore represent the approximate boundary of wetlands as evaluated by an assessor familiar and well-practiced in the delineation technique.
- The accuracy of the delineation is based solely on the recording of the onsite wetland indicators using a GPS. GPS accuracy will therefore influence the accuracy of the mapped sampling points and therefore water resource boundaries and an error of 3 – 5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin Monterra™ Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- In environments with multiple artificial water sources (e.g. leaking pipeline infrastructure, road runoff, and water discharge from various infrastructures), interpretation of natural versus artificial hydric soils

or wetland soil indicators can be difficult. In such cases, we have made an effort to substantiate all claims where applicable and necessary while acknowledging limitations.

- All vegetation information recorded was based on the onsite observations of the author and no formal vegetation sampling was undertaken. Furthermore, the vegetation information provided only gives an indication of the dominant and/or indicator riparian species and only provides a general indication of the composition of the vegetation communities. Thus, the vegetation information provided has limitations for true botanical applications i.e. accurate and detailed species lists and rare / Red Data species identification.
- Although every effort was made to correctly identify the plant species encountered onsite, veld burning at the time of inspection made it difficult to identify all plant species.
- Not all wetlands within the 500m DWS regulated area were assessed/delineated in the field. Focal areas at risk of being impacted or triggering Section 21 water use were flagged during the desktop risk/screening exercise to be assessed in detail in the field. Thus, finer habitat type details of the systems not formally assessed were not acquired.
- Mapped boundaries are based largely on the GPS locations of soil sampling points. GPS accuracy will therefore affect the accuracy rating of mapped sampling points and therefore wetland/riparian boundaries. Soil sampling points were recorded using a Garmin™ Montana Global Positioning System (GPS) with an accuracy of 3-5m.
- Infield soil and vegetation sampling was only undertaken within a specific focal area in the vicinity of the proposed development, while the remaining water resource/HGM units were delineated at a desktop level with limited accuracy.
- It is important to note that delineation of wetlands on this site was difficult in some areas due to the extent of soil disturbance, infilling, removal of indigenous wetland vegetation and the colonisation of the native vegetation community by invader exotic/alien plants that have capitalised on the habitat disturbance that has occurred.
- Inferences made about the ecological integrity/health of the wetlands assessed was based on selected variables, sampled on selected occasions at selected geographic locations. This limits the degree to which this information can be extrapolated spatially and temporally (i.e. over seasons). Wetlands by nature can be highly variable ecosystems and can display fine and large scales changes in the structure, composition and quality of the habitat over periods of time.
- No formal faunal survey was undertaken. The focus was on recording any faunal species and faunal habitat recorded during the vegetation survey in order to improve the confidence of the likelihood of occurrence assessment.

2.4.3 'Seasonality' of the Assessment

The site was surveyed in late winter (August 2017). The field surveys therefore do not cover the full seasonal variation in conditions for the entire site. However, seasonality is not such an issue for the target study area surveyed which does not warrant the need for further seasonal surveys for the following reasons:

- Soil wetness indicators (i.e. soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality has no influence on the delineation of wetland areas.
- Seasonality can also influence the species of flora encountered at the site, with the flowering time of many species often posing a challenge in species identification. Since the wetland and riparian vegetation in the study area was found to be largely secondary/degraded with low native plant diversity, seasonality would not be as significant a limitation when compared with a vegetation community that is largely natural or high in native plant diversity.
- The location of the study area within the coastal zone of KZN (subtropical climate) means that climate has less of an effect on aquatic ecosystems and vegetation characteristics than inland systems which are exposed to more extreme variations in temperatures between seasons. Thus, vegetation response is limited and species structure and composition tend to remain the same or very similar between seasons.

2.4.4 Baseline Ecological Assessment

- It should be noted that while WET-Health (Macfarlane *et al.,* 2008) is the most appropriate technique currently available to undertake assessments of wetland condition/integrity, it is nonetheless a rapid assessment tool that relies on qualitative information and expert judgment. While the tool has been subjected to an initial peer review process, the methodology is still being tested and will be refined in subsequent versions. For the purposes of this assessment, the assessment was undertaken at a rapid level with limited field verification. It therefore provides an indication of the PES of the system rather than providing a definitive measure.
- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
- The WET-Health tool's Hydrological assessment module is not particularly well suited for the assessment of wetlands with high groundwater inputs.
- The setting of the hypothetical reference state for each of the wetland and riverine units assessed was extremely difficult due to the transformed and modified nature of the systems and a lack of information regarding reference state. Therefore, the reference states presented should be considered speculative with a low level of confidence.
- The Ecological Importance and Sensitivity assessment did not specifically address the finer-scale biological aspects of the rivers such as fauna (amphibians and invertebrates) occurring.
- The assessment of the potential occurrence of flora/fauna was informed by the presence and condition of ideal habitat for each faunal species. The habitat condition / integrity was used as a surrogate indicator of the likelihood of a particular species being present.

2.4.5 Assumptions with respect to the assessment of impacts

- The Impact Assessment Methodology provided by DMT Kai Batla was applied in this assessment report.

- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar projects.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures and best management practice, as provided in this report.

2.4.6 Assumptions with respect to the assessment of risk

Risks were assessed based on the DWS Risk Assessment Matrix. The following assumptions apply to the application of the DWS risk matrix tool in the context of project in question:

- All risk ratings generated by the DWS risk matrix are conditional on the effective implementation of the specialist mitigation measures provided in this report.
- For the severity ratings, impacts to wetlands were assessed on their merits rather than automatically scoring impacts to wetlands as 'disastrous' as guided in the DWS risk matrix.
- The severity assessment for changes in flow regime and physico-chemical impacts were interpreted in terms of the changes to the local freshwater ecosystem represented by the potentially affected reaches.
- For the scoring of impact duration, the predicted change in PES was also considered which could override the actual duration of the impact where applicable e.g. if the impact duration was long term (typically a score of 4 out of 5) but the predicted change in PES is negligible, the impact duration was down-rated to a score of 2 in line with the duration criteria descriptions in the risk matrix tool.

3 DESKTOP CONTEXTUAL SURVEY

3.1 Regional & Local Biophysical Setting

A summary of key biophysical setting details of the study area and surrounds are presented in Table 8 below.

Table 8. Key biophysical setting details of the study area.

Biophysical Aspects	Desktop Biophysical Details	Source
Elevation a.m.s.l.	35 – 95m	Google Earth™
Mean annual precipitation (MAP)	983.2mm	(Shulze, 1997)
Rainfall seasonality	Mid-Summer, Early Summer, Late Summer	(DWAF, 2007)
Mean annual temperature	12 - 22°C	(DWAF, 2007)
Potential Evaporation (mm) Mean Annual A-pan Equivalent	247.3mm	(Shulze, 1997)
Median Annual Simulated Runoff (mm)	220.2mm	(Shulze, 1997)
Geology	Low lying area in valley bottoms are characterised by alluvium, mid slopes by Pietermaritzburg shale and high lying by Karoo dolerite	EThekwini Municipality
Water Management Area	Mvoti to uMzimkhulu (No. 11)	DWA
Quaternary Catchment	U30B	DWA
Main collecting river	uMdloti River	CSIR, 2011
Geomorphic Zone of the Mdloti River	Lower foothills	CSIR, 2011
DWS Ecoregion	17.01 (North-Eastern Coastal Belt)	(DWAF, 2007)

3.2 Conservation Context

Understanding the conservation context and importance of the study area and surrounds is important to inform decision making regarding the management of aquatic and terrestrial ecosystems, habitats and associated biodiversity in the area. In this regard, national, provincial and regional conservation planning information available was used to obtain an overview of the study site. Key conservation context details of the project site and surrounds have been summarised in Table 9, below.

Table 9. Key conservation context details for the area of study.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Features (s)**	**Location in Relation to Project Site**	**Conservation Planning Status**
National Vegetation Types (Mucina & Rutherford, 2006) **Ecosystem Threat Status** (NBA, 2011)	Coastal Grassland	No remaining 'natural' grassland habitat/vegetation	Endangered
The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR, 2011)	Mdloti River	Main draining river system	FEPA river catchment
	Wetlands	Intact wetland areas surrounding the site	Sub-Escarpment Savanna Veg group: (Endangered)

PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
Provincial Vegetation Types (Scott-Shaw & Escott, 2012)	KwaZulu-Natal Coastal Belt Grassland	No remaining 'natural' grassland habitat/vegetation	Critically Endangered
KZN Aquatic Conservation Plan (EKZNW, 2007)	Catchment	Study area catchment	'Available'
KZN Terrestrial Conservation Plan (EKZNW, 2016)	Critical Biodiversity Area (CBA): Irreplaceable	Various areas (see Figure 7)	Critical
LOCAL LEVEL CONSERVATION PLANNING CONTEXT			
Durban Metropolitan Open Space System (D'MOSS) (GIS Coverage)	Freshwater wetlands, thicket vegetation	Wetlands and vegetation (see Figure 8)	D'MOSS planned areas
Durban's Systematic Conservation Assessment (Maclean *et al.*, 2015)	Critical Biodiversity Area (CBA), Ecological Support Area (ESA)	Mdloti River & tributaries	Critical and Support areas

Of particular significance/relevance to the development project and study area are the following:

3.2.1 Vegetation Conservation / Threat Status

KwaZulu-Natal Coastal Belt Grassland has a national threat status of Endangered (NBA, 2011) and provincial threat status of Critically Endangered (Jewitt, 2014). Only a very small parcel is statutorily conserved, mainly in Ngoye, Mbumbazi and Vernon Crookes Nature Reserve (Mucina and Rutherford, 2006) hence it is considered moderately protected (Jewitt, 2014). *Importantly, the vegetation of the study area has been largley transformed by built/urban areas and sugarcane cultivation, with remaining untransformed habtiat having been modified by human impacts over the last century and no longer considered representative of the natural grassland that formerly characterised the area prior to cultivation and human development. The vegetation now resembles a secondary modified type that is characterised by notably high levels of invasive alien plant species.*

3.2.2 *National Freshwater Ecosystem Priority Areas (NFEPA)*

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel *et al.*, 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. The importance of water resources in meeting national freshwater conservation targets is provided in the National Freshwater Ecosystems Priority Areas (NFEPA) outputs and coverage's (CSIR, 2011).

This NFEPA coverage for the site shows that the upper reach of the perennial Mdloti River falls within a prioritised sub-quaternary catchment (**river FEPA**) whilst the lower reach does not (Figure 7). The

classification of the sub-quaternary catchment as a river FEPA indicates that the river contributes to national biodiversity goals and support sustainable use of water resources.

The NFEPA coverage also highlighted three wetlands on the flood bench of the Mdloti River classified as wetland FEPAs (Figure 6) located outside of the pipeline development footprint. The wetland vegetation group for the wetlands in the study area is the **Indian Ocean Coastal Belt Group 2** which according SANBI & DWS (2014), is regarded as ***Critically Endangered*** and generally '***Moderately protected'*** at a national level. At a wetland type level, the threat and protection status wetland types relevant to the study area are as follows:

i. **Channelled Valley-bottom Wetlands**: *Critically Endangered, Poorly Protected*
ii. **Unchannelled Valley-bottom Wetlands**: *Critically Endangered, Poorly Protected*
iii. **Seeps**: *Critically Endangered, Not Protected*

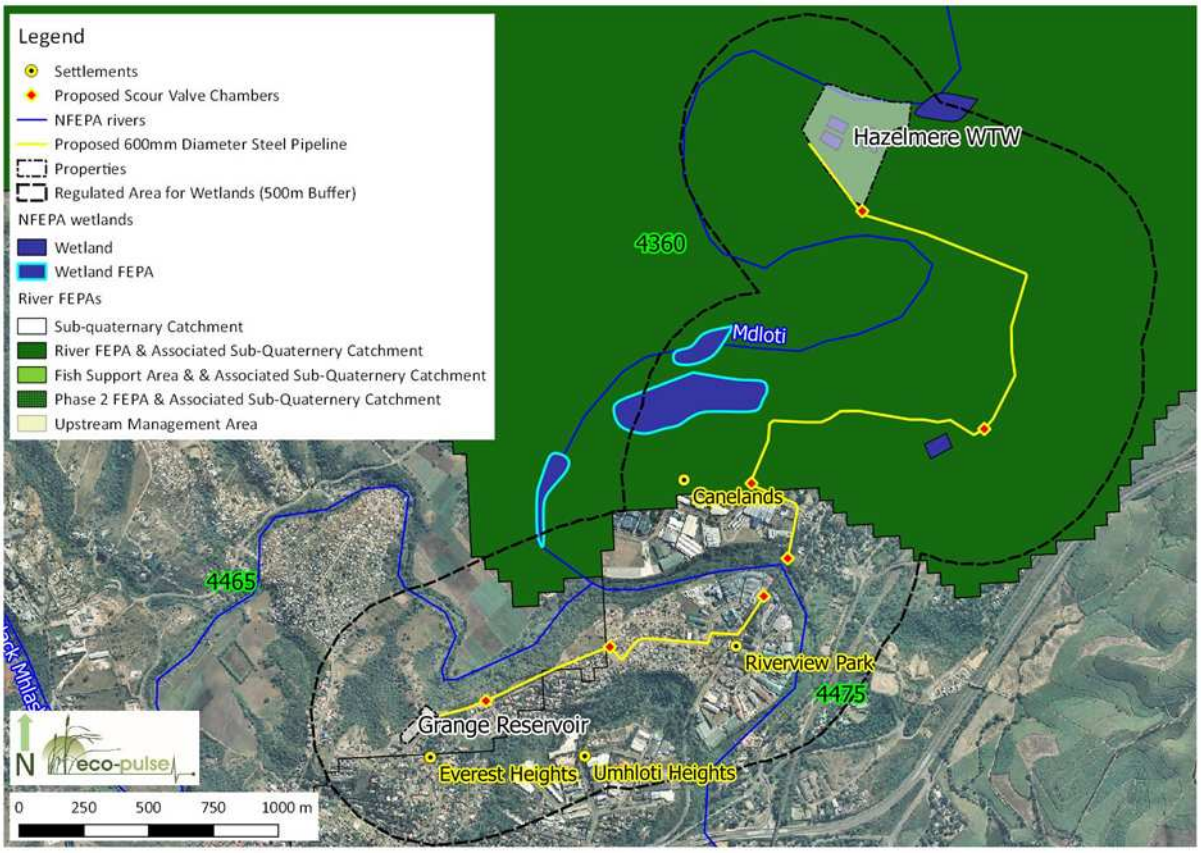


Figure 6 Outputs of the National Freshwater Ecosystem Priority Area (NFEPA) project (CSIR, 2011).

3.2.3 *KZN Systematic Conservation Assessments*

The Systematic Conservation Assessments (SCAs) is a strategic conservation plan developed in 2016 by the Provincial Conservation Authority, Ezemvelo KZN Wildlife (EKZNW) to ensure that representative samples of biodiversity are conserved. It is used as a land use decision support tool in KwaZulu-Natal and replaces the 2010 Terrestrial Systematic Conservation Plan (MINSET). The SCAs are derived from merging the Provincial Terrestrial Systematic Conservation Plan (TSCP) with other conservation datasets.

In terms of terrestrial conservation, three conservation categories were developed including (i) CBA: Irreplaceable, (ii) CBA: Optimal, and (iii) Ecological Support Area. These conservation categories are described in Table 10 below.

Table 10. Description and derivation of conservation categories.

Conservation Category	Description	Development Process
Critical Biodiversity Area: Irreplaceable	Areas considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems.	The coverage was created by merging the following datasets: • 2010 MINSET – Irreplaceable and high irreplaceable categories. • National Threatened Ecosystems – Critically endangered category • KZN Threatened Ecosystem - Critically Endangered and Endangered category. • Landscape Corridor critical linkages - Corridor type
Critical Biodiversity Area: Optimal	Areas that represent an optimised solution to meet the required biodiversity conservation targets while avoiding high cost areas as much as possible.	The coverage was created by merging the following datasets: • 2010 MINSET – Optimal categories. • Local Knowledge – aquatic and terrestrial optimal categories.
Ecological Support Area	ESA are functional but not necessarily entirely natural terrestrial or aquatic areas that are required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the CBAs.	The coverage was created by merging the following datasets: • Local Knowledge – aquatic and terrestrial ESA categories. • Local corridor • Landscape corridor

Review of the 2016 SCA planning datasets confirmed the presence of a **CBA: Irreplaceable** within the study area and the impact zone of the proposed development (Figure 7, below). The proposed pipeline will run mostly along the edge of the CBA: Irreplaceable unit and occasionally cross localised areas. The key driver of the CBA: Irreplaceable category is the potential presence of the North Coast Grassland (which has been confirmed to be absent based on field investigations by Eco-Pulse in 2017), several conservation-important invertebrates and two conservation-important plant species (EKZNW, 2010). Further details on invertebrate and plant species is provided in Section 5.1.3.

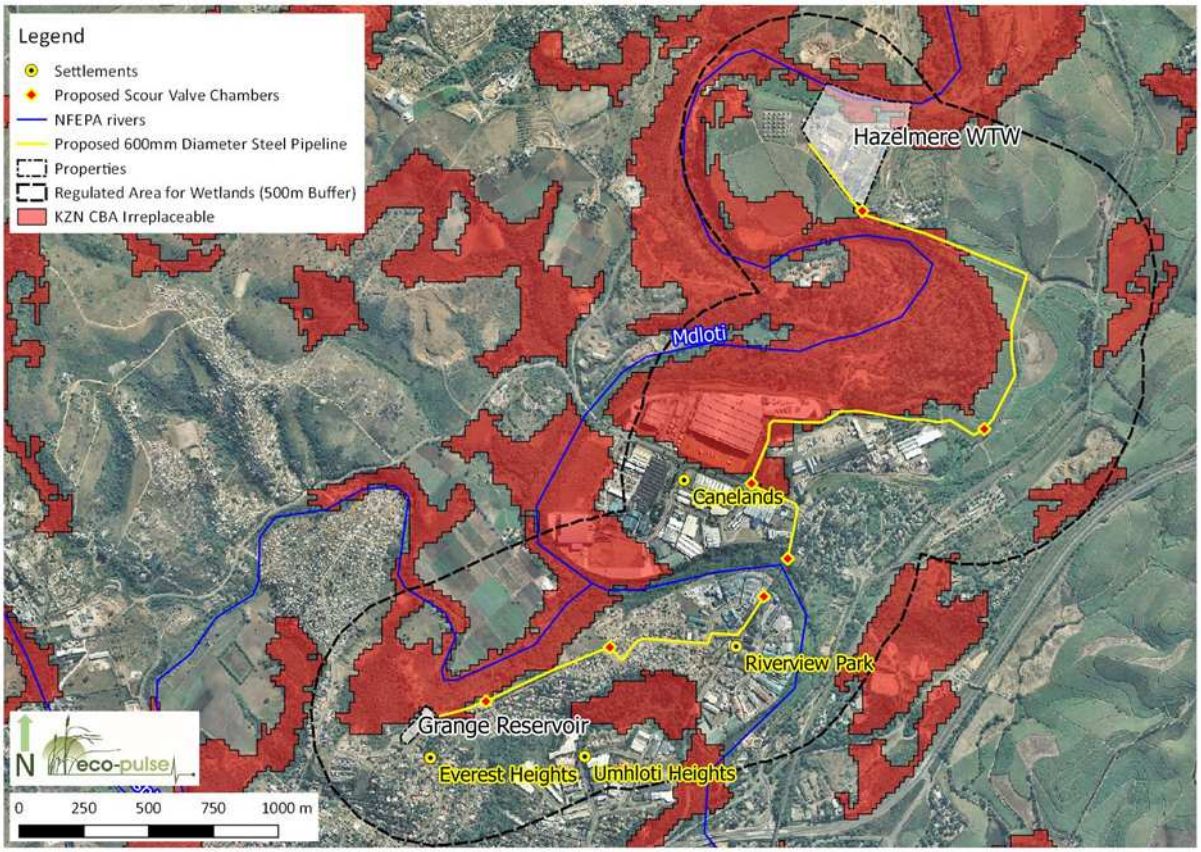


Figure 7 Map showing the extent of the KZN CBA: Irreplaceable areas mapped based on the CPAN for KZN (EKZNW, 2016).

3.2.4 Durban Metropolitan Open Space System (D'MOSS)

At a local/municipal level, there are a number of biodiversity/conservation planning datasets and documents that have been produced by eThekwini Municipality's Environmental Division. One of the tools available is the municipal conservation plan produced by the City which is linked to the Durban Metroploitan Open Space System (D'MOSS). D'MOSS is made up of a series of interconnected open spaces that incorporate areas of high biodiversity value and other supporting elements, delivering a range of ecosystem goods and services including water supply, food, raw materials, soil formation processes, nutrient cycling, erosion control, flood attenuation and climate change mitigation (i.e. carbon storage capacity). The ecosystem goods and services provided free of charge by D'MOSS were conservatively valued in 2003 to be in the order of R3.1 billion per annum, excluding the value that open space contributes to tourism. Without these free services, the municipality would require an unaffordable increase to its budget to provide these services, especially in rural areas where communities rely heavily on the natural environment for daily needs (online reference: http://www.durban.gov.za). D'MOSS is incorporated into the city's Integrated Development Plan (IDP), associated Strategic Development Framework (SDF) and the regional Spatial Development Plans (SDP).

Several D'MOSS areas were identified within the area of study, with those likely to be impacted by the proposed development including "freshwater wetlands" linked with the Mdloti River and its tributary the Black Mhlashini as well as a portion of "thicket" vegetation and habitat (Figure 8).

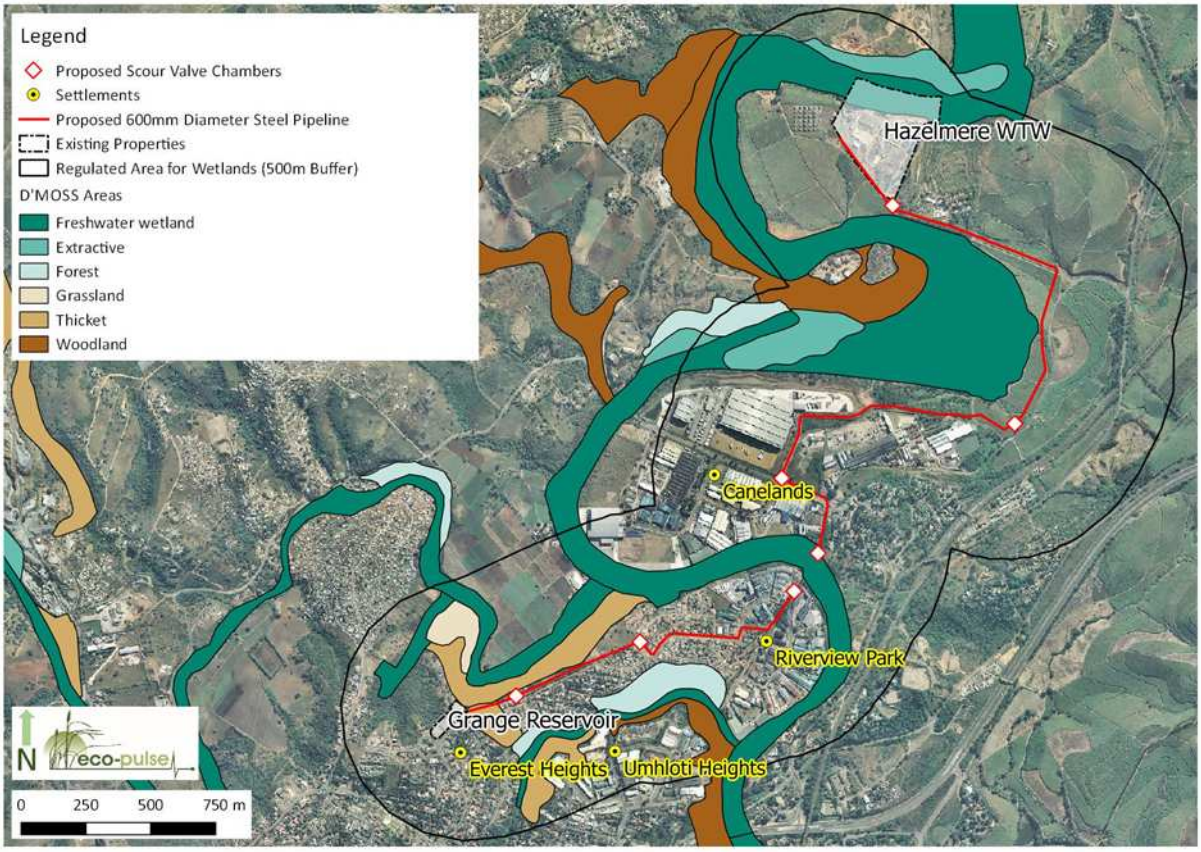


Figure 8 Map showing eThekwini's mapped "D'MOSS" areas for the area of study and in relation to the pipeline upgrade route.

3.2.5 *Durban's Systematic Conservation Assessment*

According to the Durban's Systematic Conservation Assessment (Maclean *et al,* 2015) much of the study area is highlighted as a transformed urban settlement or croplands. The low-lying area associated with the Mdloti River is highlighted as a Critical Biodiversity Area (CBA) and Ecological Support Area (ESA) due to the presence of freshwater wetland/aquatic habitat (Figure 9). Tributaries of the Mdloti River are as highlighted as either CBAs or ESAs. Critical Biodiversity Areas are natural or near natural landscapes that are considered critical for meeting biodiversity targets and thresholds, and which safeguard areas required for the persistence of viable populations of species and the functionality of ecosystems (Maclean *et al,* 2015). Ecological Support Areas are functional, but not necessarily entirely natural landscapes that are largely required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the critical biodiversity areas (Maclean *et al,* 2015).

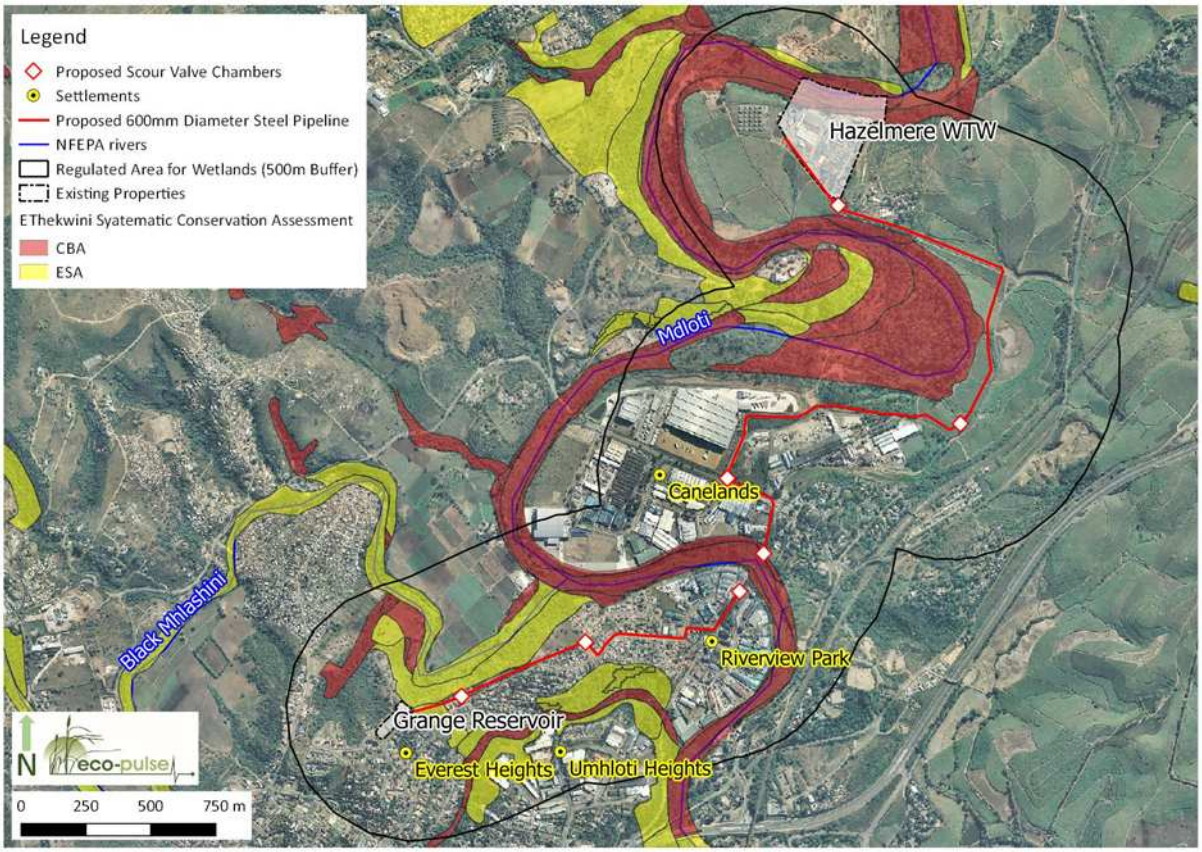


Figure 9 Map showing CBAs and ESAs for the area of study and in relation to the pipeline upgrade route according to eThekwini's biodiversity conservation plan

4 AQUATIC BASELINE AND IMPACT ASSESSMENT

This section of the report presents the findings of the **freshwater habitat baseline and impact assessment**, with the following relevant sub-sections:

4.1 Desktop Wetland and Aquatic Assessment

4.2 Baseline Wetland & Aquatic Habitat Assessment

4.3 Assessment of Potential Aquatic Ecological Impacts

4.4 Aquatic Impact Mitigation and Management Recommendations

4.1 Desktop Wetland and Aquatic Assessment

4.1.1 Desktop mapping of watercourses

Watercourses, including wetlands and rivers occurring within a 500m radius of the proposed development area (i.e. within the DWS regulated area for Section 21 c/i wetland water use), were mapped at a desktop level and classified in terms of their Hydro Geomorphic (HGM) type in accordance with the national wetland/river classification define by Ollis *et al.* (2013). A total of ten (10) definable watercourse units, including 6 wetland units and 4 river units, were mapped at a desktop level within the regulated area for wetlands (500m buffer) as shown in Figure 10. Basic information on all desktop mapped watercourse units is presented as follows:

Wetland Units:

1. Wetland Unit W01: Channelled Valley-bottom Wetland
2. Wetland Unit W02: Seep
3. Wetland Unit W03-A: Seep
4. Wetland Unit W03-B: Seep
5. Wetland Unit W04-A: Channelled Valley-bottom Wetland
6. Wetland Unit W04-B: Channelled Valley-bottom Wetland

River Units:

1. River Unit R01-A: Perennial river (upper reach of the Mdloti River)
2. River Unit R01-B: Perennial river (lower reach of the Mdloti River)
3. River Unit R02: Seasonal river (tributary of the Mdloti River)
4. River Unit R03: Seasonal river (tributary of the Mdloti River)

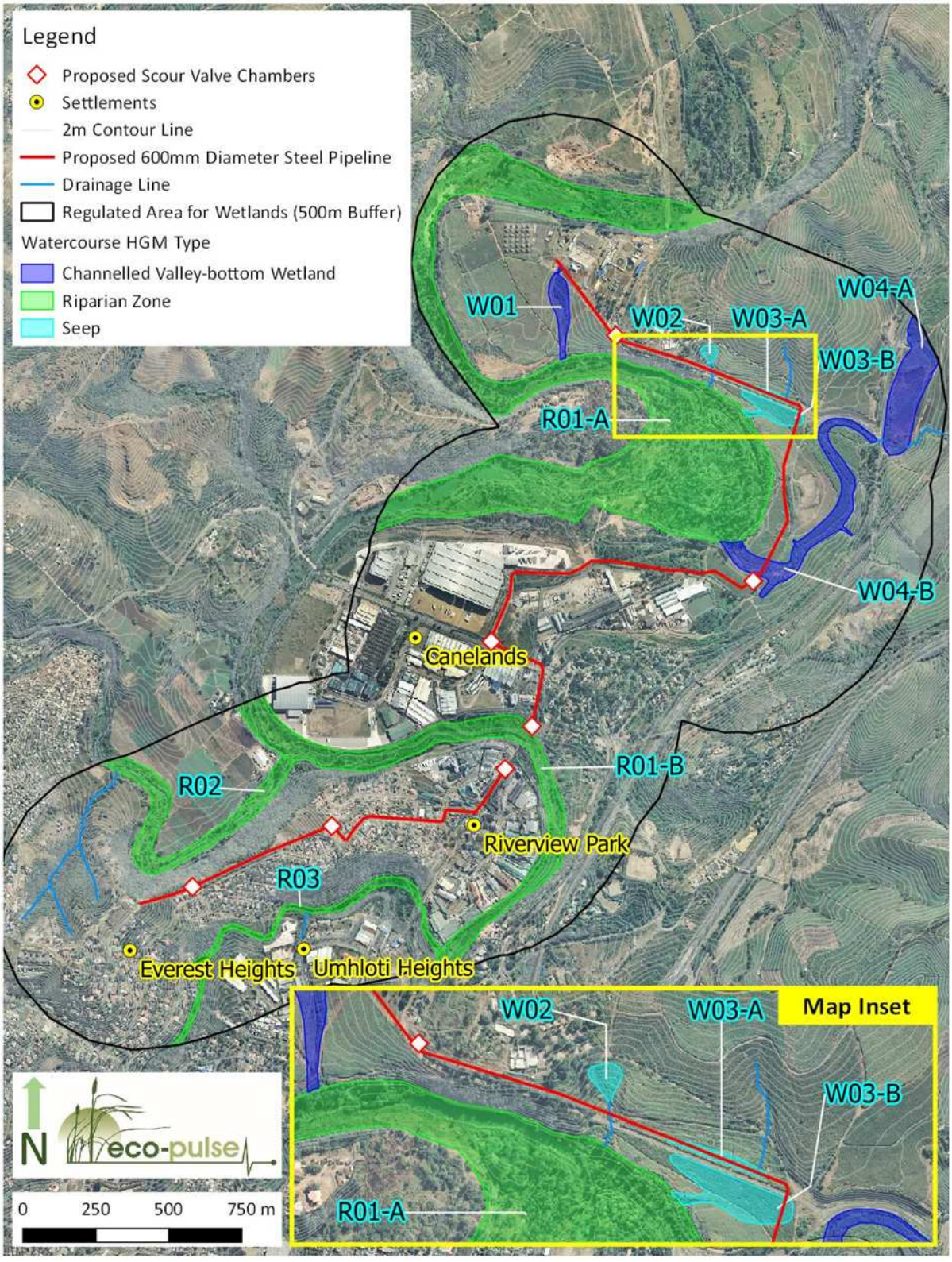


Figure 10 Map showing desktop mapped and classified watercourses (wetlands, rivers and streams) within the DWS regulated area for water use (500m buffer).

4.1.2 Screening and flagging watercourses for further focused assessment

Initially, a desktop wetland identification and mapping exercise was undertaken in GIS (Geographical Information Systems) based on available imagery (Google Earth™ and aerial photography from 1937 to present), elevation contours and existing wetland and river coverage's for the region. This allowed for the initial identification of wetlands which were later ground-truthed and delineated in the field using various indicators (discussed under Section 4.2 of this report).

An initial desktop screening of 'impact potential' for identified watercourse units within a 500m radius of the development (which corresponds to the DWS regulated area for wetlands water use) was also undertaken in GIS and then verified in the field. The main risks likely to be associated with the construction and operation of the proposed development include:

1. **Direct physical loss and/or modification** of watercourses within the development site, both planned and accidental;
2. **Direct physical alteration of flow characteristics** of watercourses within the development site and associated **erosion and sedimentation impacts**;
3. **Alteration of catchment surface water processes / hydrological inputs** and associated **erosion and sedimentation impacts**; and
4. **Surface runoff contamination** and local watercourse **water quality deterioration**.

Based on the above-mentioned risks, four (4) wetland units including W01, W03-A, W03-B & W04-B were rated as "definite" in terms of incurring potential impacts that could alter their characteristics (Table 11 and Figures 11). In addition, three (3) other watercourses are "likely" to incur potential impacts that could possibly result in the possible modification of aquatic habitat and watercourse characteristics, including W02, R01-A and R01-B. Other watercourse units such as R02, R03 and W04-A are unlikely to incur any impacts that could alter their characteristics and therefore do not require further assessments.

Table 11. Results of the preliminary "impact potential" screening.

Watercourse Unit	Impact Potential Rating	Rationale	Water Use Triggered?
W01, W03-A, W03-B & W04-B	**Definite**	These watercourse units will be subject to trenching during the construction phase of the project. As such the watercourse habitat and characteristics of each watercourse will be modified in some way.	**Yes S21 (c) & (i)**
W02, R01-A & R02-B	**Likely**	These watercourse units are unlikely to be directly physically disturbed but due to the close proximity of the pipeline construction servitude to the units, there are likely to incur secondary impacts such as erosion, sedimentation and possibly habitat disturbance by construction vehicles.	**Yes S21 (c) & (i)**
R02	**Unlikely**	This unit is unlikely to incur quantifiable direct and indirect impacts that would alter its characteristics. As such, further assessments are not required.	N/A
R03 & W04-A	**None**	These watercourse units were assessed as being at "no risk of modification" during the construction or operation of the proposed pipeline because they are located either upstream or a considerable distance from the development activity or in adjoining micro-catchments.	N/A

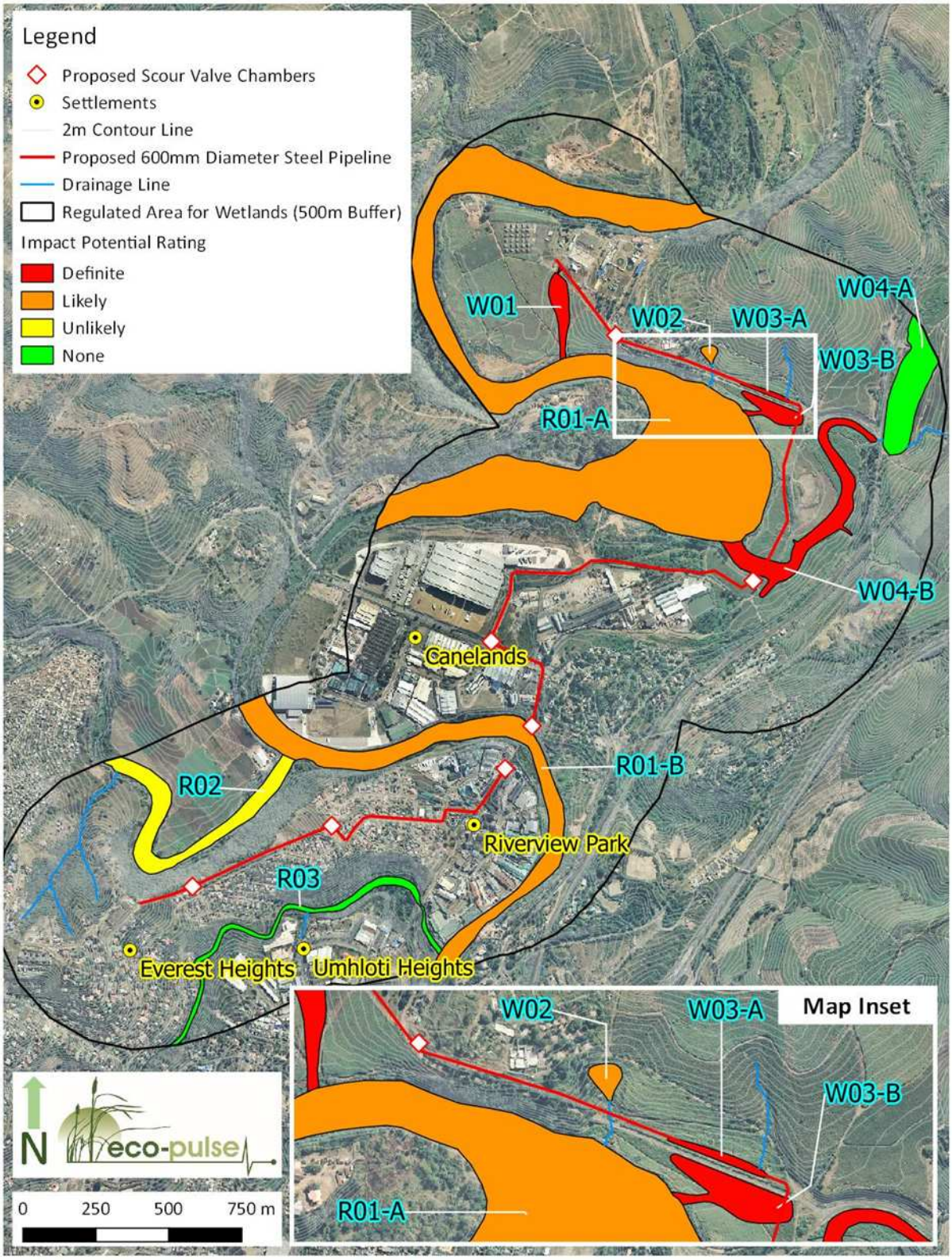


Figure 11 Map showing the results of the preliminary "impact potential" screening assessment.

4.2 Baseline Wetland & Aquatic Habitat Assessment

This section of the report presents the findings of the freshwater wetland/river delineation study and condition and functionality assessment undertaken for the following watercourse units which are likely to incur impacts that may alter their characteristics:

Wetland Units:

1. Wetland Unit W01: Channelled Valley-bottom Wetland
2. Wetland Unit W02: Seep
3. Wetland Unit W03-A: Seep
4. Wetland Unit W03-B: Seep
5. Wetland Unit W04-B: Channelled Valley-bottom Wetland

River Units:

1. River Unit R01-A: Perennial river (upper reach of the Mdloti River)
2. River Unit R01-B: Perennial river (lower reach of the Mdloti River)

4.2.1 Watercourse delineation, classification and description

A. Wetland Delineation

Wetlands targeted for detailed ground-truthing and assessment were subject to detailed in-field sampling and delineation according to the methods and techniques found in the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005). The infield sampling of soil and vegetation in conjunction with the recording of diagnostic topographical / terrain indicators and features, enabled the delineation of five (5) wetland units.

General soil characteristics:

In most cases, the soils provided a good indication of the level of wetness of the soils (seasonal and temporary), with low matrix chroma and soil mottling present in most instances. Soils sampled within all wetlands were generally seasonally saturated hydric soils characterised by light to dark grey colours with low soil matrix values and chromas (i.e. 7.5YR 3/1). The soil samples extracted using a manual soil auger along sampling transects across the wetlands surveyed revealed clear redoximorphic features in the form of orange soil mottling. A high abundance of orange soil mottling within the seasonal zone of wetness was apparent, where frequent wetting and drying of the soil that accompanies seasonal fluctuations in water levels exposes the minerals and metals within the soil to both anaerobic (oxygen deficient) and aerobic conditions, with accompanying processes of oxidation. The soil texture was found to range between sandy to sandy-clay.

Vegetation characteristics:

Due to habitat transformation associated with sugarcane cultivation, all wetland units lacked vegetation that is characteristic of naturally occurring wetlands habitats and therefore vegetation could not be used to delineate wetlands accurately in the field.

B. Riparian Zone Delineation

The recording of diagnostic topographical / terrain indicators and features such as the break in slope, extent of the river banks and the extent of the flood bench, enabled the delineation of the upper and lower reaches of the Mdloti River (R01-A and R01-B, respectively). Soils sampled within the macro channel of the river comprised light-brown coarse sandy alluvial soils with no sign of mottling. The riparian zone of both river units was characterised by typical riparian vegetation intertwined with IAPs. This made it easier to identify the extent of the riparian zone. Furthermore, historical aerial photography dating back to 1937 was sourced and used to gain insight into the historical extent of the Mdloti River riparian habitat.

C. Classification and Habitat Characteristics of Wetland & Riparian Units

A summary of the key biophysical characteristics of each watercourse assessed has been provided in Table 12, with an accompanying map indicating the spatial location of the various delineated watercourses presented in Figure 12. Wetlands have been classified according to HGM (Hydro-Geomorphic) type after the National Wetland Classification system proposed by Ollis *et al.* (2013).

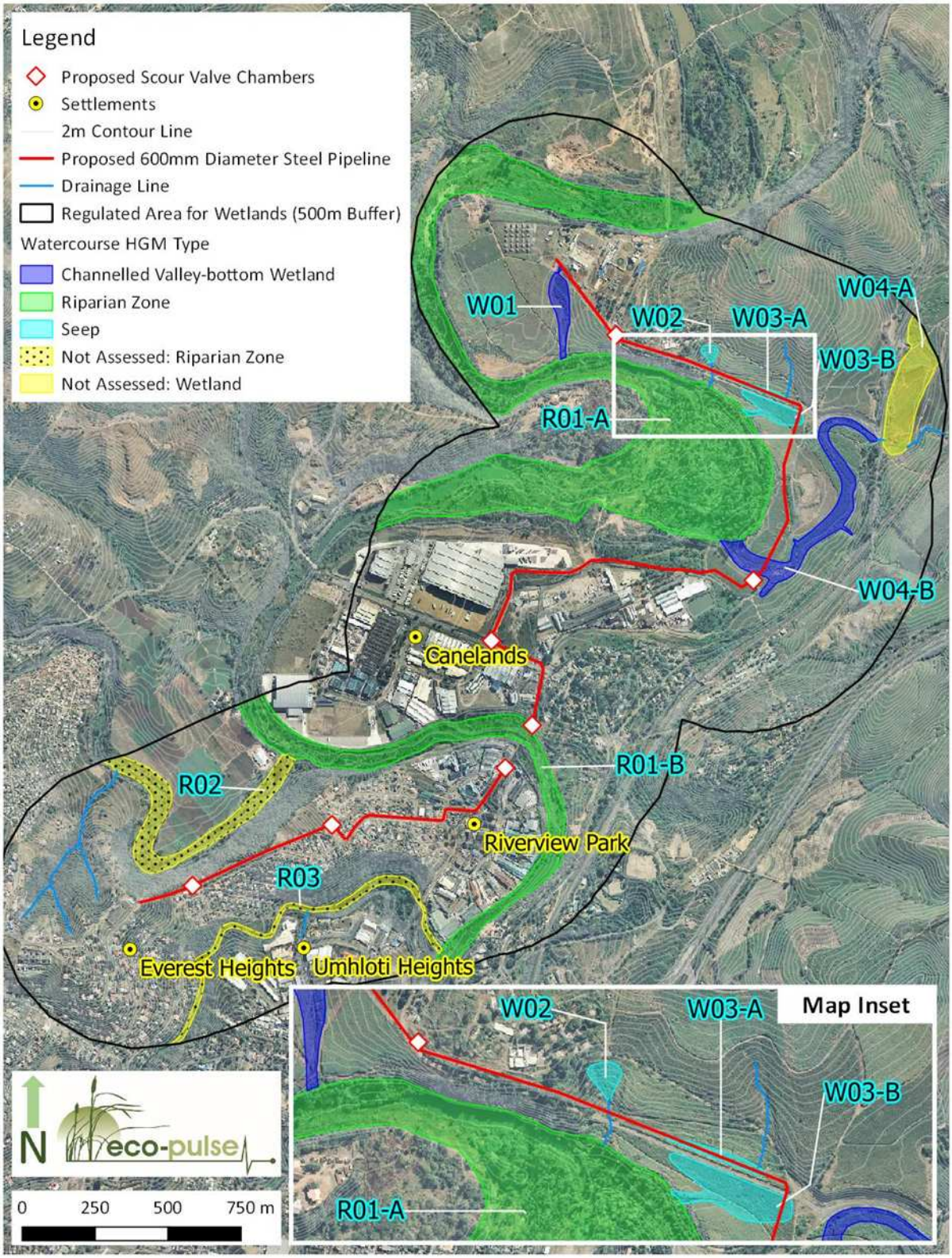


Figure 12 Map showing the spatial location and extent of watercourse units that were delineated in the field and classified according to 'HGM' type.

Table 12. Summary of the key hydro-geomorphic and biophysical characteristics of the delineated watercourses.

Unit ID	HGM Classification	Channel & Flow Characteristics	Dominant Wetness & Soil Characteristics	Broad Vegetation Communities	Existing Impacts
W01	Channelled Valley-bottom Wetland	Dominant water input: Subsurface flow Low flow pattern: Diffuse subsurface High flow pattern: Diffuse & concentrated surface flow	Dominant wetness zone: Seasonal Signs of wetness: grey-brown and grey sandy soil with distinct orange mottles.	The wetland was under cultivation and characterised by sugarcane. The drainage channel however was vegetated with *Cyperus dives* and *Ludwigia octovalis*. Invasive Alien Plant (IAP) species present included *Arundo donax, Ricinus communis* and *Pinus sp*.	• Drainage and intensive sugarcane cultivation. • Excavation and infilling. • Flow concentration by culverts. • Flow impoundment resulting from blocked culverts. • Channel incision. • Habitat transformation. • Limited IAP infestation.
W02	Seep	Dominant water input: Subsurface flow Low flow pattern: Diffuse subsurface High flow pattern: Diffuse surface flow	Dominant wetness zone: Seasonal Signs of wetness: grey sandy soil with distinct orange mottles.	The upper section of the wetland was under cultivation whilst the lower section comprised a secondary herbaceous community dominated by opportunistic weeds and IAPs (*Commelina benghalensis, Lantana camara, Canna indica & Ricinus communis*).	• Drainage and intensive sugarcane cultivation. • Sedimentation of low-lying areas. • Habitat transformation. • IAP infestation.
W03-A	Seep	Dominant water input: Subsurface flow Low flow pattern: Diffuse subsurface High flow pattern: Diffuse surface flow	Dominant wetness zone: Seasonal Signs of wetness: grey sandy clay soil with distinct orange mottles.	The wetland was under cultivation and exclusively vegetated with sugarcane.	• Drainage and intensive sugarcane cultivation. • Sedimentation of low-lying areas. • Altered surface flows by road infrastructure.
W03-B	Seep	Dominant water input: Subsurface flow Low flow pattern: Diffuse subsurface High flow pattern: Diffuse surface flow	Dominant wetness zone: Seasonal Signs of wetness: grey sandy clay soil with distinct orange mottles.	The wetland was under cultivation and exclusively vegetated with sugarcane.	• Drainage and intensive sugarcane cultivation. • Soil compaction from establishment of a dirt road through the wetland. • Erosion of wetland surface.
W04-B	Channelled Valley-bottom Wetland	Dominant water input: Subsurface flow Low flow pattern: Diffuse subsurface High flow pattern: Diffuse and concentrated surface flow	Dominant wetness zone: Seasonal Signs of wetness: grey sandy clay loam soil with distinct orange mottles.	The wetland was under cultivation and exclusively vegetated with sugarcane. The drainage channel however was vegetated with *Cyperus dives* and *Ludwigia octovalis*.	• Drainage and intensive sugarcane cultivation. • Flow concentration by culverts. • Limited flow impoundment resulting from a partially blocked culvert.

Unit ID	HGM Classification	Channel & Flow Characteristics	Dominant Wetness & Soil Characteristics	Broad Vegetation Communities	Existing Impacts
					• Channel incision. • Habitat transformation.
R01-A Upper reach of the Mdloti River	Perennial river	Perennial flows concentrated within a main active channel. Infrequent over-topping only during severe floods.	Sandy soils, no mottling.	Instream vegetation community can be classified into two communities, a reed marsh dominating the wet areas of the active channel and an alien wooded community on drier parts of the active channel. Riparian vegetation was a mixed wooded community comprising exotic and indigenous riparian plants.	• Reduced water inputs from damming of flows upstream (Hazelmere dam). • Vegetation clearing. • IAP infestation. • Excavation and infilling. • Concentration of flows by a piped culvert. • Increased inundation from the establishment of a road across the river.
R01-B Lower reach of the Mdloti River	Perennial river	Perennial flows concentrated within a main active channel. Infrequent over-topping only during severe floods.	Sandy soils, no mottling.	As above.	• Reduced water inputs from damming of flows upstream (Hazelmere dam). • Vegetation clearing. • IAP infestation. • Modification of the river channel.

A selection of digital photographs taken during the site visits and highlighting some of the important features of the various watercourses assessed are included below for interest:

Photo 1: View looking south over wetland unit W01 with the Hazelmere WTW immediately behind the camera. At the time of assessment sugarcane had been recently harvested on one side of the wetland unit.

Photo 2: Soil sample extracted from wetland unit W01. Note orange mottles within a grey-brown sandy soil matrix.

Photo 3: View looking downslope at the lower section of wetland unit W02 which was characterised by a herbaceous community comprising a mix of weeds and IAPs.

Photo 4: Soil sample extracted from wetland unit W02. Note orange mottles within a grey soil matrix.

Photo 5: View looking east over wetland unit W03-A. At the time of assessment sugarcane was being

Photo 6: View looking east over wetland unit W03-B. Note extensive sugar cultivation of the wetland unit.

harvested. The red dashed line indicates roughly where the pipeline will run.

Photo 7: View looking south over wetland unit W04-B. At the time of assessment sugarcane had just been harvested.

Photo 8: View looking west at the toe of wetland unit W04-B. The dashed red line indicates roughly where the pipeline will run.

Photo 9: View looking upstream over river unit R01-A (Mdloti River). Note signs of excavation and infilling within the river unit.

