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AQUATIC ECOLOGICAL ASSESSMENT REPORT

Proposed Social Housing Development on Erf 1359 Queensburgh, 35-53 Huntley Rd, eThekwini Municipality, KwaZulu-Natal

Draft Report

December 2022

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Declaration

I **Nikita Van Schoor,** declare that –

- I act as the independent specialist in this matter;
- I 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 National Environmental Management Act (Act 107 of 1998), (NEMA), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the NEMA Act, regulations and all other applicable legislation;
- As a registered member of the South African Council for Natural Scientific Professions in terms of the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003), I will undertake my professional duties in accordance with the Code of Conduct of the Council, as well as any other societies of which I am a member; and
- 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 report are true and correct.

Signature of the specialist:

Date: 3 December 2022

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Professional affiliation(s)	-		

Declaration

I, Nonjabulo Matomela**,** declare that -

- I act as the independent specialist in this matter;
- I 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 National Environmental Management Act (Act 107 of 1998) (NEMA), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the NEMA Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- 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 report are true and correct.

Signature of the specialist:

Date: 5 December 2022

Specialist:	Afzelia Environmental Consultants		
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Executive summary

Afzelia Environmental Consultants (PTY) Ltd were appointed by Mondli Consulting Services on behalf of Yethusodwa (Pty)Ltd to conduct an aquatic ecological assessment to determine the potential ecological impacts surrounding the construction and operation of the proposed Queensburgh Social Housing Development within KZN. This aquatic impact assessment forms part of the requirements of the Environmental Impact Assessment for the social housing development project.

A desktop analysis of the site provided key information on the climate, vegetation, soils and geology within the vicinity of the proposed development as well as information on key conservation plans and other spatial data. No National Freshwater Ecosystem Priority Area (NFEPA) wetlands or River FEPAs were identified, however, multiple Critical Biodiversity Areas were found within the associated 500m buffer (i.e. the Department of Water and Sanitation regulated area for watercourses).

A single riverine unit, the Umbilo River, was identified as a likely receiver of impacts from the proposed development. A drainage line was also observed within the 500m buffer of the development site although no water was observed in this stream. Data collected from the Umbilo River during the site investigation included aquatic macroinvertebrates, instream biotopes, fish and water quality.

The analysis of instream biotopes within the river reaches assessed indicated a fair biotope availability score at the upstream site and a poor biotope score at the downstream site. The aquatic macroinvertebrate assessment yielded an overall poor diversity of macroinvertebrates, the majority of which were tolerant of poor water quality conditions. The fish assessment yielded zero species within the Umbilo River. The Fish Response Assessment Index (FRAI) indicated that the overall fish community structure is in a critically modified state (Class F). The water quality results indicated that E. coli exceeded the Target Water Quality Range whilst the electrical conductivity of the sample deviated from natural levels. The wastewater treatment works upstream of the sampling area is likely not operating at an optimal level and is potentially the cause of the water quality issues observed onsite. The overall EcoStatus of the assessed unit within the Umbilo River was determined to be a Class D at the upstream site, and a Class D/E at the downstream site. The slightly more degraded downstream site is likely a result of the activities from the adjacent Quarry mine.

The potential impacts to the downslope riverine areas were assessed for the construction phase and operational phase of the proposed development. Potential impacts to the riverine areas arising from the construction and operation phase of the development are linked to;

- Direct habitat disturbance;
- Soil erosion and sedimentation; and
- Pollution of water resources and soil.

All of the potential impacts to the riverine unit can be reduced to low or negligible provided the mitigation measures prescribed in this report are strictly adhered to. The summary of the impact assessment results are shown in Table 1.2, below.

Table 1.1: Summary of impacts associated with the proposed development.

Impact	Phase of Activity	Without Mitigation	With Mitigation
Direct habitat disturbance	Construction	Low	Negligible
	Operation	Low	Negligible
Soil erosion and sedimentation	Construction	Medium	Low
	Operation	Medium	Low
Pollution of water resources and soil	Construction	Medium	Low
	Operation	High	Low

No risk assessment was undertaken given that the location of the proposed development activities is more than 300m upslope from the Umbilo River, whilst the drainage line is also located further than 100m away.

In the case that best practice mitigation is implemented to ensure the potential impacts to the watercourses are reduced as far as possible, it is the opinion of the aquatic specialist that no fatal flaws are applicable to the proposed development in terms of potential impacts to the riverine and aquatic environment.

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1. Introduction

1.1 Site description

Afzelia Environmental Consultants (Pty) Ltd was appointed by Mondli Consulting Services, on behalf of Yethusodwa (Pty) Ltd to conduct an aquatic ecological assessment. The aim of the assessment is to determine the potential ecological impacts surrounding the construction and operation of the proposed Queensburgh Social Housing Development within KwaZulu-Natal (KZN).

The proposed development is situated on Erf 1359, 35-40 Huntley Road, Queensburgh within the eThekwini Municipality, KwaZulu-Natal. The coordinates of the centre of the site are as follows: 29˚ 52' 26.95"S; 30˚ 55' 54.13"E. The proposed development is dominated by dense woody vegetation, adjacent to an existing residential area. A locality map showing the location of the proposed development is provided in Figure 1.1., below.

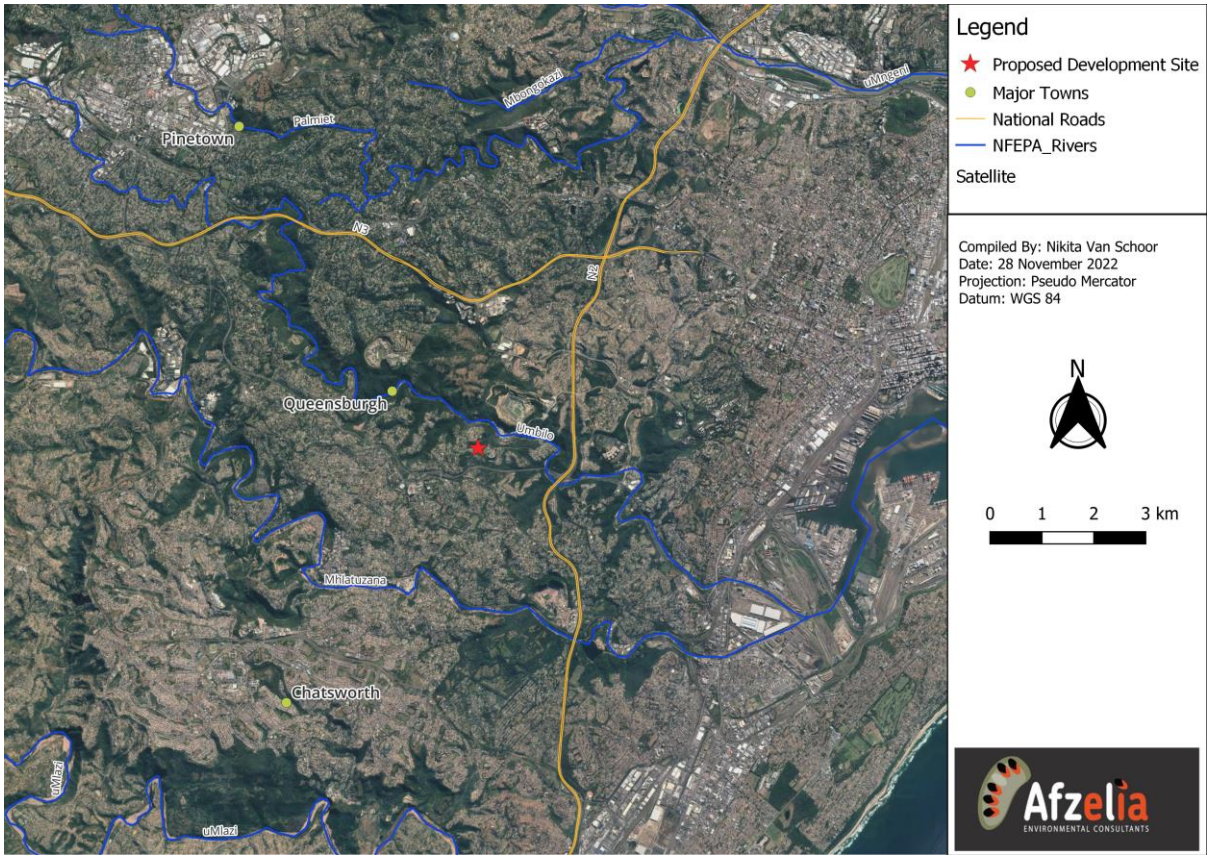


Figure 1.1: Location of the proposed development near Queensburgh, KwaZulu-Natal.

1.2 Project description

The full extent of the property is approximately 18 499m2 however only 6128m2 will be utilised. A total of 525 social housing units will be constructed in the form of six floor buildings over Blocks A to D. 263 Parking bays will also be constructed. The site is currently zoned general residential 2 but will be rezoned to "Public Housing 2" to accommodate the increased number of housing units. About 48% of the property area is classified as Durban Metropolitan Open Space System (D'MOSS). An application to develop within the D'MOSS area was submitted to eThekwini Planning and Climate Protection Department (EPCPD). This relaxation was granted with the requirement that a 25m buffer be implemented around the non-relaxed D'MOSS area.

The site is situated on a steep decline with the Umbilo River about 330m from the closest boundary.

1.3 Aim of the aquatic assessment report

An aquatic assessment serves to determine the baseline Present Ecological State (PES) of river and streams through the use of various sampling techniques and parameter analyses, which includes the;

- Assessment of aquatic macroinvertebrates;
- Assessment of fish communities;
- Assessment of instream and riparian habitat integrity; and
- Analysis of chemical water quality through an accredited laboratory

The information contained within the aquatic assessment report will provide guidance on how to conserve and manage these sensitive areas during the construction and operation of the proposed development.

1.4 Terms of reference

The Terms of Reference (ToR) for the study are as follows:

- Desktop contextualisation of the study area using all available and relevant conservation planning datasets and background biophysical context.
- Desktop mapping and screening of riparian and aquatic habitat within a 500m radius of the proposed development using available imagery, contour data and relevant spatial information (e.g. National Freshwater Ecosystem Priority Areas (NFEPA) Datasets).
- Analytical description and classification of riparian/aquatic habitat, and vegetation onsite, including a description of any potential impacts presently affecting the riparian areas.
- Riverine habitat assessment using the Intermediate Habitat Integrity Assessment (IHIA) for all riverine areas at risk of receiving negative impacts from the proposed development.
- Aquatic macro-invertebrate Assessment using the South African Scoring System Version 5 (SASS v5) methodology (Dickens & Graham, 2002) and the Macro-invertebrate Response Assessment Index (MIRAI; Thirion, 2007).
- Undertaking a fish assessment to characterise the fish community and determine the importance/sensitivity of the aquatic systems for supporting fish using the Fish Response Assessment Index (FRAI; Kleynhans, 2007) and Frequency of Occurrence (FROC).
- Water quality assessment within the rivers/streams located immediately downslope of the proposed development utilising the following parameters: free ammonia, Chemical Oxygen Demand (COD), pH, temperature, suspended solids, *E.coli*, orthophosphates, electrical conductivity and nitrate/nitrite.
- Identification of potential construction and operational phase impacts to the delineated rivers and streams.
- Provision of construction-phase and operational-phase mitigation measures.
- Undertaking an impact significance assessment on the delineated rivers and streams.
- Undertaking a DWS Risk Assessment in order to determine the risk level of the proposed development to nearby watercourses and to ascertain whether the proposed activities require a General Authorisation or a Water Use Licence. Note that a risk assessment was not undertaken as no potential water uses were triggered by the proposed development given that the development will be located further than 100m from the Umbilo River, and 500m from any wetlands.

1.5 Assumptions and limitations

The following limitations applied to this study:

- The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge.

