Aquatic Biodiversity Specialist Assessment

Freshwater Ecological Assessment for the proposed Maclear Sand Mine Project

Tsitsa River, Niagara 380, Elundi Local Municipality, Eastern Cape Province, South Africa

November 2022

CLIENT

World Focus 1143 CC

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Report Name	**Freshwater Ecological Assessment for the proposed Maclear Sand Mine Project**	
Submitted to	World Focus 1143 CC	
Survey/Report	Prasheen Singh (Pri. Sci. Nat. 116822)	
Review and Update	Andrew Husted (Pr Sci. Nat. 400213/11)	
Declaration		
The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Ecological Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.		

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Declaration

I, Prasheen Singh declare that:

- I act as the independent specialist in this application;
- 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 realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Prasheen Singh

Aquatic Ecologist

The Biodiversity Company

01 December 2022

Declaration

I, Andrew Husted declare that:

- I act as the independent specialist in this application;
- 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;
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Andrew Husted

Freshwater Ecologist

The Biodiversity Company

01 December 2022

1 Introduction

The Biodiversity Company (TBC) was appointed by Afzelia Environmental Consultants (Pty) Ltd on behalf of the Applicant, Word Focus 1143 CC to conduct a freshwater ecology specialist study in support of a Basic Assessment Report (BAR) and Water Use Licence Application (WULA). The proposed project entails mining sand directly within the Tsitsa River to supply river sand to various users. The proposed project has triggered several environmental conditions and therefore requires a BAR and WULA before the project can continue. A single site visit was conducted on the 16th of November 2022, which would constitute a high flow survey.

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener *et al.,* 2005). Proposed developments thus have the potential to negatively impact on local water resources and ecosystem services. To supply river sand to various users, a sand mining operation has been proposed. The proposed project has triggered several environmental conditions and therefore requires a Basic Assessment Report (BAR) and Water Use Licence Application (WULA) before the project can continue.

This report presents the results of the freshwater ecological study on the riverine environments associated with the proposed infrastructure project. This report should be interpreted after taking into consideration the findings and recommendations provided by the specialist herein. Further, this report should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

The aim of the assessment was to provide information to guide the construction and operation of the proposed mining project with respect to the current ecological state of the aquatic ecosystems in the area of study. As part of this assessment, the following objectives were established:

- Freshwater Ecology Studies:
  - The determination of the baseline Present Ecological Status (PES) of the local river system;
  - The functional assessment of resources within the regulation area;
  - The evaluation of the extent of site-related impacts;
  - A risk assessment for the proposed project; and
  - The prescription of mitigation measures and recommendations for identified risks.
  - Compare the feasibility of the proposed mining area in comparison to the alternative.

2 Project Area

The project area is situated approximately 17km north-east of Nqanqarhu, along the Tsitsa River, Eastern Cape. The project area falls within the T35D quaternary catchment within the Mzimvubu-Tsitsikama Water Management Area (WMA 7) (Figure 2) and the South Eastern Uplands – Upper aquatic ecoregion. The watercourse associated with the proposed sand mining project was within the T35D-5721-iTsitsa Sub Quaternary Reach (SQR) of the Tsitsa River.

The system at a desktop level is regarded as largely natural (Class B) by the Department of Water and Sanitation (DWS, 2014) due to the presence of commercial farms, alien riparian vegetation, degraded grasslands, forestry, rural settlements, and extensive dryland cultivation. Two (2) sampling points were selected for the study: upstream (MSM_UP) and downstream (MSM_DS) of the project area. The locations of the proposed mining area and the alternative are presented in Figure 1. The photos and co-ordinates for the sites sampled and surveyed are presented in Table 1. Figure 3 presents the location of the proposed project within the Level 1 Ecoregions.

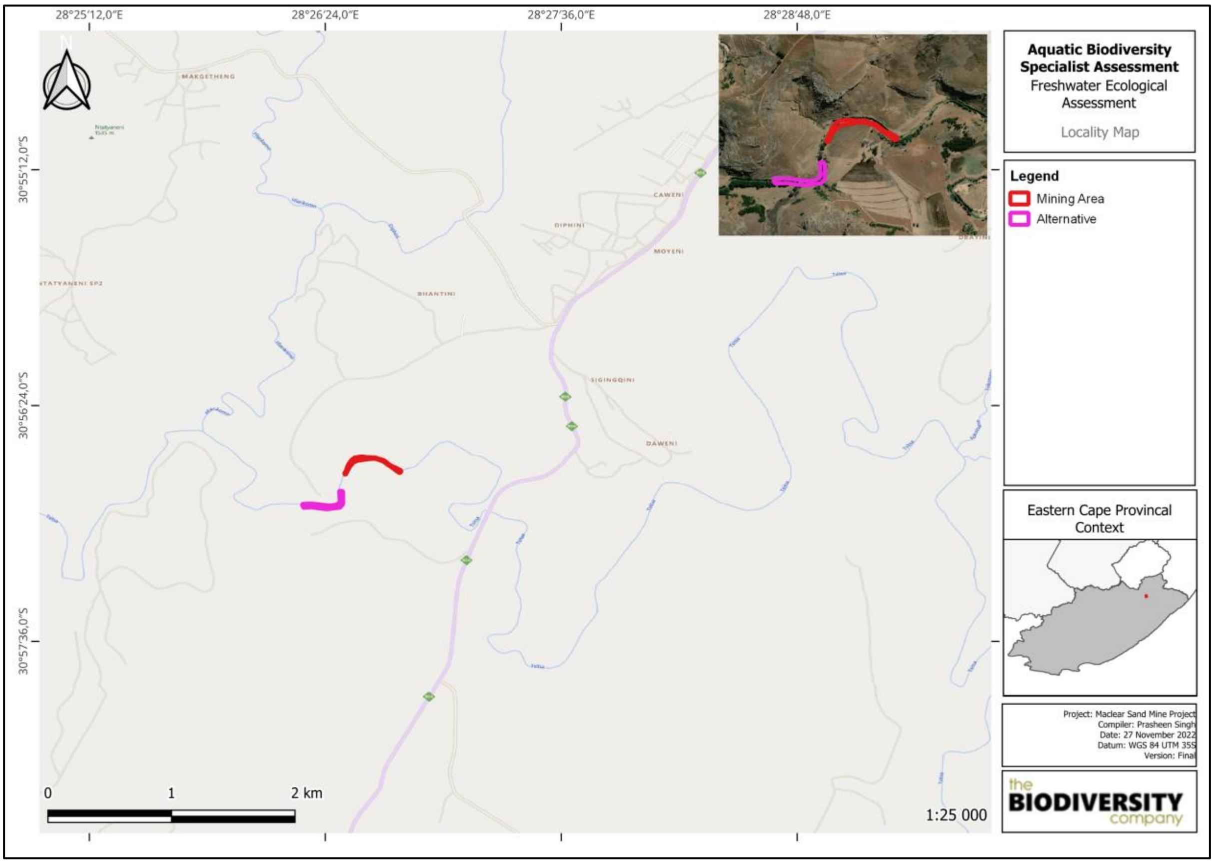

Figure 1: The location of the proposed sand mining project.

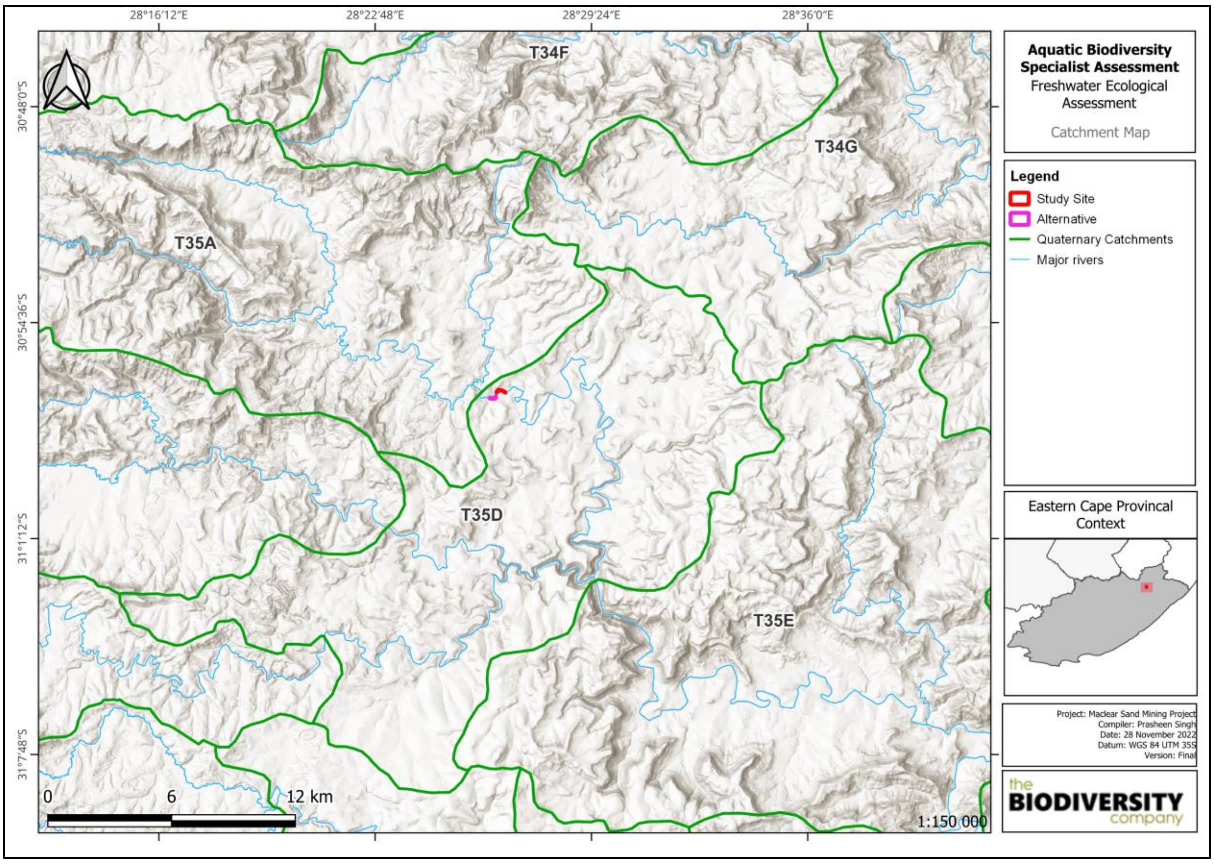

Figure 2: The location of the project area in relation to the quaternary catchments.