Photo 10: View north west across the largest excavation and clearing from sand mining activities affecting the Mdloti River and showing the extent of soil disturbance and vegetation clearing at the site.

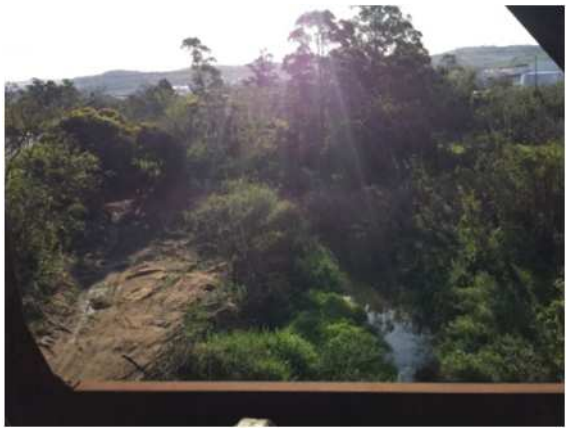


Photo 11: View looking upstream of river unit R01-B (Mdloti River). The photo was taken from the existing pipe bridge crossing.

Photo 12: View looking downstream of river unit R101-B (Mdloti River). Note the signs of clearing/disturbance on the right bank.

4.2.2 Present Ecological State (PES) Assessment

This section documents the findings of the PES assessment for wetlands and rivers and provides descriptions of key impacts and PES scores and ratings for each watercourse unit assessed.

A. Hypothetical Reference State

When assessing the PES of wetlands and rivers, it is important to first establish their hypothetical reference state (prior to any anthropogenic impacts) against which deviation can be measured. This is achieved by reviewing of historical aerial photography, local reference wetland sites and professional experience working in the area.

In light of the above interpretations, a summary of the hypothetical reference states in terms of wetness regime and vegetation for each of the hydro-geomorphic wetland types encountered onsite is provided in Table 13 below.

Table 13. Hypothetical reference states for the wetland and river units assessed.

Unit ID	Reference HGM Type	Reference Wetness Zone / Flow regime	Hypothetical Reference Vegetation
W01	Channelled Valley-bottom Wetland	Mix of seasonal and temporary saturation zones. **Water inputs:** interflow from adjoining slopes. **Water movement through the wetland:** diffuse subsurface flow. **Water Exit:** Concentrated surface flow.	Hygrophilous grassland dominated by facultative grasses and forbs. Obligate wetland plants may have been present only along the channel.
W02	Seep	Largely seasonal with limited temporary saturation zone. **Water inputs:** interflow from upslope. **Water movement through the wetland:** diffuse subsurface flow. **Water Exit:** Concentrated surface flow.	Hygrophilous grassland dominated by facultative wetland grasses and forbs.
W03-A & W03-B	Seep	Mix of seasonal and temporary saturation zones. **Water inputs:** interflow from upslope. **Water movement through the wetland:** diffuse subsurface flow. **Water Exit:** Diffuse sub-surface flow with limited concentrated surface flow.	Hygrophilous herbaceous community characterised by a mix of grasses sedges, rushes and possibly reeds.
W04-B	Channelled Valley-bottom Wetland	Mix of seasonal and temporary saturation zones. **Water inputs:** surface and subsurface flow from upstream supplemented by interflow from adjacent slopes. **Water movement through the wetland:** diffuse subsurface flow. **Water Exit:** Concentrated surface flow.	Dense herbaceous wetland plant community characterised by a mix of grasses sedges, rushes and possibly reeds.
R01 (Mdloti River)	Alluvial lower foothills river	Perennial flows characterised by high flood peaks in summer and possible over-topping of channel banks linked to high flows after significant floods.	Instream habitat characterised by alluvial material with little to no vegetation. Riparian zone was likely characterised by a typical wide belt of wooded indigenous vegetation (coastal riverine forest) comprising a mix of trees, shrubs and an understory of grasses, ferns and herbs.

B. *Wetland PES Assessment*

Wetlands form at the interface between terrestrial and aquatic environments, and between groundwater and surface-water systems. The complex interaction of inflows and outflows of water, sediment, nutrients and energy over time is what shapes the physical template of the wetland and understanding theses fluxes and interactions considered is fundamentally important in developing an understanding the occurrence, morphology and dynamics of different wetland systems (Ellery et al., 2009). The current health or Present Ecological State (PES) of wetlands was assessed using the WET-Health tool (Macfarlane et al. 2008) which was applied at a rapid level 1 assessment level. WET-Health assesses wetland condition or PES based on an understanding of both catchment and on-site impacts. The approach to assessing wetland PES essentially works by comparing a wetland in its current state with the estimated/anticipated baseline/reference conditions for the wetland. Specification of the reference state (see Table 6, above) is followed by an impact-based approach, whereby the extent and intensity of anthropogenic impacts are interrogated to interpret the level of modification to the primary drivers of wetland health, namely (i) ***hydrology****, (ii)* ***geomorphology*** *and (iii) the structure and composition of wetland* ***vegetation.***

A summary of the results of the WET-Health condition/PES assessment (i.e. impacts to and current state of each component of wetland health: hydrology, geomorphology and vegetation) is included below in Table 14. All wetland units were found to be in a poor to very poor condition as indicated by a "D" PES Class (largely modified) for units W01, W02 and an "E" PES Class (seriously modified) for units W03-A, W03-B and W04-B. Key impacts sustained by the wetlands which have led to the significant deviation from natural/reference wetland state are summarised as follows:

i. Altered patterns and distribution of water as a result of artificial drainage of the wetlands, leading to desiccation of wetland soils and a change in saturation.

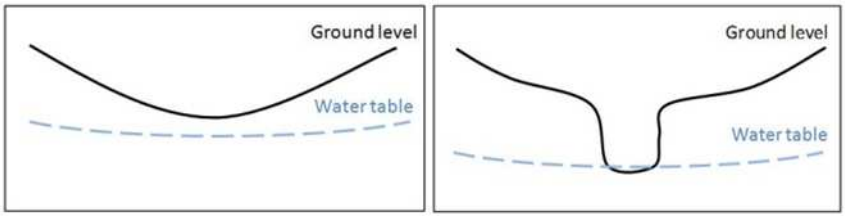


Diagram illustrating the change in water table due to ground water drawdown anticipated as a result of erosion gulley formation and/or artificial drainage in wetlands.

ii. Cultivation of sugarcane within wetlands, resulting in the loss of indigenous vegetation, reduced surface roughness, increased onsite water use, negligible increase in runoff and erosion;

iii. Concentration of flows by culverts resulting in increased channel incision, through flows and desiccation of wetland habitat (wetland units W01 and W04-B in particular).

iv. Transformation of wetland habitat for urban infrastructure (roads, buildings etc.);

v. Alteration of surface flows by the road infrastructure through the wetland unit;
vi. Borrowing of sand within the wetland unit (particularly W01); and
vii. Limited sediment deposition in localised areas (particularly W01).

Table 14. PES summary for the wetland units assessed.

Unit ID	Hydrological PES (0-10)	Geomorphology PES (0-10)	Vegetation PES(0-10)	Overall PES (0-10)	PES Description
W01	5.8 PES D	3.0 PES C	9.1 PES F	**5.9 PES D**	***Largely modified.*** *A large change in ecosystem processes and loss of natural habitat and biota and has occurred.*
W02	3.5 PES C	1.4 PES B	7.5 PES E	**4.0 PES D**	*As above.*
W03-A & W03-B	6.8 PES E	4.0 PES D	9.2 PES F	**6.7 PES E**	***Seriously modified.*** *The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.*
W04-B	6.8 PES E	2.4 PES B	9.1 PES F	**6.2 PES E**	*As above.*

C. *River PES Assessment*

DWS (2015) undertook a Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area. The Mdloti River reach assessed for the purpose of this report, Sub Quaternary (SQ) U30B-04475, is located downstream of the Hazelmere Dam and is within the Integrated Unit of Analysis (IUA) U3-2, which is the related unit assessed in the report by DWS (DWS, 2015). The water resources within this IUA are regulated by the upstream dam, which has been approved to be raised in the near future, thereby having a further impact on downstream flows (DWS, 2015).

A large extent of the IUA is occupied by urban areas and numerous Waste Water Treatment Works (WWTW) enter the river which have an impact on both flow and water quality of the river. The specific SQ reach assessed has been flagged as a water quality hotspot by the eThekwini Municipality due to a 'critical' impact rating being identified for this reach based on the presence of elevated nutrients, blue-green algae and WWTWs. Additional significant land uses in the IUA include both dryland and irrigated sugarcane cultivation as well as low density rural settlements (DWS, 2015). According to the desktop PES and EIS assessments undertaken by DWS (2014) the Mdloti River reach is 'Largely Modified' ('D' PES Category), has a 'High' Ecological Importance (EI) and a 'Very High' Ecological Sensitivity (ES). No information on PES and EIS is available for the specific SQ reach assessed in this report from the report compiled by DWS (2015). The text box below summarises the finding of the desktop PES and EIS information (DWS 2014):

Quaternary Catchment	River Name	Reach length	Assessed by experts	PES (present ecological state)	EI (ecological importance)	ES (ecological sensitivity)
U30B-04475	Mdloti	11.49km	Yes	D: Largely Modified	High	Very High

i. Water Quality

The term 'water quality' is used to describe the microbiological, physical and chemical properties of water resources as defined by the National Water Act (Act No. 36 of 1998) that determine its fitness for a specific use, determined by substances which are either dissolved or suspended in the water (DWAF, 2001). In the context of this impact assessment water quality refers to its fitness for maintaining the health of aquatic ecosystems.

A single water quality sample was from the upper reach of the Mdloti River (Unit R01-A). Of the nine (9) water quality parameters analysed, there were no particular noteworthy pollution / contamination indicators present from the once-off grab sample taken. Based on DWS (2015) it is apparent that this sample may not be representative of general (average) water quality conditions for this river reach, which has been identified as a water quality hotspot and rated as critical (DWS, 2015). Table 15 below contains a summary of the results of a once off water quality sample collect during the site visit.

It is important to note that without detailed routine water quality monitoring, the once off grab sample cannot be considered conclusive nor representative of 'normal' or average conditions for the river reach. The grab sample taken was used as ancillary data to gauge the current integrity, importance and sensitivity of the receiving environment, not for the purposes of a detailed water quality assessment.

Table 15. Summary results of water sample analysis for the Mdloti River below Hazelmere dam.

Water Quality Parameter	**Unit**	**TWQR[8] for aquatic ecosystems**	**Sample result:** Upper Mdloti River
1. Ammonia	mg N/l	Not vary >15% compared with background unimpacted conditions, <0.5 will limit eutrophication	<0.22
2. COD (Chemical Oxygen Demand)	mg O2/l	N/A	16
3. Chloride	mg Cl/l	N/A	45
4. E. coli	colonies per 100ml	130	14
5. Electrical conductivity at 25°C	mS/m	N/A	42
6. Nitrate/Nitrite	mg N/l	Not vary >15% compared with background unimpacted conditions, <0.5 will limit eutrophication	<0.18
7. Orthophosphate	mg P/l	Not vary >15% compared with background unimpacted conditions, <0.005 will limit eutrophication	<0.03
8. pH	pH units	5 - 9	7.7
9. Suspended solids at 105°C	Mg/l	N/A	7

[8] TWQR: Target Water Quality Range (DWAF)

ii. SASS5 Derived River Health

The South African Scoring System or SASS5 (Dickens & Graham, 2002) was used assess the ecological integrity of the river reach assessed. SASS5 provides a useful indication of localised conditions in a river over the short term (a reflection of both in-stream water quality and the availability, quality and diversity of instream habitats) as aquatic invertebrate organisms require specific aquatic habitat types and water quality conditions for at least part of their life cycle and are relatively short-lived and remain in one area during their aquatic life phase.

The results of the SASS5 assessment are presented in Table 16 below. According the South Africa Scoring System (SASS) Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Coastal Belt: lower geomorphic zone, the Mdloti River reach assessed should be classified as 'Fair' ('Moderately Modified') based on the SASS5 Score and Average Score Per Taxa (ASPT). The ecological category is driven by the SASS5 due to the number of Taxa (23) rather than the sensitivity of the taxa to water quality which was relatively low on average (ASPT of 4.8). The low ASPT illustrates that the taxa persisting in this reach of the river are tolerant of a range of water quality conditions, including modified physico-chemical conditions. The only noteworthy family of aquatic invertebrate of particular sensitivity were *Perlidae* which is intolerant to modified water quality conditions and requires fair to good water quality conditions to persist.

Table 16. Results from the SASS5 assessment for the upper Mdloti River site.

Component/ index	Rating/Score
Biotope Score (%)	62
SASS Score	110
No. of Taxa	23
ASPT	4.8
Ecological Category (PES)	**C: Fair/ Moderately Modified**

iii. Index of Habitat Integrity (IHI)

The Present Ecological State (PES) refers to the health or integrity of a river system, and includes both in-stream habitat as well as riparian habitat adjacent to the main channel. Habitat is considered one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996).

The 'habitat integrity' of a river refers to the "*maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region*" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes. The IHI or Index of Habitat Integrity (Kleynhans, 1996) was used to assess riverine habitat integrity for rivers and is based on an interpretation of the

deviation from the reference condition for the river reach assessed and is approached from both an instream and riparian zone perspective. Specification of the reference state is followed by an impact-based approach, whereby the extent and intensity of anthropogenic impacts are interrogated to interpret the level of modification to the primary drivers of river health, namely hydrology, vegetation and physico-chemical conditions. Naturally, the severity of impacts on habitat integrity will vary according to the natural characteristics of different rivers, with particular river types being inherently more sensitive to certain types of impacts than others. Habitat integrity for instream and riparian habitats was assessed separately based on the following indicators of habitat integrity:

1. Water abstraction
2. Flow modification
3. Inundation
4. Bed modification
5. Bank erosion
6. Channel modification
7. Water quality
8. Solid waste disposal
9. Vegetation removal
10. Exotic vegetation
11. Connectivity

A summary of the results of the IHI assessment undertaken is presented below in Table 17. Both river units R01-A and B (upper and lower Mdloti sampling sites) were assessed as being in a 'poor condition' as indicated by a "D" PES Class (largely modified). Key impacts which have led to the significant deviation from natural/reference state for the Mdloti River include:

i. Substantial flow reduction and alteration of flow patterns as a result of the establishment of the Hazelmere Dam upstream of the Mdloti River reach surveyed. This has resulted in the alteration of the instream habitat, with less frequent inundation of habitats, transformation/modification of instream biotopes and reduced frequency of overtopping of the channel banks.
ii. Increased inundation of the instream habitat of unit R01-A caused by road fill across the river.
iii. Substantial bank modification linked with sand mining activities particularly for unit R01-A (upper sample reach of the river).
iv. Notable modification of the instream habitat resulting from increased sediment deposition owing to cultivation within the catchment of both river units and sand mining disturbance.
v. Increased vegetation removal linked with existing sand mining activities for unit R01-A.
vi. Increased Invasive Alien Plant (IAP) infestation particularly within the riparian habitat for both units R01-A and -B.

Table 17. PES summary for the river units assessed using the Index of Habitat Integrity (IHI).

Unit ID	Instream Habitat PES (% intact)	Riparian Habitat PES (% intact)	Overall PES (% intact)	PES Description
R01-A	57.1% intact	51.4% intact	**54.2% intact**	**PES "D": Largely modified**. *A large change in ecosystem processes and loss of natural habitat and biota and has occurred.*
R01-B	56.6% intact	47.2% intact	**51.9% intact**	

4.2.3 Wetland Functionality Assessment (Ecosystem Services)

Wetlands are known to provide a range of ecosystem goods and services to society, and it is largely on this basis that policies aimed at protecting wetlands have been founded. This section of the report provides a summary of the predicted level of importance of the various wetland ecosystems in terms of their effectiveness in providing aquatic ecosystem goods and benefits. A modified version of the WET-Ecoservices assessment method by Kotze et al. (2009) was used for this purpose.

The predicted level of importance of the wetland HGM units in providing various ecosystem goods and services has been summarised in Table 18. Key findings of the assessment can be summarised as follows:

- All wetland units were found to be of very low to moderately importance at providing key regulating and supporting services such as flood attenuation and stream flow regulation services. Despite there being a relatively high regional demand for these services, the wetland in their current degraded/transformed state lack the specific characteristics suited for attenuating and regulating flows as a consequence of artificial drainage, concentration of flows and removal of indigenous vegetation.
- Seepage wetland Unit W03 was assessed as the most important in terms of providing water quality enhancing services such as sediment trapping and nutrient assimilation, albeit at only a moderate level still.
- In terms of biodiversity maintenance value, all wetland units were assessed as being of very low to low importance due to high levels of habitat transformation caused by cultivation and human development/activities, which has resulted in decreased habitat diversity, reduced species richness and loss of habitat capable of supporting flora and fauna of conservation importance.
- All wetlands were found to be of very low importance in terms of providing water supply, harvestable natural resources and food for livestock as the wetlands lacked substantial surface water that can be abstracted and wetland vegetation has been transformed through cultivation activities.
- Wetlands were found to be most important (moderate rating) at providing cultivated foods (80 – 95% of the wetland areas are under sugarcane cultivation).
- All wetland units were assessed as being of very low importance in terms of providing cultural services. This is largely driven by the degraded nature of the wetlands owing to existing cultivation, low utilisation of wetlands for cultural services (i.e. limited local demand) and limited opportunities for education and research.

Table 18. Summary of the level of importance of each wetland unit in terms of providing ecosystem goods and services.

Ecosystem Service		Wetland Units			
		W01	W02	W03	W04-B
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0.8 L	1.1 ML	1.4 ML	0.8 L
	Stream flow regulation	0.5 VL	0.8 L	0.6 L	0.5 VL
	Sediment trapping	1.2 ML	1.1 ML	1.6 M	1.2 ML
	Erosion control	1.0 ML	1.5 ML	1.2 ML	0.8 L
	Phosphate removal	0.8 L	1.0 L	1.5 ML	0.8 L
	Nitrate removal	0.8 L	1.3 ML	1.5 ML	0.7 L
	Toxicant removal	0.8 L	1.0 L	1.4 ML	0.8 L
	Carbon storage	0.9 L	1.3 ML	1.3 ML	1.0 L
	Biodiversity maintenance	0.5 VL	0.8 L	0.5 VL	0.5 VL
PROVISIONING SERVICES	Water supply	0.0 VL	0.0 VL	0.0 VL	0.5 VL
	Harvestable natural resources	0.4 VL	0.4 VL	0.4 VL	0.4 VL
	Food for livestock	0.2 VL	0.2 VL	0.2 VL	0.2 VL
	Cultivated foods	2.1 M	1.3 ML	2.1 M	2.2 M
CULTURAL SERVICES	Cultural significance	0.0 VL	0.0 VL	0.0 VL	0.0 VL
	Tourism & recreation	0.0 VL	0.0 VL	0.0 VL	0.0 VL
	Education and research	0.2 VL	0.2 VL	0.2 VL	0.2 VL

Key: **VL**: Very Low | **L**: Low | **ML:** Moderately Low | **M:** Moderate

4.2.4 Ecological Importance and Sensitivity (EIS) Assessment

Ecological Importance is an expression of the importance of an aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to an ecosystem's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).

A. Wetland EIS Assessment

Based on the PES assessment and importance of the various wetlands in terms of wetland goods and services, the Ecological Importance and Sensitivity (EIS) of wetlands was rated using the Wetland EIS tool developed by Eco-Pulse (2017). A summary of the EIS assessment is provided in Table 19.

Ecological Importance (EI) was noted to be a key driver of EIS. Ecological Sensitivity (ES) was generally low for all wetland units assessed, owing to the absence of sensitive or conservation important flora and fauna, lack of sensitive habitats and high level of general anthropogenic disturbance in the study area. Wetland W03-A and -B (assessed as one unit) attained the highest EIS score and rating of Moderate. This is largely attributed to the wetland's ecological importance in terms of its potential role in providing

water quality enhancing services (nutrient and sediment trapping). All other units were assessed as being of moderately-low EIS.

Table 19. Summary of wetland EIS scores and ratings.

Unit ID	HGM Type	Ecological Importance (0 – 4)	Ecological Sensitivity (0 – 4)	EIS Score (0 – 4)	EIS Rating
W01	Channelled Valley-bottom Wetland	**1.17**	1.00	**1.17**	Moderately-low
W02	Seep	1.50	**1.50**	**1.50**	Moderately-low
W03-A & W03-B	Seep	**1.64**	0.85	**1.64**	Moderate
W04-B	Channelled Valley-bottom Wetland	**1.17**	1.00	**1.17**	Moderately-low

B. River EIS Assessment

For the purposes of this assessment, river EIS was based on rating the importance and sensitivity of riparian & in-stream biota (including fauna & flora) and habitat, using both desktop and on-site indicators.

i. Macroinvertebrate sensitivity (R01-A)

Based on the SASS5 assessment and invertebrate taxa collected during the Mdloti River sampling, it is apparent that the vast majority of invertebrates are tolerant of a wide range of physico-chemical conditions including moderately modified to largely modified water quality. It is however important to note that to spite the low average sensitivity ratings, taxa of moderate to high sensitivity are still persisting in the river reach, the most noteworthy of which is *Perlidae* which are intolerant poor water quality conditions. Table 20 provides a summary of the sensitivity scores for the taxa collected within the Mdloti River reach assessed.

Table 20. Summary of aquatic invertebrate taxa collected along with their respective sensitivity rating according to Dickens and Graham (2002).

Taxon	Sensitivity Score
Oligochaeta (Earthworms)	1
Atyidae (Freshwater Shrimps)	8
Perlidae	12
Baetidae 2 sp	6
Coenagrionidae (Sprites and blues)	4
Gomphidae (Clubtails)	6
Libellulidae (Darters/Skimmers)	4
Belostomatidae* (Giant water bugs)	3
Corixidae* (Water boatmen)	3
Gerridae* (Pond skaters/Water striders)	5
Naucoridae* (Creeping water bugs)	7
Nepidae* (Water scorpions)	3
Notonectidae* (Backswimmers)	3

Taxon	Sensitivity Score
Veliidae/M...veliidae* (Ripple bugs)	5
Hydropsychidae 1 sp	4
Leptoceridae	6
Gyrinidae* (Whirligig beetles)	5
Hydrophilidae* (Water scavenger beetles)	5
Ceratopogonidae (Biting midges)	5
Chironomidae (Midges)	2
Simuliidae (Blackflies)	5
Lymnaeidae* (Pond snails)	3
Corbiculidae (Clams)	5

Key for interpreting sensitivity of aquatic macro-invertebrate taxa to poor water quality (pollution) based on Dickens and Graham (2002).		
Sensitivity Rating	1 5	Highly tolerant to pollution (Low/Very Low Sensitivity taxa)
	10	Moderately tolerate to pollution (Moderate Sensitivity taxa)
	15	Intolerant to pollution (High Sensitivity taxa)

ii. Fish Sensitivity (R01-A)

A single fish survey was undertaken on the upper reach of the Mdloti River (R01-A) in order to assess the presence of any rare, threatened or sensitive fish species. Only two (2) native fish species were recorded during this survey, namely *Oreochromis mossambicus* (Mozambique tilapia) and *Tilapia sparrmanii* (Banded tilapia). Both fish species are tolerant of wide range of physico-chemical and flow conditions (DWS, 2014). In addition, six (6) individual *Micropterus salmoides* (Largemouth bass) specimens were collected and additional individual were visually observed within the reach during sampling.

According to the desktop PES and EIS assessment (DWS, 2014) additional fish species have been recorded within this particular reach of the Mdloti River reach assessed, many of which have a high confidence rating for presence (meaning they have recently been recorded in the sub-quaternary reach). A number of these species are sensitive or highly sensitive to water quality (physico-chemical) and flow (no-flow) modifications. Table 21 presents the desktop species list according DWS (2014) along with species recorded during the fish survey undertaken as part of this assessment.

Table 21. Summary of fish species presence and sensitivity based on DWS desktop dataset (DWS, 2014) along with fish species recorded during the survey by Eco-Pulse.

Fish Species Scientific / Common Name		Desktop Assessment DWS (2014)			Eco-Pulse Sampling (2017)
		Confidence in Presence	Physico-chemical sensitivity	No-flow sensitivity	No. Collected
Micropterus salmoides	Largemouth Bass	n/a	n/a	n/a	6
Awaous aeneofuscus	Freshwater goby	High	2.8	2.0	
Anguilla mossambica	Longfin eel	High	2.5	2.8	
Barbus gurneyi	Redtail barb	High	4.0	2.0	
Barbus natalensis	Scaly	High	3.0	3.5	
Barbus viviparus	Bowstripe barb	High	3.0	2.3	
Clarias gariepinus	Sharptooth catfish	High	1.0	1.7	
Clarias theodorae	Snake catfish	High	2.0	1.0	
Gilchristella aestuaria	Estuarine round-herring	High	3.0	1.5	
Glossogobius callidus	River goby	High	2.3	1.5	
Glossogobius giuris	Tank goby	High	2.5	1.7	
Liza macrolepis	Large-scale mullet	High	3.0	1.5	
Myxus capensis	Freshwater mullet	High	3.0	3.5	
Mugil cephalus	flathead grey mullet	High	2.5	2.8	
Oreochromis mossambicus	Mozambique tilapia	High	1.3	0.9	40+
Pseudocrenilabrus philander	Southern mouthbrooder	High	1.4	1.0	
Tilapia rendalli	Redbreast tilapia	High	2.1	1.8	
Tilapia sparrmanii	Banded tilapia	High	1.4	0.9	10
Acanthopagrus berda	Riverbream	Medium	1.8	1.1	
Anguilla marmorata	Giant mottled eel	Medium	2.5	2.8	
Anguilla bengalensis labiata	African mottled eel	Medium	2.7	2.8	
Liza richardsonii	Southern mullet	Medium	0.0	0.0	
Monodactylus argenteus	Silver moony	Medium	2.0	1.5	
Microphis brachyurus	Short-tailed pipefish	Medium	4.0	1.0	
Redigobius dewaali	Checked goby	Medium	3.5	1.0	
Barbus pallidus	Goldie barb	Low	3.3	2.8	
Microphis fluviatilis	Freshwater pipefish	Low	4.0	1.0	

Table 22. Key for species 'Physico-chemical' and 'No-flow sensitivity' (DWS, 2014).

Score	Sensitivity class	Physico-chemical sensitivity	No-flow sensitivity
1-2	Tolerant (Low/Very Low Sensitivity)	Breed under severely modified physico-chemical conditions.	*Species not requiring flow during any part of the life-cycle. However, increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. With some species, flow will stimulate breeding activities and stimulate migration.*
>2-3	Moderately tolerant (Moderate sensitivity)	Breed under moderately modified physico-chemical conditions.	*Species requiring flow during certain phases of the life-cycle - to breed in particular habitats (often fast flows) for instance, or make nursery areas with suitable cover available. Generally, increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. Flow will stimulate breeding activities and stimulate migration.*
>3-4	Moderately intolerant (High Sensitivity)		
>4-5	Intolerant (Very High Sensitivity)	Breed under unmodified or near natural physico-chemical conditions.	*Species requiring flow during all phases of the life-cycle. Often prefer fast flow and clear water and use these conditions both for breeding and feeding purposes.*

Table 23. Key for confidence in presence (DWS, 2014).

Confidence	Description
Low	The species has not been recorded in the SQ but based on the local species "pool", the PES, the spp sensitivity and the SQ similarity to other SQs where the spp occurs (Level 2 ecoregion, Geozone, altitude and habitats available), is expected to be present.
Medium	The species has not been recorded recently in the SQ, but based on the PES and species sensitivity it is expected to be present. Where the general PES for the SQ has changed, there are still sections suitable for habitation by the species.
High	The species has recently been recorded in the SQ. The PES has not changed to such extent that it would be expected to be absent

iii. River EIS

A summary of the EIS assessment scores and ratings for the river units is provided in Table 24 below. The EIS assessment for Mdloti River units R01-B and R01-B was based on rating the importance and sensitivity of instream and riparian biota (including fauna & flora) and instream and riparian habitat, using available desktop information such as the desktop PES/EIS assessment (DWS, 2014) supplemented by on-site indicators and sampling undertaking during field investigations for the river reach assessed. The results of the EIS assessment indicate that both units are of **Moderate EIS**, which can be attributed to the following factors:

- The riparian and instream habitat integrity is considered to be in poor condition ("D" PES Category), however, water quality remains fairly good for the specific reach which is a key factor influencing the persistence of some sensitive biota within the reach at the time of the assessment.
- Based on macro-invertebrate (SASS5), selected aquatic invertebrates found within unit R01-A are highly sensitive to physico-chemical modifications. This is likely to be the same for unit R01-B which is immediately downstream.
- The fish survey undertaken within unit R01-A recorded two native fish species which are tolerant of flow and water quality impacts.
- In addition to the fish recorded during the survey, the desktop DWS assessment (2014) noted a number of fish species that are moderately to highly sensitive to flow and water quality conditions. These have recently been recorded in this sub-quaternary river reach and were likely not present in the specific reach assessed due to the level of habitat modification. These species will however make use of this reach as they undertake longitudinal movements within and between river reaches.
- Both river units represents moderate instream habitat connectivity which provides some migration opportunity for instream fauna, although these have been limited by the construction of informal drifts at a local scale and the upstream dam at a more regional scale.
- Desktop Ecological importance (EI) is rated as 'High' and Ecological Sensitivity (ES) is rated as 'Very High' according to DWS (2014).

Table 24. Summary of River EIS assessment for both units.

Determinant		River EIS Assessment	
		R01-A	R01-B
RIPARIAN & INSTREAM BIOTA	Rare & endangered species	1.5	1.5
	Unique species (endemic, isolated, etc.)	1.0	1.0
	Intolerant species sensitive to flow/water quality modifications	2.0	2.0
	Species/taxon richness	2.0	2.0
RIPARIAN & INSTREAM HABITAT	Diversity of habitat types	2.0	2.0
	Refugia for biota	2.0	2.0
	Sensitivity to flow changes	2.0	2.0
	Sensitivity to flow related water quality changes	2.0	1.5
	Migration route/corridor (instream & riparian)	2.0	2.0
	Importance of conservation & natural areas	4.0	2.0
EIS Category		**2.0 Moderate**	**2.0 Moderate**

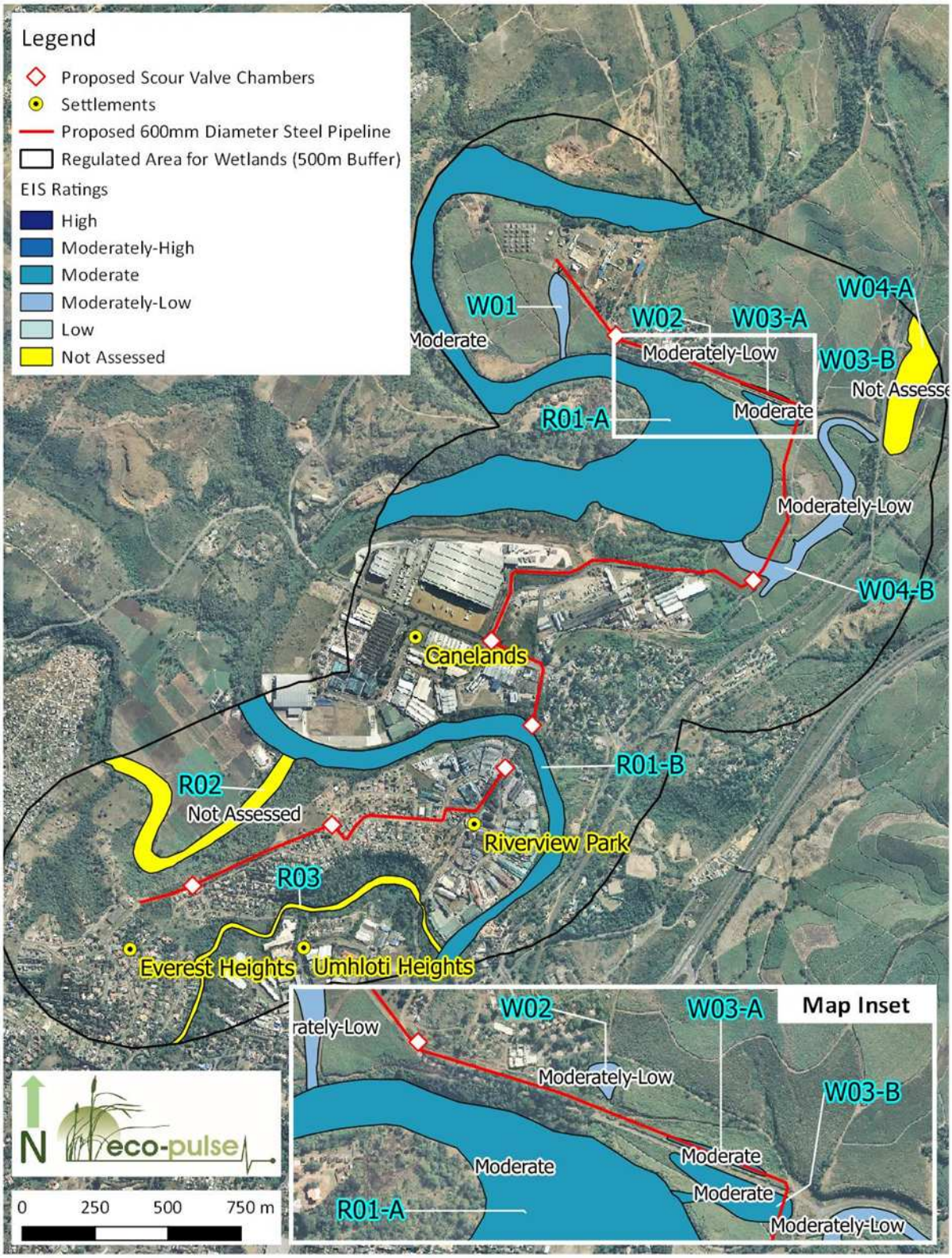


Figure 13 Aquatic sensitivity map showing watercourses (wetlands & rivers) categorised according to their relative 'EIS' ratings.

4.2.5 *Recommended Ecological Category (REC) & Management Objectives (RMOs)*

The future management of the freshwater ecosystems identified for the project area should be informed by recommended management objectives (RMOs) for the specific water resource which, in the absence of classification, is generally based on the current ecological state or PES (Present Ecological State) and the EIS (Ecological Importance and Sensitivity) of water resources (DWAF, 2007 – see Table 13, below). The recommended ecological category (REC) is the target or desired state of resource units required to meet water resource management objectives and quality targets. It is determined through the consideration of the PES, EIS and realistic opportunities to improve the PES that is driven by the context / setting.

The modus operandi followed by DWAF's Directorate: Resource Directed Measures (RDM) is that if the EIS is high or very high, the ecological management objective should be to protect and even improve the condition of rivers or wetlands that are presently in a degraded state or on a negative trajectory towards becoming further degraded (Kleynhans & Louw, 2007). However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable, which often relates to whether the problems in the catchment can be addressed and mitigated (Kleynhans & Louw, 2007). If the EIS is evaluated as moderate or low, the objective should be to maintain the river/wetland in its PES (Kleynhans & Louw, 2007). Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states depending on the EIS and PES (Kleynhans & Louw, 2007). Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed if possible (Kleynhans & Louw, 2007). A generic matrix for the determination of RECs and RMOs for water resources is shown in Table 25.

Table 25. Generic matrix for the determination of REC and RMO for water resources.

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**Pristine/Natural**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Largely Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Good - Fair**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Poor**	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	**Very Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

Based on this matrix (Table 25) and the catchment context of each wetland unit, the recommended management objective for all water resource units were assessed as being to ***'maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning'*** (Table 25, below). This management objective is driven by the generally poor PES and low to moderate EIS for most watercourses.

Table 26. REC and RMO for the delineated watercourse units based on their PES and EIS ratings.

Unit	HGM Type	PES	EIS	REC	RMO
W01	Channelled Valley-bottom Wetland	D: Poor	Moderately-low	D	*Maintain PES*
W02	Seep	D: Poor	Moderately-low	D	*Maintain PES*
W03-A and W03-B	Seep	E: Serious	Moderate	E	*Maintain PES*
W04-B	Seep	E: Serious	Moderately-low	E	*Maintain PES*
R01-A	Upper reach of the perennial Mdloti River	D: Poor	Moderate	D	*Maintain PES*
R01-B	Lower reach of the perennial Mdloti River	D: Poor	Moderate	D	*Maintain PES*

This is further supported by Ezemvelo KZN Wildlife (EKZNW) in their guideline document: Guidelines for Biodiversity Impact Assessment (EKZNW, 2013). According to the document, the guiding principle with regards to biodiversity conservation and sustainable development adopted by EKZNW is one of ***no net loss of biodiversity and ecosystem processes.***

To achieve this principle, a proactive approach to planning and biodiversity conservation must be adopted to ensure:

- The early identification and evaluation of potential ecological impacts that may constitute 'fatal flaws', or significant biodiversity related/management issues;
- The early identification and evaluation of conceptual alternatives which could prevent, avoid or reduce significant impacts on aquatic biodiversity, or enhance or secure opportunities for ecosystem conservation; and
- The appropriate design of mitigation through the mitigation hierarchy which should strive first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining residual negative impacts on biodiversity.

Aquatic ecological impacts have been identified and assessed in Section 4.3 of this report in order to inform and provide for the appropriate mitigation and management of impacts associated with the proposed development project in an effort to meet the management objectives defined for the water resources in the area of study.

4.3 Assessment of Potential Aquatic Ecological Impacts

Freshwater ecosystems, including wetlands and rivers, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to these ecosystems. Threats to freshwater biodiversity include processes and activities which reduce system persistence, and alter community diversity and patterns, including reduced genetic diversity (Rivers-Moore *et al.*, 2007).

This section of the report deals with the identification, prediction, description and assessment of the potential construction and operational impacts and risks posed to the aquatic environment by the proposed upgrade of the rising main water pipeline.

Generally, impacts to aquatic ecosystems can be grouped into the following broad categories:

- **Direct impacts**: are those impacts directly linked to the project (e.g. clearing of land, destruction of vegetation and habitat).
- **Indirect impacts**: are those impacts resulting from the project that may occur beyond or downslope/downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from development sites).
- **Cumulative impacts**: are those impacts from the project combined with the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity or natural resources (e.g. a number of developments in the same catchment or ecosystem type collectively affecting or impacting the same ecosystem types or local endemic species).

Each one of the potential impact types are discussed and assessed separately for the construction and operational phases, under the 'realistic poor/standard' and 'realistic good/best practical' mitigation scenarios as defined in the methods section. Construction impacts are denoted 'C' and operational impacts 'O'. For the purposes of this assessment **'physical habitat modification'** has been defined as the *primary impact causing activity* associated with the construction and operation of the proposed upgrade to water pipeline infrastructure. Secondary impacts associated with this activity form part of the impact pathway that is initiated by this impact causing activity and will be described and assessed thereunder. For descriptive purposes an attempt had been made to sub-divide impacts into (a) Destruction or modification of aquatic vegetation and habitat, (b) flow modification and erosion/sedimentation impacts and (c) water quality impacts and the effects on aquatic biota.

The significance of these impacts was then contextualised in terms of their ultimate consequences to water resource management and biodiversity conservation using the following consequence categories:

(i) Impacts to **water** resources and the ability to meet water resource management objectives;
(ii) Impacts to **ecosystem conservation and the ability to meet of ecosystem conservation targets**;
(iii) Impacts **to species of conservation concern and the ability to meet species conservation targets**; and
(iv) Impacts to **ecosystem goods and services of direct value to communities** and resultant impacts to human health, safety and livelihood.

4.3.1 Aquatic Ecological Impact Descriptions

Impact 1: Physical Destruction and/or Modification Impacts

This impact refers to the physical destruction or disturbance of wetland and riverine (instream and riparian) habitat caused by vegetation clearing, excavation and/or infilling during pipeline upgrading as well as associated unintended indirect/ secondary disturbances that are likely to persist during the operational phase of the pipeline.

A. <u>Construction Phase Impacts:</u>

Construction activities associated with the upgrading of the pipeline (i.e. removal of existing pipeline and installation of new pipe. including labour/vehicle access, clearing of vegetation, excavation/trenching) will result in the physical disturbance of the vegetation within the pipeline construction servitude and the modification of any channel bed and bank habitat associated with channelled systems. Clearing and disturbance of freshwater habitat is likely to be limited to the construction servitude and may include areas used by machinery and workers to gain access the site and to construct temporary drainage, storm water infrastructure and erosion control measures, for example. The result is either the complete loss/destruction or disturbance of indigenous wetland/aquatic habitat, including structural habitat components. Vegetation clearing, excavation and back-filling of the pipeline trench will be associated with the crossing of watercourse units, which are presently cultivated under sugarcane (including W01, W03-A, W03-B and W04-B) hence the impact of vegetation clearing will be minimal as no or minimal wetland vegetation is associated with these units. Ultimately, due to the largely degraded nature of the wetland/riverine habitats within the construction servitude and lack of sensitive species of flora/fauna (essentially what stands to be disturbed are already heavily transformed/modified vegetation communities characterised by crops, alien plants/weeds and locally common and disturbance/tolerant plant species.

Under a 'good/best practical' mitigation scenario where the recommended best practical mitigation measures (below) are implemented timeously and correctly, the impact extent and intensity is expected to be managed, resulting in an overall **low impact significance** rating for this impact. *Due to the limited extent of the impact and small residual losses to wetland habitat and functioning*

anticipated and which are considered insignificant, compensation for loss of wetland habitat/functioning is not deemed unnecessary and ***wetland offsets are not appropriate or applicable mitigation measure for the project in question***[9] *((i.e. small size of impact, small functional losses anticipated, no loss of sensitive species).*

B. Operation Phase Impacts:

Development within and/or adjacent to wetland/aquatic environments will introduce unnatural disturbance to the aquatic ecosystems and generally promote the establishment of disturbance-tolerant species, including colonization by Invasive Alien Plants (IAPs), weeds and pioneer plant species particularly where there is an existing seed source for these plants nearby. Although this impact is initiated during the construction phase of a project, it is likely to persist well into the operation phase unless properly dealt with. IAPs can have far-reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss in South Africa. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, promote erosion, change litter accumulation and soil properties and promote or suppress fire. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses. Overall, encroachment by alien plants will result in the deterioration of freshwater habitat integrity if rehabilitation and monitoring are not implemented correctly.

The extent and severity of existing transformation/modification and alien plant populations within watercourses significantly lowers the intensity of expected alien plant impacts however for this project and the resulting impact is likely of be of a ***low significance*** *and is easily manageable (see recommended best practical mitigation measures below. Note that in addition, the potential for further destruction/modification of wetland/riverine vegetation and habitat is a possibility should any section of pipeline crossing wetlands/rivers require maintenance. A similar suite of impacts to those dealt with under the construction phase can be anticipated under this scenario.*

Impact 2: Flow Modification and Erosion/Sedimentation Impacts

This refers to the alteration of surface and sub-surface water flow patterns and quantities and associated impacts to the fluvial geomorphic processes (e.g. rates of erosion and sedimentation) of onsite and downstream watercourses.

[9] This conclusion was based on emerging best-practice wetland offset guidelines (Macfarlane *et al.,* 2014) which suggests that four key components be evaluated when assessing residual impacts to wetland systems: i) Indirect (regulating and supporting) Services, (ii) Direct (cultural and provisioning) Services, (iii) Ecosystem Conservation, and (iv) Species of Conservation Concern and where only "significant" impacts to wetlands should qualify for offset mitigation.

A. Construction Phase Impacts:

A temporary change in local hydrological regimes will result from construction activities associated with trenching across wetlands/rivers to install the pipeline upgrade, including the use of diversions and dewatering activities to create a 'dry' working area. This will likely alter the volume, timing and pattern of flows within these watercourses and downstream resources, potentially affecting the integrity of the freshwater habitat and biotic communities. Interception and diversion of diffuse surface and subsurface flows from trenching within wetland/river systems could temporarily drain wetland habitat and reduce flows to downstream areas. Trench dewatering will also alter the natural distribution and retention of flows received by downstream habitats by increasing the volume and velocity of surface flows for a short period of time. These impacts will be especially significant in wetland ecosystems characterised by diffuse surface and subsurface flows (i.e. seeps and unchannelled valley-bottom wetlands in the study area) and less significant for channelled watercourses such as rivers and streams and channelled valley bottom wetland types. Given that the majority of wetlands have been artificially drained to allow for sugarcane cultivation within these systems, further drainage effects associated with pipeline trenching are likely to be limited in intensity.

Disturbance of soil profiles within wetlands and river/stream banks (at pipeline crossings) will also render soils susceptible to suspension and transport via surface runoff and result in the sedimentation and increased turbidity of downstream water resources. This may occur as surface runoff transports fine soil particles (e.g. sand and clay) while draining and dewatering of active work areas may result in the discharge of sediment rich water. Furthermore, where flows from dewatering or temporary diversions are discharged downstream/downslope there is a risk of point source scouring at the diversion outlet which could lead to the formation of erosion headcuts and ultimately, gully erosion. If outlets are located in terrestrial areas this would result in dryland erosion features and the probable deposition of sediment within adjacent/downslope watercourses. If diverted/dewatered flows are discharged directly into watercourses this may result in scouring and incision of wetlands and stream channels, with the consequence being the likely desiccation ('drying out') of wetland habitat.

Finally, catchment impacts from clearing and earthworks upslope of watercourses will temporarily reduce groundcover and infiltration rates and lead to slightly increased peak discharges reaching watercourses. Earthworks upslope of watercourses will also reduce soil cohesion and render soils susceptible to suspension and transport via surface runoff into watercourses located immediately downslope. This is likely to result in riling and possible gully erosion upslope of watercourses and result in the sedimentation of the watercourses immediately below the construction servitude. Furthermore, the trench itself will intercept runoff and act as a preferential flow path channelling runoff containing high concentrations of suspended sediment into wetlands/channels. The result of increased run-off velocities and sediment rich surface runoff is the erosion and/or sedimentation of freshwater habitat downstream with impacts pronounced during higher rainfall events and/or windy conditions. Some of the key consequences of sedimentation of freshwater habitat and increased water turbidity include:

- Partial to complete burial of instream biotopes such as runs, riffles and pools due to sediment deposition;
- Reductions in soil saturation rates of areas buried with sediment and/or eroded,
- Colonisation by alien invasive and weedy plant species associated with recent erosional and depositional features.
- The creation of low light conditions reducing photosynthetic activity and the visual abilities of foraging instream aquatic biota;
- Increased downstream drift by benthic invertebrates causing localised reductions in population densities; and
- Reduced density and diversity in benthic invertebrate and fish communities as a result of reduced water quality (suspended solids impacting intolerant taxa).

Under a 'good/best practical' mitigation scenario where the recommended best practical mitigation measures (below) are implemented timeously and correctly, the impact extent and intensity is expected to be managed, resulting in an overall ***low impact significance*** *rating for this impact.*

B. <u>Operation Phase Impacts:</u>

Operationally, the impact of the pipeline upgrade on flows through the wetland are likely to remain largely unchanged (pipeline upgrade rather than a new installation) with likely impact to include hydrological regimes by pipelines intercepting or impeding natural patterns of flow if the pipeline is not installed correctly (i.e. where pipes are installed at an angle to the general direction of flows through wetlands or where exposed pipes interfere with flows through channelled watercourses such as rivers and streams). This can also be induced partly in response to soil compaction adjacent to the pipeline created by construction machinery, backfilling and compaction. The preferential flow of water along pipeline/trench bedding material could also lead to changes hydrological regimes within wetlands (i.e. use of river sand for bedding material, for example, could result in preferential flow of water along the pipeline route, which could essentially drain wetland areas and potentially causing scouring and gully erosion where flows are concentrated. Altered hydrological conditions will also affect geomorphic process (rates of erosion and deposition), which plays a fundamental role in the structuring of wetland and riverine habitats. Furthermore, during operation and in the event of a damaged/broken or malfunctioning pipeline, waste water inputs to wetlands/rivers will likely result in increased saturation and may reduce hydrological variability in wetland ecosystems, resulting in a probable shrift in the structure and composition of vegetation communities to favour species suited to higher soil saturation and result in a reduction in natural species diversity. Discharges from broken/leaking pipeline infrastructure and uncontrolled releases can also lead to point scouring of wetland and riverine instream habitats and channel incision at the point of discharge, with the associated sedimentation of downstream ecosystems.

While the impacts discussed above are all possible in the absence of careful planning, design consideration and implementation of construction phase mitigation measures, the likelihood of flow and flow related erosion and sedimentation risks is generally low during the operation phase of a typical pipeline project. The likelihood of unintentional discharges is also of low concern and in most cases small leakages may occur which would increase saturation within localised areas of wetlands and streams/rivers by a negligible amount. Overall then, ***impact significance is likely to remain low.***

Impact 3: Water Quality Impacts

This impact refers to the alteration or deterioration in the physical, chemical and biological characteristics of the river water. The term 'water quality' must be viewed in terms of the fitness or suitability of the water for a specific use (DWAF, 1996).

A. <u>Construction Phase Impacts:</u>

In the context of the planned development and receiving wetland/riverine environments, water quality refers to its fitness for maintaining the health aquatic ecosystems, such as wetlands, river and streams. Construction phase contaminants and their relevant sources can include:

- Hydrocarbons – leakages from petrol/diesel stores and machinery/vehicles, spillages from poor dispensing practices.
- Oils and grease - leakages from oil/grease stores and machinery/vehicles, spillages from poor handling and disposal practices.
- Cement - spillages from poor mixing and disposal practices.
- Sewage – leakages from and/or poor servicing of chemical toilets and/or informal use of surrounding bush by workers.
- Suspended solids – suspension of fine soil particles as a result of soil disturbance and altered flow patterns (particularly relevant to steep areas where there is increased the risk of sediment being washed into downstream wetlands/rivers).

These contaminants may enter wetlands/rivers during construction activities and have the capacity to negatively affect receiving aquatic habitat, aquatic biota and water resource integrity. These impacts are of particularly significant for aquatic flora and fauna sensitive to changes physico-chemical water quality (i.e. nutrients, toxicants). Where significant changes in water quality occur, a shift in species composition will result, favouring tolerant species, and potentially resulting in the localised reduction of sensitive species of flora and fauna. Sudden drastic changes in water quality can also have chronic effects on aquatic biota such as invertebrates, fish and amphibians which have specific pollution tolerances. Where these tolerances are exceeded, localised extinctions may result. Exclusion of intolerant species, particularly within plant communities, often results in proliferation of more disturbance tolerant species due to reduced competition for resources such as space, nutrient and light, leading ultimately to a change in vegetation community composition.

Given the largely disturbed/secondary nature of the wetland habitat at site and the nature of the proposed development activity, water quality impacts are largely unlikely to occur during construction on a normal operating basis (apart from accidental spills for example) and should these occur, are likely to be localised in extent and of moderately low intensity, resulting in a ***low impact significance.*** *This is based on a 'good/best practical' mitigation scenario where recommended best practical mitigation measures are implemented timeously and correctly.*

B. <u>Operation Phase Impacts:</u>

Water quality impacts during the operational phase of the pipeline are limited to potential erosion and sedimentation/turbidity issues in the event of a water leak of pipe burst. Discharge of sediment laden water into adjoining watercourses can potentially alter the water quality which will have a negligible and temporary impact on aquatic biota sensitive / intolerant to high turbidity.

The ***significance of this operational impact is likely to be low*** *due to the low volumes of suspended solids likely to be generated by a water leak or burst pipe and the low probability of such an event occurring.*

4.3.2 Aquatic Impact Significance Assessment

The proposed upgrading of the bulk water pipeline infrastructure could potentially lead to a number of negative ecological impacts to the freshwater aquatic environments in the study area, including wetland and river ecosystems and associated aquatic habitats. While localised disturbances to wetland and river/stream habitat are expected as a result of pipeline construction across these habitats, impacts will be largely confined with the pipeline construction servitude and will be restricted largely to existing degraded wetland/river habitats including areas under artificial drainage and sugarcane cultivation and aquatic habitats characterised by dense infestations of alien plants. The same can be said for flow and flow related erosion and sedimentation impacts, which while expected during construction, will be short-term and relatively low to medium intensity, with no long-term residual loss of hydrological integrity or functioning expected within the receiving ecosystems/aquatic habitat. Flow-related erosion and sedimentation impacts are likely to be associated with trench excavation and associated soil excavations in the short-term but which may also persist in the longer-term should erosion (gullies or headcuts) and/or sedimentation occur as a result of construction. While water quality impacts identified can have a measurable effect on wetland/riverine vegetation and local aquatic biota, the likelihood of these impacts occurring is relatively low for a project of this nature. The significance of the 'ultimate consequences' of construction and operational phase impacts on aquatic ecosystems (wetlands and rivers/streams) are summarised below as follows:

i. The impacts identified are unlikely to cause a reduction in the integrity or present ecological state (PES) of wetlands and rivers/streams at a broader scale and will therefore not

compromise local management objectives and the ability to maintain aquatic ecosystem integrity in accordance with the recommended ecological categories.

ii. In terms of ecosystem services, the wetlands at the site are generally not considered to be of great importance in providing ecosystem goods and services and anticipated impacts are very unlikely to further diminish the currently low ecosystem service supply levels.

iii. In terms of ecosystem and species conservation, wetland habitats were found to be largely degraded or secondary in nature and do not represent reference vegetation/habitat types in their current state whilst also not being suited to meet the habitat requirements of typical wetland-dependant species of conservation concern, of which none were identified at the site. Impacts on habitat and species are therefore highly unlikely to contribute to the loss of species of specific conservation importance/concern such as protected/endangered wildlife..

iv. Overall, the significance of the ultimate ecological consequences associated with the development construction and operational phases were assessed as being of '**Low' significance** under a 'poor/standard mitigation' scenario and can be easily mitigated/managed, which is likely to reduce significance to an overall **'Very Low' level** under a 'good/best practical mitigation' which is deemed acceptable from an aquatic ecological perspective (Tables 27 and 28).

v. All adverse impacts linked with the project can be mitigated to an environmentally acceptable level As such, no fatal flaws were identified for the construction phase of the proposed development. Potential cumulative impacts associated with the construction phase of the project are also expected to be negligible as there will be no significant residual loss of aquatic habitat or functioning. It is important, however, that impact mitigation and management recommendations provided in this report are adhered to (see Section 4.4).