- Infield delineation was focused only on rivers and streams that may be directly or indirectly impacted by the proposed development. All other watercourses were delineated at a desktop level resolution.
- Information pertaining to the location and technical information regarding stormwater infrastructure was not available at the time of report writing, therefore inferences upon the potential impact could not be made regarding the possible placement of stormwater infrastructure within the riparian zone of the Umbilo River.
- The high density of vegetation onsite rendered the proposed development area largely inaccessible during fieldwork. Therefore the extent of the riparian zone was determined predominantly from a desktop level and limited infield delineation.
- No wetlands were considered during this study. The wetland impact assessment report should be consulted.
- Sampling of the river occurred during one season (Spring) only, therefore temporal trends are not represented.

2. Methodology

2.1 Desktop assessment

Desktop assessments are based on available information for the area, and several databases and datasets were checked. These included the following:

- The latest Google Earth imagery, as well as 2016 aerial imagery for the study area, was used for mapping of the property boundary and watercourses as well as an assessment of the drainage and previous impacts in the area.
- Mucina and Rutherford Vegetation Map, the National Vegetation Map of South Africa (SANBI, 2018) as well as the KZN Vegetation Map to determine the local reference vegetation for the site.
- Conservation Planning Tools including the NFEPA datasets and the KwaZulu-Natal Systematic Conservation Assessment for the study site to provide context.
- Sub-Quaternary Reach (SQR) specific data from the River Eco-status Monitoring Programme regarding aquatic macroinvertebrate assemblages, fish assemblages, Present Ecological State, Ecological Importance and Ecological Sensitivity (DWS, 2014).

2.2 Field assessment

All watercourses located within 500m of the proposed development were delineated at a desktop level using the best available spatial information for the Quarter Degree Grid Square 2930DD. Riverine areas were then delineated at a higher resolution onsite during a field assessment on the 15th November 2022 using the DWAF (2005a) field delineation guidelines which included the use of three key indicators, namely;

- The presence of alluvial soils and deposited materials from upstream sources.
- The topography and morphology associated with a watercourse (i.e. macrobanks or clear gradient changes on the edge of watercourses.
- The robustness and composition of vegetation.

The field investigation also included an assessment of riparian and instream habitat as well as aquatic habitat, biota and water quality.

2.3 Intermediate Habitat Integrity Assessment

The ecological status of the riparian and instream zones of the study area was assessed using the Intermediate

Habitat Integrity Assessment (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D: Appendix R4, 1999). The IHIA is derived from Kleynhans (1996). The methodology assesses various aspects of the riparian and instream habitat, each with their own weighting. The score is then calculated to derive a present ecological score and category (See Appendix 1 for Index of Habitat Integrity categories and associated weighted criteria). The riparian and instream habitat was assessed at areas immediately upstream and downstream of the proposed development.

2.4 Aquatic Macroinvertebrate Analysis

2.4.1 The South African Scoring System Version 5 (SASSv5)

Aquatic macroinvertebrate communities were sampled and investigated according to the method of Dickens & Graham (2002). The method involves the collection of macroinvertebrates according to the SASS v5 protocol at three different habitat types or biotopes (Dickens & Graham, 2002). The three different biotopes include stones (i.e. stones in current, stones out of current and bedrock), vegetation (marginal and aquatic) and GSM (gravel, sand and mud). These three biotopes were sampled with a standard SASS net (1 mm mesh and dimensions of 30 x 30 x 30 cm) and analysed separately according to the standardised protocol in order to consider habitat availability which may affect the distribution of macroinvertebrates.

Sampled invertebrates were then identified using the Aquatic Invertebrates of South African Rivers Illustrations book, compiled by Gerber and Gabriel (2002). Identification of organisms was made to family level (Dickens & Graham, 2002; Gerber & Gabriel, 2002). Interpretation of the results in relation to the reference scores was made according to the classification of SASS v5 scores presented in the SASS methodologies published by Dickens & Graham (2002). The SASS v5 results are expressed both as an index score (SASS score) and the average score per recorded taxon (ASPT score). Interpretation of the SASS v5 outcomes involves considering the habitat availability and state at the sampled sites. The SASS v5 results (SASS scores and ASPT values) were analysed using the SASS data interpretation guidelines for the North Eastern Coastal Belt ecoregion (Dallas, 2007).

The score for different biotopes onsite were assigned according to the discretion of the practitioner from 1 to 5, with 1 indicating a low biotope diversity and 5 indicating a high biotope diversity. The biotope score is required as part of the SASS v5 assessment. The biotopes onsite were assessed and weighted in accordance with Tate and Husted (2015).

2.4.2 The Macroinvertebrate Response Assessment Index (MIRAI)

The Macroinvertebrate Response Assessment Index (MIRAI) is utilised to determine the Ecological Category (EC) of aquatic invertebrates based on the integration of the ecological requirements for various invertebrate taxa and their response to an alteration in local habitat conditions, thereby informing the overall PES (Thirion, 2007). The data collected during the SASS survey has been used to inform the MIRAI (Dickens and Graham, 2002; Thirion, 2007). SASS provides key insight into the present state of local invertebrate assemblages as well as water quality, however, SASS lacks a “strong cause-effect basis” whereas the MIRAI aims to provide a “habitat-based cause-and-effect foundation” to assist in the interpretation of the difference in aquatic invertebrate assemblages from a hypothetical reference or unmodified system for a specific SQR (Dickens and Graham, 2002; Thirion, 2007).

2.5 Fish (Ichthyofauna) Assessment

Fish sampling was undertaken within the riverine unit onsite using an Electroshocker. Potential fish captured during the field visit would be identified and photographed in the field and released shortly afterwards. The freshwater fish species would then be identified utilising the Complete Guide to the Freshwater Fishes of Southern Africa (Skelton,

2001). The desktop information provided for the SQR was used to assess the potential occurrence of certain fish species as well as the sensitivity of the recorded fish species (DWS, 2014).

The Fish Response Assessment Index (FRAI) is an index based on the response of fish communities and species to various environmental factors (Kleynhans, 2007). These factors include preferences and tolerances of specific fish species which have been categorised into five habitat related metric groups, namely: velocity – depth metrics, flow modification metrics, migration metrics, cover metrics as well as health and condition metrics (Kleynhans, 2007). The FRAI also provides a "habitat-based cause-and-effect" foundation to assist in the interpretation of the difference in fish assemblages from a hypothetical reference or unmodified system for a specific SQR (Kleynhans, 2007). The FRAI was utilised to assist in determining the PES of the assessed riverine reach of onsite based on the data collected on the local fish population.

2.6 Water Quality Assessment

The water quality of the river onsite was sampled upstream and downstream of the proposed development boundary. Once-off samples were taken from the sample sites within the river using designated sample bottles provided by a SANAS accredited laboratory. The samples were sent to the laboratory for further analysis on key water quality parameters, including; ammonium, Chemical Oxygen Demand (COD), Nitrates, Orthophosphates, E. coli and Suspended Solids at 105°C. The results of the water quality analysis were used to interpret the Ecological Category of the fish and macroinvertebrate communities as well as the overall aquatic PES.

2.7 Present Ecological Status

Ecological classification refers to the determination and classification of the health of various biophysical attributes of rivers when compared to its natural or near natural reference condition (Kleynhans, 2007). The purpose of this test is to identify causes and sources of deviation of the health of rivers from its natural state. The instream, riparian, invertebrate and fish criteria were utilised to produce a final present ecological state of each sampling site.

2.8 Impact assessment

The significance (quantification) of potential environmental impacts identified during the aquatic ecological assessment has been assessed in terms of the Guideline Documentation on EIA Regulation (Department of Environmental Affairs and Tourism, 2014). This is the rating scale developed by Afzelia for use in our reports. To determine the significance of impacts identified for a project, there are several parameters that need to be assessed. These include four factors, which, when entered into a formula, will give a significance score. The following four parameters were assessed:

1. **Duration**, which is the relationship of the impact to temporal scale. This parameter determines the timespan of the impact and can range from very short term (less than a year) to permanent.
2. **Extent**, which is the relationship of the impact to spatial scales. Each impact can be defined as occurring in minor extent (limited to the footprint of very small projects) to International, where an impact has global repercussions (an example could be the destruction of habitat for an IUCN CR listed species).
3. **Magnitude**, which is used to rate the severity of impacts. This is done with and without mitigation, so that the residual impact (with mitigation) can be rated. The Magnitude, although usually rated as negative, can also be positive.
4. **Probability**; which is the likelihood of impacts taking place. These include unlikely impacts (such as the rate of roadkill of frogs, for example) or definite (such as the loss of vegetation within the direct construction footprint of a development).

Each of these aspects is rated according to Table 2.1., below.

Table 2.1: Table of Evaluation criteria ranking

Score	Label	Criteria
Duration		
1	Very short term	0 -1 years
2	Short term	2 – 5 years
3	Medium term	5 – 15 years
4	Long term	>15 years
5	Permanent	Permanent
Extent		
1	Minor	Limited to the immediate site of the development
2	Local	Within the general area of the town, or study area, or a defined Area of Impact
3	Regional	Affecting the region, municipality, or province
4	National	Country level
5	International	International level
Magnitude		
0	Negligible	Very small to no effect on the environment
2	Minor	Slight impact on the environment
4	Low	Small impact on the environment
6	Moderate	A moderate impact on the environment
8	High	The impacts on the environment are large
10	Very high	The impacts are extremely high and could constitute a fatal flaw
Probability		
1	Very improbable	Probably will not happen
2	Improbable	Some possibility, but low likelihood
3	Probable	Distinct possibility
4	Highly probable	Most likely
5	Definite	The impact will occur

Once each of these aspects is rated, the overall significance can be scored (based on the score for Effect). The significance is calculated by combining the criteria in the following formula:

$$S = (D+E+M) P$$

S = Significance weighting

D = Duration

E = Extent

M = Magnitude

P = Probability

The explanation for each of the overall significance ratings are presented in Table 2.2., with the layout of all possible scores and their overall significance presented in Table 2.3.

Table 2.2: Significance weighting

Score	Label	Motivation
<10	Negligible	The impact is very small to absent
10-20	Low	Where this impact would not have a direct influence on the decision to develop in the area
20-50	Medium	Where the impact could influence the decision to develop in the area unless it is effectively mitigated
50 -70	High	Where the impact must have an influence on the decision process to develop in the area
>70	Very high	Where the impact may constitute a fatal flaw for the project

Table 2.3: Possible significance scores based on Effect x Likelihood

Likelihood	Effect																			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Very improbable (1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Improbable (2)	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
Probable (3)	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Highly probable (4)	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
Definite (5)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

Each impact was assessed based on the methodology above, and a table produced, indicating the scores and the overall significance rating both without and with mitigation. Where relevant, mitigation measures are recommended.

3. Description of the project area

3.1 Biophysical Context

The following table (Table 3.1) summarizes the biophysical attributes of the study area.

Table 3.1: The biophysical attributes of the study site.