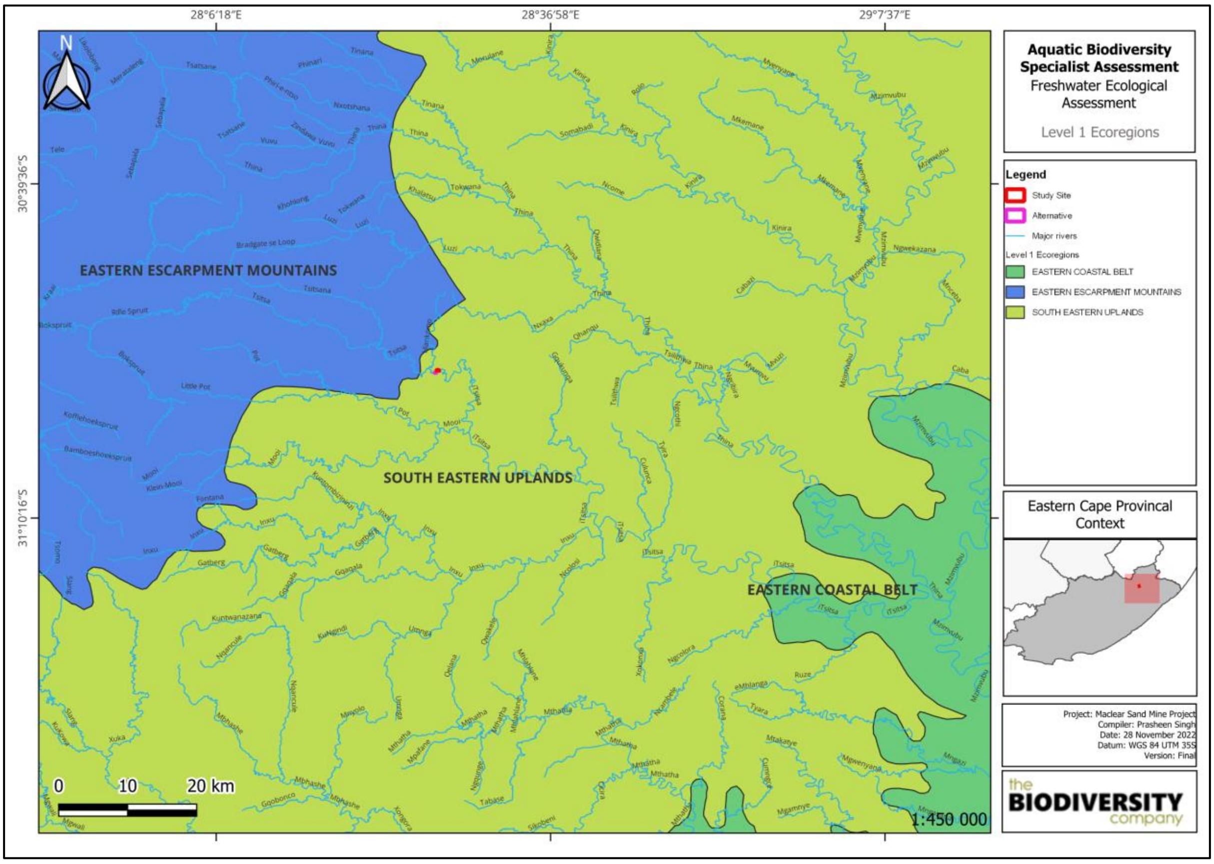

Figure 3: The location of the project area in relation to the Level 1 Ecoregions.

Table 1: Photos and co-ordinates for the sites sampled (November 2022)

Site	Tsitsa River	
MSM -UP		
GPS	30°56'47.99"S 28°26'28.04"E	
MSM -DS		
GPS	30°56'44.15"S 28°26'47.59"E	
Dam		
GPS	30°56'45.09"S 28°26'44.48"	

MSM_ALT		
GPS	30°56'54.26"S 28°26'15.79"E	
Site	Tributary/Drainage of the Tsitsa River (Alternative)	
Trib		
GPS	30°56'57.10"S 28°26'22.24"E	
D1		
GPS	30°56'54.92"S 28°26'28.96"E	
D2		

GPS	30°56'55.82"S 28°26'27.44"E
Site	Possible Wetland Area (Alternative)
W1	 
GPS	30°56'55.80"S 28°26'25.29"E

3 Methodology

The National Freshwater Ecosystem Priority Areas (Nel, *et al.* 2011) – The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on which rivers, wetlands and estuaries should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

South African National Biodiversity Assessment (NBA) 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm (Van Deventer *et al*. 2019) - The principle aim of the National Biodiversity assessment is to inform policy and decision-making in a range of sectors and contribute to national development priorities. Information obtained from the database include Flagship Status, Free-flowing Status Present Ecological State (PES), Ecosystem Threat Status and Ecosystem Protection Level.

The following information sources were considered for the desktop assessment:

- Aerial imagery (Google Earth Pro);
- The National Freshwater Ecosystem Priority Areas (Nel *et al*., 2011);
- Contour data (5 m);
- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer, H., et al., 2018); and
- Department of Water and Sanitation (2014). A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa

3.1 Wetland Assessment

3.1.1 Wetland Identification and Mapping

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) was considered for this assessment, where and if applicable. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels. In addition, the method also includes the assessment of structural features at the lower levels of classification (Ollis *et al.,* 2013).

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 4. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
    - The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.

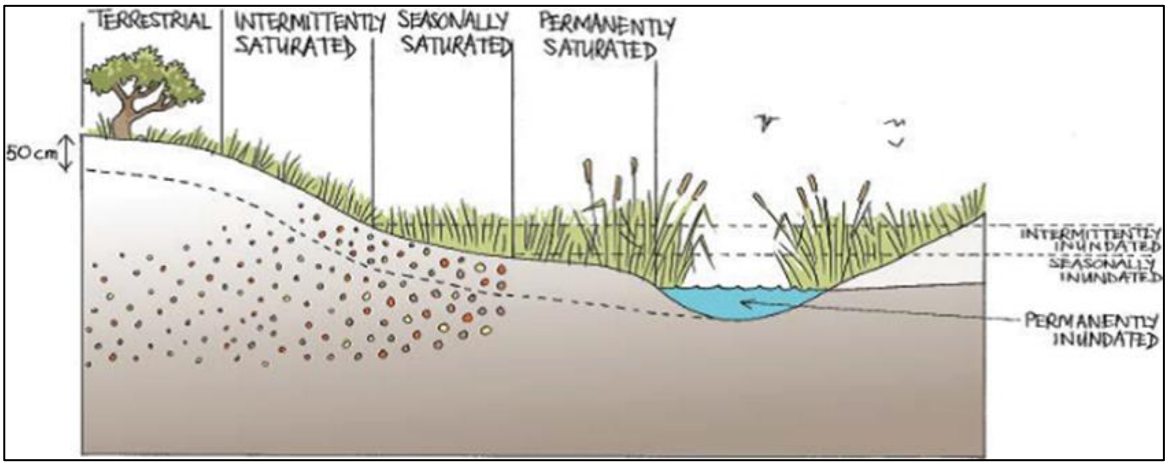

Figure 4: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al., 2013).

3.1.2 Functional Assessment

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands as well as humans. Eco Services serve as the main factor contributing to wetland functionality.

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze *et al*. 2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 2).

Table 2: Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low

1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

3.1.3 Present Ecological Status (PES)

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 3.

Table 3: The Present Ecological Status categories (Macfarlane et al., 2009)

Impact Category	Description	Impact Score Range	PES
None	**Unmodified, natural**	**0 to 0.9**	**A**
Small	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.	1.0 to 1.9	B
Moderate	Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2.0 to 3.9	C
Large	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	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.	6.0 to 7.9	E
Critical	Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F

3.1.4 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999). The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 4 (Rountree and Kotze, 2013).

Table 4: Description of Ecological Importance and Sensitivity categories

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

3.2 Aquatic Assessment

3.2.1 Water Quality

Water quality was measured *in situ* using a calibrated multi-parameter water quality meter. The following constituents were measured: pH, electrical conductivity (µS/cm), water temperature (°C) and dissolved oxygen (DO) in mg/l. Water quality has a direct influence on aquatic life forms. Although these measurements only provide a “snapshot”, they can provide valuable insight into the characteristics and interpretation of a specific sample site at the time of the survey.

3.2.2 Intermediate Habitat Integrity Assessment

The Intermediate Habitat Integrity Assessment (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 was used to define the ecological status of the Tsitsa River reach. The sites used to complete the IHIA for the Tsitsa River included MSM-UP (upstream) and MSM-DS (downstream).

The IHIA model will be used to assess the integrity of the habitats from a riparian and in-stream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale which are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).

This model compares current conditions with reference conditions that are expected to have been present. Specification of the reference condition follows an impact-based approach where the intensity and extent of anthropogenic changes are used to interpret the impact on the habitat integrity of the system. To accomplish this, information on abiotic changes that can potentially influence river habitat integrity are obtained from surveys or available data sources. These changes are all related and interpreted in terms of modification of the drivers of the system, namely hydrology, geomorphology and physico-chemical conditions and how these changes would impact on the natural riverine habitats. The criteria and ratings utilised in the assessment of habitat integrity in the current assessment are presented in Table 5 and Table 6 respectively.

Table 5: Criteria used in the assessment of habitat integrity (Kleynhans, 1996)

Criterion	Relevance
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.
Bed modification	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.
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.
Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively 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.

Criterion	Relevance
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic 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.
Indigenous 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.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the riverbank 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.

Table 6:Descriptions used for the ratings of the various habitat criteria

Impact Category	Description	Impact Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

3.2.3 Riparian Delineation and Buffer Zone

Riparian areas possess high conservation value and are an important part of a catchment due to the array of ecosystem services they supply. The vegetation they contain aids in maintain the water balance of the system. They are crucial for riverbank stability and in preventing erosion within the channel. Therefore, they are considered as high priority areas and should be avoided where possible. The riparian delineation was completed according to DWAF (2005a). Typical riparian cross sections and structures are provided in Figure 5. Indicators such as topography and vegetation were the primary indicators used to define the riparian zone. Five-meter contour data obtained from topography spatial data as well as aerial imagery was used to delineate the riparian zone.