Table 27. Impact significance assessment summary: construction phase aquatic impacts.

Potential Impacts	Nature	Type	Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance
C1. Destruction and modification of freshwater habitat	Negative	Direct	'Poor'	Local	Low	Short term	**Low**	Definite	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Definite	**Very Low**
C2. Flow modification and erosion / sedimentation	Negative	Direct & Indirect	'Poor'	Local	Medium	Medium term	**Low**	Definite	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Probable	**Very Low**
C3. Alteration of water quality	Negative	Direct & Indirect	'Poor'	Local	High	Medium term	**Medium**	Possible	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Improbable	**Insignificant**
Overall (cumulative) Impact	Negative	Cumulative	'Poor'	Local	Medium	Medium term	**Low**	Definite	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Definite	**Very Low**

Table 28. Impact significance assessment summary: operational phase aquatic impacts.

Potential Impacts	Nature	Type	Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance
O1. Destruction and modification of freshwater habitat	Negative	Indirect	'Poor'	Local	Low	Long term	**Low**	Probable	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Improbable	**Insignificant**
O2. Flow modification and erosion / sedimentation	Negative	Direct & Indirect	'Poor'	Local	Medium	Long term	**Medium**	Possible	**Low**
			'Good'	Site	Low	Medium term	**Low**	Possible	**Very Low**
O3. Alteration of water quality	Negative	Indirect	'Poor'	Local	Low	Medium term	**Low**	Possible	**Very Low**
			'Good'	Site	Low	Short term	**Very Low**	Improbable	**Insignificant**
Overall (cumulative) Impact	Negative	Cumulative	'Poor'	Local	Medium	Long term	**Medium**	Possible	**Low**
			'Good'	Site	Low	Short term	**Low**	Improbable	**Very Low**

4.4 Aquatic Impact Mitigation and Management Recommendations

According to the National Environmental Management Act No. 107 of 1998 (NEMA), sensitive, vulnerable, highly dynamic or stressed ecosystems, such as wetlands, rivers and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. NEMA also requires "*a risk-averse and cautious approach which takes into account the limits of current knowledge about the consequences of decisions and actions*". The 'precautionary principle' therefore applies and cost-effective measures must be implemented to pro-actively prevent degradation of the region's water resources and the social systems that depend on it. ***Ultimately, the risk of water resource degradation and biodiversity reduction/loss must drive sustainability in development design.***

Driver *et al.* (2011) recommend that the management of freshwater ecosystems should aim to prevent the occurrence of large-scale damaging events as well as repeated, chronic, persistent, subtle events which can in the long-term be far more damaging (e.g. as a result of sedimentation and pollution). Prior to assessing the significance of the potential impacts of the proposed sewer pipeline and associated infrastructure, the ecologists from Eco-Pulse therefore considered opportunities for initial mitigation in accordance with the "mitigation hierarchy" (see Figure 14), which considers it best practice to protect water resources (wetlands & rivers in this instance), which is also in line with the recommended management objective for the project and receiving aquatic environment, that being to '***maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning***' . This essentially then begins with the avoidance of adverse impact-causing activities and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces in situ impacts.

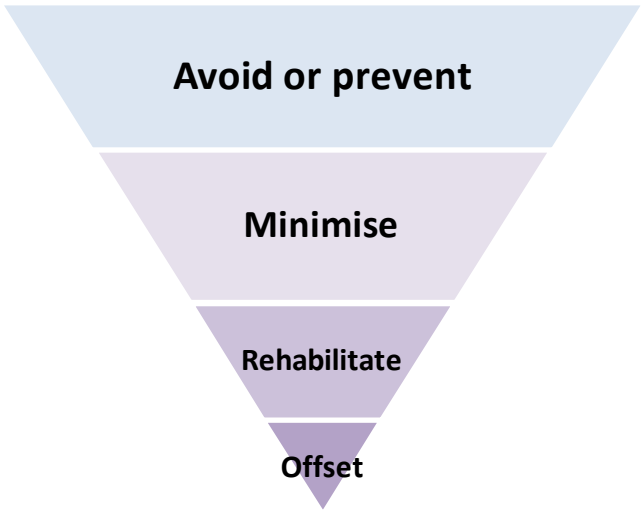


Figure 14 Diagram illustrating the 'mitigation hierarchy' (after DEA et al., 2013).

Impact mitigation measures and recommendations have been compiled based on specialist knowledge and experience in similar waste water pipeline projects as well as a range of literature including:

- FERC (US Federal Energy Regulatory Commission), 2002. Wetland and Waterbody construction and mitigation procedures.
- DWAF (Department of Water Affairs and Forestry) 2005b. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- DWAF (Department of Water Affairs and Forestry) 2005c. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- eThekwini Municipality, 2009. Generic EMP for Construction Activities.

4.4.1 Design & Planning Recommendations

For the pipeline upgrade project, the incorporation of ecologically sensitive and important features such as wetland and river ecosystems/habitat into the planning and design of the project was considered through a process of delineating the extent of wetlands and riverine habitats, assessing the condition and importance of the aquatic habitats and ecosystems then considering alternative layout, alignment and design planning upfront before considering practical onsite measures to manage impacts and reduce impact significance. In line with the mitigation hierarchy (Figure 14), where environmental impacts can be severe, the guiding principle should be "anticipate and prevent" rather than "assess and repair". A stepped approach should therefore be followed in trying to minimize development impacts which includes:

1. Firstly, attempting to avoid/prevent impacts through project design and location;
2. Secondly, employing mitigation aimed at minimizing the magnitude/significance of impacts where these are unavoidable; and
3. Lastly, compensating for any remaining/residual impacts through on-site rehabilitation or through the application of offsets where deemed relevant.

A. Identification of Ecologically Important and Sensitive Areas to Inform Realignment Recommendations

In line with the first step of the 'mitigation hierarchy' which is to 'avoid or prevent' potential impacts wherever possible, the identification of sensitive area/ecosystems and recommendations of buffer zones/set-backs and realignments of planned infrastructure should be taken into consideration.

The most ecologically important and sensitive watercourse identified for the study area is the Mdloti River main channel (moderate EIS), with other wetland areas identified as being of low ecological importance and sensitivity as a result of the existing level of transformation/modification of these habitat, with significant loss of condition and functioning having already occurred. As such, wetland

buffer zone and realignment recommendations have not been recommended for this project given the already degraded state of the aquatic environment and the fact that the project considers upgrading an existing pipeline (the best environmental solution will be to install the new pipeline within the existing location).

B. Pipeline Design Recommendations

In line with the second step of the 'mitigation hierarchy' which is to 'minimise' the probability and intensity of potential impacts wherever possible, the following best practice environmental design considerations should be incorporated into the design of the proposed pipeline upgrade wherever practically possible:

i. Pipelines crossing wetlands/rivers should be aligned with existing areas of vegetation/habitat disturbance such as those associated with cultivation and existing servitudes.

ii. All pipelines must cross all watercourses at right angles (i.e. perpendicular to the general direction of flow through the wetland to be crossed). *Pipeline trenches and sandy bedding material can produce preferential flow paths for water across wetlands that can potentially drain wetland areas. Crossing wetlands perpendicular to the general direction of flows instead of at an angle will reduce this risk.*

iii. Where coarse bedding material is to be used for the pipeline (i.e. such as river sand), it is recommended that clay plugs be at regular (10-20m) intervals within the bedding along the pipeline to reduce preferential water flow along the pipeline length via bedding material where pipelines cross wetlands with saturated soils.

iv. Pipelines across wetlands should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions where flows can cause erosion to initiate.

v. For channelled watercourses (rivers, streams and channelled valley bottom wetlands), the pipeline should be designed in such a way so as to take into account possible future channel dynamics. Where practically possible, larger stream/river channel crossings are to follow pipe bridges over the river and not cross with the channel. The pipe bridges will need to be designed such that pipes are suspended sufficiently high above the channel bed and above the high water mark so as not to interfere with natural flow regimes and such that pipes do not act as traps for debris and sediment transported through the channel. Piers are to be placed on either side of the watercourse for smaller rivers/streams and not to be placed within the channel bed. Piers should be placed a sufficient distance up the bank (preferably on the top of the upper bank) and not below the water mark/bank full level.

vi. Where necessary, construct any necessary erosion protection works where the pipeline intersects the macro-channel banks of rivers /streams in order to prevent scouring or outer-bank erosion. Protection works to be considered may include gabions, reno-mattresses or other stabilising structures to armour them. Note that the outside bends of channels are

particularly vulnerable to erosion/ bank collapse and should preferably be avoided when detailed crossing positions are fixed.

vii. Buried pipelines within wetlands will need to be protected to minimise the risk of damage or leakage. This means typically encasing the pipe in concrete or other suitable resistant material.

viii. Underground sewer pipelines across channels should be encased with concrete to minimise the risk of damage and leakage.

ix. No scour chambers must be established within the delineated watercourses (wetlands and riparian zones of rivers).

x. Erosion protection measures such as gabions, reno-mattresses must be installed below scour chambers were water may flow.

4.4.2 Construction-Phase Impact Mitigation Measures

In addition to the project design/planning recommendations in 4.4.1, on-site mitigation measures and controls to manage the extent, intensity and duration of construction-phase aquatic ecological impacts (identified and discussed in this report) have been developed and are provided below. These mitigation measures are intended to supplement any other standard mitigation measures included in the Construction Environmental Management Programme (CEMPr) for the development project.

1. Finalisation of Designs and Plans

The following plans will need to be completed and approved prior to commencement of construction:

- Finalisation of watercourse crossing method for wetland unit W04-B. The method statements must provide detail on the following, where applicable:
    a. Working area extent and demarcation.
    b. Vegetation and soil clearing / grubbing / stripping and stockpiling.
    c. Access and running track establishment and decommissioning.
    d. Method of excavation.
    e. Temporary flow diversion measures.
    f. Infrastructure placement measures.
    g. Trench backfilling.
    h. Rehabilitation – reshaping, soil preparation, stabilisation / erosion control and revegetation.
- Finalisation of temporary laydown/storage areas locations.
- An EMPr must be compiled for the construction phase by an environmental consultant and the EMPr must incorporate all of the below listed mitigation measures.

2. Demarcation of Construction Servitudes and No-Go areas

For pipeline-watercourse crossings the following is recommended:

- For watercourses crossings, a maximum construction working servitude of 6m is allowed within wetland units. The watercourse crossing construction servitude must consist of the following features only:
    - A maximum 3 metre wide, one-way access and haulage track / running track established across the wetland.
    - Trench corridor / working area (maximum of 1.5m).
    - Erosion protection infrastructure upslope of the wetland (1.5m).
- The construction servitude across the watercourses must be demarcated using orange hazard netting prior to construction commencing.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- Demarcations are to remain until construction and rehabilitation is complete.
- All freshwater habitats outside of the demarcated areas must be considered 'no-go' areas for the duration of the construction phase.
- A maximum construction working servitude of 15m is allowed outside watercourses. The 15m construction working servitude must accommodate all construction related activities, including access routes, material storage, soil stockpiles, workers etc.
- No equipment laydown or storage areas must be located within 20m of any watercourse and/or within the 1:100 year floodline of the Mdloti River.
- Access to and from the development target areas should be either via existing roads or within the construction servitude itself (as defined above).
- Do not paint or mark any natural feature. Marking for surveying and other purposes must be done using pegs, beacons or rope and droppers.

3. Accidental incursions into No-Go areas

- Any contractors found working inside the 'No-Go' wetland/river areas (areas outside the construction/ working servitude) should be fined as per a fining schedule/system setup for the project.
- Watercourse units outside of the construction corridor that are disturbed during the construction phase must be rehabilitated immediately. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per the conceptual rehabilitation guidelines (see **Annexure D**).
- Where river channels have been disturbed, the channels should be re-graded (where necessary) and stabilised using geofabric and re-vegetated as per the relevant re-vegetation/re-planting plan.

4. Vegetation clearing

- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Install protective works (e.g. gabions, reno-mattresses) to stabilise and protect unstable banks immediately upstream and downstream of the pipeline crossing prior to commencing construction.
- The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes.
- Prior to the stripping, infilling, excavation and re-shaping of any wetland/aquatic habitat within the development footprint/corridor, a search and rescue of indigenous vegetation must be undertaken prior to habitat destruction for use in rehabilitation. Arrangements must be made to store and/or relocate the relevant species into suitable onsite or offsite habitats or in a temporary nursery/storage area. This process should be led by the appointed ECO.
- Thereafter, topsoil and vegetation from areas to be excavated should be stripped and stored at the designated soil stockpile area outside of the wetland/aquatic zone for use later in rehabilitation (see **Annexure D**). Topsoil and subsoil to be stored separately.

5. Construction Timing

- It is recommended that construction within or across delineated watercourses (wetlands/rivers) be undertaken in the dry/winter months to reduce erosion and sedimentation risks during the construction phase. This will reduce the risk of secondary/ downstream erosion and sedimentation impacts associated with construction works within watercourses. This could potentially negate the need for instream coffer dams and temporary diversions in some instances, which themselves pose the risk of inherent negative ecological impacts.
- The Contractor should ensure that weather conditions that could result in flooding are taken into account by monitoring local weather forecasts and ensuring that activities are restricted during such events. This will also reduce the risks to human safety associated with potential flooding of watercourses.

6. General Stormwater Management Measures

Stormwater and erosion control measures must be implemented during the construction phase to ensure that erosion and sedimentation impacts to watercourse habitats are avoided or at least minimised. In this regard, the following measures must be implemented:

- Construction activities should be scheduled to minimise the duration of exposure to bare soils on site, especially on steep slopes.
- The natural flow of watercourses shall not be permanently diverted or blocked. Maintain adequate through flows to downstream aquatic ecosystems to protect aquatic life, and prevent the interruption of existing downstream uses.

- The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of sediment barriers (e.g. silt fences, sandbags, hay bales, earthen diversion berms). Sediment barriers should be regularly maintained and cleaned so as to ensure effective drainage.
- Sediment barriers must only be removed once vegetation cover has successfully re-colonised disturbed areas.
- Ensure that any trenches or excavations are closed and compacted immediately after construction is completed.

7. Soil Management Measures (Stockpiles)

Where deemed relevant, the following measures should be implemented:

- Soil required for construction purposes must not be derived from the wetlands or rivers/streams. Only approved borrow areas are to be used under the supervision of the ECO. Any soil removed from wetlands should be stockpiled and used in rehabilitation.
- Soil stockpiles must be established on flat ground at least 20m away from delineated watercourses.
- Erosion/sediment control measures such as silt fences, low soil berms or wooden shutter boards must be placed around the stockpiles to limit sediment runoff from stockpiles.
- Subsoil and topsoil is to be stockpiled separately. Stockpiled soil must be replaced in the reverse order as to which it was removed (subsoil first followed by topsoil).
- Stockpiles of construction materials must be clearly separated from soil stockpiles in order to limit any contamination of soils.
- The stockpiles may only be placed within demarcated stockpile areas, which must fall within the demarcated construction area. The contractor shall, where possible, avoid stockpiling materials in vegetated areas that will not be cleared.
- Stockpiles shall be located outside of freshwater habitat (including riparian zones).
- Stockpiled soils are to be kept free of weeds and are not to be compacted. The stockpiled soil must be kept moist using some form of spray irrigation on a regular basis as appropriate and according to weather conditions.
- If soil stockpiles are to be kept for more than 3 months they must be hydro-seeded.
- The slope and height of stockpiles must be limited to 1.5m and are not be sloped more than 1:2 to avoid collapse.

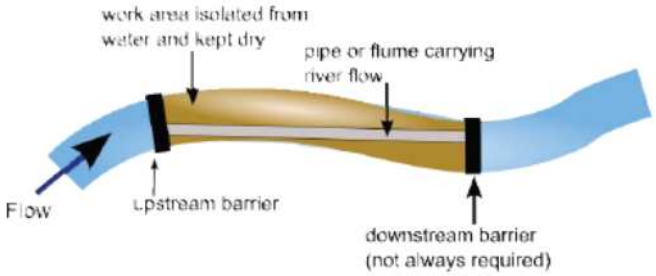
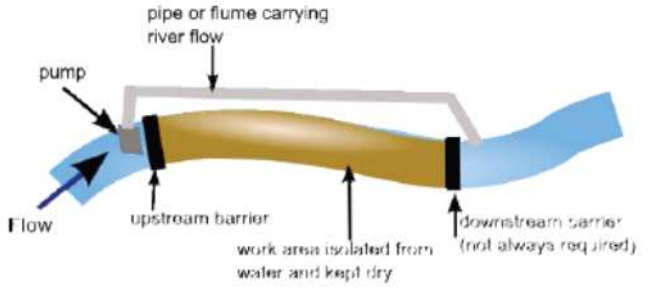
8. Temporary Flow diversion / Trench Dewatering

Note: These recommendations may not be applicable due to the temporary to seasonal nature of some wetlands/rivers and will only apply as necessary:

- To reduce the need to divert water away from the construction working when crossing watercourses, all construction activities within wet areas should ideally take place in the dry season/winter where this is possible and depending on project timeframes.

- Construction within/across watercourses should progress as quickly as practically possible to reduce the risk of exceeding the temporary diversion capacity.
- Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse.
- Not more than one diversion is to be undertaken within any given watercourse any given time.
- Re-directed flow must accompanied by erosion protection measures at the outlet point to avoid scouring, gully erosion and sedimentation of downstream habitat.
- Sandbags used in any diversion or for any other activity within a watercourse must be in a good condition, so that they do not burst and empty sediment into the watercourse;
- Under no circumstances should the creation of a new channel be considered to divert flows away from the current river channels position.
- Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns.
- Options for temporary flow diversion when working within channels may include:
    - diversion of the entire watercourse through use of a bypass large diameter pipe;
    - the installation of removable coffer dams; and
    - use of removable sandbags.
- Water must be piped over or around the working area to allow the trench excavation to take place. This will involve the establishment of an adequate number of flume pipes (to be determined by the engineer and ECO), and the establishment of a temporary coffer dam wall and running track upstream of the trench corridor:
    - The dam wall/bund wall should be established using sand bags laid across the wetland and over the flume pipes.
    - Protective rip-rap or other erosion protection measures should be established across the face of the dam/bund exposed to flow.
    - The pipe outlets should also be armoured against erosion using rip-rap and dump rock to reduce bed/watercourse scour.
    - Once the bund wall and running track is established, subsoil excavated from the trench must be stored at the demarcated subsoil stockpile area and subsoil layers must be stored in the layers they are excavated.
- If the trench requires dewatering, water pumped from the working areas must be diverted into an appropriate filtering area to handle dewatering. Pumped water must be passed through a series of silt traps prior to flowing back to any watercourse. The location of the filtering area should be approved by the ECO with aim of minimising erosion/sedimentation risks.
- The time that an excavation across a watercourse if left to stand open must be minimised through careful planning by the contractor. In this regard, trenches within watercourses should be backfilled within 2 days of excavation.
- During works within the channel, the downstream silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt), and repaired where necessary.

Table 29. Best practise methods for partial and full isolation (after SEPA, 2009).

Description of Method	Schematic of Method
1 Full isolation gravity/flume pipe A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area.	
2 Full isolation over pumping / siphon A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipe work need not be located in the isolated area.	

9. Alien Plant Control

- All alien invasive vegetation that colonise the construction site must be removed, preferably by uprooting. The contactor should consult the ECO regarding the method of removal.
- All bare surfaces across the construction site must be checked for IAPs every two weeks and IAPs removed by hand pulling/uprooting and adequately disposed.
- Herbicides should be utilised where hand pulling/uprooting is not possible. ONLY herbicides which have been certified safe for use in wetlands by independent testing authority are to be used. The ECO must be consulted in this regard.

10. Trench backfilling

- Once the pipes are laid, the trench must be backfilled first and subsoil and topsoil must be reinstated in the proper order that they were excavated.
- The bund wall and running track within watercourse must be removed. All foreign material (e.g. sand bags, rock fill, imported soils, aggregate, geofabric, etc.) must be removed from the watercourse, taking care not to remove natural sediment/rock from the watercourse.
- The bed must be reinstated as close to its original condition (including cross sectional and longitudinal profiles) as possible.
- Once re-graded, soils must be adequately ripped/loosened where compacted in order to promote re-vegetation, as informed by the ECO, and topsoil must be re-distributed across the banks in parallel to implementation of bank stabilisation and erosion protection. Care shall be taken not to mix the topsoil with the subsoil during re-shaping operations.
- If there is not enough topsoil to cover over the entire construction corridor, additional topsoil must be sourced from a geologically comparable area.

- All river/stream banks must be protected with a biodegradable geofabric such as Biojute. Temporary measures to prevent soil loss on the banks must be implemented and may include rows of sand bags/silt fences and silt fences at the water's edge.
- Immediately after the topsoil is reinstated and the wetland/river areas are stabilised, the disturbed areas must be re-vegetated according to the guidelines contained in Section 10 of this report.
- The re-vegetation should immediately upon completion of every lag of the pipeline (ideally every 500m).

11. Water Pollution Prevention Measures

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, etc.) needs to be administered.
- All cement mixing or other hazardous substances handling and dispensing activities must be undertaken on an impermeable surface.
- No refueling, servicing or chemical storage should occur within 50m of the delineated watercourse.
- No vehicles transporting concrete or any hazardous product may be washed on site.
- If a water pump is required, the water pump must operate inside a drip tray to prevent any spillage of fuel and limit the risk of soil/water contamination. The drip tray will need to be lined with absorbent material and checked daily while in use.
- All equipment to be used within the instream habitat (within the channel) must be checked daily for oil and diesel leaks before gaining access to working areas.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- Sanitation - portable toilets (1 toilet per 10 users) to be provided where construction is occurring. Workers need to be encouraged to use these facilities and not the natural environment. Toilets must not be located within the 1:100yr flood line of a watercourse or closer than 50m or from any natural watercourses. Waste from chemical toilets must be disposed of regularly (at least once a week) and in a responsible manner by a registered waste contractor. Toilet facilities must be serviced weekly and in a responsible manner by a registered waste contractor to prevent pollution and improper hygiene conditions.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.

12. Solid Waste Pollution Control

- Provide adequate rubbish bins and waste disposal facilities on-site and educate/encourage workers not to litter or dispose of solid waste in the natural environment but to use available facilities for waste disposal.

- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- Recycling/re-use of waste is to be encouraged.
- Litter generated by the construction crew must be collected in rubbish bins and disposed of weekly at registered sites by a registered waste management company.
- Litter bins must be equipped with a closing mechanism to prevent their contents from blowing out or wild animals from accessing the contents.
- No litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the site may be placed, dumped or deposited on adjacent/surrounding properties during or after the construction period, but disposed of at an approved dumping site. The construction site must be kept clean and tidy and free from rubbish.

13. Water Abstraction and Use

The following guidelines pertain to the abstraction and general use of water from wetlands and streams/rivers:

- No water is to be abstracted from wetlands/streams/rivers for use in construction activities without prior approval by the Department of Water and Sanitation (DWS), subject to acquiring a relevant Water Use License in terms of Section 21 of the National Water Act for taking water from a water resource.
- Abstraction points should be carefully selected to minimize impacts to sensitive water courses. To this effect, large perennial rivers should be selected for water abstraction purposes rather than abstracting from small streams that are more sensitive to reductions in water volume.
- The Contractor shall only be allowed to draw water from the source/s designated by the ECO.
- Excavating trenches or pits within wetlands or rivers/streams for the purpose of intercepting groundwater or diffuse surface flows to facilitate water abstraction is not to be permitted.
- Water abstraction is to be by suction pumps connected to water carts only. Water carts are to utilise existing access roads to abstraction points and are not to encroach into "no-go" areas. Water carts are not to enter directly into the watercourse from which they are drawing water.
- Care is to be taken not to disturb the channel bed of watercourses during abstraction of water using suction pumps.
- Locate the suction pump inlet at a sufficient height above the channel bed/floor where bed-load sediments accumulate.
- Where necessary, install a suitable sediment filter/screen in front of the suction pump inlet to remove undesirable sediments, particles and debris from entering the pump.
- Employees are not to make use of any natural water sources (e.g. rivers) for the purposes of swimming, bathing or washing of equipment, machinery or clothes.
- Drinking water is to be provided to all employees and labourers are to be discouraged from drinking directly from rivers on site. Suitable domestic water supply to be sourced for human consumption by workers onsite (to comply with DWS specifications for drinking water). Water for human consumption should be available at the site offices and at other convenient locations on site where work occurs.

4.4.3 *Construction Phase Ecological Monitoring*

Key impacts that will require monitoring during the construction phase include:

- Destruction of habitat outside the construction servitude including 'No Go' areas;
- Signs of IAP infestation;
- Premature clearing of the construction servitude;
- Use of fire and location of fire places;
- Illegal water abstraction from wetlands/rivers;
- Signs of intense or excessive erosion (gullies, rills, scouring and headcuts) and/or sedimentation within, along the edge and/or immediately downstream of the construction zone;
- Erosion of disturbed soils, road batters and soil stockpiles by surface wash processes;
- Poorly managed soil stockpiles;
- Altering the hydrology and through flows to downstream aquatic habitat during construction;
- Poorly maintained and damaged erosion control measures (e.g. sand bags, silt fences and silt curtains);
- Sedimentation of aquatic habitats downstream of work areas; and
- Pollution of water resource units (with a particular focus on hazardous substances such as fuels, oils and cement products).

Regular monitoring of the construction activities is critical to ensure that any problems with are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration and monitored by the ECO (together with construction staff):

- Destruction of habitat outside the construction servitude including 'No Go' areas.
- Signs of dense alien plant infestations.
- Undertaking daily inspection of the construction vehicles for leakage.
- Checking daily the level of sedimentation in the river and the effectiveness of sediment barriers.
- During works within the channel, the downstream silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt), and repaired where necessary.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and re-shaped.
- Stockpiles must be checked on a regular and if erosion is recorded sediment barriers must be installed.

4.4.4 *Operational Phase Impact Mitigation Measures*

Additional management measures for potential operation-phase aquatic ecological risks and impacts (identified and discussed in this report) have been developed and are provided below.

1. Guidelines for Undertaking Pipeline Maintenance/Repairs

- Maintenance of pipelines must be undertaken as sensitively as possible to prevent adverse impacts to the environment during access and repairs.
- When emptying the pipeline for the purposes of undertaking repair work, care must be taken not to erode wetland areas below scour chambers.
- Any vegetation clearing and excavation within watercourses required to maintain/repair sections of pipeline must adhere to the relevant construction phase impact mitigation measures provided in **Section 4.4.2** and **4.4.3**

4.4.5 *Operation Phase Ecological Monitoring*

Key operational impacts that require monitoring may include:

- Infestation by IAPs following construction disturbance of the area.
- Establishment of vegetation within the construction corridor post rehabilitation.
- Pipeline leaks.

Key methods of ecological monitoring include:

- Undertaking biannual visual inspection of the construction servitude for signs of IAP infestation and any leaks.
- Taking fixed-point photographs during biannual visual inspections.

5 TERRESTRIAL HABITAT BASELINE & IMPACT ASSESSMENT

This section of the report presents the findings of the terrestrial habitat baseline and impact assessment

5.1 Baseline Terrestrial Ecological Assessment

5.2 Assessment of Potential Terrestrial Ecological Impacts

5.3 Ecological Impact Mitigation and Management Recommendations

5.1 Baseline Terrestrial Ecological Assessment

5.1.1 Summary of Vegetation Community Assessment

Following desktop mapping using colour imagery in GIS of the terrestrial vegetation/habitat along the pipeline development corridor[10], focused ground-truthing was undertaken in the field which resulted in the classification of four (4)distinct terrestrial vegetation communities, namely: **Primary Scarp Thicket** (sub-community 1 & 2), **Secondary Wooded Grassland**, **Mixed Alien Thicket** (sub-community 1 & 2) and ***Schinus terebinthifolius* Alien Thicket**. An additional two transformed units were also recorded, namely a **Sugarcane Plantation** and an **Urban Development** area. The spatial distribution and extent of the vegetation communities / units is shown in Figure 15.

In terms of Ecological Condition (EC), only the Scarp Thicket (sub-community 2), was assessed as being the most notable and this is reflected by the EC rating of **'moderately modified'**. The rest of the vegetation communities were evaluated as either **'largely modified / degraded'** or **'seriously modified / secondary'**. Similarly, the Ecological Importance and Sensitivity (EIS) assessment revealed the Scarp Thicket (sub-community 2) as being the most notable with a rating of **'moderately EIS'** whilst other vegetation communities were assessed as being either **'low'** or **'moderately low EIS'**. A detailed summary of the EC and EIS assessment results and size for each vegetation community is presented in Table 30.

Note that freshwater/aquatic vegetation communities are specifically excluded as these have already been address under Section 4: Aquatic baseline & Impact Assessment.

[10] *The development corridor was defined as a 100m corridor of the pipeline route (i.e. 50m width each side of the pipeline route).*

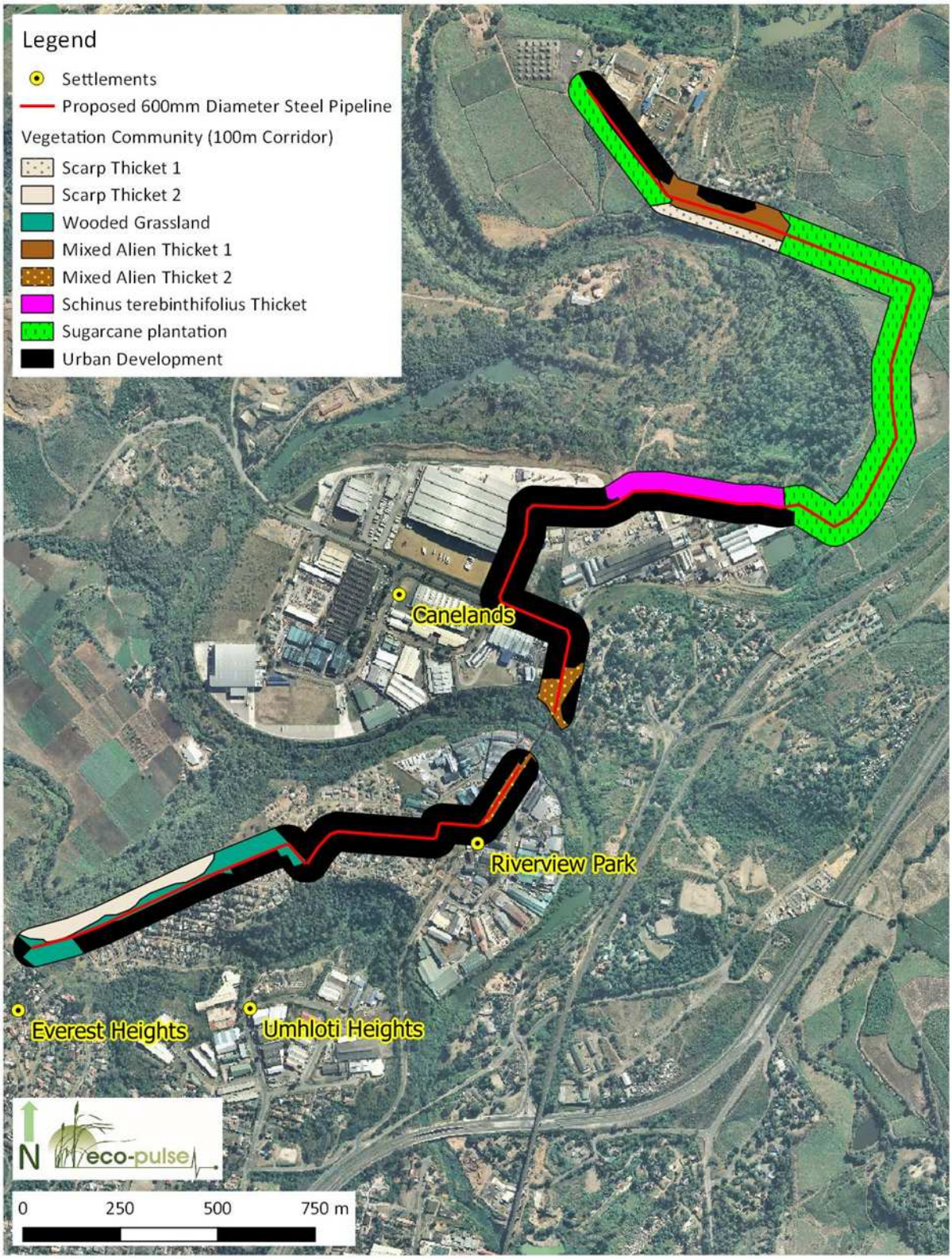


Figure 15 Spatial distribution and extent of mapped terrestrial habitat/vegetation types within the development corridor assessed.

Table 30. Summary of the EC and EIS assessment results and size for each vegetation community.

Vegetation Community	Status	EC	EI	ES	EIS	Area (Ha)
Primary Scarp Thicket 1	Secondary Vegetation Community	Secondary (Seriously Modified)	Moderately Low	Moderately Low	**Moderately Low**	0.951
Primary Scarp Thicket 2	Primary Vegetation Community	Moderately-Modified	**Moderate**	Moderately Low	**Moderate**	1.947
Secondary Wooded Grassland	Partly Secondary Vegetation Community	Degraded (Largely Modified)	Moderately Low	Moderately Low	**Moderately Low**	2.888
Mixed Alien Thicket 1	Secondary Vegetation Community	Secondary (Seriously Modified)	Low	Low	**Low**	1.834
Mixed Alien Thicket 2	Partly Secondary Vegetation Community	Degraded (Largely Modified)	Moderately Low	Moderately Low	**Moderately Low**	1.59
***Schinus terebinthifolius* Alien Thicket**	Secondary Vegetation Community	Secondary (Seriously Modified)	Low	Low	**Low**	2.394
Sugarcane plantation	Transformed	Transformed	N/A	N/A	**N/A**	13.569
Urban Development	Transformed	Transformed	Low	Low	**Low**	22.41
					Total	**47.58**

5.1.2 *Vegetation Community Description & Ecological Condition Assessment*

A. Primary Scarp Thicket (Sub-community 1 & 2)

Two vegetation sub-communities identified within the Primary Scarp Thicket community (sub community 1 and 2) were recorded on two separate scarp positions. Sub-community 1 is situated on a west facing slope that adjoins the left bank of the Mdloti River near the Hazelmere WTW while sub-community 2 is situated on a north-east facing slope that adjoins the right bank of the Black Mhlashini River, a right bank tributary of the Mdloti River, near the Grange Reservoir. Combined they occupy 6.1% (thus 2.9 Ha) of the development corridor.

Scarp Thicket sub-community 1 appeared to be largely secondary owing to the high abundance of exotic trees and a few mature indigenous pioneer tree species. In terms of structure, this unit was characterised by a mix of tall and small trees which have formed a dense thicket. *Pinus patula* was recorded as the most dominant along with the following additional invasive alien plants: *Schinus terebinthifolius, Melia azedarach, Tecoma stans, Litsea glutinosa* and with indigenous species being *Trema orientalis, Dalbergia obovata, Albizia adianthifolia, Bridelia micrantha* and *Trichilia emetica*. The understorey vegetation was somewhat absent owing to poor light penetration caused by trees particularly those of the genus *Pinus*. The Scarp Thicket 1 was assigned a "**seriously degraded / secondary**" rating in terms of ecological condition, largely due to the fact that it is secondary in nature

and characterised largely by exotic plants. Despite having some indigenous species, this unit was considered not representative of the natural/reference thicket/forest vegetation type.

Scarp Thicket sub-community 2 was noted as being a primary vegetation community and this was confirmed by review of the 1937, 1967 and 1996 historic imagery which suggests that the area was never transformed for sugarcane cultivation. It must be mentioned that access into this unit was restricted by the dense vegetation and very steep slope. Analysis of species recorded along the edge of the unit obtained from upslope suggested that unlike the secondary sub-community 1, this unit was characterised by a high abundance of indigenous woody vegetation that has formed an impenetrable thicket. Native tree species recorded included: *Albizia adianthifolia*, *Dalbergia obovata, Trichilia emetica, Strelitzia nicolai, Cussonia spicata, Euphorbia tirucalli* and *Brachylaena discolor*. A few scrambling shrubs (*Acacia ataxacantha, A. schweinfurthii and Jasminum)* were also recorded and these likely play a key role is creating the impenetrable thicket. A few vines including *Rhoicissus tomentosa* and exotic creepers *Cardiospermum grandiflorum* and *Ipomoea purpurea* were noted blanketing the canopy of the thicket community. Despite being poorly vegetated, the basal layer had *Oplismenus hirtellus,* a grass common to shaded coastal forest understorey vegetation. Although present, IAP were somewhat limited to the edge of the thicket. The Scarp Thicket 2 was assessed as being **"moderately modified"** in terms of ecological condition, with the prevalence of IAPs and weeds having altered the species composition and structure of the vegetation community.

Photo 13: View looking north over the Scarp Thicket 2 on a north-west facing slope.

B. Secondary Wooded Grassland

The secondary wooded grassland community was recorded on a crest that adjoins the Scarp Thicket 2 vegetation community and a residential area. This unit constitutes approx. 6.1% (thus 2.9 Ha) of the development corridor assessed. The community was characterised by open grassland patches and patches of woody vegetation (shrubs and trees). The graminoid community was represented by a few indigenous pioneer and sub-climax grasses: *Chloris gayana, Melinis repens, Panicum maximum* and *Eragrostis curvular.* These grass species are common within disturbed areas, especially following

cultivation and it is likely that they dominated following the cessation of cultivation owing to a high seed bank in the soil. Other grasses recorded albeit in low abundance included *Sorghum halepense* and those common in areas with heavy foot traffic were *Cynodon dactylon* and *C. nlemfluensis*. Wooded vegetation was characterised by a mix of both indigenous and exotic plants including *Albizia adianthifolia, Tecomaria capensis, Acacia robusta, Dalbergia obovata, Cestrum laevigatum, Melia azedarach, Pinus sp.* and *Solanum mauritianum*. Forbs were limited to a few common weeds of disturbance including *Plantago lanceolata* and alien plants such as *Opuntia stricta, Sansevieria hyacinthoides* and *Bidens pilosa*. Despite localised areas of this vegetation community being historically cultivated, two (2) specially protected plants were recorded within the vegetation community, including *Aloe arborescens* and *Ledebouria sp.* (*probably L. floribunda and L. revoluta*). The ecological condition of the Secondary Wooded Grassland was assessed as being "**largely modified / degraded**" due to the secondary nature of the vegetation, high abundance of weeds and a significant change in the structure and composition of the vegetation community caused by alien plant infestations. This vegetation community has significantly deviated from the benchmark vegetation type which would likely have been KZN Coastal Belt Grassland.

Photo 14: View of the Wooded Grassland community. The trees on the left side of the photograph mark the edge of the Scarp Thicket (sub-community 2). The red line indicates roughly where the pipeline will run.

Photo 15: View of the transition between the Wooded Grassland to the left and the Scarp Thicket to the right. The red line indicates roughly where the pipeline will run.

C. Mixed Alien Thicket (sub-community 1 & 2)

Two sub-communities identified as Mixed Alien Thicket 1 and 2 were identified, with Sub-community 1 recorded on the eastern side of the Hazelmere WTW and sub-community 2 on both sides of the Mdloti River crossing between the Canelands industrial area and Riverview Park and comprising approx. 7.2 % (thus 3.4 Ha) of the total area of the development corridor. Both these sub-communities werecharacterised by a high abundance of invasive and non-invasive alien plants, occasionally forming dense stands. Structurally, both units were characterised by a mix of arborescent alien shrubs such as *Chromolaena odorata, Lantana camara* and *Ricinus communis* and medium to tall alien trees

including *Acacia mearnsii, Melia azedarach, Morus alba, Schinus terebinthifolius* and *Tecoma stans*. Small thicket communities of *C. odorata* where recorded within sub-community 1. Groundcover was generally sparse and irregular. Some areas were covered with a mix of tufted weedy grasses such as *Panicum maximum, Melinis repens* and *Sporobolus africanus* whilst other areas were covered with rhizotomous grasses such as *C. dactylon* and *C. nlemfluensis*. Common forbs recorded included *Hypochaeris radicata, Ageratum sp., Felicia mosambicensis* and *Conyza canadensis*. A few climbers namely *C. grandiflorum, Passiflora subpeltata* and *P. suberosa* were recorded covering the crown of some of the larger trees. Common indigenous trees recorded included coastal forest pioneers such as *Dalbergia obovata, Albizia adianthifolia, Trichilia emetica* and *Trema. orientalis*. Sub-community 1 was found to be secondary in nature and likely established following the cessation of sugarcane cultivation. A small portion of the sub-community 2 was also considered secondary in nature as the vegetation community has established on an artificial berm that protects a series of pipelines that run across the Mdloti River. Despite being secondary, this community harbours a nationally protected tree, *Sclerocarya birrea* subsp. *caffra* (Marula) for which a licence in respect of protected trees is required if it is to be handled in any manner during construction.

The Mixed Alien Thicket (sub-community 1) was generally assessed as being **"seriously modified / secondary"** in terms of ecological condition, largely due to the composition being predominantly alien whilst sub-community 2 was assessed as **"largely modified"** because despite being partly secondary in nature, there was a fair portion of indigenous plant species native to the area found occurring in this unit. Both these communities bear little resemblance to the natural benchmark vegetation type which would have likely been KZN Coastal Belt Grassland.

Photo 16: View of a recently disturbed area within the Mixed Alien Thicket (sub-community 1). A *C. odorata* thicket can be seen on the left hand side of the photograph. The red line indicates roughly where the pipeline will run.

Photo 17: View of a footpath through the Mixed Alien Thicket (sub-community 2) established on an artificial berm. The red line indicates roughly where the pipeline will run.

D. *Schinus terebinthifolius* Thicket

A *Schinus terebinthifolius* (Brazilian Peppertree) dominated alien thicket was recorded along the north-eastern edge of the Canelands Industrial area. This unit constitutes 5 % (thus 2.39 Ha) of the total area of the development corridor. The vegetation community was characterised by a dense impenetrable stand of woody invasive alien plants particularly *S. terebinthifolius* and *Chromolaena odorata*. Review of Google Earth™ historic imagery dated back to April 2002 suggests that *S. terebinthifolius* may have taken advantage of disturbance at the site with poor vegetation cover. Unchecked for over a decade, *S. terebinthifolius* has developed numerous overhanging multi-branches that choke other trees and cast a shade on the understorey herbaceous community resulting in poorly developed vegetation undergrowth. Other species that have managed to take advantage of the situation and establish themselves albeit in low abundance include the following IAPs: *Eucalyptus sp.* (seen towering above the tree canopy), *C. odorata* (recorded mainly in small open areas), *Morus alba*, *Mangifera sp.* and *Lantana camara*. Indigenous trees included only a few specimens of pioneer forest/coastal bush species, namely *Dalbergia obovata* and *Trema orientalis* with *Syzygium guineense* as well as *Strelitzia nicolai* also present in low abundance. This vegetation community has been assessed as being "**seriously modified / secondary**" in terms of ecological condition due to the predominance of IAPs, with the community bearing little resemblance to the natural benchmark vegetation type which would have likely been KZN Coastal Belt Grassland.

Photo 18: View of the edge of the *S. terebinthifolius* Thicket. The red line indicates roughly where the pipeline will run.

Photo 19: View of the interior of the *S. terebinthifolius* Thicket. Note the absence of groundcover beneath the thicket canopy.

E. Sugarcane Plantation

Two portions of land within the northern section of the study area were found to be under sugarcane (*Saccharum officinarum*) cultivation (Photo 20), contributing to approx. 28.5 % (thus 13.569 Ha) of the total area of the development corridor. Low number of indigenous grasses and forbs that are weeds of disturbance namely; *C. dactylon, C. nlemfluensis, V. bonariensis* and *Hypochaeris radiate* were recorded along footpaths through the sugarcane plantations. An assessment of EC and EIS was not performed on this unit as it has been completely transformed for the cultivation of sugarcane crops.

Photo 20: View of the sugarcane plantation within the study area just south of the Hazelmere WTW. The red line indicates roughly where the pipeline will run.

F. Urban Development

Urban development is defined as built up areas characterised by small random patches of vegetation which ranges from a few isolated trees to short manicured/maintained vegetation community (e.g. lawn grass) in between buildings and the road infrastructure. This was found to constitute roughly 47 % (thus 22.41 Ha) of the total area of the development corridor. Much of the central to southern portion of the pipeline was identified as urban development. A wide array of small vegetation communities, often dominated by weedy, exotic and cosmopolitan species were recorded. These include short secondary grassed lawn areas adjoining road shoulders, mixed alien dominated herbaceous community, ornamental trees and hedges demarcating property boundaries. This unit was assigned an EC rating of **"transformed"** which means it is largely characterised by development infrastructure (buildings, roads, parking areas etc.)..

Photo 21: View of a mowed stoloniferous grassland community within the Canelands industrial area. The red line indicates roughly where the pipeline will run.

5.1.3 *Potential Occurrence (POC) Assessment of Species of Conservation Concern*

A. Flora POC

Species of conservation concern refer to species of flora (plants) and fauna (animals) that have a high conservation importance in terms of preserving South Africa's high biological diversity. Interrogation of SANBI's online threatened species database for the quarter degree grid square (QDGS) 2931CA and the KZN C-Plan (EKZNW, 2010) highlighted eleven (11) plant species for consideration (Table 31). Two species (*Barleria natalensis* and *Vernonella africana*) were assessed as being highly unlikely to be present on site owing to the fact they are considered extinct. Four (4) plant species were however assessed as being potentially present within the Scarp Thicket despite not being recorded during the site visit. These include the following species considered "Declining": *Elaeodendron croceum, Hypoxis hemerocallidea, Adenia gummifera var. gummifera* and *Cassipourea malosana* (Table 31). The potential occurrence of these species does not present a red flag or fatal flaw for the development but simply highlights the importance of undertaking a pre-construction walk-through to identify whether any of these species occur and require translocation prior to construction occurring.

Table 31. Flora of conservation significance potentially occurring in the project area according to SANBI's POSA online database for the quarter degree 2921CA.

Species Name	Threat Status [11]	Description	Habitat Preferences	Relevant Onsite Habitat	Potential Occurrence (POC)
1. ***Barleria natalensis***	**EX**	Herb	Coastal Grasslands.	Wooded Grassland	Highly Unlikely
2. ***Vernonella africana***	**EX**	Herb	Coastal Grasslands.	Wooded Grassland	Highly Unlikely
3. ***Lotononis dichiloides***	**CR PE**	Perennial shrub	Alt: 122 – 1220m.	Unknown	Unlikely
4. ***Kniphofia littoralis***	**NT**	Perennial herb.	Marshy coastal areas. Alt: 3 – 600m.		Unlikely
5. ***Jubaeopsis caffra***	**EN**	Perennial. Tree.	Pondoland coastal forest, steep sandstone cliffs above river banks. Alt: 0-30m	Scarp Thicket	Highly unlikely
6. ***Crinum macowanii***	**DEC**	Perennial geophyte	In grasslands and rocky areas near rivers. Alt: 200 – 1650m.	Wooded Grassland	Unlikely
7. ***Elaeodendron croceum***	**DEC**	Perennial tree	Occurs in coastal and inland forests and forest margins. Alt: 250 – 2600m.	Scarp Thicket	**Possible but not recorded**
8. ***Hypoxis hemerocallidea***	**DEC**	Bulbous herb	Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Alt: 50 – 1800m.	Wooded Grassland	**Possible but not recorded**

[11] ***EX –*** *Extinct,* ***CR PE –*** *Critically Endangered Potentially Extinct,* ***EN –*** *Endangered,* ***NT*** *– Near Threatened,* ***DEC*** *– Declining,* ***LC*** *– Least Concern*

Species Name	Threat Status [11]	Description	Habitat Preferences	Relevant Onsite Habitat	Potential Occurrence (POC)
9. ***Disperis woodii***	**LC**	Perennial geophyte	Occurs in damp grassland, usually sandy soils, sometimes within grass tussocks. Alt: 2 – 1800m.	N/A	Unlikely
10. ***Adenia gummifera var. gummifera***	**DEC**	Perennial climber	Occurs in forests and scrubs. Alt: 50 – 1650m.	Scarp Thicket	**Possible but not recorded**
11. ***Cassipourea malosana***	**DEC**	Perennial shrub / tree	Occurs in forest and forest margins where it reaches 25m in height. Alt: 600 – 1700m.	Scarp Thicket	**Possible but not recorded**

B. Fauna POC

Fauna of conservation significance for the study area were highlighted by investigating at a desktop level:

i. Species records found in the South African Bird Atlas Project (SABAP) database for the Region;
ii. Available species records (ADU, 2013); and
iii. Professional experience regarding rare/threatened amphibian species, reptiles and small mammals and their habitat requirements in eastern South Africa (KZN).

- **Mammals**

The potential occurrence of mammal species of conservation significance (i.e. Red data/Endangered species) was assessed based on available distribution records and habitat requirements for these species, with the outputs of the desktop POC survey summarised in Table 32, below. The lack of species-specific habitat for most of the mammals listed in Table 32 greatly reduces the likelihood of their occurrence at the site, which is further reduced by the proximity of habitats in the study area to development, roads and human activities. Larger mammal species have either been eradicated or have moved away from the area due to high levels of human and domesticated livestock disturbance associated with human occupation in the area as well as a history of large-scale commercial sugarcane agriculture in the region. Small mammal species are also extremely vulnerable to human impacts, poaching as well as dogs and feral cats. It is therefore quite unlikely that the development site itself constitutes significant habitat for any species of threatened mammal species as well as for mammal species in general. The dominant small mammal species occurring within adjacent intact habitats are also likely to be limited to those with one or more of the following traits:

- Have generally small range requirements and broad habitat requirements;
- Tolerance for human disturbance;
- Characterised by high reproductive and survival rates; and
- The ability to move easily between remaining untransformed vegetation patches.

Whilst no signs of any of the listed species were observed at the site during field investigations, it is important to note that small mammals are also mainly nocturnal species which limits the chances of observing these species during day-time surveys. Note that no small mammal trapping was conducted due to time and budget constraints.

Table 32. Potential occurrence of mammal species within the study area.

Species Name	Status[12]	Habitat Requirements/ Preferences (after Stuart & Stuart, 2007)	Distribution/ Range	Habitat requirements met at site?	Site within distribution/ range?	Potential Occurrence
Reddish-grey Musk Shrew *Crodidura cyanea*	**DD**	Moist habitats but also found in very dry terrestrial habitats. Show a preference for dense, matted vegetation.	Widespread in RSA	Partial	Yes	Unlikely
Forest Shrew *Myosorex varius*	**DD**	Occur in a wide range of habitats, associated with well vegetated and generally moist areas.	Widespread in KZN	Partial	Yes	Unlikely
Least Dwarf Shrew *Suncus infinitesimus*	**DD**	Range of habitats. Commonly found in association with termite mounds, which provide shelter and probably also food.	Widespread in KZN	Partial	Yes	Unlikely
Rough-haired golden Mole *Chrysospalax villosus*	**CR**	Have very specific habitat requirements. Thought to be found mostly in grassland with a preference for drier soils bordering on vleis.	Widespread in KZN	No	No	Highly unlikely
Aardwolf *Proteles cristatus*	**Rare**	Preference for open habitats and avoids heavily wooded areas and forest.	Widespread in RSA	No	Yes	Highly unlikely
African striped weasel *Poecilogale albinucha*	**DD**	Moist grasslands with flourishing populations of small rodents (their main food source). Soil texture may be important as weasels often excavate their own burrows.	Eastern RSA	No	Yes	Unlikely
Cape clawless otter *Aonyx capensis*	**Specially protected in KZN**	Unpolluted, unsilted streams (though species is not adversely affected by turbid waters) and rivers with good supply of food (crabs) and dense riverine vegetation (long grass, reeds, bushes) and other cover (holes, boulders).). Areas with dense reed beds and a rocky substrate on banks are used	Eastern RSA	No	Yes	Unlikely

[12] ***CR –*** *Critically Endangered,* ***EN –*** *Endangered,* ***VU*** *– Vulnerable,* ***NT*** *– Near Threatened,* ***DD*** *– Data Deficient*

Species Name	Status[12]	Habitat Requirements/ Preferences (after Stuart & Stuart, 2007)	Distribution/ Range	Habitat requirements met at site?	Site within distribution/ range?	Potential Occurrence
		most intensively, probably on account of a localized high food biomass. Impoundments, both large and small, appear to be secondary (less suitable) habitat.				