Biophysical Attributes		
General description	**Site**	Proposed Queensburgh Housing Development
	GPS coordinates	**Centre of Proposed Development:** 29˚ 52' 26.95"S; 30˚ 55' 54.13"E
	Climate (Schulze, 1997; DWAF, 2005)	**U60F**: The mean annual precipitation (MAP) is ~967.8 mm; potential evapotranspiration (PET) is ~224.2 mm with a simulated mean annual run-off of ~217.1 mm.
		DWAF Ecoregion 17.01 (North Eastern Coastal Belt): Rain falls from early to mid-summer with highly infrequent winter rainfall. Maximum temperatures vary between 24-28°C in February and 20-24°C in July whilst minimum temperatures are between 16->20°C in February and 6 - >10°C in July.
	MAP:PET (Schulze, 1997)	4.32
	Simulated annual run-off (Schulze, 1997)	217.1 mm
	Geology (Department of Agriculture Land Types Database)	The study site is underlain by Natal Group Arenite
	Quaternary catchment	**U60F**
	Receiving river systems	Umbilo River
National Classification and status	**Vegetation Type and Conservation Status** (Mucina & Rutherford, 2006; SANBI, 2018)	**KwaZulu-Natal Coastal Belt Grassland** (CB 3): Endangered (EN) **Northern Coastal Forest** (FOz 7): Least Threatened (LT)
	FEPA features	None
	FEPA Unit ID	**ID:** 4632
KZN vegetation classification and status	**Vegetation Type and Conservation Status** (Scott-Shaw & Escott, 2011)	**KwaZulu-Natal Coastal Belt Grassland** (CB 3): Critically Endangered (CR) **KwaZulu-Natal Coastal Forests : Southern Mesic Coastal Lowlands Forest** (FOz 7): Critically Endangered (CR)
	Ezemvelo KZN Wildlife Aquatic Conservation Plan (EKZNW, 2007)	Earmarked (ID 3364)

3.1.1 Quaternary Catchment and Sub-quaternary Reach Information

The proposed development falls within quaternary catchment U60F which forms part of the greater Mvoti to uMzimkulu Water Management Area (WMA). The proposed development is located within the sub-quaternary reach (SQR) U60F-04632.SQR. U60F-04632 comprises the full extent of the Umbilo River which terminates at the confluence of the Umbilo and Mhlatuzana Rivers.

The SQR is considered to be in a largely modified or Class D state, whilst the ecological integrity (EI) and ecological sensitivity (ES) are rated as high and very high, respectively (DWS, 2014). Primary impacts to the SQR include large scale catchment hardening (i.e. the Pinetown Residential Area), upstream industrial areas, the prevalence of Invasive Alien Vegetation within the riparian zone, the prevalence of rural areas within the catchment, a quarry (located within 500m of the site) and the Umbilo Waste Water Treatment Works (DWS, 2014).

3.1.2 Conservation Guidelines

The KwaZulu-Natal Systematic Conservation Assessment

The KwaZulu-Natal Biodiversity Plan defines the areas of land in the form of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) required to ensure the persistence and conservation of biodiversity within the province (EKZNW, 2016). The spatial plan then provides a tool to guide conservation and protected area expansion as well as informing economic sectors involved in alien plant control, conservation officer priorities and guiding the nature of development (EKZNW, 2016).

The spatial guidelines provided by the plan outline two main categories of areas that are required to meet conservation targets for the province (EKZNW, 2016). These two main categories include CBAs and ESAs, including corridors. These categories are further divided as outlined in Table 3.2.

Upon interrogation of the KZN Biodiversity Plan, it was determined that provincial CBA Irreplaceable areas are located within 500m of the proposed development but not within the defined development boundary (See figure 3.1., below). It is not advisable to develop within areas identified as CBA: Irreplaceable. No Ecological support areas (ESAs) were identified within 500m of the proposed development.

Table 3.2: Subcategories of CBA and ESAs*.

Critical Biodiversity Areas (CBAs) – Crucial for supporting biodiversity features and ecosystem functioning and are required to meet biodiversity and/or process targets	
Critical Biodiversity Areas: 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.
Critical Biodiversity Areas: Optimal	Areas that represent an optimised solution to meet the required biodiversity conservation targets while avoiding high cost areas as much as possible (Category driven primarily by process, but is informed by expert input).
Ecological Support Areas (ESAs) – Functional but not necessarily entirely natural areas that are required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within Critical Biodiversity Areas.	
Ecological Support Areas	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 Critical Biodiversity Areas. The area also contributes significantly to the maintenance of Ecosystem Services.
Ecological Support Areas: Species Specific	Terrestrial modified areas that provide a critical support function to a threatened or protected species, for example agricultural land or dams associated with nesting/roosting sites.
Ecological Support Areas: Buffers	Terrestrial areas identified as requiring land-use management guidance not necessarily due to biodiversity prioritisation, but in order to address other legislation/ agreements which the biodiversity sector is mandated to address, e.g. WHS Convention, Triggers Listing Notice criteria, etc.

*Taken from EKZNW (2016)

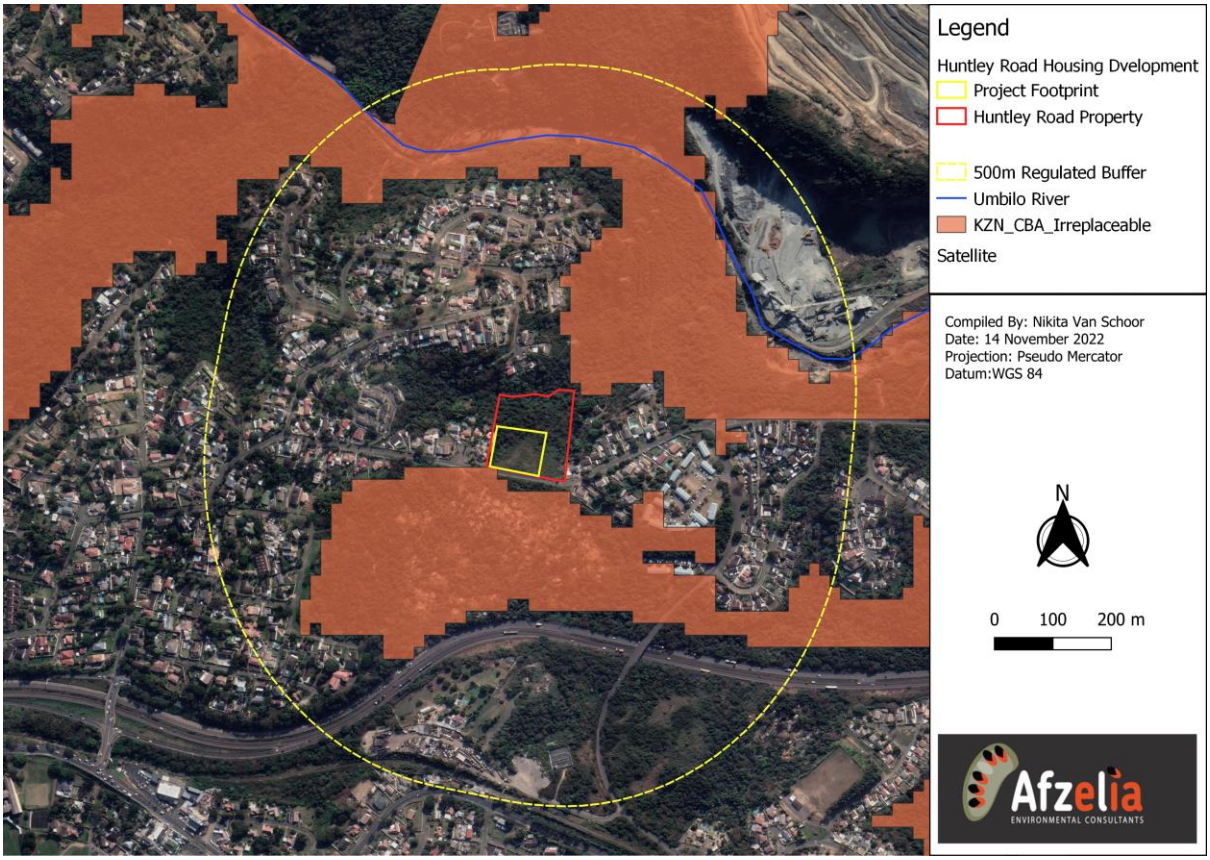


Figure 3.1: Map showing the extent of CBA: Irreplaceable areas in relation to the proposed development near Queensburgh, KZN.

The Durban Metropolitan Open Space System (D'MOSS)

The Durban Metropolitan Open Space System (D'MOSS) is a municipal level conservation plan produced by the City which comprises open spaces of high biodiversity value and other aspects including ecosystem services relating to water supply, food supply, raw materials, nutrient cycling, erosion control and flood attenuation. According to a World Bank report, the estimated value of ecosystem services provided by semi-natural and natural D'MOSS areas was R4.2 billion per year in 2017 with the total asset value of these areas estimated to be between R48 and R62 billion. If these ecosystem services were not available, the municipality would require much higher budgets, particularly in rural areas where the local population has a higher reliance on the natural environment than people within the city centre. D'MOSS forms part of Durban's Integrated Development Plan (IDP), Strategic Development Framework (SDF) and the regional Spatial Development Plans (SDP).

The D'MOSS spatial dataset shows that D'MOSS areas are located within the preferred development area (see Figure 3.2, below). The preferred development area has since been subjected to a relaxation by the eThekwini Municipality with the requirement of a 25m buffer around the D'MOSS boundary (see Figure 3.3.)

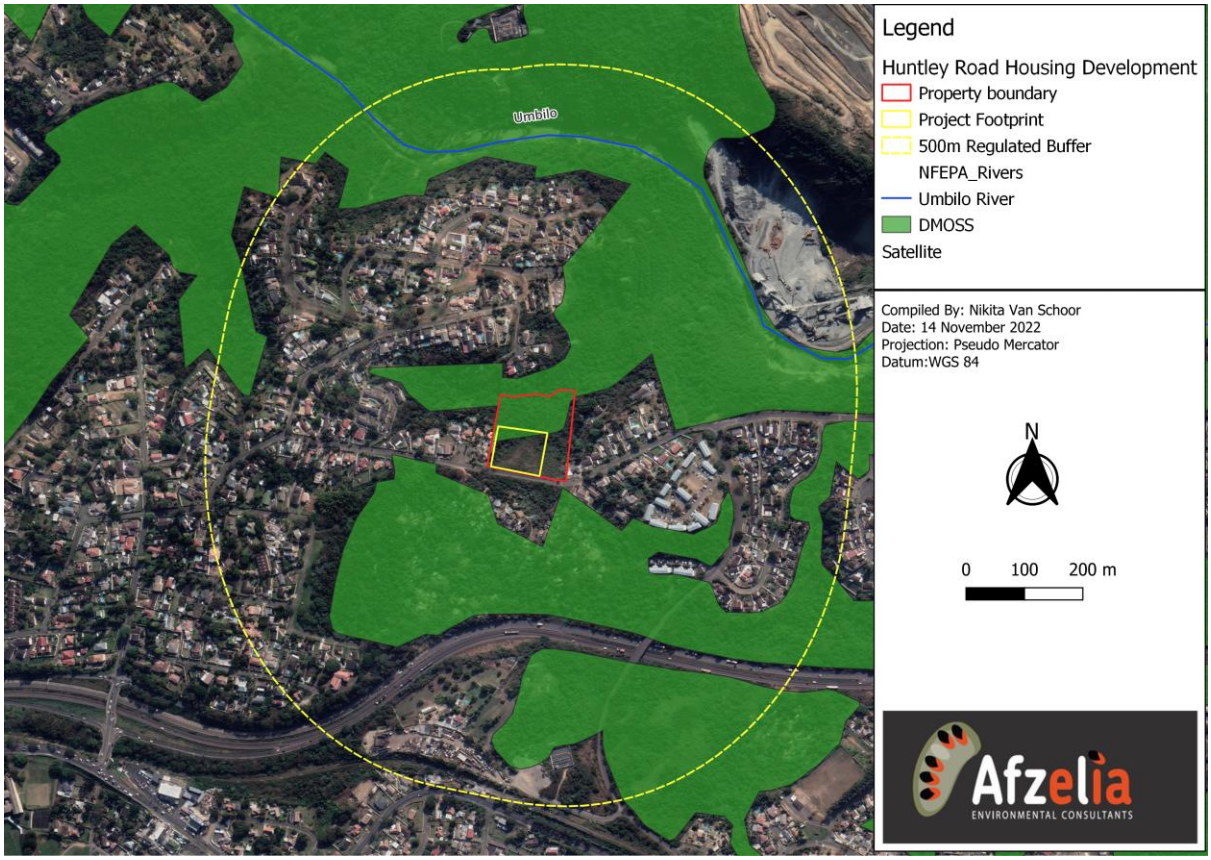


Figure 3.2: Map showing the extent of D'MOSS areas in relation to the proposed development boundary near Queensburgh, KZN.