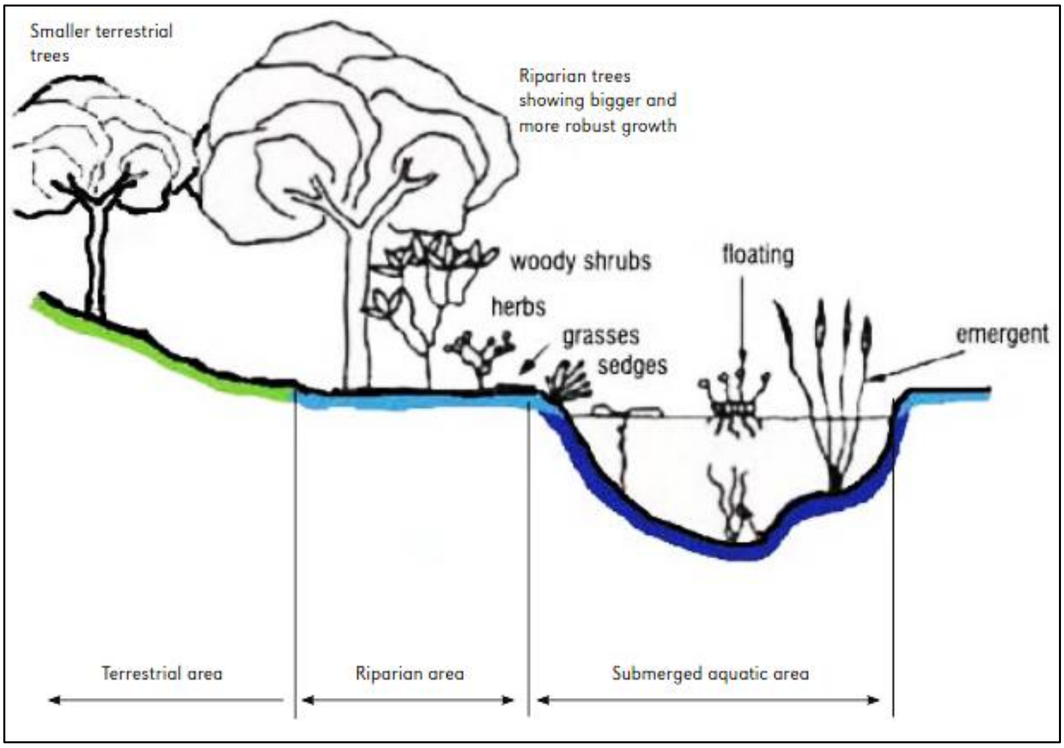

Figure 5: Riparian Habitat Delineations (DWAF, 2005a)

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane *et al.,* 2007) was used to determine the appropriate buffer zone for the proposed activity.

3.2.4 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al*., 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al*., 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

3.2.4.1 Integrated Habitat Assessment System

Habitat availability and diversity are major attributes for the biota found in a specific ecosystem, and thus knowledge of the quality of habitats is important in an overall assessment of ecosystem health. Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour *et al*. 1996). Both the quality and quantity of available habitat affect the structure and composition of resident biological communities (USEPA, 1998). Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations to facilitate the interpretation of results.

The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore, assessment of the habitat is critical to any assessment of ecological integrity. The Integrated Habitat Assessment System (IHAS, version 2) was applied at each of the sampling sites in order to assess the availability of habitat biotopes for macroinvertebrates. The IHAS was developed specifically for use with the SASS5 index and rapid biological assessment protocols in South Africa (McMillan, 1998). The index considers sampling habitat and stream characteristics. The sampling habitat is broken down into three sub-sections namely Stones-In-Current (SIC), Vegetation (VEG), Gravel Sand & Mud (GSM) and other habitat/ general. It is presently thought that a total IHAS score of over 65% represents good habitat conditions, a score over 55% indicates adequate/fair habitat conditions and where 100% represents "ideal" habitat availability (McMillan, 1998) (Table 7).

Table 7:Integrated Habitat Assessment System Scoring Guidelines

IHAS Score	Description
> 65%	Good
55-65%	Adequate/Fair
< 55%	Poor

3.2.4.2 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. *Chironomidae*) to highly sensitive families (e.g. *Perlidae*). SASS5 results are expressed both as an index score (SASS5 score) and the Average Score Per Recorded Taxon (ASPT value).

Sampled invertebrates were identified using the “Aquatic Invertebrates of South African Rivers” Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al*. 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the relevant ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database. The project area falls within the South Eastern Uplands (Upper) level 1 ecoregion. Biological bands for the South Eastern Uplands - Upper are presented in Figure 6.

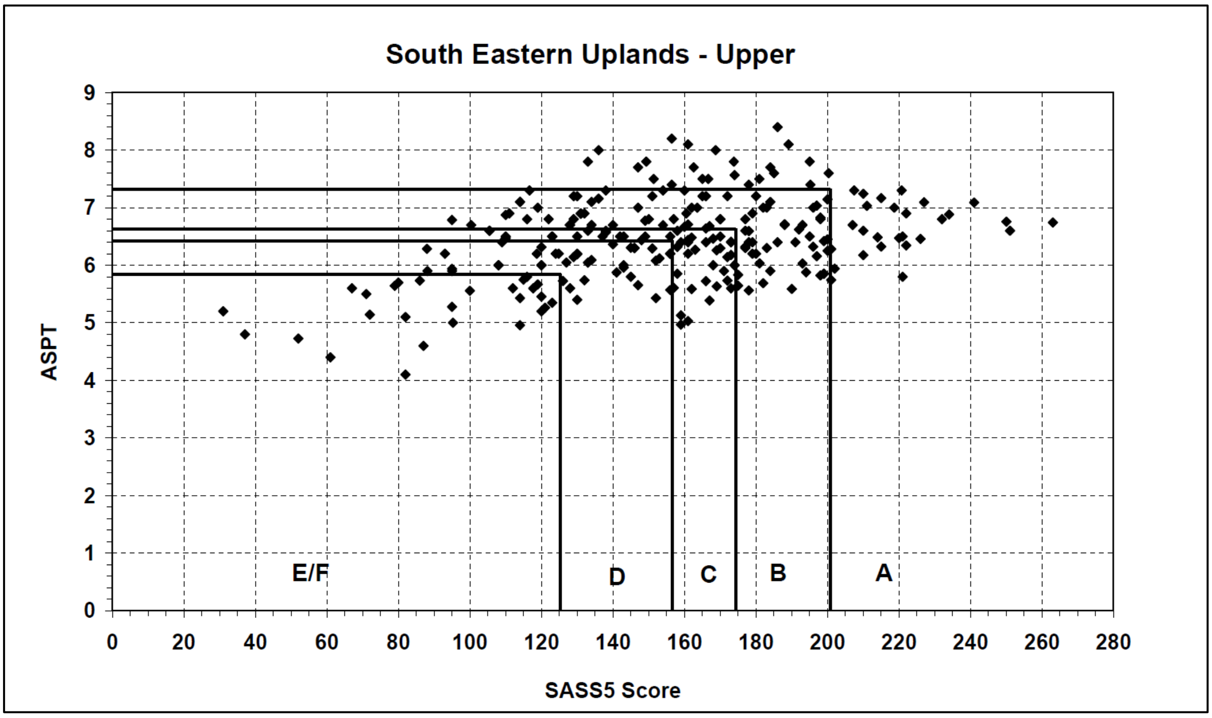

Figure 6: Biological bands for the South Eastern Uplands - Upper ecoregion (Dallas, 2007)

3.2.4.3 Macroinvertebrate Response Assessment Index (MIRAI)

Aquatic macroinvertebrate assemblages and communities offer a good understanding of the flow regime and water quality in a river. In addition, they form an essential component of the riverine ecosystem. Macroinvertebrates are important processors of transported organic matter in aquatic systems, perform vital functions in purifying the water and furthermore provide a food source for aquatic and terrestrial biota. Aquatic macroinvertebrate assemblages are guided by the physical-chemical tolerance of the individuals in the population to an array of environmental influences. The distribution pattern resulting from habitat selection by a given aquatic macroinvertebrate species reflects the optimal overlap between habit (mode of existence) and physical environmental conditions such as habitat and flows. Therefore, the often-discontinuous distribution of aquatic macroinvertebrate populations is a result of interplay between habitat, habit and the availability of food resources.

The major components of a stream system that determine productivity for aquatic organisms include:

- flow regime,
- physical habitat structure (e.g., channel form and substrate distribution), and
- Water quality (e.g., temperature, dissolved oxygen).

According to Thirion (2007), the determination of aquatic invertebrate ecological category is done by integrating the ecological requirements of the invertebrate taxa in a community or assemblage and their response to modified habitat conditions. These are based on:

- An interpretation of the environmental requirements, preferences an intolerance of Invertebrate taxa constituting the natural assemblage in a particular river delineation, and their responses to changes in habitat conditions as brought about by changes in driver components.

3.2.5 Fish Community Assessment

Collection techniques of fish within selected sites will be dependent on habitat and will include but not limited to the use of electroshocking, fyke nets, cast nets and angling. Fish to be identified in the field using Skelton (2011), selected specimens photographed and released at the point of capture. Quantitative data to be collected at each site to establish fish diversity and abundances of the aquatic systems. Fish habitat preferences to be determined through assessment of various drivers. Cover features, substrates and habitat abundances to be recorded and rated.

3.2.6 Fish Response Assessment Index

The information gained using the Fish Response Assessment Index (FRAI) gives an indication of the PES of the river based on the fish assemblage structures observed (Kleynhans, 2007). According to Kleynhans (2007), "the FRAI is an assessment index based on the environmental intolerances and preferences of the reference fish assemblage and the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers" as illustrated in Figure 7.

The expected fish species list will be developed from a literature survey and include sources such as DWS (2014), Kleynhans *et al.* (2007) and previous studies conducted within the catchment. It is noted that the FRAI Frequency of Occurrence (FROC) ratings are calculated based on the habitat present at the sites.

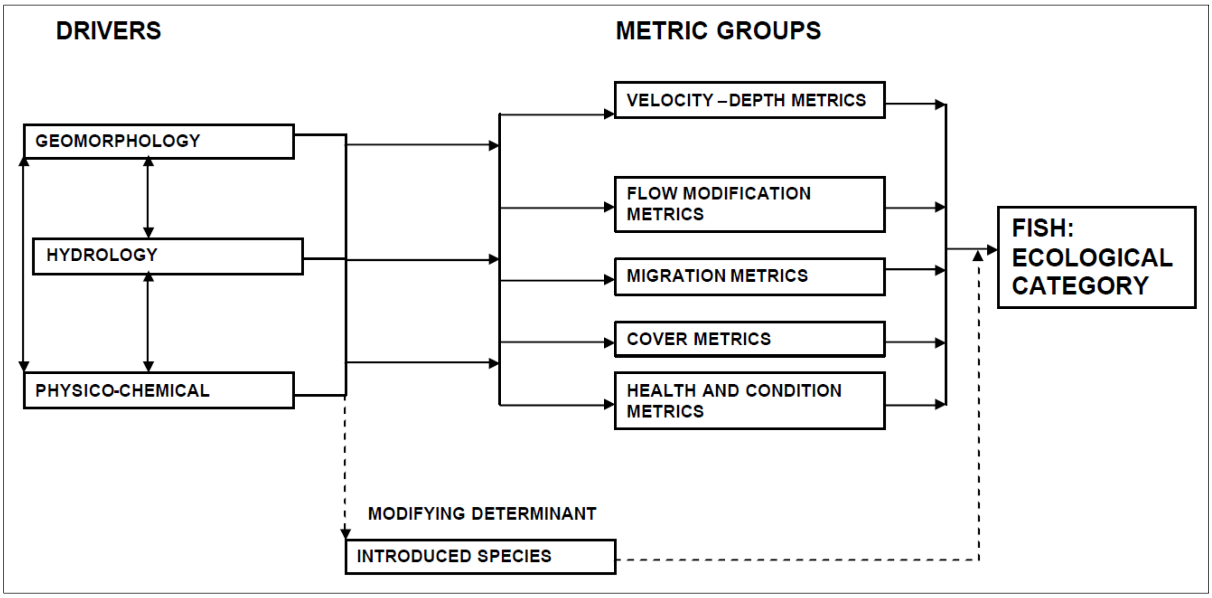

Figure 7: The relationship between drivers and fish metric groups (Kleynhans, 2007)

3.2.7 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this assessment, ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007).