- **Avifauna (birds)**

The South African Bird Atlas Project (SABAP) aims to map the distribution and relative abundance of birds in southern Africa and relies heavily on data uploaded by "citizen scientists". Birds of conservation concern were identified through use of the South African Bird Atlas Project (SABAP) database (available online at http://sabap2.adu.org.za/).

A review of Pentad 2935-3100 highlighted 29 conservation important bird species for consideration (Table 33). The distributional ranges and habitat requirements/preferences for each bird species of conservation concern was reviewed (based on available literature) to estimate the likelihood of these species occurring within the study area. Based on their habitat preferences and distributional ranges, of the 29 species none of these are likely to be present within the transformed and secondary terrestrial habitats in the study area.

Table 33. Summary of the potential occurrence of bird species within the study area.

Species Name	Status[13]	Habitat Preferences (after Chittenden, 2009)	Potential Occurrence
White-backed Night-Heron	VU	It inhabits quet lowveld rivers and seeks refugre In dense waterside vegetation.	Highly unlikely
Eurasian (Great) Bittern	CR	It inhabitas floodplains, permanent marshes and streams in grasslands where it hides in read beds and similar dense vegetation.	Unlikely
Marabou Stork	NT	Open areas within coastal areas of KZN.	Highly unlikely
African Pygmy-Goose (*Nettapus auritus*)	NT	Sheltered pans,dams and pools with clear water and water lillies.	Unlikely
Martial Eagle	VU	Bushveld Woodland and Thornveld.	Highly unlikely
African Crowned (Crowned) Eagle (*Stephanoaetus coronatus*)	NT	Evergreen forsts, forested kloofs, dense riparian forests with large trees and well-wooded hillsides.	Unlikely
Lesser Jacana	NT	Pans,dams and river backwaters with floating vegetation.	Unlikely
Greater Painted-snipe (*Rostratula benghalensis*)	NT	Muddy shorelines of dams, pans and swamp pools.	Unlikely

[13] ***CR –*** *Critically Endangered,* ***EN –*** *Endangered,* ***VU*** *– Vulnerable,* ***NT*** *– Near Threatened*

Species Name	Status[13]	Habitat Preferences (after Chittenden, 2009)	Potential Occurrence
Black-winged Lapwing (Plover)	NT	Hiily grassslands, on golf courses and playing fields where grass is short.	Unlikely
Collared (Red-winged) Pratincole (*Glareola pratincola*)	NT	Sandbanks, mudflats, grassy flood plains, ploughed fields, burnt grass and overgrazed veld, especially if adjacent to coastal lakes, pans, large rivers, estuaries and dams	Unlikely
Half-collared Kingfisher	NT	Heavilly wooded inland waters and well-wooded estuaries.	Unlikely
African Broadbill (*Smithornis capensis*)	NT	Coastal evergreen or lowland forest, deciduous thickets or dense woodland.	Unlikely
Lanner Falcon (*Falco biarmicus*)	NT	Favours open grassland or woodland near cliffs.	Unlikely
Woolly-necked Stork (*Ciconia episcopus*)	NT	Wetlands, river margins and adajcent cultivated lands, estuaries. From being rare about 30 years ago this bird has discovered the advantages of human association, and often breeds in suburbia (pers. comm. Dr. D. Johnson).	Highly unlikely
Yellow-billed Stork (*Mycteria ibis*)	NT	Shoreline of most inland freshwater bodies, also estuaries.	Highly unlikely
African marsh-harrier (*Circus ranivorus*)	VU	Inland and coastal wetlands as well as adjacent moist grassland. Breeding demands a stretch of undisturbed long grass with concealed clearings.	Highly unlikely
Black-throated Wattle-eye (*Platysteyira peltata*)	NT	Estuarine and riparian forest, seldom far from water.	Unlikely
Black Stork (*Ciconia nigra*)	NT	Associated with mountainous regions, but not restricted by them.	Unlikely
Grey Crowned Crane (*Balearica regulorum*)	VU	Breeds in marshes, pans and dam margins with tall emergent vegetation. Found in pairs during breeding season, roosting on the ground near nest in wetlands. Feed in adjacent short to medium height grassland, wetlands and agricultural fields.	Unlikely
Spotted Ground-Thrush (*Zoothera guttata*)	EN	Coastal forest and scarp forest.	Unlikely

- **Reptiles**

A number of red-data, endemic and near-endemic reptile species, including lizards, snakes and skinks, are modelled to occur in the region. Of the four (4) reptiles were flagged for further assessment (table 34) only two (2) could possibly be present and restricted to the dense thicket vegetation communities. All reptile species are sensitive to major habitat alteration and fragmentation. As a result of human presence in the area coupled with livestock grazing disturbances, alterations to the original reptilian fauna are expected to have already occurred, with remaining areas where anthropogenic impacts are limited possibly hosting some of the species listed. With the pipeline to be largely restricted to an existing disturbed/transformed corridor, impacts on reptilian fauna of conservation importance are likely to be negligible.

Table 34. Summary of reptile species of conservation significance potentially occurring in the study area.

Species Name	Threat Status[14]	Habitat Requirements/ Preferences (after Bates *et al*. 2014)	Distribution/ Range	Relevant Onsite Habitat	Potential Occurrence
Large-scaled Grass Lizard *Chamaesaura macrolepsis*	**NT**	Found in grassland, especially rocky, grassy hillsides.	Endemic to SA (KZN, Mpumalanga and Limpopo), Swaziland and Zimbabwe	Wooded Grassland	Unlikely
Eastern Green Mamba *Dendroaspis angusticeps*	**VU**	Strictly arboreal and restricted to forests, occurring from sea level to 200m.	Restricted to low altitude forests along KZN coastline	Scarp Thicket	**Possible**
KwaZulu Dwarf Chameleon *Bradypodion melanocephalum*	**VU**	Inhabits a number of vegetation types such as grasses, bushes, thickets, trees and roadside verges.	Coastal regions of KZN	Wooded Grassland / Scarp Thicket	**Possible**
KwaZulu-Natal Black Snake *Macrelaps microlepidotus*	**NT**	Frequents moist leaf litter and humic soils in forests.	Eastern parts of SA.	Wooded Grassland	**Possible**

- **Amphibians**

Three (3) frog species of conservation importance were flagged for further verification (Table 35), however, there was deemed to be inadequate habitat in the study area to support viable populations of these species which depend largely on very specific aquatic/wetland vegetation/habitat which is absent from the area of assessment.

Table 35. Summary of the potential occurrence of amphibian species within the study area.

Species & Common Name	IUCN Status[15]	Habitat Requirements/Preferences	Distribution / Range	Relevant Onsite Habitat	Potential Occurrence
Afrixalus spinifrons **Natal leaf-folding frog**	NT	Breeds in standing water, in dense sedge beds and inundated grassy wetlands with abundant surface vegetation.	KZN endemic, narrow restricted range along the central KZN coast extending inland	Wetland Habitat	Unlikely
Hemisus guttatus **Spotted shovel-nosed frog**	VU	Inhabits grassland and savannah. It breeds in seasonal pans, swampy areas, and in pools near rivers where there are sandy soils/alluvial deposits. Spend most of their time underground in areas of flat, sandy	Central and northern KZN	N/A	Unlikely

[14] ***CR –*** *Critically Endangered,* ***EN –*** *Endangered,* ***VU*** *– Vulnerable,* ***NT*** *– Near Threatened,* ***DD*** *– Data Deficient*

[15] ***CR –*** *Critically Endangered,* ***EN –*** *Endangered,* ***VU*** *– Vulnerable,* ***NT*** *– Near Threatened*

Species & Common Name	IUCN Status [15]	Habitat Requirements/Preferences	Distribution / Range	Relevant Onsite Habitat	Potential Occurrence
		soil that tend to flood during the rains. Breeds in burrows and is seldom encountered above ground.			
***Hyperolius pickersgilli* Pickersgill Reed frog**	CR	The species is a habitat specialist occurring within perennial wetlands in Coastal Bushveld-Grassveld at low altitudes, comprised of very dense reed beds with typical vegetation including the Common Reed (Phragmites australis), Bulrushes (Typha capensis) and sedges such as Cyperus dives, Cyperus latifoloius and Cyperus papyrus and requiring an understudy of thick vegetation such as Snakeroot (Persicaria attenuata).	KZN endemic, narrow restricted range along the KZN coast	N/A	Highly Unlikely

- **Invertebrates**

There is generally very little available long-term information on invertebrate species and populations for most of South Africa, with the limited available information on invertebrates for the study area not really permitting a viable assessment of potential occurrence. The Terrestrial Systematic Conservation Plan for KZN (EKZNW, 2010) was reviewed however and flagged nine (9) conservation important invertebrate species (including millipedes, snails and a grasshopper) modelled to potentially occur in the study area (Table 36). Only millipede species could potentially be associated with the more natural thicket vegetation community in the study area and given the limited disturbance area of the proposed development, it is unlikely that these species will be significantly impacted by the project.

Table 36. Summary of the POC assessment for invertebrates flagged in the Terrestrial C-Plan (EKZNW, 2010).

Feature Name	Status	Habitat Preference	Relevant Onsite Habitat	Potential Occurrence at Site
Gnomeskelus spectabilis *Visible keeled millipede*	Endemic	Leaf litter associated with forests or thickets.	Scarp Thicket	Possible
Doratogonus cristulatus *Cristulate black millipede*	KZN endemic	Eggs laid in thick vegetation, in soil or rotting logs or in cattle dung. Adults in leaf litter, under rocks or logs, or top 50cm of soil, in cool, wet weather often seen on soil / vegetation.	Wooded Grassland	Unlikely
Doratogonus falcatus *Sickle-shaped black millipede*	LC	Forest/grassland	Scarp Thicket and Wooded Grassland	Possible
Doratogonus natalensis *Natal Black millipede*	VU	It is likely to be confined to forest habitat. It was originally recorded from the Howick and Rietvlei areas and Kranskop in KwaZulu-Natal. More recently (1999) it was recollected at one locality in the Karkloof Forest complex near Howick, and	Scarp Thicket	Unlikely

Feature Name	Status	Habitat Preference	Relevant Onsite Habitat	Potential Occurrence at Site
		from Ngoye Forest.		
Doratogonus peregrinus *Wandering black millipede*	Unknown	No information available	Unknown	Unknown
Gulella separata *Snail*	Unknown	No information available	Unknown	Unknown
Eremidium erectus *Wingless grasshopper*	Unknown	No information available	Unknown	Unknown
Euonyma lymneaeformis *Cone-shaped snail*	NEV	Forest/grassland	Scarp Thicket	Possible
Edourdia conulus	NEV	Woodland/forest	Scarp Thicket	Possible

5.1.4 *Ecological Importance & Sensitivity Assessment*

The Scarp thicket (sub-community 2) attained the highest EIS rating of moderate whilst the Scarp thicket (sub-community 1), with the Secondary Wooded Grassland and the Mixed Alien Thicket 2 communities attaining moderately-low EIS ratings. The other remaining units (the Mixed Alien thicket 1, *Schinus terebinthifolius* Thicket and the Urban Development) attained a low EIS rating due to the high level of habitat modification that has occurred in these units.

The rationale for the EIS ratings is presented in Table 37 and Figure 16 provides a terrestrial habitat sensitivity map for the area of study.

Table 37. Summary of the EIS assessment results for each vegetation community.

Terrestrial Vegetation Community	Ecological Importance(EI) Rating & Rationale	Ecological Sensitivity (ES) Rating & Rationale	Overall EIS
1. Scarp Thicket 1	**Moderately Low Ecological Importance** This unit was assessed as being of moderately low EI because: (a) It has a high abundance IAPs and weeds of disturbance although not dominant (b) It does not represent any known indigenous vegetation types, and (c) It is highlighted as a CBA: irreplaceable for certain biodiversity features.	**Moderately Low Ecological Sensitivity** This unit was assessed as being of moderately low ES because: (a) It occurs on a very steep slope that is vulnerable to erosion should it be disturbed (b) It contains a fair diversity of indigenous plant species	Moderately Low
2. Scarp Thicket 2	**Moderate Ecological Importance** This unit was assessed as being of moderate EI because: (a) It is a primary vegetation community characterised by indigenous plants. (b) (c) It is highlighted as a CBA: irreplaceable for biodiversity	**Moderate Ecological Sensitivity** This unit was assessed as being of moderately low ES because: (a) It occurs on a very steep slope that is vulnerable to erosion should it be disturbed (b) It contains a moderate diversity of	Moderate

Terrestrial Vegetation Community	Ecological Importance(EI) Rating & Rationale	Ecological Sensitivity (ES) Rating & Rationale	Overall EIS
	features and D'MOSS area. (c) It represents an indigenous vegetation type albeit having some IAPs.	indigenous plant species (c) It is moderately modified in terms of its EC	
3. Secondary Wooded Grassland	**Moderately Low Ecological Importance** This unit was assessed as being of moderately low EI because: (a) Despite harbouring 2 specially protected species (A. arborescens and Ledebouria sp.) both of which are listed as being of Least Concern, indigenous plant diversity is limited. (b) IAPs are present in high abundance. (c) There are many small patches that were covered with a secondary vegetation community following recent disturbances.	**Moderately Low Ecological Sensitivity** This unit was assessed as being of low ES because: (a) It is characterised by a moderate-low species diversity (b) Lacks sensitive species	Moderately Low
4. Mixed Alien Thicket 1	**Low Ecological Importance** This unit was assessed as being of low EI because: (a) It is secondary and characterised by IAPs and weeds of disturbance. (b) It does not represent any known indigenous vegetation types.	**Low Ecological Sensitivity** This unit was assessed as being of low ES because: (a) It is characterised by a low species diversity (b) Lacks sensitive species.	Low
5. Mixed Alien Thicket 2	**Moderately Low Ecological Importance** This unit was assessed as being of moderately-low EI because: (a) It has a high abundance IAPs and weeds of disturbance although not dominant. (b) Some patches are secondary in nature, (c) It does not represent any known indigenous vegetation types.	**Moderately Low Ecological Sensitivity** This unit was assessed as being of low ES because: (a) It is characterised by a moderate species diversity (b) Lacks sensitive species	Moderately Low
6. *Schinus* alien Thicket	**Low Ecological Importance** This unit was assessed as being of low EI because: (a) It is secondary and characterised by IAPs and weeds of disturbance. (b) It does not represent any known indigenous vegetation types.	**Low Ecological Sensitivity** This unit was assessed as being of low ES because: (a) It is characterised by a low species diversity (b) Lacks sensitive species	Low
7. Sugarcane plantation	*Not assessed: Transformed to cropland*		
8. Urban Development	**Low Ecological Importance** This unit was assessed as being of low EI because: (a) The vegetation community is secondary and characterised by exotic plants and weeds of disturbance. (b) Does not represent any known indigenous vegetation types.	**Low Ecological Sensitivity** This unit was assessed as being of low ES because: (a) It is characterised by a low species diversity (b) Situated within a transformed and artificial landscape (c) Lacks sensitive species	Low

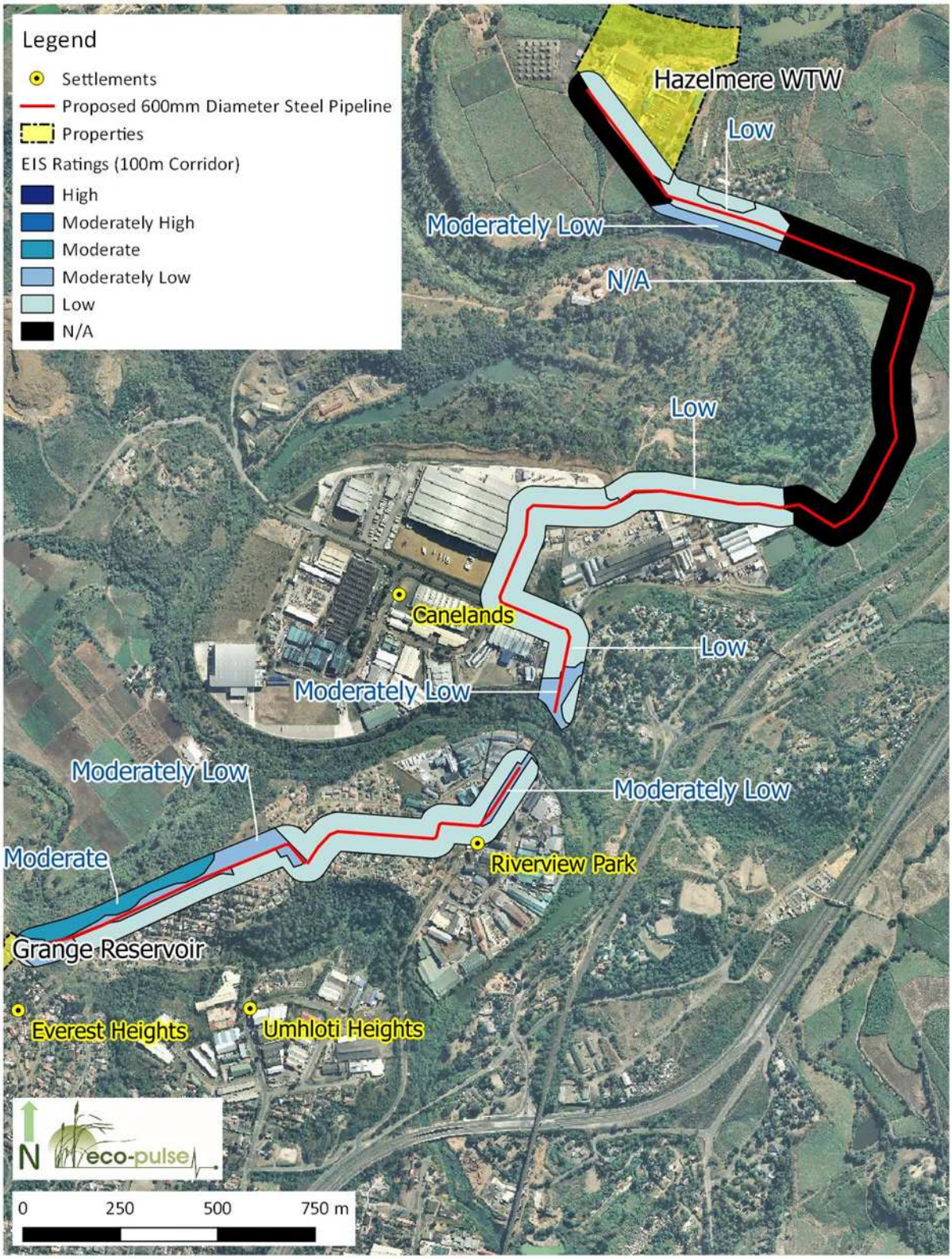


Figure 16 Terrestrial habitat sensitivity map showing the EIS rating of each vegetation community within the development corridor assessed.

5.1.5 Other noteworthy findings and ecological concerns

- ***Remaining natural linkages/corridors***

Development in the Mdloti River catchment has led to the large-scale transformation of natural habitat for the purposes of sugarcane cultivation and establishing transportation, residential, commercial/retail and industrial infrastructure. As such, natural corridors/linkages are largely restricted to the Mdloti River main channel and riparian vegetation, with the adjacent supporting terrestrial habitat having been largely transformed or modified to such an extent that these areas no longer support viable populations of local flora/fauna and natural linkages have been severed. Any remaining intact / untransformed terrestrial grassland and coastal forest patches would be considered important refugia and potential linkage areas between terrestrial and aquatic environments in this context and it is considered critical that remaining intact natural habitat be preserved wherever possible. Vegetation and habitat in these areas should be maintained in as natural as state as possible such that movement of local wildlife is not jeopardized any further.

- ***Slopes and soils***

The majority of the site is characterized by gentle slopes steep slopes and stable soil profiles.

5.2 Assessment of Potential Terrestrial Ecological Impacts

5.2.1 Impact Identification and Description

Natural ecosystems are inherently vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to ecosystems. Threats to terrestrial ecosystems and biodiversity include processes and activities which reduce system persistence, affect landscape structure and composition and alter community diversity and patterns, including reduced genetic diversity. One such threat to biological process could be the loss of important species due to loss or transformation of habitat. When making inferences on the potential impacts or risks that development activities place on ecosystems, it is important to understand that these impacts speak specifically to their effect on the ecological condition and/or functional importance/value of these ecosystems.

Generally, impacts can be grouped into the following four (4) broad categories:

A. **Direct impacts**: are those impacts directly linked to the project (e.g. clearing of land, destruction of vegetation and habitat).

B. **Indirect impacts**: are those impacts resulting from the project that may occur beyond or downslope/downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from construction sites).

C. **Induced impacts**: are impacts that are not directly attributable to the project, but are anticipated to occur because of the presence of project (e.g. impacts of associated developments, establishment of residential settlements with increased pressure on biodiversity).

D. **Cumulative impacts**: are those impacts from the project combined with the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity or natural resources (e.g. a number of developments in the same catchment or ecosystem type collectively affecting or impacting the same ecosystem types or local endemic species).

There is normally a risk that human development can generally impact either directly (e.g. physical change to habitat) or indirectly (e.g. soils erosion and disturbance creating conditions for alien plants to invade natural areas). Typical ecological impacts to terrestrial vegetation and habitat that are likely to be associated with this project are discussed in detail below. Impacts were identified and described based on an understanding of the receiving terrestrial environment and associated biodiversity, the location and extent of the proposed pipeline, scour valves and the identification of factors that could affect the receiving environment through the various project phases (i.e. construction and operational impacts).

Note that while an attempt has been made to separate impacts into categories, there is inevitably some degree of overlap due to the inherent interrelatedness of many ecological impacts.

Impact 1: Direct physical destruction of flora and fauna

This refers to the direct physical destruction, complete removal or partial destruction of vegetation and loss of indigenous flora and fauna by machinery and workers during the construction and operational phases of the project.

A. **Construction Phase Impacts:**

The construction of the rising main pipeline will impact on primary vegetation communities of moderate conservation importance, secondary vegetation communities of low conservation importance and transformed areas of negligible importance and very low ecological sensitivity. Primary vegetation communities that stand to be impacted include Scarp Thicket located within the southern end of the study corridor where the pipeline links with the Grange Reservoir. Clearing vegetation within these two communities will result in the loss of indigenous plant species most of which are herbaceous types. Trees may also be lost if the construction corridor is not limited to a reasonable width. Plants that stand to be lost include mainly common indigenous species and alien plants that are of minimal conservation importance. There is the potential however for the project to impact on provincially protected plant species, namely *Ledebouria floribunda,* recorded within the construction corridor but a simple plant rescue and translocation exercise would address this issue.

Furthermore, construction activities are likely to temporarily remove vegetation and expose the soil to erosive elements (wind, rain etc.). This could be exacerbated by water flowing down slopes and access roads, as well as from trench de-watering activities. Soil erosion can result in the loss of valuable topsoil and formation of erosion gullies. This can cause localized habitat loss / alteration due to increased sediment deposition or erosion of intact areas. Some of the key ecological effects related to the erosion/deposition of sediment may include:

- Habitat alteration due to increased sediment deposition or erosion of areas;
- Reduced density and diversity of organisms as a result of habitat degradation, blanketing of sites and the establishment of more tolerant taxa or exotic species; and
- Exposure disturbed sites to invasion by weeds and other undesirable plants.

Faunal impacts are likely to be insignificant as the habitat in their present degraded and heavily fragmented state are unlikely to harbour conservation important wildlife or appreciable populations of sedentary and locally common fauna. Simple generic rehabilitation measures post-construction will seek to reinstate any vegetation/habitat impacted during pipeline excavation and upgrading.

B. <u>Operational Phase Impacts:</u>

The operational phase of the pipeline is unlikely to result in the direct or indirect destruction of flora and fauna within the construction corridor as the pipeline will be buried below ground and the surface soils reinstated and revegetated post-construction. The only time such an impact could be experienced is when undertaking repairs to the pipeline in the event that it leaks. Impacts resulting from undertaking repairs will be similar to those discussed under the construction impact section (above).

Impact 2: Habitat Degradation & Fragmentation Impacts

This impact refers to the secondary effects of vegetation disturbance, including but not limited to: erosion risk and encroachment/colonisation of terrestrial habitats by Invasive Alien Plants (IAPs).

A. <u>Construction Phase Impacts:</u>

Vegetation clearing and disturbance of natural habitat can not only reduces the availability of habitat (refugia/breeding/nesting sites) and food for local wildlife but may also temporarily or even permanently restrict corridor movement between natural areas through associated fragmentation of natural habitat and the severing of natural ecological linkages/corridors. This will be of particular significance where relatively un-impacted areas may be affected, especially for existing local wildlife movement corridors. The effect of habitat fragmentation will generally be greater for fauna than for flora and is typically lower for grasslands when compared with wooded/forest communities but this is unlikely to be of much relevance for this particular project since the pipeline will be buried below ground and the affected habitat will be rehabilitated (also natural habitats are already generally

degraded and highly fragmented). Habitat degradation impacts are likely to be experienced mainly within the Secondary Wooded Grassland which has a moderate abundance of indigenous plant species, albeit these are locally common and of low conservation importance.

Setting up of storage areas for construction materials within the construction corridor and setting up a construction site camps outside the construction corridor will also result in degradation of affected areas through vegetation clearing, trampling and soil compaction. Use of heavy machinery within open spaces will likely alter the soil structure underneath. It has been shown that compaction can be up to 200 times greater than in undisturbed land (Trombulak & Frissell, 2000). If soil compaction is not addressed at the cessation of construction, plants that need deep soils will fail to establish themselves. Only plants that do well in shallow and compact soils will establish.

The development would probably have a relatively minor impact on small mammals such as rodents and shrews because only a limited proportion of habitat with respect to the broader vegetation community, with sufficient adjacent habitat retained for the overall impact to be slight. Nocturnal species such as hares would generally avoid disturbance through their nocturnal habit. Excavation for development would have a direct impact on moles through loss of habitat, with the overall extent of impact related to the proportion of area developed (which is insignificant). Loss of habitat will have a small deleterious impact on ants.

B. <u>Operational Phase Impacts:</u>

Following construction, the potential disturbance of soil and vegetation within natural areas (and adjacent habitats) encourages the establishment of pioneer vegetation, in many cases creating an ideal opportunity and optimal conditions for weeds and Invasive Alien Plants (IAPs) to invade both disturbed and adjacent undisturbed areas. IAPs can have far reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil chemistry and stability, promote erosion, change litter accumulation, reduce food supply for fauna and soil properties and promote of suppress fire. Failure to manage stripping of vegetation, topsoil and rehabilitation can lead to serious IAP infestation which compromises the quality of habitat provided by the naturally occurring vegetation community. Clearing and disturbance can also result in an increase in edge habitat immediately adjacent to disturbed areas. Edge habitat is characterized by a predominance of generalist and alien species that are usually highly competitive species which can invade areas of established vegetation, resulting in a loss of sedentary species of mature habitats which are normally considered sensitive. Edge effects will be typically lower for grasslands when compared with wooded communities such as forests/thicket. The spread of existing alien plants within natural areas can be exacerbated if not properly managed, and new alien plant species may be introduced to natural areas as a result of human disturbance and re-vegetation using undesirable plants species that are not naturally common to the region or study area.

When considering that the study area has a high IAP seed source, poor rehabilitation of the temporarily physically disturbed areas will likely result in the proliferation of opportunist / weedy plant and invasive alien plant (IAP) that will hinder natural recruitment of the disturbed areas by locally occurring indigenous species over time. Such an impact could alter the structure and species composition of affected vegetation communities and thus reduce their quality and ability to meet habitat requirements by local faunal.

Impact 3: Pollution Impacts

This refers to the alteration or deterioration in the physical, chemical and biological characteristics of soil and water, which inevitably impacts negatively on vegetation.

A. Construction Phase Impacts:

Waste products and pollutants generated during the construction phase of the development may include fuels and oils from construction vehicles, cement and concrete products, paints and other hazardous substances; as well as solid waste in the form of building material and litter from labourers. Potential contaminants and their relevant sources are listed below include:

- **Hydrocarbons** – leakages from petrol/diesel stores and machinery/vehicles, spillages from poor dispensing practices;
- **Oils and grease** - leakages from oil/grease stores and machinery/vehicles, spillages from poor handling and disposal practices;
- **Cement** - spillages from poor mixing and disposal practices; and
- **Sewage** – leakages from and/or poor servicing of chemical toilets and/or informal use of surrounding bush by workers.
- **Dust** – generated from movement of earth and vehicles.

If above mentioned contaminants are poorly handled or mismanaged during the construction phase, there is a risk that small areas of the construction soils and surfaces will be contaminated. During rainfall events, such contaminants could be washed into adjacent intact terrestrial habitats. These contaminants have the capacity to negatively affect soil ecosystems including sensitive or intolerant species of flora and fauna. When highly toxic pollutants come into contact with plants they often result in the destruction of plant parts (e.g. leaves) ultimately resulting in the death of the plant. Where significant changes in soil quality occur, this will ultimately result in a shift in flora and soil microbes species composition, favouring more tolerant species and encouraging the invasion of early successional and alien invasive species and potentially resulting in the localised exclusion of any sensitive species. Because these pollutants linger in the soil for extensive periods of time, they may inhibit the establishment of vegetation during rehabilitation of disturbed areas.

B. Operational Phase Impacts:

The operation of a water pipeline is unlikely to pollute the environment. As such this impact was not assessed any further for the operational project phase.

Impact 4: Indirect Ecological Disturbance & Nuisance Impacts

This refers to the alteration of the ambient environment by nuisance factors such as noise, vibrations, light pollution, etc. produced by machinery, vehicles and labourers during construction.

A. Construction Phase Impacts:

Local wildlife (fauna) generally respond to disturbances caused by human activities according to the magnitude, timing, and duration of the particular disturbance. Human activities can affect an animal's ability to feed, rest, and breed if it is unable to habituate to the disturbance caused (Rodgers & Schwikert, 2003). Anthropogenic activities occurring within a close proximity to natural habitats containing fauna (wildlife) can lead to both the physical disturbance of habitats supporting animal life by construction machinery/labourers (already discussed above) as well as the disturbance of fauna due to noise and artificial light pollution at the site during construction. Locally common species already occurring at the site are likely to be less sensitive to noise/light disturbance (due to the proximity of existing human development) and can probably become habituated at the site. No species of conservation importance were highlighted as being of a specific concern for this project and hence the significance of this impact is likely to be low/insignificant.

B. Operational Phase Impacts:

The operation of a water pipeline is highly unlikely to result in any noise/nuisance impacts. As such this impact was not assessed any further for the operational project phase.

5.2.2 Terrestrial Impact Significance Assessment

The proposed upgrading of the bulk water pipeline infrastructure could potentially lead to a number of negative ecological impacts to the terrestrial habitat and vegetation communities in the study area, and while localised disturbance to habitat is expected as a result of pipeline construction across these habitats, impacts will be largely confined with the pipeline construction servitude and will be restricted largely to existing degraded/secondary and transformed habitats of comparatively low ecological importance and sensitivity. The significance of the ecological consequences of construction and operational phase impacts on the terrestrial vegetation and habitat in the study area are summarised below as follows:

i. Impacts identified are unlikely to cause a reduction in the condition of habitat once rehabilitated post-construction, hence the project will not compromise provincial ecosystem

conservation targets. Furthermore, the secondary and transformed vegetation communities that characterise the study area are not representative of any endangered reference/benchmark vegetation types.

ii. The degraded secondary grasslands and alien bush at the site provide minimal value in terms ecological functioning and ecosystem service supply, hence there is likely to be only a negligible loss of ecosystem goods and services provided by these degraded ecosystems.

iii. No species of fauna of conservation concern (such as rare, endangered, protected plants/animals) were recorded onsite nor are they expected to be habituated within the degraded and secondary grassland /alien bushland habitat at the site. Where the development is restricted to the sections of degraded secondary grassland and invaded bushland, the impact on flora and faunal species is likely to be very low to insignificant. It is therefore reasonable to conclude that the proposed development will not have any adverse impact on conservation-important flora and fauna.

iv. Overall, the significance of the ecological consequences associated with the development construction and operational phases were assessed as being of '**Low' significance** under a 'poor/standard mitigation' scenario and can be easily mitigated/managed, which is likely to reduce significance to an overall **'Very Low' to 'Insignificant' level** under a 'good/best practical mitigation' which is deemed acceptable (Tables 38 and 39).

v. All adverse impacts linked with the project can be mitigated to an environmentally acceptable level and no fatal flaws were identified for the construction and operational phase of the proposed development from a terrestrial ecological perspective. Potential cumulative impacts associated with the construction phase of the project are also expected to be negligible as there will be no significant residual loss of habitat or functioning. It is important, however, that impact mitigation and management recommendations provided in this report are adhered to (see Section 5.3).

Table 38. Impact significance assessment summary: construction phase terrestrial impacts.

Potential Impacts	Nature	Type	Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance
C1. Direct physical destruction of flora and fauna	Negative	Direct	'Poor'	Local	Medium	Short term	**Low**	Definite	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Definite	**Very Low**
C2. Habitat Degradation & Fragmentation Impacts	Negative	Indirect	'Poor'	Local	Medium	Medium term	**Low**	Probable	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Possible	**Very Low**
C3. Pollution Impacts	Negative	Direct & Indirect	'Poor'	Local	Medium	Medium term	**Low**	Possible	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Improbable	**Insignificant**
C4. Indirect Ecological Disturbance & Nuisance Impacts	Negative	Indirect	'Poor'	Local	Low	Short term	**Very Low**	Probable	**Very Low**
			'Poor'	Site	Low	Short term	**Very Low**	Possible	**Insignificant**
Overall (cumulative) Impact	Negative	Cumulative	'Poor'	Local	Medium	Medium term	**Low**	Definite	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Definite	**Very Low**

Table 39. Impact significance assessment summary: operational phase terrestrial impacts.

Potential Impacts	Nature	Type	Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance
O1. Direct physical destruction of flora and fauna	Negative	Direct	'Poor'	Local	Medium	Short term	**Low**	Possible	**Very Low**
			'Good'	Site	Low	Short term	**Very Low**	Possible	**Insignificant**
O2. Habitat Degradation & Fragmentation Impacts	Negative	Indirect	'Poor'	Local	Low	Long term	**Low**	Probable	**Low**
			'Good'	Site	Low	Medium term	**Very Low**	Possible	**Insignificant**
O3. Pollution Impacts	Negative	Direct & Indirect	*Impact not applicable to water pipeline operation*						
O4. Indirect Ecological Disturbance & Nuisance Impacts	Negative	Indirect	*Impact not applicable to water pipeline operation*						
Overall (cumulative) Impact	Negative	Cumulative	'Poor'	Local	Medium	Medium term	**Low**	Probable	**Low**
			'Good'	Site	Low	Short term	**Very Low**	Possible	**Insignificant**

5.3 Terrestrial Ecological Impact Mitigation and Management Recommendations

In terms of Section 2 and Section 28 of NEMA (National Environmental Management Act, 1998), the land owner is responsible for any environmental damage, pollution or ecological degradation caused by their activities "inside and outside the boundaries of the area to which such right, permit or permission relates". In dealing with the range of potential ecological impacts to natural ecosystems and biodiversity highlighted in this report, this would be best achieved through the incorporation of the management & mitigation measures (recommended in Sections 5.3 of this report) into the Construction **Environmental Management Programme (EMPr**) for the development project. The EMPr should be separated into construction & operational phase.

The EMPr should define the responsibilities, budgets and necessary training required for implementing the recommendations made in this report. This will need to include appropriate monitoring as well as impact management and the provision for regular auditing to verify environmental compliance. The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance. The ECO will need to be responsible for conducting regular site-inspections of the construction process and activities and reporting back to the relevant environmental authorities with findings of these investigations. The ECO will also need to be responsible for preparing a monitoring programme to evaluate construction compliance with the conditions of the EMPr.

5.3.1 *Sensitive Terrestrial Areas & Biodiversity Buffer Zones*

No sensitive/core terrestrial habit was identified within the study area that is currently being used by terrestrial species (flora/fauna) of conservation importance. Based on this and the fact that the proposed developed will have a negligible impact on biodiversity, terrestrial biodiversity buffer zones are not applicable to this project and context.

5.3.2 *Construction Phase Impact Mitigation Measures*

Mitigation measures and site controls specific to the terrestrial ecological impacts identified and discussed in this report have been provided below and are intended to augment standard mitigation measures included in the construction EMPr.

1. Finalisation of Plans

- An EMPr must be compiled for the construction phase by an environmental assessment practitioner and the EMPr must incorporate all below listed mitigation measures.
- A rehabilitation plan must be in place prior to commencement with construction.

2. Defining the Extent of the Construction Footprint and No-Go areas

- In order to minimise the loss of habitat degradation and loss, the width of the construction corridor[16] particularly through the Wooded Grassland and along the Scarp Thicket 2 should be minimised as far as practically possible. Ideally the construction corridor must be 6m including a 3m width for access, 1m wide trench and 2m for stockpiling.
- The width / extent of the construction corridor through other vegetation communities must be finalised prior to construction commencing and must form part of the EMPr.
- Furthermore, laydown and storage, and soil / road material stockpile areas must accommodated with the construction corridor.

3. Demarcation of the Construction Corridor & No-Go Areas

- The construction corridor within the Wooded Grassland and along the Scarp Thicket 2 will need to be demarcated using highly visible material e.g. danger tape or an orange hazard fence.
- Any trenches left open overnight will need to be demarcated using highly visible material e.g. danger tape or an orange hazard fence.
- Terrestrial areas outside of the construction corridor are to be considered sensitive 'No-Go' areas. Access through and construction activities within the No-Go areas are strictly prohibited in these areas and need to be strictly controlled. **Any contractors found working inside the no-go areas should be fined as per fining schedule/system setup for the project.**
- Do not paint or mark any natural feature. Marking for surveying and other purposes must be done using pegs, beacons or rope and droppers.
- Maintain site demarcations in position until the cessation of construction works.
- Access must be confined to the existing road infrastructure where possible and disturbed areas within the study area.
- All demarcation work must be signed off by the ECO before any work commences.

4. Accidental Incursions into 'No-Go' Areas

- All disturbed terrestrial areas beyond the construction corridor that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO.

[16] *Area required to be physically cleared, reshaped and/or infilled as part of the construction and establishment of the proposed pipeline.*

- Where adjoining areas have been disturbed, there should re-vegetated as per the relevant re-vegetation/re-planting plan.

5. Managing the Extent of Disturbance

- Vegetation removal/stripping must be limited to the construction footprint. No areas outside the construction corridor may be cleared.
- **Grubbing is not permitted as a method of clearing vegetation**. Any trees needing clearing must be cut down using chain saws and hauled from the site using appropriate machinery.
- Vegetation clearing/stripping must only be done as the construction front progresses.
- No clearing of indigenous vegetation outside of the defined working servitudes is permitted for any reason (i.e. for fire wood or medicinal use).

6. Protection of Conservation-important Flora (plants)

- Prior to commencement of construction, a qualified and skilled botanist must be appointed to survey the construction corridor within the Wooded Grassland, identify all conservation importance species and apply for necessary permits and licences to cut, disturb, damage, destroy, remove or translocate them.
- Demarcate areas identified as harbouring protected plants using suitable measures (such as fencing these areas or using perimeter stakes with high visibility/barrier tape for example).
- The commencement of construction must be preceded by a plant rescue programme which must be conducted only when plant permits and licences have been issued by the relevant authority.
- Conservation-important plants falling just outside the construction footprint must be fenced off to minimise any accidental impacts such as destruction.
- No material storage or laydown is permitted under trees.
- No heavy equipment, machinery and vehicles may be parked under any tree, unless authorized by the ECO.
- No open fires to be permitted outside of designated areas.
- No harvesting of plants for firewood, medical purposes or other uses is to be permitted.

7. Alien plant/weed control

- All invasive alien plants that have colonised the construction site must be removed, preferably by uprooting.
- All bare surfaces across the construction site must be checked for IAPs every two weeks and IAPs removed by hand pulling/uprooting and adequately disposed.
- Herbicides should be utilised where hand pulling/uprooting is not possible.

8. Wildlife Management

- Education of workers/employees onsite on not to harm wildlife unnecessarily will assist in mitigating this impact. Contractor induction and staff/labour environmental awareness training needs are to be identified and implemented through staff/contractor environmental induction training. This should include basic environmental training based on the requirements of the EMPr, including training on avoiding and conserving local wildlife.
- No wild animal may under any circumstance be hunted, snared, captured, injured, killed, harmed in any way or removed from the site. This includes animals perceived to be vermin (such as snakes, rats, mice, etc.).
- Any fauna that are found within the construction zone must be moved to the closest point of natural or semi-natural habitat outside the construction corridor.
- The handling and relocation of any animal perceived to be dangerous/venomous/poisonous must be undertaken by a suitably trained individual.
- All vehicles accessing the site should adhere to a low speed limit to avoid running over susceptible species such as reptiles (snakes and lizards).
- No litter, food or other foreign material should be disposed of on the ground or left around the site or within adjacent natural areas and should be placed in demarcated and fenced rubbish and litter areas that are animal proof.
- Ensure that workers accessing the site conduct themselves in an acceptable manner while on site, both during work hours and after hours.
- Temporary noise pollution should be minimized by ensuring the proper maintenance of equipment and vehicles, and tuning of engines and mufflers as well as employing low noise equipment where possible.

9. Fire Management

- No open fires to be permitted on construction sites. Fires may only be made within the construction camp and only in areas and for purposes approved by the ECO.
- Fire prevention facilities must be present at all hazardous storage facilities.
- Ensure adequate fire-fighting equipment is available and train workers on how to use it.
- Ensure that all workers on site know the proper procedure in case of a fire occurring on site.
- Smoking must not be permitted in areas considered to be a fire hazard.

10. Rehabilitation

- Close and backfill all trenches and compact soil.
- Remove all waste and rubble.
- Close any erosion features created during construction.
- Revegetate via seeding or planting of plugs of fast colonising indigenous runner grasses such as *Cynodon dactylon, Chloris gayana* and *Stenotaphrum secundatum*.

- No exotic plants to be used in revegetation.

5.3.3 *Operational Phase Impact Mitigation Measures*

A. Undertaking repair work

All maintenance and repair work to will need to comply with recommendations and guidelines provided for the construction phase. Please refer to Sections 5.3.1.

B. Alien Plant/Weed Monitoring and Control

In line with the requirements of the NEM:BA, which obligates the landowner/developer to control IAPs on his property, it is recommended that IAPs be controlled or eradicated where necessary according to the legislation, on an on-going basis.

6 ENVIRONMENTAL LICENSING AND PERMIT REQUIREMENTS

6.1 Water Use Licensing Requirements

6.1.1 Water Uses

Section 21 of the National Water Act No. 36 of 1998 (NWA) lists certain activities that constitute water uses that must be licensed prior to construction commencing, unless the use is excluded. There are several reasons why water users are required to register and license their water use with the Department of Water & Sanitation (DWS), the most important being: (i) to manage and control water resources for planning and development; (ii) to protect water resources against over-use, damage and impacts and (iii) to ensure fair allocation of water among users.

Depending on the nature of the development and water use, Section 21 (c) and (i) water uses described in Table 40 (below) could potentially be triggered by the development (and associated activities) and would then require a Water Use License (WUL) from the DWS. Given that planned development activities will cross a number of watercourses, such activities constitute Section 21 (c) and (i) water uses that would require water use authorisation in the form of a Water Use Licence Application (WULA) through the DWS. A description of the applicable activities that are likely to constitute water uses is provided in Table 40, below. Figure 17 show the location of watercourse crossing which constitute water uses. Note that watercourse crossings 4 - 7 are within the 1:100 year floodline (Figure 17). Section 21 (a) water use was not defined (taking water from a watercourse).

Table 40. Water uses relevant to the proposed development.

No.	Water Uses[17]	Description	Unit ID	Length of crossing (m)	GPS Coordinates
1	Section 21 (c) & (i)	Construction of the pipeline across the head the wetland unit.	W01	12m	29°36'46.65"S 31° 3'12.83"E
2	Section 21 (c) & (i)	Construction of the pipeline 25m below the toe of the wetland unit.	W02	N/A	29°36'57.46"S 31° 3'31.98"E
3	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit.	W03-A	200m	29°37'0.62"S 31° 3'38.96"E
4	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River.	W03-B	50m	29°37'3.59"S 31° 3'42.90"E
5	Section 21 (c) & (i)	Construction of the pipeline 44m from the edge of the river unit but within the 1:100 year floodline of the Mdloti River.	R01-A	N/A	29°37'9.76"S 31° 3'39.66"E

[17] ***Section 21(c): Impeding or diverting the flow of water in a watercourse:*** *This water use includes the temporary or permanent obstruction or hindrance to the flow of water into watercourse by structures built either fully or partially in or across a watercourse; or a temporary or permanent structure causing the flow of water to be re-routed in a watercourse for any purpose.*

Section 21(i): Altering the bed, banks, course or characteristics of a watercourse: *This water use relates to any change affecting the resource quality of the watercourse (the area within the riparian habitat or 1:100 year floodline, whichever is the greatest).*

No.	Water Uses[17]	Description	Unit ID	Length of crossing (m)	GPS Coordinates
6	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River	W04-B	75m	29°37'20.04"S 31° 3'38.64"E
7	Section 21 (c) & (i)	Strapping of the pipeline to an existing pipe bridge & trenching of pipeline in the vicinity of the river unit and within the 1:100 year floodline of the Mdloti River.	R01-B	N/A	29°37'38.89"S 31° 3'8.39"E

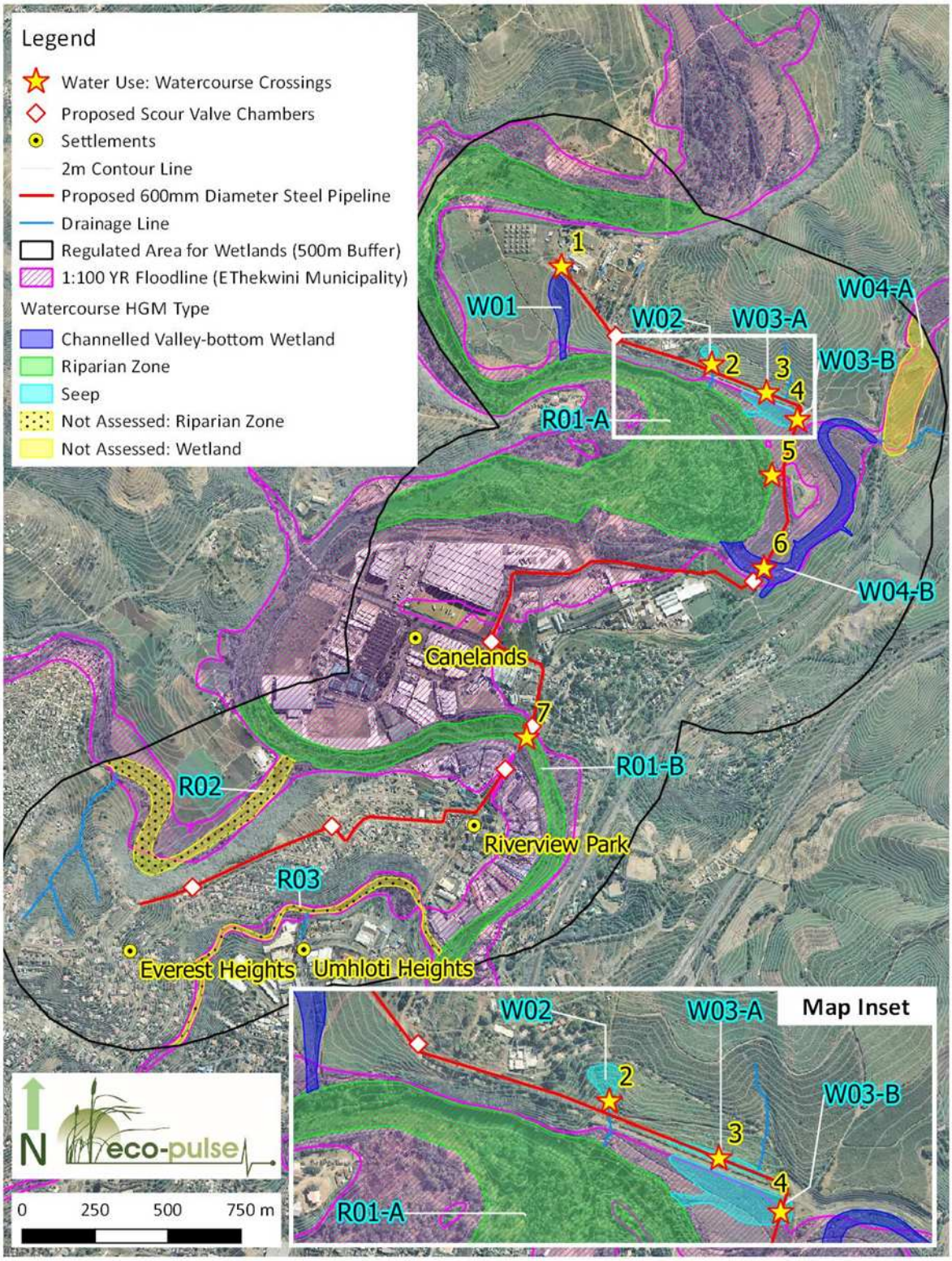


Figure 17 Map showing watercourse crossings 1 – 7 which constitute Section 21 (c) and (i) water uses.

6.1.2 Aquatic Risk Assessment

The recent General Authorisation (GA) in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (C) or Section 21 (I), (as contained in Government Gazette No. 40229, 26 August 2016) replaces the need for a water user to apply for a license in terms of the National Water Act No. 36 of 1998, '*provided that the water use is within the limits and conditions of the GA*'. Note that the GA does not apply to:

1. Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
2. Use of water within the 'regulated area'[18] of a watercourse where the Risk Class is **Medium or High.**
3. Where any other water use as defined in Section 21 of the NWA must be applied for.
4. Where storage of water results from Section 21 (c) and/or (i) water use.
5. Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: '*Section 21 (c) and (i) water use Risk Assessment Protocol*') was applied to the proposed construction and operation of the water pipeline in order to determine the risk level of the project. The summary of the results of the assessment indicate that the construction and operational activities qualify as a low risk activity because affected watercourses are highly degraded, lack sensitive habitats, lack conservation important aquatic biota and are therefore unlikely to be significantly modified as a result of the construction and operation of the proposed pipeline. **This implies that the proposed project qualifies for authorisation under the provisions of a GA** (Table 41).

[18] *The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:*

i. The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.
ii. In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).
iii. A 500m radius from the delineated boundary of any wetland or pan.

Table 41. Summary of the DWS Risk Matrix/Tool assessment results applied to the proposed Verulam water pipeline upgrade project.