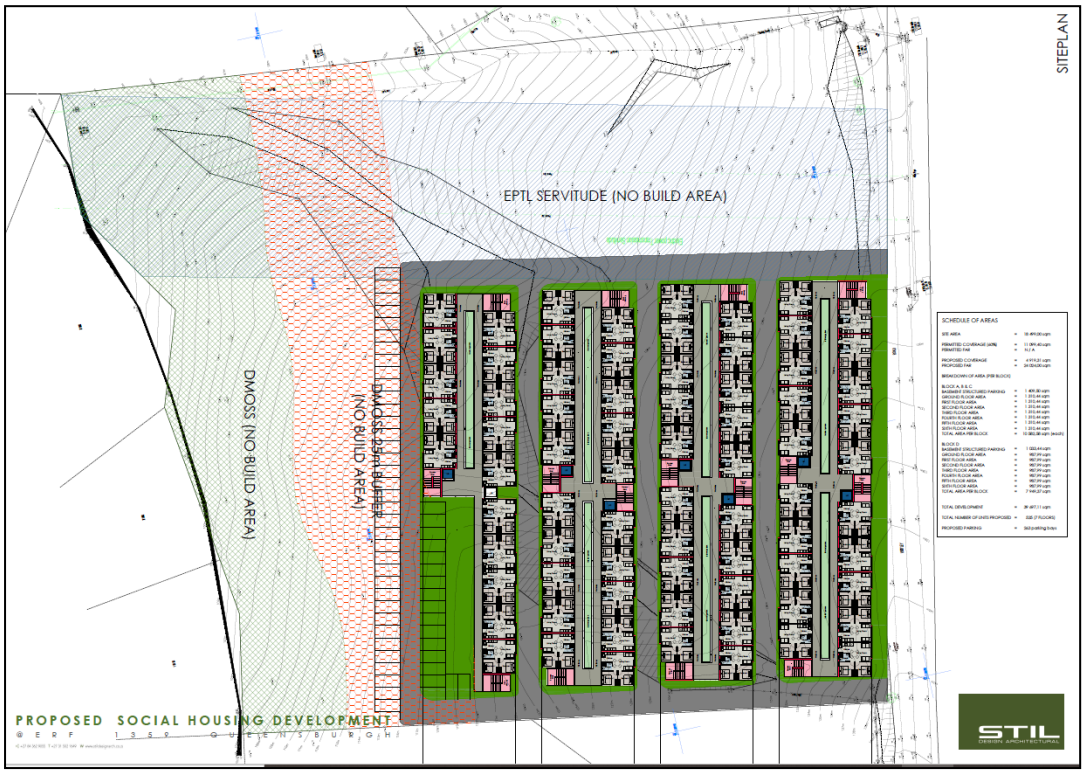


Figure 3.3: Map showing a relaxation of D'MOSS areas, granted by the eThekwini Municipality, in relation to the proposed development boundary near Queensburgh, KZN.

3.1.3 NFEPA Wetlands and Rivers

The National Freshwater Ecosystem Priority Areas (NFEPA) project aims to:

1. Identify Freshwater Ecosystem Priority Areas (FEPAs) to meet national biodiversity goals for freshwater ecosystems; and
2. Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers (Nel *et al*. 2011).

The project was developed to respond to the threats to water resources in South Africa including river, wetland and estuarine ecosystems and provides strategic spatial priorities for conserving freshwater ecosystems as well as supporting sustainable use of water resources. The strategic spatial priorities are known as Freshwater Ecosystem Priority Areas (FEPAs) (Net et al. 2011).

The SQR within which the site is located has not been identified as a River FEPA, nor has any wetland or riverine unit in proximity to the site been identified as a Wetland FEPA on the national coverage (Nel et al. 2011). The Umbilo River does occur to the north of the proposed development site with a single drainage line discharging into the northern reach of the river. General drainage lines and the Umbilo River, in proximity to the site, are shown in Figure 3.5.

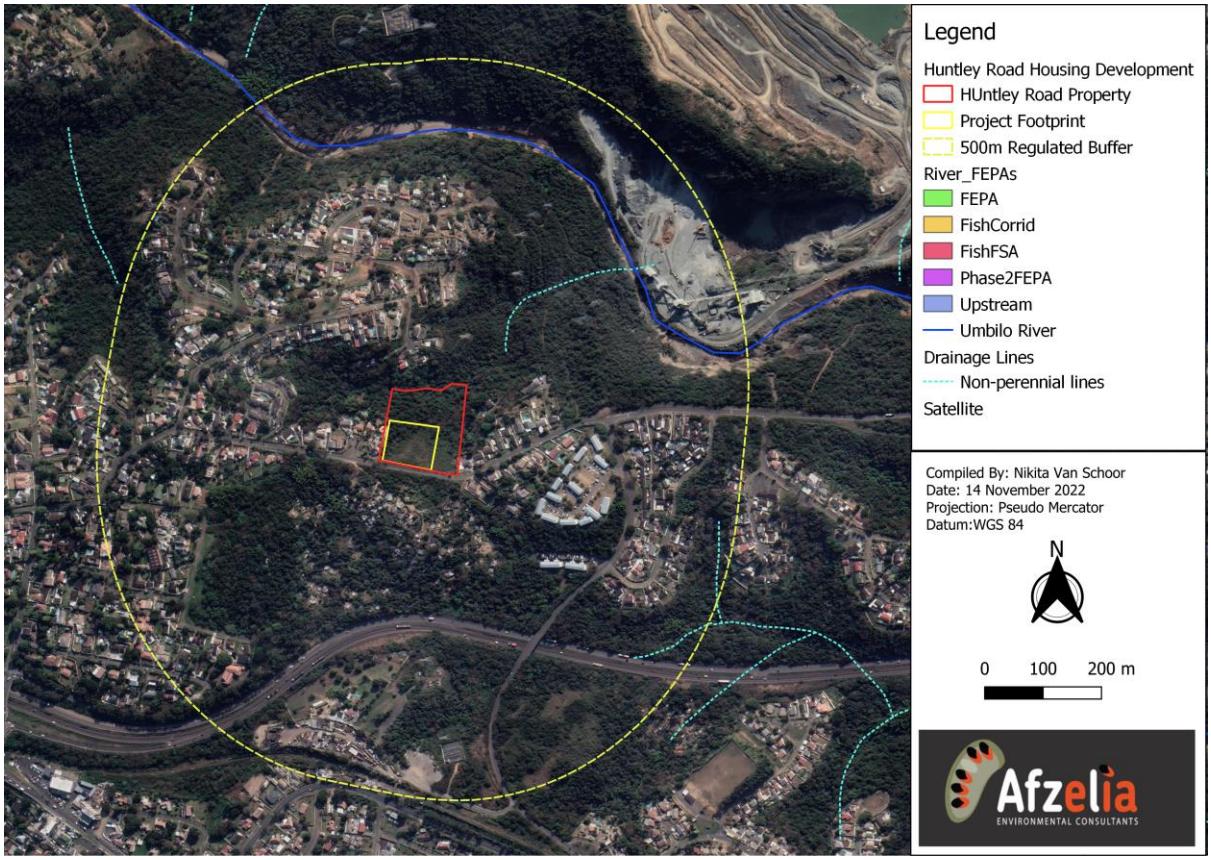


Figure 3.4: General drainage and River FEPA coverage within proximity to the study area

3.2 Site investigation

Sampling points were selected to represent a site upstream of the proposed development and downstream of the proposed development. A drainage line was identified approximately 83m from the boundary of the proposed site property (Figure 3.5). During the field visit no water was observed within this drainage line and so abiotic and biotic components could not be tested. Figure 3.6 depicts the upstream and downstream views of the sites sampled.

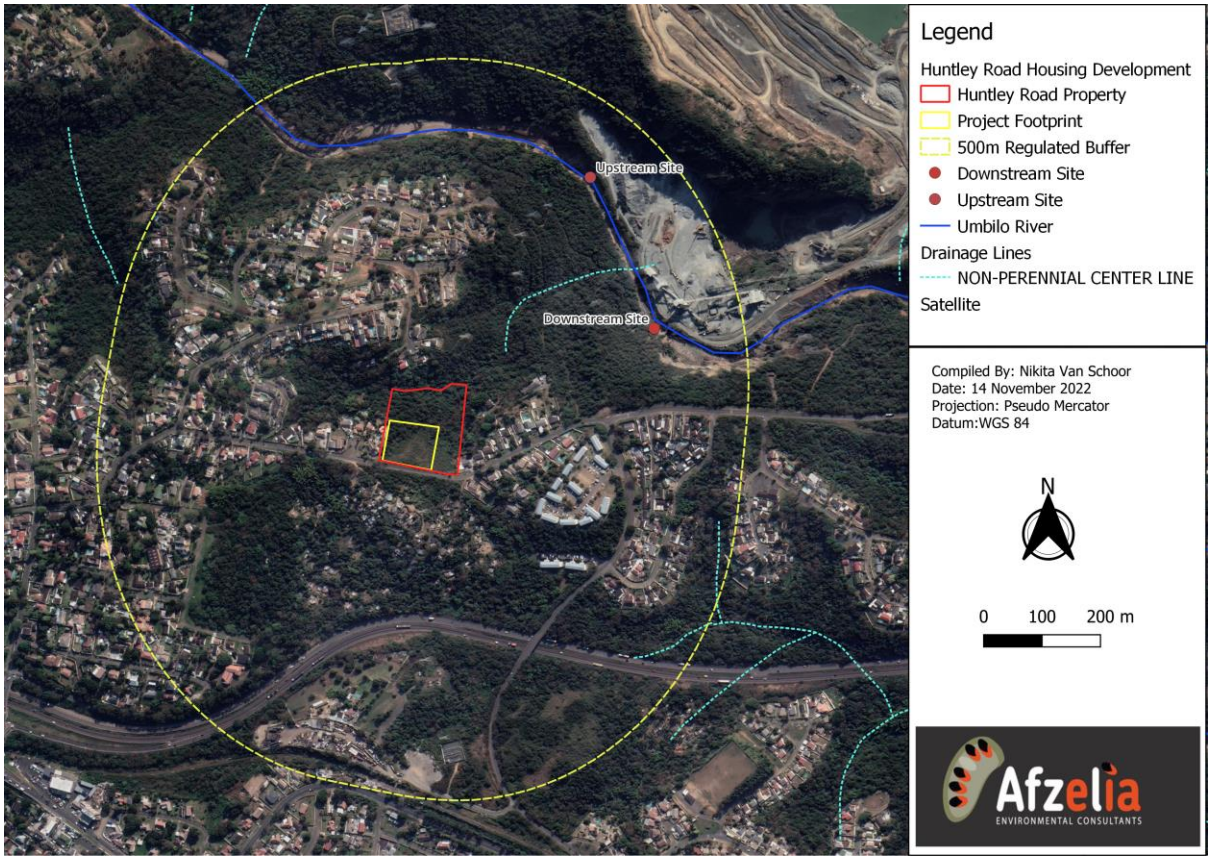


Figure 3.5: Location of the sampling points in relation to the drainage line and proposed development

Site	Upstream View	Downstream View
UM -US		

UM -DS		
UM -DL		

Figure 3.6: Upstream and downstream view of field investigation sites

4. Results

4.1 Water Quality Assessment

Water samples were collected at the upstream and downstream location of the proposed development and sent for analysis at a SANAS accredited laboratory. The location of the sample point is shown in Figure 3.5. above, whilst the results are shown in Table 4.1, below.