3.3 Determining Buffer Requirements

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane *et al.,* 2014) was used to determine the appropriate buffer zone for the proposed activity. Comparison was also made to the recommended buffer requirements in the Eastern Cape Biodiversity Conservation Plan (ECBCP, 2019) The current condition of the river was then used to further refine the buffer zone.

3.4 Risk Assessment

The risk assessment was completed in accordance with the requirements of the DWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). The significance of the impact was calculated according to Table 8.

Once significance rating has been determined for each impact, management and mitigation measures must be determined for all impacts that have a significance ranking of Medium and higher in order to attempt to reduce the level of significance that the impact may reflect.

The EIA Regulations, 2014 specifically require a description is provided of the degree to which these impacts:

- can be reversed;
- may cause irreplaceable loss of resources; and
- can be avoided, managed or mitigated.

Based on the proposed mitigation measures, the mitigation efficiency is also determined whereby the initial significance is re-evaluated and ranked again to effect a significance that incorporates the mitigation based on its effectiveness. The overall significance is then re-ranked and a final significance (with mitigation) rating is determined. Further to the below table,

1. **High** - Impacts where an accepted limit or standard is exceeded; impacts are outside the range of normal variation or adverse changes to a receptor are long-term. Natural recovery is unlikely or may only occur in the long-term and assisted and ongoing rehabilitation is likely required to reduce the impact to an acceptable level. High significance residual impacts warrant close scrutiny in decision-making and strict conditions and monitoring to ensure compliance with mitigation or other compensation requirements. Positive social impacts of high significance would be those where considerable economic or social benefits are obtained from the project for an extended duration in the order of several years.
2. **Moderate** - Adverse changes to a receptor where changes may exceed the range of natural variation or where accepted limits or standards are exceeded at times. Potential for natural recovery in the medium-term is good, although a low level of residual impact may remain. Medium impacts will require mitigation to be undertaken and demonstration that the impact has been reduced to as low as reasonably practicable (even if the residual impact is not reduced to Low significance). Positive social impacts of medium significance would be those where a moderate level of benefit is obtained by several people or a community, or the local, regional or national economy for a sustained period, generally more than a year.

3. **Low** - Minor effects will be experienced, but the impact magnitude (or consequence) is sufficiently small (with and without mitigation) and well within the range of normal variation or accepted standards, or where effects are short-lived. Natural recovery is expected in the short-term, although a low level of localised residual impact may remain. In general, impacts of low significance can be controlled by normal good practice but may require monitoring to ensure operational controls or mitigation is effective. Positive social impacts of low significance would be those where a few people or a small proportion of a community in a localised area may benefit for a few months.

Table 8: Significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

3.5 Limitations and Assumptions

The following is applicable:

- According to the wetland desktop study and onsite characteristics, a riverine assessment was better suited for the proposed Maclear sand mining project;
- A single aquatic ecology survey was completed for this assessment. Thus, temporal trends (seasonal change) were not investigated in establishing the baseline conditions;
- Lower than normal aquatic biodiversity may be observed in the river due to heavy rainfall experienced recently in the catchment;
- The extent of the riparian zone was initially delineated on a desktop level, and refined on completion of the site assessment;
- Due to the rapid nature of the assessment and the survey methods applied, fish diversity and abundance was likely to be under estimated;
- The final sand mining layout and footprint was available at the time of writing this report;
- The GPS used for delineations is accurate to within five meters. Therefore, the delineation plotted digitally may be offset by at least five meters to either side; and
- One (1) alternative was considered for this assessment.

4 Desktop Assessment

4.1 Present Ecological Status of Sub-Quaternary Reach

The proposed activity falls within the T35D-5721-iTsitsa SQR which spans. The PES category of the reach is classed as largely natural (class B) (Table 9). The largely natural state of the reach is attributed to a small impact on wetland and riparian zone continuity, wetland and riparian zone modifications, flow modifications and potential impacts on physico-chemical (water quality) conditions. No instream habitat continuity modifications and potential instream habitat modification activities (DWS, 2014).

Table 9:Present Ecological Status of the T35D-5721-iTsitsa.

Present Ecological State	Ecological Importance	Ecological Sensitivity
B (Largely Natural)	High	High
Anthropogenic Impacts		
Habitat & continuity (fish): Commercial farms; alien riparian vegetation. Riparian/wetland zone & continuity: Degraded grasslands; forestry; rural settlements. Physico-chemical: Settlements; erosion; extensive dryland cultivation.		

4.2 National Freshwater Ecosystem Priority Areas

The T35D-5721-iTsitsa has no freshwater priority area designated to it (Figure 8). The Tsitsa River forms an important upstream management area. Conserving the ecological functioning within the Tsitsa River will aid in the protection of riverine habitat supporting fish species occurring within the entire catchment and water quality for the downstream aquatic and terrestrial biota which includes coastal and marine biota in the downstream systems. The SQR's in which human activities occur need to be managed to maintain water quality and prevent further degradation of downstream rivers.

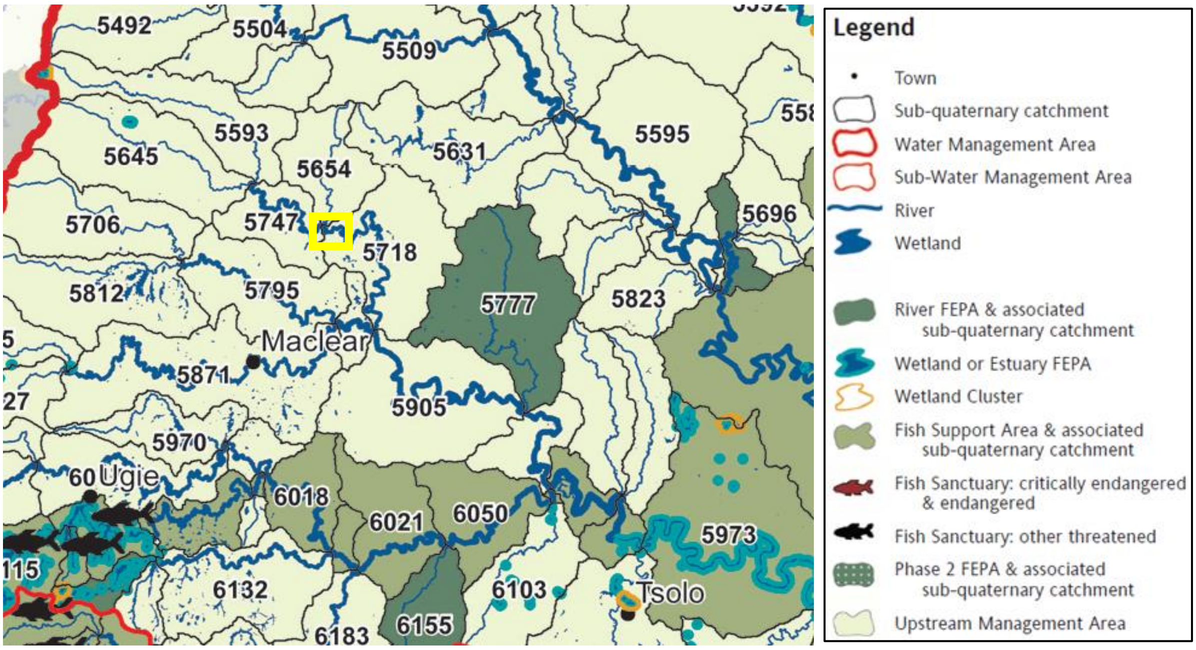

Figure 8: Illustration of NFEPAs for the project area (Yellow square) (Nel et al., 2011)

4.3 South African Inventory of Inland Aquatic Ecosystems

This spatial dataset is part of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) which was released as part of the National Biodiversity Assessment (NBA) 2018. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. According to SAIIAE dataset, a single wetland was identified as a river (Tsitsa River) (Figure 9). There are also seepage wetlands to the south of the mining area and alternative sites. The Alternative will encroach on the seep wetland whilst the proposed mining area does not pose a risk to the proximal seep zone, as the latter is drains into the Tsitsa

River. The focus of this study is on the proposed mining area. Owing to this fact no further ecological assessment of the wetland has been completed for this project, with emphasis rather afforded to the aquatic assessment of the Tsitsa River possibly at risk as a result of the proposed project.

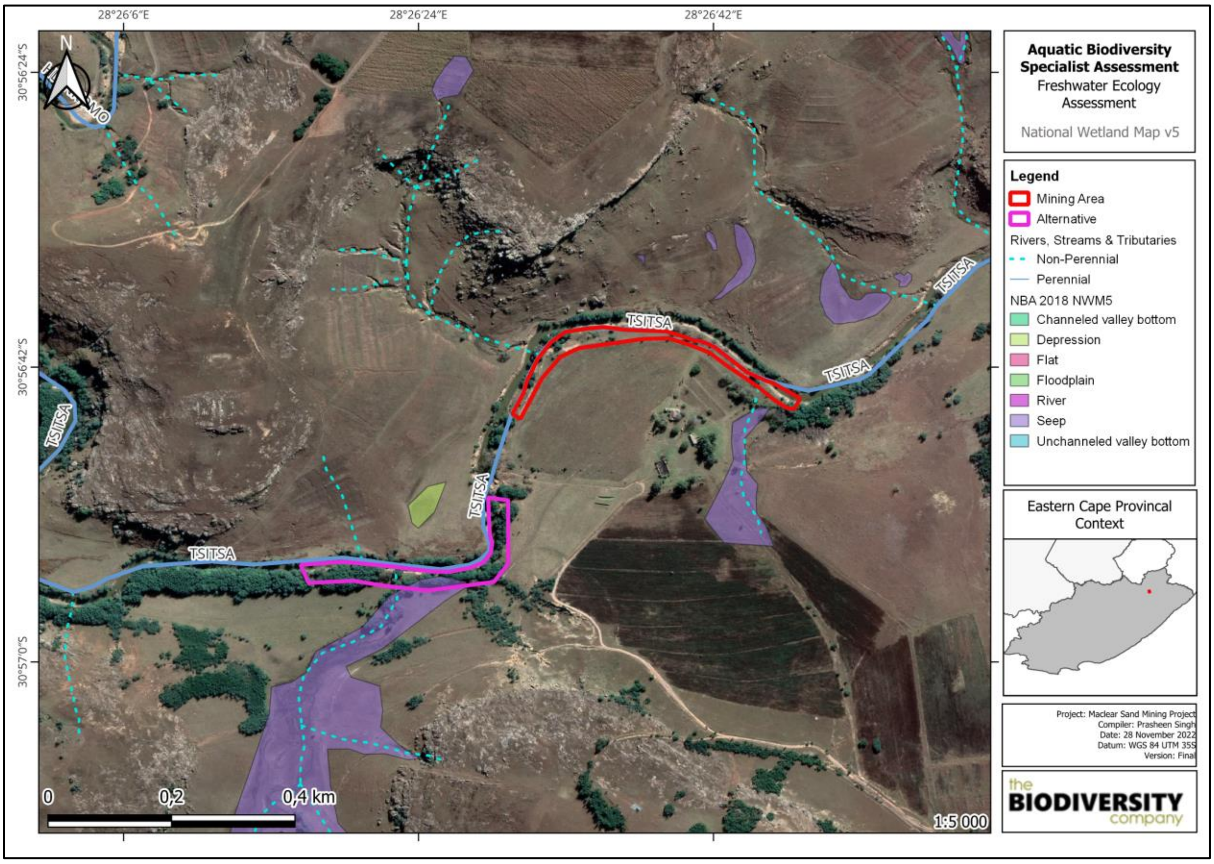

Figure 9: Map of the South African Inventory of Inland Aquatic Ecosystems wetlands within the project area