Phase & Activity	Aspect	Impacts	Risk Rating	
			Risk Rating[19]	Mitigation
Construction Phase: *Undertaking construction of the pipeline and associated infrastructure (vegetation stripping, trenching and soil stockpiling, dewatering, pipeline installation & construction of scour chambers)*	1. Planned or accidental physical disturbance to watercourses (infilling, excavation, clearing etc. at crossings)	• Destruction of freshwater vegetation and habitat. • Sedimentation of downstream habitat and associated ecological impacts. • Destruction or modification of bed and bank profiles. • Proliferation of alien plants and associated impact on vegetation communities	**45 Low**	Onsite BMPs, post-construction rehabilitation
	2. Soil stockpiling	• Sedimentation of downstream watercourses and associated ecological impacts.	**33 Low**	Onsite BMPs, post-construction rehabilitation
	3. Temporary impedance or diversion of flows	• Altered natural flows for a period of time. • Increased habitat inundation and change in flow patterns with associated ecological impacts. • Increased erosion and associated impacts.	**39 Low**	Onsite BMPs regarding flow diversion
	4. Dewatering of trenches	• Increased soil saturation. • Increased rates of erosion and associated ecological impacts.	**30 Low**	Onsite BMPs regarding dewatering
	5. Accidental spills & mis-management of potential pollution-causing substances	• Watercourses pollution, deterioration in local water quality and associated ecological impacts.	**40 Low**	Onsite BMPs, post-construction rehabilitation
Operational Phase: *Operation of pipeline (conveyance of raw water)*	1. Planned or accidental physical disturbance to watercourses (from pipeline maintenance)	• Destruction of freshwater vegetation and habitat • Sedimentation of downstream habitat and associated ecological impacts • Destruction or modification of bed and bank profiles • Proliferation of alien plants and associated impact on vegetation communities	**38 Low**	Post-construction monitoring & Onsite BMPs
	2. Leakage of pipeline	• Increased soil saturation. • Increased erosion and associated sedimentation impacts.	**40 Low**	Planning and design + monitoring

[19] *Risk assessed based on the application of standard mitigation measures (i.e. standard project design and application of standard EMPr mitigation).*

6.1.3 Conditions of the GA

Note that conditions set for Section 21 (c) and (i) water use in terms of the GA specify that the water user must ensure that compliance with the following is achieved:

a. Impeding or diverting flow or altering the characteristics of a watercourse does not detrimentally affect other water users, property, health and safety of the general public or the resource quality.
b. The existing hydraulic, hydrologic, geomorphic and ecological functions of the watercourse in the vicinity of the structure is maintained or improved upon.
c. Full financial provision for the implementation of the management measures prescribed in the GA, including an annual financial provision for any future maintenance, monitoring, rehabilitation or restoration works (as may be applicable).
d. Construction camps, storage, washing and maintenance of equipment, storage of construction materials or chemical, sanitation and waste management facilities are located outside of the 1:100yr flood line or riparian habitat of a river, spring, lake, dam or outside any drainage feeding any wetland or pan and is removed within 30 days of completion of any works.
e. The site where water use will occur must not be located on a bend in the watercourse, must avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs and seeps; avoid or minimise realignment of a watercourse, minimise the footprint of alteration and construction footprint.
f. A maximum impact footprint around the works must be established, clearly demarcated, no vegetation cleared or damaged beyond this demarcation and equipment/machinery only operated within the delineated impact footprint.
g. Minimise the duration of disturbance and the footprint of disturbance of the bed and banks of the watercourse.
h. Prevent the transfer of exotic biota to the site.
i. All works must start upstream and proceed in a downstream direction to ensure minimal impact on the water resource.
j. Excavated material from the bed or banks of a watercourse must be stored appropriately and returned to the original locations upon completion of the works.
k. Adequate erosion control measures are to be implemented at and near all alterations, with an emphasis on erosion control on steep slopes and drainage lines.
l. Alteration or hardened surfaces must be structurally stable, not induce sedimentation, erosion or flooding, not cause a detrimental change in the quantity, velocity, pattern, timing, water level, water quality, stability or geomorphological structure of a watercourse, or cause nuisance or health or safety hazards.
m. Measures are undertaken to protect the breeding, nesting or feeding patterns of aquatic biota (including migratory species), allow for the continued movement of biota up and

downstream and prevent a decline in the composition and diversity of indigenous and endemic aquatic biota.

n. Ensure that no substance or material that can potentially cause pollution of the water resource is being used in works.
o. Measures are undertaken to prevent increased turbidity, sedimentation and detrimental chemical changes to the composition of the water resource.
p. Instream water quality is to be measured on a weekly basis during construction (includes pH, EC/TDS, TSS/Turbidity, DO) both upstream and downstream of the works.
q. In-stream flow is to be measured on an on-going basis by means of instruments and devices certified by the SABS, with a baseline measurement at least one week prior to initiation of the works.
r. One or more photographs or video-recordings must be taken of the watercourse and its banks at least 20m upstream and 20m downstream from the structure/works. These must be taken on a daily basis, starting one week before commencement of any works and continuing of one month upon completion.

Furthermore:

- Rehabilitation[20] authorised in terms of the GA (i.e. where risk is deemed "Low") must be conducted in terms of a rehabilitation plan, with implementation overseen by a suitably qualified SACNASP registered professional natural scientist.
- Upon completion of construction activities, a systematic rehabilitation programme must be undertaken to restore the watercourse to its condition prior to the commencement of the water use. All disturbed areas must be re-vegetated with indigenous vegetation suitable to the area.
- Active alien invasive plant control measures must be implemented to prevent invasion buy exotic and alien vegetation within the disturbed area.
- Upon completion of any works, during any annual inspection to determine the need for maintenance at any impeding or diverting structure, disturbed areas are to be cleared of construction debris/blockages, alien invasive vegetation, must be re-shaped to free-draining and non-erosive contours and r re-vegetated with indigenous vegetation suitable to the area.
- Upon completion of any works, the hydrological functionality and integrity of the watercourse (bed, banks, riparian habitat and aquatic biota) must be equivalent or exceed that which existed before commencing with the works.

[20] 'Rehabilitation' means the process of reinstating natural ecological driving forces within part or the whole of a degraded watercourse to recover former or desired ecosystem structure, function, biotic composition and associated ecosystem services.

- The water user must establish and implement monitoring programmes to measure the impact on resource quality to ensure water use remains within the parameters in terms of water quality and quantity (maintaining instream flow).
- Baseline monitoring to be undertaken to determine 'present day values' for water resource quality before commencement of water use.
- Upon completion of construction activities, an Environmental Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages, instabilities and erosion with remedial and maintenance actions where required.
- Audits to be undertaken annually for three years to ensure that the rehabilitation is stable.

6.2 Protected Plant Permits

Three (3) protected plant species were identified within the study area including two (2) specially protected plant species under Schedule 12 of the Natal Nature Conservation Ordinance, No. 15 of 1974: *Aloe arborescens and Ledebouria sp. (L. revoluta or L. floribunda)* and a single nationally protected tree: *Sclerocarya birrea subsp. caffra*. under Section 15(1) of the National Forests Act. Specially protected plants require an Ordinary Permit from Ezemvelo KZN Wildlife whilst nationally protected trees require a licence in terms of protected trees from the Department of Agriculture, Forestry and Fisheries (DAFF) if they are to be handled in any manner (translocation, destruction, cutting down, pruning etc.). Basic information on all protected plants is provided in Table 42 and their locality within the study area is shown spatially in Figure 18.

Table 42. Basic information on identified conservation-important plant species.

Botanical name	Common name	Plant type	Applicable legislation	Conservation status
Aloe arborescens	Krantz Aloe	Succulent shrub	Natal Nature Conservation Ordinance, No. 15 of 1974	Least Concern / **Specially protected in KZN**
Ledebouria sp. (either L. revoluta or L. floribunda)	N/A	Herb		
Sclerocarya birrea subsp. caffra	Marula tree	Tree	National Forest Act	Least Concern **Nationally Protected Tree**

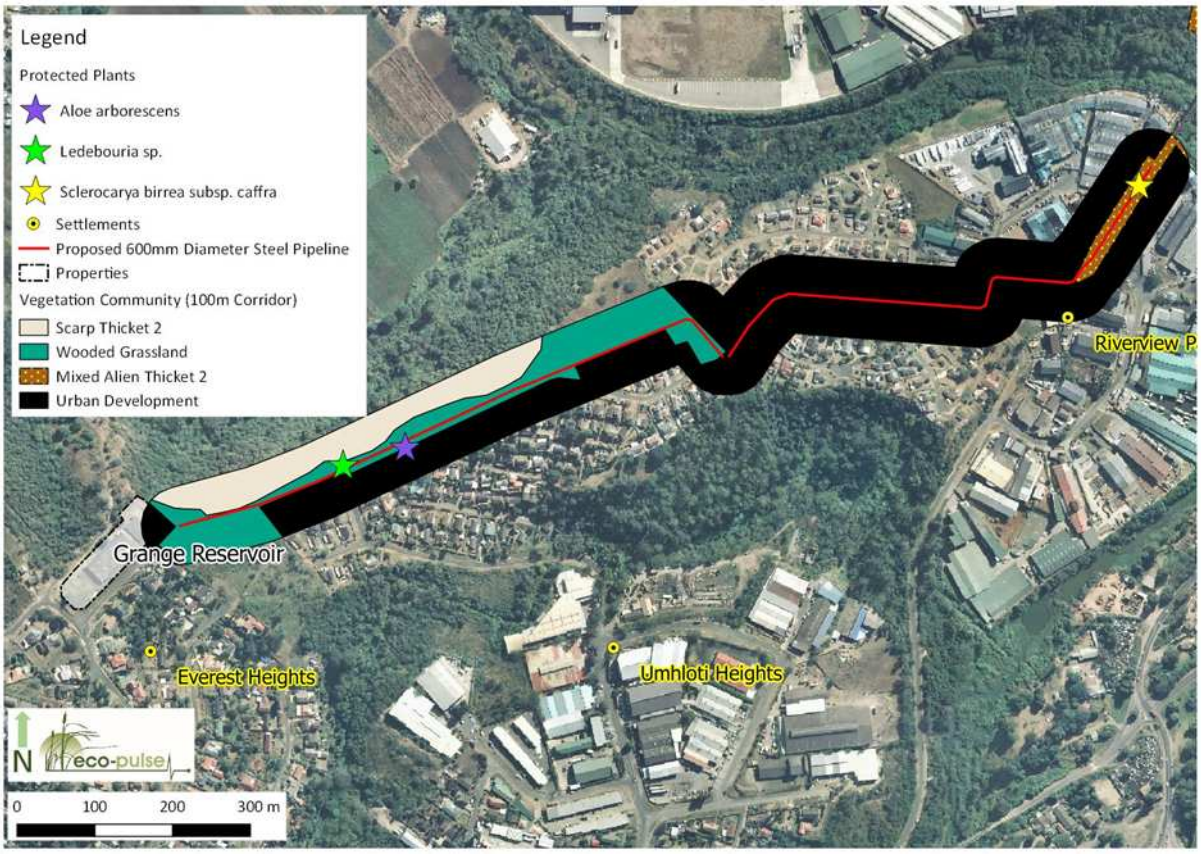


Figure 18 Location of protected plant species identified within the study area.

Below are selected photographs of some of the recorded protected plant species:

Photo 22: *Aloe arborescens* (Krantz Aloe).

Photo 23: *Ledebouria sp. (either L. revoluta or L. floribunda).*

Photo 24: *Sclerocarya birrea* subsp. *caffra* (Marula)

7 FURTHER RECOMMENDATIONS

Based on the outcomes of this assessment, a number of additional tasks have been identified and will be required to be undertaken for the project to satisfy the environmental legislative requirements:

i. A **construction method statement** will need to be developed for trenching and pipeline removal and installation based on the recommendations contained in this specialist report. The method statement must address flow diversion requirements during construction and post-construction rehabilitation.

ii. A **plant rescue and translocation programme** must be established to salvage all protected plants falling within the construction corridor. This must include a plant search and rescue and applications for plant permits prior to commencement of construction.

8 CONCLUSION

This combined Specialist Freshwater & Terrestrial Habitat Impact Assessment was undertaken to inform the EIA process and WULA for the proposed upgrade and re-routing of a 600mmØ rising main from Hazelmere Water Treatment Works to Grange Reservoir in Verulam, eThekwini Municipality, KwaZulu-Natal.

The main findings of the assessment indicate that numerous wetlands and rivers stand to be potentially negatively impacted by the project and also require a water use license prior to construction taking place. Wetlands and rivers were found to be in a Largely Modified ("D" PES Category) to Seriously Modified condition ("E" PES Category) as a result of numerous existing onsite and catchment related impacts (associated with sugarcane cultivation, development and dams) affecting watercourse condition and functioning, with only the Mdloti River being moderately functionally important and considered to be of moderate EIS (Ecological Importance & Sensitivity). The Recommended Management Objective (RMO) for the watercourses affected by the project should be to 'maintain current PES'. The assessment of terrestrial vegetation communities highlighted only a Scarp Thicket (sub-community 2) to be the most notably important as reflected by the 'moderately modified' and rating of 'moderately EIS' whilst other vegetation communities were found to be transformed/heavily modified by cultivation, development and alien plant infestations and assessed as being of relatively low importance and sensitivity.

Overall, the significance of the ultimate ecological consequences associated with the development construction and operational phases were assessed as being of 'Low' significance under a 'poor/standard mitigation' scenario and can be easily mitigated/managed, which is likely to reduce significance to an overall 'Very Low' level under a 'good/best practical mitigation' which is deemed acceptable from an aquatic and terrestrial ecological perspective. As such, no fatal flaws were identified for the various phases of the proposed development. Potential cumulative impacts associated with the project are also expected to be negligible as there will be no residual loss of aquatic habitat or functioning during both construction and operation where impacts are mitigated to acceptable levels and managed properly in accordance with the recommendations made in this report. Impact mitigation and management would be best achieved by incorporating the recommended environmental design, management & mitigation measures into an Environmental Management Programme (EMPr) for the site with appropriate rehabilitation and ecological monitoring recommendations also included.

Based on the above impact assessment summary, the proposed development can be considered acceptable from both an aquatic and terrestrial ecological perspective if various mitigation measures proposed in this report are strictly adhered to during the various phases of the project. It however recommended that the relevant sections of this report which deal with 'Impact

Mitigation/Management' be referenced in the Environmental Authorisation (EA) and Water Use Licence (WUL) for this project as a specific condition of the EA and WUL.

Also, given the low risk potential of the development, which was confirmed by application of the DWS Aquatic Risk Assessment tool, the proposed development effectively qualifies for authorisation under the provisions of a General Authorisation (GA) in terms of the requirement for water use licensing.

Finally, should the following species: *Aloe arborescens* and *Ledebouria sp*. (either *L. revoluta or L. floribunda*) and *Sclerocarya birrea* subsp. *caffra* identified within some of the terrestrial habtiats along the pipeline development corridor be handled in any manner (translocation, destruction, cutting down, pruning etc.), an Ordinary Permit from Ezemvelo KZN Wildlife will be required for the *Aloe* and *Ledebouria* whilst a licence in terms of protected trees from the Department of Agriculture, Forestry and Fisheries (DAFF) for the *S. birrea* subsp. *caffra*.

Should you have any queries regarding the findings and recommendations in this combined Specialist Freshwater and Terrestrial Habitat Impact Assessment report, please contact Eco-Pulse Environmental Consulting Services directly.

Yours sincerely

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10 ANNEXURES

ANNEXURE A: Detailed Assessment Methods.

A1 Wetland/Riparian Areas Delineation

A. Wetland delineation

The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005). Three specific wetland indicators were used in the detailed field delineation of wetlands, which include:

i. Terrain unit indicator

A practical index used for identifying those parts of the landscape where wetlands are likely to occur based on the general topography of the area.

ii. Wetland vegetation indicator

Vegetation in an untransformed state is a useful guide in finding the boundary of a wetland as plant communities generally undergo distinct changes in species composition as one proceeds along the wetness gradient from the centre of a wetland towards adjacent terrestrial areas. An example of criteria used to classify wetland vegetation and inform the delineation of wetland zones is provided in Table 43.

Table 43. Criteria used to inform the delineation of wetland habitat based on wetland vegetation (adapted from Macfarlane *et al.,* 2008 and DWAF, 2005).

Vegetation	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
Herbaceous	Mixture of non-wetland species and hydrophilic plant species restricted to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Emergent plants including reeds and bulrushes; floating or submerged aquatic plants
Woody	Mixture of non-wetland and hydrophilic species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas with morphological adaptations to prolonged wetness (e.g.: prop roots)
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

iii. Soil wetness indicator

According to the wetland definition used in the National Water Act (NWA, 1998), vegetation is the primary indicator which must be present under normal circumstances. However, in practice the soil wetness indicator (informed by investigating the top 50cm of wetland topsoil) tends to be the most important, and the other three indicators are used to refine the assessment. The reason for this is that vegetation responds relatively quickly to changes in soil moisture and may be transformed by local impacts; whereas the soil morphological indicators are far more permanent and will retain the signs of frequent saturation (wetland conditions) long after a wetland has been transformed/drained (DWAF, 2005). Thus the on-site assessment of wetland indicators focused largely on using soil wetness indicators, determined through soil sampling with a soil auger, with vegetation and topography being a secondary indicator. Soil sampling points were recorded using a GPS (Global Positioning System) and captured using Geographical Information Systems (GIS) for further processing. An example of soil criteria used to assess the presence of wetland soils is provided below in Table 44 while Figure 19 provides a conceptual overview of soil and vegetation characteristics across the different wetness zones.

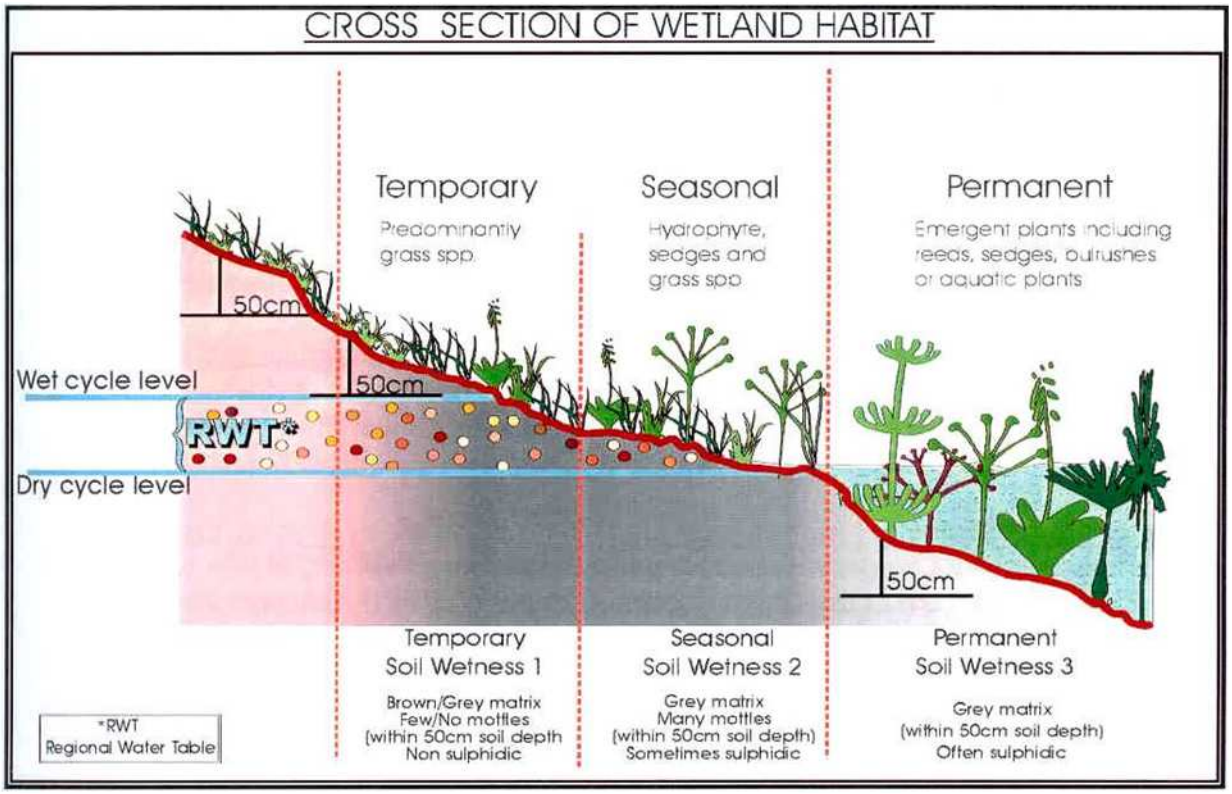


Figure 19 Diagram representing the different zones of wetness found within a wetland (DWAF, 2005).

Table 44. Soil criteria used to inform wetland delineation using soil wetness as an indicator (after DWAF, 2005).

Soil depth	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone

0 – 10cm	**Matrix chroma**: 1- 3 (Grey matrix <10%) **Mottles**: Few/None high chroma mottles **Organic Matter**: Low **Sulphidic**: No	**Matrix chroma**: 0- 2 (Grey matrix >10%) **Mottles**: Many low chroma mottles **Organic Matter**: Medium **Sulphidic**: Seldom	**Matrix chroma**: 0- 1 (Prominent grey matrix) **Mottles**: Few/None high chroma mottles **Organic Matter**: High **Sulphidic**: Often
30 – 50cm	**Matrix chroma**: 0 – 2 **Mottles**: Few/Many	As Above	As Above

B. Delineation of riparian areas

The location of drainage features and boundary of any riparian areas (also known as the riparian zone) was delineated according to the methods in the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005*)*. According to the manual, this involves marking the outer edge of the macro-channel bank and associated vegetation. Like wetlands, riparian areas have their own unique set of indicators required in order to delineate these features. Delineation of riparian areas generally requires that the following be taken into account:

- **Topography associated with the watercourse**: the outer edge of the macro-channel bank associated with a river/stream provides a rough indication of the outer edge of a riparian area.
- **Vegetation**: this is the primary indicator of a riparian area, whereby the edge of the riparian zone is defined as the zone where a distinctive change in species composition and physical structure occurs between those of surrounding/adjacent terrestrial areas. In this case a combination of aerial photography analysis and on-site field information (pertaining to the vegetation health, compactness, crowding, size, structure and numbers of individual plants) was used to differentiate between riparian and terrestrial vegetation.
- **Alluvial soils and deposited material**: this includes relatively recently deposited sand, mud, etc. deposited by flowing water that can be used to confirm the topographical and vegetation indicators.

A2 Classification of wetlands, rivers and streams

For the purposes of this study, wetlands were classified according to HGM (hydro geomorphic) type (Level 4A classification level) using the National Wetland Classification System which was developed for the South African National Biodiversity Institute (Ollis *et al.,* 2013) as outlined in Table 45 below.

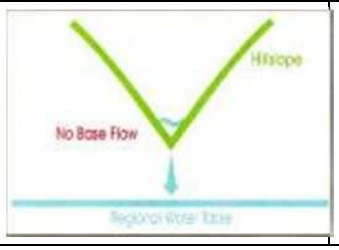
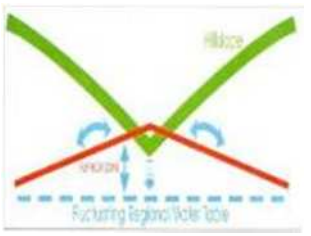
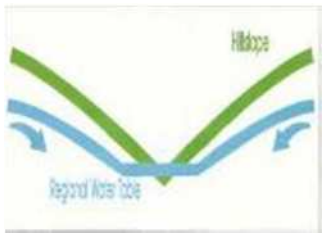
Table 45. Wetland classification (based on Ollis *et al.,* 2013).

LEVEL 3	LEVEL 4A	
Landscape Setting	**HGM Type**	**Description**
SLOPE	Channel (river)	*Areas of channelled flow including rivers and streams where water is largely confined to a main channel during low flows. Flood waters may over top the banks of the channel and spread onto an adjacent floodplain*
	Hillslope seep	*Wetlands on slopes formed mainly by the discharge of sub-surface water.*
VALLEY FLOOR	Channel (river)	*River channels in a valley floor setting.*
	Channelled valley-bottom wetland	*Valley floors with one or more well-defined stream channels, but lacking characteristic floodplain features.*
	Unchannelled valley-bottom wetland	*Valley floors with no clearly defined stream channel.*
	Floodplain wetland	*Valley floors with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbows and natural levees.*
	Depression	*Basin-shaped areas that allow for the accumulation of surface water, an outlet may be absent (e.g. pans).*
	Valleyhead seep	*Seeps located at the head of a valley, often the source of streams.*
PLAIN	Channel (river)	*River channels in a plain landscape setting.*
	Floodplain wetland	*Floodplain wetlands as above but in a plain landscape setting.*
	Unchannelled valley-bottom wetland	*Unchannelled valley bottom type wetlands as above but in a plain landscape setting.*
	Depression	*Depression type wetlands as above but in a plain landscape setting.*
	Flat	*Extensive areas characterised by level, gently undulating or uniformly sloping land with a very gentle gradient.*
BENCH (HILLTOP / SADDLE / SHELF)	Depression	*Depression wetlands located on a bench.*
	Flat	*Flat wetlands located on a bench.*

River and stream channels within the project areas were mapped in GIS using a combination of digital satellite imagery in conjunction with GPS points and data captured in the field. The classification of channels was based on the nature of flows through the channel (Table 46).

Table 46. Classification of channels according to nature of flows.

	CHANNEL SECTION (CLASS)		
	"A" type	**"B" type**	**"C" type**
	Ephemeral systems	**Weakly ephemeral to seasonal systems**	**Perennial systems**

DESCRIPTION	A water-course that has no riparian habitat and no soil hydromorphy (ie. strongly ephemeral systems). Signs of wetness rarely persist in the soil profile	A water-course with riparian vegetation/habitat and intermittent base flow (ie. weakly ephemeral to non-perennial/seasonal systems). These channels show signs of wetness indicating the presence of water for significant periods of time.	A water-course with permanent-type riparian vegetation/habitat, permanent base flow and permanent inundation (ie. perennial systems).
HYDROLOGY	A-section channels are situated well above the zone of saturation (no direct contact between surface water system and ground water system) and hence do not carry base-flows . They do however carry storm water runoff following intense rainfall events (ephemeral), but this is generally short-lived.	Channel bed situated within the zone of the seasonally fluctuating regional water table (ie. intermittent base flow depending on water table). Periods of no flow may be experienced during dry periods, with residual pools often remaining within the channel.	Water course is situated within the zone of the permanent saturation, meaning flow is all year round except in the case of extreme drought.
TOPOGRAPHICAL POSITION	Valley head (upper reaches of catchments). Channel type also linked to steep slopes which are responsible for water leaving the system rapidly.	Mid-section of valley (middle reaches of catchments).	Valley bottom areas (middle to lower reaches of catchments).
DIAGRAM			

A3 Present Ecological State (PES) Assessment for wetlands: WET-Health

The qualitative/rapid wetland health assessment tool used in this assessment was adapted from the Level 1 WET-Health tool (Macfarlane *et al.*, 2008) which provides an appropriate framework for undertaking an assessment to indicate the functional importance of the wetland system that could be impacted by the proposed development. The assessment also helps to identify specific impacts thereby highlighting issues that should be addressed through mitigation and rehabilitation activities. While this is a rapid assessment, we regard it as adequate to inform an assessment of existing impacts on wetland condition. This approach relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:

- ***Hydrology*:** defined as the distribution and movement of water through a wetland and its soils.
- ***Geomorphology*:** defined as the distribution and retention patterns of sediment within the wetland.
- ***Vegetation*:** defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have impacted upon wetland functioning or condition. While the impacts

considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 47). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component. The reader is encouraged to refer back to the tables below to help interpret the results presented in the site assessment.

Table 47. Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane et al., 2008).

IMPACT CATEGORY	DESCRIPTION	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table 48. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 48. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

PES CATEGORY	DESCRIPTION	RANGE
A	Unmodified, natural.	0 – 0.9

B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9
E	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6 – 7.9
F	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 – 10

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

A4 Wetland Ecosystem Services (Functional) Importance Assessment

The supply of ecosystem goods and services of the wetland was assessed using an approach based on the WET-EcoServices assessment tool Kotze *et al.* (2009). This approach relies on a combination of desktop and on-site indicators to assess the importance of a range of common wetland ecosystem services as described in Table 49, below.

Table 49. Descriptions of common wetland ecosystem goods and services (after Kotze *et al.*, 2009).

ECOSYSTEM SERVICE	Description
Flood Attenuation	*Refers to the effectiveness of wetlands at spreading out and slowing down storm flows and thereby reducing the severity of floods and associated impacts.*
Stream Flow Regulation	*Refers to the effectiveness of wetlands in sustaining flows in downstream areas during low-flow periods.*
Sediment Trapping	*Refers to the effectiveness of wetlands in trapping and retaining sediments from sources in the catchment.*
Nutrient & Toxicant Retention and Removal	*Refers to the effectiveness of wetlands in retaining, removing or destroying nutrients and toxicants such as nitrates, phosphates, salts, biocides and bacteria from inflowing sources, essentially providing a water purification benefit.*
Erosion Control	*Refers to the effectiveness of wetlands in controlling the loss of soil through erosion.*
Carbon Storage	*Refers to the ability of wetlands to act as carbon sinks by actively trapping and retaining carbon as soil organic matter.*
Biodiversity Maintenance	*Refers to the contribution of wetlands to maintaining biodiversity through providing natural habitat and maintaining natural ecological processes.*
Water Supply	*Refers to the ability of wetlands to provide a relatively clean supply of water for local people as well as animals.*
Harvestable Natural Resources	*Refers to the effectiveness of wetlands in providing a range of harvestable natural resources including firewood, material for construction, medicinal plants and grazing material for livestock.*
Cultivated Foods	*Refers to the ability of wetlands to provide suitable areas for cultivating crops and plants for use as food, fuel or building materials.*
Food for Livestock	*Refers to the ability of wetlands to provide suitable vegetation as food for livestock.*

ECOSYSTEM SERVICE	Description
Cultural significance	*Refers to the special cultural significance of wetlands for local communities.*
Tourism & Recreation	*Refers to the value placed on wetlands in terms of the tourism-related and recreational benefits provided.*
Education & Research	*Refers to the value of wetlands in terms of education and research opportunities, particularly concerning their strategic location in terms of catchment hydrology.*

A level 2 (detailed) assessment was conducted that assessed a suite of services/benefits by assigning a score to each service based on a rating system that rates a range of pre-defined variables affecting the importance of services provided by the wetland system. The results are captured in tabular form as a list of services/goods with the level of supply and demand rated on a scale of 0 - 4. The following rating shown in Table 50 was used to describe the level of supply, demand and importance (integration of supply and demand).

Table 50. Classes for determining the likely level to which a service is being supplied or demanded.

Score	Supply/Demand/Importance Scores	Importance Description
0.0 – 0.5	Very Low	Not important
0.6 – 1.0	Low	Low importance
1.1 – 1.5	Moderately-Low	Moderately-low importance
1.6 – 2.4	Moderate	Moderately important
2.5 – 2.9	Moderately-High	Important
3.0 – 3.4	High	Very/highly important
3.5 – 4.0	Very High	Critically important

Since the importance of wetland goods and services is dictated not only by the supply (service availability) of a particular good/benefit but also on the need or demand (user requirement) for such a benefit, the overall importance of the ecosystem service is ultimately derived from a combination of supply and demand scores. For example, a wetland may supply a particular service at a high level; however this service may not be in great demand, limiting the importance of the benefit to society. The results of the assessment were therefore interpreted to reflect the perceived importance of each of the ecosystem goods and services assessed.

A5 Wetland Ecological Importance and Sensitivity (EIS) Assessment

The outcomes of the WET-Health and WET-EcoServices functional assessment were used to inform an assessment of the importance and sensitivity of wetland and river ecosystems using a Wetland EIS (Ecological Importance and Sensitivity) assessment tool developed by Eco-Pulse Consulting (2015). The Eco-Pulse Wetland EIS tool includes an assessment of the following components:

- Biodiversity maintenance supply (informed by biodiversity noteworthiness, PES and ecological viability of the habitat);
- Biodiversity maintenance demand (at a regional/national scale); and

- Sensitivity of the water resource (i.e. Biota, floods, low flows, sediment, water quality, erosion risk and edge disturbances)

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 51, below.

Table 51. Rating table used to rate EIS (Eco-Pulse, 2015).

EIS Score	EIS Rating
>3.4	Very High
3.0 - 3.4	High
2.5 - 2.9	Moderately-High
1.6 - 2.4	Moderate
1.1 - 1.5	Moderately-Low
0.6 - 1.0	Low
<0.6	Very Low

A6 Aquatic invertebrates sampling and analysis (SASS5)

The composition and structure of aquatic invertebrate communities provides a useful indication of the ecological condition of rivers. A variety of invertebrate organisms (e.g. insect larvae, snails, crabs, worms) require specific aquatic habitat types and water quality conditions for at least part of their life cycle. As most invertebrates are relatively short-lived and remain in one area during their aquatic life phase, they are particularly good indicators of localised conditions in a river over the short term (months). The South African Scoring System or SASS 5 (Dickens & Graham, 2002) is a rapid bio-assessment method for determining the health or condition of rivers based on sampling aquatic macroinvertebrate communities. It can be applied to river health and water quality monitoring (Dickens and Graham, 2002) and to gauge the ecological state of aquatic ecosystems (Thirion, 2007). This technique has been accredited to ISO17025 standards and forms part of one of the DWS river ecoclassification models for EcoStatus determination. The SASS is a relatively simple index that is based on the families of aquatic invertebrates present at the site. Generally depending on the occurrence of different aquatic taxa, which have different pollution tolerance ratings, each bio-indicator assessment provides an indication of the state of health of the river. The scores range on a scale from 1 to 15, with 1 assigned to taxa tolerant of poor or variable water quality and 15 assigned to taxa that are intolerant to poor or fluctuating water quality. Generally the higher the index (e.g. SASS score or ASPT) the better the health, or condition, of a river. Interpretation of the results obtained was done using the Ecological Categories or "Biological Bands" of Dallas (2007). The bands are region-specific aggregations of SASS score and ASPT Values into categories which indicate the condition or health of a reference site in that region. Higher SASS and ASPT values place the site into categories of better condition or health. The descriptions of the various bands are shown in Table 52, below.

Table 52. Biological bands or ecological categories used to define stream condition (Dallas, 2007).

Biological Band / Ecological Category	Ecological Category Name	Description
A	Natural	No or negligible modification of in-stream and riparian habitats and biota.
B	Good	Ecosystems essentially in good state; biodiversity largely intact
C	Fair	A few sensitive species may be lost; lower abundances of biological populations may occur.
D	Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer breed or alien species have invaded the ecosystem).
E/F	Seriously modified	Loss of habitat availability and high levels of pollution, result in few families being present due to the loss on most intolerant forms.

Site selection is important when using SASS5 as results are positively influenced when a diversity of aquatic habitats are sampled, although habitat poor rivers produce valuable results. Data cannot be interpreted independently but must be viewed in light of habitat availability, quality and diversity, and overall ecoregion and season (Dickens and Graham, 2002). Biotopes fall into three broad categories, namely vegetation, stones and GSM (gravel, sand and mud) which are further subdivided (Table 53).

Table 53. SASS5 sampling biotope groups (Dickens and Graham, 2002).

SASS Biotopes	Abbr.	Description
Stones in current	SIC	Stones in flowing water, may include bedrock
Stones out of current	SOOC	Stones out of any perceptible current (with visible silt seen accumulating on stone surfaces), may include bedrock
Marginal vegetation in current	MV-IC	Emerged and submerged vegetation in fast current, at the river's edge or on the edge of the in-channel islands
Marginal vegetation out of current	MV-OC	Emerged and submerged vegetation out of any perceptible current, at the river's edge or on the edge of the in-channel islands
Aquatic vegetation	AQV	Submerged or partially submerged vegetation within the channel, normally in flowing water
Gravel	G	Stones <2cm in diameter
Sand	S	Sand grains >2mm in diameter
Silt/Mud/Clay	M	Particles <0.06mm in diameter

A7 Fish assessment

Fish (ichthyofauna) sampling was undertaken downstream on the perennial Mdloti River using a 12 volt DC Samus 725G backpack electro-fisher at all available instream habitats. Fish were identified in-field (catch and release) and where identification was not possible, a sample was taken. This enabled a species record for the river system to be compiled. Endemic/threatened or particularly sensitive/vulnerable species and their relative abundance was noted. The Desktop Assessment component of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa (DWS, 2014) was used to assess the potential occurrence and sensitivity of fish species for the Mfolozi River reach assessed. The model is

based on the best available fish information, actual fish sample data and expert knowledge (available at http://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx).

A8 Water chemistry sampling and analysis

The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use or user (DWAF, 2001). In the context of this assessment, water quality refers to its fitness for maintaining a health aquatic ecosystems and its fitness for domestic users should there be any. Water quality results were compared to the Target Water Quality Range (TWQR) for aquatic ecosystems as set out by DWAF (1996). Table 54 below provides descriptions of the various TWQR effects on aquatic biota.

Table 54. Descriptions of Target Water Quality Range (TWQR) for aquatic ecosystems (DWAF, 1996).

Category	Description and effect
Target Water Quality Range (TWQR) for aquatic ecosystems	The Target Water Quality Range (TWQR) is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems, and should therefore ensure their protection.
Chronic Effect Value (CEV) for aquatic ecosystems	The Chronic Effect Value (CEV) is defined as that concentration or level of a constituent at which there is expected to be a significant probability of measurable chronic effects to up to 5 % of the species in the aquatic community. If such chronic effects persist for some time and/or occur frequently, they can lead to the eventual death of individuals and disappearance of sensitive species from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, since all components of aquatic ecosystems are interdependent.
Acute Effect Value (AEV) for aquatic ecosystems	The Acute Effect Value (AEV) is defined as that concentration or level of a constituent above which there is expected to be a significant probability of acute toxic effects to up to 5 % of the species in the aquatic community. If such acute effects persist for even a short while, or occur at too high a frequency, they can quickly cause the death and disappearance of sensitive species or communities from aquatic ecosystems. This can have considerable negative consequences for the health of aquatic ecosystems, even over a short period.

In situ physico-chemical water quality variables were measured and recorded at elected sites using a YSI Pro Series hand-held meter in addition to water samples which were collected analysis at a SANAS accredited laboratory, where necessary. These parameters were sampled to provide prevailing physico-chemical water quality, as well as to provide ancillary data to assist in the interpretation of aquatic macro-invertebrate (SASS) and fish data collected

A9 River Present Ecological State Assessment (IHI)

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "*maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region*" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

The IHI (Index of Habitat Integrity)1996, version 2 (Kleynhans, 2012) was used to assess habitat integrity and is based on an interpretation of the deviation from the reference condition for the river reach assessed and is approached from both an instream and riparian zone perspective. Specification of the reference state is followed by an impact-based approach, whereby the extent and intensity of anthropogenic impacts are interrogated to interpret the level of modification to the primary drivers of river health, namely hydrology, geomorphology and physic-chemical conditions. Naturally, the severity of impacts on habitat integrity will vary according to the natural characteristics of different rivers, with particular river types being inherently more sensitive to certain types of impacts than others. The IHI assessment involved the assessment and rating of a range of criteria for instream and riparian habitat (see Box 1, below) scored individually (using an impact magnitude rating scale from 0-10) using Table 55 as a guide. This assessment is informed by a site visit to a specific section or reach of the river but is refined based on a desktop review of reach and catchment-scale impacts based on available aerial photography and land cover information.

Table 55. Rating table used to assess impacts to riverine habitat.

Impact Class	Description	Score
A	Unmodified, natural.	90 – 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 – 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 – 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 – 19

Box 1. Criteria assessed in the Index of Habitat Integrity *(after* Kleynhans, 1996).

- ***Water abstraction:*** Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
- ***Flow modification*****:** Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
- ***Inundation*****:** Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al.*, 1992).
- ***Bed modification:*** This has a direct bearing on the amount and availability of substrate characteristics of available habitats. Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
- ***Bank erosion*****:** Decrease in bank stability will cause sedimentation and possible collapse of the river bank

resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

- ***Channel modification:*** May be the result of a change in flow which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included. Any densification of woody exotic species would lead to channel shape change through increased sediment deposits. This has serious implications for more extensive bank over-topping during flood events with increased scouring along outer edges of the Dry Bank. It is the extremes, i.e. drought or very wet events, which are particularly crucial sensitive periods to be considered.
- ***Water quality:*** Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
- ***Inundation:*** Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al.*, 1992).
- ***Exotic macrophytes:*** Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
- ***Exotic fauna***: The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
- ***Solid waste disposal***: A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
- ***Vegetation removal:*** Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing. Includes both exotic and indigenous vegetation.
- ***Exotic vegetation:*** Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone.
- ***Connectivity:*** Relates to changes that influence the movement of aquatic biota, both laterally onto adjacent floodplain areas and longitudinal movement upstream and downstream. These modifications can affect the life-history stage requirements and recolonization options for instream biota.

A10 River Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of riverine areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). For the purposes of this assessment, the EIS assessment for riparian areas was based on rating the following criteria using the scheme in Table 56.

Table 56. Rating scheme used to rate EIS for riparian areas.

CRITERIA	RATING SCORE				
	0	1	2	3	4
Presence of rare/endangered species	None	Low	Moderate	High	Very High
Presence of unique/endemic species					
Presence of species considered intolerant/sensitive to changes in flows/water quality					
Diversity of habitat types	Very Low	Low	Moderate	High	Very High
Presence of refugia/Refuge value of habitat types					
Habitat sensitivity to changes in flow					
Habitat sensitivity to changes in water quality					
Importance in terms of migration					

routes/ecological corridors					
Conservation importance	None	Low (Local level)	Moderate (Provincial level)	High (National level)	Very High (National/ International level)

The scores assigned to the criteria in Table 56 were used to rate the overall EIS of each mapped unit according to Table 57 which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane *et al*., 2008).

Table 57. EIS classes used to inform the assessment (after Kleynhans & Louw, 2007).

EIS Score	EIS Rating	General Description
0	None/ Negligible	Features that are highly transformed and have no ecological importance at any scale. Such features have a very low sensitivity to anthropogenic disturbances.
1	Very Low	Features are not ecologically important and sensitive at any scale. The biodiversity of these areas is typically ubiquitous with low sensitivity to anthropogenic disturbances and play an insignificant role in providing ecological services.
2	Low	Features regarded as somewhat ecologically important and sensitive at a local scale. The functioning and/or biodiversity features have a low-medium sensitivity to anthropogenic disturbances. They typically play a very small role in providing ecological services at the local scale.
3	Medium	Features that are considered to be ecologically important and sensitive at a local scale. The functioning and/or biodiversity of these features is not usually sensitive to anthropogenic disturbances. They typically play a small role in providing ecological services at the local scale.
4	High	Features that are considered to be ecologically important and sensitive at a regional scale. The functioning and/or biodiversity of these features are typically moderately sensitive to anthropogenic disturbances. They typically play an important role in providing ecological services at the local scale.
5	Very High	Features that are considered ecologically important and sensitive on a national or even international level. The functioning and/or biodiversity of these features are usually very sensitive to anthropogenic disturbances. This includes areas that play a major role in providing goods and services at a local or regional level.

A11 Impact Significance Assessment Method

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact (or resource being affected), and the likelihood / probability of the impact occurring. In light of this understanding, significance can only be assessed if one knows the importance or value of the environmental change/impact. Thus, end point or eventual impacts that can be valued like impacts to water resources, ecosystem services and biodiversity conservation can only be assessed in terms of significance and are referred to as ultimate consequences of an activity or a suite of impacts. Put another way, the significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed.

For the purposes of this assessment, the assessment of potential impacts was undertaken using an "Impact Assessment Methodology" provided by DMT Kai Batla. This methodology allows for the identified potential impacts to be analysed in a systematic manner, with significance rating (from *insignificant* to *very high*) assigned to each potential impact. The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The criteria used to determine impact consequence include extent, intensity and duration of the impact and are presented in Table 58 below.

Table 58. Criteria used to determine the consequence of the impact

Rating	Definition of Rating	Score
A. *Extent– the area in which the impact will be experienced*		
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. *Intensity– the magnitude or size of the impact*		
Low	Site-specific and wider natural and / or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and / or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and / or social functions or processes are severely altered	3
C. *Duration– the time frame for which the impact will be experienced*		
Short-term	For the duration of project activities / up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years	3

The combined score of these three criteria corresponds to a consequence rating, as set out in Table 59 below. (Note that the lowest possible consequence score is 3).

Table 59. Method used to determine the consequence score

***Combined Score* (A+B+C)**	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Once the consequence is derived, the probability of the impact occurring is considered, using the probability classifications presented in Table 60 below.

Table 60. Probability classification.

Probability of impact – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring

Definite	> 90% chance of occurring

The overall significance of impacts is determined by considering consequence and probability using the rating system prescribed in Table 61.**Error! Reference source not found.**

Table 61. Impact significance rating.

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	Low	VERY LOW	VERY LOW	LOW	LOW
	Medium	LOW	LOW	MEDIUM	MEDIUM
	High	MEDIUM	MEDIUM	HIGH	HIGH
	Very High	HIGH	HIGH	VERY HIGH	VERY HIGH

Different types of impacts were also considered in the impact ratings, as listed in the Box below**Error! Reference source not found.**.

Types of Impact

Direct – impacts that result from the direct interaction between a project activity and the receiving environment (e.g. dust generation which affects air quality).

Indirect – impacts that result from other (non-project) activities but which are facilitated as a result of the project or impacts that occur as a result of subsequent interaction of direct project impacts within the environment (e.g. reduced water supply that affects crop production and subsequently impacts on subsistence-based livelihoods).

Cumulative – impacts that act together with current or future potential impacts of other activities or proposed activities in the area / region that affect the same resources and / or receptors (e.g. combined effects of waste water discharges from more than one project into the same water resource, which may be acceptable individually, but cumulatively result in a reduction in water quality quality).

There is no statutory definition of 'significance' and its determination is therefore necessarily partially subjective. Criteria for assessing the significance of impacts arise from the following key elements:

- Status of compliance with relevant local legislation, policies and plans, any relevant or industry policies, environmental standards or guidelines and internationally accepted best practice;
- The consequence of the change to the biophysical or socio-economic environment (e.g. loss of habitats, decrease in water quality) expressed, wherever practicable, in quantitative terms. For socio-economic impacts, the consequence must be viewed from the perspective of those affected, by taking into account the likely perceived importance of the impact and the ability of people to manage and adapt to the change;
- The nature of the impact receptor (physical, biological, or human). Where the receptor is physical (e.g. a water resource) its quality, sensitivity to change and importance must be considered. Where the receptor is biological, its importance (e.g. its local, regional, national or international importance) and its sensitivity to the impact must be considered. For a human receptor, the sensitivity of the household, community or wider societal group must be considered along with their ability to adapt to and manage the effects of the impact; and
- The probability that the identified impact will occur. This is estimated based upon experience and / or evidence that such an outcome has previously occurred.

The impact significance rating also reflects the need for mitigation. While low significance impacts may not require specific mitigation measures, high significance negative impacts demand that adequate measures be put in place, to reduce the residual significance (impact significance rating, after mitigation), as described below in Table 62.

Table 62. Definitions of Impact Significance.

Insignificant:	The potential impact is negligible and no mitigation measures or environmental management is required.
Very Low & Low:	No specific mitigation measures required, beyond normal environmental good practices.
Medium - High:	Specific mitigation measures should be devised, to reduce the impact significance to an acceptable level. If mitigation is not possible, compensation measures should be considered.
Very High:	Specific mitigation measures should be identified and implemented, to reduce the impact significance to an acceptable level. If such mitigation is not possible, very high significance negative impacts should be considered in the project's authorisation process.

Note that impact significance will be rated in the prescribed way both without and with the effective implementation of the recommended mitigation measure.

ANNEXURE B: Species List – Flora.

**Species of conservation importance are highlighted in "green", exotic/alien plants in "red" text.*

#	SPECIES NAME	COMMON NAME	TYPE	SPECIES STATUS	CONSERVATION STATUS	Scarp Thicket 1	Scarp Thicket 2	Wooded Grassland	Mixed Alien Thicket 1 & 2	S. terebinthifolius Thicket
1.	*Acacia ataxacantha*	Flame thorn	Shrub	Indigenous			1			
2.	*Acacia kraussiana*	Coast climbing thorn	Tree	Indigenous	LC		1		1	
3.	*Acacia mearnsii*	Black wattle	Tree	Alien (invasive)	N/A	1			1	
4.	*Acacia robusta subsp. robusta*	Splendid thorn	Tree	Indigenous	LC		1			
5.	*Acacia schweinfurthii*	River climbing thorn	Climber	Indigenous	LC		1			
6.	*Achyranthes aspera*	Burweed	Herb (upright)	Alien (weed)	N/A	1	1	1	1	
7.	*Ageratum conyzoides*	Ageratum	Herb (upright)	Alien (invasive)	N/A	1		1	1	1
8.	*Ageratum houstonianum*	Ageratum	Herb (upright)	Alien (invasive)	N/A			1	1	
9.	*Albizia adianthifolia*	Flat-crown	Tree	Indigenous		1	1		1	
10.	*Aloe arborescens*		Herb	Indigenous	Provincially Protected			1		
11.	*Arundo donax*	Spanish reed/Giant reed	Grass/reed	Alien (invasive)	N/A				1	
12.	*Asystacia gangetica*	Wild foxglove	Herb (flat growing)	Indigenous	LC		1	1		
13.	*Bidens pilosa*	Blackjack	Herb (upright)	Alien (weed)	N/A			1	1	1
14.	*Brachylaena discolor*	Coastal silver oak	Tree	Indigenous		1	1			
15.	*Bridelia micrantha*	Mitzeeri	Tree	Indigenous	LC	1	1		1	
16.	*Canna indica*	Indian-shot	Herb (upright)	Alien (weed)	N/A					
17.	*Cardiospermum grandiflorum*	Balloon vine	Climber	Alien (weed)	N/A	1	1		1	1
18.	*Catharanthus roseus*	Madagascar periwinkle	Herb (upright)	Alien (weed)	N/A			1		
19.	*Centella asiatica*	Marsh pennywort	Herb (flat growing)	Indigenous (weed)	LC	1		1		
20.	*Cestrum laevigatum*	Inkberry	Tree	Alien (weed)	N/A	1	1	1	1	
21.	*Chloris gayana*	Rhodes grass	Grass	Indigenous	LC			1		
22.	*Chromoleana odorata*	Parafin weed	Shrub	Alien (invasive)	N/A	1	1	1	1	1
23.	*Commelina benghalensis*	Benghal commelina	Herb (flat growing)	Alien (weed)	N/A				1	
24.	*Commelina erecta*	Blue commelina	Herb (flat growing)	Indigenous		1				
25.	*Conyza canadensis*	Horseweed fleabane	Herb (upright)	Alien (weed)	N/A			1	1	
26.	*Cussonia spicata*	Common cabbage	Tree	Indigenous	LC		1			

#	SPECIES NAME	COMMON NAME	TYPE	SPECIES STATUS	CONSERVATION STATUS	Scarp Thicket 1	Scarp Thicket 2	Wooded Grassland	Mixed Alien Thicket 1 & 2	S. terebinthifolius Thicket
		tree								
27.	*Cynodon dactylon*	Couch grass	Grass	Indigenous	LC	1		1	1	1
28.	*Cynodon nlemfuensis*	Star grass	Grass/reed	Alien (invasive)	N/A			1	1	1
29.	*Dalbergia obovata*	River climbing bean	Climber	Indigenous	LC	1	1	1	1	1
30.	*Ekebergia capensis*	Cape-ash	Tree	Indigenous	LC		1			1
31.	*Eragrostis curvular*	Weeping love grass	Grass	Indigenous	LC			1	1	
32.	*Eucalyptus sp.*	Gum tree	Tree	Alien (invasive)	N/A	1			1	
33.	*Euphorbia tirucalli*	Rubber Euphorbia	Tree	Indigenous	LC		1			
34.	*Felicia mossamedensis*		Herb	Indigenous	LC			1	1	
35.	*Hypochaeris radicata*	Hairy Wild Lettuce	Herb (upright)	Alien (invasive)	N/A			1	1	
36.	*Ipomoea purpurea*	Common morning glory	Climber	Alien (weed)	N/A	1			1	
37.	*Jasminum* sp.		Climber	Indigenous	LC			1		
38.	*Justicia flava*	Yellow justicia	Herb (upright)	Indigenous	LC			1		
39.	*Kalanchoe rotundifolia*	Common Kalanchoe	Herb	Indigenous	LC					1
40.	*Lantana camara*	Lantana	Shrub	Alien (invasive)	N/A	1	1	1	1	1
41.	*Ledebouria sp.*	Ledebouria	Herb (upright)	Indigenous	Provincially Protected			1		
42.	*Leucaena leucocephala*	Leucaena	Tree	Alien (invasive)	N/A				1	1
43.	*Litsea glutinosa*	Indian laurel	Tree	Alien (weed)	N/A	1	1		1	
44.	*Mangifera indica*	Mango tree	Tree	Alien (weed)	N/A					1
45.	*Melia azedarach*	Syringa	Tree	Alien (invasive)	N/A	1	1	1	1	1
46.	*Melinis repens*	Natal red-top	Grass/reed	Indigenous	LC	1		1	1	1
47.	*Mimosa pigra*	Sensitive plant	Tree	Alien (weed)	N/A				1	
48.	*Morus alba*	Mulberry	Tree	Alien (invasive)	N/A				1	1
49.	*Oplismenus hirtellus*	Basket grass	Grass	Indigenous	LC		1			
50.	*Opuntia sp.*		Herb (upright)	Alien (invasive)	N/A			1		
51.	*Pachycarpus* sp.		Herb	Indigenous	LC			1		
52.	*Panicum maximum*	Guinea grass	Grass	Indigenous	LC	1		1	1	
53.	*Passiflora suberosa*	Devil's pumpkin/Indigo berry	Climber	Alien (invasive)	N/A	1	1	1	1	1
54.	*Passiflora subpeltata*	Granadina	Climber	Alien (weed)	N/A		1	1	1	
55.	*Pinus patula*	Patula Pine	Tree	Alien (invasive)	N/A	1			1	

#	SPECIES NAME	COMMON NAME	TYPE	SPECIES STATUS	CONSERVATION STATUS	Scarp Thicket 1	Scarp Thicket 2	Wooded Grassland	Mixed Alien Thicket 1 & 2	S. terebinthifolius Thicket
56.	*Plantago lanceolata*	Narrow-leaved ribwort	Herb (upright)	Alien (weed)	N/A			1		
57.	*Psidium guajava*	Guava	Tree	Alien (invasive)	N/A			1	1	1
58.	*Rhoicissus tomentosa*	Forest Grape	Climber	Indigenous	LC		1			
59.	*Ricinus communis*	Castor-oil plant	Tree	Alien (invasive)	N/A	1			1	1
60.	*Saccharum officinarum*	Sugarcane	Grass/reed	Alien (weed)	N/A			1	1	
61.	*Sansevieria hyacinthoides*	Mother-in-law's-tongue	Herb	Indigenous	LC			1		
62.	*Schefflera actinophylla*	Australian cabbage tree		Alien (weed)	N/A				1	
63.	*Schinus terebinthifolius*	Brazilian Pepper tree	Tree	Alien (invasive)	N/A	1			1	1
64.	*Sclerocarya birrea*	Marula	Tree	Indigenous	Protected Tree				1	
65.	*Senna didymobotrya*	Peanut butter cassia	Shrub	Alien (invasive)	N/A			1	1	
66.	*Setaria megaphylla*	River bristle grass	Grass/reed	Indigenous	LC		1			
67.	*Sida rhomboidea*	Arrow-lead Sida	Herb	Indigenous	LC				1	
68.	*Smilax anceps*	Lig ripper/Thorny rope	Creeper/climber	Indigenous	LC	1	1			1
69.	*Solamun mauritiunum*	Bugweed	Tree	Alien (invasive)	N/A	1	1	1	1	1
70.	*Solanum campylacanthum Hochst. ex A.Rich. subsp. panduriforme*	Bitter Apple	Shrub	Alien (invasive)	N/A			1		
71.	*Solanum incanum*	Grey bitter apple	Herb (upright)	Alien (invasive)	N/A			1	1	
72.	*Sorghum halepense*	Johnson grass	Grass/reed	Alien (invasive)	N/A			1	1	1
73.	*Sporobolus africanus*	Rat's tail dropseed	Grass	Indigenous	LC			1	1	
74.	*Sporobolus pyramidalis*	Cats tail dropseed	Grass	Indigenous	LC			1	1	
75.	*Strelitzia nicolai*	Natal wild banana	Tree	Indigenous			1		1	1
76.	*Syzygium cordatum*	Waterberry/Umdoni	Tree	Indigenous	LC	1	1			
77.	*Syzygium guineense*	Water pear	Tree	Indigenous					1	
78.	*Tagetes minuta*	Khaki weed	Herb (upright)	Alien (weed)	N/A	1		1	1	
79.	*Tecoma stans*	Yellow-bells	Tree	Alien (weed)	N/A	1			1	1
80.	*Tecomaria capensis*	Cape honey-suckle	Shrub	Indigenous	LC		1	1		
81.	*Tithonia*	Mexican sunflower	Shrub	Alien (weed)	N/A			1	1	

#	SPECIES NAME	COMMON NAME	TYPE	SPECIES STATUS	CONSERVATION STATUS	Scarp Thicket 1	Scarp Thicket 2	Wooded Grassland	Mixed Alien Thicket 1 & 2	S. terebinthifolius Thicket
	diversifolia									
82.	*Trema orientalis*	Pigeonwood	Tree	Indigenous	LC	1	1		1	1
83.	*Trichilia emetica*	Natal mahogany	Tree	Indigenous	LC	1	1		1	1
84.	*Urochloa mosambicensis*	Bushveld signal grass	Grass	Indigenous	LC			1		
85.	*Verbena bonariensis*	Purple-top	Herb (upright)	Alien (invasive)	N/A			1		
86.	*Zinnia peruvianna*	Redstar Zinnia	herb	Alien (weed)	N/A			1		

ANNEXURE C: DWS Risk Assessment Summary Results Table.