The water quality results show that the pH of the river are within the TWQR for aquatic systems, however, the electrical conductivity of the sample is below the DWS General Effluent Standard and slightly elevated from a natural system. Above average electrical conductivity is known to be associated with general household wastewater and malfunctioning sewerage infrastructure due to an increase in chloride, phosphate and total nitrogen levels (e.g. EPA, 2019). A distinct odour of the water was also noted. Based on the observed conditions onsite it is likely that the upstream waste water treatment works is not functioning at an optimal efficiency and having a negative impact on water quality. This is a key cumulative impact that appears to have affected the watercourse over a prolonged period of time.

The results of the laboratory analysis of water quality from the upstream site are shown in Table 4.1., below.

Table 4.1: A summary of the water quality results from the laboratory analysis for the study area

Measured Parameters	Units	Target Water Quality Range (DWAF, 1996)	DWS General Effluent Standard	Upstream	Downstream
				US	DS
Electrical Conductivity	**mS/m**	Not Available	**70 – 150**	52,9	50,9
pH	**pH units**	pH must not vary by more than 5% or 0.5 pH units of background pH for a specific site and time of day	**5.5 – 9.5**	7.3	7.5
Free Ammonia	**mg N/ℓ**	0.007	**≤3**	<1.5	<1.5
Chemical Oxygen Demand (Total)	**mg O2/ℓ**	n/a	**≤75**	44,00	52,00
Nitrate	**mg N/ℓ**	Inorganic nitrogen concentrations must not vary more than 15 % from background concentrations under unimpacted conditions at any time of the year	**≤15**	2.19	2.33
Orthophosphate	**mg P/ℓ**	Inorganic phosphorus concentrations must not vary more than 15 % from background concentrations under unimpacted conditions at any time of the year	**≤10**	1,92	1,56
Suspended Solids at 105°C	**mg/ℓ**	Total suspended solids (TSS) must not vary by more than 10% of background TSS for a specific site and time of day. Should be less than 100 mg/ℓ for all aquatic ecosystems	**≤25**	<18	<18
E. coli	**Colonies per 100mℓ**	130	**1000**	>2420	>2420

The results from the laboratory analysis show that the Escherichia coli (E. coli) levels are exceeding the TWQR within the unit indicating water quality issues at the sites. E. coli is a bacterium commonly used as a faecal indicator and subsequently an indicator of water quality issues. The likely cause of the high E. coli levels at the site is malfunctioning wastewater infrastructure from upstream sources. The marginally high free Ammonia levels are likely associated with faecal contamination of the riverine environment. This is particularly supported by the relatively high chemical oxygen demand levels.

Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is detrimental to higher aquatic life forms. The inorganic phosphorus levels observed onsite are indicative of hypertrophic conditions synonymous with problem aquatic plants, algal blooms and very low levels of species diversity (DWAF, 1996)

4.2 Intermediate Habitat Integrity Assessment

4.2.1 River Unit UM-US (Umbilo River)

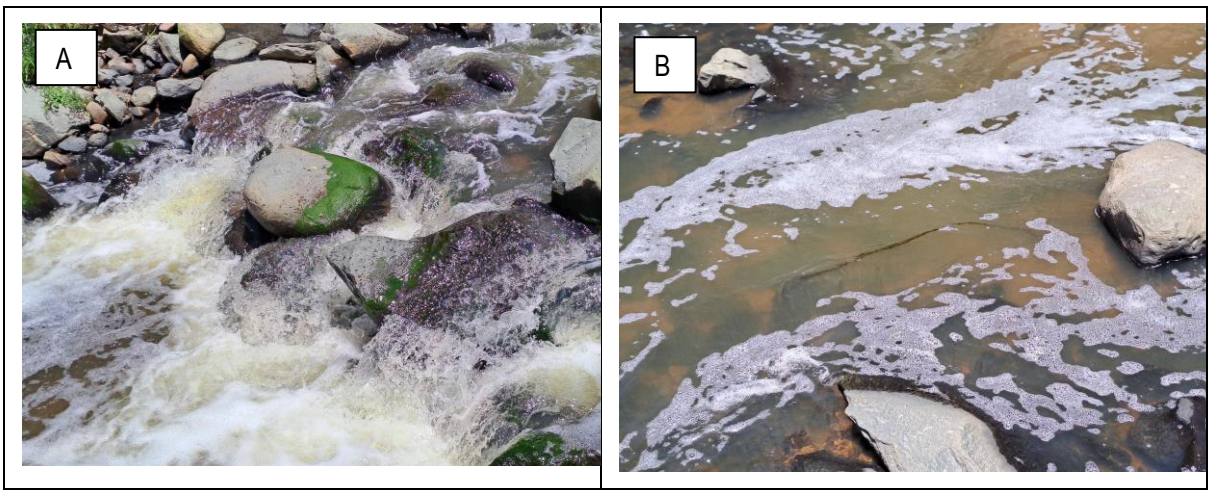
The Intermediate Habitat Integrity Assessment (IHIA) scores for the instream and riparian zones of the upstream site are shown in table 4.2., below.

Table 4.2: The IHIA scores and weightings for unit UM-US

Instream Criteria	Weight	Score
Water abstraction	14	0,00
Flow modification	13	2,08
Bed modification	13	3.64
Channel modification	13	5.72
Water quality	14	11.2
Inundation	10	0,00
Exotic macrophytes	9	3.96
Exotic fauna	8	0,00
Solid waste disposal	6	0,72
TOTAL	100	**72,68 (Class C)**

Riparian Zone Criteria	Weight	Score
Indigenous vegetation removal	13	7.8
Exotic vegetation encroachment	12	10,56
Bank erosion	14	12,32
Channel modification	12	2,88
Water abstraction	13	0,00
Inundation	11	0,00
Flow modification	12	0,96
Water quality	13	5,2
TOTAL	100	**60,28 (Class C)**

The IHIA indicated that, in terms of the habitat associated with the Umbilo River (unit UM-US), the instream and riparian habitat is in a moderately modified condition (Class C). The primary impacts affecting the instream and riparian habitat are associated with poor water quality and prevalence of alien vegetation within the assessed unit. Indigenous vegetation was limited with a greater presence of noxious weeds and invasive plant species (Figure 4.1). The poor water quality is likely having a larger impact on instream and marginal vegetation with a lower impact on riparian vegetation. Evidence of water quality degradation was evident with the presence of algae growth and filamentous algae instream. Erosion of the right bank, when looking upstream, was evident which has also resulted in changes to the instream channel and bed.



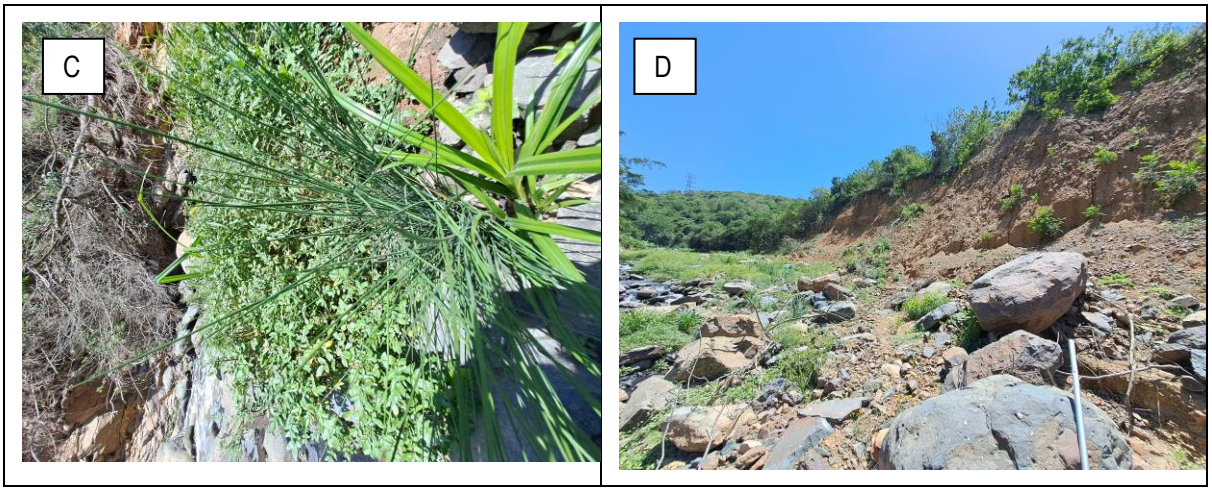


Figure 4.1: Upstream Site of the Umbilo River depicting, a and b) water quality issues, c) *Cyperus dives* indigenous vegetation and, d) Bank erosion.

4.2.2 River Unit UM-DS (Umbilo River)

The IHIA scores for the instream and riparian zones of the downstream site are shown in table 4.4., below.

Table 4.3: The IHIA scores and weightings for unit UM-DS

Instream Criteria	Weight	Score
Water abstraction	14	0,00
Flow modification	13	4.16
Bed modification	13	9.88
Channel modification	13	11.44
Water quality	14	11.2
Inundation	10	0,00
Exotic macrophytes	9	5.4
Exotic fauna	8	0,00
Solid waste disposal	6	0.24
TOTAL	100	**57.68 (Class D)**

Riparian Zone Criteria	Weight	Score
Indigenous vegetation removal	13	10.92
Exotic vegetation encroachment	12	10,56
Bank erosion	14	11.2
Channel modification	12	5,76
Water abstraction	13	0,00
Inundation	11	0,00
Flow modification	12	2.4
Water quality	13	5,20
TOTAL	100	**53.96 (Class D)**

The IHIA indicated that, in terms of the habitat associated with the downstream site of the Umbilo River, the instream and riparian habitat is in a largely modified (Class D) condition. The primary impacts affecting the instream and riparian habitat are associated with bed and channel modification, bank erosion and exotic vegetation encroachment. Exotic species identified included *Ricinus communis* (invasive), *Ageratum conyzoides* (invasive), *Alyssum maratima* (exotic), and *Argemone Mexicana* (1b invasive). The site displayed signs of sedimentation within the channel which is highly likely a result of the mining activities taking place alongside the river. Stockpiles were also observed along the banks of the site.