The Eastern Cape Biodiversity Conservation Plan (ECBCP, 2019) for the freshwater biodiversity assessment of the Eastern Cape Province classifies areas within the province on the basis of their contribution to reaching the conservation targets within the province. These areas are classified as Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs). The CBAs are classified as either 'CBA1' (Irreplaceable and must be maintained in a natural state, if disturbed then biodiversity targets will not be achieved), or 'CBA2' (maintain in a natural or near-natural state, some flexibility in landscape to achieve biodiversity targets).

CBAs are terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near-natural state to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. CBAs are areas of high biodiversity value and need to be kept in a natural state, with no further loss of habitat or species (MTPA, 2014). Thus, if these areas are not maintained in a natural or near natural state then biodiversity targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses (SANBI, 2017). Figure 10 illustrates the project area superimposed on the CBA map. The project area does overlaps with CBA2 and ESA1 areas.

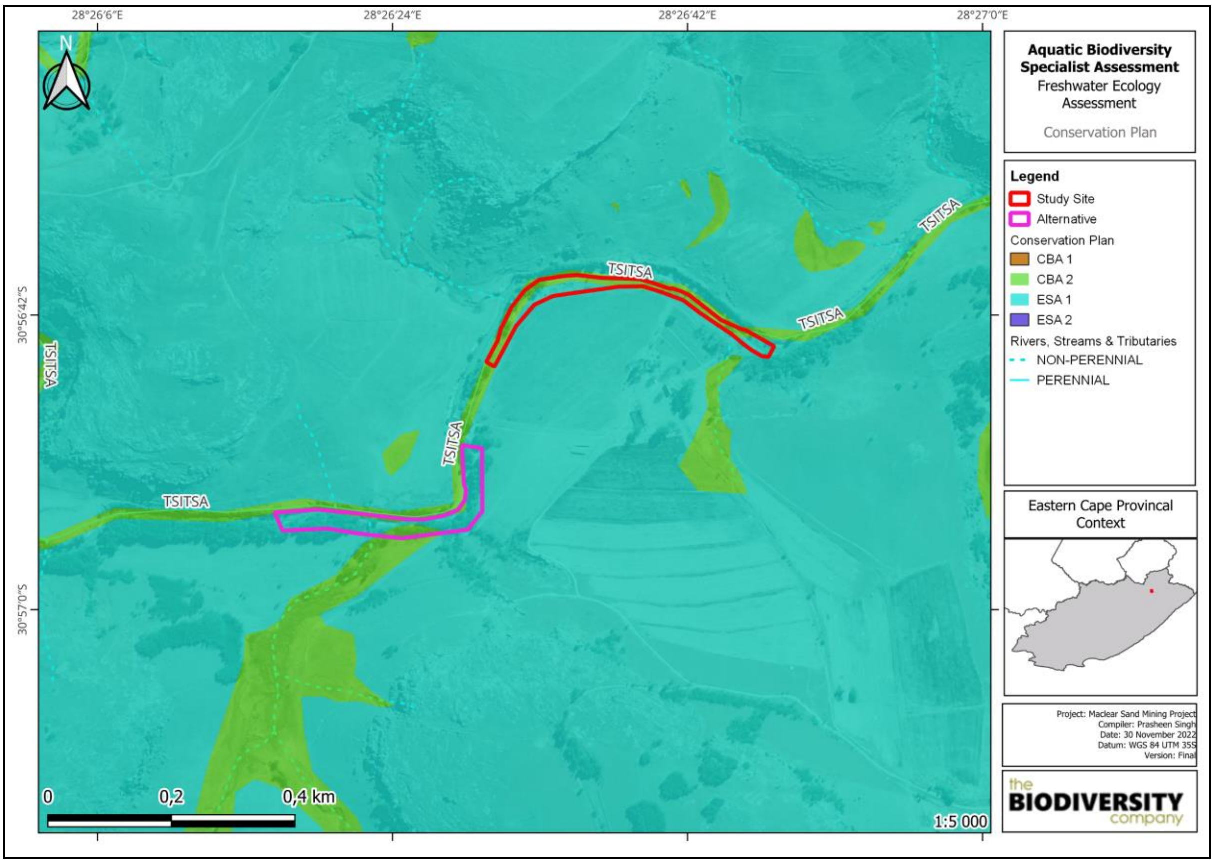

Figure 10: Map illustrating the project area in relation to CBAs and ESAs.

According to the SAIIAE, the Ecosystem Threat Status (ETS) of aquatic ecosystem types is based on the extent to which each aquatic ecosystem type had been altered from its natural condition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Concern (LC), with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Van Deventer *et al*., 2019; Skowno *et al.,* 2019) This reach of the Tsitsa River is Critically Endangered (Figure 11) and Not Protected (Figure 12).

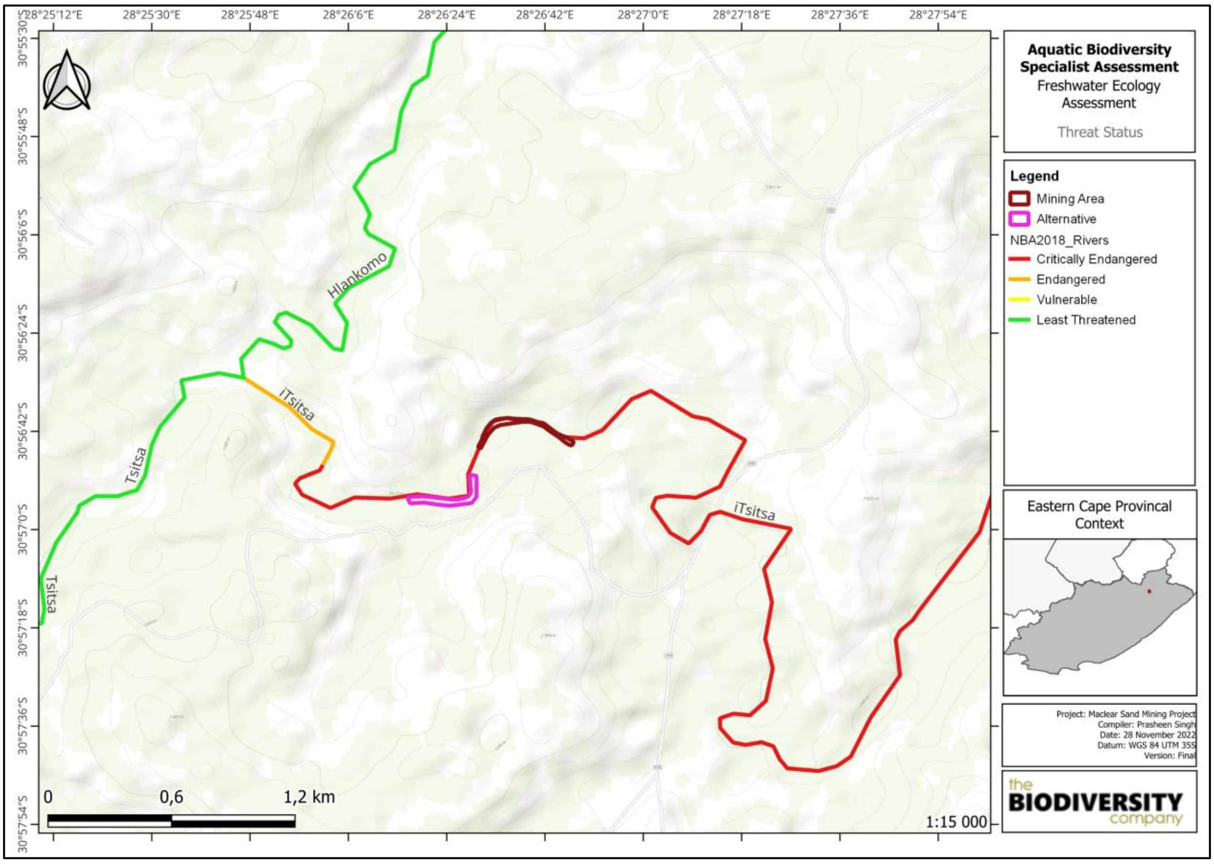

Figure 11: Map illustrating SAIIAE riverine Ecosystem Threat Status associated with the project area.

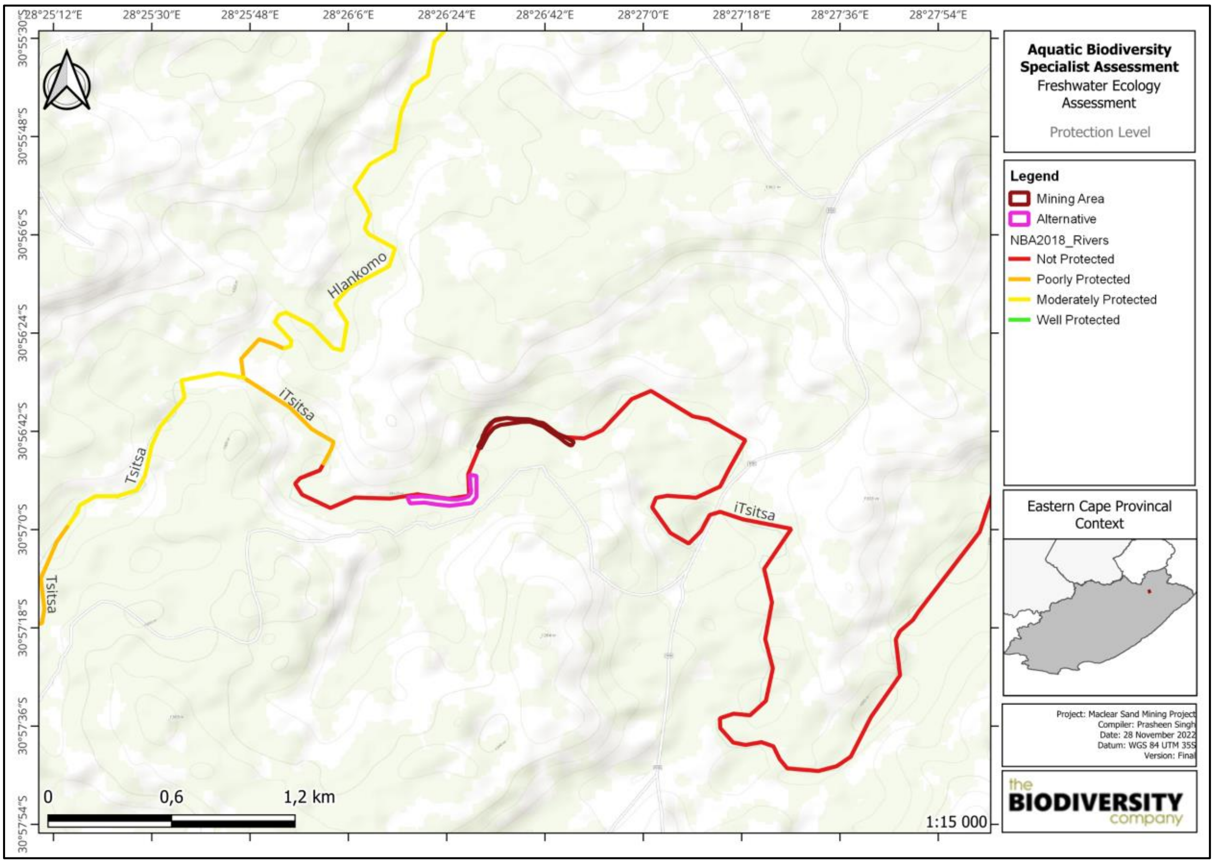

Figure 12: Map illustrating SAIIAE riverine Ecosystem Protection Level in proximity to the project area.

5 Results and Discussion

The study focused on the proposed mining area, as the alternative would impact on a tributary, drainage lines and a possible wetland area, in addition to the Tsitsa River (Figure 15). For the purposes of this assessment, the Tsitsa River has been classified as a riverine system and assessed accordingly. No additional wetlands were identified within the 500 m regulation area. A dam is located towards the east of the mining area, which is regarded as an artificial system. The functional assessment has been achieved for the river system, which considers the dam and the associated impacts to the functioning of the river. According to Ollis *et al* (2013) a dam is classified as '*an artificial body of water formed by the unnatural accumulation of water behind an artificial barrier that has been constructed across a river channel or an unchannelled valley-bottom wetland'*.

5.1 Water Quality

In situ water quality results assist in the interpretation of biological results because of the direct influence water quality has on aquatic life forms. The results of the November 2022 survey are presented in Table 10. Results were compared to the Target Water Quality Range (TWQR) for aquatic ecosystems (DWAF, 1996). Therefore, the overall water quality within the sampled river reach would not pose a considerable limitation on diversity and abundance of local biota.

Table 10: Water Quality Results November 2022

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	6.5-9.0*	**	>5.00*	5-30*
MSM_UP	9.28	59.6	6.4	25.2
MSM_DS	9.24	60.7	6.3	24.8

*TWQR – Target Water Quality Range

The results of the *in situ* assessment indicated limited perturbations in terms of physical water quality within the reach. The dissolved oxygen and water temperature were within the TWQR for aquatic life. The pH indicated alkaline conditions within the Tsitsa River. According to Barbour *et al*, (1996) most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6.5 to 8.5, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals. The pH target for fish health is presented as ranging between 6.5 and 9.0. However, the concern is changes in pH in a short distance result in aquatic biota having to change the rate of osmotic and ionic regulation with increased energy requirements, resulting in physiological stress. Such stress leads to slowed growth, reduced fecundity (less offspring produced) and in the long term death (Dallas & Day, 1993).

5.2 Intermediate Habitat Integrity Assessment

The IHIA was completed for the assessed watercourses and is presented below (Table 11).

Table 11: Intermediate Habitat Integrity Assessment for the Tsitsa River Reach

Instream	**Tsitsa River**	
	Average Impact Score	Weighted Score
Water abstraction	10	5.6
Flow modification	20	10.4

Bed modification	22	11.4
Channel modification	22	11.4
Water quality	12	6.7
Inundation	8	3.2
Exotic macrophytes	5	1.8
Exotic fauna	4	1.3
Solid waste disposal	5	1.2
Total Instream	**53**	
Category	**D**	
Riparian	**Tsitsa River**	
	Average Impact Score	Weighted Score
Indigenous vegetation removal	10	5.2
Exotic vegetation encroachment	20	9.6
Bank erosion	22	12.3
Channel modification	20	9.6
Water abstraction	5	2.6
Inundation	5	2.2
Flow modification	8	3.8
Water quality	12	6.2
Total Riparian	**51**	
Category	**D**	

The results of the instream and riparian integrity assessment both derived a class D (largely modified) status for the considered Tsitsa River reach. Several cumulative impacts were observed within the considered river reach. Bed and channel modification (Figure 13) can be attributed to extensive proximal farming and sand mining within the river channel resulting in erosion, sedimentation and alteration of flow.

In addition to instream habitat modification, the riparian zone of the Tsitsa River reach was largely modified because of several cumulative impacts. These impacts included clearance of vegetation and the establishment of alien (tree) stands on the embankments (Figure 14). The establishment of *Acacia dealbata* and *Salix babylonica* is evidence of historical disturbances, attributed to sand mining.

Figure 13: Photograph of the observed instream alterations of the Tsitsa River (November, 2022)

Figure 14: Photograph of the alien vegetation (Acacia dealbata and Salix babylonica) on the embankments of the Tsitsa River (November, 2022)

5.1 Riparian Delineation and Buffer Zone

Riparian areas have high conservation value and can be considered as the most important part of a watershed for a wide range of values and resources. They provide important habitat for a large volume of wildlife and often forage for domestic animals. The vegetation they contain are an important part of the water balance for the hydrological cycle through evapotranspiration. Buffers are crucial for riverbank stability and in preventing erosion within the channel (Elmore, and Beschta, 1987). Therefore, they are considered as high priority areas and should be avoided. The delineation of the watercourse riparian zone extent observed in the study area and the aquatic recommended buffer are presented in Figure 15. The 32m buffer recommended by the ECBCP (2019) has been reduced to 10m at the discretion of the specialist, due to the current condition of the river, banks and riparian area. Furthermore, non-native vegetation species were observed to be extensive on the bankside and channel edge vegetation. It is noted, the stockpile is within the riparian area and buffer zone. It is recommended stockpiles of the sand resource should not be kept within the delineated riparian area and buffer zone, unless authorised to do so.

A riparian assessment was completed by Ikhwane Wetland Science (2019) for a downstream reach of the Tsitsa River reach. The integrity of the riparian habitat was determined to be moderately modified (class C) which has been considered for this assessment. The major impacts on the riparian habitats were an altered catchment hydrology, the presence of alien invasive tree species and the impacts of historic sand mining (Ikhwane Wetland Science, 2019).

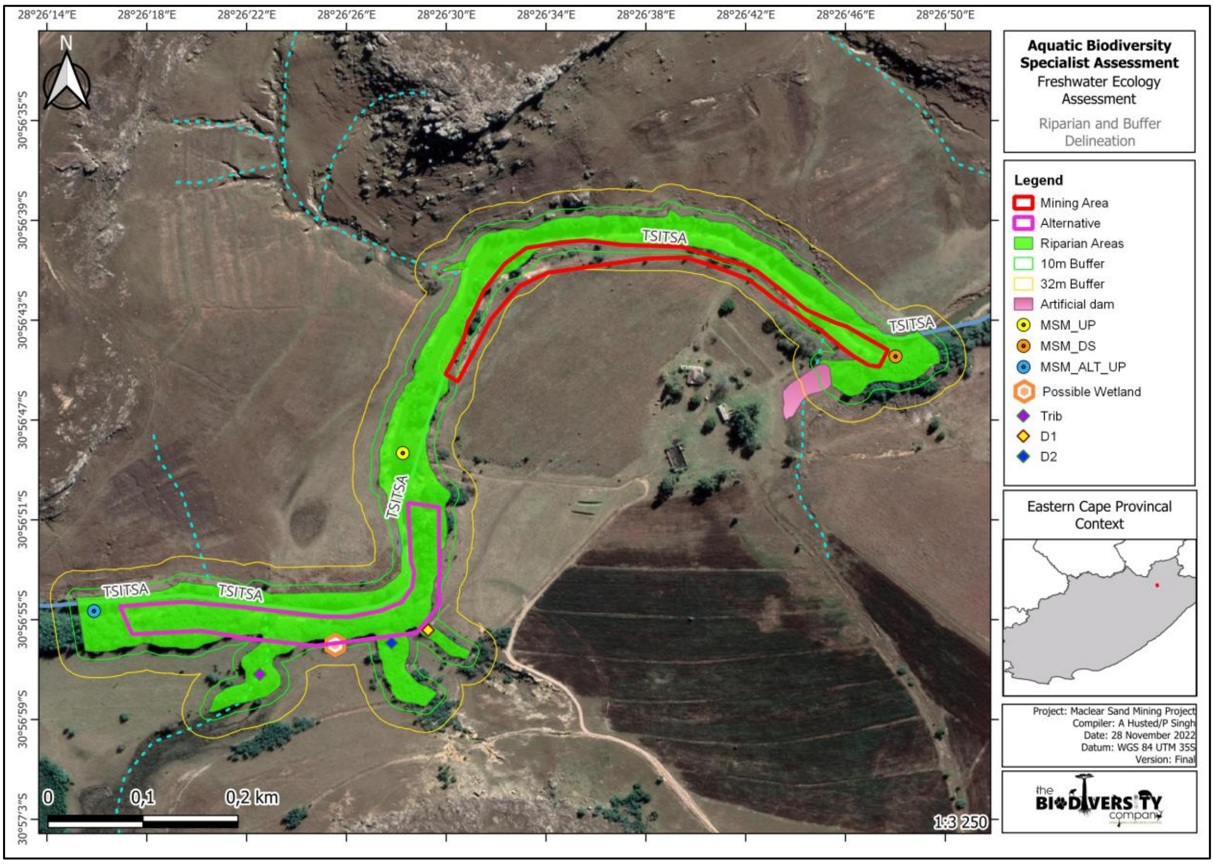

Figure 15: Riparian delineation and aquatic buffer for the Maclear sand mining project

5.2 Aquatic Macroinvertebrates Assessment

5.2.1 Integrated Habitat Assessment System

The IHAS index was developed by McMillan (1998) for use in conjunction with the SASS5 protocol. The IHAS results for the various surveys are presented in Table 12. The biotope diversity at both sites was determined to be poor. The stones biotope was absent, with limited marginal vegetation present. The gravel, sand and mud biotope was dominant for the reach.

Table 12: Availability of habitat for aquatic macroinvertebrates based on IHAS results recorded during the November 2022 survey

Date		MSM_UP	MSM_DS
November	Score	21	35
	Suitability	Poor Diversity	Poor Diversity

5.2.2 Biotic Integrity Based on SASS5 Results

The aquatic macroinvertebrate (SASS5) results for the survey period are presented in Table 13. The sampled aquatic systems fell within the South Eastern Uplands - upper ecoregion. The SASS5 scores within the Tsitsa River ranged from 13 at MSM_UP to 21 at MSM_DS. The ASPT (average sensitivity) values ranged from 4.3 at MSM_UP to 4.2 at MSM_DS. Based on the ASPT scores the aquatic macroinvertebrate communities at all sampled sites were comprised of mostly tolerant taxa (Intolerance Rating < 5) with no moderately intolerant taxa (Intolerance Rating 5 – 10) nor intolerant taxa (Intolerance Rating 11 – 15) sampled.

Table 13: Macroinvertebrate Assessment Results (November, 2022)

Survey Date		MSM_UP	MSM_DS
November 2022	SASS Score	13	21
	No of taxa	3	5
	ASPT*	4.3	4.2
	Ecological Category (Dallas, 2007)	E/F	E/F

The SASS5 assessment results generated SASS5 scores that are categorised as a class E/F (Dallas, 2007) for both sites which indicates a seriously to critically modified macroinvertebrate community within the Tsitsa River reach. The average score per taxon (ASPT) indicated that only the tolerant macroinvertebrate species were collected.

5.2.3 Macroinvertebrate Response Assessment Index

The results of the MIRAI assessment (Thirion, 2007) are provided in Table 14, for the November 2022 survey.

Table 14: MIRAI results for the November 2022 survey

Metric Group	Tsitsa River
Flow modification	30
Habitat	29
Water Quality	26.4
Ecological Score	**28**
Invertebrate Category	E

The results of the MIRAI derived an ecological category of class E (Seriously modified) state for the Tsitsa River. All three factors (Flow, water quality and habitat) contributed to the seriously modified macroinvertebrate community status. The presence of only few highly intolerant taxa (>10 sensitivity score) indicated modified physico-chemical conditions and poor physical conditions within the reach.

5.3 Fish Community Assessment

No fish were sampled across the Tsitsa River reach. Based on this the ecological integrity of the fish community was determined to be seriously modified (class E).

5.4 Present Ecological Status

The results for the reach-based PES assessment are presented in Table 15. The overall results of the PES assessment derived a largely modified ecological category (class D). This modified status can be primarily attributed to habitat related drivers and riparian areas, which result in flow modifications within the Tsitsa River reach. Alien vegetation encroachment was found to have the highest impact to riparian ecological condition, followed by erosion and subsequent sedimentation within the Tsitsa River.

Table 15: The Present Ecological Status for the Tsitsa River

Aspect Assessed	Category
Riparian Ecological Category	77
Aquatic Invertebrate Ecological Category	28
Fish Ecological Category	30
Ecostatus	class D

5.5 Regulatory Zone

The following regulatory zone is applicable and pertains to the project area being proximal to the Tsitsa River.

Table 16: The zone of regulation for the project

Regulatory authorisation required	Zone of applicability
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998). Department of Water and Sanitation (DWS)	Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) in accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21c and 21i is defined as: • the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation.

6 Risk Assessment and Recommendations

It is assumed that the mining method involves the use of a hydraulic excavator to remove sand/gravel from the Tsitsa River and embankment. This mining method involves the use of a hydraulic excavator to remove sand/gravel from below the water table and the partial dewatering of the river system to allow access. Based on the type of proposed mine, the sand mining operation will have the following activities associated with it:

- Establishment of eating areas and ablution services for staff;
- Creating access for excavators;

- Excavation of the river bed (sand mining);
- Stockpiling of soil;
- Construction of impoundments and river diversions;
- Sand haulage;
- Storage of fuels and oils; and
- Operation, refuelling and maintenance of equipment and vehicles.

The potential impacts arising from the abovementioned activities are summarised and provided below (Table 17).

6.1 Instream Aquatic Habitat

Removal of river bed material in volumes greater than natural replenishment rates though upstream aggradation can result in river bed degradation, increased suspended sediment content (increased turbidity/reduced light penetration/habitat and gill smothering) and the sand/gravel siltation of rapid/cobble areas. The removal of gravel and clay layers alters the physical morphology of the river channel and can create excessive scour and sediment movement resulting in further bed and channel modification.

Due to the increased gradient caused through the removal of the river bed, head cut erosion, increased flow velocities and concentrated flows can occur upstream of the mining area resulting in the further alteration to instream aquatic habitats. The extraction process causes a diversion of water flow resulting in the formation of pools which can subsequently cut downstream areas of the instream habitat off from water volumes.

Overall the abovementioned physical instream impacts can have a negative effect on aquatic ecology through the direct loss of habitat (cover), loss of spawning habitats and loss of fine sediment sensitive taxa through gill smothering.

Unsustainable extractions are likely to have habitat and morphological consequences that are likely to manifest in the longer term (such as floodplain and beach erosion), which may incur critical impacts at the site and on downstream aquatic environments.

6.2 Marginal Vegetation

The sand mining operation can potentially degrade the marginal zone of the considered water course through the following processes. Loss of the marginal and riparian zones can occur through the direct loss of habitat during the construction of access routes and mining platforms. The destruction of the riparian zone can result in the destabilisation of the river banks, increased erosion, loss of cover and increased stream temperatures. In addition, due to the lowered level of water in the active channel, the groundwater levels can drop on associated floodplains resulting in additional stresses to floodplain vegetation, if and where applicable.

Table 17: Impacts Assessed for the Tsitsa River Sand Mining

Phase	Activity	Aspect	Impact
Construction	Ablution and eating areas	Staff ablutions Litter	Sewage contaminants from toilets Solid waste inputs from the staff of the mining operation
	Creating access for excavators	Clearing of wetland vegetation in order to access the mining resource (river sand) Use of hydrocarbons in proximity to the watercourse	The loss/degradation of wetland/riparian areas Alteration of natural hydrology Hydrocarbon related contamination
	Construction of resource stockpiles	Stockpile in riparian zone runoff and seepage Hydrocarbon contamination	Surface water contamination
Operation	Operation of toilets and eating areas	Staff ablutions and Litter Maintenance of vehicles & equipment Storage of fuel and oils	Alteration of site hydrology Sewage contaminants from toilets Solid waste inputs from the staff of the mining operation Hydrocarbon related contamination
	Excavation of the river bed	The removal of sediments (sand) from the active river channel Haulage of sand Operation of machinery and equipment	Bed, flow and channel modification Altered hydro-dynamics Lowering of the water table Increased suspended solids Surface water contamination
	Resource stockpiles and transportation (removal)	Stockpile in riparian zone runoff and seepage Hydrocarbon contamination	Surface water contamination

Table 18: DWS Risk Impact Matrix for the Tsitsa River Sand Mining

Risk Impact Matrix by Andrew Husted (Pr. Sci. Nat. 400213/11)									
Aspect	**Mitigation**	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**
Construction Phase									
Removal of soil, vegetation and leveling for site preparation	Without	**1**	**2**	**2**	**2**	1.8	**1**	**2**	4.8
	With	**1**	1	1	1	1	**1**	2	4
Use of hydrocarbons in proximity to the watercourse	Without	**1**	3	2	3	2.3	**2**	2	6.3
	With	**1**	2	1	2	1.5	**2**	2	5.5
Staff ablutions, waste management	Without	**1**	2	2	2	1.8	**2**	2	5.8
	With	**1**	1	1	1	1	**2**	2	5
Clearing of riparian vegetation and bank shaping to access the mining resource (river sand)	Without	**2**	2	5	3	3	**2**	2	7
	With	**1**	1	3	2	1.8	**2**	2	5.8
Stockpile of mining resource (river sand)	Without	**1**	2	2	3	2	**2**	2	6
	With	1	1	1	1	1	2	2	5
Operational Phase									
Altered geomorphology of the watercourse	Without	**5**	**3**	**4**	**4**	4	**3**	**4**	**5**
	With	**3**	2	2	2	2.3	**2**	2	**3**
Staff ablutions, waste management, hydrocarbon spills/leaks	Without	**1**	3	3	2	2.3	**2**	2	**1**
	With	**1**	2	2	1	1.5	**2**	2	**1**
The removal of sediments (sand) from the active river channel and embankment	Without	**5**	5	4	4	4.5	**3**	4	**5**
	With	**4**	3	2	2	2.8	**2**	2	**4**
Operation of machinery, vehicles and equipment	Without	**2**	3	2	2	2.3	**2**	2	**2**
	With	**1**	2	1	1	1.3	**2**	2	**1**
Stockpile of mined resource (river sand)	Without	**2**	2	2	2	2	**2**	2	**2**
	With	**1**	1	1	1	1	**2**	2	**1**

Table 19: DWS Risk Impact Matrix for the Tsitsa River Sand Mining Continued

Aspect	Mitigation	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	With/Without Mitigation
			Construction Phase					
Removal of soil, vegetation and leveling for site preparation	Without	**3**	**2**	**5**	**3**	13	62	**Moderate***
	With	**2**	2	5	2	11	44	**Low**
Use of hydrocarbons in proximity to the watercourse	Without	**3**	2	4	3	12	75	**Moderate***
	With	**3**	2	4	3	12	66	**Low**
Staff ablutions, waste management	Without	**3**	2	5	3	13	75	**Moderate***
	With	**3**	2	5	3	13	65	**Low**
Clearing of riparian vegetation and bank shaping to access the mining resource (river sand)	Without	**4**	5	5	1	15	105	**Moderate**
	With	**3**	4	5	1	13	75	**Moderate**
Stockpile of mined resource (river sand)	Without	**3**	3	5	3	14	84	**Moderate**
	With	**2**	2	5	2	11	55	**Low**
			Operational Phase					
Altered geomorphology of the watercourse	Without	**5**	**5**	**5**	**3**	18	198	**Moderate**
	With	**5**	4	5	3	17	106	**Moderate**
Staff ablutions, waste management, hydrocarbon spills/leaks	Without	**3**	3	1	3	10	63	**Moderate**
	With	**2**	2	1	2	7	39	**Low**
The removal of sediments (sand) from the active river channel and embankment	Without	**5**	5	5	3	18	207	**High**
	With	**5**	5	5	1	16	108	**Moderate**
Operation of machinery, vehicles and equipment	Without	**3**	3	1	3	10	63	**Moderate***
	With	**2**	2	1	2	7	37	**Low**
Stockpile of mined resource (river sand)	Without	**3**	3	5	3	14	84	**Moderate**
	With	**3**	2	5	2	12	60	**Moderate**

(*) denotes-In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80).

The risk of the removal of sediments from the active river channel and embankment, and subsequent structural changes to the watercourse are detailed below. Considering the criteria for the risk matrix the factors: Flow Regime, Water Quality, Habitat and overall effect on Biota, the proposed removal of sediments (sand) was rated as a high-risk activity, without mitigation. This could be reduced to a moderate risk activity provided that mitigation measures are implemented. The spatial scale of the activity was rated as “regional” with the downstream river reaches being affected. The duration of the potential impact of the activity was determined to be “greater than the life of the activity” as it will take some time for conditions to reach equilibrium after the cessation of the project.

The frequency of the removal of sediments activity was rated as “daily” as the activity will likely take place throughout the project duration. The frequency of impacts associated with the removal of sediments activity was determined to be “daily” with anticipated impacts stemming from daily activities for the duration of the project.

The removal of sediments from an active river channel and embankment is a listed activity and requires governmental authorisation and therefore was rated as “fully covered by legislation”. The detection of the impacts stemming from the removal of sediments was derived to be “immediately” as alterations to the stream substrate will be clear in the project area.

As presented above (Table 19), the results of the risk assessment determined low risks for activities occurring outside of the delineated watercourse and buffer areas. However, activities occurring within the instream and riparian zones were derived to be high and moderate risk activities pre-mitigation. The post-mitigation risk level for all aspects was determined to be moderate for most of the considered aspects. The proposed mining is likely to have instream habitat impacts at the site over the mining period. The sustainable mining volume for the proposed Tsitsa River must be determined and adhered to if detrimental consequences are to be avoided.

6.3 Cumulative Impact

There will be a reduced PES of the aquatic ecosystem within the proposed project area if not mitigated. There are other sand mining activities along the Tsitsa River reach. Therefore, this proposed sand mining will further impact the river reach. The scale of the impact will be limited to the immediate river reach. However, should no mitigation actions be followed the scale of the impact will extend downstream of the project area.

Considering this, it is recommended that an overall sediment aggradation study is completed to determine the quantity of sediment that may be mined without negatively affecting the aquatic ecology of the Tsitsa River. The aggradation study will inform the confidence level of the mitigation, and provide site-specific mitigation measures that can be applied for this project.

6.4 Mitigation Measures

The outcomes of the risk assessment derived high-risk activity(s) that can be mitigated to moderate risk, based on the current condition of the watercourse and associated riparian area. The following mitigation actions are recommended.

- Extraction should be limited to low flow periods (May-October);

- The extraction from the riverbed should not exceed 1 m or deeper than the defined base layer of the river;
- Bar skimming is recommended if feasible;
- If possible, the thalweg (lowest point connecting the sections of the river) of the river reach being mined must be maintained. This will ensure that a flat uniform wide channel is not formed which results in thinly spread flows. A good example of bad and good practice is provided below (Figure 16).

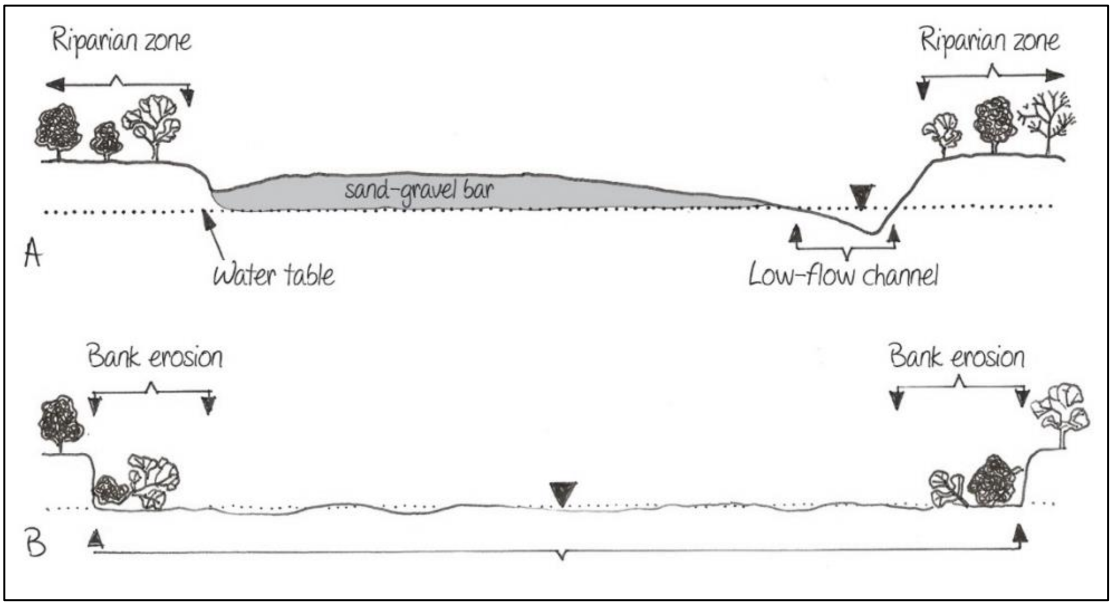

Figure 16: Maintenance of the thalweg A: best practice; B: Poor practice (Day et al., 2016)

- A single access point through the delineated vegetation zones (ecological class D) should be made. Once this access point has been created mining platforms should be constructed outside of the delineated zone (i.e. 2 m from the delineated bank). This is due to the nature of the habitats;
- Erosion control such as gabions must be established at the access point through the vegetation;
- Existing roads must be used and access to the river should be made perpendicular to flow;
- Temporary storm water management systems must be in place and preferential runoff channels be filled with aggregate and/or logs (branches included) to dissipate flows, limiting erosion and sedimentation;
- Silt traps and sediment trapping berms must be in place in drainage lines around the stockpile area;
- The footprint area of the must be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;

- All machinery and equipment should be inspected regularly for faults and possible leaks and must have drip trays to contain oil leakage, these should be serviced off-site;
- Adequate sanitary facilities and ablutions must be provided for all personnel throughout the construction site. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- All solid waste generated on-site during construction and operation must be adequately managed. Separation and recycling of different waste materials should be supported;
- Stockpiles of the sand resource should not be kept within the delineated buffer zone;
- Access routes and other infrastructure areas must be rehabilitated;
- In order to avoid floodplain ponding, no floodplain areas (if present) should be mined with the focus of the mining operation on the instream sand resource; and
- In order to monitor for potential environmental degradation downstream of the mining permit bi-annual (High and low flow) aquatic biomonitoring should take place at the sites already assessed in this report.

6.5 Recommendations

The following are general recommendations as per Dr. van der Waal.

- Avoid mining the flood benches or river banks;
- Prevent sand mining activities within 10 m of banks to prevent bank destabilisation and subsequent collapse;
- Mine sand from features such as sand bars, that are not in the main low flow channel (to reduce fine sediment being resuspended and washed downstream);
- Do not disturb areas of riparian vegetation;
- Access the river from one point along the bank only;
- Limit the amount of driving in the river channel;
- Prevent erosion of the bank in the direct surrounds of the access point (slope to 1:3 gradient and vegetate steep and bare areas); and
- Prevent erosion of the bank and flood bench caused by the erosive power of the return flow (dredge and pipeline option).

Due to the current state of the river and riparian areas, it is unlikely the sand mining activities (instream and in the riparian area) will further reduce the condition, hence the following revision may be considered for the Maclear Sand Mine:

- Mining the flood benches or river banks, provided that a slope that prevents bulk erosion is maintained and does not increase flood risk or level;
- Sand mining activities within 10 m of banks must have mitigation that prevents bank destabilisation and subsequent collapse;

- Where applicable, mine sand from features such as sand bars, that are not in the main low flow channel (to reduce fine sediment being resuspended and washed downstream);

- Mining of the disturbed riparian vegetation areas, subject to rehabilitation with indigenous vegetation.

- Access the river from one point along the bank only;

- Limit the amount of driving in the river channel;

- Prevent erosion of the bank in the direct surrounds of the access point (slope to 1:3 gradient and vegetate steep and bare areas); and

- Prevent erosion of the bank and flood bench caused by the erosive power of the return flow (dredge and pipeline option).

- Stockpiling in the riparian and buffer areas, provided that measures are in place to prevent the stockpiles from re-entering the watercourse, and are removed regularly to avoid the establishment of alien/invasive vegetation.

6.6 Monitoring

It is recommended the riverine monitoring be conducted on a bi-annual basis for the life of the project. The methodologies included herein must be replicated for the monitoring programme.

7 Conclusion

According to *in situ* water quality analysis, the water quality conditions within the Tsitsa River reach are not expected to be a notable limiting factor to aquatic biota. The Intermediate Habitat Integrity Assessment (IHIA) indicated large modifications to the instream and to the riparian habitat within the assessed reach. Instream and riparian habitat modifications were attributed to bed and channel modification, exotic vegetation encroachment within the catchment, bank erosion by livestock, historical and current sand mining, and sedimentation.

The local aquatic macroinvertebrate community within the system was rated as seriously modified according to the biological bands. The average sensitivity scores within the reach indicated that tolerant macroinvertebrate taxa were collected within the sampled Tsitsa River reach. No fish were sampled, and the assigned integrity of the fish community structure was determined to be seriously modified. The overall integrity of the riparian habitat was determined to be moderately modified. The ecological status of the sampled Tsitsa River was determined to be largely modified (class D).

7.1 Risk Assessment

The post-mitigation risk level for all aspects was determined to be moderate. Therefore, the proposed mining volume is likely to have moderate instream habitat effects at the site over the mining period, granted that the necessary mitigation measures are in place. The sustainable mining volume for the proposed mining site must be determined if long-term consequences are to be avoided. Due to the overall moderate residual risk posed by the project, a Water Use License is required for the operation.

7.2 Specialist Input

Considering the status of the aquatic ecosystems, and furthermore the nature and requirements of the project, the proposed project has the potential to negatively affect local aquatic ecology. All prescribed recommendations and mitigation measures must be considered by the issuing authority. It is the opinion of the specialist that the proposed sand mining of the river and its banks be supported, subject to mitigation measures during the operational phase and rehabilitation of the mining and riparian area post-mining. The proposed mining area is preferred over the alternative as the latter footprint would degrade drainage lines, a non-perennial tributary, and a possible wetland area. It is further recommended that should authorisation be issued, riverine monitoring be included as a condition of the authorisation.

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