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I Water Use Risk Assessment Protocol)

Project Name: Proposed upgrading of 600mmØ rising main from Hazelmere Water Treatment Works to Grange Reservoir in Verulam

Date: 07 September 2017

Name of Assessors: Mr. Brian Mafela *(Cand.Sci.Nat.)*; Mr. Adam Teixeira-Leite *(Pr.Sci.Nat.)* — **SACNASP Registration No.** 100214/15; 400332/13

Name of Reviewer: Mr. Adam Teixeira-Leite *(Pr.Sci.Nat.)* — **SACNASP Registration No.** 400332/13

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

				Severity																		
Phase(s)	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Physico & chemical (water Quality)**	**Habitat (Geomogh & Vegetation)**	**Biota**	Severity	**Spatial Scale**	**Duration**	**Consequence**	**Frequency of Activity**	**Frequency of Impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence Level**	**Control measures**	**PES & EIS of Affected Watercourse**
Construction	Undertaking construction of the pipeline and associated infrastructure (vegetation stripping, trenching and soil stockpiling, dewatering, pipeline installation & construction of scour chambers)	1. Planned or accidental physical disturbance to watercourses (infilling, excavation, clearing etc. at crossings)	• Destruction of freshwater vegetation and habitat. • Sedimentation of downstream habitat and associated ecological impacts. • Destruction or modification of bed and bank profiles. • Proliferation of alien plants and associated impact on vegetation communities	2	2	2	1	**1.75**	1	1	**3.75**	1	5	5	1	**12**	**45**	**Low**	80	Onsite BMPs, post-construction rehabilitation	W01 PES D, Moderately-low EIS W02 PES D, Moderately-low EIS W03-A & W03-B PES E, Moderate EIS W04-B PES E, Moderately-low EIS R01-A PES D, Moderate EIS R01-B PES D, Moderate EIS
		2. Soil stockpiling	• Sedimentation of downstream watercourses and associated ecological impacts.	1	2	1	1	**1.25**	1	1	**3.25**	1	3	5	1	**10**	**32.5**	**Low**	80	Onsite BMPs, post-construction rehabilitation	
		3. Temporary impedance or diversion of flows	• Increased habitat inundation and change in flow patterns with associated ecological impacts. • Increased erosion and associated impacts.	2	2	1	1	**1.5**	1	1	**3.5**	1	4	5	1	**11**	**38.5**	**Low**	60	Onsite BMPs regarding flow diversion	
		4. Dewatering of trenches	• Increased rates of erosion and associated ecological impacts.	1	1	1	1	**1**	1	1	**3**	1	3	5	1	**10**	**30**	**Low**	80	Onsite BMPs regarding dewatering	
		5. Accidental spills & mis-management of potential pollution-causing substances	• Deterioration in local water quality and associated ecological impacts.	1	3	1	2	**1.75**	1	1	**3.75**	1	2	5	3	**11**	**41.25**	**Low**	60	Onsite BMPs, post-construction rehabilitation	
Operation	Operation of pipeline (Conveyance of water)	1. Planned or accidental physical disturbance to watercourses (from pipeline maintenance)	• Destruction of freshwater vegetation and habitat • Sedimentation of downstream habitat and associated ecological impacts • Destruction or modification of bed and bank profiles • Proliferation of alien plants and associated impact on vegetation communities	2	2	2	1	**1.75**	1	1	**3.75**	1	3	5	1	**10**	**37.5**	**Low**	80	Post-construction monitoring & Onsite BMPs	W01 PES D, Moderately-low EIS W02 PES D, Moderately-low EIS W03-A & W03-B PES E, Moderate EIS

				Severity																		
Phase(s)	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Physico & chemical (water Quality)**	**Habitat (Geomogh & Vegetation)**	**Biota**	Severity	**Spatial Scale**	**Duration**	**Consequence**	**Frequency of Activity**	**Frequency of Impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence Level**	**Control measures**	**PES & EIS of Affected Watercourse**
		2. Leakage of pipeline & pipeline dewatering	• Increased soil saturation • Watercourses habitat pollution and associated ecological impacts.	3	2	1	2	**2**	1	1	**4**	1	2	5	2	**10**	**40**	**Low**	60	Planning and design mitigation measures & Onsite BMPs	W04-B PES E, Moderately-low EIS R01-A PES D, Moderate EIS R01-B PES D, Moderate EIS

ANNEXURE D: Conceptual Wetland/Riparian Rehabilitation Guidelines.

What is Rehabilitation?

Rehabilitation refers to the process of reinstating the natural hydrological, geomorphological and ecological processes of a degraded riverine/wetland habitat system with the aim of recovering system integrity and ecosystem service delivery (Russell, 2009). Rehabilitation can also refer to the halting the decline in integrity (stabilisation) of an ecological system that is in the process of degrading with the aim of maintaining system integrity and ecosystem service delivery (Russell, 2009). The rehabilitation process outline in this conceptual report will follow the second process of halting the decline in health of watercourses impacted by construction activities linked with the construction of the proposed pipeline.

Purposes of this plan

The following conceptual rehabilitation guidelines have been developed specifically to guide the rehabilitation of wetland and riverine areas potentially impacted directly (or indirectly) during the pipeline construction phase. Rehabilitation will aid the recovery of impacted wetland and river/stream ecosystems and can be seen as critical in preventing further impacts to these sensitive ecosystems including those associated with alien plant infestations, soil erosion and sedimentation for example.

These guidelines are intended to be both educational and provide a practical tool that can be used to guide the development of a detailed plan or method statement for the rehabilitation of disturbed wetland/riparian habitat.

Anticipated Construction Phase Impacts & Rehabilitation Strategy

As with all contraction activities it is expected that all watercourses traversed by the proposed pipeline will be significantly modified which could lead to degradation of affected wetland units. Understanding these impacts is key to prescribing the correct mitigation measure to rectify such environmental disturbances. The following list of key issues / impacts are not intended to be exhaustive but serves as an indication of broad environmental impacts that require rectification (*Please note that a detailed description of these impacts is included in the main Aquatic Habitat Impact Assessment report)*:

i. Direct loss of aquatic/wetland habitat due to increased sediment deposition and infilling.
ii. Compaction of wetland soils.
iii. Increased erosion and sediment loss resulting from disturbance of erosion sensitive habitats such as stream banks.
iv. Proliferation of IAPS and weeds of disturbance.

Given the above mentioned impacts, key rehabilitation interventions should be to:

i. Reshape all physically disturbed watercourses habitat to their pre-development state.

ii. Stabilisation of areas susceptible to erosion (e.g. stream banks associated with wetland unit W04 and river R01.

iii. Re-vegetate all areas where vegetation was stripped in order to trench the pipeline.

Recommended Rehabilitation Methods / Interventions

The following steps must be followed during the implementation of a rehabilitation programme for the project as per the guideline steps, tasks and methods outlined below:

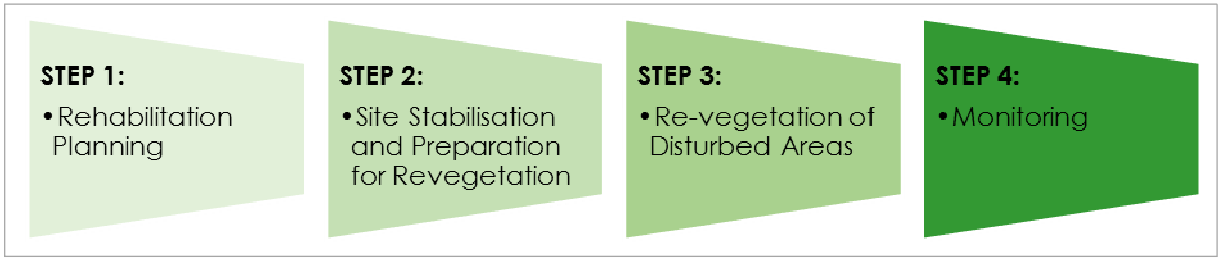


Figure 20 Steps involved in the rehabilitation of aquatic ecosystems.

Step 1: Rehabilitation Planning

Proper planning early on is critical for ensuring that rehabilitation is both cost-effective and successful. Once there is a formalised work plan in place, preparation for onsite rehabilitation of wetlands/rivers disturbed by construction activities can commence. Table 63 (below) highlights key aspects that must be considered as part of the rehabilitation planning process.

Table 63. Aspects to consider during the rehabilitation planning process.

Process	Planning Aspect	Description
Pre-construction planning	Budget	a. The Applicant/Developer is responsible for securing adequate funding to implement rehabilitation and an annual budget for the implementation of key activities will therefore need to be developed to support key activities, including costing of all management and rehabilitation activities and equipment costs which should be compiled prior to any rehabilitation activities occurring in collaboration with the contracted parties (wetland specialist, etc.), and should form part of the overall development project budget.
	Target Sites	b. Rehabilitation target areas must be identified prior to the implementation of this Plan. These include disturbed wetland/riverine areas for example.
	Appointment of rehabilitation / wetland specialists	c. Whilst appointment of external rehabilitation specialist is a feasible and acceptable option, a lot of preparation will need to be undertaken exclusively by the main contractor at the inception of the project. Preparation activities include correct stockpiling of topsoil needed for rehabilitation, harvesting of indigenous plants for use later on in rehabilitation, etc.
	Timing of rehabilitation	d. Rehabilitation of disturbed watercourses should ideally be initiated as soon as possible and occur concurrently as pipeline construction works progress. While it would be advantageous to re-vegetate disturbed areas at the onset of the wet season (early spring) such timing may not coincide exactly with the project and would likely coincide with

Process	Planning Aspect	Description
		potential peak flow events that could pose a high risk in terms of re-vegetation failure. Therefore, carefully planning is required to maximise the success of re-vegetation and avoid peak flow events.
Defining roles and responsibilities	Developer	a. Shall be responsible for the implementation of the rehabilitation plan; b. Shall be responsible for appoint all other key stakeholders involved in implementing the rehabilitation plan.
	Contractor	a. Shall be responsible for monitoring all rehabilitation efforts for a minimum of one year post construction or as stipulated in the contractual agreement; b. Shall be responsible for the actions of all sub-contractors as well as disseminating information pertaining to rehabilitation of the site.
	ECO	a. Shall be responsible for providing basic training and environmental awareness to the contractors and labourers undertaking rehabilitation; b. Shall be responsible for monitoring and reporting on the rehabilitation process.
	Wetland Specialist	a. Shall be responsible for making amendments and exceptions to rehabilitation measures provided in this document; b. Signing off on all rehabilitation related activities.

Step 2: Site Stabilisation and Preparation for Revegetation

A. Site Stabilisation

Reinstating the physical structure of the watercourses and protecting areas against erosion is a critical step in the active rehabilitation of areas disturbed during construction. The newly reinstated area must be structurally stable enough to support additional rehabilitation interventions such as top soiling, revegetation, protection of revegetated areas, etc. Guidance on possible hard and soft engineering interventions for further consideration during the development a detailed method statement has been provided in Table 64, below.

Table 64. Guidance on engineered rehabilitation interventions potentially applicable to the project for further consideration during detailed rehabilitation planning.

Rehab Tasks	Proposed materials/technique	Intervention Description
Stabilisation of river/stream banks	**Gabion baskets**	Gabion baskets are usually used to retain slopes at high risk of collapse or at high risk of being eroded. They are particularly useful at reinforcing the river banks immediately upstream or downstream of the pipeline crossing.
	Geo-fabrics	Geo-fabrics are generally used to reinforce other interventions such as the ones described above. Once constructed or re-shaped, geotextiles fabrics like Soil Saver™ and MacMat™ can be placed on constructed plugs or reshaped areas and pegged in place. Go-fabrics assist with controlling erosion.
Armouring of river/stream beds prone to scouring	**Honeycomb cellular structure**	For rivers and streams characterised by moderate to intermittent flows, the honeycomb cellular structures such as Multi-cells cellular structure can be laid on the river bed, soil filled and vegetated to provide a flexible effective erosion protection surface.
	Reno™ mattresses	For rivers and stream characterised by high flows, reno mattresses can be used to protect the river bed against erosion.
Deactivating erosion gullies / headcuts /	**Backfilling and Earthen plugs**	The quickest and simplest method to deactivate gullies within the watercourses is either to backfill with soil and compact or alternatively to use clay plugs at intervals along the gully to "plug" the gully which will naturally silt-up, stabilise and become vegetated. If backfilling is possible, suitable

Rehab Tasks	Proposed materials/technique	Intervention Description
rills		cohesive soil material must be used to backfilled systematically in layers using selected clay material. Material containing organic matter must not be used to backfill the trench. Each 150mm of backfill must be compacted until the natural ground level has been achieved.
	Re-sloping	Reshaping (usually headcut reshaping) generally provides a good long term solution to halting drain/gully advancement. Typically, the headcut (Knick-point) is reshaped to a surface of less than 25% slope. Vegetation plugs will need to be planted strategically across the entire surface to promote revegetation and improve the stability of the rehabilitated gully.
	Rock packing	Rock packing entails placement of medium to large rocks in the gully to slow down the velocity of water travelling in the gully and to encourage sediment deposition.
	Hard engineered structures e.g. concrete / gabion chute	Hard engineered structures such as concrete / gabion chute structures are not cost effective and are applicable to larger highly unstable erosion features or where soils are dispersive. *In light of the high cost of engineered structures, it is recommended that 'softer' less costly options first be investigated, unless risk of failure is high or high energy environments dictate the need for hardened engineering works.*
	Bioengineering	The following soft interventions can be investigated for controlling erosion features: • Fibre mats / blankets/ mattresses / nets. • Fibre rolls. • Fibre bags. • Brush or vegetation mattresses (mats). • Live or inert fascines. • Live staking. It is important to note, however, that bioengineering interventions are vulnerable to failure immediately following construction should a drought or large flood take place. Thus, the timing of construction to avoid peak flow conditions is very important to the rehabilitation success. This will, however, result in the need to irrigate the re-vegetated area to aid establishment.

B. Site Preparation

Prior to commencing with any revegetation activity (e.g. planting/seeding), it is important that disturbed areas are adequately prepared in advance. The following are general land preparation requirements for areas requiring rehabilitation/revegetation and apply primarily to watercourses.

i. Removal of Rubble and Solid Waste

Prior to undertaking any vegetation work it is important that all rubble, litter, foreign materials and waste products are removed from target watercourses and disposed of at proper local waste disposal/landfill facilities. During such undertaking use of heavy vehicles and excessive trampling must be minimised. Any large plumes of sediment washed into wetland, river or riparian habitat from upslope must also be removed, taking care not to remove or disturb the natural soil profile. The Detailed Rehabilitation Plan must address what tools and small machinery are to be used during site clean-up. Where possible this should be done manually by hand clearing instead of using machines that could result in further habitat destruction. Care must be taken not to disturb the vegetation, river banks, soils or in-stream areas during site clean-up. No natural material (e.g. sediment, rocks, and stones) from the stream channel or river banks shall be removed during this activity.

ii. Addressing soil compaction

Soil compaction in riparian and wetland areas falling within the construction servitude is a common problem for revegetation. When soil is compacted, seeds and plant roots and rootlets cannot penetrate through the hard surface and less oxygen is available for plant establishment and growth. This problem can be easily rectified through de-compaction by various means such as disking, ripping, ploughing, and rototilling. The following steps should be included in a Detailed Rehabilitation Plan:

- De-compaction must be undertaken prior to replacing topsoil.
- The subsoil must be ripped to a depth of 30cm or as advised by engineers following testing of the depth of compaction.
- Ripped soil must have no clod over 3 inches in diameter.
- Do not rip and / or scarify areas that are saturated with water, as the soil will not break up.

iii. Top-soiling

Immediately after ripping and scarifying disturbed areas, about 300mm of topsoil must be applied on top. The thickness of the topsoil on road embankments may be reduced at the instruction of the engineer only if 300mm of topsoil compromises the integrity of the works. The following should be done:

- Topsoil must be placed in the same area from where it was originally stripped or used for rehabilitation of disturbed areas.
- If there is insufficient topsoil available from a particular soil zone to produce the minimum specified depth, topsoil of similar quality may be brought from other areas. Where topsoil is lost during construction as a result of erosion, topsoil will need to be imported to the site and re-established. Such topsoil must be sourced responsibly, legally and ideally from the same underlying geology as that of the site.
- The topsoil must be compacted to similar compaction levels as natural soils in the area. The engineer will provide detailed advice on this.
- For seeding, the soil needs to be prepared to optimise germination. This is typically undertaken by racking to loosen the soil in the seedbed but should be firm enough to facilitate good contact between the seeds and the soil.
- The original surface topography of the wetlands prior to disturbance needs to be reinstated as close as possible through appropriate earthworks/landscaping.
- Re-establish the natural water flow patterns within the channel through re-shaping of disturbed areas.
- A weed-free mulch is recommended to help retain moisture for plant germination. Mulch should be crimped in if possible to limit floatation if flooding is likely to occur. It is very important that mulch not be derived from stands of invasive exotic species or weeds.

iv. Erosion control

Wetland soils are considered erodible and sensitive to disturbance. Erosion control measures such as soil savers, eco-logs, sand bags and biodegradable silt fences must therefore generally be installed prior to revegetation.

Step 3: Re-vegetation of Disturbed Areas

Owing to the vital role of wetland vegetation in wetland and aquatic ecosystem health and functioning, the re-establishment of natural or semi-natural vegetation is widely recognized as an important component of any wetland/river rehabilitation programme or plan. Generally, the broad aim of re-vegetation should be to introduce desirable plants in order to develop a plant community that will eventually become naturally self-sustaining over time (Brock & Casanova, 2000).

Once construction is completed and alien vegetation and waste products have been removed and soils are prepared for planting, vegetation is to be reinstated as soon as weather conditions allow for good plant growth. Immediately after preparing the soil, re-vegetation must commence in order to help bind the soil and prevent soil erosion and to inhibit IAP/weed establishment which will compete with the natural vegetation for space, light, nutrients and water. All re-vegetation should be undertaken by a qualified professional landscaper/landscaping company. It is the responsibility of the appointed landscaper to ensure successful vegetation establishment and to undertake regular maintenance for a year after successful establishment.

A. Strategy for revegetation of disturbed areas

For this particular project, due to the degraded nature of the wetland habitat and vegetation to be affected at the site, a minimalistic approach to re-vegetation of the degraded wetlands and channels is proposed that will involve the **rapid re-establishment of an indigenous pioneer plant dominated vegetation cover suitable to the wetness conditions** via a combination of cost-effective planting methods. It is recommended that re-vegetation be undertaken according to the following simple strategy:

- In areas where sugarcane cultivation is to be continued, sugarcane must be planted immediately following reshaping of the wetland surface.
- In areas where sugarcane cultivation is to be discontinued temporarily or permanently, a mixture of rapid-colonising grasses (such as *Cynodon dactylon* or *Stenotaphrum secundatum*) must be planted immediately following reshaping of the wetland surface to bind the soils and prevent erosion.

B. Description of Revegetation Methods

Re-vegetation Method 1: Hydroseeding

Hydroseeding is a preferred option to re-vegetating slopes and the pipeline servitude. The following guidelines should be followed when hydroseeding:

- The slurry (basic materials) for hydroseeding must consist of water, seed, fertiliser, anti-erosion compounds (soil binders) and organic supplements to enhance grass growth.

- Prior to hydroseeding water must be sprayed over target area to provide added moisture.
- The target groundcover of re-vegetated areas shall be no less than 80% of specified vegetation and there must be no bare patches of more than 500 x 500 mm in maximum dimension.
- No exotic/alien plants are to be used in hydroseeding (e.g. Kikuyu grass, *Pennisetum clandestinum*, is not recommended).
- The quantity of seed used will depend on the slope, with a steeper slope requiring a heavier application of seed. For slopes >15°: 25-50 kg/ha, slopes <15°: 15-25 kg/ha.
- The areas which have been seeded may need be regularly watered directly after seeding until the grass cover becomes established.
- Watering is to be done in a manner that ensures that no erosion of the topsoil and seed mix takes place

Re-vegetation Method 2: Broadcasting of Seed

In non-flowing or low energy wetland systems, direct seeding is often the most cost-effective method of re-vegetation (Water and Rivers Commission, 2000). The following recommendations must be followed when hand broadcasting:

- Seed mixtures should be sown at the proper time of year specified for the mixture.
- In terms of the timing of construction and re-vegetation, it is best that all re-seeding and planting take place during the growing season. Where this is impractical, the re-vegetated areas will need to be regularly watered until establishment is successful.
- For seeding, the soil needs to be prepared to optimise germination. This is typically undertaken by hand hoeing to loosen the soil in the seedbed but should be firm enough to facilitate good contact between the seeds and the soil.
- On application, seeds must be manually/hand broadcasted or can be planted in rows either by hand and then racked in the soil then watered immediately after.
- If topsoil and native seed mixes are used, fertilizer is often not needed.
- The seeds can be spread manually (broadcast) over the wetland or can be planted in rows by hand.
- The seeding rate (seed used in kg/ha) varies according to the method and the type of seed being used. A good rule of thumb is to use twice the amount of seed used for row planting when broadcasting.
- The amount of seed to be used must also be modified for areas that are not irrigated or do not have a regular supply of moisture. An increase of 20% in seeding rate is recommended for most dryland (non-irrigated) establishment (Russell, 2009). The higher density for wetland seed is also in part to compensate for the higher seed mortality inherent with smaller seed sizes
- Generally, the small-seeded sedges, rushes, grasses and forbs should be placed near the soil surface as they require light to germinate, whilst the larger-seeded species can be buried deeper and may prefer to be buried (Jacobson, 2006).

- The seed should be planted no deeper than 2.5 times the width of the seed but never left lying on the surface of the soil. The more sandy a soil, the deeper the seed should be planted and the more rich in clay a soil is, the shallower the seed should be sown (within the above limits).
- When broadcasting seed it is necessary to lightly cover the seed with soil by hand raking the seed into the soil to ensure the seed has good contact with the soil.
- Avoid sowing or thatching in areas where runoff concentrates (i.e. naturally channelled flow, drains, etc.).
- All planted areas should be mulched preferably immediately following planting, but in no later than 14 days from planting. Mulch conserves water and reduces erosion. Harvested sugarcane can be used as mulch.
- Thorough weed control is essential for the seeding method to be successful, as germinating native seedlings tend to be out-competed by faster growing introduced species.
- Temporary erosion protection measures must only be removed once good vegetation cover has established.

Re-vegetation Method 3: Transplanting or Planting of Live Plants/Plant Plugs

Transplanting/ planting of live plant plugs is applicable to disturbed river banks and riparian areas. The following recommendations must be followed:

- Planting or transplanting of live wetland plants can be used to establish emergent aquatic vegetation in shallow open water, deep marsh and shallow marsh zones where seed can often be difficult to establish in these "wet" zones.
- The timing of planting is best done shortly before or at the beginning of the growing season (i.e. spring, or at the onset/early summer).
- It is recommended that one starts by establishing an interim herbaceous/grass community using easily-establishing ground cover such as fast growing, stoloniferous annual grasses. This will serve a dual purpose of exerting a competitive influence, thereby inhibiting alien seed recruitment, and stabilizing the bare soil until the natural climax community has established itself. It is anticipated that, with the return of a more evenly distributed hydrological regime, indigenous wetland grasses, reeds and sedges will naturally colonise the rehabilitated area.
- No exotic/alien plants are to be used in re-vegetation.
- Mono-specific planting should be avoided as diversity is the key to robustness, which will assist in retaining sediment and preventing erosion.
- Once the soil surface is prepared and stabilised, plugs are to be planted at moderate densities in alternating rows / patches with areas to be broadcasted. The pattern of planting is to be determined as part of the detailed plan for implementation.
- When using vegetation plugs, the spacing of plugs should not be too wide and planting should be done in patches rather than wider spacing. Hoag (2005) recommends a spacing of 46-50cm centers in patches that are about $3m^2$ spaced about 3m apart. Over time the plants will

then spread from the planted areas into adjoining unplanted parts of the wetland, particularly along water flow paths.

- Furthermore, where applicable, on steep slopes i.e. slopes steeper than 1:6, a biodegradable geofabric should be established over the slopes in conjunction with the re-planting.
- It is essential that when a plug is planted that the receiving cavity is slightly deeper than the length of the root ball so that when the cavity is pinched closed a slight depression remains around the base of the leaves.
- No form of fertilizer, or soil ameliorant such as lime, should be used in the planting in any watercourse.
- When looking at transplanting live plants, select a nearby watercourses that is well-vegetated with required plants.
- Any harvesting must be undertaken with caution so as not to unduly disturb the donor site. Material from within stream channels, flow concentration zones or in any other areas susceptible to erosion should not be targeted for plant harvesting.
- For whole/growing plants, ensure that plants are dug up with as much of their roots intact and such that the soil around the roots is not disturbed (i.e. intact root ball). Care also needs to be taken that weeds/alien plants are not transplanted with the donor plants.
- Collected plants should be replanted as quickly as possible following removal (i.e. within a day of harvesting).
- Large clumps of plants can be carefully separated into smaller clumps or into several individual stems with attached roots, known as slips.
- A recommended approximate planting density of 1–3 plants per m^2 generally applies to wetlands (Clarkson and Peters, 2012).
- The plants should be planted with their roots in as much of the original soil medium as possible from which they were removed and in a water depth similar to that where they were collected.
- Plants in general must be planted with their tops out of the water or they will die.
- When planting the material, dig a hole deep enough to ensure that the roots do not bend upwards.
- The bottom of the root ball should be in contact with the saturation zone (Hoag, 2005).
- The soil around the plant should be firmly compacted.
- Leaves of large plants must be trimmed back to about 10 to 15cm in length so as to reduce water losses through transpiration.
- Vegetation that has very recently been planted is generally susceptible to being washed away until it has become well established, particularly in areas of permanent water flow or high-energy environments. The plants may need to be secured using a coarse mesh (steel wire or plastic) and/or a fine biodegradable mat placed over the vegetation to secure the plants while they become established. The plants must be able to grow unhindered through the mesh or mat. Biodegradable fiber mats may be placed on the soil surface to protect the soil

from erosion and will generally decompose by the time the vegetation has become well established. Mats can be staked down or held down with timber batons tied down using duckbill anchors. Planting can also be done into holes punched in sisal bags filled with soil and buried, or into ecologs.

- Temporary erosion protection measures must only be removed once good vegetation cover has established.
- It is essential that survival of all plants be monitored closely for at least the first eight weeks from the day following their planting and any dead plants be replaced as soon as possible

Step 4: Monitoring

Aftercare, maintenance, monitoring and evaluation of rehabilitation and re-vegetation efforts must be undertaken during and post construction. The monitoring and evaluation of rehabilitation activities and outcomes is critical in assessing the extent to which the rehabilitation has achieved what it set out to accomplish. Monitoring the condition of the re-established vegetation cover will be necessary to assess particular aftercare or plant maintenance requirements. Visual monitoring of the site must be carried out in accordance with the rehabilitation guidelines at regular intervals during the rehabilitation process. The benefit of regular monitoring will be that problems can be quickly identified and easily addressed during the process whilst rehabilitation teams are busy at the site.

The monitoring process must be conducted in the presence of the main contractor by a suitably qualified external/independent party, such as an Environmental Control Officer (ECO) but can also be undertaken by the Environmental Site Officer (ESO), Competent Authority and Interested and Affected Parties (I&APs). Should any defects or failures be identified during each monitoring exercise, the main contractor must take all necessary and relevant actions address these immediately and accordingly. The recovery of disturbed areas that have been rehabilitated should be assessed for at least the first 3 months following rehabilitation completion to assess the success of rehabilitation actions. Any areas that are not progressing satisfactorily must be identified (e.g. on a map) and action must be taken to actively re-vegetate these areas. If natural recovery is progressing well, no further intervention may be required. The ECO should assess the need / desirability for further monitoring and control after the first 6 months and include any recommendations for further action to the relevant environmental authority. Table 65 (below) provides a basic monitoring framework and checklist of aspects of the wetland rehabilitation to be monitored.

Table 65. Description of basic visual monitoring requirements to assess the success of wetland and riparian areas rehabilitation.

Aspect	Description	Frequency of monitoring
Solid waste and construction rubble	Has all solid waste, litter and construction rubble been adequately cleared from the site and disposed of at a registered site?	Weekly
Salvaged indigenous species	Are salvaged indigenous species being watered twice a week?	Bi-weekly

Aspect	Description	Frequency of monitoring
	Are there any mortalities?	
Watering/maintenance requirements of planted grass, trees and shrubs	What is the plant survival rate? Are there areas of bare soil/poor growth? Is there a need for follow-up re-vegetation?	Daily until plants are established, thereafter weekly
Response of planted grass, trees and shrubs	What is the progress of re-vegetation planting? Are there areas of bare soil/poor growth?	Bi-weekly
Alien plant control and eradication (including follow-up control	Are there dense infestations of alien plants within and around the rehabilitated site? (Seedlings, shoots, coppice growth, etc.) Is there a need for further follow-up control?	Weekly during and immediately after rehab, thereafter on a monthly basis
Sediment barriers/traps and erosion control measures	Are sediment/erosion controls functioning adequately? Have these been properly maintained? Are there signs of erosion/sedimentation?	Daily during rehabilitation

At the completion of site rehabilitation, an evaluation of the success of the rehabilitation project will need to be undertaken in order to facilitate the dissemination of lessons learnt and provide a means of reporting on the success of specific rehabilitation initiatives. In order to evaluate project success, the following attributes/rehabilitation indicators need to be clearly defined and understood:

i. Aspects/values of interest referred to herewith as 'concerns';
ii. Level of achievement required to consider the rehabilitation exercise successful; and
iii. Quantitative performance level used as a desirable target.

Table 66, below, provides for basic rehabilitation evaluation guidelines useful for evaluating the success of the rehabilitation project. The evaluation process can be conducted by the developer, Competent Authority, I&APs or an independent ECO after a period of 3-6 months post-completion of the rehabilitation process. An external audit report on performance should ideally be provided as part of the rehabilitation project success evaluation process.

Table 66. Summary guideline for evaluating the success of rehabilitation.

Item	Concern	Performance indicator	Desired Target
1	There should be low levels of Invasive Alien Plants	IAP species cover/abundance	<10% IAP cover
2	Indigenous vegetation should be re-instated	Indigenous species cover/abundance	>90% indigenous cover
3	Erosion and slope instability should be managed appropriately	Signs of soil erosion and slope/bank instability	No signs of erosion
4	Sedimentation of water resources must be limited	Signs of sedimentation in downstream channel	No signs of major sedimentation/turbidity in water column
5	There should be no foreign solid waste materials or waste within rehabilitated areas	Solid waste/litter levels	No solid waste remaining

Addressing any Potential Negative Impacts of Wetland Rehabilitation

While the intention of rehabilitation should always to benefit the environment and society through the protection or improvement of freshwater ecosystems and the services that they provide, poorly planned rehabilitation can often cause more harm than good (Armstrong, 2008). Rehabilitation interventions vary considerably in terms of their potential to cause environmental impacts both in terms of the type of impact caused as well as the magnitude of the impact. Thus it is appropriate that all rehabilitation efforts/projects are scrutinized for their potential to cause unintended, negative environmental impacts (Armstrong, 2008). Potential negative impacts associated with rehabilitation projects are highlighted by Armstrong (2008) and those most relevant to these rehabilitation guidelines have been summarised in Table 67, below.

It is recommended that these and other potential negative impacts be noted by the Implementing Agent responsible for the rehabilitation and managed on-site according to means of avoidance/ mitigation described in Table 67 and in conjunction with the aquatic ecological impact management and mitigation measures discussed in this specialist report.

Table 67. Key potential negative environmental impacts associated with wetland rehabilitation activities and interventions and means of avoiding or mitigating these impacts (after Armstrong, 2008).

Item	Rehabilitation Interventions/Actions	Potential negative environmental consequences	Means of avoidance or mitigation
1	**A earthen plug or sediment fence across a stream channel, artificial drainage channel or erosion gully**	Trapping of bedload and spreading of high flows.	Little that can be done to mitigate.
2	**Sloping of steep slopes and erosion gully head/sides**	Exposure of soils to risk of erosion, which may impact negatively on river/stream and riparian areas and downstream aquatic habitats.	Assess whether bioengineering will be adequate. Ensure re-vegetation takes place as rapidly as possible. Provide supplementary support (e.g., biomats, ecologs, etc.) to the vegetation, where required.
3	**Infilling of erosion gullies or artificial drainage channels**	Fill material may be washed away, which may impact negatively on the aquatic habitats nearby and downstream aquatic habitats. Obtaining fill will also have associated impacts	Re-vegetate the fill as quickly as possible. Temporarily divert flow, if required, until the fill has become adequately re-vegetated.
4	**Planting of vegetation**	Introduction of alien species that spread beyond the site. Use of plant material of indigenous species that is genetically different to that occurring locally, resulting in 'genetic contamination'.	Do not use species with invasive potential. Use local material only.
5	**Access to the site during rehabilitation by workers and equipment**	Soil compaction and disturbance and vegetation disturbance.	As far as possible, use existing roads and tracks. In very wet areas obtain foot access using boards. Rehabilitate access paths when work is complete (e.g. loosen compacted areas).
6	**Temporary storage of materials**	Disturbance of vegetation. Visual impact.	Remove all material on completion of the work. Rehabilitate site when work is complete.
8	**Human waste associated**	Contamination of soil and water.	Locate toilets outside of the

Item	Rehabilitation Interventions/Actions	Potential negative environmental consequences	Means of avoidance or mitigation
	with toilets		delineated watercourses.
10	**Fuel spills or leaks**	Contamination of soil and water.	Maintain any machines (e.g., pumps) being used at the site in good working order, and any stored fuel should be located well outside of the delineated watercourses.
11	**Temporary diversion**	Temporary drying out or redirecting of flows as well as secondary erosion and sediment impacts.	Ensure that the diversion channel or coffer dam is removed and natural flow regimes are restored
12	**Removal of plugs of vegetation from donor sites**	Potential exposure of donor sites to erosion. Disturbance of sensitive habitat.	Remove plugs where the threat of erosion is low and the site is not considered sensitive.
13	**Cutting and filling (e.g. in order to slope a gully head or sides)**	Disturbance of soil and vegetation. Erosion and washing of sediment into downstream habitats.	Where the site is located in water flow paths, particularly where discharges are high, confine activity to the dry season. Divert flow until the intervention is well stabilised. Encourage rapid re-vegetation.
16	**In all cases of disturbance of soil or vegetation, the opportunities for invasive alien species to invade are increased,**	Competition and displacement of native vegetation, loss of biodiversity, increased soil erosion/fire risk, increased water consumption (depending on species of IAPs).	Control alien plants and weeds.

Outstanding Tasks and Way Forward

The following area outstanding tasks that still need to be completed as part of the finalisation of rehabilitation planning:

a) Defining key roles and responsibilities and budgets for implementation.
b) Development of an implementation plan based on the phasing of construction activities and expected completion dates.
c) Comprehensive list of plant species required for rehabilitation based on availability of plants.
d) Development of a detailed planting strategy and planting method that is specific to target areas.
e) Identification and estimation of the final extent of areas requiring wetland/river rehabilitation .
f) Compilation of a detailed method statement that addresses the following issues:
    - Stabilisation measures and resources based on slope and soil types.
    - Planting methods, preferred species, plant spacing and densities.
    - Methods and equipment for IAP clearing.
    - Bill of quantities and costs for all interventions (including re-vegetation).

APPENDIX E: PUBLIC PARTICIPATION

1. PROOF OF PUBLIC PARTICIPATION

APPENDIX E1
Advertisement

DMT Kai Batla (Pty) Ltd

APPENDIX E1.1
Site Notices

NOTICE OF BASIC ASSESSMENT AND GENERAL AUTHORISATION APPLICATION FOR THE PROPOSED UPGRADE OF A 600mmØ RISING MAIN FROM HAZELMERE WATER TREATMENT WORKS TO GRANGE RESERVOIR, IN THE KWAZULU-NATAL PROVINCE (REF: DM/0045/2017; NEAS REF: KZN/EIA/0000715/2017)

Notice is hereby given in terms of Section 24 (4) (v) of the National Environmental Management Act, Act No. 107 of 1996 (NEMA) for activities that require Environmental Authorisation and a Water Use Authorisation

Project Applicant: eThekwini Water and Sanitation

Project Location: The project is located in the town of Verulam in the eThekwini Municipality, in the KwaZulu-Natal province. The pipeline runs from the Hazelmere Water Treatment Works (WTW) to Grange Reservoir. It crosses through the suburbs of Grangetown, Umhloti Heights, Riverview park and the Canelands- prior to reaching the Hazelmere WTW.

Project Description / Activities: It is proposed that the existing 375mm diameter (Ø) Constant Inside Diameter (CID) Asbestos-Cement rising main be upgraded by a 600mmØ steel pipeline routed along surrounding roads within an existing servitude en route to Grange Reservoir. The upgrading of the rising main is also being done in consideration of future housing developments in the area as well as to meet the associated increase in water demands.

In order to obtain Environmental Authorisation, a Basic Assessment (BA) and General Authorisation (GA) application process need to be followed.

PUBLIC CONSULTATION

DMT-Kai Batla (Pty) Ltd (DMT-KB) has been appointed as the Independent Environmental Consultants to conduct the public consultation, compilation of the Basic Assessment Report (BAR) and Environmental Management Programme (EMPr) as part of the environmental impact assessment process for the proposed project. All interested & affected parties (I&APs) are invited to participate in this proposed project by forwarding comments or concerns relating to the project to DMT-Kai Batla. To register as an I&AP please submit your name and contact details and your comments in writing to the Consultants by **9 December 2017.** A background information document (BID) can be obtained from DMT-Kai Batla upon request. The Draft BAR and EMPr are available for commenting for a period of 30 days **(9 November to 9 December 2017).** To access these reports, please go to the following:

Canelands Library: 1 Alec Bean Rd, Canelands, Verulam, 4339; or

Follow the Dropbox link below:

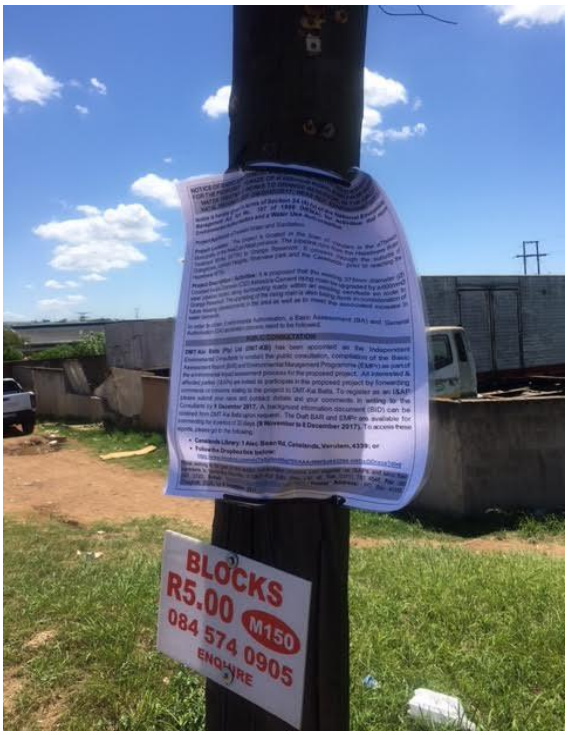
- **https://www.dropbox.com/sh/7x8xllm495at785/AAArMWSa042Z86-H9DzODrxca?dl=0**

Those wishing to be part of the public consultation process can register as I&APs and send their comments to Samantha Moodley of DMT-Kai Batla (Pty) Ltd, at: **Tel:** (011) 781 4548; **Fax**: 086 545 2720; **E-mail:** Samantha.Moodley@dmt-group.com; **Postal Address:** PO Box 41955, Craighall, 2024, by **9 December 2017.**

Corner of New Glascow and Duiker Road (29°37'28.65"S; 31° 3'3.44"E)

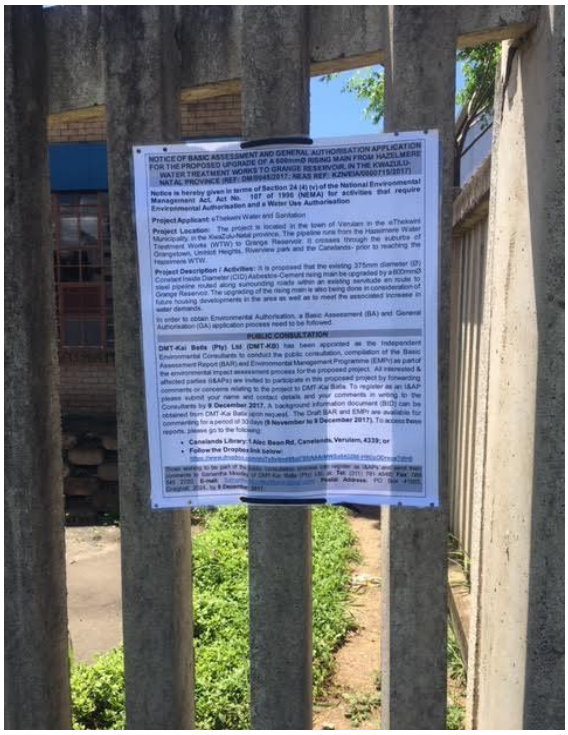
Corner Himlaya Drive & Tensing Drive (29°38'13.21"S; 31° 2'14.57"E)

Corner of Spring Place and Estuary Drive (29°37'48.50"S; 31°2'57.59"E)



Grange Reservoir, Prabat Crescent (29°38'1.32"S; 31°2'14.43"E)

Mission Road (29°37'51.83"S; 31°2'40.58"E)



DMT Kai Batla (Pty) Ltd

APPENDIX E1.2
Newspaper Advertisement

NOTICE OF BASIC ASSESSMENT AND GENERAL AUTHORISATION APPLICATION FOR THE PROPOSED UPGRADE OF A 600mmØ RISING MAIN FROM HAZELMERE WATER TREATMENT WORKS TO GRANGE RESERVOIR, IN THE KWAZULU-NATAL PROVINCE

Notice is hereby given in terms of Section 24 (4) (v) of the National Environmental Management Act, Act No. 107 of 1996 (NEMA) for activities that require Environmental Authorisation and a Water Use Authorisation

Project Applicant: eThekwini Water and Sanitation

Project Location: The project is located in the town of Verulam in the eThekwini Municipality, in the KwaZulu-Natal province. The pipeline runs from the Hazelmere Water Treatment Works (WTW) to Grange Reservoir. It crosses through the suburbs of Grangetown, Umhloti Heights, Riverview park and the Canelands- prior to reaching the Hazelmere WTW.

Project Description / Activities: It is proposed that the existing 375mm diameter (Ø) Constant Inside Diameter (CID) Asbestos-Cement rising main be upgraded by a 600mmØ steel pipeline routed along surrounding roads within an existing servitude en route to Grange Reservoir. The upgrading of the rising main is also being done in consideration of future housing developments in the area as well as to meet the associated increase in water demands.

In order to obtain Environmental Authorisation, a Basic Assessment (BA) and General Authorisation (GA) application process need to be followed.

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DMT-Kai Batla (Pty) Ltd (DMT-KB) has been appointed as the Independent Environmental Consultants to conduct the public consultation, compilation of the Basic Assessment Report (BAR) and Environmental Management Programme (EMPr) as part of the environmental impact assessment process for the proposed project. All interested & affected parties (I&APs) are invited to participate in this proposed project by forwarding comments or concerns relating to the project to DMT-Kai Batla. To register as an I&AP please submit your name and contact details and your comments in writing to the Consultants by **9 December 2017.** A background information document (BID) can be obtained from DMT-Kai Batla upon request. The Draft BAR and EMPr are available for commenting for a period of 30 days **(9 November to 9 December 2017).** To access these reports, please go to the following:

- Canelands Library: 1 Alec Bean Rd, Canelands, Verulam, 4339; or
- Follow the Dropbox link below:

https://www.dropbox.com/home/Draft%20Basic%20Assessment%20Report#

Those wishing to be part of the public consultation process can register as I&APs and send their comments to Samantha Moodley of DMT-Kai Batla (Pty) Ltd, at: **Tel:** (011) 781 4548; **Fax**: 086 545 2720; **E-mail:** Samantha.Moodley@dmt-group.com; **Postal Address:** PO Box 41955, Craighall, 2024, by **9 December 2017.**

The proof of advert will be included in the final BAR.

DMT Kai Batla (Pty) Ltd

Appendix E2
Stakeholder Notification

APPENDIX E3
Comments and Responses

No comments have been received on the project to date. Comments received from I&APs during the public review of the Draft BAR will be included in a Comments and Responses Report that will be submitted with the Final BAR.

DMT Kai Batla (Pty) Ltd

APPENDIX E4
Background Information Document

Background Information Document

Basic Assessment and General Authorisation Application for the Proposed Re-Routing of a 600mmØ Rising Main from Hazelmere Water Treatment Works to Grange Reservoir, in the Kwazulu-Natal Province.

PURPOSE OF THE DOCUMENT

The purpose of the Background Information Document (BID) is to provide information to assist stakeholders in participating in the environmental permitting process for the proposed project. This BID has been developed to:

- Share information about the proposed project;
- Present the Basic Assessment (BA) process that will be followed to obtain environmental authorisation (EA) according to NEMA;
- Provide more details about the

BACKGROUND

Water supply infrastructure in South Africa has been undergoing replacement and upgrading in recent years. The existing infrastructure was initially installed in the 1960s. Over the years, the water supply pipeline scheme in the country has deteriorated and this has been catalysed by the rapid population and economic growth which has resulted in increased water supply demand over the last 25 years[1]. As the country has developed (particularly since 1996), there has been a greater need for efficient basic service infrastructure- particularly where water services and supply are concerned. In a bid to ensure the delivery of clean, safe, potable water to local communities, the eThekwini Municipality implemented a R1.6 billion project in 2010 where existing pipelines in the Durban area were replaced so as to combat the deteriorating efficiency of water infrastructure[2]. In addition to this, the eThekwini Water and Sanitation (EWS) Unit has implemented operational interventions- such as pipeline replacements- to address issues associated with the reduction in supply from its water treatment works[3].

The material commonly used for the initial infrastructure installation was Asbestos-Cement (AC), which has subsequently been banned in South Africa due to its hazardous impact on humans and the environment. As part of delivering on its service mandate, the EWS is proposing that the existing undipped AC rising main water pipe between Hazelmere and Grange Reservoir be replaced to combat material degradation as the AC pipes have reached the end of their serviceable life. Regular pipe bursts cause water loss during a time where water conservation is of utmost importance in the country. The bursts also speak to service delivery needs and the inconvenience that is suffered by receiving water users. This is seen in the leaks and flooding experienced by some private landowners through whose property the pipeline traverses. Numerous pipe bursts have led to insurance claims against the Municipality and the overall state of the pipeline is compromising the level of service being delivered to consumers- which the EWS aims to address with the implementation of the proposed project.

THE APPLICANT

EWS is a unit of the eThekwini Metropolitan Municipality and is responsible for the provision of water and sanitation services to all customers in the Municipality. The Unit counts customer focus, cost consciousness and a concern for the well-being of our staff as part of their core values, and they are continually looking for new and innovative ways to provide services to their customers.

The EWS is known for introducing some of the earliest water management measures in South Africa. This includes initiatives such as free basic water, flow limiters, the use of plastic bodied water meters, polypropylene

[1] http://www.infrastructurenews.ws/2013/03/20/replacement-of-water-pipes-in-major-municipalities-is-long-overdue/

[2] http://www.engineeringnews.co.za/article/municipal-pipe-replacement-projects-could-help-relieve-local-water-pressures-2016-02-12

[3] Http://www1.durban.gov.za/Durban/services/water_and_sanitation/services/replacement-of-ac-secondary-watermains/acprojectendsjune2010

water piping, ground tanks and semi-pressure water service levels, urine diversion toilets, anaerobic baffled reactors, the use of grey water for urban agriculture, customer services agents, residential sewerage and a customer water debt repayment policy. Furthermore, the Unit has a standing agreement with the University of Kwazulu-Natal for co-operative research aimed at furthering the water agenda.

As listed on their website, the Unit's key priorities include[4]:

- Eradicating the backlog in the provision of water and sanitation services:
  - The water backlog has been reduced to 15% of what it was in 1996;
  - The sewerage backlog stands at approximately 50% of the 1996 figure.
- Reducing non-revenue water from the present level of 30%, to 25%, over the next 5 years.
- Improving asset management systems.
- Training young graduates in engineering and retaining skilled staff to respond to the shortage of engineers and professional skills in SA.
- Improving performance management systems.
- Improving customer services and services payment levels.

The pipeline upgrade is in line with the EWS the priorities listed above, and is part of the Unit's mandate for basic service delivery. The project is one of many that the entity has embarked on in the area of infrastructure management, and it displays the measures being taken by the Municipality as a front runner in service infrastructure upgrades and maintenance.

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PROJECT DESCRIPTION

In the past, AC pipes were touted for their light weight and ease of handling, low coefficient and corrosion resistant properties. However, the appeal and durability of the AC pipes has lost favour over the years due to the introduction of material that is proven to be more durable. Based on this, and in addressing the water service delivery backlogs, eThekwini has now opted for steel pipes with a wider diameter which will see greater water volumes flowing between certain water treatment plants and reservoirs. As such, the EWS has proposed the upgrading of the existing AC rising main between Hazelmere Water Treatment Works (WTW) to Grange Reservoir which is approximately 6km in length The current rising main forms part of an existing registered

Figure 1: Example of a scour valve

Figure 2: Example of an air valve chamber

servitude (servitude ref. no xxx) and traverses private property. It also bursts on occasion resulting in flooding of properties and subsequent insurance claims against the Municipality. The valves located on this main are in various stages of deterioration- some severely corroded, and others being non-operational. The EWS conducts on-going repairs on the pipelines and valves. However, problems on this rising main are hampering supply to the three reservoirs that source water from Grange Reservoir – namely Everest Heights Reservoir, Redcliffe Reservoir and Mountainview Reservoir.