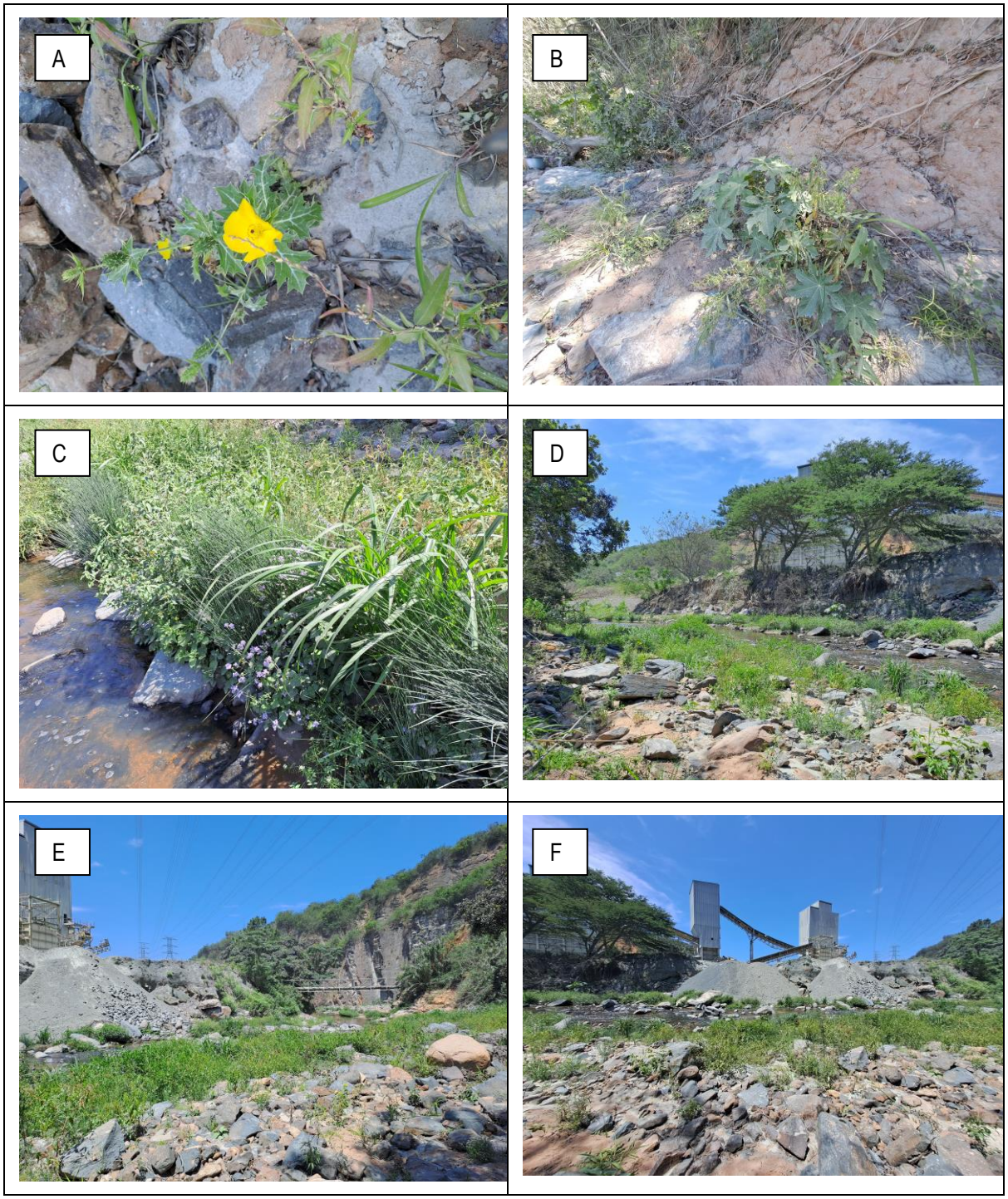


Figure 4.2: Downstream site of the Umbilo River depicting a and b) Invasive species *Ricinus communis* and *Argemone Mexicana*, c) marginal indigenous vegetation mixed with invasive species, d) Bank erosion, e and f) stockpiling along river bank and adjacent mining activities.

4.3 Aquatic Macroinvertebrate Analysis

The South African Scoring System v5 (SASS) was utilised to assess the ecological integrity of the riverine unit using benthic macroinvertebrates as indicator species (Dickens and Graham, 2002). These organisms are suitable indicators as they are susceptible to changes in water quality and habitat integrity with some organisms being more susceptible to changes than others.

4.3.1. Upstream Site (UM-US)

Biotope diversity within the upstream site was fair (Class B), primarily due to the high diversity of the stones biotope (Stones In Current, Stones Out of Current and Bedrock) within the assessed reach (See Table 4.4., below). The vegetation and gravel, sand and mud (GSM) biotopes were moderate overall with limited aquatic vegetation and mud.

The water quality within the assessed reach is likely the key limiting factor to macroinvertebrate diversity at the upstream site. The site comprised mostly of taxa that are tolerant to pollution. This includes species from the families Baetidae, Hirudinea, Ceratopogonidae, Simuliidae and Lymnaedae. The SASS data interpretation guidelines for the North Eastern Coastal Belt: Upper longitudinal zone indicates that the macroinvertebrate community within the upstream site should be classified as 'Largely Modified' (Dallas, 2007; Figure 4.3.).

Table 4.4: Summary of the Biotope and SASS results attained for the Upstream Site

Variable	Result
Biotope score (%)	**62 (Class B)**
SASS Score	66
No. of Taxa	12
Average Score Per Taxa (ASPT)	5.5
SASS Class	**Class D**: Largely Modified

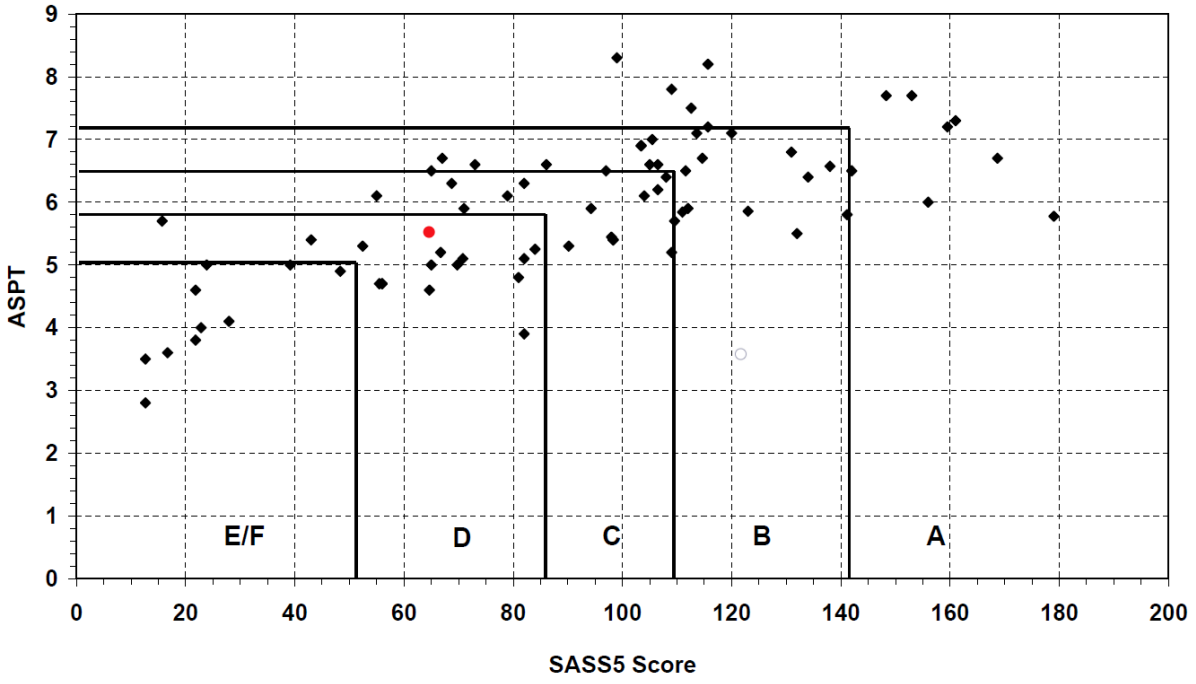


Figure 4.3: SASS graph for the North Eastern Coastal Belt: Upper longitudinal zone with the results from the Upstream Site (Dallas, 2007).

The MIRAI results indicate that the overall aquatic macroinvertebrate community at the upstream site is in a seriously modified state (Class E) (See Table 4.5., below). Water quality was identified as the primary metric responsible for the

composition of macroinvertebrates within the sampling area. Most taxa found during the site survey were tolerant of poor water quality conditions most likely a result of catchment water quality related impacts. Catchment related activities which could be negatively affecting the water quality of the Umbilo River include the industrial activities within the Pinetown area and the Umbilo Wastewater Treatment Works which is approximately 5km upstream of the site.

Table 4.5: Summarised results of the Macroinvertebrate Response Assessment Index (MIRAI)

River Units	Invertebrate Ecological Score and Category	
	MIRAI (%)	MIRAI (EC)
UM-US	33.71	E

4.3.2. Downstream Site (UM-DS)

Biotope diversity within the downstream site was rated as Poor (Class C). The close proximity of the quarry has resulted in changes to the typical habitat types associated with upper foothills. As such alluvial sand is dominant followed by marginal vegetation. Stones in and out of current are less represented.

The Downstream site comprised mostly of taxa that are tolerant to pollution. This included species from the families Baetidae, Hirudinea, Simuliidae and Turbellaria. The SASS data interpretation guidelines for the North Eastern Coastal Belt: Upper longitudinal zone indicates that the macroinvertebrate community within the downstream site should be classified as 'Severely Modified' (Dallas, 2007; Figure 4.4). The likely limiting factors for the macroinvertebrate community are water quality and habitat modification.

Table 4.6: Summary of the Biotope and SASS results attained for the Downstream Site

Variable	Result
Biotope score (%)	**52 (Class C)**
SASS Score	44
No. of Taxa	9
Average Score Per Taxa (ASPT)	4.8
SASS Class	**Class E/F**: Seriously Modified

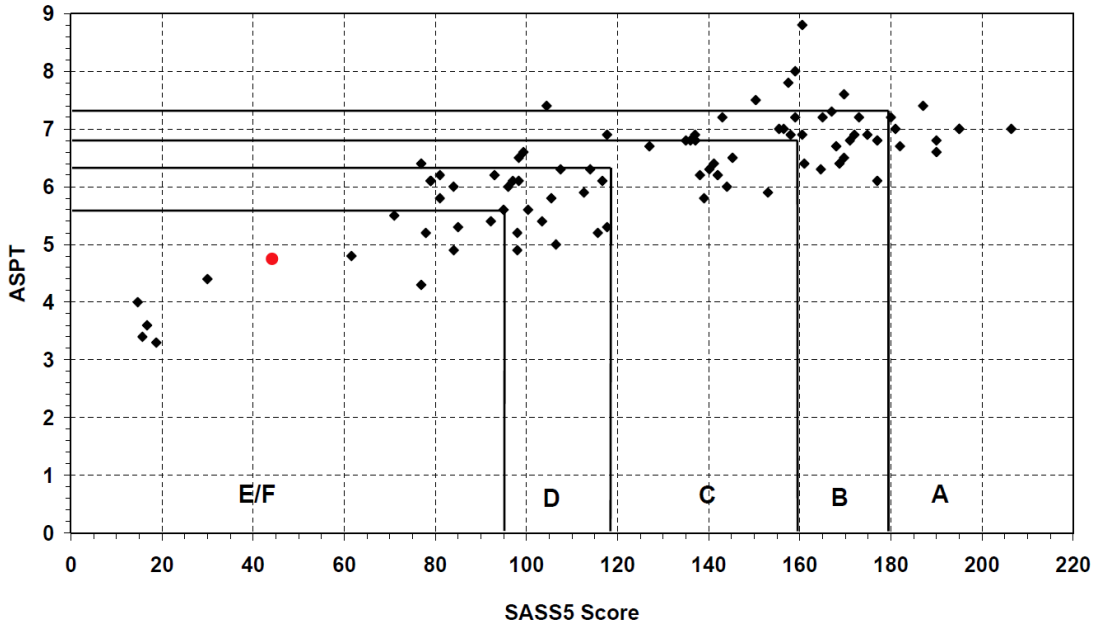


Figure 4.4: SASS graph for the North Eastern Coastal Belt: Upper longitudinal zone with the results from the Upstream Site (Dallas ,2007).

The MIRAI results indicate that the overall aquatic macroinvertebrate community at the downstream site is in a critically modified state (Class F) (See Table 4.7., below). Water quality was identified as the primary metric responsible for the composition of macroinvertebrates within the sampling area. Most taxa found during the site survey were tolerant of poor water quality conditions. Poor water quality and excessive alien invasive plant species would have overshadowed the possibility of a more diverse invertebrate community. A quarry mine was also located alongside the downstream site. Habitat modifications were obvious along the banks of the river along with sedimentation from the mining activities.

Table 4.7: Summarised results of the Macroinvertebrate Response Assessment Index (MIRAI)

River Units	Invertebrate Ecological Score and Category	
	MIRAI (%)	MIRAI (EC)
UM-US	14.98	F

4.3 Fish (Ichthyofauna) Assessment

The fish community of the study area was sampled at the upstream and downstream sampling points during the field assessment in November 2022. A standard sampling method was implemented which yielded no fish within the assessed area.

The reference species list for fish known to occur within similar habitats within the general study area is provided in Table 4.7., below. The list includes one species listed as Vulnerable (*Oreochromis mossambicus*) on the IUCN Red List (IUCN, 2019). *O. mossambicus* assemblages are under pressure due to the threat of habitat invasion by *Oreochromis niloticus* within its natural range as well as hybridisation (Cambray and Swartz, 2007).

Table 4.8: Summary of the potential fish species present within the study area based on historic sampling as part of the River Health Programme and reference data for local SQRs (DWAF, 2007; DWS, 2014). Note that cells marked with a 'dash' indicate no species caught.

Scientific Name	Common Name	Threat Status (IUCN, 2019)	River Unit
			UM-US andUM-DS
Anguilla mossambica	Longfin Eel	Least Concern	-
Awaous aeneofuscus	Freshwater Goby	Least Concern	-
Clarias gariepinus	Sharptooth Catfish	Least Concern	-
Cyprinus carpio	Common carp	Exotic	-
Enteromius viviparous	Bowstripe Barb	Least Concern	-
Glossogobius giuris	Tank Goby	Least Concern	
Labeobarbus natalensis	KwaZulu-Natal Yellowfish	Least Concern	-
Oreochromis mossambicus	Mozambique Tilapia	Vulnerable	-
Poecilia reticulate	Guppy	Exotic	-
Pseudocrenilabrus philander	Southern Mouthbrooder	Least Concern	-
Coptodon rendalli	Red Breast Tilapia	Least Concern	-
Tilapia sparrmanii	Banded Tilapia	Least Concern	-

The results of the Fish Response Assessment Index (FRAI) indicate that the fish community structures at the site (UM-US and UM-DS) are in a critically modified (Class F) condition. No fish species were recorded at either site despite the availability of potential fish habitat within the assessed reach and a consistent sampling method being implemented. Water quality is the primary metric responsible for the complete absence of a fish community within the assessed reach.

The FRAI summary is shown in table 4.9., below.

Table 4.9: Summarised results of the Fish Response Assessment Index (FRAI)

River Units	Automated FRAI Scores and Ecological Category	
	FRAI (%)	FRAI (EC)
UM-US/UM-DS	10,44	F

4.4 Overall EcoStatus

The Ecostatus of a river is defined as all features and characteristics of a river and associated riparian areas that relate to the ability of a system to support reference flora and fauna as well as the capacity of a system to provide important ecosystem goods and services (Kleynhans and Louw, 2007). The EcoStatus result integrates scores for both the drivers (hydrology, geomorphology and pyhsico-chemical) and responses (fish, aquatic macroinvertebrates and vegetation) of overall riverine health (Kleynhans and Louw, 2007).

The results of the collective PES assessments of the upstream and downstream sites are shown in Table 4.10.

Table 4.10: Overall EcoStatus of unit UM-US and UM-DS

Ecological Categories Assessed	Ecological Category Score (UM-US)	Ecological Category Score (UM-DS)
Instream Ecological Category	C	D
Riparian Ecological Category	C	D
Aquatic Macroinvertebrate Ecological Category	E	F
Fish Ecological Category	F	F
EcoStatus	D	D/E

The EcoStatus of unit UM-US was determined to be Class D (Largely Modified) based on the site assessment completed in November 2022. The 'largely modified' conditions are driven by water quality issues within the assessed reach which has resulted in the absence of key invertebrates and fish from sites. Habitat within the unit is also subjected to invasive alien plant encroachment within the riparian zones.

The EcoStatus of unit UM-DS was determined to be Class D/E (Largely to seriously modified). This reach of the Umbilo River has been heavily impacted on by the adjacent Quarry. Sedimentation has resulted in changes to the channel morphology as well as high levels of alien invasive species encroachment which has further reduced the number of invertebrate species present.

5. Impact Assessment

The purpose of this phase of the study was to identify any riverine or stream units that are likely to receive potential impacts from the proposed construction and operation of the Queensburgh Housing Development, and to provide a short description of these impacts including potential mitigation measures so as to limit the perceived impacts on the natural environment. Freshwater ecosystems, including wetlands and rivers, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, cumulative changes to these ecosystems. When making inferences on the impact of project activities on riverine ecosystems, it is important to understand that these impacts speak specifically to their effect on the Present Ecological State (PES). All of these are linked to the physical components and processes of aquatic ecosystems, including; hydrology, geomorphology, vegetation as well as the biota that inhabit these ecosystems (Macfarlane et al., 2014).

Anthropogenic activities generally impact either directly (e.g. physical change to habitat) or indirectly (e.g. changes to water quantity and quality) (Macfarlane et al., 2014).

Mitigation measures must be implemented to limit the significance of these impacts on the functionality and hydrology of the riverine areas associated with the proposed development.

The proposed housing development is likely to have some level of impact on the Umbilo River and associated drainage line during the construction and operation phases.

The potential impacts to riverine habitat that could occur during the construction and operation phases of the proposed development include;

- Direct habitat disturbance due to riparian, instream and bank modifications from the placement of new stormwater infrastructure and discharge points. Note, however, that the placement of stormwater infrastructure has not been planned at this stage although it is known that the developer intends for stormwater to be collected in attenuation ponds and thereafter discharged into the Umbilo River.
- Soil erosion and downstream sedimentation as a result of in-effective stormwater management during the construction and operation phase of the development.
- Pollution of the water resource during the construction phase from construction vehicles, concrete or bitumen. Operation phase impacts related to water pollution would be as a result of potentially malfunctioning sewerage infrastructure.

5.1 Direct Habitat Disturbance

Direct habitat disturbance in the form of vegetation clearing will have a highly localised negative impact on both fauna and flora. Clearing and destruction of riparian vegetation can take place both intentionally, for servitude clearing purposes, or unintentionally due to negligence of the active staff onsite. Vegetation clearing for the development, maintenance of the electric line servitudes, and internal roads will have a minimum impact on the aquatic resources largely because of the distance between the development site and the river. At the properties outermost boundary the Umbilo River is approximately 330m from the site, and the drainage line is approximately 80m from the site. However, only 33% of the property will be utilized for development with the property set back from the D'MOSS area along its outer boundary. The actual distance between the development footprint and the Umbilo River is therefore approximately 405m and the drainage line approximately 163m from the site. A final layout for the site was not available at the time of report writing and therefore inferences regarding the potential construction of stormwater within the riparian zone could only be made with low confidence.

In terms of direct habitat disturbance during the operation phase of the proposed development, any maintenance relating to the stormwater infrastructure in proximity to the riparian zone, will likely result in instream and riparian habitat as well as bank disturbance due to potential incursions within these sensitive environments.
All other riverine units within 500m of the proposed development will receive negligible impacts relating to direct habitat disturbance due to their location within an adjacent sub-catchment or a considerable distance upstream or downstream from the development.

An impact summary table for direct habitat disturbance is shown in Table 5.1., below.

Table 5.1: A summary of the potential impacts to the assessed riverine unit from direct habitat disturbance showing the significance of impact with or without adequate mitigation.

Potential impact	Extent		Duration		Magnitude		Probability		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
	Construction Phase									
Direct habitat disturbance	1	1	1	1	2	0	2	1	8 (Low)	2 (Negligible)
	Operational Phase									
	1	1	1	1	2	0	1	1	4 (Negligible)	2 (Negligible)

Mitigation Options

- A buffer of 32m is recommended from the edge of delineated riparian habitat and should be enforced for the duration of the project. These buffers should be clearly demarcated when/ or if work is to be undertaken nearby to ensure no unnecessary incursions by vehicles or clearing takes place within these sensitive areas.
- Stormwater attenuation structures should not be placed within the riparian zones or associated 15m buffer. Stormwater outlet protection may be placed within these sensitive areas in order to negate, or at least minimise, potential erosion from the stormwater outlets.
- The use of existing tracks and roads to gain access to the work area must be prioritised as far as practically possible.
- There shall be no mining of soil, sand or rock required for construction purposes from the banks of riverine areas. Soil must be brought in, as/if needed, for construction purposes. The rock and soils stockpiles must be located at least 50m away from the riverine units.
- Additional soil stockpiling related mitigation includes the following;
    - The soil stockpiles should be stored at a maximum height of 2m to avoid compaction and loss of micro-organisms.
    - Soil stockpiles should also be kept free of weeds and potential alien plant invasion.
- In the case that soil is excavated for the sewer pipeline trench, the topsoil and subsoil must be separated. The pipeline should be buried at least 0.5m below the surface, where possible, as an insufficient burial depth may lead to unnecessary erosion.
- During the replacement of soil within the trenches, replacement of subsoil must precede the topsoil replacement, and all material must be well compacted.

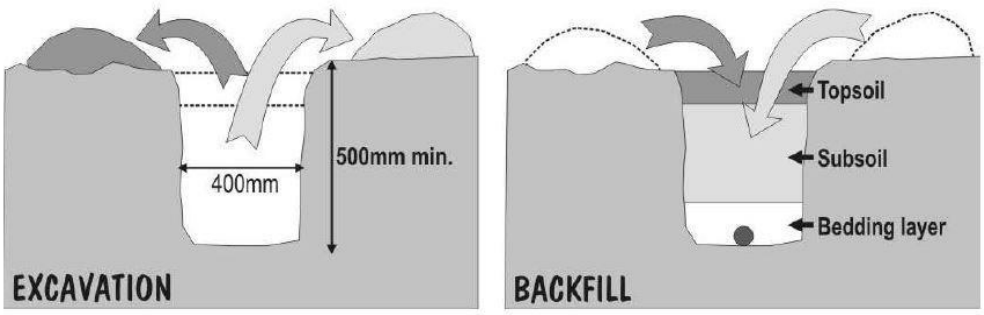


Figure 5.1: Diagram showing the correct management of excavation and backfill of soil for pipeline implementation

- An Environmental Control Officer (ECO) must be appointed to monitor compliance with mitigation onsite.

- A copy of the Environmental Management Programme (EMPr) should be available at the site camps or offices during the construction phase of the proposed development.

5.2 Soil Erosion and Sedimentation

Construction activities (i.e. excavations, vegetation clearing and depositing fill material) expose soil to environmental factors including rainfall and wind which can lead to the removal of topsoil resulting in soil erosion. Sedimentation caused by this loose soil can impact riverine systems through diminishing water quality by increasing turbidity which may affect local floral and faunal assemblages.

Compaction of soil will occur in the working areas due to heavy vehicle traffic during construction which will promote surface run-off and reduce infiltration which, in turn, will increase the volume and velocity of surface water entering the river system, thereby creating an erosion risk. Erosion risks during the operation phase of the development will be linked with the negative impacts of catchment hardening stemming from the onsite placement of impervious bitumen roads / parking surfaces as well as from the construction of residential blocks, which will alter the natural hydrology of the catchment and potentially increase velocity of stormwater reaching the nearby riverine unit. Additionally, poor placement or design of stormwater infrastructure on the edge of the riparian zone unit could potentially cause increased erosion and sedimentation downstream over time.

Key impacts related to erosion and the deposition/ suspension of sediment within riverine environments include:

- Reduced bank stability causing infrastructural issues and natural habitat alteration;
- Habitat alteration downstream of the proposed development due to increased sediment deposition within the active channel;
- Reductions in photosynthetic activity and primary production caused by sediment impeding light penetration; and
- Reduced density and diversity in benthic invertebrate communities as a result of habitat degradation.

An impact summary table for soil erosion and sedimentation is shown in Table 5.2., below

Table 5.2: A summary of the potential impacts to the assessed riverine unit from soil erosion and sedimentation showing the significance of impact with or without adequate mitigation.

Potential impact	Extent		Duration		Magnitude		Probability		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
	Construction Phase									
Soil erosion and sedimentation	2	1	2	1	4	2	3	2	24 (Medium)	8 Low
	Operational Phase									
	2	1	4	2	8	2	3	2	42 (Medium)	10 (Low)

Mitigation Options

- Erosion control measures must be implemented in areas sensitive to erosion such as near water supply points, edges

of slopes, near valley low points, drainage features and at the base of embankments and/or platforms. These measures include but are not limited to - the use of sand bags, geotextiles such as soil cells which are used in the protection of slopes, hessian sheets, silt fences and retention or replacement of vegetation. These erosion control measures must also be used during progressive rehabilitation of the site, where necessary, during and after construction activities.

- Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes without erosion protection measures being in place.
- Install sediment barriers across the downslope extent of the construction area to prevent potential sedimentation of the riparian zones.
- Any necessary temporary access roads must be aligned along the natural contour of the slopes and sufficient stormwater controls must be in place in order to avoid the road acting as a preferential flow path for water runoff.
- Stormwater and any runoff must flow into energy dissipation structures prior to being discharged back into the natural watercourses (such as retention ponds or areas with rock riprap / grassed with indigenous vegetation to encourage the trapping of silt and attenuation of flows). Stormwater attenuation must take place outside the recommended buffer zones.
- Permeable surfaces should be used, where possible, throughout the development in order to assist with rainwater infiltration which will reduce the intensity of and volume of stormwater runoff. Visual examples of these semi-pervious paving options are shown in Figure 5.2., below.

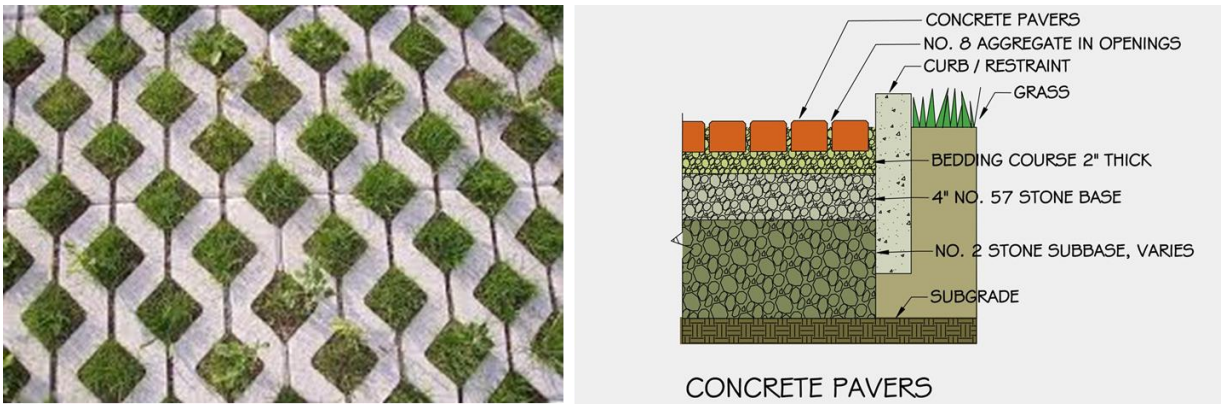


Figure 5.2: Permeable paving options that could be implemented for the roads and/or the parking bays onsite. Left image was extracted from Ecology Matters (2017), whilst the right image was extracted from Salmon Falls Nursery (2016).

- Soft or 'green' engineering practices should be employed, where viable, to allow for reduced run-off from the hardened surfaces associated with development. Recommended soft engineering practices include the reshaping and revegetation (i.e. landscaping) of disturbed areas as well as the construction of vegetated swales and infiltration trenches as opposed to concrete v-drains. Examples of vegetated swales are shown in Figure 5.3., below.

Figure 5.3: Examples of grass swales which can be implemented on low gradient areas within the site. Left image was extracted from Jaxshells (2019), whilst the right image was extracted from WBDG (2016).

- During the construction and operation phase it is recommended that potentially disturbed riparian / instream habitats and rehabilitated areas are monitored for potential erosion. This should initially take place monthly during construction, immediately after the cessation of construction and thereafter quarterly for two years.
- A stormwater management plan must be compiled for the proposed development which must include site specific mitigation measures in addition to the mitigation presented above.

5.3 Pollution of Water Resources and Soil

Mismanagement of solid waste and pollutants during construction including hydrocarbons, cement, bitumen, oils and grease as well as other hazardous chemicals will result in these substances entering and polluting sensitive riverine environments either directly through surface runoff during rainfall events or subsurface water movement. The linked nature of watercourses will result in the pollutants being carried downstream from the working site. An increase in pollutants will lead to a decline in the water quality of the riverine unit leading to overall habitat degradation and potential localised floral or faunal extinctions.

It was confirmed that the pipeline capacity is sufficient to manage the additional sewer inflow. However, the process components at the Southern WWTW need to be assessed to determine if the plant can handle an additional 0.38 Ml/d. An alternate option would be to treat sewage with a package plant on site and discharge the treated waste water (grey water) into the Umbilo River. In the event that this alternative option is pursued, the potential impacts to the Umbilo River will increase significantly.

An impact summary table for the pollution of water resources and soil is shown in Table 5.3., below.

Table 5.3: A summary of the potential impacts to the assessed riverine unit from the pollution of water resources and soil showing the significance of impact with or without adequate mitigation.

Potential impact	Extent		Duration		Magnitude		Probability		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
	Construction Phase									
Pollution of water resources and soil	2	1	2	1	6	4	3	2	30 (Medium)	12 Low
	Operational Phase									
	2	1	4	1	8	2	4	2	56 High	8 Low

Mitigation Options

- All waste must be disposed of at an appropriate licensed facility and proper management and disposal of construction waste must occur throughout the construction phase.
- All solid waste generated during construction is to be disposed of as per the EMPr.
- Waste bins must be provided at the site camp for solid waste purposes. Note that refuse generated by workers and construction related waste should not be mixed.
- No washing of paint brushes, containers, wheelbarrows, spades, picks or any other equipment adjacent to, or within, riparian or instream areas is permitted. Washing of implements should take place within a bunded area at least 50m away from the delineated boundary of the riverine unit.

- No disposal of any substance, such as cement, oil or bitumen, within the nearby watercourses is permitted.
- Spillages of fuels, oils and other potentially harmful chemicals must be cleaned up immediately and contaminants properly drained and disposed of using suitable licensed solid/hazardous waste facilities (not to be disposed of within the natural environment). Any contaminated soil must be removed, and the affected area rehabilitated immediately. A spill response plan must be drafted and communicated to all onsite staff in this regard.
- The site camp, fuel depots and equipment lay-down areas are not to be located within delineated riparian or wetland areas. These areas should ideally be located at least 50m from the edge of the riparian zone on a relatively flat area, if possible. The proposed location of the site camp, fuel depots, equipment lay-down areas will need to be approved by the ECO before commencing with construction.
- Bunded areas should be created and suitably maintained onsite. All refuelling and storage of harmful chemicals, if necessary, should take place within these areas to ensure that no harmful run-off reaches the watercourses. It is also important for heavy machinery operating onsite to be routinely checked for fuel leaks or malfunctions to minimise the risk of a pollutant spill.
- Portable toilets must be placed on impervious level surfaces that are bunded to prevent potential leakages. The portable toilets must be located at least 50 m away from the edge of the riparian zones.
- The portable toilets must be serviced weekly by the contractor. The service records should be available for the ECO in this regard.
- Education of workers is necessary to employ sound pollution prevention practices. Training programs must be provided and contain information on the handling of hazardous materials, spill prevention and emergency spill response.
- Any abstraction from the riverine units for construction purposes must be approved by the Department of Water and Sanitation (DWS).
- During the construction phase it is recommended that aquatic biomonitoring is undertaken on a quarterly basis, with one assessment post-construction.
- The contractor must utilise industry best-practice measures when implementing and maintaining the sewerage infrastructure onsite.
- An environmental contingency plan is recommended for the proposed development to ensure that potential environmental incidents or emergencies, such as malfunctioning sewerage infrastructure, can be quickly and effectively resolved.
- The applicant must ensure that the sewage treatment works receiving the additional sewage from the proposed housing development has sufficient capacity before allowing occupancy at the housing development.

6. Conclusion

6.1 General

One perennial river system, the Umbilo River, was identified as a likely receiver of impacts from the proposed Queensburgh Housing Development. The Umbilo River was assessed at a locality immediately upstream (UM-US) and downstream (UM-DS) of the site. A drainage line was also observed which discharged into the Umbilo River between the upstream and downstream sites. No flowing water was observed at this drainage line and the presence of stormwater infrastructure along this line suggests that it is likely in use as a stormwater outflow.

Although disturbances were observed at both sampling sites, the upstream site was observed to be in a slightly less impacted condition (PES D), when compared to the downstream site (PES D/E). The upstream site recorded more invertebrate species and greater biotope varieties. Water quality degradation was obvious along with riparian bank erosion. In comparison, the downstream site recorded a reduced invertebrate species richness, excessive channel sedimentation, and bank erosion. Although available biotopes were fair, invasive plant species and the adjacent mining activity, coupled with catchment water quality issues resulted in an overall reduced river health.

Although the development occurs within 500m of the Umbilo River and drainage line, these systems are still at least 300m

and 100m away from the proposed development respectively. The impacts associated with the proposed development will therefore be medium to low without mitigation; however, most of these impacts can be reduced to low/negligible. The steep terrain of the surrounding area does increase the risks of pollution runoff, particularly if sewage is to be treated on site. These risks are depicted in the pollution impacts table, but again can be reduced significantly if mitigation measures are followed. Furthermore, the downstream site of the Umbilo River, which would receive runoff from the proposed development via the drainage line, is already highly impacted on by the adjacent quarry mine. These impacts are of a greater magnitude than potential impacts from the development, solely because the quarry is in such close proximity to the river.

Impacts associated with construction and operation of the proposed development are summarised in Table 6.1., below.

Table 6.1: Summary of impacts associated with the proposed development.

Impact	Phase of Activity	Without Mitigation	With Mitigation
Direct habitat disturbance	Construction	Low	Negligible
	Operation	Low	Negligible
Soil erosion and sedimentation	Construction	Medium	Low
	Operation	Medium	Low
Pollution of water resources and soil	Construction	Medium	Low
	Operation	High	Low

No risk assessment was undertaken given that the location of the proposed development activities is more than 300m upslope from the Umbilo River, whilst the drainage line is also located further than 100m away.

Key Recommendations

The following is recommended prior to the commencement of the project;

- Considerations and management of the drainage line within and immediately downslope of the development area must be undertaken by the client. This area will be a likely location of stormwater attenuation structures.
- During the construction phase it is recommended that aquatic biomonitoring is undertaken on a quarterly basis, with one assessment post-construction.
- A stormwater management plan must be compiled for the proposed development which must include site specific mitigation measures.
- A contingency plan must be compiled to deal with any unforeseen emergency situations onsite including sewer or stormwater-related malfunctions.

In the case that best practice mitigation is implemented for the duration of the project and key recommendations are adhered to, it is the opinion of the aquatic specialist that no fatal flaws are applicable to the proposed development in terms of potential impacts to the riverine and aquatic environment.

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8. Appendices

Appendix 1 – IHI Criteria

The weighted instream and riparian criteria as well as the categories of IHI are shown in table 8.1. and 8.2., below.

Table 8.1: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996).

Instream Criteria	Weight
Water abstraction	14
Flow modification	13
Bed modification	13
Channel modification	13
Water quality	14
Inundation	10
Exotic macrophytes	9
Exotic fauna	8
Solid waste disposal	6
TOTAL	**100**

Riparian Zone Criteria	Weight
Indigenous vegetation removal	13
Exotic vegetation encroachment	12
Bank erosion	14
Channel modification	12
Water abstraction	13
Inundation	11
Flow modification	12
Water quality	13
TOTAL	**100**

Table 8.2: Index of Habitat Integrity categories (Kleynhans, 1996).

Score	Category	Description
90 - 100	A	Unmodified, natural.
80 - 89	B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
60 - 79	C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.
40 - 59	D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
20 - 39	E	The loss of natural habitat, biota and basic ecosystem functions is extensive.
0 - 19	F	Modifications have reached a critical level and the lotic 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.