It is proposed that the existing 375mm diameter (Ø) Constant Inside Diameter (CID) AC rising main be upgraded by a 600mmØ steel pipeline routed along surrounding roads within the existing servitude en route to Grange Reservoir. The proposed rising main will have air valve chambers and scour valve chambers positioned at crest and troughs respectively (see Figures 2[5] and 3[6]). Air valves are placed at regular intervals along the pipeline and serve the purpose of evacuating dissolved air from the pipeline. Scour valves are located at lower points or between valved areas along the pipeline. They facilitate the periodic flushing of the pipelines to remove sediment and allow the pipeline to be drained during maintenance and repairs. The

[4] This information was extracted from the EWS website, from the "Who we Are?" page, available on: http://www.durban.gov.za/City_Services/water_sanitation/About_Us/Pages/default.aspx

[5] Source: http://www.chings.co.nz/projects_infrastructure_water.html

[6] Source: http://drivingstrategicsales.com/martech-stories)1/2016/3/15/1upsfqo3jmq6es17syqvwofwg

upgrading of the rising main is also being done in consideration of future housing developments in the area as well as to meet the associated increase in water demands. Furthermore, the upgrades are being done to ensure the efficient pumping of water to and between Grangetown and Hazelmere, as well as to ensure that the pipeline operations and cross connection along the pipeline route do not affect the water supplied to the Canelands industrial area.

PROJECT LOCALITY

The project area falls within the eThekwini Metropolitan Municipality. eThekwini is the largest city in KwaZulu-Natal (KZN) Province and the third-largest city in the country. Its land area is comparatively larger than that of other South African cities and is topographically hilly, with many gorges and ravines. The proposed pipeline development area is located in the southern area of KwaZulu-Natal, and falls to the northeast of Durban. The pipeline runs from the Hazelmere Water Treatment Works (WTW) to Grange Reservoir (see Figure 4). The area in which the most of the proposed pipeline is laid is situated is on a floodplain and is therefore topographically flat. Areas of higher elevation and steeper topography are only found at the Hazelmere WTW and Grange Reservoir (MSJ 2016). The nearest town to the project area is Verulam- located just to the south east of Grangetown. The greater project area is located approximately 15km west of the King Shaka International Airport, and the nearest major urban centres are Tongaat, La Mercy and Umdloti- located to the far north east, to the far south respectively.

The pipeline crosses through the suburbs of Grangetown, Umhloti Heights, Riverview park and the Canelands- prior to reaching the Grange Reservoir located on Prabat Crescent. The upgraded water main will cross the following roads:

- Hazelmere Road in the north of the site
- Duiker Road and New Glascow Road in the Canelands Industrial park
- Spring Place in Riverview Park
- Mission Road in the southern residential area

In some areas along the existing pipeline route, the EWS main runs adjacent to- and crosses - a Sasol gas pipeline (please refer to Figure 5 for a depiction of the Sasol gas pipeline route in relation to the proposed water main upgrades). The proposed pipeline will cross the Sasol gas pipe at the Corner of Duiker Road and New Glascow, and there will be three crossings on the corner of Spring Place and the unnamed gravel path leading to the existing pipe bridge. To ensure that the pipeline upgrade does not interfere with the Sasol line, the EWS has obtained a signed way leave from the energy company, permitting the upgrades of the water main along their [Sasol's] pipeline route and within the gas pipeline servitude. The way leave was signed in October 2016, and it also permits EWS subcontractors (such as specialists working on the project) access to the pipeline servitude as part of the investigations into the EWS water main upgrades.

The pipeline route also falls within a Critical Biodiversity Area due to the presence of the Mdloti river, the associated wetland and aquatic habitats, as well as the terrestrial ecological features. In addition, the pipeline crosses a number of watercourses along its route, which triggers the need for obtaining a water use authorisation prior to the commencement of development. This is dealt with further under Construction Works.

CONSTRUCTION WORKS

The pipeline currently runs below and above ground, along roads and through properties- as described above. Given the current setting of the pipeline, the following construction activities will take place.

- *Materials:* The new pipeline will be a 600mmØ Class 16 steel high pressure pipeline. The EWS has proposed the use of pipe jacking at points where the pipeline crosses a watercourse. The jacking will be used to run the pipeline below the river bed and is envisaged to cause minimal environmental disturbance other than what will be incurred during the construction phase.

- *Construction corridor and servitude:* The EWS has planned a construction corridor of 10m parallel to the pipeline- i.e. 5m on each side of the proposed route. This will allow construction vehicles access to the pipeline servitude without causing adverse damage to the receiving environment by limiting the footprint of the total disturbed areas. The final pipeline servitude width will be 3m on each side to allow

Figure 3: A depiction of a pipeline underlain by riversand bedding

access for maintenance purposes. Say something about rehab of the construction corridor

- *Pipes laid below ground*: Pipelines are to be laid below ground by conventional open trench excavation except in the sensitive areas- such as the water crossings- where bridges will be used to place pipes across the watercourses. The depth of the various trenches varies according to location and topography of the existing ground level but generally an average depth of 1m above the top of the pipe is adhered to. The trench widths will be 300mm wider on either side of the pipeline which is in accordance with SANS 1200.

- *Bedding:* Flexible bedding will be prepared prior to the laying of the pipe. River sand has been selected as the most ideal material for the cradle and bedding for the pipe (see Figure 37 for a depiction of similar bedding).
    - Standard bends will be used to negotiate the pipeline route. Concrete anchor blocks will be constructed at the bends.
    - Butt welding will be used to join the pipe.
    - More river sand will be put on the sides to 100mm above the pipe secure its position.
    - The trench will then be backfilled to ground level and compact with a motorised rammer layers until the ground profile is reached

Figure 4[8] below depicts a cross section of the laying of the pipeline.

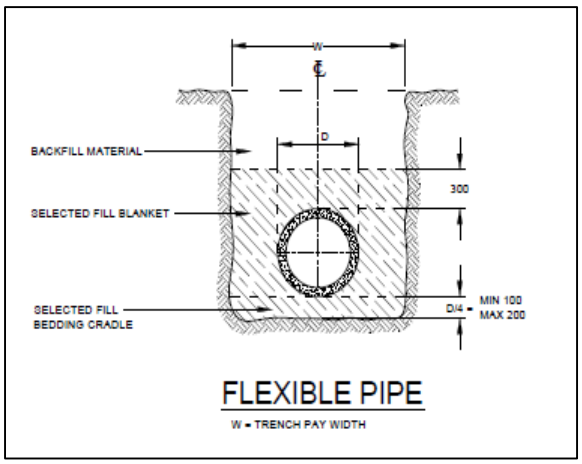

Figure 4: Proposed Steel pipeline bedding

- *Road Crossings:* Where the pipeline crosses the road, conventional open cut trenching with traffic controls will be utilised followed by temporary reinstatement [of traffic]. Once completed formal reinstatement will proceed, here the pipeline will be laid at a depth of 1200mm above the crown of pipe.

- *Wetland crossings:* The route of the pipe has wetland crossing that have been identified. Pipeline route crosses a wetland at the points listed in Table 5 below. Trenches where sections of the pipeline will be laid in the wetland will be excavated by manually. The section of the pipe which will be laid in the wetland will be excavated by hand. This is due to most of the wetland area being inaccessible and it will be done to prevent unnecessary damage to the wetland and the adjacent causeways waterbody. The main point at which the pipeline crosses the wetland is as follows: The sections of the pipeline that cross the watercrossings underground will be laid at a minimum depth of 800m below the river bed.

A total of 7 watercourse crossings were identified as follows:

Table 1: Identified watercourses

Description	GPS Coordinates
1. Section 21 (c) & (i)Construction of the pipeline across the head the wetland unit.	29°36'46.65"S 31° 3'12.83"E
2. Section 21 (c) & (i)Construction of the pipeline 25m below the toe of the wetland unit.	29°36'57.46"S 31° 3'31.98"E
3. Section 21 (c) & (i)Construction of the pipeline across the wetland unit.	29°37'0.62"S 31° 3'38.96"E
4. Section 21 (c) & (i)Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River.	29°37'3.59"S 31° 3'42.90"E
5. Section 21 (c) & (i)Construction of the pipeline 44m from the edge of the river unit but within the 1:100 year floodline of the Mdloti River.	29°37'9.76"S 31° 3'39.66"E
6. Section 21 (c) & (i)	29°37'20.04"S 31° 3'38.64"E
7. Section 21 (c) & (i)Strapping of the pipeline to an existing pipe jack & trenching of pipeline in the vicinity of the river unit and within the 1:100 year floodline of the Mdloti River.	29°37'38.89"S 31° 3'8.39"E

APPLICATION PROCESS

The EWS is applying for Environmental Authorisation in terms of the National Environmental Management Act (Act No. 107 of 1998 (NEMA)). The proposed development has triggered activities from Listing Notice 1 (Government Notice Regulation (GN R. 327 and 325, as amended in 2017)) of the Environmental Impact Assessment (EIA) Regulations. These activities are given in Table 2. In complying with legislation, a BA process needs to be carried out before the project is implemented. Furthermore, the pipeline route will traverse water crossings along its path which is likely to

[7] Source: http://www.wbho.co.za/category/roads-and-earthworks/pipelines-and-infrastructures/

[8] (Source: Ethekwini Water and Sanitation: Water Design Branch)

trigger the following water uses as listed in the National Water Act (Act No. 36 of 1198):

- Section 21 (c) “impeding or diverting the flow of water in a watercourse”
- Section 21 (i) “altering the bed, banks, course or characteristics of a watercourse”

The pipeline infrastructure installation options listed above have been proposed as a means of avoiding negative and adverse impact on the watercourses concerned. These include the use of pipe jacking for points at which the water main crosses the river, and manual (i.e. hand digging) in place of motorised excavations in areas near the identified wetland.

Ultimately, the outcome of the BA Process is to provide the Competent Authority (i.e. the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA)), with sufficient information to provide a decision on the Application in terms of environmental authorisation in order to avoid or mitigate any detrimental impacts that the activity may inflict on the receiving environment. This also applies to the DWS who will make the ultimate decision on permitting the works within the identified watercourse. In respect of this, the EWS has appointed DMT-Kai Batla (Pty) Ltd as the Independent Environmental Assessment Practitioner (EAP), to undertake the Basic Assessment and GA application processes.

In light of this, and to ensure that the activity occurs lawfully, part of this environmental authorisation process will include applying for a General Authorisation (in terms of Government Notice 509 of 2016: General Authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as defined in Section 21(c) or Section 21(i)). The GA will be lodged with the KZN regional office of the DWS.

Table 2: Triggered activities from the NEMA and NWA

ACTIVITIES TRIGGERED BY THE PROJECT	
Legislation	**List of Activities**
National Environmental Management Act, No. 107 of 1998 (as amended in)	**GNR 327 Activity 19:** The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving— (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies; (d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or (e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.
	GNR 325 Activity 12: The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan, in d. KwaZulu-Natal: v. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;
National Water Act, No. 36 of 1998	**Section 21:** • 21 (c): impeding or diverting the flow of water in a watercourse • 21 (i): altering the bed, banks, course or characteristics of a watercourse

PUBLIC PARTICIPATION PROCESS

The aim of the Public Participation Process (PPP) is to allow interested and Affected Parties (I&APs) the opportunity to gain an understanding of the project and consider all facets of the proposed development. The PPP will:

- Provide I&APs with information about the proposed development and associated potential impacts;
- Allow I&APs the opportunity to raise concerns on the proposed project; and
- Incorporate the concerns raised by I&APs in the study and ultimate decision-making process.

The following activities will take place during this period:

- Advertising the BA Process (in a local/regional press). An advertisement will be placed in the (*The Daily News*) and site notices will be placed at the project site and public venues;
- Registering I&APs and key stakeholders on the database. BIDs will be distributed to I&APs informing them that the Environmental Authorisation application is being lodged by the EWS. The Basic Assessment Report (BAR) and Environmental Management Plan (EMP) will be available at the Canelands Library, and on Dropbox (link provided below);
- Recording all comments, issues and concerns raised by I&APs and preparation of a PPP report and Comments & Responses Report.
- Updating of the BAR and EMPr taking into consideration all comments received; and
- Submission of the final BAR and EMPr to the DEDTEA for Authorisation.

GETTING INVOLVED

Surrounding communities, government and other stakeholders such as traditional authorities, community leaders, Non-Governmental Organisations (NGOs) and others are invited to register as I&APs. Stakeholders have the opportunity to comment on the draft BAR and EMPr and these comments will be incorporated into the final report and a separate public participation report will be compiled and submitted to the relevant authorities.

The Draft BAR and EMPr are available for commenting for a period of 30 days (16 October-16 November 2017). To access these reports, please go to the following venues:

- Canelands Library: 1 Alec Bean Rd, Canelands, Verulam, 4339; or
- On Dropbox, at via the link below:

https://www.dropbox.com/home/SS%20Draft%20BAR

How to get involved?

All persons who wish to take part in the Public Participation Process by commenting on or raising any concerns regarding the development are invited to do so through the following means:

1) Registering as an Interested and Affected Party (In writing or telephonically at the details provided below);
2) Submit any comments in writing on the response sheet attached to this document if you have any (and return to us by **16 November 2017**); and
3) Review the Draft BAR and EMPr and raise any concerns or comments.

The Draft BAR and EMPr are available for commenting for a period of 30 days, from **16 October to 16 November 2017** as follows:

- Canelands Library: 1 Alec Bean Rd, Canelands, Verulam, 4339; or
- On Dropbox, at via the link below:

https://www.dropbox.com/home/SS%20Draft%20BAR

How to get involved?

Contact Details for Registering as an I&AP and commenting on the proposed project:

Contact Samantha Moodley (Environmental Assessment Practitioner- EAP); Tel: (011) 781 4548; Fax: 086 545 2720; E-mail: Samantha.Moodley@dmt-group.com; Postal Address: PO Box 41955, Craighall, 2024, by **16 November 2017**

Once the authorities have made a decision regarding the project, stakeholders will be informed accordingly.

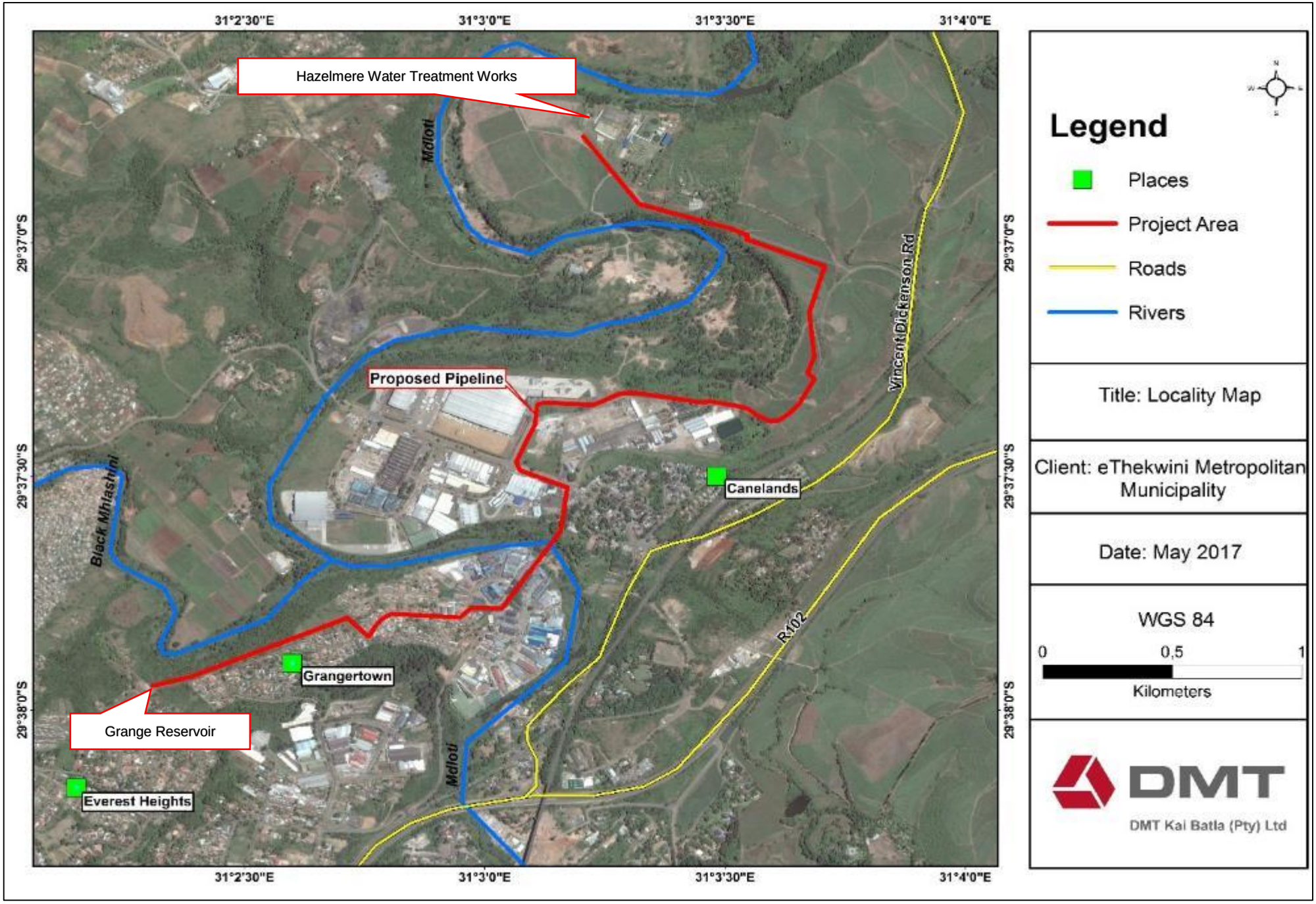

Figure 6: Project locality

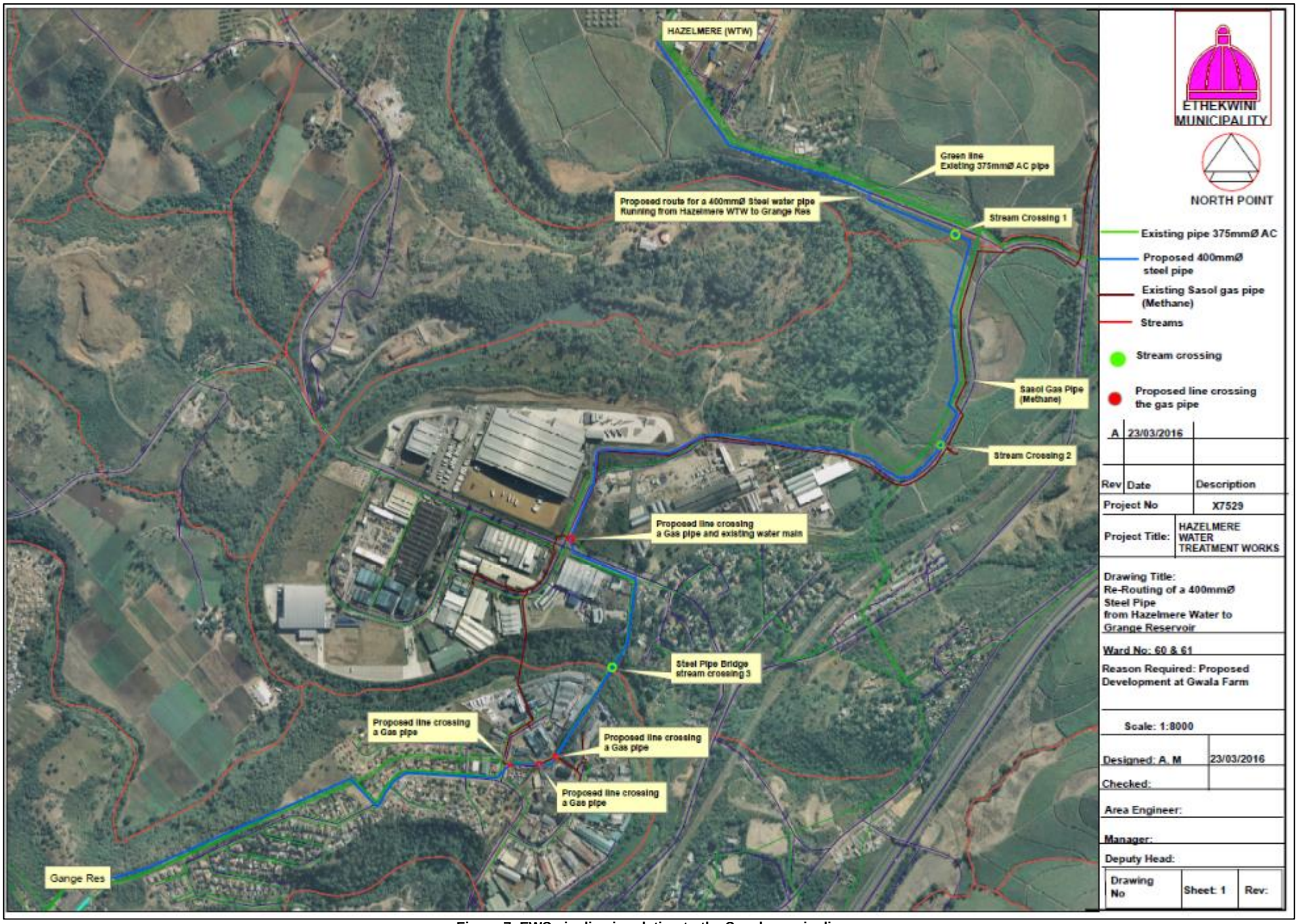

Figure 7: EWS pipeline in relation to the Sasol gas pipeline

ETHEKWINI WATER AND SANITATION

Basic Assessment and General Authorisation Application for the Proposed Re-Routing of a 600mmø Rising Main from Hazelmere Water Treatment Works to Grange Reservoir, in the Kwazulu-Natal Province

in terms of Government Notice Regulation 983 (Listing Notice 1) of the National Environmental Management Act (Act No. 107 Of 1998) &

The National Water Act (Act No. 36 Of 1998)

Comments and Response Sheet

Name and Surname			
Company/ Organisation			
Capacity (landowner, manager, director etc.)			
Postal Address			
Email Address			
Fax Number			
Telephone and/or Cellphone Number			
Have you received a BID?	**Yes**		
	No		

Questions, comments and responses

Would you like to be kept informed about progress of the proposed project?	**Yes**		
	No		

Are there any other individuals, organisations or stakeholders who you think should be consulted regarding the development? If yes, provide list their names and contacts details?

Contact Details for Registering as an I&AP and commenting on the proposed project:
Samantha Moodley (Environmental Assessment Practitioner- EAP)
Postal Address: PO Box 41955, Craighall, 2024
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APPENDIX E5

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APPENDIX F: ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPR)

DMT Kai Batla (Pty) Ltd

Basic Assessment and General Authorisation Application for the Proposed Re-Routing of a 600mmØ Rising Main from Hazelmere Water Treatment Works to Grange Reservoir, in the Kwazulu-Natal Province (REF: DM/0045/2017; NEAS REF: KZN/EIA/0000715/2017)

DRAFT ENVIRONMENTAL MANAGEMENT PLAN SUBMITTED FOR PUBLIC REVIEW

Prepared for:

eThekwini Water and Sanitation

Prepared by:
DMT Kai Batla (Pty) Ltd

Date:
November 2017

DMT Kai Batla (Pty) Ltd

DOCUMENT SUMMARY DATA

Project:	Basic Assessment and General Authorisation Application for the Proposed Re-Routing of a 600mm Ø Rising Main from Hazelmere Water Treatment Works to Grange Reservoir, in the Kwazulu-Natal Province (EDTEA Ref. No.) (REF: DM/0045/2017; NEAS REF: KZN/EIA/0000715/2017)
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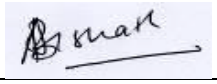
COMPILED BY:	CHECKED & APPROVED BY:
Samantha Moodley	Avinash Bisnath
DATE: 8 November 2017	DATE: 8 November 2017
	

DISCLAIMER

This report is based on state of affairs at the date of the Basic Assessment Report compilation. It is based on information received from eThekwini Water and Sanitation personnel. DMT Kai Batla (Pty) Ltd and its employees do not accept any responsibility for liability incurred by the organisation, or any of its agents, parent companies, affiliates, employees or contractors, as a result of reliance on the findings and opinions, or because of any omissions from the report content, findings or opinions.

Table of Contents

1 IDENTIFICATION OF THE APPLICATION

The details of the Environmental Authorisation (EA) application and the parties involved are as follows:

1.1 Applicants Details

Table 1: Contact details of Proponent

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1.2 Environmental Consultant

Table 2: Contact details of the EAP's Organisation

Item	Company Details
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2 INTRODUCTION

2.1 Project Background

Water supply infrastructure in South Africa has been undergoing replacement and upgrading in recent years. The existing infrastructure was initially installed in the 1960s. Over the years, the water supply pipeline scheme in the country has deteriorated and this has been catalysed by the rapid population and economic growth which has resulted in increased water supply demand over the last 25 years[1]. As the country has developed (particularly since 1996), there has been a greater need for efficient basic service infrastructure- particularly where water services and supply are concerned. In a bid to ensure the delivery of clean, safe, potable water to local communities, the eThekwini Municipality implemented a R1.6 billion project in 2010 where existing pipelines in the Durban area were replaced so as to combat the deteriorating efficiency of water infrastructure[2]. In addition to this, the eThekwini Water and Sanitation (EWS) Unit has implemented operational interventions- such as pipeline replacements- to address issues associated with the reduction in supply from its water treatment works[3].

The material commonly used for the initial infrastructure installation was Asbestos-Cement (AC), which has subsequently been banned in South Africa due to its hazardous impact on humans and the environment. As part of delivering on its service mandate, the EWS is proposing that the existing undipped AC rising main water pipe between Hazelmere and Grange Reservoir be replaced to combat material degradation as the AC pipes have reached the end of their serviceable life. Regular pipe bursts cause water loss during a time where water conservation is of utmost importance in the country. The bursts also speak to service delivery needs and the inconvenience that is suffered by receiving water users. This is seen in the leaks and flooding experienced by some private landowners through whose property the pipeline traverses. Numerous pipe bursts have led to insurance claims against the Municipality and the overall state of the pipeline is compromising the level of service being delivered to consumers- which the EWS aims to address with the implementation of the proposed project.

The Applicant

EWS is a unit of the eThekwini Metropolitan Municipality and is responsible for the provision of water and sanitation services to all customers in the Municipality. The Unit counts customer focus, cost consciousness and a concern for the well-being of its staff as part of their core values, and they are continually looking for new and innovative ways to provide services to their customers.

The EWS is known for introducing some of the earliest water management measures in South Africa. This includes initiatives such as free basic water, flow limiters, the use of plastic bodied water meters, polypropylene water piping, ground tanks and semi-pressure water service levels, urine diversion toilets, anaerobic baffled reactors, the use of grey

[1] http://www.infrastructurenews.ws/2013/03/20/replacement-of-water-pipes-in-major-municipalities-is-long-overdue/
[2] http://www.engineeringnews.co.za/article/municipal-pipe-replacement-projects-could-help-relieve-local-water-pressures-2016-02-12
[3] Ihttp://www1.durban.gov.za/Durban/services/water_and_sanitation/services/replacement-of-ac-secondary-watermains/acprojectendsjune2010

water for urban agriculture, customer services agents, residential sewerage and a customer water debt repayment policy.

Furthermore, the Unit has a standing agreement with the University of Kwazulu-Natal for co-operative research aimed at furthering the water agenda.

As listed on their website, the Unit's key priorities include[4]:

- Eradicating the backlog in the provision of water and sanitation services:
  - The water backlog has been reduced to 15% of what it was in 1996;
  - The sewerage backlog stands at approximately 50% of the 1996 figure.
- Reducing non-revenue water from the present level of 30%, to 25%, over the next 5 years.
- Improving asset management systems.
- Training young graduates in engineering and retaining skilled staff to respond to the shortage of engineers and professional skills in SA.
- Improving performance management systems.
- Improving customer services and services payment levels.

The pipeline upgrade is in line with the EWS priorities listed above, and is part of the Unit's mandate for basic service delivery. The project is one of many that the entity has embarked on in the area of infrastructure management, and it displays the measures being taken by the Municipality as a front runner in service infrastructure upgrades and maintenance.

2.2 **Project Description**

In the past, AC pipes were touted for their light weight and ease of handling, low coefficient and corrosion resistant properties. However, the appeal and durability of the AC pipes has lost favour over the years due to the introduction of material that is proven to be more durable. Based on this, and in addressing the water service delivery backlogs, eThekwini has now opted for steel pipes with a wider diameter which will see greater water volumes flowing between certain water treatment plants and reservoirs. As such, the EWS has proposed the upgrading of the existing AC rising main between Hazelmere Water Treatment Works (WTW) to Grange Reservoir which is approximately 6km in length. The current rising main forms part of an existing registered servitude and traverses private property. It also bursts on occasion resulting in flooding of properties (as seen in Figure 1) and subsequent insurance claims against the Municipality. The valves located on this main are in various stages of deterioration- some severely corroded, and others being non-operational. The EWS conducts on-going repairs on the pipelines and valves (similar to those depicted in Figures 2 and 3). However, problems on this rising main are hampering supply to the three reservoirs that source water from Grange Reservoir – namely Everest Heights Reservoir, Redcliffe Reservoir and Mountainview.

[4] This information was extracted from the EWS website, from the " Who we Are?" page, available on: http://www.durban.gov.za/City_Services/water_sanitation/About_Us/Pages/default.aspx

Figure 1: The images depicting the water main leaks and burst (Source: EWS)

It is proposed that the existing 375mm diameter (Ø) Constant Inside Diameter (CID) AC rising main be upgraded by a 600mmØ steel pipeline routed along surrounding roads within the existing servitude en route to Grange Reservoir. The proposed rising main will have air valve chambers and scour valve chambers positioned at crest and troughs respectively (see Figures 2[5] and 3[6]). Air valves are placed at regular intervals along the pipeline and serve the purpose of evacuating dissolved air from the pipeline. Scour valves are located at low points. They facilitate the periodic flushing of the pipelines to remove sediment and allow the pipeline to be drained during maintenance and repairs. The upgrading of the rising main is also being done in consideration of future housing developments in the area as well as to meet the associated increase in water demands. Furthermore, the upgrades are being done to ensure the efficient pumping of water to and between Grange Reservoir and Hazelmere WTW.

Figure 3: Example of a scour valve (Source:

Figure 3: Example of an air valve chamber

[5] Source: http://www.chings.co.nz/projects_infrastructure_water.html
[6] Source: http://drivingstrategicsales.com/martech-stories)1/2016/3/15/1upsfqo3jmq6es17syqvwofwg

2.3 Locality of the Activity

The project area falls within the eThekwini Metropolitan Municipality. The nearest major urban centre is the city of Durban which is eThekwini is the largest city the in KwaZulu-Natal (KZN) Province and the third-largest city in the country. Its land area is comparatively larger than that of other South African cities and is topographically hilly, with many gorges and ravines. The proposed pipeline development area is located in the southern area of KwaZulu-Natal, and falls to the northeast of Durban. The pipeline runs from the Hazelmere Water Treatment Works (WTW) to Grange Reservoir (see Figure 4). The area in which most of the proposed pipeline is laid is situated is on a floodplain and is therefore topographically flat. Areas of higher elevation and steeper topography are only found at the Hazelmere WTW and Grange Reservoir (MSJ 2016). The nearest town to the project area is Verulam- located just to the south east of Grangetown. The greater project area is located approximately 15km west of the King Shaka International Airport, and other surrounding urban centres are Tongaat, La Mercy and Umdloti- located to the far north, east, and to the far south respectively.

2.4 Physical Footprint of the Activity

The pipeline crosses through the suburbs of Grangetown, Umdloti Heights, Riverview park and Canelands- prior to reaching the Grange Reservoir located on Prabat Crescent. The upgraded water main will cross the following roads:

- Hazelmere Road in the north of the site
- Duiker Road and New Glascow Road in the Canelands Industrial park
- Spring Place in Riverview Park
- Mission Road in the southern residential area

In some areas along the existing pipeline servitude, the EWS main runs adjacent to- and crosses - a Sasol gas pipeline (please refer to Figure 5 for a depiction of the Sasol gas pipeline route in relation to the proposed water main upgrades). The proposed pipeline will cross the Sasol gas pipe at the Corner of Duiker Road and New Glascow, and there will be three crossings on the corner of Spring Place and the unnamed gravel path leading to the pipe bridge. To ensure that the pipeline upgrade does not interfere with the Sasol line, the EWS has obtained a signed way leave from the energy company, permitting the upgrades of the water main along their [Sasol's] pipeline corridor and within the gas pipeline servitude. The way leave was signed in October 2016, and it also permits EWS subcontractors (such as specialists working on the project) access to the pipeline servitude as part of the investigations into the EWS water main upgrades.

The pipeline route also falls within a Critical Biodiversity Area due to the presence of the Mdloti river, the associated wetland and aquatic habitats, as well as some sensitive terrestrial ecological features. In addition, the pipeline crosses a number of watercourses, which triggers the need for obtaining a water use authorisation prior to the commencement of development.

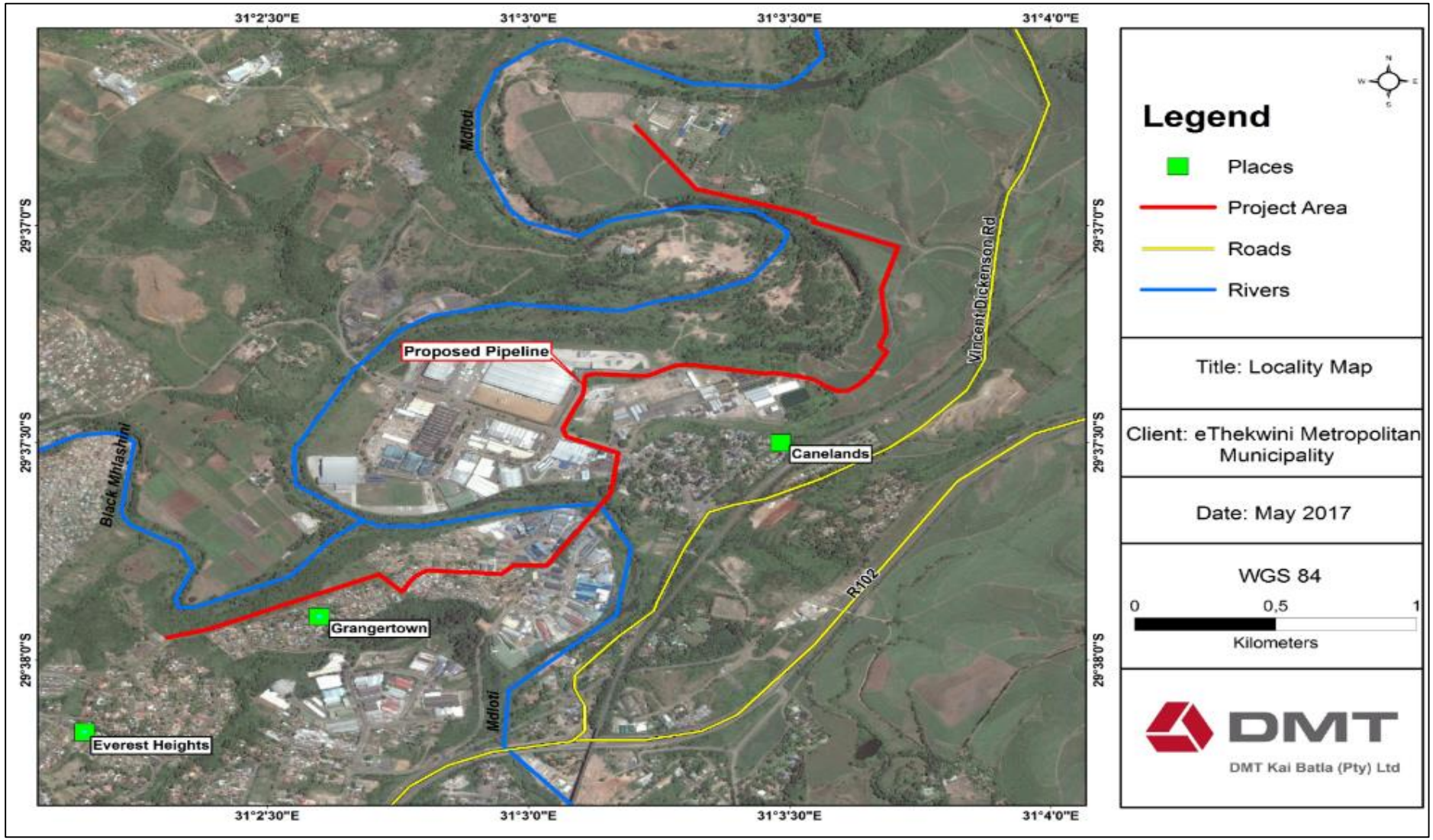


Figure 4: Project locality map

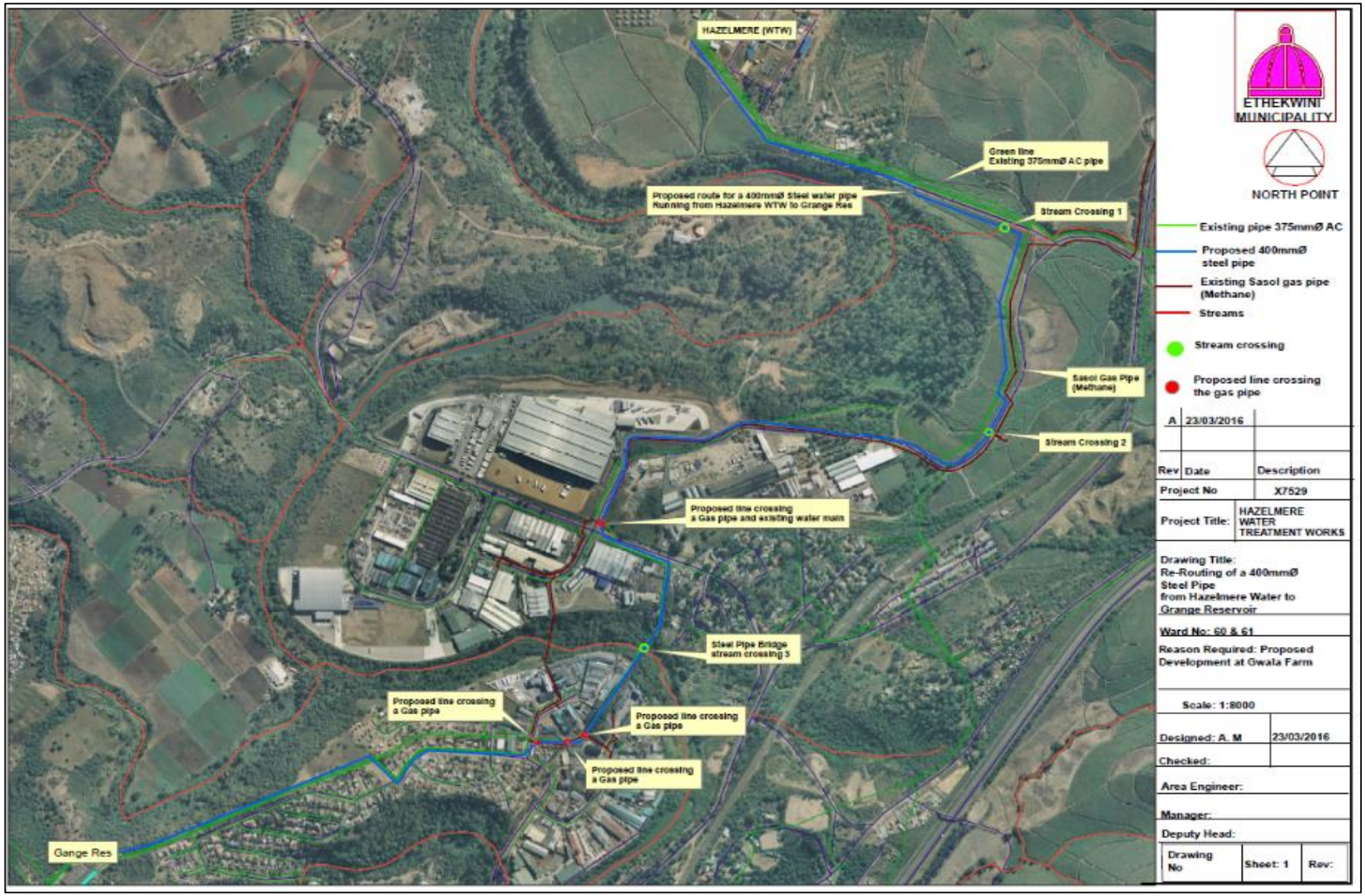


Figure 5: EWS pipeline in relation to the Sasol gas pipeline

2.5 Construction Works

The pipeline currently runs below and above ground, along roads and through properties- as described above. Given the current setting of the pipeline, the following construction activities will take place:

- *Materials*: The new pipeline will be a 600mmØ Class 16 steel high pressure pipeline. The EWS has proposed the use of bridges at points where the pipeline crosses a watercourse. A pipe bridge (also known as a pipe rack) is essentially a structure used to run a pipeline over a river. In terms of the pipeline crossing the watercourse, the pipe bridge is the most feasible option as it avoids having to run the pipeline through the affected course. This is most applicable to rivers and streams and is envisaged to cause minimal environmental disturbance other than what will be incurred during the construction phase.

- *Construction corridor and servitude: The* EWS has planned a construction corridor of 10m parallel to the pipeline- i.e. 5m on each side of the proposed route. This will allow construction vehicles access to the pipeline servitude without causing adverse damage to the receiving environment by limiting the footprint of the total disturbed areas. The final pipeline servitude width will be 3m on each side to allow access for maintenance purposes. Say something about rehab of the construction corridor.

- *Pipes laid below ground:* Pipelines are to be laid below ground by conventional open trench excavation except in the sensitive areas- such as the water crossings- where bridges will be used to place pipes across the watercourses. The depth of the various trenches varies according to location and topography of the existing ground level but generally an average depth of 1m above the top of the pipe is adhered to (please see Figures 6[7] and 7[8] for a depiction of this). The trench widths will be 300mm wider on either side of the pipeline which is in accordance with South Africa National Standards (SANS) 1200 stipulations.

Figure 6: A depiction of a pipeline underlain by riversand bedding

[7] Source: http://www.wbho.co.za/category/roads-and-earthworks/pipelines-and-infrastructures/
[8] Source: Ethekwini Water and Sanitation: Water Design Branch

- *Bedding:* Flexible bedding will be prepared prior to the laying of the pipe. River sand has been selected as the most ideal material for the cradle and bedding for the pipe (see Figure 6 for a depiction of similar bedding).
    - Standard bends will be used to negotiate the pipeline route. Concrete anchor blocks will be constructed at the bends.
    - Butt welding will be used to join the pipe.
    - More river sand will be put on the sides to 100mm above the pipe secure its position.
    - The trench will then be backfilled to ground level and compacted with a motorised rammer in 300mm layers until the ground profile is reached.

Figure 7 below depicts a cross section of the laying of the pipeline.

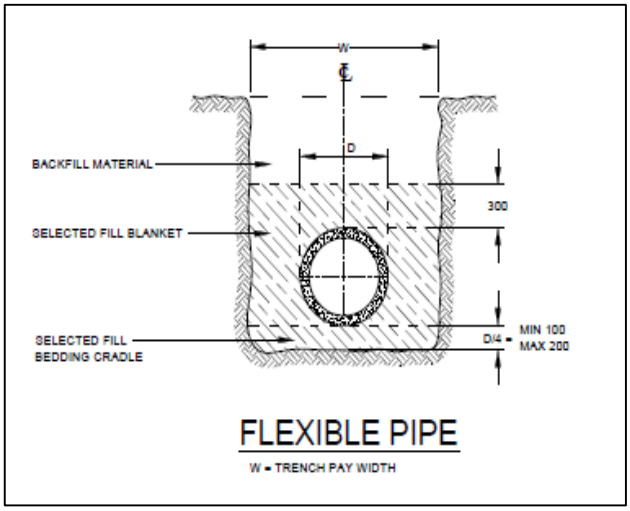


Figure 7: Proposed Steel pipeline bedding

- *Road Crossings:* Where the pipeline crosses the road, conventional open cut trenching with traffic controls will be utilised followed by temporary reinstatement [of traffic]. Once completed formal reinstatement will proceed, here the pipeline will be laid at a depth of 1200mm to the crown of pipe.

- *Wetland crossings:* The pipeline route crosses a wetland at the points listed in Table 3 below. Trenches where sections of the pipeline will be laid in the wetland will be excavated by manually. This is due to most of the wetland area being inaccessible and it will be done to prevent unnecessary damage to the wetland and the adjacent causeways. The sections of the pipeline that cross the watercrossings underground will be laid at a minimum depth of 800m below the river bed.

A total of 7 watercourse crossings were identified for which a water use authorisation is required. A description of the applicable activities that are likely to constitute water uses is provided in the Table below.

Table 3: Water uses relevant to the proposed development.

No.	Water Uses[9]	Description	Length of crossing (m)	GPS Coordinates
1	Section 21 (c) & (i)	Construction of the pipeline across the head the wetland unit.	12m	29°36'46.65"S 31° 3'12.83"E
2	Section 21 (c) & (i)	Construction of the pipeline 25m below the toe of the wetland unit.	N/A	29°36'57.46"S 31° 3'31.98"E
3	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit.	200m	29°37'0.62"S 31° 3'38.96"E
4	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River.	50m	29°37'3.59"S 31° 3'42.90"E
5	Section 21 (c) & (i)	Construction of the pipeline 44m from the edge of the river unit but within the 1:100 year floodline of the Mdloti River.	N/A	29°37'9.76"S 31° 3'39.66"E
6	Section 21 (c) & (i)	Construction of the pipeline across the wetland unit and within the 1:100 year floodline of the Mdloti River	75m	29°37'20.04"S 31° 3'38.64"E
7	Section 21 (c) & (i)	Strapping of the pipeline to an existing pipe bridge & trenching of pipeline in the vicinity of the river unit and within the 1:100 year floodline of the Mdloti River.	N/A	29°37'38.89"S 31° 3'8.39"E

Considering this, the Applicant would have to obtain authorisation form the KZN regional Department of Water and Sanitation (DWS) for the proposed activity to go ahead. In support of the water use authorisation application, a specialist aquatic study was conducted, where an assessment of the potential aquatic risks of the project was assessed. The DWS Risk Assessment tool was used in the assessment, whose results indicate that the construction and operational activities of the proposed development qualify as a low risk activity because affected watercourses are highly degraded, lack sensitive habitats, lack conservation important aquatic biota and are therefore unlikely to be significantly modified as a result of the construction and operation of the proposed pipeline. As such, based on these results, **the proposed project qualifies for authorisation under the provisions of a General Authorisation (GA)**.

It is envisaged that the installation of the water pipeline will commence in March 2017 once all relevant environmental permits are in place.

[9] ***Section 21(c): Impeding or diverting the flow of water in a watercourse:*** *This water use includes the temporary or permanent obstruction or hindrance to the flow of water into watercourse by structures built either fully or partially in or across a watercourse; or a temporary or permanent structure causing the flow of water to be re-routed in a watercourse for any purpose.* ***Section 21(i): Altering the bed, banks, course or characteristics of a watercourse:*** *This water use relates to any change affecting the resource quality of the watercourse (the area within the riparian habitat or 1:100 year floodline, whichever is the greatest).*

2.6 Operational and decommissioning

No activities other than routine inspections and maintenance of the pipeline will take place during the operational phase. The pipeline has an expected life in excess of 80 years and if required sections of it can easily be replaced by accessing damaged sections through chambers en-route. Should the pipeline ever need to be removed in future the EIA requirements at that time will be applied for and fulfilled during the decommissioning phase.

2.7 Property Description

The properties impacted by the proposed pipeline upgrade and their respective owners is reflected in **Table 3** below.

Table 4: Properties through which the pipeline runs

	Surveyor-General Cadastral Code No.	Title Deed Reference	Owner
1.	N0FU00000000157500690	T2523/1921	Transnet Ltd
2.	N0FU000000001575 00689	T2533/1921	Transnet Ltd
3.	N0FU00000000157502050	-	
4.	N0FU00000000157501970	T18280/2015	Dube Tradeport Corporation
5.	N0FU00000000157501949	T18621/1984	Umgeni Water
6.	N0FU00000000157501971	T4395/2015	Canelands Trust
7.	N0FU00000000157502026	T13294/1984	Tongaat Hulett Dev Pty Ltd
8.	N0FU00410000003200000	T36240/1998	NTMSC
9.	N0FU03660000796100000	T4627/2013	Ethekwini Municipality
10.	N0FU03660000789300000	T11588/2005	Everest Flexibles Pty Ltd
11.	N0FU03660000457800000	T8177/1989	Ethekwini Municipality
12.	N0FU03660000789700000	T15003/1991	Rampersad Baijnath
13.	N0FU03660000789800000	T33710/2000	NOBCON Inv CC
14.	N0FU00000000157501240	T18280/2015	Dube Tradeport Corporation
15.	N0FU03660000036300000	-	Registered Pipeline Servitude
16.	N0FU00000000157500276	-	Registered Pipeline Servitude
17.	N0FU03660000036300002	-	Registered Pipeline Servitude
18.	N0FU03660000036400000	-	Registered Pipeline Servitude
19.	N0FU03660000036500000	T27698/1984	North Coast Regional Water Services
20.	N0FU00410000022100000	T24975/1985	Moreland Dev Pty Ltd

2.8 Basic Assessment and General Authorisation Application Process

The proposed development requires Environmental Authorisation in terms of the National Environmental Management Act (NEMA) (Act 107 of 1998). An activity identified in Listing

Notices 1 and 3 of the EIA Regulations of 2014- as amended in 2017- will be triggered by the proposed project and thus a Basic Assessment (BA) process is being undertaken. The said activities are as follows:

Table 5: NEMA Triggered activities

Legislation, triggered activity	Description and application
National Environmental Management Act (Act No 107 of 1998); GNR 327: Listing Notice 1 of the EIA Regulations of 2014- as amended in 2017 Activity 19: The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse	The construction works will involve excavating trenches along the pipeline route in preparation for laying of the pipe. The excavation will be taking place within the buffer zone of a watercourse as the pipeline crosses a watercourse at two points (as described under the National Water Act triggers).
National Environmental Management Act (Act No 107 of 1998); GNR 325: Listing Notice 3 of the EIA Regulations of 2014- as amended in 2017 Activity 12: The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. d. KwaZulu-Natal: v. Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;	The excavation and removal of the existing pipeline will require the clearing of any vegetation along the pipeline route and within the pipeline servitude. The pipeline route falls within a Critical Biodiversity Area (CBA) and the area is part of the KwaZulu-Natal Coastal Belt vegetation unit. Considering the length of the pipeline, and the fact that the project area falls within this vegetation unit and in a CBA, the project has been identified to trigger Activity 12 of Listing Notice 3.

Furthermore, the pipeline route will traverse water crossings along its path which is likely to trigger Section 21 water uses as listed in Table 3. The pipeline infrastructure installation options listed above have been proposed as a means of avoiding negative and adverse impact on the watercourses concerned. These include the use of pipe bridges for points at which the water main crosses the river, and manual (i.e. hand digging) in place of mechanical excavations in areas near the identified wetland. In light of this, and to ensure that the activity occurs lawfully, part of this environmental authorisation process will include applying for a General Authorisation (in terms of Government Notice 509 of 2016: *General Authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as defined in Section 21(c) or Section 21(i)*. The GA will be lodged with the KZN regional office of the Department of Water and Sanitation (DWS).

Ultimately, the outcome of the BA Process is to provide the Competent Authority (i.e. the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA)), with sufficient information to provide a decision on the Application in terms of environmental authorisation in order to avoid or mitigate any detrimental impacts

that the activity may inflict on the receiving environment. This also applies to the DWS who will make the ultimate decision on permitting the works within the identified watercourse. In respect of this, the EWS has appointed DMT-Kai Batla (Pty) Ltd as the Independent Environmental Assessment Practitioner (EAP), to undertake the Basic Assessment and GA application processes.

3 GOVERNANCE REQUIREMENTS FOR ENVIRONMENTAL MANAGEMENT

The following key pieces of legislation will be relevant to the proposed project:

Table 6: Applicable legislation

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
Constitution of the Republic of South Africa Act No. (106 of 1996)	The Constitution is the supreme Law in South Africa. Chapter 2 of the Constitution contains the Bill of Rights including section 24 which provides that: "Everyone has the right- to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that- prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development." Other rights protected by the Constitution relevant to an application for environmental authorisation include the right to administrative justice and to information, and rights, known as "socio-economic rights", such as access to adequate housing. The right to administrative justice is relevant to applications for environmental authorisations because decisions made by the competent authority in the course of the EIA process (such as the decision to accept a basic assessment report) as well as a final decision on the application fall into the definition of "administrative action" The constitution, and the stipulations it sets out on environmental management are the guiding principles on which environmental and development legislation has been conceptualised. The responsibility that the Applicant has to the environment needs to be in line with the Constitution- hence the need to ensure that all potential harm and pollution is highlighted and brought to the attention of the relevant decision makers (in this case, the KZN EDTEA).	South African Government	1996

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
The National Environmental Management Act (NEMA), (Act No 107 of 1998) **Environmental Impact Assessment Regulations of 2014- as amended in 2017(Government Notice No. R. 324, 325, and 327)**	The requirement to obtain environmental authorisation for certain development proposals or projects is legislated in NEMA. Any activity which is listed in Listing Notice 1 - Listing Notice 3 of these EIA Regulations is subject to environmental authorisation. Chapter 5 of NEMA focuses on promoting the use of appropriate environmental tools, primarily environmental and social impact assessment procedures, as a means to achieve the goal of integrated environmental management. The EIA Regulations, made under section 24 of NEMA, are intended to integrate and facilitate environmental impact management with development activities or processes, in line with sustainable development objectives. They provide a method for the investigation, assessment and communication of the potential consequences or impacts of listed activities The purpose of the EIA Regulations is to ensure that the impacts of activities for which environmental authorisations are necessary are properly assessed; so that the positive environmental impacts are enhanced; the activities which may have an unacceptable, negative effect on the environment are not authorised and those which are suitable for authorisation are approved, with conditions to avoid or mitigate possible detrimental effects. The proposed project triggers activities in Listing Notice 1 (GNR 327) and Listing Notice 3 (GNR 325) of the EIA activities, as amended in 2017. The proposed project triggers activities in both Listing Notice 1 and 3, and is therefore subject to Basic Assessment as the process to be followed in obtaining environmental authorisation.	Department of Environmental Affairs (DEA)	1998 2017
The National Water Act, 1998 (Act No 36 of 1998)	The National Water Act, 1998 (Act No. 36 of 1998) mandates the Minister of Water Affairs to ensure that water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. Furthermore, the Act will guide the steps towards the application for and obtaining the required authorisation in order for the proposed development to proceed, in terms of the water crossings identified along the pipeline route. For this project the DWS would, make the decision based on matters directly related to water resources. The proposed pipeline crosses the Mdloti river and a wetland along its route. As such, consultation will need to be conducted between the Applicant and the DWS to confirm the potential water uses that the project will trigger, as well as the procedure to follow in obtaining the necessary water use authorisation.	Department of Water and Sanitation	1998
National Environmental	The National Waste Act stipulates the manner which various waste classes should be stored, managed and disposed of while being cognisant of the potential impact the waste handling may have on the environment. In terms of the proposed project, waste will be generated during the construction	Department of Environmental Affairs (DEA)	2008

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
Management: Waste Act No. 59 of 2008 and GNR 921	phase, however, in accordance with the waste regulations, waste will not be stored but responsibly disposed of at the nearest registered landfill site (i.e. the Durban Solid Waste). In addition, a suitably qualified asbestos handler must be tasked with handling of the asbestos pipe and any asbestos containing waste (ACW) associated with it. This is in line with Policy on the Handling and Disposal of Asbestos and Asbestos Containing Waste in terms of Section 20 of the Environment Conservation Act, 1989 (Act 73 OF 1989), the Occupational Health and Safety Act (OHSA) (Act 85 of 1993) and the Asbestos Regulations of 2001.		
Water Services Act, Act 108 of 1997 **eThekwini Water Service Delivery Plan, 2011**	The Water Services Act sets out the regulatory framework for institutions tasked with the supply of water services and provides for different water services institutions to be established, i.e.: - the water services authority - i.e. the responsible municipality - the water services provider - whose role is to physically provide the water supply and sanitation services to consumers. The EWS policies for water service delivery (such as the Water Service Delivery Plan, 2011 (WSDP)) are based on the stipulations set in this Act. Implementing this water main upgrade is in line with the EWS's mandate in terms of the Act's requirements.	Department of Water and Sanitation	1997 2011
National Heritage Resources Act (Act 25 of 1999) **KwaZulu-Natal Heritage Act, (Act No. 4 of 2008)**	The Act, and the provincial legislation stemming from it, serve to lay down general principles for governing heritage resources management throughout the country. Based on knowledge of the site and the pipeline servitude, heritage or cultural artefacts do not occur in the direct pathway of the pipeline. Should archaeological artefacts or skeletal material be revealed in the area during development activities, such activities should be halted, and the KZN Provincial Heritage Authority (i.e. Amafa) be notified in order for an investigation and evaluation of the find(s) to take place.	Amafa KwaZulu-Natali (AMAFA)	1999
Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)	The OHS Act provides for the health and safety of persons at work and for the health and safety of persons indirectly associated with the daily construction site activities; the protection of persons other than persons at work; and protects against hazards to health and safety arising out of or in connection with the activities of persons at work. This Act will be enforced during the construction and it serves to	Department of Labour	1993

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
	mitigate any potentially negative impacts the proposed project may have on any of the labour force and on the surrounding communities.		
Noise Regulations under the Environment Conservation Act (ECA) (Act 73 of 1989) **SANS 10103-2008**	Noise is regulated in terms of the Noise Control Regulations of ECA. Legislative responsibility for the Noise Control Regulations is devolved to the provinces and implemented at a local level by municipalities. In terms of the proposed project, the construction phase is likely to result in noise generation but of a temporary nature. The noise level is anticipated to be less than 45- 50dBA to the nearest sensitive receivers as required by SANS 10103-2008. This standard governs "*measurement and rating of environmental noise with respect to annoyance and to speech communication*". The project proponent is required to adhere to these limits during the project development and/or operation.	Department of Environmental Affairs (DEA)	1989
National Environmental Management: Air Quality Act (Act No 39 of 2004)	Sections 18, 19 and 20 of the Act allow certain areas to be declared and managed as "priority areas". The developer must take heed of the declaration of controlled emitters (Part 3 of Act), controlled fuels (Part 4 of Act) with relevant emission standards, as well as the Dust Control Regulations (R. No. 827 of 1 November 2013).	Local authorities, i.e. eThekwini Municipality, Overseen by the KZN EDTEA	2004
Ethekwini Municipality Integrated Development Plan (IDP) (2017/18 – 2021/2022)	The IDP displays the EMA's efforts in the provision of quality and affordable basic services, providing a safe and clean environment while also creating a favourable environment for local economic development. The development of the proposed development is in line with the IDP which sets out the objectives for the desired spatial form of the greater province. It provides strategic guidance for the location and nature of future development in the Municipality.	eThekwini Municipality	2017
eThekwini Municipality Spatial Development Framework Review 2016-2017 (SDF)	The Municipal Spatial Development Framework (SDF) displays the EMA's efforts in the provision of quality and affordable basic services, providing a safe and clean environment while also creating a favourable environment for local economic development. The SDF sets out the objectives for the desired spatial form of the municipal area. It provides strategic guidance for the location and nature of future development in the Metro. It contains a strategic assessment of the environmental impact of the SDF and identifies programs and projects for the development of land within the municipality.	eThekwini Municipality	2016

4 PLANNED MONITORING AND PERFORMANCE ASSESSMENT

4.1 Principles of the EMPr

The aim of implementing an Environmental Management Programme (EMPr) is to ensure that all activities attributed to the project, with irreversible impacts are avoided, and measures are taken to minimise or rectify impacts where possible. The EMPr also provides guidance on-going monitoring and management of these impacts by highlighting the need to for recording good or bad performances and compliances. The implementation of this EMPr is aimed at ensuring that all activities attributed to the project, with irreversible impacts are avoided, and measures are taken to minimise or rectify impacts where possible. The EMPr also provides on-going monitoring and management of these impacts by documenting good or bad performances and compliances with the EMPr. The objectives of the EMPr include:

- Ensuring that all associated activities are undertaken in a way that minimises identified potential negative effects on the surrounding environment;
- Ensuring that appropriate environmental management measures are assimilated in the final development plans;
- Ensuring that relevant environmental management are well stipulated, understood and documented for all relevant parties;
- Ensuring that the suitable record keeping and reporting structures are put in place to ensure that implementation of the stipulated environmental management measures are monitored in the long-term; and
- Ensuring that the roles and responsibilities for the management of various aspects are clearly defined and understood.

4.2 Role and Responsibilities

Effective implementation of the EMPr requires that all parties or role players involved in this project need to comply with the directives set out. A concise description of impacts and their mitigation/management measures will be provided and understood by all role players responsible for the implementation and monitoring of the mitigation measures. The project will comprise of the following role players:

Table 7: Project Roles

Role	Responsible Party
Authorities	KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA)),
Developer or Proponent	eThekwini Municipality: Water and Sanitation Unit (EWS)
Environmental Assessment Practitioner (EAP)	DMT Kai Batla (Pty) Ltd

4.3 Environmental Management Programme Implementation and Monitoring

Table 8: Roles and Responsibilities for the EWS pipeline upgrade

FUNCTION	RESPONSIBILITY
Developer/Proponent **(EWS)**	The eThekwini Water and Sanitation Unit (EWS) is responsible for ensuring that the proposed pipeline upgrade is in line with the standards of NEMA, as well as the provincial and municipal development and spatial plans. They are also responsible for ensuring that the upgraded pipeline operates more efficiently than the infrastructure currently in place. In implementing environmental management measures during the pipeline operation, EWS needs to: • Ensure that all parties during operational activities, are well aware of and implement the applicable environmental management requirements (as listed in the EMPr); • Ensure that all personnel are well versed with the EMPr; • Ensure that the Construction Manager is undertaking all activities in accordance with the requirements of the EMPr and that high standards of environmental management are pursued; • Allocate and manage resources to ensure adequate supervision of environmental matters; and • Undertake and review environmental monitoring reports and verify that environmental monitoring results are within specified limits. • Ensure that personnel are adhering to the conditions of the - should the application be successful.
Construction/Project Manager	The Construction/Project Manager has complete responsibility of the whole project and any contracted parties and ensuring that all environmental management facets are adhered to. The roles and responsibilities of the Construction Manager during the Construction Phase will include: • Identifying the need for remedial measures with regard to proposed works; • Communicating directly with the Contractors; and • Issuing non-conformance notifications to Contractors that do not comply with the requirements as set out in the EMPr.
Contractor	A number of Contractors will be employed by the EWS for different components of the project. This EMPr applies to each individual Contractor. The Contractor's primary responsibilities are to construct the works and ensure compliance with the Construction Phase EMP. The Contractor shall appoint an Environmental Officer (EO) whose role is to ensure compliance with the requirements of the EMPr.
Lead Authority	The KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA is responsible for approving the EA application. Ensuring that the monitoring and adherence to EMPr is carried out, by going through/reviewing audit reports submitted by the proponent and conducting regular site visits.
Environmental Control Officer	EWS's obligation is to ensure that the implementation of the project complies with the requirements of any environmental authorisations and permits, and obligations emanating from other relevant environmental legislation. This obligation is partly met through the development and the implementation of the EMPr - through its integration into the contract documentation. The responsibility of the Environmental Control

FUNCTION	RESPONSIBILITY
	Officer (ECO) will be to ensure that all EMPr obligations are implemented and that all activities taking place in the pipeline upgrade project are in compliance with the EA conditions and EDTEA requirements.
Environmental Assessment Practitioner	As defined in Section 1 of NEMA; "the individual responsible for the planning, management and coordination of environmental impact assessments, strategic environmental assessments, environmental management plans and programmes, or any other appropriate environmental instrument introduces through regulations". DMT Kai Batla is the EAP appointed to conduct the environmental assessment as part of the environmental authorisation process.
Wetland Specialist	The wetland specialist shall be responsible for making amendments and exceptions to rehabilitation measures provided in this document and signing off on all rehabilitation related activities.

4.4 Procedures for the Pre-Operational Phase

The implementation and monitoring procedures to be undertaken for the successful execution of the EMPr include:

- Undertaking an initial site visit during which EWS and the parties tasked with the management and maintenance of the water main discuss issues of environmental concern relating to the project, and agree on roles and responsibilities, communication and reporting procedures;
- Executing an environmental awareness training workshop prior to the commencement of construction and operations for all EWS and contractor personnel involved- informing them of the purpose and importance of the EMPr;
- The implementation of the EWS's emergency response plan;
- The ECO will inspect the site regularly to monitor and review the environmental performance of the upgraded pipeline against the commitments of the EMPr;
- During construction, the ECO will prepare weekly compliance checklist reports, detailing any environmental issues, non-compliance and actions to be implemented, to be submitted to the Construction Manager or the relevant party as decided on by EWS. Furthermore,
    - The ECO or the Construction Manager will be formally notified of the required corrective action;
    - The ECO will be expected to implement the required corrective action as detailed in the formal notification, and within the timeframes specified by the ECO; and
- These procedures should also be implemented for all activities during the Operational Phase- where applicable.

4.5 Environmental awareness training

Environmental awareness training courses should be provided to all personnel on site prior to the commencement of operation activities, detailing their obligations towards environmental management and in terms of the EMPr. The environmental training courses will include, amongst others, aspects such as:

- Environmental issues on site and having a full understanding of the environmental setting of the pipeline;
- Roles and responsibilities of all EWS, external employees, service providers and all parties involved in the project;
- The operational environmental management measures;
- Toolbox talks on environmental practices and safety awareness on site, and the prevention of any incidents or disasters; and
- Cultural awareness.

Courses shall be held during normal working hours, at a suitable venue. All attendees shall remain for the duration of the course and, on completion, sign an attendance register that clearly indicates participants' names. A copy of the register shall be handed to the ECO for record keeping/ evidence of attending the training session.

4.6 Non-compliance and Corrective Action

Should, under any circumstance, the operational activities pose any damage on the environment and not comply with measures as stipulated in the EMPr, the Construction Manager will be held responsible for such non-compliance. It is therefore the responsibility of the Construction Manager to ensure that all relevant measures are taken to rectify such damage, at the wrong-doer's expense. It is the duty of the ECO to monitor compliance with the EMPr, and report and notify EWS of any non-compliance, highlighting the following:

- Details of the nature of the non-conformance;
- The actions to be taken to correct the situation; and
- The date by which each corrective action should be executed.

The Construction Manager will be held liable for any non-compliance on site. Following the identification and reporting of such occurrences, the Manager will be given 10 days to submit a Corrective Action Plan to the EWS Environmental Management Department, which should detail how the required corrective actions will be implemented. This plan will be submitted to the ECO for approval prior to implementation. Once approved and the corrective measures have been carried out, the ECO will then determine the success or failure of the corrective action.

4.7 Environmental Management Programme Implementation and Monitoring

The frequency and nature of reporting of environmental management performance will depend upon the nature of the activity and aspect that is being managed. Reporting may take several forms:

- Reports to the ECO on critical issues that may arise;
- Compliance checklist reports on a weekly basis;
- Monthly reports on environmental performance and compliance or non -compliance;
- Performance reports on key indicators on a quarterly basis;
- Environmental monitoring reports to confirm whether or not environmental monitoring results fall within specified limits on the EMPr; and
- Summary reports to external stakeholders.

Reports and records to be kept are presented in Table 9.

Table 9: Reports required during operations

Item	Report	Frequency	From	To	Aim / Objective
1	Internal Environmental Compliance Audit Report	Bi-annual	ECO	Construction Manager, EWS and EDTEA	Detailed pipeline compliance across all relevant legislation, identifying non-compliances, actions to be taken to rectify and timeframes to implement actions by responsible persons.
2	External Compliance Audit Report	Annual	External auditor	EWS and EDTEA	Detailed site compliance across all relevant legislation, identifying non-compliances, actions to be taken to rectify and timeframes to implement actions by responsible persons. Verify internal compliance audits.
3	Environmental, Health and Safety Monitoring Reports and relevant/ accompanying checklists (environmental, first aid, baling machine, etc.)	Monthly	ECO	EWS	Verify that environmental monitoring results are within specified limits. Report on any environmental issues, non-compliance and actions to be implemented.
4	Corrective Action Plans	As required	Construction Manager in the event of environmental non-conformance	ECO	Detail how the required corrective actions will be implemented.
5	Incident Reports	As required	Construction Manager in the event of an incident	ECO	Report any environmental incidents, how they occurred, damage caused and how future incidents will be prevented.

5 ENVIRONMENTAL MANAGEMENT PROGRAMME

5.1 General Guidelines on Site

The following measures provide guideline solutions to frequently anticipated issues on most development activities:

- The prevention of any site degradation due to non-compliance, administrative or financial problems, and inactivity during the pre-construction, construction and operational phases, illegal activities, delays caused by archaeological finds, etc. is ultimately the responsibility of the applicant/developer as stipulated under Section 28, National Environmental Management Act [NEMA] (Act No. 107 of 1998);
- Operations must be limited to the servitude as that is where all licensed activities will be taking place;
- Any damage incurred to be repaired immediately and to the satisfaction of the property owner/s;
- All private and public amenities along the pipeline route must be protected against damage at all times, and any damage must be rectified immediately;
- Relevant landowners and businesses must be informed of the starting date of construction/operations and the activities to take place;
- The Construction Manager must adhere to all contractual agreements- including the EMPr;
- Proper documentation and record keeping of all complaints and actions taken;
- A positive attitude towards environmental management by all site personnel must be motivated through regular and effective awareness and training sessions.

5.2 Environmental Management Measures

The following tables detail the environmental management measures that have to be put in place for the various aspects of the project that may result in impacts, both negative and positive, on the receiving and surrounding environment. Environmental Management Measures in the Pre-construction and Construction Phase (Table 10); and Operational Phase (Table 11) phases are detailed. The environmental management tables also provide information on the frequency at which each aspect and management measure should be monitored, and the person responsible for implementing the management measures.

Table 10: Pre-construction and Construction Phase EMPr

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
Environmental Management Programme (EMPr)	• A finalized EMPr must address all authorization conditions stipulated by the EDTEA (and other commenting authorities). • The EMPr should also encompass all environmental impact mitigation measures as identified in the final BAR.	Annually or as specified by the EDTEA	Construction Manager
Appointment of Environmental Control Officer	• EWS will appoint an ECO that will be tending the compliance and related as aspects on the pipeline upgrade.	Once-Off	Construction Manager, EWS
Permits and Permissions	• EWS must ensure that all licensing, permits or certificates required for the project are in place prior to the commencing of any activities on site. • Construction Manager must ensure that copies of all licensing, permits or certificates required are kept ta the construction site camp.	On-going	Construction Manager
Grievances	• Develop grievance mechanisms for the recording and management of complaints and grievances specifically including (but not limited to) grievances from those living in the area.	Weekly	Construction Manager
Vegetation Clearing	• The extent of the development footprint and working servitude area must be limited to the planned 10m. • The alignment of pipelines with existing roads and/or human settlement, as shown in the proposed layouts must be complied with. • Areas to be cleared must be clearly marked and clearing of vegetation must only take place within these demarcated areas. • A suitably qualified biodiversity specialist must be tasked with any features which require permit applications prior to their removal /	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	destruction. Any required permits must be obtained prior to the feature being removed or destroyed. • Limit vegetation clearance to construction footprint. • Retain as much indigenous vegetation as possible so it can be replanted during rehabilitation. • Clear as much alien vegetation as possible to retain nutrients for indigenous vegetation		
Soil disturbance and Stockpiling	• All topsoil stockpiles must be protected against wind, erosion and seeds, i.e. by use of shade cloth or netting. • Topsoil stockpiles should not exceed 1.5 meters in height. • All soils compacted as a result of construction activities falling outside of project footprint areas should be ripped and profiled. • Sloped areas can be temporarily stabilized during construction using geotextiles. • It is strongly recommended that the rehabilitation measures be undertaken with emphasis on the use of plants to protect the river bank. The following is recommended for promoting of vegetation growth: for rehabilitating the slopes along the pipeline corridor: o Biomac must be installed along trenches located at gentle slopes (i.e. >1:10). This will promote vegetation growth o Mac-mat must be laid around the wetland areas (or areas with a medium velocity flow), and in areas with a slope gradient of between 1:20 and 1:10. • Reno- mattresses to be constructed on the river bed at its existing level. This is particularly for areas which run through private property. • All exposed earth should be rehabilitated promptly with suitable vegetation to stabilize the soil.	On-going	Construction Manager, ECO
Planned or accidental physical disturbance to watercourses (infilling,	• It is recommended, where possible, that plants (particularly indigenous ones) be stripped and set aside for use in rehabilitation. • Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold.	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
excavation, clearing etc. at crossings)	• Install protective works (e.g. gabions and geotextiles) to stabilise and protect unstable banks immediately upstream and downstream of the pipeline crossing prior to commencing construction. • The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes. • Topsoil and vegetation from areas to be excavated should be stripped and stored at the designated soil stockpile area outside of the wetland/aquatic zone for use later in rehabilitation and subsoil to be stored separately. • All alien invasive vegetation that colonise the construction site must be removed.		
Temporary impedance or diversion of flows **Dewatering of trenches**	• To reduce the need to divert water away from the construction working when crossing watercourses, all construction activities within wet areas should ideally take place in the dry season/winter where this is possible and depending on project timeframes. • Construction within/across watercourses should progress as quickly as practically possible to reduce the risk of exceeding the temporary diversion capacity. • Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse. • Not more than one diversion is to be undertaken within any given watercourse any given time. • Re-directed flow must be accompanied by erosion protection measures at the outlet point to avoid scouring, gully erosion and sedimentation of downstream habitat. • Sandbags used in any diversion or for any other activity within a watercourse must be in a good condition, so that they do not burst and empty sediment into the watercourse. • Under no circumstances should the creation of a new channel be considered to divert flows away from the current river channels position.	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility

	• Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns.
	• Options for temporary flow diversion when working within channels may include:
	  ○ Diversion of the entire watercourse through use of a bypass large diameter pipe;
	  ○ The installation of removable coffer dams; and
	  ○ Use of removable sandbags.
	• Water must be piped over or around the working area to allow the trench excavation to take place. This will involve the establishment of an adequate number of flume pipes (to be determined by the engineer/construction manager and ECO), and the establishment of a temporary coffer dam wall and running track upstream of the trench corridor:
	  ○ The dam wall/bund wall should be established using sand bags laid across the wetland and over the flume pipes.
	  ○ Protective rip-rap or other erosion protection measures should be established across the face of the dam/bund exposed to flow.
	  ○ The pipe outlets should also be armed against erosion using rip-rap and dump rock to reduce bed/watercourse scour.
	  ○ Once the bund wall and running track is established, subsoil excavated from the trench must be stored at the demarcated subsoil stockpile area and subsoil layers must be stored in the layers they are excavated.
	• If the trench requires dewatering, water pumped from the working areas must be diverted into an appropriate filtering area to handle dewatering. Pumped water must be passed through a series of silt traps prior to flowing back to any watercourse. The location of the filtering area should be approved by the ECO with aim of minimising erosion/sedimentation risks.		

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• The time that an excavation across a watercourse if left to stand open must be minimised through careful planning by the contractor. In this regard, trenches within watercourses should be backfilled within 2 days of excavation. • During works within the channel, the downstream silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt), and repaired where necessary. Note: These recommendations may not be applicable due to the temporary to seasonal nature of some wetlands/rivers and will only apply as necessary.		
Accidental spills & mismanagement of potential pollution-causing substances	• Potentially hazardous materials used during the construction phase (including cement and solvents) must be housed under cover (where practical) and utilised bunded areas, where necessary. • Accidental oil and fuel spillages to be cleaned up immediately by the Contractor, placed in sealed containers and disposed of at a licensed waste disposal site. • Spill kits and all necessary equipment for dealing with spills must be made available and the correct procedures followed during the clean-up of spills. • To prevent contamination of surface water resources due to oil and fuel leakages and accidental spillages, vehicles and construction equipment should not undergo maintenance procedures on site, and should not occur within 100 m of the Mdloti River and watercourse areas. • Sediment traps and fences must be used to prevent excess levels of sediment entering the watercourse from the working area. • Any contaminated water associated with construction activities must be contained in separate areas or receptacles such as Jo-Jo	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	tanks or water-proof drums, and must not be allowed to enter into the natural drainage systems / watercourse / wetlands; • The EWS stormwater management plan will be implemented in the duration of construction and operations (please find a copy of this attached in Appendix I). • Any significant spills on-site must be reported to the relevant Authority (e.g. Department of Water and Sanitation / EDTEA / Municipality etc.) and must be remediated as per the requirements of the EMPr. • If a water pump is required, the water pump must operate inside a drip tray to prevent any spillage of fuel and limit the risk of soil/water contamination. • All equipment to be used within the instream habitat (within the channel) must be checked daily for oil and diesel leaks before gaining access to working areas. • Sanitation - portable toilets (1 toilet per 10 users) to be provided where construction is occurring. Workers need to be encouraged to use these facilities and not the natural environment. Toilets must not be located within the 1:100yr flood line of a watercourse or closer than 50m or from any natural watercourses. Toilet facilities must be serviced weekly and in a responsible manner by a registered waste contractor to prevent pollution and improper hygiene conditions. Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.		
Visual impacts	• No stockpiles may exceed 2m in height. • Limit exposed areas (removal of vegetation) to the project footprint. Keep all areas neat, clean and organised in order to portray a general tidy appearance. • Implement an effective dust suppression/control management programme, to reduce dust during the construction phase, especially during the dry and windy occasions.	Weekly	ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• Restrict access to site, only allowing permitted project personnel to be on site- particularly when working on private property.		
Noise impacts	• Limit the noise levels to construction hours, and adhere regulated noise levels. Noisy activities to be undertaken during normal working hours (i.e. between 07h00 to 18h00 on weekdays, 07h00 to 13h00 on Saturdays). • Introduce a formal recording system/grievance mechanism to capture public perceptions and complaints with regard to noise. • Track investigation actions and introduce corrective measures for continuous improvement. • Vehicles and machinery to be kept in good working order with the prescribed mufflers and silencers. • All noise and sounds generated by plant or machinery must adhere to SABS 10103 specifications for the maximum allowed noise levels for residential areas (i.e. noise levels must beless than 45-50Dba).	Weekly	ECO
Traffic disruption	• Public to be notified 7 days prior to construction commencing. • Strict adherence to working hours. • Limiting the number of vehicles entering and exiting the construction site will ensure that traffic is kept to what is needed for construction and monitoring purposes. • Access roads should be planned ahead of time, with the public receiving sufficient warning of impending traffic. • Alternative routes to be provided for local motorists as far as possible should road closures be required. • Flagmen to be posted when construction works are being undertaken adjacent to roads. • Signage is to be displayed indicating construction activities. • Any damage caused to surrounding roads as a result of construction activities must be repaired as soon as possible to prevent further deterioration to the private or public road network.	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• Construction vehicles must not be permitted outside of the demarcated construction working zone unless it is on a public road. • The use of private access roads must be strictly forbidden unless a prior agreement has been entered into with the affected landowners.		
Dust fallout	• Minimise the extent of open areas (areas cleared of vegetation). • Topsoil stockpiles should be covered to prevent the surface soil from being blown away. • Dust suppression techniques to be used on all dust generating surfaces. • The speed of construction vehicles to be restricted to 25km/h within the construction area or near stockpiles. • Trucks transporting any form of soil or waste should be covered with a canvas.	Weekly	EWS
Socio economic changes	• Inform the surrounding communities and general public of the proposed activity as soon as possible. This will serve to ease potential social anxiety. • A Community Liaison Officer should assist in raising any concerns/ complaints noted by the affected community to the Construction Team. It is recommended that a clear line of communication and contact person be established to inform local farmers of any upcoming construction. • No private lands outside of the construction zone may be accessed without due authorisation. • Where boundary fences are removed in agricultural areas the project managers and contractor are to ensure that adequate temporary fencing to secure the affected farm land.	Weekly	Construction Manager, ECO
Health and Safety and security	• The construction management needs to communicate the commencement and duration of construction activities to the community.	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• Clear signage needs to be put up to make and keep the community awareness of construction activities so as to prevent any hazardous occurrences. • Provide adequate safety warning signage on the roads. • Construction workers and vehicle operators must take heed of normal road safety regulations, thus all personnel must obey and respect the law of the road. A courteous and respectful driving manner must be enforced and maintained so as not to cause harm to any individual. • A safe designated speed limit must be set by the project managers to limit possible road strikes and accidents. • Construction paths must be clearly demarcated. • The position of the water main is to be placed away from the footpaths. • Demarcate and barricade the pipeline footprint to prevent access to open trenches site during construction. • Enforce the use of appropriate Personal Protective Equipment at all times (i.e. hard hats, steel capped safety boots, protective goggles) • Security to be provided (where possible) after hours to protect equipment in the construction camp. • No construction staff must be permitted to trespass on private land. Any construction personnel found to be trespassing on private land must be immediately subjected to a disciplinary action. • Access to site to be strictly controlled.		
Impact on existing infrastructure	• Should any features of heritage of significance or graves be identified / uncovered during construction events then work in that area must cease immediately until an archaeologist has inspected the feature and is satisfied, or the necessary authorisations to continue with work have been obtained from AMAFA. • All specific requirements of state entities responsible for such infrastructure (e.g. Sasol) must be adhered to by the applicant	Weekly	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	where the pipeline intersects the respective organization's servitudes. This includes obtaining the necessary approvals prior to construction commencing. • Notify I&APs as soon as possible of the commencement of construction in areas close to their services.		
Impacts on pipeline material	• During construction, anchor blocks should be used to hold the pipe in place. • with a drainage release system such as subsoil drains. • This will cause water would then be diverted from the trench by means of appropriate subsoil drainage towards drainage lines or the local drainage system. • This will prevent the pushing up of groundwater post-construction.	Weekly	Construction Manager, ECO
Erosion	• Strict erosion and stormwater control measures will need to be implemented in this area during construction (please refer to the EWS stormwater management plan in Appendix I). • The area must be rehabilitated immediately after the pipeline has been buried. • Sand bags must be used to channel the flow of stormwater during rainfall events. • For steep slopes, berms will be positioned so that the velocity of the stormwater run-off will be reduced. • Ensure that erosion management and sediment controls are strictly implemented from the beginning of site clearing activities. • All topsoil stockpiles must be protected against wind, erosion and seeds, i.e. by use of shade cloth or netting. • Topsoil stockpiles should not exceed 2 meters in height. • The areas surrounding watercourse crossings must be regularly checked for signs of erosion. If erosion is evident, corrective action must be taken.	On-going	Construction Manager, ECO
Loose materials flowing into watercourse	• Construction activities should be undertaken during the dry season to limit the possibility of normal to heavy infrequent rainfall events. • The EWS stormwater management plan must be implemented to prevent and control erosion impacts.	On-going	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• This will include construction of temporary ditches and runoff containment areas, such that all runoff emanating from the topsoil/material stockpile areas together with any additional dirty water areas are conveyed and contained within the site area.		
Waste	• Regarding the existing AC pipeline, this will be left in-situ asper the EWS's policy and procedure for water mains infrastructure handling. If there is any waste stemming from handling the existing pipeline, a suitably qualified asbestos handler must be appointed for the management of any asbestos containing waste (ACW). • Minimise waste generation, e.g. by providing re-usable items and refillable containers (e.g. for drinking water). • Waste bins are to be located at the construction camp and construction sites. Bins to have secured lids to prevent waste from being blown into the surrounding area. • Comply with legal requirements for waste management and pollution control and employ "good housekeeping" and monitoring and monitored by the ECO. The site must be kept clean and tidy at all times. • Store waste in labelled containers, indicating clearly whether the waste is hazardous or non-hazardous (general waste). • Waste generated should be collected by recyclers as far as possible, with the remainder being disposed of weekly at the nearest registered landfill. • Hazardous waste to be disposed of by a qualified service provider. • Awareness raising to be undertaken with the construction workers and the local community regarding health and environmental impacts from illegal dumping.	Weekly	Construction Manager, ECO
Alien vegetation encroachment	• Removal of species should take place throughout the construction phase. • All removal of alien vegetation must be undertaken in such a way as to ensure that at no time is there excessive base ground created which would be susceptible to erosion.	Weekly	Construction Manager, ECO

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring Frequency	Responsibility
	• All alien vegetation control should be overseen by a suitably qualified alien vegetation control specialist.		

Table 11: Operational Phase EMPr

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring	Responsibility
Records and Administration	• A register should be kept of all complaints against any issues experienced with the new pipeline. • Photographs of areas of concern (areas as well corrective action applied) must be kept on record.	Inspect weekly to ensure that complaints are well recorded and addressed	EWS
Erosion	• Monitor the replanted vegetation and check their as erosion barriers. • It is strongly recommended that the rehabilitation measures be recommended by the aquatic specialist be implemented, with emphasis on the use of plants to protect the river bank. • Should hard structures be installed, regular monitoring and maintenance of the structures must be performed.	On-going	EWS
Leakage, wear and tear, and potential malfunctioning of the water main	• It is recommended that a leak detection system be fitted to the pipe. • Maintenance of pipelines must be undertaken as sensitively as possible to prevent adverse impacts to the environment during access and repairs. • When emptying the pipeline for the purposes of undertaking repair work, care must be taken not to erode wetland areas below scour chambers.	On-going	EWS
Wear and tear, and potential malfunctioning of the water main	• Regular maintenance to be undertaken by the EWS. • The pipeline's efficacy to be monitored and regulated throughout its life cycle. • Proactive steps to be taken towards the end of the pipeline's life cycle to prevent the occurrence of the issues that ae are being experienced with the current pipeline.	On-going	EWS
Planned or accidental physical disturbance to watercourses (from pipeline maintenance	• Any vegetation clearing and excavation within watercourses required to maintain/repair sections of pipeline must adhere to the relevant construction phase impact mitigation measures provided under the mitigation measures for the construction phase impacts.	On-going	EWS

Management Aspect	Mitigation Measure/ Actions to be implemented	Monitoring	Responsibility
Improved water infrastructure	• Special care must be taken to seal the pipeline trench along its length so as to avoid establishing a situation in which water leaks away along the trench. • It is recommended that a leak detection system be fitted to the pipe. • A rigid maintenance plan should be implemented and adhered to, to ensure that future issues are mitigated and handled timeously.	On-going	EWS
Minimised disturbance to other infrastructure	• Regular maintenance to be undertaken by the EWS. • The pipeline's efficacy to be monitored and regulated throughout its life cycle. • Proactive steps to be taken towards the end of the pipeline's life cycle to prevent the occurrence of the issues that ae are being experienced with the current pipeline.	On-going	EWS
Cost saving	• A rigid plan maintenance plan must be implemented to pre-empt any issues with the pipeline and to manage them timeously. This will minimise costs incurred from repair work that could have been prevented, as well as costs incurred as a result of claims from the public. • Proactive steps to be taken towards the end of the pipeline's life cycle to prevent the occurrence of the issues that ae are being experienced with the current pipeline.	On-going	EWS

6 COMPLIANCE AUDITS, REVISING THE EMPR AND CONCLUDING RECOMMENDATIONS

6.1 Compliance Audits and Reporting

Audits of compliance with the EA conditions and implementation of the EMPr must be undertaken internally on a biannual basis (i.e. twice a year). A report of the audit findings must be compiled, and the report should include:

- The date of when the audit was conducted;
- The name of the auditor;
- The outcome of the audit in terms of compliance with the environmental authorisation conditions and the requirements of the EMPr; and
- Corrective measures to ensure that EWS' compliance rating is improved or maintained.

In addition, EWS should appoint an independent party to undertake external audits on the EMPr implementation during the construction phase. The auditor must be provided with the internal audit reports for review, and must produce a report containing the type of information presented in the internal audit reports. This report must be submitted to the competent authority (i.e. the EDTEA) and copies should be readily available on site.

6.2 The EMPr as a Live Document

When considered necessary, the EMPr should be revised and updated to incorporate issues identified through emergencies, incidents, monitoring or audits. EWS should be cognisant of the fact that the EMPr is a dynamic document, and revisions and updates made to it will ensure that the operation activities are planned and implemented taking identified environmental issues into account.

6.3 Concluding Recommendations

In implementing the proposed project, and this EMPr, the following is recommended:

1. Maintaining the existing infrastructure- like the storm water management system, roads, fences and other structures.
2. Managing the operational areas in accordance with the integrated and spatial development plans, and implementing the environmental protection measures detailed therein.
3. Implementing the EMPr to guide the pre-construction, construction and operational activities, and to provide a framework for the on-going assessment of environmental performance.
4. Maximising the employment of local people and the procurement of local resources during operations to ensure maximum benefit to the provincial/local economy.

5. A suitably qualified licence holder employee must be mandated with the task of monitoring compliance, and correct implementation of all mitigation measures and provisions as stipulated in the licence, EMPr and standard operation procedures.

It is also recommended that the developer appoint an independent external party to undertake annual audits of site's compliance to the license conditions.

APPENDIX G: DETAILS OF EAP AND EXPERTISE

DMT Kai Batla (Pty) Ltd

COMPETENT PERSON'S CERTIFICATE

Position: **Senior Environmental Manager**
Name of Firm: **DMT-Kai Batla (Pty) Ltd**
Name of Staff Member: **Samantha Moodley**
Profession: **Principal Environmental Consultant**
Nationality: **South African**

Professional Profile

A highly competent Environmental Consultant with 10 years' experience and advanced knowledge in the global environmental and engineering fields, predominantly in oil and gas, infrastructure development, industrial developments, minerals and metals. Successful track record in environmental permitting processes, managing specialists, project budgets, project management, conflict resolution, project administration, interfacing with other disciplines, environmental strategy and policy, environmental and related legislation (South African and international) and public participation processes. Successfully led and contributed to ESIAs for large multi-disciplinary projects and accomplished in producing sound scientific reports that are understandable to non-technical stakeholders. Strong communicator with project and technical teams, client, authorities and public role-players.

Membership in Professional Societies

- International Association for Impact Assessment (or)

Key Qualifications:

- Environmental and Social Impact Assessments according to international best practice standards, i.e. IFC Performance Standards.
- Project Management.
- Business Integration (environmental engineering sustainability).
- Identifying key environmental attributes, opportunities and constraints.
- Sensitivity analyses and sustainability assessments.
- Strategic environmental management plans.
- Technical report writing including: scoping reports; environmental and social impact assessment reports; environmental management plan reports and amendments; inception reports; status quo reports; desired state reports; environmental management framework reports; strategic environmental assessment reports; performance assessment reports; ecological specialist reports.
- Global experience (Botswana, Mozambique, Malawi, Nigeria, Zimbabwe and South Africa).
- Coordinating and managing specialists including developing terms of references, managing information needs, organising site visits, reviewing reports.
- Infrastructure experience (port and marine terminals, industrial plants, rail and road).
- Coal mining experience (Mozambique, Botswana and South Africa).
- Public participation processes including: communication strategies; stakeholder's analysis; background information documents, issues and responses reports; feedback stakeholders during public and focus group meetings.

Education:

Degree/Diploma	Field	Institution	Year
B.Soc. Sc. Honours	Geography and Environmental Management	University of KwaZulu Natal	2005
Bachelor of Social Science (B.Soc.Sc)	Geography and Environmental Management	University of KwaZulu Natal	2004

Employment Record:

Position	Company	Job description	Duration
Manager: Environmental Division	**Fourth Element Consulting (Pty) Ltd**	Manager: Environmental Division	2014
Environmental Advisor	**Hatch Goba (Pty) Ltd**	Environmental Advisor	2011 – 2013
Senior Environmental Consultant	**ERM Southern Africa**	Senior Environmental Consultant	2006 – 2011

Business and Project Management

- Pro-actively seeking out additional opportunities with the various parties involved in projects.
- Managing budgeting, work planning, team briefing, progress monitoring, financial monitoring, invoicing, reviews and QA/QC.
- Managing and contributing to high quality, successful proposals over the last 8 years.

Authorisation Permitting Studies

- Authoring and/or project managing a variety of environmental authorisations processes.
- Successfully undertaking EIAs for a range of projects across a number of sectors all over Africa.
- Excellent understanding of the legislative requirements associated with EIAs as well as an understanding of the in-country, South African and provincial regulatory and permitting processes.
- Fostering good relationships with competent authorities as well as local authorities in South Africa.
- Assisting clients in ensuring that projects meet international environmental and social assessment standards (including those of the IFC, World Bank, the African Development Bank (AfDB) and JBIC and others).
- Applying expertise to assist in the development of bankable projects in compliance with the Equator Principles and IFC Performance Standards in the last 2 years. This includes working for project developers seeking finance from the Equator Principles Financial Institutions as well as acting on behalf of project lenders in reviewing project compliance against the Equator Principles.

Engineering Interface

- Experience in working alongside engineering design teams in applying the required environmental assessment methodologies, at the appropriate time within the project life cycle process, providing her with the ability to recognise potential gaps that need to be addressed during the EIA and allowing for improved integration of information between the EIA project team and the engineering design team. This experience allowed her to manage potential EIA schedule delays by detailed planning and communication of required engineering inputs to the EIA and identification of tasks which can be advanced independently of the engineering design.
- Providing a managed interface between clients, engineering design teams and environmental assessment practitioner to facilitate the effective integration of environmental considerations into the design and planning processes.

Global Work experience

- Worked on Projects in: Botswana, Mozambique, Malawi, Zambia, Zimbabwe, Nigeria and South Africa.
- Proposals prepared for: Botswana, Brazil (Sao Paulo), Canada, Democratic, Lesotho, Liberia, Malaysia, Mozambique, Malawi, Namibia, Sierra Leone, Swaziland, Zambia, Zimbabwe and South Africa.

Technical Papers, Conferences and Seminars

- Kamal Govender, Stuart Heather-Clark, Samantha Moodley, EIA for coal barging on the Zambeze River: A successful EIA, IAIA 11, Mozambique, 2011.

Key Strengths

- Strong prioritisation and time management skills with particular focus on meeting deadlines.
- Able to manage multiple projects simultaneously in a team environment.
- Track record for meeting timelines and meeting expectations.

- Responds quickly to changing situations and works well under pressure while maintaining individual team effectiveness.
- Able to cope with ambiguity, contradiction, stress and uncertainty.
- Attention to detail, planning, organisation and daily delivery requirements.
- Excellent internal and external negotiation skills with ability to engage and influence clients.
- Good interpersonal skills - works well with others, motivates and encourages.
- Solid judgment and management skills to effectively deal with people's needs/issues.

Key Project Experience:

OIL AND GAS PROJECTS

EIA for NEMA Rectification Applications, Shell SA, Western Cape and Gauteng, 2006, Project Consultant

This project entailed the completion of the National Environmental Management Act (NEMA) Rectification Applications for above and below ground fuel storage sites. Responsibilities included coordinating the public consultation as well as the project report write-up for multiple sites

Proposed aboveground storage facility and baghouse at ArcelorMittal, Vanderbijlpark Works, 2008, Assistant Project Manager

Appointed to undertake a Basic Assessment process for an aboveground storage facility and baghouse emission abatement technology for ArcelorMittal's Sinter Plant

EIA for underground storage tank at Mafube Colliery, 2008, Project Manager

Appointed to undertake a Scoping/ EIA process for a proposed underground storage tank at Mafube Colliery

Mafube Coal Mining BA for AST installation 2010, Project Manager

Appointed to undertake a Basic Assessment for the proposed installation of aboveground storage tanks at Mafube Colliery, Middelburg, Mpumalanga Province

ENGEN London Rd EIA 2009-Ongoing, Project Manager

Appointed to undertake an EIA for the proposed construction of two filling stations at the N3/London Road intersection, Gauteng.

Vodacom EA Audit 2009, Project Manager

Appointed to undertake an environmental audit of the Environmental Authorisation for the installation of bulk above ground storage tanks at the Vodacom 6 Development in Midrand, Gauteng.

Chevron ERP and EMP for depot at OR Tambo 2009, Project Consultant

Appointed to undertake an EMP and ERP for bulk fuel off-loading at the rail siding near OR Tambo Airport, Gauteng.

ENGEN Filling Station EIA, Ventersdorp EIA 2010, Project Manager

Appointed to undertake an EIA for the proposed construction of an Underground Storage Tank (UST) at the Voorwaarts Filling Station in the North West Province

MINING PROJECTS

Order of Magnitude Study for Rio Tinto Iron and Titanium - TIO4 Program, Mozambique, 2011

Hatch was appointed by Rio Tinto Mining and Exploration Limited (RTME) to conduct the OMS for the proposed mineral sand mining project in Mutamba, Mozambique. Key responsibilities on this project included reviewing the environmental requirements in terms of the permitting as well as design standards associated with the project.

Environmental, Social and Health Impact Assessment (ESHIA) of the Mmamabula Coal and Power Station in Botswana for CIC, 2006-2009, Project Consultant

CIC required an integrated ESHIA to be undertaken for a new coal mine and power station in south eastern Botswana. This ESHIA was required to meet the IFC Performance Standards. This is a multifaceted project which has a number of EIAs being conducted parallel to each other. Assisted with

compiling ESHIA for the entire project, Compiled the Environmental Awareness Plan, assisted with other Management Plans, and overall project management.

ESIA for proposed Sheba's Ridge Mine, 2007-2008, Project Consultant
The project involves the development of a large, greenfield open pit nickel and copper mine and processing plant in Limpopo Province, South Africa. The ESIA was guided by Equator Principle and IFC requirements. Designated as the coordinator for the public participation process and was involved with managing stakeholder database, interacting with stakeholders and the writing up of documentation required for public participation process.

Project Mafutha Environmental Baseline Study, South Africa, 2008, Assistant Project Manager
Project Mafutha comprises a coal-to-liquid plant, a coal mine a town, water supply infrastructure and associated activities. As part of the pre-feasibility studies for Project Mafutha, ERM was appointed to undertake the Environmental Baseline Assessment. The project required delicate managing, in light of stakeholder expectations, the client's ongoing property purchasing negotiations, client's prospecting activities, and a related basic assessment for road construction and widening (also being undertaken by ERM). Managing a multi-disciplinary team of specialists, managing a desktop and detailed assessment and managing the public participation aspect required integration of different expertise and project components. The timeframe was short (12 months) and required innovative solutions to run processes in parallel to deliver on time.

Mafube EMPR Revision 2010, Project Manager
Appointed to undertake a revision of the EMPR for Mafube Colliery, Middelburg, Mpumalanga Province as per a Directive issued by DMR.

Anglo Prospecting EMP 2010, Project Manager
Appointed to undertake an EMP for prospecting activities carried out by a mine in Rustenburg. The EMP involved researching environmental and social impacts of prospecting activities as well as providing adequate mitigation measures for these impacts.
Coal of Africa Due Diligence, South Africa
Coal of Africa, 2011, Project Consultant
ERM was appointed Coal of Africa Limited to undertake an independent International Finance Corporation and Equator Principles review of the proposed Makhado Colliery Project in the Limpopo Province, South Africa. This includes a review of all environmental and social factors to determine overall conformance with IFC performance standards.

INFRASTRUCTURE PROJECTS

Kudumatse Wellfield EIA for Mmamabula Energy Project, 2007-2008, Project Consultant
Specific responsibilities for this project included working with specialists to ensure that the different environmental and social impacts of the project were carefully considered. Involvement in the public participation process of the EIA included holding meetings with relevant authorities and potentially affected communities. Further responsibilities included drafting of the Terms of Reference and EIS.

Railway Link and Services Corridor EIA for Mmamabula Energy Project, 2007 to 2008, Assistant Project Manager
Appointed to undertake EIA process for a proposed railway line, road upgrade and water supply pipelines as part of the Mmamabula Energy Project in Botswana. Key roles on this project included management of specialists and compilation of ESIA.

Basic Assessment for Road Construction and Widening, South Africa, 2008, Assistant Project Manager
Appointed to undertake a Basic Assessment for a proposed road construction and widening project to facilitate bulk sampling as part of clients' prospecting activities.

Riversdale Coal Barging Project, Phase 1, Mozambique, 2009
Project Consultant
Appointed to undertake a baseline sensitivity analysis of the proposed Zambezi River Coal Barging project with a view to identifying baseline sensitivities and potential fatal flaws.
ESIA for Riversdale Zambezi River Coal Barging Project, Mozambique, 2009 to 2011

Assistant Project Manager
The ESIA is to meet the Mozambican regulatory requirements as well as best practice as defined by the IFC Performance Standards. Key responsibilities on this project include regular interaction with client, managing a suite of specialists, budget control and compiling necessary reports.

Beira Coal Terminal EMP, Mozambique
Vale, 2011, Project Consultant
A comprehensive construction and operational Environmental Management Plan was prepared for Vale for the proposed coal terminal located at the Port of Beira, Mozambique.
EIA for Riversdale Beira Transhipment Project, Mozambique, 2010 to 2011, Project Manager
The EIA is to meet the Mozambican regulatory requirements. Key responsibilities on this project include regular interaction with client, managing subcontractors, budget control and compiling necessary reports

FEL 2 and FEL 3 Studies for Expansion of Terminal de Carvão da Matola Lda ("TCM") at Port of Maputo, Mozambique, 2011-2013, Environmental Manager.
Hatch Africa (Hatch) was appointed by Grindrod Terminals to carry out investigations for the proposed new coal terminal which will be developed and constructed in two phases**.** Samantha served as the Environmental Manager on the Project in which she managed the environmental requirements related to the expansion of Matola's TCM Facility. This involved compiling of project Environmental design criteria which are needed to guide the Project Technical Team during the planning phases and design work, interfacing and coordinating with engineering disciplines, management of the EAP undertaking environmental authorisation process (Environmental and Social Impact Assessment), managing of monitoring programmes, report review, construction management in terms of environmental compliance, as well as ensuring environmental best practice is applied to the expansion in feasibility and during project execution.

Vereeniging City Urban Design Framework, Gauteng Provincial Government, 2012-2013, Environmental Specialist
Appointed to as environmental specialist to inform the project design approach. Key responsibilities on this project involved addressing the environmental and social sectors, which includes the development of environmental and social inputs to the Status Quo report and the development of environmental and social sector plans. In addition to the sector specific input, sustainability input to the integrated visioning and sector planning process was provided.

INDUSTRIAL PROJECTS

FEL 2 and FEL 3 Studies for Nyanza Light Metals Recovery of Titanium from Slag Project, South Africa, Ongoing, Environmental Advisor
Hatch was retained by Arkein Capital to evaluate beneficiation options of discard furnace slag from Evraz Highveld as Nyanza Light Metals intends to construct and operate an industrial rutile pigment production facility in an area yet to be determined in South Africa. The environmental scope involves project deliverables that are based directly on those defined and described in the Hatch Project Lifecycle Process (PLP) ensuring that the sustainable development aspects of the study are adequately addressed.
Fry's Metals, 2009, Project Manager
Appointed to undertake a legal review for the proposed new Battery Crusher at the Fry's Metals plant in Germiston.
Technical Consulting for an Environmental Impact Assessment for Bus Assembly Plant, Confidential Client, Nigeria, 2008, Project Manager
Appointed to provide technical support to the team carrying out an EIA for a proposed bus assembly plant in Nigeria. The EIA process and report was audited against the Nigerian regulatory EIA requirements. Recommendations were made to address gaps.

Certification:
I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe my qualification, my experience, and me.

_____
Samantha Moodley

APPENDIX H: SPECIALIST'S DECLARATION OF INTEREST

edtea
Department:
Economic Development, Tourism and Environmental Affairs
PROVINCE OF KWAZULU-NATAL

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	DC/
NEAS Reference Number:	
Date Received:	

Application for an environmental authorisation in terms of section 24(2) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) or for a waste management licence in terms of section 20(b) of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008).,

PROJECT TITLE

Basic Assessment and General Authorisation Application for the Proposed Re-Routing of a 600mm Ø Rising Main from Hazelmere Water Treatment Works to Grange Reservoir, in the Kwazulu-Natal Province

Specialist:	Eco-Pulse Consulting		
Contact person:	Mr. Adam Teixeira-Leite		
Postal address:	26 Mallory Road, Hilton, KZN		
Postal code:	3245	Cell:	082 310 6769
Telephone:	031 2666 700	Fax:	-
E-mail:	ateixeira@eco-pulse.co.za		
Professional affiliation(s) (if any)	1 Professional Natural Scientist (Pr.Sci.Nat.) registered with SACNASP (South African Council for Natural Scientific Professions) under the 'Ecological Science' field of practice 2 Founding member of the South African Wetland Society (SAWS)		

Project Consultant:	DMT-Kai Batla (Pty) Ltd		
Contact person:	Samantha Moodley		
Postal address:	Po Box 41955 Craighall		
Postal code:	2024	Cell:	0717814548
Telephone:	011 781 4548	Fax:	086 545 2720
E-mail:	Samantha.Moodley@dmt-group.com		

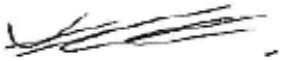
Specialist Declaration

4.2 The specialist appointed in terms of the Regulations_

I, Adam Teixeira-Leite , declare that –

General declaration:

- I act as the independent specialist in this application;
- do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).



Signature of the specialist

Eco-Pulse Consulting

Name of company (if applicable):

9th October 2017

Date: