AQUATIC ECOLOGICAL AND WETLAND ASSESSMENT

TRANSALLOYS, LOCATED

NEAR EMALAHLENI IN THE MPUMALANGA PROVINCE

FEBRUARY 2019

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I, **Jacob Schrijvershof,** 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 assessment relevant to this application, including knowledge of the National Environmental Management Act (Act 107 of 1998) (NEMA) and the National Water Act (Act 36 of 1998), regulations and any guidelines that have relevance to the proposed 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 report are true and correct;
- I am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B (1) of the National Environmental Management Act, 1998 (Act 107 of 1998); and
- I understand that any false information published in this document is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Joppie Schrijvershof

Executive summary

The purpose of this report is to summarise the aquatic and wetland findings for Transalloys (Pty) Ltd. as part of a WULA (Water Use Licence Application) for the proposed Ashplant and Powerplant on Portion 20 and Portion 24 of Schoongezicht 308 JS and Portion 34 and Portion 35 of Elandsfontein 309 JS. The aquatic and wetland assessment was conducted on the 17th of January 2019 in order to assess the current watercourse conditions and to expand baseline data for future reference. The farm portions are located adjacent to Emalahleni in the Mpumalanga Province.

The aim of this study is to ensure compliance with the general legislative requirements as part of the for the Water Use Authorisation process prescribed by the National Water Act (NWA) of 1998 (Act no 36 of 1998).

The scope of work entailed determining the Present Ecological Status (PES) for the aquatic and wetland systems associated with the proposed Transalloys Ashplant and Powerplant. In order to make this determination, the following components were assessed:

- *In situ* water quality in accordance with guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa;
- Habitat Assessment (via the Intermediate Habitat Integrity Assessment (IHIA));
- The riparian vegetation was determined with the use of Riparian Vegetation Response Assessment Index (VEGRAI);
- Macroinvertebrates were assessed using the South African Scoring System Version 5 (SASS5), Integrated Habitat Assessment System (IHAS) and Macroinvertebrate Response Assessment Index (MIRAI);
- Fish was assessed using the Fish Response Assessment Index (FRAI);
- The Ecological Category (EC) in accordance with the River Eco-Status Monitoring Program (REMP);
- Identify and delineate any wetland areas and/or watercourses associated within the study boundary according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas";
- Determine the Present Ecological Status (PES) and Functional Integrity of identified wetlands within a 500 m buffer around Transalloys using the WET-Health and Wet-EcoServices approach;
- Determine the Ecological Services, Importance and Sensitivity of identified watercourses using the latest applicable approach as supported by the DWS (formally DWA);
- Determine and assess the significance of the impacts caused by the proposed Ashplant and Powerplant on any associated wetlands or watercourses;
- Identifying, describing and rating potential impacts/risks to the rivers/streams/wetlands and recommend mitigation measures for the identified impacts to minimise the negative impacts; enhance any positive impacts; and
- Indicate the minimum buffer required to protect any wetland/ watercourses identified within the study boundary.

The overall results of the aquatic assessment based on the various components of the River Eco-Status Monitoring Program (REMP) methodologies concluded that:

- The Brugspruit in the study area is considered to be **seriously modified (E/F Ecological Category) from reference conditions** and is considered as a **moderately important and a highly sensitive** area to any proposed developments. These systems are under immense pressure from current pollution from the surrounding rural settlements, mining activities. Other impacts include, erosion and extensive invasive alien plants are found to occur within the riparian zones.
- *In situ* water quality for all sites were within **Unacceptable** limits compared to guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa. The *in situ* water quality analysis for this assessment indicated that electrical conductivity levels were elevated above guideline levels, except for the tributary of the Brugspruit. Dissolved oxygen levels were below guideline levels and is most likely associated with the pollution in these systems, this is negatively effecting the in-stream biota. Other variables (pH, temperature) measured, were found to be within acceptable limits.
- From overall scores obtained for the habitat assessment (IHIA), all sites assessed could be ranked within a **seriously modified state (Category E/F)**.
- The findings of the riparian vegetation assessment revealed that riparian habitat of the area was **seriously modified (Category E/F)** for the Brugspruit system. Vegetation along the stream/marginal zone has been extensively disturbed by alien invasive plant species and over grazing.
- SASS5 scores for the both the Brugspruit and its tributary were found to be in a **seriously modified (Category E/F)**.
- The presence of highly pollution tolerant organisms and no sensitive organisms indicates the pressure from extensive pollution on both these systems.
- The habitat assessment for macroinvertebrates (IHAS assessment) concluded that all habitat reaches assessed were found to be **inadequate**. The dominant feature of the invertebrate habitat is the sandy-clay substrate which dominates the river systems under study. Limited to no stone habitats were available at the study sites.
- The MIRAI results show that water quantity, poor water quality and impoundments are the primary drivers for the loss of migratory and sensitive macroinvertebrates within the Brugspruit and its tributary and were found to be in a **seriously modified state (Category E/F)**.
- Although no fish are thought to occur within this stretch of stream, one Chubbyhead barb (*Enteromius anoplus*) was sampled at the downstream site of the Brugspruit and were considered to **be seriously modified (Category E/F)** according to the FRAI results, this finding coincides with the findings of the MIRAI assessment.

The overall results for the wetland delineation and assessment in accordance with the Department of Water and Sanitation (DWS) requirements concluded that:

- Three wetland areas were delineated within a 500m buffer surrounding the Transalloys boundary and associated infrastructure.
- The wetlands were classified into three hydrogeomorphic (HGM) units, comprising of one seepage wetland (HGM1) and two channelled valley bottom wetland (HGM 2 and HGM 3).
- A wetland health assessment concluded the seep wetland to be **largely modified (Category D)** and the two valley bottom wetlands to be **moderately modified (Category C)**.
- The Ecological Sensitivity and Importance of the wetlands has generally been recorded as **low** as a result of the provision of natural resources and the maintenance of biodiversity that many of these wetlands provide.
- The Ecological Services of the wetlands has generally been recorded as **intermediate**.

Although current impacts consists predominantly of upstream impoundments, mining, sewage and runoff at the Brugspruit from surrounding activities, the construction of proposed activity will have a medium impact on these systems, although owing that these systems are already heavily transformed/altered the operational phase will have a high impact on the Brugspruit and surrounding wetlands. Other existing impacts include erosion, alien invasive vegetation, and grazing.

Potential impacts assessed for the construction phase for Transalloys were related to pollution from the runoff from the construction phase activities, possible accidental spills from heavy machinery and drain of excess water; erosion and sedimentation from the backfilling; and the spread of alien invasive plant species.

The rated potential impacts for the construction from the Ashplant and Powerplant were found to be of **moderate significance** on the already highly transformed landscape.

From the Department Water and Sanitation based risk matrix, construction phase impacts from the Ashplant and Powerplant were found to be a **medium risk**.

The operational phase impacts include alterations on the flow patterns of the river and stream as well as possibly increased toxic levels. The operational phase has an overall **high risk** rating.

From the Department Water and Sanitation based risk matrix the operational phase impacts from the Ashplant and Powerplant were found to be a **high risk**.

Although the impacts and risks were found to be high, mitigation measures are advised to limit the effects on the ecosystems and include the protection of soil, the rehabilitation of disturbed areas, and the management of stormwater and pollution prevention. Mitigation measures stated in this report must be included in the Environmental Management Programme.

Mitigation measures, aimed at minimising the afore-mentioned impacts, include (but are not limited to):

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;
- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer was implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during construction and operational phases; and
- Aquatic biomonitoring (SASS 5 and habitat assessments) where/if flow conditions allow for effective sampling) must take place bi-annually to determine any trends in ecology and hydrology.

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BGIS:	Biodiversity Geographic Information System
DEM:	Digital Elevation Model
DWAF:	Department of Water Affairs and Forestry
DWS:	Department of Water Affairs and Sanitation
EC:	Ecological Category
EIS:	Ecological Importance and Sensitivity
EMPr:	Environmental Management Program
FRAI:	Fish Response Assessment Index
FROC:	Frequency of Occurrence
GIS:	Geographic Information System
HGM:	Hydrogeomorphic
IHAS:	Invertebrate Habitat Assessment System
IHIA:	Intermediate Habitat Integrity Assessment
MAMSL:	Meters Above Mean Sea Level
MAP:	Mean Annual Precipitation
MIRAI:	Macro-Invertebrate Assessment Index
NFEPA:	National Freshwater Priority Area
NWA:	National Water Act (Act no 36 of 1998)
PES:	Present Ecological Status
REMP:	River Eco-Status Monitoring Program
REMP:	River Eco-Status Monitoring Program
RHP:	River Health Programme
SANBI:	South African National Biodiversity Institute

SASS5: South African Scoring System

TWQRs Target Water Quality Ranges

VEGRAI: Riparian Vegetation Assessment Index

WMA: Water Management Areas

WUL: Water Use Licence

1 INTRODUCTION

1.1 Background

Oasis Environmental Specialists (Pty) Ltd was appointed by Enviroroots (Pty) Ltd to conduct an aquatic and wetland assessment report for Savanah (Pty) Ltd as part of the WULA (Water Use Licence Application) for the proposed Ashplant and Powerplant, which will make use of Circulating Fluidised Bed (CFB) boiler technology for Transalloys (Pty) Ltd on the farms Elandsfontein 309 JS and Schoongezicht 308 JS situated within the Emalahleni Local Municipality and the Nkangala District Municipality (**Figure 1**). The aquatic and wetland assessment was conducted on the 17th of January 2019 in order to assess the current watercourse conditions and to expand baseline data for future reference.

Transalloys (Pty) Ltd, a producer of export grade Siliconmanganese, is an energy intensive electricity user and is proposing the development of a Coal Fired Power Plant adjacent to its smelter complex near Emalahleni. The proposed power plant will have a generation capacity of 120 MW to 150 MW in order to meet Transalloys current electricity demands and future expansion electricity requirements. The proposed power plant will make use of Circulating Fluidised Bed (CFB) boiler technology which allows for the use of low-grade coal and coal discards, to be sourced from various coal mines in the area (**Figure 2**).

The development area is situated in the Mpumalanga Province, and falls within the quarter degree square 2529CC. The site is currently surrounded by informal settlements and mining activities.

1.2 Scope of work

Aquatic Assessment

The scope of work entails in determining the Present Ecological Status (PES) for the aquatic environment associated with the proposed project. In order to make this determination, the following components were assessed:

- *In situ* water quality in accordance with guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa;
- Habitat (via the intermediate habitat assessment index and Invertebrate Habitat Assessment Index);
- The riparian vegetation was determined with the use of Riparian Vegetation Response Assessment Index (VEGRAI);
- Macroinvertebrate health (South African Scoring System version 5 and Macroinvertebrate Response Assessment Index);
- Fish assessment (Fish Response Assessment Index);
- The Ecological Category (EC) in accordance with the River Eco-Status Monitoring Program (REMP); and

- Identifying, describing and rating potential impacts to the rivers/streams and recommend mitigation measures for the identified impacts to minimise the negative impacts; enhance any positive impacts.

The River Eco-Status Monitoring Program (REMP), formally the River Health Programme (RHP) of South Africa was developed to monitor and assess the state of the rivers within South Africa. To this end specific methodologies were designed to assess the individual components that make up the aquatic ecosystem, these were implemented within this study.

Wetland Delineation and Assessment

The scope of work entailed the following:

- Field visit to delineate the outer boundary of wetland/riparian habitats within a 500m buffer from the Transalloys boundary according to the methods contained in the manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005);
- Assess and describe the health of any wetland units identified, through evaluation of indicators based on geomorphology, hydrology and vegetation as per the WET-Health methods;
- Assess and describe the Ecological Services, Importance and Sensitivity of any wetlands identified on site,
- Identify potential negative impacts on the wetland(s) from the proposed development and assess the significance of these impacts;
- Provide recommended mitigation measures for the identified impacts in order to avert or lower the significance of the negative impacts.

1.3 Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations, and consequential assumptions need to be made. The following constraints may have affected this assessment:

- A hand-held Garmin eTrex 30 were used to delineate the channels had an accuracy of 3 m to 6 m
- The findings, results, observations, conclusions and recommendations provided in this report are based on the author's best scientific and professional knowledge as well as available information regarding the perceived impacts on the wetlands; and
- The assessment in determining the present ecological state (PES) of the identified system was based on a single site

visit. Site visits should ideally be conducted over differing seasons in order to better understand the vegetation, hydrological and geomorphologic processes driving the characteristics of the watercourse. In order to obtain a comprehensive understanding of the dynamics of the aquatic ecosystem in an area, ecological assessments should always consider investigations at different time scales (across seasons/years) and through replication, as river systems are in constant change; and

- The watercourse management and rehabilitation plan will need to be updated as more information about the dynamics of the system and its response to the implemented management measures are observed over time.

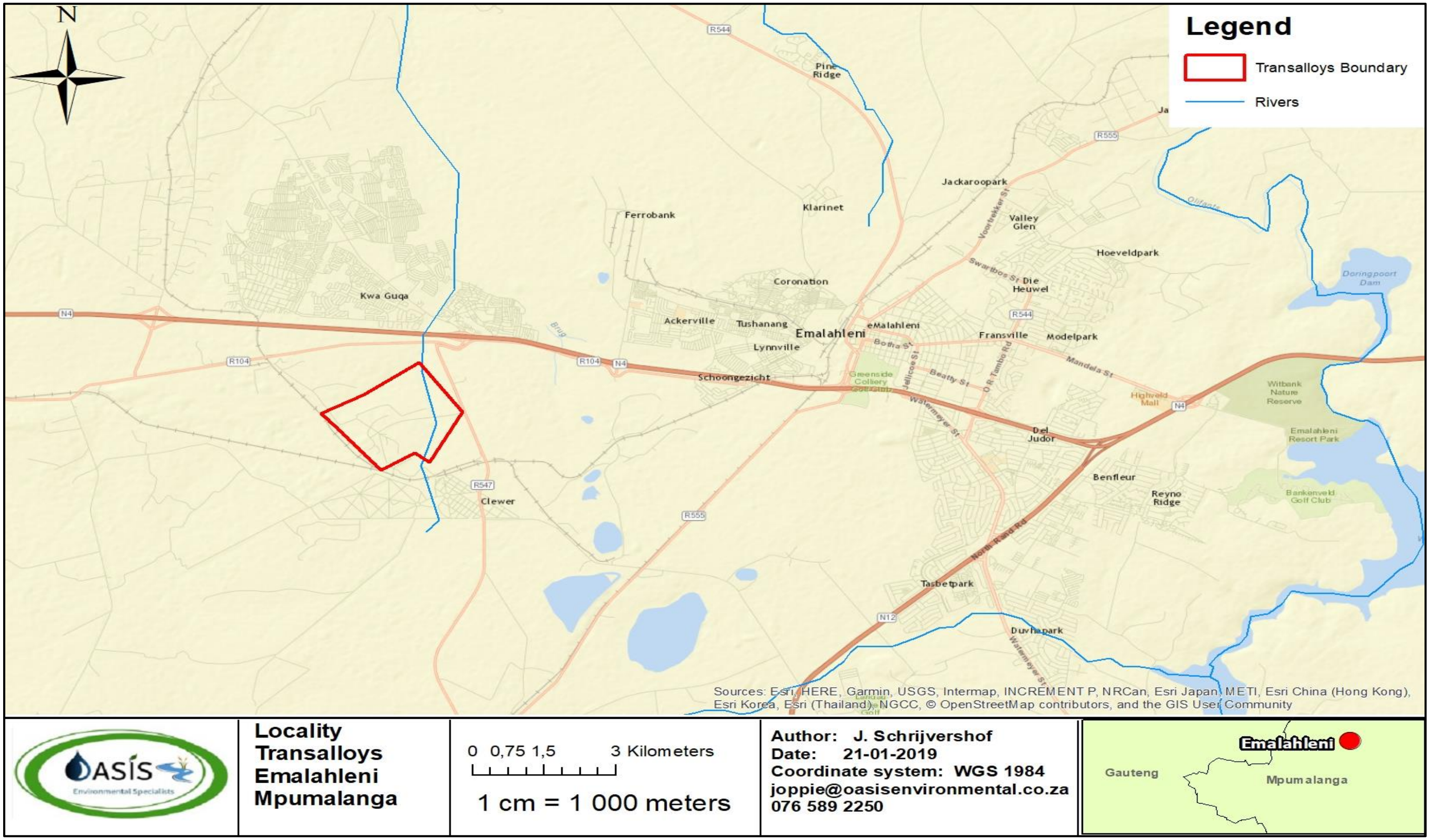

Figure 1: Locality of Transalloys near Emalahleni, Mpumalanga Province.

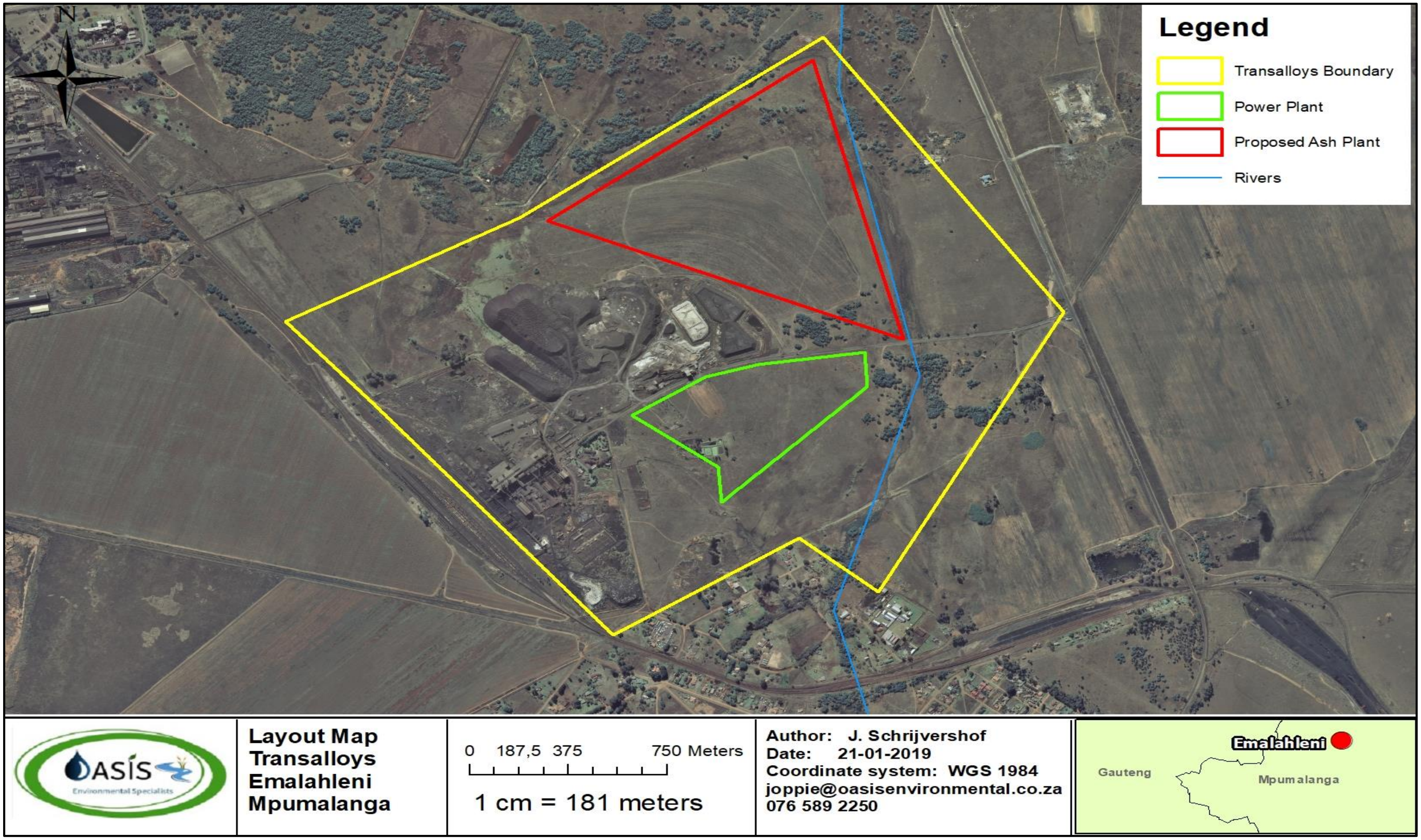

Figure 2: Layout of Transalloys near Emalahleni, Mpumalanga Province.

2 Methodology

This section details the different techniques and methods utilised to obtain the data for this report in order to finally assess the aquatic and wetland conditions of the site based on the various inputs explained below.

2.1 Aquatic Assessment

2.1.1 ***In situ* Water Quality**

The physical and chemical properties of water that determine its suitability for a variety of uses and for the protection of the health and integrity of aquatic ecosystems refers to the quality of water (DWAF, 1996). The various water quality parameters were all taken *in situ*. These parameters include pH, temperature (°C), electrical conductivity (µS/cm), and dissolved oxygen (DO % and mg/L) using calibrated water quality meters. These values were measured using an Aquameter (model no AM-200) and Aquaprobe (model no AM-800). These parameters were compared to guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa.

2.1.2 **Intermediate Habitat Integrity Assessment (IHIA)**

Habitat was assessed and characterised according to section D of the "Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems, (Kemper, 1999)".

The Intermediate Habitat Integrity Assessment (IHIA) model was 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 that are comparable to the characteristics of natural habitats of the region (Kleynhans 1996). The criteria used in the assessment of habitat integrity for the current study are presented in the table below (**Table 1**).

Table 1: Criteria used in the assessment of habitat integrity (Kleynhans, 1996).

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. 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 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 sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which can 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 derived based on agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. This is dependent upon the species involved and scale of colonisation.
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.

Criterion	Relevance
Solid waste disposal	A direct anthropogenic impact which alters habitat structurally. 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 (Gordon *et al*., 1992). 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[1] organic matter input will be changed. Riparian zone habitat diversity is reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

The relevant criteria are then weighted and scored according to Kleynhans (1996), as seen in **Table 2**.

[1] denoting a deposit or formation that originated at a distance from its present position.

Table 2: Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996).

Impact Category	Description	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

Table 3: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996).

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**	**TOTAL**	**100**

Scores are then calculated based on ratings received from the assessment. The estimated impacts of the criteria (**Table 3**) are then summed and expressed as a percentage to arrive at a provisional habitat integrity assessment. The scores are placed into the Intermediate habitat integrity categories (Kleynhans, 1996) as seen in **Table 4**.

Table 4: Ecological categories classes (Kleynhans, 1996).

Category	Description	Score
A	Unmodified, natural.	90-100
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.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
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.	0

2.1.3 Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation areas are divided into two sub-zones, marginal and non-marginal zones. This is important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. The EC of the riparian zone is then assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) level 3 (Kleynhans *et al*., 2007).

Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area. This is done (in part) before going into the field, using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, any anecdotal data available and knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. With this information, the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond. Impacts on riparian vegetation at the site are then described and rated. It is important to distinguish between a visible / known impact (such as flow manipulation) and the response of riparian vegetation to other impacts such as erosion and sedimentation, alien invasive species and pollution. If there is no response to riparian vegetation, the impact is noted but not rated since it has no visible / known effect. These impacts are then rated according to a scale from 0 (No Impact) to 5 (Critical Impact). Once the riparian zone and sub- zones have been delineated, the reference and present states have been described and quantified (basal cover is used) and species description for the study area has been compiled, the VEGRAI metrics are rated and qualified (Kleynhans *et al*., 2007).

The riparian ecological integrity was assessed using the spreadsheet tool that is composed of a series of metrics and metric groups, each of which is rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian zone:

- Removal of the riparian vegetation;
- Invasion by alien invasive species;
- Flow modification; and
- Impacts on water quality.

Results from the lower and upper zones of the riparian vegetation are then combined and weighted with a value that reflects the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. The score is then placed into one of six classes, namely A to F (Kleynhans *et al*., 2007).

Macroinvertebrates

2.1.4 The South African Scoring System (SASS 5)

The SASS5 is the current index 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 and Culicidae) to highly sensitive families (e.g. Oligoneuridae). SASS results are expressed both as an index score (SASS 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, 2007; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Highveld Ecoregion (Ecoregion 11) (**Figure 3**). 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.

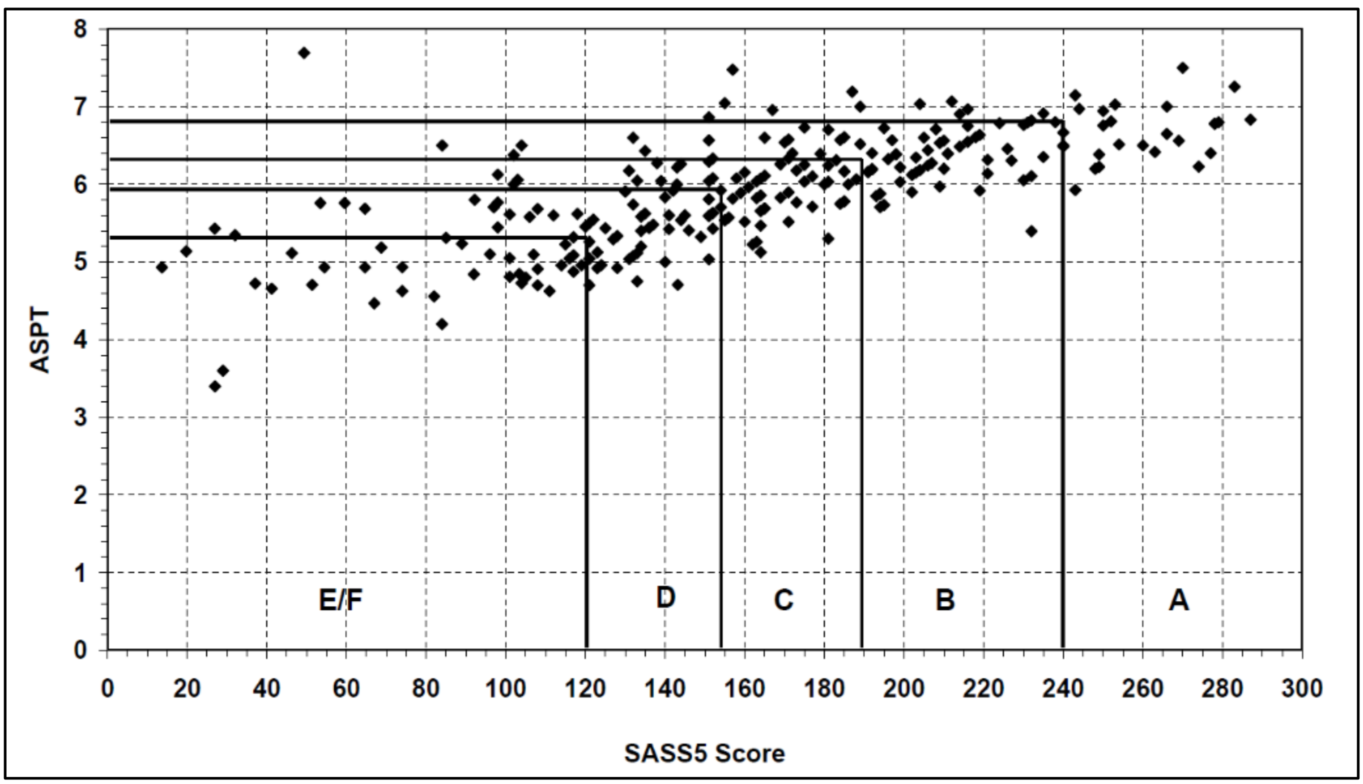

Figure 3: SASS5 Classification using biological bands calculated from percentiles from Dallas (2007) for the Highveld Higher Ecoregion.

2.1.5 **Integrated Habitat Assessment System (IHAS)**

The IHAS was specifically designed to be used in conjunction with the SASS5, benthic macroinvertebrate assessment. The IHAS assesses the availability of the biotopes at each site and expresses the availability and suitability of habitat for macroinvertebrates, this is determined as a percentage, where 100% represents "ideal" habitat availability. A description based on the IHAS percentage scores is presented in **Table 5**.

Table 5: Description of IHAS scores with the respective percentage category (McMillan, 1998).

IHAS score	Interpretation
<65%	Habitat diversity and structure is inadequate for supporting a diverse aquatic invertebrate community.
65%-75%	Habitat diversity and structure is adequate for supporting a diverse aquatic invertebrate community.
>75%	Habitat diversity and structure is highly suited for supporting a diverse aquatic invertebrate community.

2.1.6 **Macroinvertebrate Response Assessment Index (MIRAI)**

The aim of the MIRAI is to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community for the Highveld Higher Ecoregion (11) conditions the reference conditions provided by Department Water and Sanitation. This does not preclude the calculation of SASS scores if required (Thirion 2007). The four major components of a stream system that determine productivity for aquatic organisms are as follows:

- Flow regime;
- Physical habitat structure; and
- Water quality.
- Energy inputs from the watershed (e.g., nutrients and organic matter).

Fish Assessment

2.1.7 **Fish Response Assessment Index (FRAI)**

The purpose of the Fish Response Assessment Index (FRAI) is to provide a habitat-based, cause-and-effect underpinning fish communities and habitats to interpret the deviation of the fish assemblage from a Fish Reference Frequency of Occurrence

(FROC) database in accordance with the SQR fish data from DWS (2013) and is implemented by the National River Health Programme (Kleynhans *et al.*, 2007). The FRAI methodology was implemented to evaluate the existing state of the fish communities. This community metric measure allows for the evaluation of a range of metrics (flows, cover feature availability, migration impacts, water quality impacts and alien invasive fish's impacts) that are known to affect fish community conditions (Kleynhans *et al.*, 2007).

Effective fish sampling included an electro-fishing apparatus (SAMUS 1000®) for 45 minutes per site. Stunned fish is then collected, photographed, identified and released. All fish sampled were identified using Skelton (2001). Fish data was collected using the protocol prescribed for velocity/depth-categorised habitats (Kleynhans *et al.*, 2007). Undercut banks and riparian vegetation were identified, their coverage estimated and scored. The fish and environmental data collected during this study was used to determine the ecological integrity of the fish communities. The reference frequency of occurrence developed by Kleynhans *et al.* (2007) was used in conjunction with the fish species list per quaternary reach in the SQR data provided by DWS to determine the reference fish species list in order to calculate the FRAI.

The FRAI was used to address specific information requirements regarding the response of fish assemblages to changes in the environment (Kleynhans *et al*, 2007). These ecosystem variables usually include physical and chemical variables, which are referred to as "ecological driver components".

An assessment of the responses of the species metrics to changing environmental conditions may be done either through direct measurement (surveys) or are concluded from the change in environmental conditions (habitat) (Kleynhans *et al.*, 2007). Evaluation of the derived response of species metrics to habitat changes is based on knowledge of the ecological requirements of species. Changes in environmental conditions are related to fish stress and form the basis of ecological response interpretation (Kleynhans *et al.*, 2007). These metric groups include: the available habitats or velocity and depth; a cover metric which considers the preferences of overhanging vegetation, aquatic vegetation, water column, substrata as well as undercut banks and root wads; flow modifications in terms of volume, timing and the duration of flows; migration and introduced species. As a result, expected and actual patterns can be evaluated to achieve an Ecological Category (EC) rating.

2.2 Ecological Classification (EC)

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 & Louw, 2007). For the purpose of this study ecological classifications have been determined for biophysical attributes for the associated water course A to F (**Figure 4**). This was completed using the river Eco-classification manual by Kleynhans & Louw (2007). In essence the EcoStatus represents an ecologically integrated state representing the drivers (physico-chemical aspects) and responses (fish, aquatic invertebrates and riparian vegetation) (Kleynhans & Louw, 2007).

Figure 4: Ecological Categories (EC) eco-status A to F continuum approach (Kleynhans & Louw, 2007).

2.3 Wetland Assessment

For the purpose of this assessment, wetlands are considered as those ecosystems defined by the National Water Act No. 36 of 1998 as:

"*Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.*"

2.3.1 **Desktop Assessment**

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA)'s databases were undertaken for the project. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPAs are determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. They are identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al*., 2009).

The assessment of the study site involved the investigation of aerial photography, GIS databases including the NFEPA and South African National Wetland maps as well as literature reviews of the study site in order to determine the likelihood of wetland areas within this site.

The following data sources and GIS information provided in **Table 6** was utilised to inform the delineation.

Table 6: Information used to inform the desktop wetland assessment.

DATA	USE	SOURCE
Latest and Historic Google Earth ™ imagery	Used to assist with identifying potential areas within the study boundary for the presence of wetland systems.	Google Earth PRO™ On- line
River line	Mapping of watercourses outside of the study site.	Surveyor General
National Wetland Classification System	Assistance with information collection about the site and surrounding areas.	SANBI
National Freshwater Ecosystem Priority Area maps and database	Information gathering regarding the presence of FEPA wetlands on the site and within surrounding areas.	Water Research Commission, Implementation: Manual and Maps for FEPA area

2.3.2 **Field Assessment**

The wetland delineation was conducted as per the procedures described in ‘A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1’ (Department of Water Affairs, 2005) (**Figure 5**). This document requires the delineator to give consideration to four indicators in order to find the outer edge of the wetland zone:

- 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 Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation. Signs of wetness are characterised by a variety of aspects. These include marked

variations in the colours of various soil components, known as mottling; a gleyed soil matrix or the presence of Mn/Fe concretions. **It should be noted that the presence of signs of wetness within a soil profile is sufficient to classify an area as a wetland area despite the lack of other indicators.**

- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where the above indicators are no longer present. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland, to delineate the boundary of that wetland and to assess its level of functionality and health.

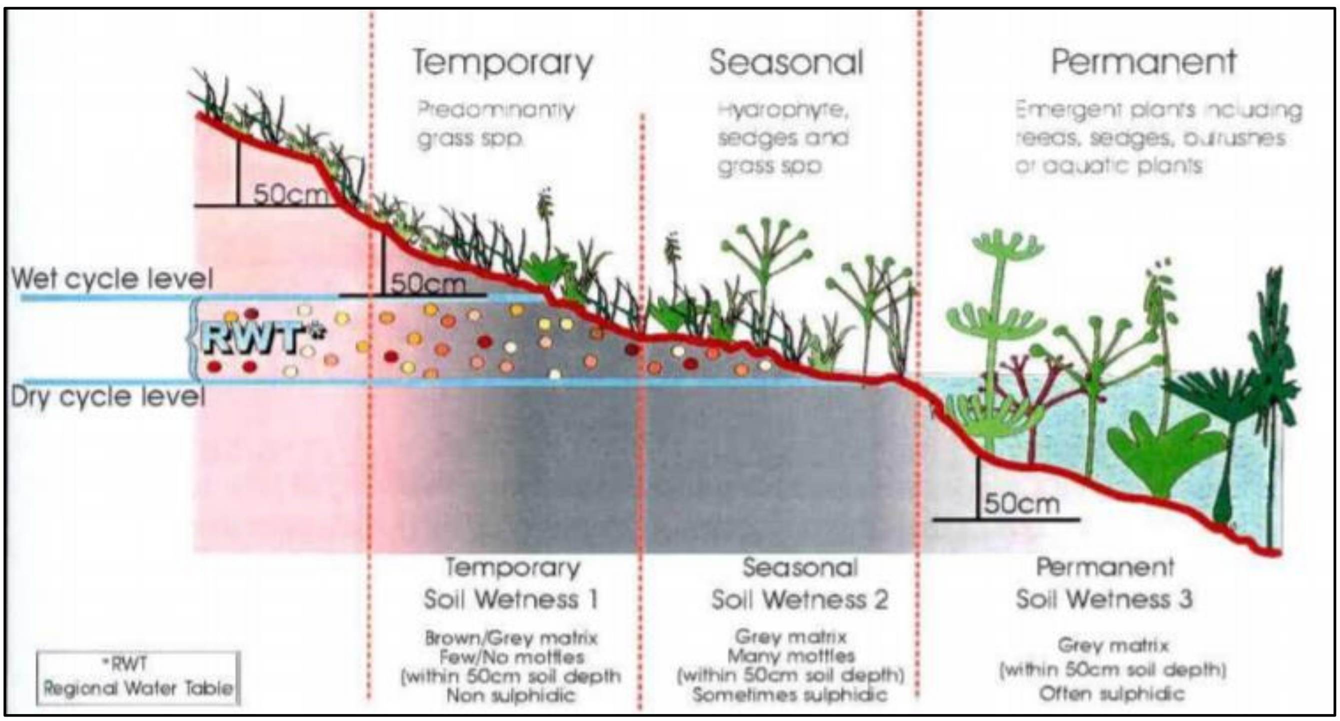

Figure 5: Different zones of wetness found in wetlands, indicating how the soil wetness and vegetation indicators change (DWAF, 2005).

2.3.3 Wetland Functionality and Health

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits contribute directly or indirectly to increased biodiversity within the transformed study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (**Table 7**).

Table 7: Ecosystem services provided by wetlands (Kotze *et al*, 2008).

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream.
			Streamflow regulation		Sustaining streamflow during low flow periods.
			Water quality enhanced benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters.
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters.
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters.
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter.
	Biodiversity Maintenance				Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity of the surrounding area.
	Direct benefits	Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods.
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or harvesting of culturally significant plants.
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife.
Education and research					Sites of value in the wetland for education or research.

An indication of the functions and ecosystem services provided by wetlands can be assessed through the WET- EcoServices manual (Kotze *et al*., 2008) and are based on a number of characteristics that are relevant to the particular benefit provided by the wetland. A Level 2 WET-EcoServices assessment was undertaken for the wetlands occurring on site. A Level 2 assessment is the highest form of WET-Ecoservices assessment that can be undertaken and involves an on-site and desktop assessment.

Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. A Level 2 Wetland Health assessment was conducted on the wetlands delineated as per the procedures described in *'Wet- Health: A technique for rapidly assessing wetland health'* (MacFarlane *et al*., 2009). This document assesses the health status of a wetland through evaluation of three main factors -

Hydrology: *defined as the distribution and movement of water through a wetland and its soils.*

Geomorphology: *defined as the distribution and retention patterns of sediment within the wetland.*

Vegetation: *defined as the vegetation structural and compositional state.*

The WET-Health tool evaluates the extent to which anthropogenic changes have impacted upon wetland functioning or condition through assessment of the above-mentioned three factors. Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had completely destroyed the functioning of a particular component of the wetland. Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions (**Table 8**).

Table 8: Guideline for interpreting the magnitude of impacts on wetland integrity.

IMPACT CATEGORY	DESCRIPTION	RANGE
None	No discernible modification or the modification is such that it has no impact on wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a clearly adverse effect on this component of habitat integrity. Well in excess of 50% of the wetland integrity has been lost.	6 – 7.9
Critical	The modification is present in such a way that the ecosystem processes of this component of wetland health are totally / almost totally destroyed.	8– 10

The tool evaluates the health of the wetland and is determined by a score known as the Present Ecological Score. The health assessments for the hydrology, geomorphology and vegetation components were then represented by the Present Ecological State (PES) categories. The PES categories are divided into six units (A-F) based on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in **Table 9**.

Table 9: Health categories used by WET-Health for describing the integrity of wetlands.

DESCRIPTION	IMPACT SCORE	HEALTH CATEGORY
Unmodified, natural.	0 – 1.0	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.1 - 2.0	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2.1 - 4.0	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4.1 - 6.0	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6.1 - 8.0	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.1 - 10.0	F

Since hydrology, geomorphology and vegetation are interlinked their scores have been aggregated to obtain an overall PES health score using the following formula (MacFarlane *et al*., 2009):

Health = ((Hydrology score) x3 + (Geomorphology score) x2 + (Vegetation score) x2)) ÷ 7

This gives a score ranging from 0 (pristine) to 10 (critically impacted in all respects). Hydrology is weighted by a factor of 3 since it is considered to have the greatest contribution to wetland health. Due to differences in the pattern of water flow through various hydro-geomorphic (HGM) types (**Figure 6**), the tool requires that the wetland is divided into distinct HGM units at the outset. Ecosystem services for each HGM unit are then assessed separately.

Each HGM unit is discussed on the following pages in more detail in terms of the functional integrity, Present Ecological Score and the impacts which affect these.

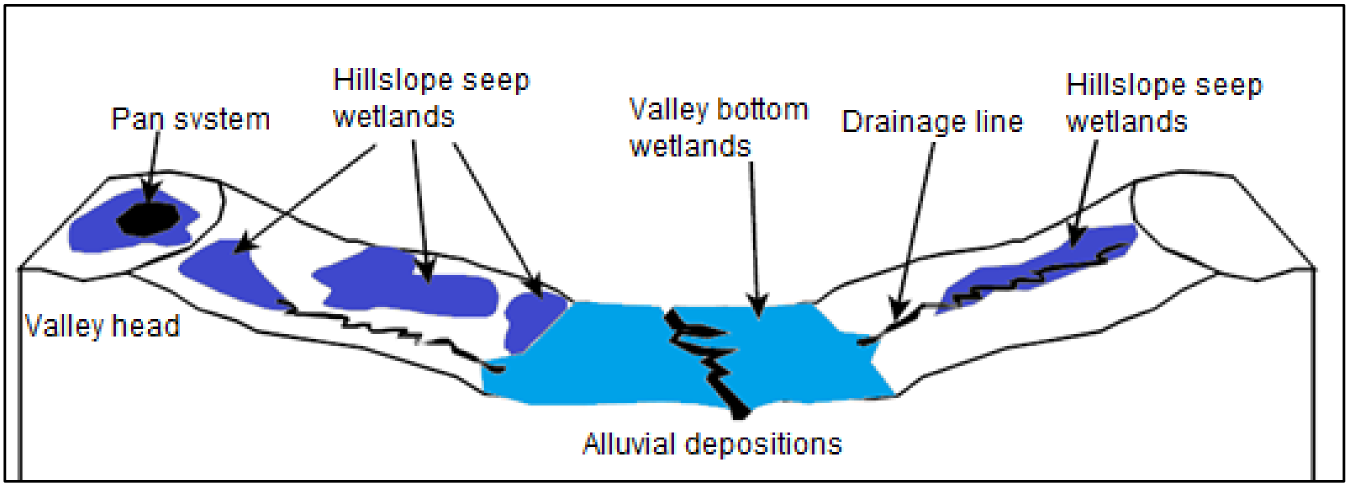

Figure 6: Diagrammatic representation of common wetland systems identified in Southern Africa (based on Kotze *et al*., 2008).

2.4 Significance of Identified Impact

Significance scoring assesses and predicts the significance of environmental impacts through evaluation of the following factors; probability of the impact; duration of the impact; extent of the impact; and magnitude of the impact. The significance of environmental impacts is then assessed considering any proposed mitigations. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required. Each of the above impact factors have been used to assess each potential impact using ranking scales as seen in **Table 10**.

Impact scores given "with mitigation" are based on the assumption that the mitigation measures recommended in this assessment are implemented correctly and rehabilitation of the site is undertaken. Failure to implement mitigation measures during and after construction will keep impacts at an unacceptably high level.

Unknown parameters are given the highest score (5) as significance scoring follows the Precautionary Principle. The Precautionary Principle is based on the following statement: *When the information available to an evaluator is uncertain as to whether or not the impact of a proposed development on the environment will be adverse, the evaluator must accept as a matter of precaution, that the impact will be detrimental*. It is a test to determine the acceptability of a proposed development. It enables the evaluator to determine whether enough information is available to ensure that a reliable decision can be made.

Table 10: Significance scoring used for each potential impact.

Probability	Duration
1 - very improbable 2 - improbable 3 - probable 4 - highly probable 5 - definite	1 - very short duration (0-1years) 2- short duration (2-5 years) 3 - medium term (5-15 years) 4 - long term (>15 years) 5 - permanent/unknown
Extent	**Magnitude**
1 - limited to the site 2 - limited to the local area 3 - limited to the region 4 - national 5 - international	2 – minor 4 – low 6 – moderate 8 – high 10 – very high

Significance Points = (Magnitude + Duration + Extent) x Probability. The maximum value is 100 Significance Points.

Potential Environmental Impacts are rated as high, moderate or low significance as per the following:

<30 significance points = Low environmental significance

31-59 significance points = Moderate environmental significance

>60 significance points = High environmental significance

2.5 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines.

The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

Consequence = Severity + Spatial Scale + Duration

Whereas likelihood is calculated as:

Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection.

Significance is calculated as:

Significance \Risk= Consequence x Likelihood.

Each metric of the severity (flow regime, water quality, geomorphology, biota and habitat) and spatial scale, duration, frequency of the activity, frequency of the incident/impact and detection are rated to a 1 to 5 scale (GNR 509, of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as Defined in Section 21(C) or Section 21(I), 2016).

The score is then placed into one of the three classes, with low risks to the watercourse will qualify for a General Authorisation (GA). Medium and high risk activities will require a Section 21(c) and (i) water use licence as per the National Water Act of 1998 (**Table 11**).

Table 11: Significance of the Section 21 C and I ratings matrix as prescribed by the National Water Act 1998 (Act no. 36)

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 notably and require mitigation measures on a higher level, which costs more and require specialist input.
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 BACKGROUND INFORMATION

3.1 Climate

Stretches over the Mpumalanga and Gauteng Provinces, with plains between Belfast to the east and the eastern side of Johannesburg and extending southwards to Bethal, Ermelo and Piet Retief. Altitude ranges between 1520 to 1780 m, but also as low as 1300 m (Mucina & Rutherford, 2006). Strongly seasonal summer rainfall, with very dry winters. Mean annual precipitation ranges between 650 mm to 900 mm (overall average: 726 mm) and is relatively uniform, but increases significantly in the southeast areas (Mucina & Rutherford, 2006). Incidence of frost from lasts from 13 to 42 days, but is higher at higher elevations (Mucina & Rutherford, 2006).

3.2 Vegetation Eastern Highveld Grassland

Slightly too moderately undulating plains, including some low hills and pan depressions (Mucina & Rutherford, 2006). The vegetation is short dense grassland dominated by the usual Highveld grass composition (*Aristida*, *Digitaria*, *Eragrostis*, *Themeda*, *Tristachya* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra*, *Celtis africana*, *Diospyros lycioides* subsp *lycioides*, *Parinari capensis*, *Protea caffra*, *P. welwitschii* and *Rhus magalismontanum*) (Mucina & Rutherford, 2006).

Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and dams. Cultivation may have had a more extensive impact, indicated by land-cover data (Mucina & Rutherford, 2006). No serious alien invasions are reported, but *Acacia mearnsii* can become dominant in disturbed sites, with very low erosion (Mucina & Rutherford, 2006). **Figure 7** illustrates the range of this vegetation type in accordance with the study area.

3.3 Geology

Red to yellow sandy soils of the Ba and Bb land types found on shales and sandstones of the Madzaringwe Formation (Karoo Supergroup). Land types are Bb (65%) and Ba (30%) (Mucina & Rutherford, 2006). Found on younger Pleistocene to recent sediments overlying fine-grained sedimentary rocks of the Karoo Supergroup (on sediments of both Ecca and Beaufort Groups due to the large extent of the area of occurrence) as well as of the much older dolomites of the Malmani Subgroup of the Transvaal Supergroup in the northwest (Mucina & Rutherford, 2006). In the areas built by Karoo Supergroup sediments are associated with the occurrence of Jurassic Karoo dolerite dykes having a profound influence on run-off (Mucina & Rutherford, 2006).

Soils are peaty (Champagne soil form) to vertic (Rensberg soil form) (Mucina & Rutherford, 2006). The pans and wetlands forms where flow of water is impeded by impermeable soils and/or by erosion resistant features, such as dolerite intrusions (Mucina & Rutherford, 2006). Many pans of this type of freshwater wetlands are inundated and/or saturated only during the summer rainfall season, and for some months after this into the middle of the dry winter season, but they may remain saturated all year round (Mucina & Rutherford, 2006). Surface water inundation may be present at any point while the wetland is saturated and some plant species will be present only under inundated conditions, or under permanently saturated conditions (Mucina & Rutherford, 2006). The presence of standing water should not be taken as a sign of permanent wet conditions (Mucina & Rutherford, 2006).

3.4 Quaternary catchment and Land Use

The site falls within the quaternary drainage region B11K which is part of the Olifants Water Management Area (**Figure 8**). The land use features within the study site are mainly agriculture in the form of subsistence farming, crops and grazing (**Figure 9**). The Brugspruit which flows into the Klipspruit adjacent to the farm portions, where water abstraction for agricultural activities occur. Beyond the reaches the Klipspruit reaches are dominated with coal mining activities and informal settlements.

According to the ecological importance classification for the quaternary catchments B11K; the Klipspruit floodplain system is classified as a moderate system which in its present state can be considered to be a Category E (Seriously Modified) system. The default ecological management class for the relevant quaternary catchments is considered to be moderate sensitive system in terms of ecological importance with a highly ecological sensitivity. The attainable ecological management class for the system is a Category B (Largely natural). A summary of the ecological integrity (health) and management categories for the Klipspruit floodplain in quaternary catchments B11K is presented in **Table 12**.

Table 12: Sub-Quaternary reach desktop data for the area assessed (DWS, 2013)

Reach	SQR Name	PES Category Median	Mean EI Class	Mean ES Class	Length km	Stream Order	Attainable Pes
B11K-01127	Klipspruit	E	Moderate	High	23	1	B

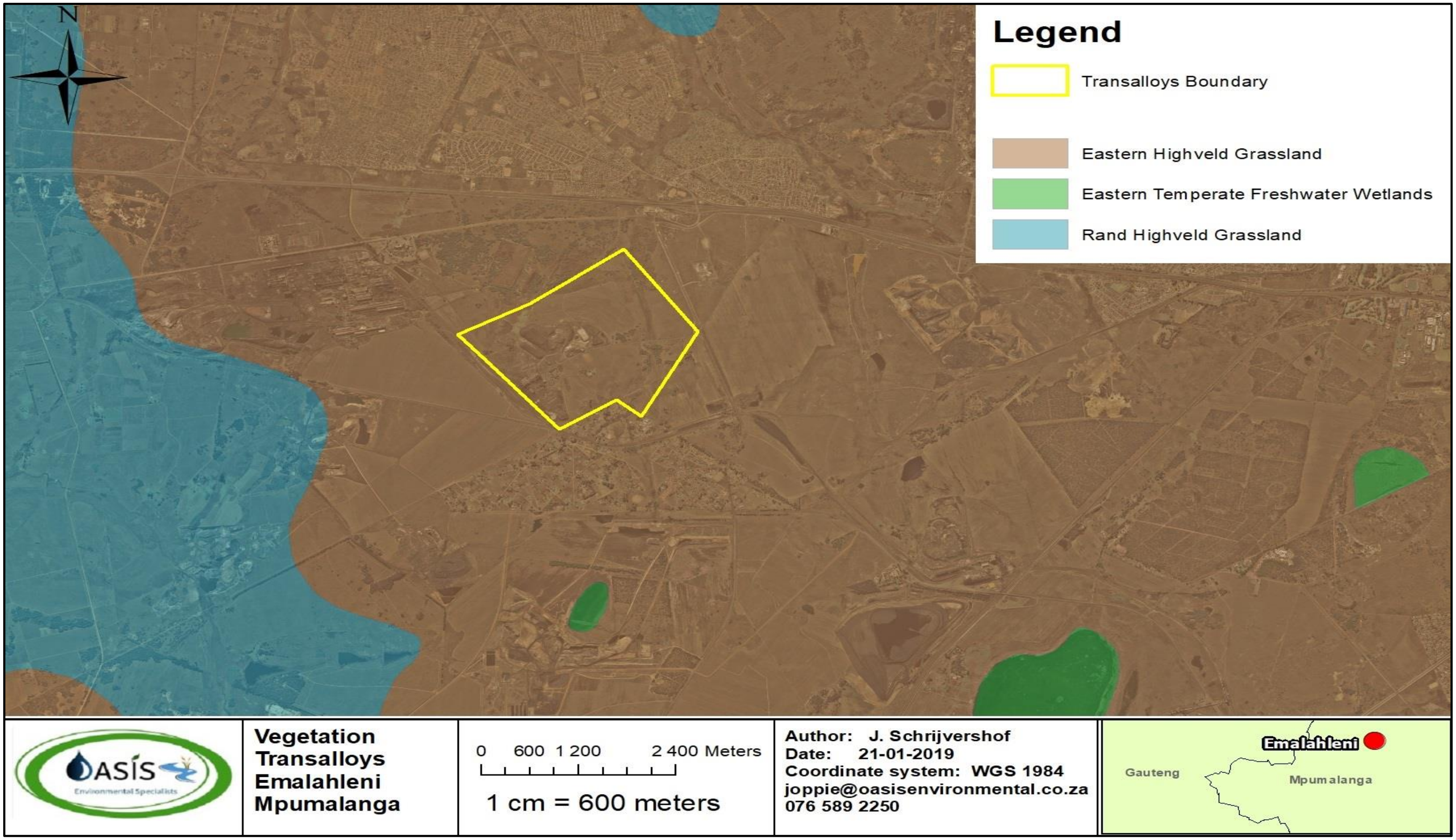

Figure 7: Transalloys - Vegetation map.

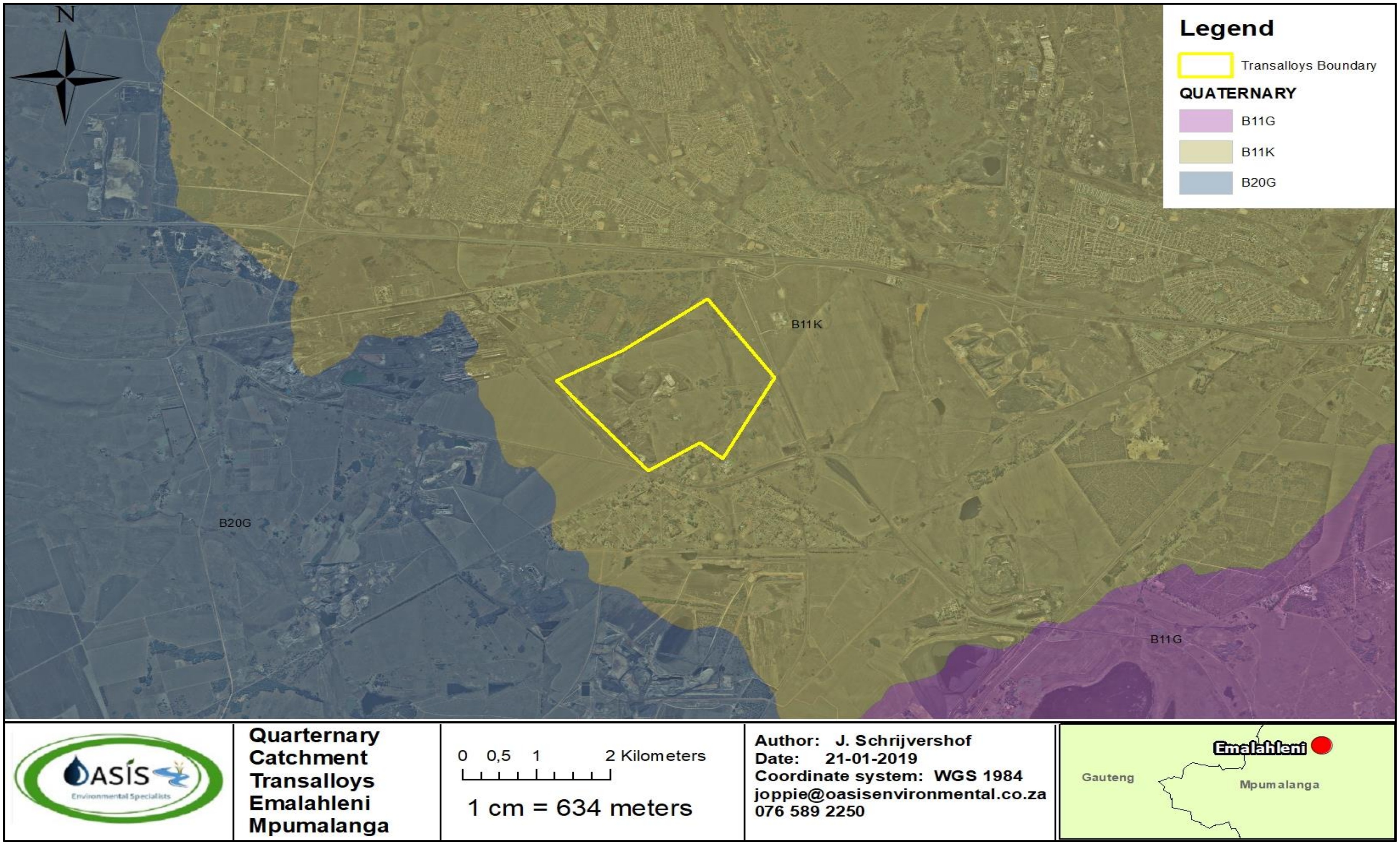

Figure 8: Transalloys - Catchment map.

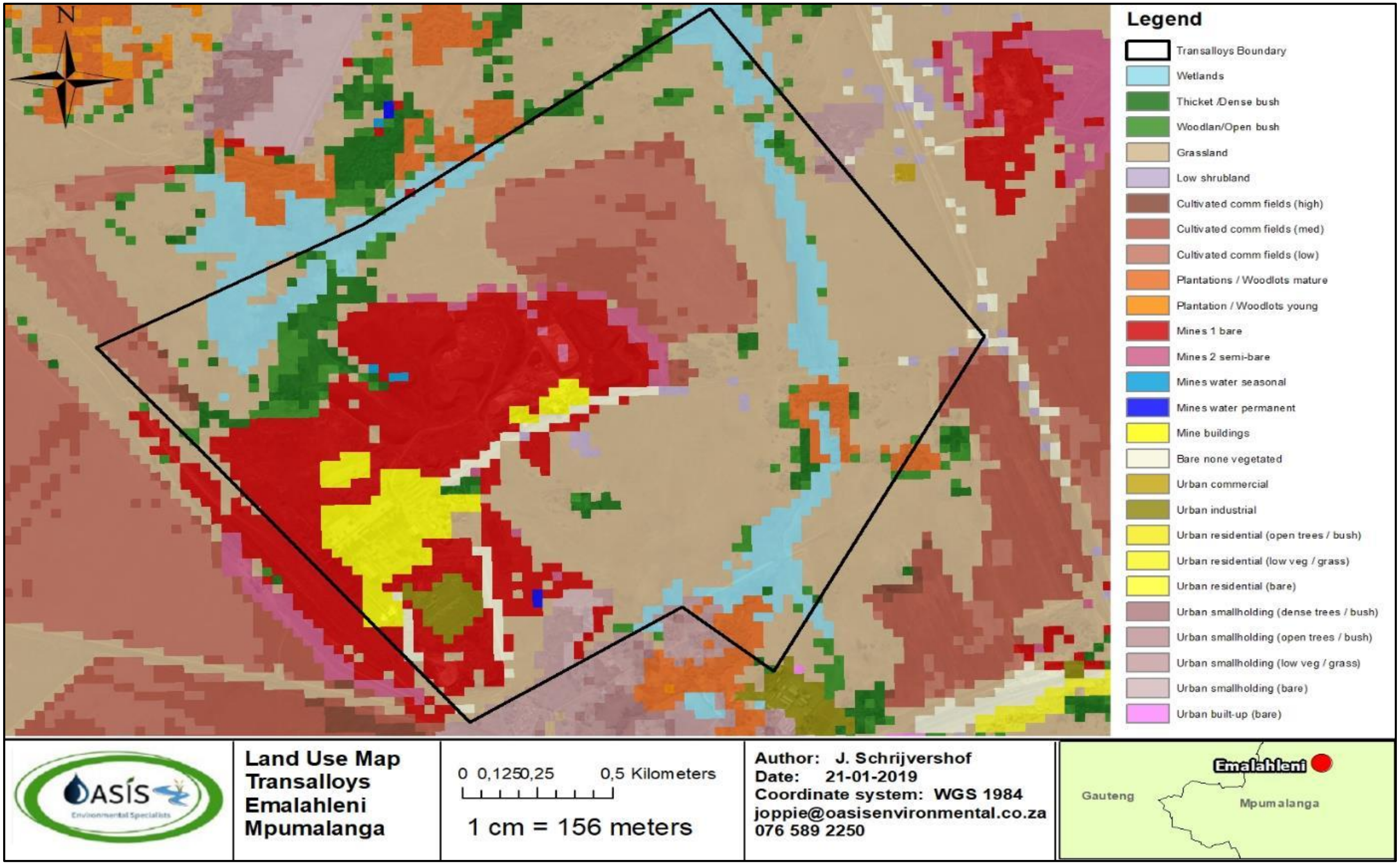

Figure 9: Transalloys – Land-use map.

3.5 Highveld Ecoregion

Kleynhans *et al*. (2005) describes the Highveld Ecoregion (11) as plains with a moderate to low relief, as well as various grassland vegetation types (with moist types present towards the east and drier types towards the west and south) (**Table 13**). Several large perennial rivers have their sources in the region for e.g. Vet, Modder, Riet, Vaal, Olifants, Steelpoort, Marico, Crocodile (east and west) and the Great Usutu (**Figure 10**).

- Mean annual precipitation: Rainfall varies from low to moderately high, with an increase from west to east.
- Coefficient of variation of annual precipitation: Moderately high in the west, decreasing tolow in the east.
- Drainage density: Mostly low, but medium in some areas.
- Stream frequency: Low to medium.
- Slopes <5%: >80%, but 20-50% in a few hilly areas.
- Median annual simulated runoff: Moderately low to moderate.
- Mean annual temperature: Hot in the west and moderate in the east.

Table 13: Highveld Ecoregion attributes (Department of Water Affairs, 2012).

Main attributes	Highveld
Terrain morphology: Broad division (dominant types in bold (Primary)	Plains; Low Relief; Plains; Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief
Vegetation types (Dominant types in bold)	Mixed Bushveld (limited); Rocky Highveld Grassland; Dry Sandy Highveld Grassland; Dry Clay Highveld Grassland; Moist Cool

Main attributes	Highveld
	Highveld Grassland; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (m.a.m.s.l) (secondary)	1100-2100, 2100-2300 (very limited)
MAP (mm) (modifying)	400 to 1000
Coefficient of Variation (% of annual precipitation)	< 20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max temp. (°C) February	20 to 32
Mean daily max temp. (°C) July	14 to 22
Mean daily min. temp. (°C): February	10 to 18
Mean daily min. temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

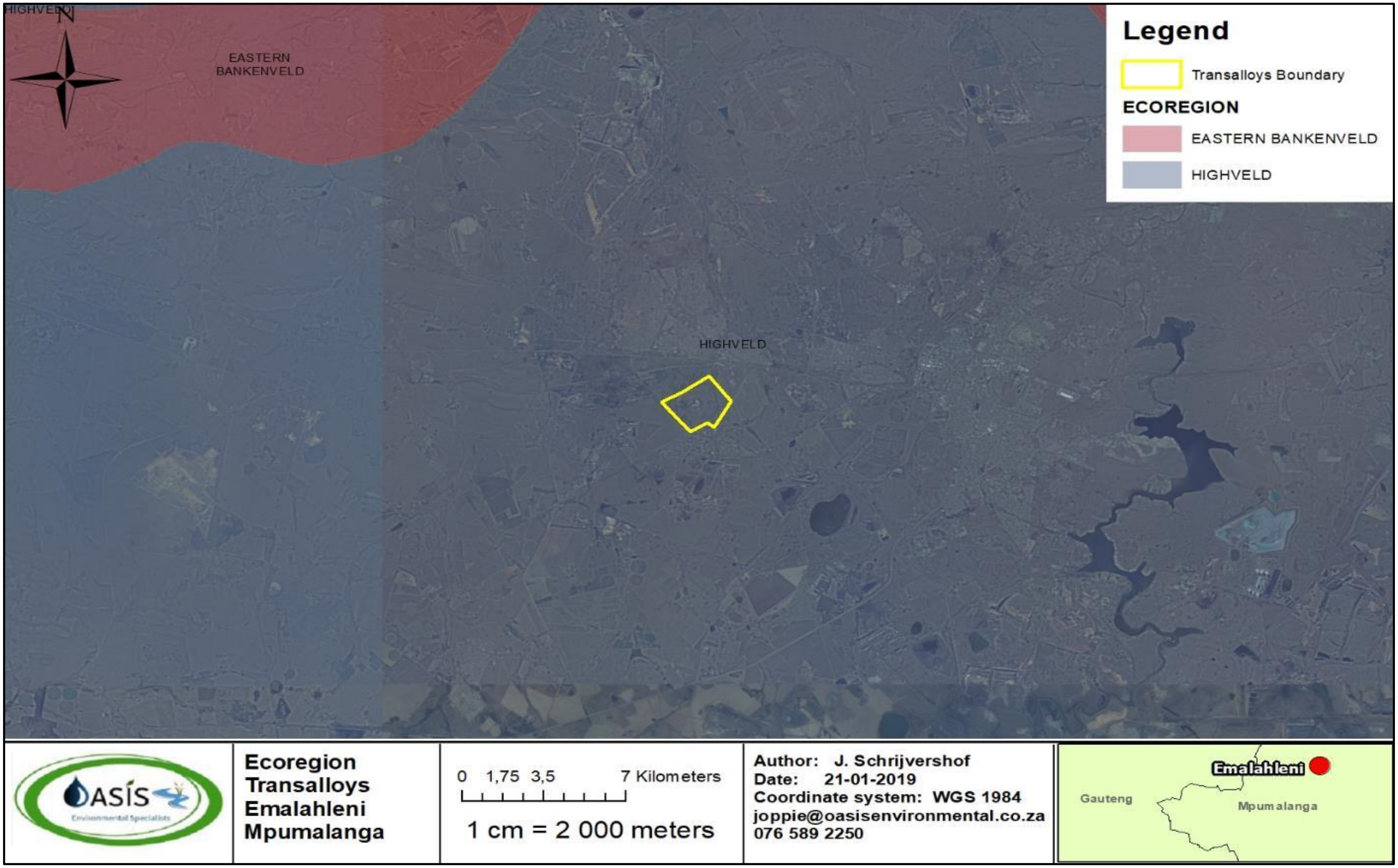

Figure 10: Transalloys - Ecoregion map.

4 RESULTS

A site assessment was conducted on the 17th January 2019. The sampled sites are illustrated in the **Figure 11 and Figure 12** and the coordinates for each site assessed are provided in **Table 14**. During the site visit it was evident that alien invasive plant infestation and extensive mining activities were present within certain sections of the study boundary and that water quality were impacted by the upstream sewer pipeline discharging in the Brugspruit at Sample Point 1. It must be noted that the study sites had stagnant water in certain sections of the streams at the time at the assessment.

Table 14: Coordinates for the aquatic study sites for the Transalloys.

Site	Coordinates	
Sample point 1	25°53'12.95"S	29° 6'54.93"E
Sample point 2	25°52'43.30"S	29° 7'39.68"E
Sample point 3	25°53'43.63"S	29° 7'45.76"E

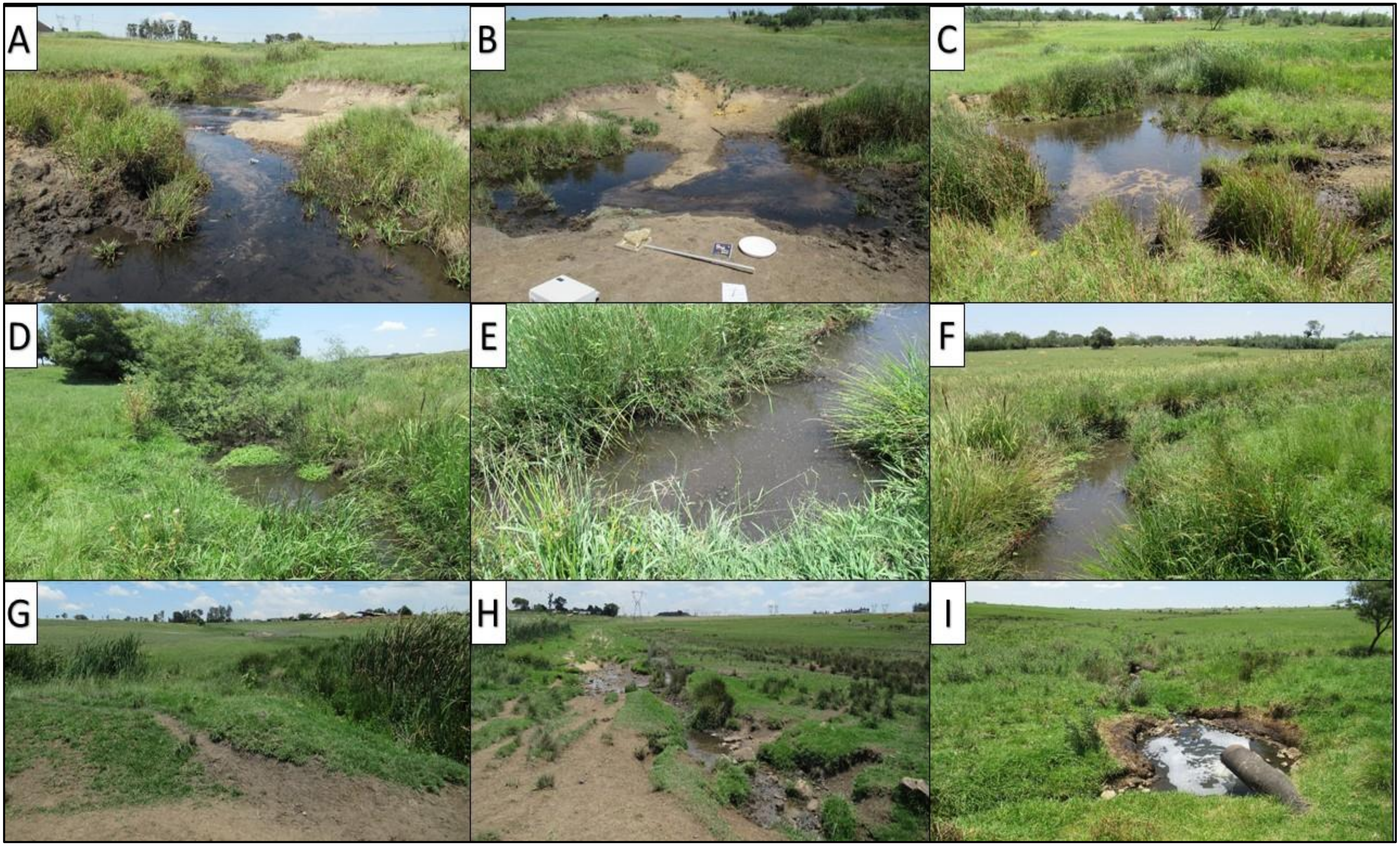

Figure 11: Sample Localities for the Transalloys study area where (A-C) represents the tributary of the Brugspruit (Sample point 1), (D-F) Downstream site for the Brugspruit (Sample point 2); and (G-I) the Upstream site of the Brugspruit (Sample point 3), note the sewage discharge in (I).

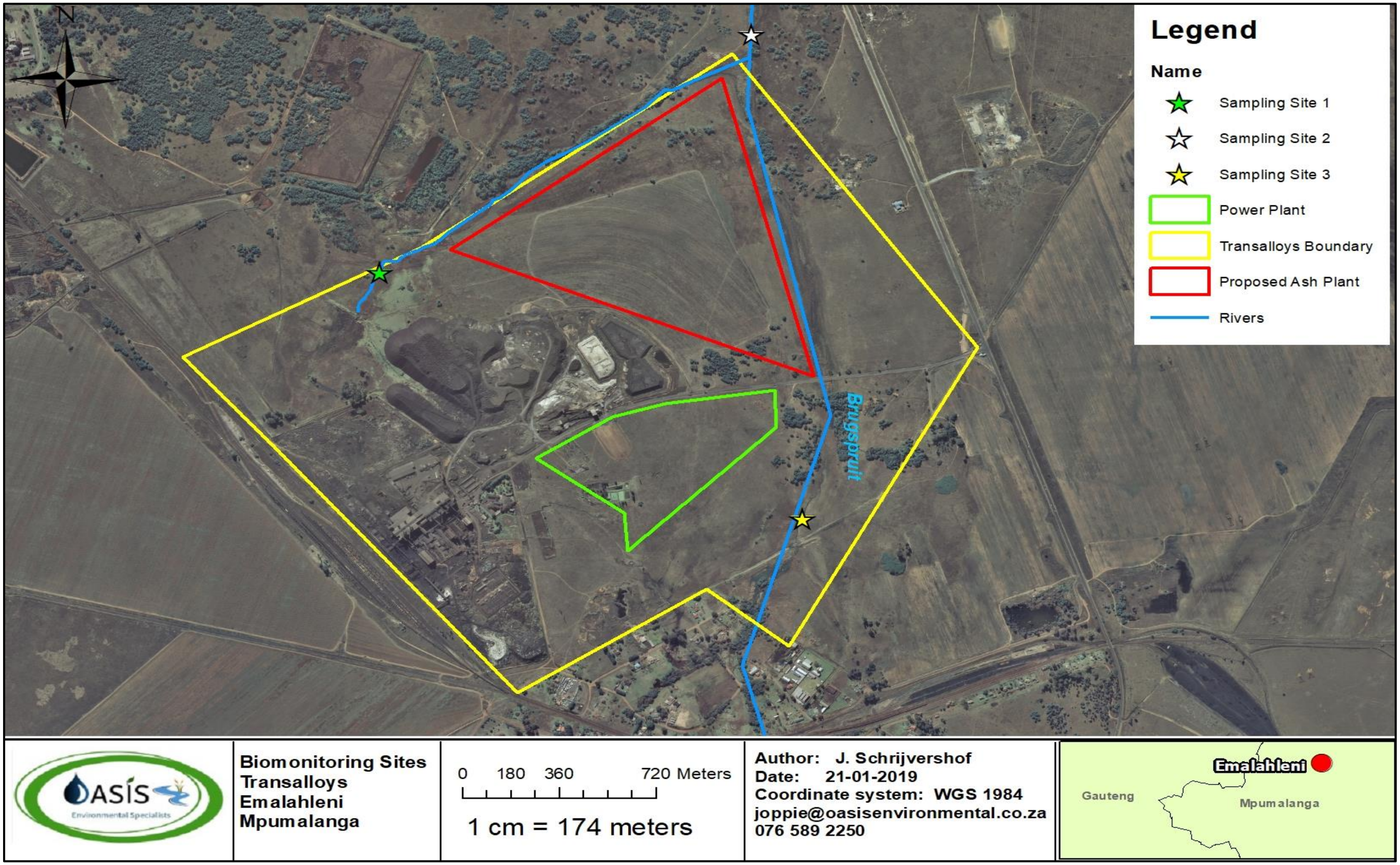

Figure 12: Transalloys – Sample localities map.

4.1 *In Situ* Water Quality

In situ water quality variables was within **unacceptable** limits compared to the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa. The pH remained relatively constant throughout the sites and within the neutral range. Temperatures was relatively stable, where electrical conductivity levels (except the Brugspruit tributary) were exceeding guideline levels and dissolved oxygen (DO) levels were below guideline levels at all sites (**Table 15**).

It must be noted that *in situ* water quality testing cannot identify specific chemicals for the basis for the health determination of a river system.

Table 15: *In situ* water quality results of the Transalloys sites compared to guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa.

Constituents	Guideline values (TWQRs)	Sample point 1	Sample point 2	Sample point 3
pH	6.5-9,5	8,14	7,39	7,78
Temp (°C)	5-30	22,38	21	26,6
Conductivity (µS/cm)	<700	491	983	950
Dissolved Oxygen (%)	>80%	38,3	5,5	60,1
Dissolved Oxygen (mg/L)	>6	2,79	0,41	0,85

4.2 Intermediate Habitat Integrity Assessment (IHIA)

The IHIA results recorded, place all sites assessed within a **seriously modified state (Category E)**. A category of E indicates that the loss of natural habitat, biota and basic ecosystem functions is extensively transformed from reference conditions. The predominant cause for concern was erosion, alien invasive plants, mining and water pollution.

The IHIA assesses the number and severity of anthropogenic impacts and the damage they potentially inflict on the habitat integrity of aquatic ecosystems. The results of the IHIA are presented below in **Table 16.**

Table 16: Overall IHIA instream and riparian results for the sites of Transalloys.

INSTREAM CRITERIA	WEIGHT	Site 1 Tributary	Site 2 Brugspruit DS	Site 3 Brugspruit US	Average	Score
Water abstraction	14	18	15	20	17,67	9,89
Flow modification	13	19	15	18	17,33	9,01
Bed modification	13	15	16	19	16,67	8,67
Channel modification	13	16	17	19	17,33	9,01
Water quality	14	15	18	24	19,00	10,64
Inundation	10	17	16	18	17,00	6,80
Exotic macrophytes	9	13	16	16	15,00	5,40
Exotic fauna	8	5	8	4	5,67	1,81
Solid waste disposal	6	5	10	18	11,00	2,64
TOTAL	100					**36,12**
RIPARIAN ZONE CRITERIA	**WEIGHT**	**Site 1 Tributary**	**Site 2 Brugspruit DS**	**Site 3 Brugspruit US**	**Average**	**Score**
Indigenous vegetation removal	13	15	15	12	14,00	7,28
Exotic vegetation encroachment	12	14	14	14	14,00	6,72
Bank erosion	14	15	12	14	13,67	7,65
Channel modification	12	16	15	15	15,33	7,36
Water abstraction	13	15	14	16	15,00	7,80
Inundation	11	15	13	16	14,67	6,45
Flow modification	12	20	14	17	17,00	8,16
Water quality	13	14	16	20	16,67	8,67
TOTAL	100					**39,91**

4.3 Riparian Vegetation Assessment Index (VEGRAI)

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for Watercourses. Vegetation also forms a central part of the watercourse component in the National Water Act, Act 36 of 1998. Disturbances included the presence of alien invasive species, erosion and grazing within the area.

Hydrophytic riparian vegetation consisted of mainly of *Typha capensis* and *Cyperus spp*. Others included *Juncus spp*. (**Figure 13**).

Alien invasive plants observed onsite included Khaki Weed (*Tagetes minuta*), Castor Oil Plant (*Ricinus communis*), Black Wattle (*Acacia meansii*) Balloon Vine (*Cardiospermum grandiflorum*), Bugweed (*Solanum mauritianum*), Pom Pom Weed (*Campuloclinium macrocephalum*), Spiny Cocklebur (*Xanthium spinosum*) Pampas Grass (*Cortaderia jubata*) and Gumtrees (*Eucalyptus spp.*).

Figure 13: Overall view of hydrophytic vegetation associated with the watercourses in the study area.

The findings for the vegetation assessment revealed that riparian habitat of the area was **seriously modified (Category E)** (**Table 17**). The entire study area has, been disturbed as a result of mining, erosion, alien invasive plant species and overgrazing in the marginal and non-marginal zones.

Table 17: VEGRAI score for the riparian vegetation of the area associated with Transalloys.

Site	**Transalloys**
Marginal	29,3
Non-Marginal	45,3
LEVEL 3 VEGRAI (%)	**34,1**
VEGRAI EC	**E**
AVERAGE CONFIDENCE	3

4.4 Macroinvertebrates

4.4.1 South African Scoring System (SASS5)

During this survey; no sensitive organisms were sampled at any of the study sites. These results should be approached with caution as it is not a true representation of the site, due to a lack of suitable flow conditions. Sampled invertebrates included the *Beatidae, Corixidae, Gerridae, Gyrinidae, Ceratopogonidae, Culicidae* and *Chironomidae.*

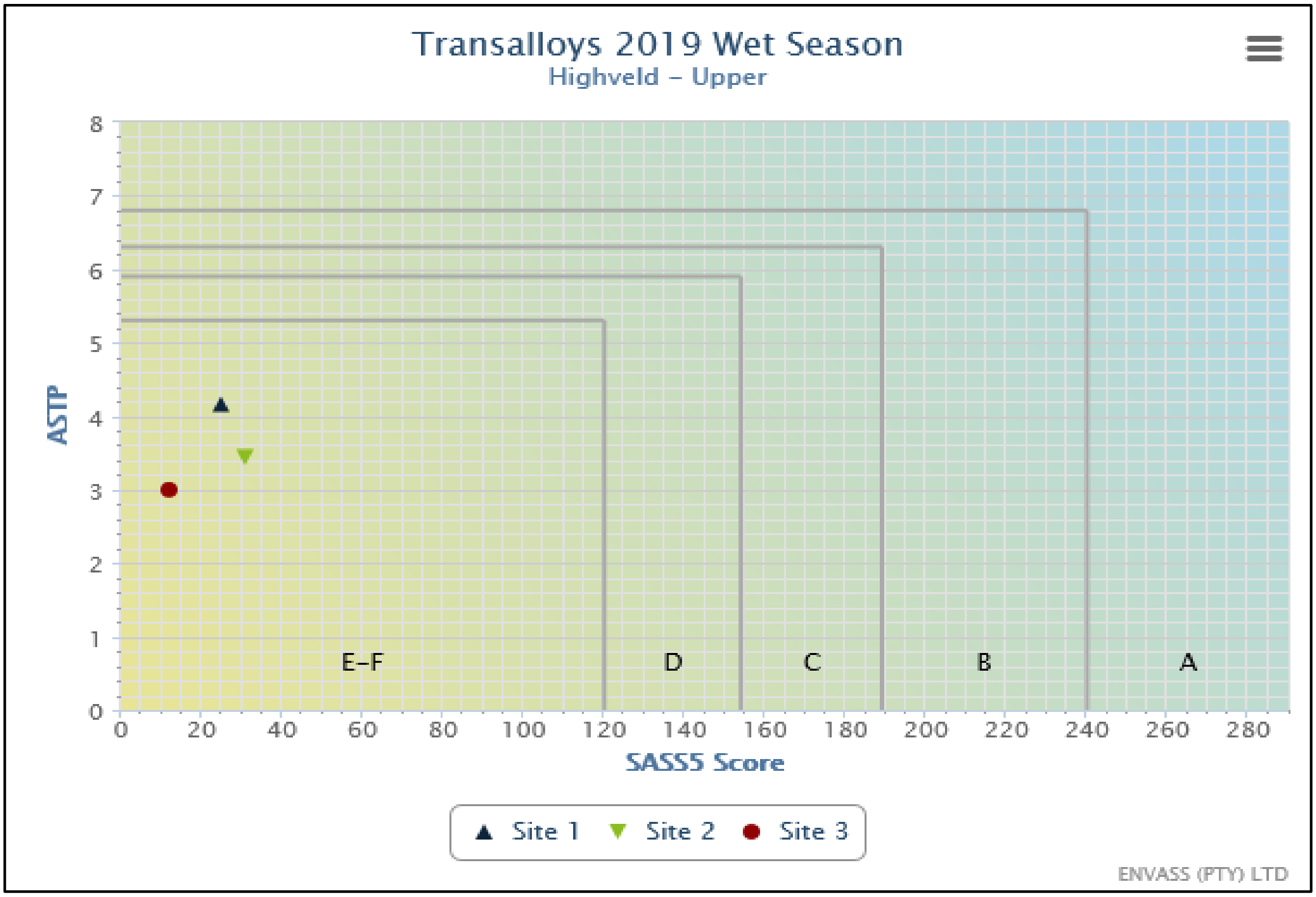

Figure 14: SASS 5 Classification using biological bands calculated from percentiles from Dallas (2007) for the all 3 study sites at Transalloys in accordance with the Highveld Upper Ecoregion as reference.

SASS5 scores for all three sites (Brugspruit and its tributary) were found to be in a **seriously modified (Category E/F) (Figure 14)**. The presence of highly pollution tolerant organisms indicates the pressure from extensive pollution upstream on both these systems. The high abundance and occurrence of *Culicidae* indicates that this system is heavily transformed.

According to the SASS5 interpretation guidelines there is a major deterioration in water quality at all of the sites. The results of the *in situ* water quality and FRAI corroborate this finding. Additionally, only pollution tolerant species were found to be present at the selected sites. The complete absence of sensitive species is indicative of water quality impairment.

The seriously modified SASS5 categories confirm the observation of the negative effects and presence of sewage effluent and rural settlement runoff upstream at Site 3.

4.4.2 **Invertebrate Habitat Assessment System (IHAS).**

The invertebrate habitat assessment is presented below in **Table 18**.

Table 18: IHAS results for the macro-invertebrate habitat available associated with Transalloys.

	Site 1 Tributary	Site 2 Brugspruit DS	Site 3 Brugspruit US
IHAS Score	52	57	59
EC Rating	**Inadequate**		

The habitat reaches which were assessed and found to be **inadequate**, where biotopes with limited habitat structures were present. The dominant feature of the invertebrate habitat is the sandy-clay substrate which dominates the streams under study. Generally, no stones in or out of current biotope were found to be available throughout the Brugspruit system.

4.4.3 Macroinvertebrate Response Assessment Index (MIRAI)

In order to compressively understand the structure and status of the invertebrate population, MIRAI was implemented using the Highveld Higher Ecoregion reference conditions provided by DWS (2018). The results of the MIRAI assessment for each site are presented below in **Table 19**.

Table 19: MIRAI results associated with Transalloys.

	Site 1 Tributary	Site 2 Brugspruit DS	Site 3 Brugspruit US
Flow Modification	43,5	50,4	43,5
Habitat	34,5	45,1	17,0
Water Quality	13,5	24,7	6,5
Connectivity & Seasonality	33,9	33,9	33,9
Invertebrate EC	**31,34**	**39,39**	**21,66**
EC Rating	**E**	**D/E**	**E/F**

The MIRAI assessment shows that the system is in a **seriously modified state (Category E)** for the study sites. The MIRAI results show that water quantity, poor water quality and mining are the primary drivers for the loss of migratory and sensitive macroinvertebrates within these systems.

4.5 Fish Assessment

4.5.1 Fish Response Assessment Index (FRAI)

No fish data are available for that section of the Klipspruit/Brugspruit according to the SQR data provided by DWS (2013). Only one *Enteromius anoplus* (Chubbyhead barb) was sampled at the downstream site for the Brugspruit.

Table 20: FRAI score for the study area associated with the Brugspruit.

Automated	
FRAI (%)	**90,8**
EC: FRAI	**A/B**
Adjusted	
FRAI (%)	**46,5**
EC: FRAI	**D**

The FRAI assessment was adjusted to suit the site-specific requirements with the frequencies of occurrence (FROC) of particular species adjusted from the expected species list, where no fish were expected (Kleynhans *et al*., 2007). The FRAI score have been adjusted according to the following factors: sampling effort, habitat type, cover combination, stream lengths, water quality and altitude.

The adjusted FRAI results indicated that fish community is in a **largely modified state (Category D)** as a result of poor water quality compounded with low flows and poor habitat availability (**Table 20**).

The very low diversity of fish species confirms that the water quality as well as the instream habitat of the associated the aquatic system was heavily impacted on.

Figure 15: *Enteromius anoplus* (Chubbyhead barb) sampled at site 2 downstream of Transalloys in the Brugspruit.

4.6 Ecological Classification (EC)

The overall Ecological Category (EC), is determined through the application of the Eco-status V4 integration tool combining the metrics from the macroinvertebrate assessment (MIRAI), fish assessment (FRAI) and the riparian vegetation assessment (VEGRAI) according to a weighed and ranked metric score as presented in **Table 21**.

Table 21: Overall EC scores for all sites associated with Transalloys.

INTEGRATED ECOLOGICAL CATEGORY (%)	**22,07**
INTEGRATED ECOSTATUS CATEGORY	**E**

This resulted in a **seriously modified E-category rating** for all study sites assessed for Transalloys The main impacts are extensive pollution from surrounding informal settlements in the form of sewage and rural runoff, the presence of alien invasive plants and surrounding mining activities. All sites were found to be low **sensitive** (EIS), due to the extensive anthropogenic activities.

4.7 Wetland Delineation and Assessment

This section provides the findings of the various methodologies utilised during the wetland assessment.

4.7.1 Desktop Assessment

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA) database were undertaken for the proposed Ashplant and Powerplant for Transalloys. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. They were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al*., 2009). Identification of FEPA Wetlands are based on a combination of special features and modelled wetland conditions that include expert knowledge on features of conservation importance as well as available spatial data on the occurrence of threatened frogs and wetland-dependent birds.

Several valley bottom, flat and seepage NFEPA wetlands were identified within the area (**Figure 16**).

However, ground-truthing the existence and condition of FEPA wetlands is important to understand local conditions which have an impact on the wetland system, their functional integrity and health.

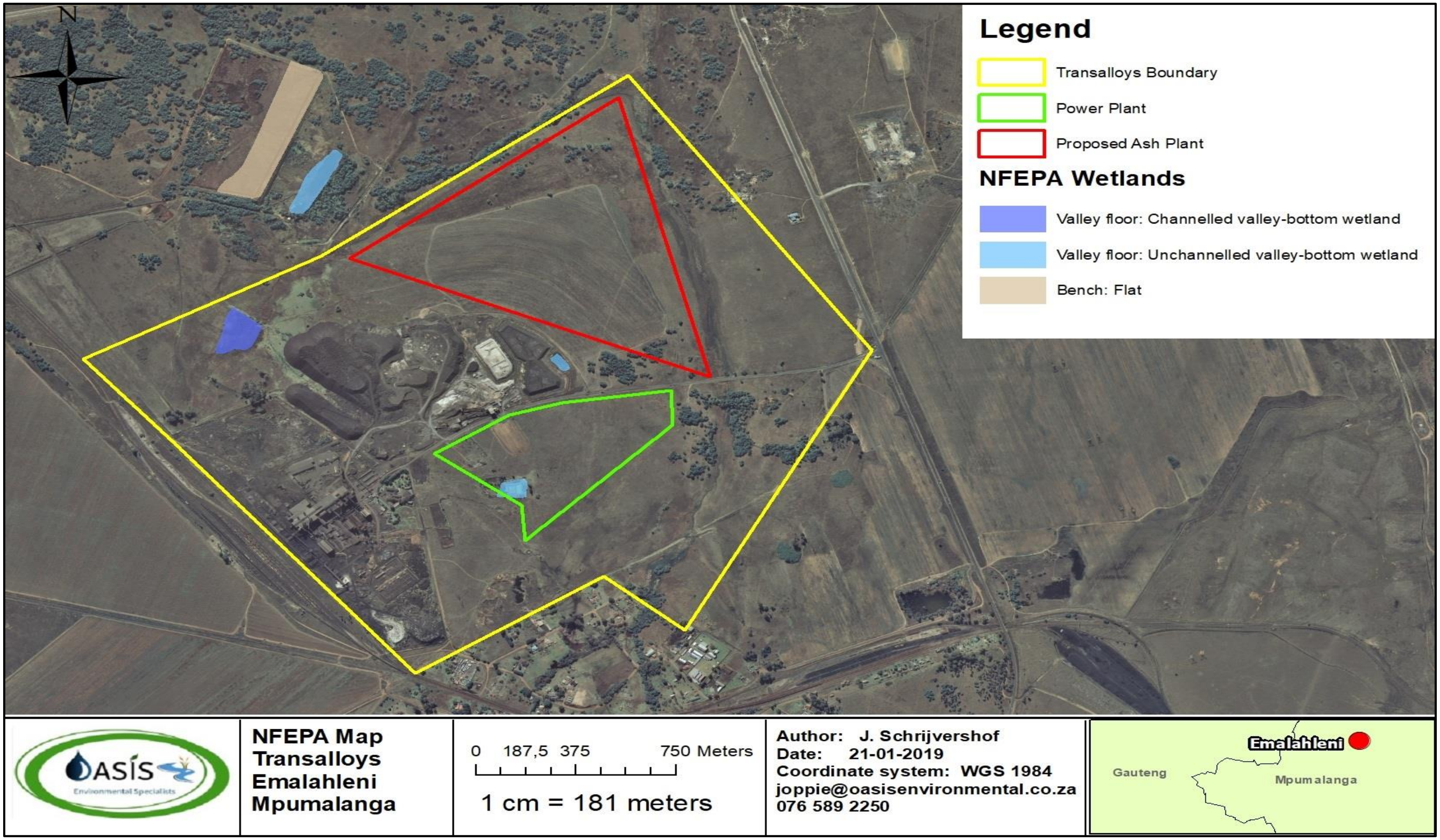

Figure 16: Transalloys – NFEPA Wetlands map.

4.7.2 **Terrain indicator**

The topography of an area is generally a good practical indicator for identifying those parts in the landscape where wetlands are likely to occur. Generally, wetlands occur as a valley bottom unit however wetlands can also occur on steep to mid slopes where groundwater discharge is taking place through seeps (DWAF, 2005). In order to classify a wetland system, the localised landscape setting must be taken into consideration through ground-truthing of the study site after initial desktop investigations (Ollis *et al*., 2014).

The study site can be characterised as having rolling hills with relatively steep sloping topography. The site ranges in altitude from 1481 m to 1578 m above sea level. A Digital Elevation Model (DEM) of the aerial photography of the site revealed valley bottom systems and drainage channels associated with the Olifants catchment (**Figure 17**). These areas identified during the desktop assessment where then assessed in more detail during the field investigation and confirmed to be seepage and valley bottom wetlands.

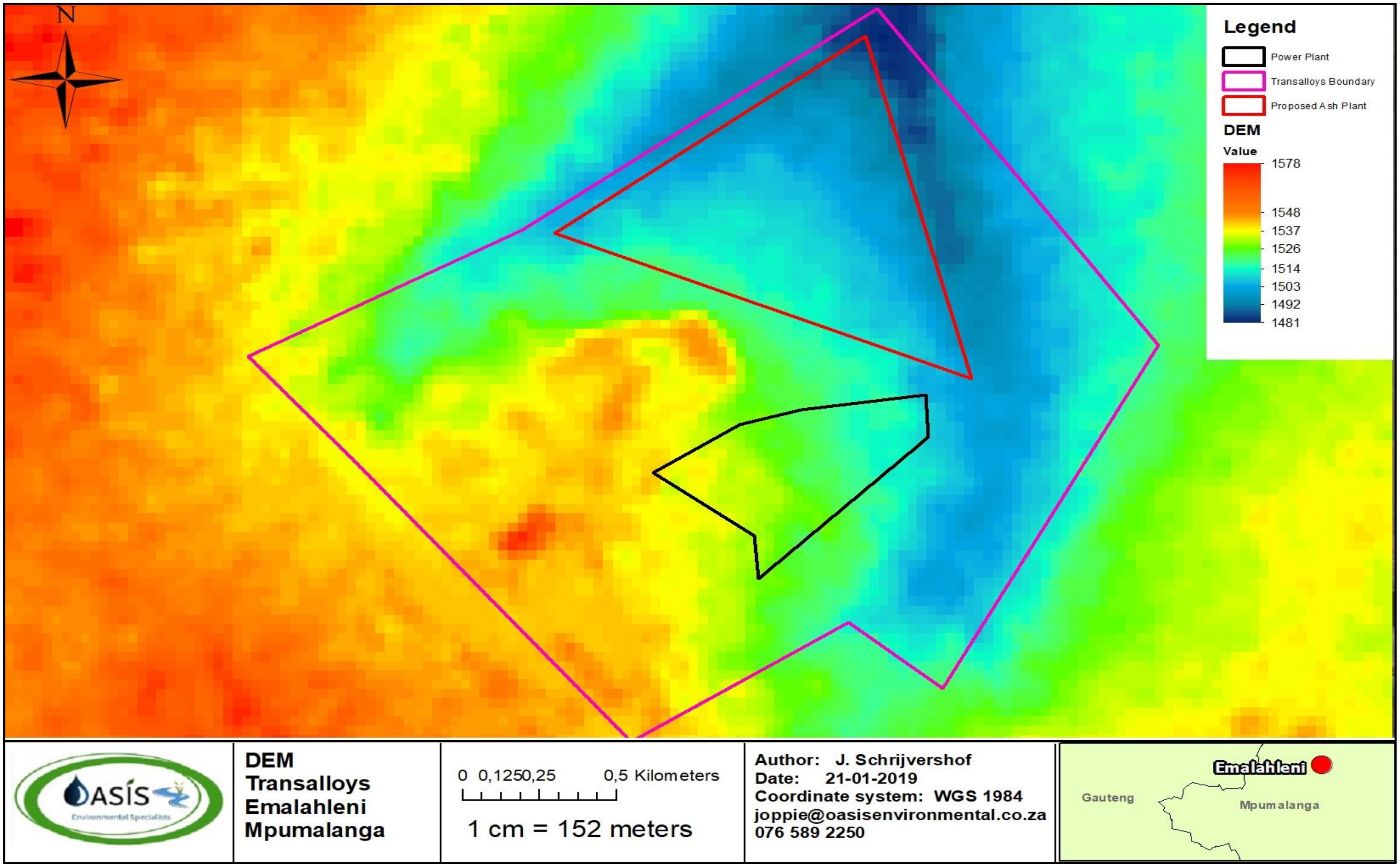

Figure 17: Transalloys – Digital Elevation Model map.

4.7.3 Soil wetness and soil form indicator

Wetland areas were identified within the 500 m buffer of Transalloys where the Ashplant and Powerplant activities were proposed. These wetlands were identified and mainly delineated according to the presence of hydric (wetland) soil types. Hydric soils are defined as those which show characteristics (redoximorphic features) resulting from prolonged and repeated saturation. Characteristics include the presence of mottling (i.e. bright insoluble manganese and iron compounds) a gleyed matrix and/or Mn/Fe concretions.

The presence of redoximorphic features are the most important indicator of wetland occurrence, as these soil wetness indicators remain in wetland soils, even if they are degraded or desiccated (DWAF, 2005). Redoximorphic features are soil characteristics which develop as a result of prolonged and repeated saturation. It is important to note that the presence or absence of redoximorphic features within the upper 500 mm of the soil profile alone is sufficient to identify the soil as being hydric, or non-hydric (Collins, 2005).

Hydric soils identified within the site were classified as a Sandy Clay Loam (**Figure 18**) and the Katspruit soil form (**Figure 19**); in some areas with a high organic content (**Figure 20**) soil forms. Katspruit is a widely encountered wetland soil in South Africa (Fey, 2010). Alluvial soils were identified within the heavily eroded channel areas (**Figure 21**).

Terrestrial soils sampled were dominated by Clovelly (**Figure 22**) and Hutton soils (**Figure 23**). Soil properties identified on site are shown below (**Table 22**).

Table 22: Information used to inform the wetland delineation for the wetlands identified within the Transalloys study boundary.

Soil Form and Horizons		Soil	Zone of wetness	Observations
Hydric Soil				
Katspruit	Orthic A G Horizon	Clay	Permanent, Seasonal and Temporary zone	Gleyed matrix, clay soil identified. Mottling is also prominent in the G horizon.
Sandy Clay Loam	Orthic A Unspecified with signs of wetness	Sandy Clay	Permanent and Seasonal	Gleyed matrix, sandy-clay soil identified. No mottling was found
Terrestrial Soil				
Clovelly	Orthic A Hard Rock	Sandy	None	Yellow structureless soil with no signs of saturation observed. No mottling was observed in the profiles examined
Hutton	Orthic A Red Apedal	Sandy	None	Terrestrial soil identified outside of wetland areas. Red apedal soils identified on the tops of hills. No mottling was identified in these soils as the sandy nature of the soils ensures a quick infiltration of surface water.

Figure 18: Hydric soils included a Sandy Clay Loam soil form associated with the wetland areas.

Figure 19: Hydric soils included Katspruit soil form associated in the wetland areas.

Figure 20: Organic matter found and associated with hydric characteristics and wetland conditions.

Figure 21: Alluvial soils associated with the channel areas.

Figure 22: Clovelly soils were identified and dominant outside of the wetland system within the grasslands.

Figure 23: Hutton soils were identified and dominant outside of the wetland system within the grasslands.

4.7.4 **Vegetation indicator**

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. However, using vegetation as a primary wetland indicator requires an undisturbed condition (DWAF, 2005). Minor disturbances were however noted in the wetland systems making it difficult to rely solely on vegetation as a wetland indicator. Disturbances included the presence of alien invasive species, mining, erosion and grazing within the area.

Despite this a number of wetland species were identified within the wetland system including grasses and sedges. Hydrophytic wetland vegetation consisted of *Typha capensis*, *Cyperus spp*. and *Juncus spp. (***Figure 24**).

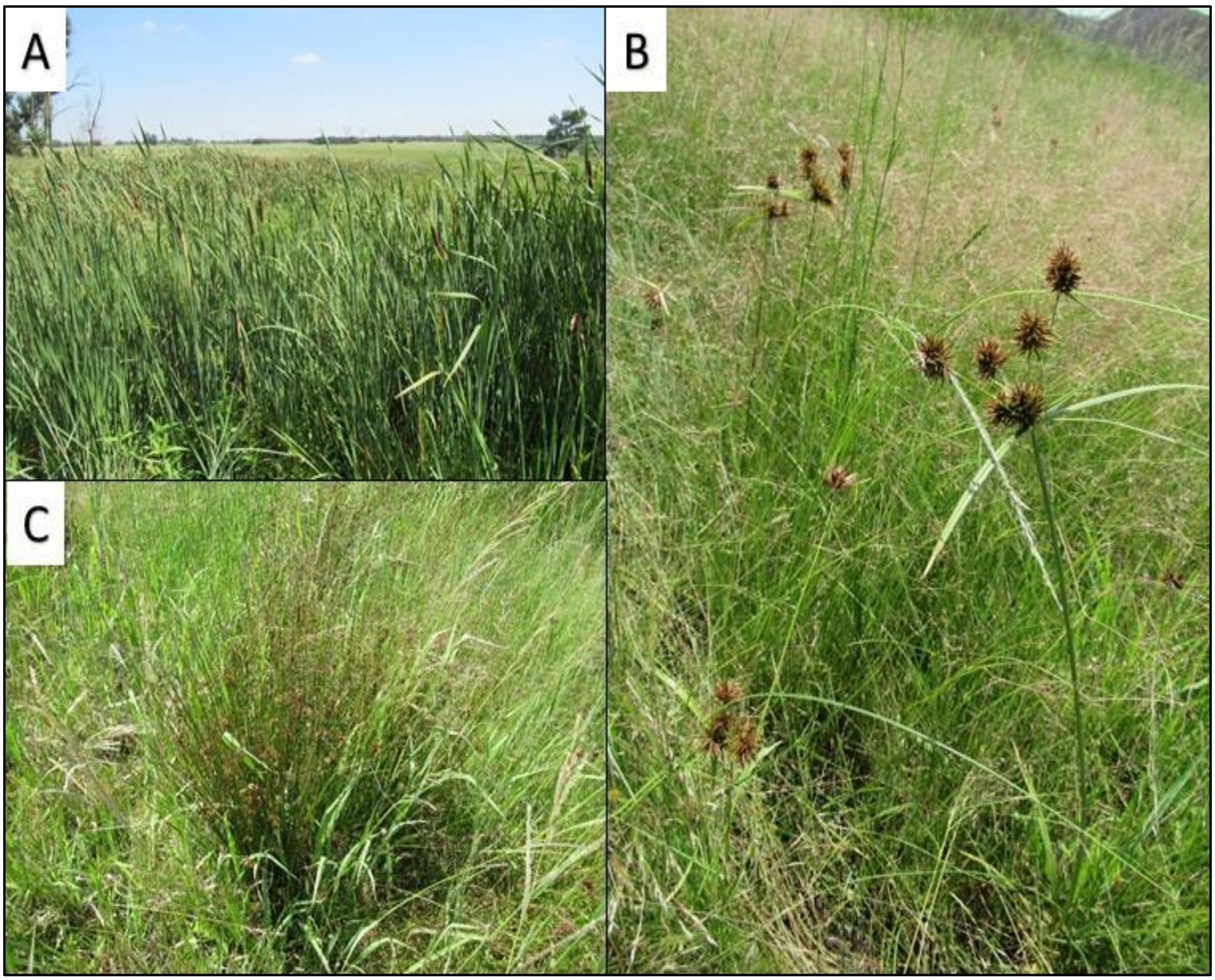

Figure 24: *Typha capensis, Juncus spp.* and *Cyperus spp.* were identified in wetland systems.

4.7.5 Wetland Delineation

The wetlands identified on the sites were categorised according to the National Wetland Classification System for South Africa (Ollis *et al*., 2013). Wetland areas were classified as a hydrogeomorphic (HGM) units. An HGM unit is a recognisable physiographic wetland-unit based on the geomorphic setting, water source of the wetland and the water flow patterns (MacFarlane *et al*., 2009).

Three wetland systems were identified (one seep and two channelled valley bottom wetland systems) within the study boundary (**Figure 25**).

Seepage wetlands are characterised by their association with topographic positions that either cause groundwater to discharge to the land surface or rain derived water to seep down-slope as subsurface interflow. Water movement through the seep is primarily attributed to interflow, with diffuse overland flow often being significant during and after rainfall events (Kotze *et al*., 2008; Ollis *et al*., 2013).

Channelled valley bottom wetlands are characterised by their location on valley floors and the presence of a channel flowing through the wetland. Dominant water inputs to these wetlands are from/into a channel, in this instance an upstream source, flowing through the wetland either as surface flows resulting from flooding or as subsurface flow. Water generally moves through the wetland as diffuse surface flow although occasionally as short-lived concentrated flows during flood events (Kotze *et al*., 2008; Ollis *et al*., 2013). A description of the channelled valley bottom wetland types is given in **Table 23**.

Table 23: Wetland hydrogeomorphic (HGM) types (Kotze *et al*., 2008).

HGM Unit	Description	Source of water maintaining the wetland	
		Surface	Subsurface
Seep 	Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from subsurface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Channelled Valley bottom 	Valley bottom areas with a well- defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***

Precipitation is an important water source and evapotranspiration an important output in all of the above settings Water source:

* Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on the local circumstances

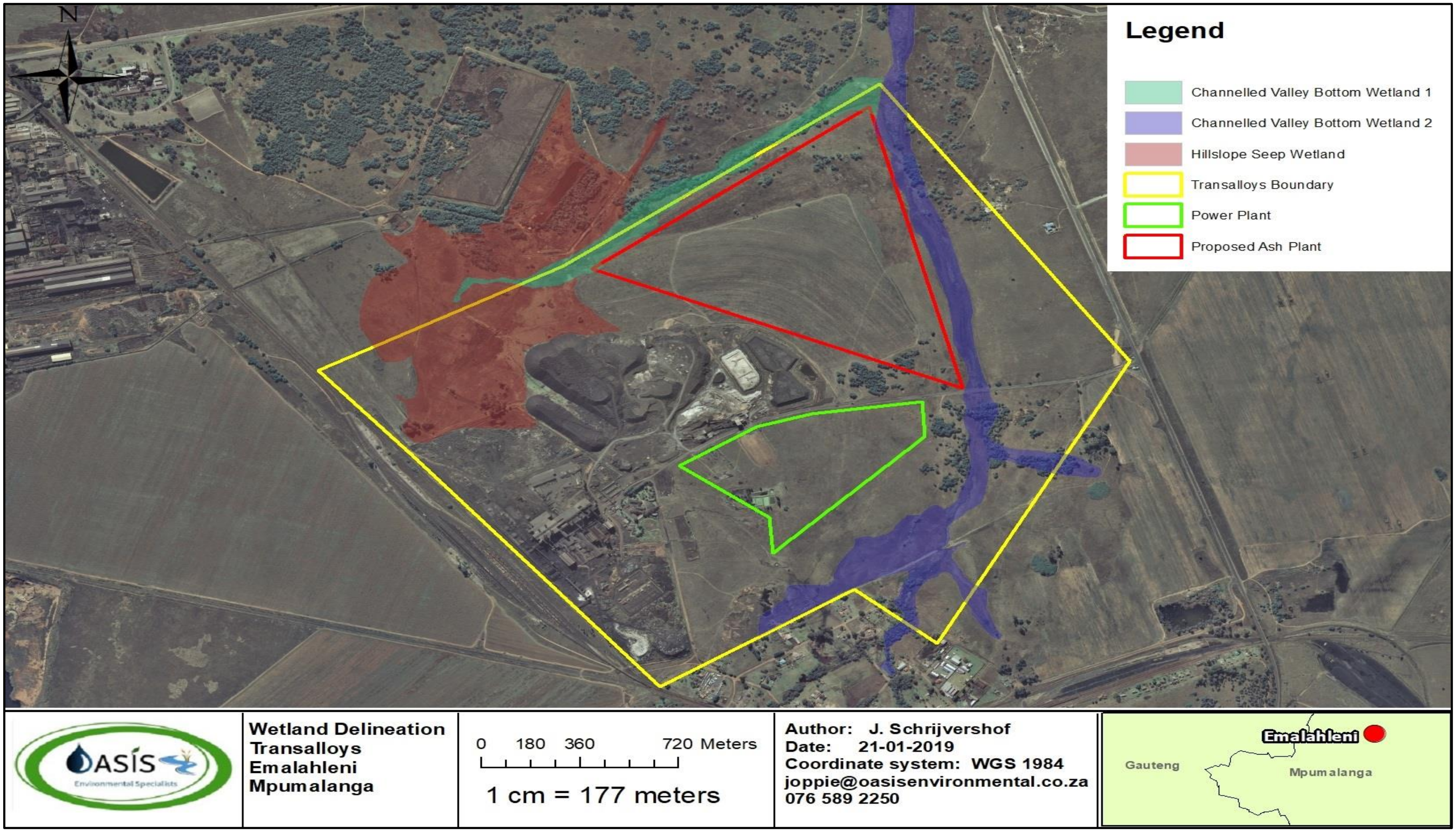

Figure 25: Transalloys – Wetland delineation map.

4.7.6 Wetland Functional and Health Assessment

The associated Hydro-geomorphic (HGM) units is discussed on the following pages in more detail in terms of the functional integrity, Present Ecological Score and the impacts which affect wetland functionality.

The Ecological Services of the wetland has generally been recorded as intermediate (**Table 24**) and the EIS as low (**Table 25**). Although no red-data species were identified during the site investigation, the majority of channelled valley bottom systems provide habitat for a number of floral and faunal species. The presence of open water and vegetation provides a suitable area for breeding, feeding, and protection for some faunal and floral species. The area has no specific cultural significance, however some trapping of nutrients and sediments occur within the upstream reach of the seepage wetland system. The two channelled valley bottom wetland units are affected by extensive erosion, alien invasive plants species and sewage pollution. The seepage wetland system are less disturbed by erosion.

Table 24: Summary of the Ecological Services of the three wetland systems in proximity of Transalloys.

Condensed summary sheet	Seepage Wetland		Channelled valley bottom 1		Channelled valley bottom 2	
	Overall score	Confidence rating	Overall score	Confidence rating	Overall score	Confidence rating
Flood attenuation	1,2	4	3	4	1	4
Streamflow regulation	1,1	3	2,5	3	1,3	3
Sediment trapping	0,9	2,1	2,2	2,1	1,6	2,1
Phosphate trapping	1	1	2,6	1	2	1
Nitrate removal	2	1	1	1	2	1
Toxicant removal	1,5	1	1	1	0,1	1
Erosion control	1,5	3	1	4	1	4
Carbon storage	2	3	2,2	3	2	3
Maintenance of biodiversity	1	2	2,5	2	1	2
Water supply for human use	1	3	2	3	2	3
Natural resources	2	3	2	3	1	3
Cultivated foods	1	4	2	2	1	3
Cultural significance	1	3	1	3	1	3
Tourism and recreation	1	3	1	3	1	3
Education and research	1	3	1	3	1	3
Threats	2	3	2	3	3	3
Opportunities	2	3	2	3	2	3
Overall	**1,5**	**2,8**	**1,9**	**2,8**	**1,5**	**2,8**

Note: <0.5 Low; 0.5-1.5 Moderately low; 1.5-2.5 Intermediate; 2.5-3.5 Moderately high; and >3.5 High

Table 25: Summary of the Ecological Importance and Sensitivity of the wetland systems associated with the Transalloys.

ECOLOGICAL IMPORTANCE AND SENSITIVITY:		
Ecological Importance	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**0,77**	***3,00***
Presence of Red Data species	**0,50**	***3,00***
Populations of unique species	**0,50**	***3,00***
Migration/breeding/feeding sites	**1,30**	***3,00***
Landscape scale	**1,46**	***3,00***
Protection status of the wetland	**1,50**	***2,00***
Protection status of the vegetation type	**1,60**	***2,00***
Regional context of the ecological integrity	**1,30**	***2,00***
Size and rarity of the wetland type/s present	**1,20**	***2,00***
Diversity of habitat types	**1,70**	***2,00***
Sensitivity of the wetland	**1,33**	***2,33***
Sensitivity to changes in floods	**1,50**	***3,00***
Sensitivity to changes in low flows/dry season	**1,20**	***2,00***
Sensitivity to changes in water quality	**1,30**	***2,00***
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1,19**	***2,78***
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1,44**	***1,44***
DIRECT HUMAN BENEFITS	**0,67**	***4,00***
OVERALL	**1,10**	**2,74**

None, Rating = 0 rarely sensitive to changes in water quality/hydrological regime; Low, Rating =1 One or a few elements sensitive to changes in water quality/hydrological regime; Moderate, Rating =2 some elements sensitive to changes in water quality/hydrological regime; High, Rating =3 Many elements sensitive to changes in water quality/ hydrological regime; Very high, Rating =4 Very many elements sensitive to changes in water quality/ hydrological regime

Table 26: Summary of PES scores for the HGM Units within proximity of Transalloys.

HGM Unit 01 (Seep Wetland)			
Module	**Impact Score**	**Category**	**Trajectory**
Hydrology	4,3	D	↓
Geomorphology	4,3	D	↓↓
Vegetation	3,3	C	↓
Overall Score	**4,01**	**D**	↓
HGM Unit 02 (Valley Bottom Wetland 1)			
Module	**Impact Score**	**Category**	**Trajectory**
Hydrology	3,6	D	↓
Geomorphology	2,5	B	↓
Vegetation	3	C	↓
Overall Score	**3,11**	**C**	↓
HGM Unit 03 (Valley Bottom Wetland 2)			
Module	**Impact Score**	**Category**	**Trajectory**
Hydrology	4,1	D	↓↓
Geomorphology	3,5	C	↓
Vegetation	3,9	C	↓
Overall Score	**3,87**	**C**	↓

4.7.7 **Seep Wetlands**

The seepage wetland (HGM1) was identified within the study area above one of the channelled valley bottom wetland (HGM2). The seep wetland received generally bad score, indicating that this wetland is largely modified functioning systems. According to the functional assessment flood attenuation; damming; the maintenance of biodiversity; and the provision of natural resources are the predominant attributes provided by these wetlands to the surrounding landscapes, this is due to the Transalloys stockpiles within this wetland system (**Figure 26**).

The seep wetland system was assessed in terms of health and were found to be categorised as **largely modified (Category D)** (**Table 26**). The majority of the indigenous vegetation within the development footprint and the surrounding area is modified (**Figure 27**).

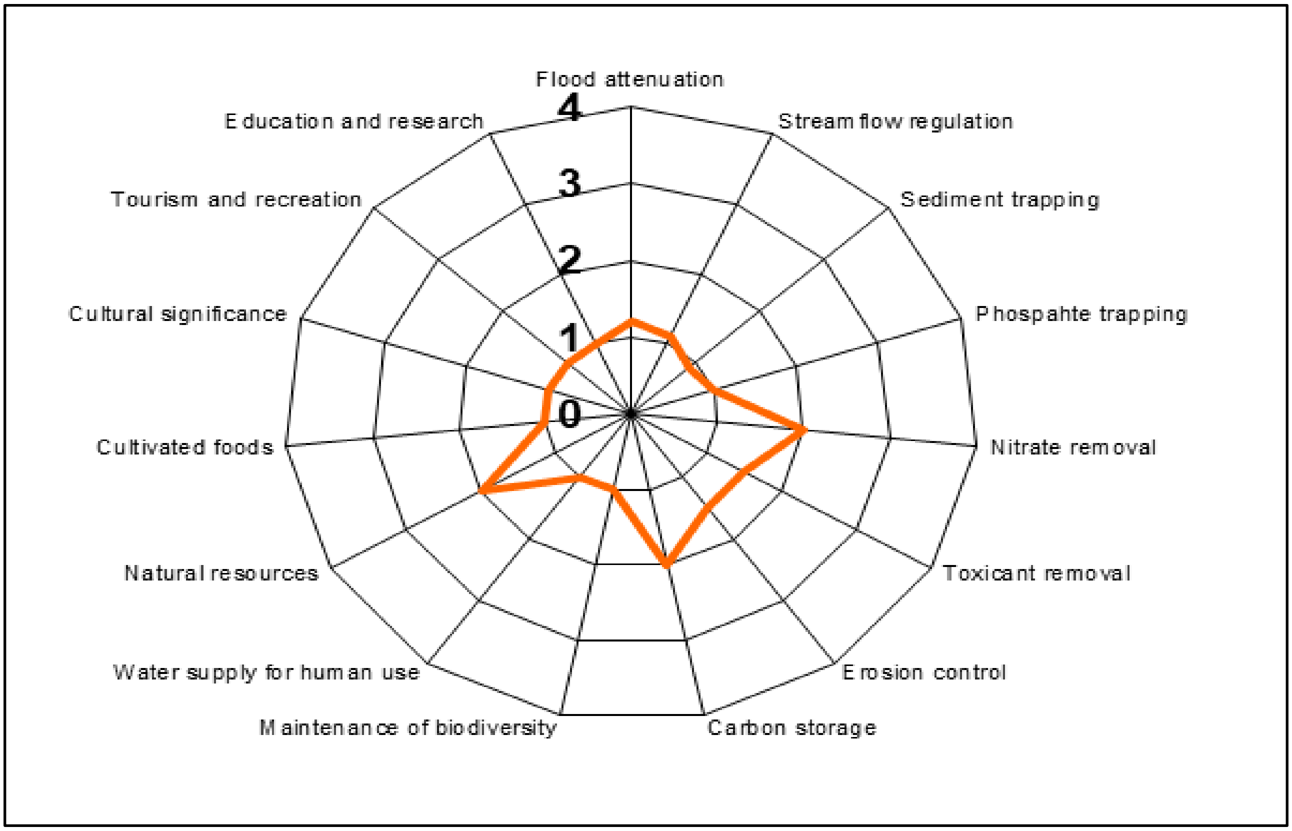

Figure 26: WET-Eco Services results for HGM 1

Figure 27: Seepage wetland (HGM 1).

4.7.8 Channeled valley bottom wetlands

Two channelled valley bottom wetlands were (HGM 2 and HGM 3) identified within a 500 m buffer of Transalloys. Channelled valley bottom wetlands received moderate scores, indicating that these wetlands are moderately functioning systems. According to the functional assessment flood attenuation; sediment trapping; erosion control; the maintenance of biodiversity; and the provision of natural resources are the predominant attributes provided by these wetlands to the surrounding landscapes (**Figure 28**).

The channelled valley bottom wetland systems were assessed in terms of their health and were found to be categorised as **moderately modified (Category C)** (**Table 23**). Modifications to the systems and the resultant effect on the health of the wetlands is predominantly related to the surrounding mining, pollution, alien invasive vegetation, erosion and grazing (**Figure 29**) (**Figure 30**).

Overgrazing, and erosion have had a negative impact on the basal cover of vegetation within the catchments associated with the channelled valley bottom wetlands, leading to an increase in velocity entering the wetlands and the formation of erosion gullies in the majority of these systems. This results in a negative impact on the wetlands ability to maintain biodiversity.

Despite the modified nature of the wetlands they still provide a number of functions to the larger landscape, particularly with regard to flood attenuation; sediment trapping; erosion control; the maintenance of biodiversity; and the provision of natural resources.

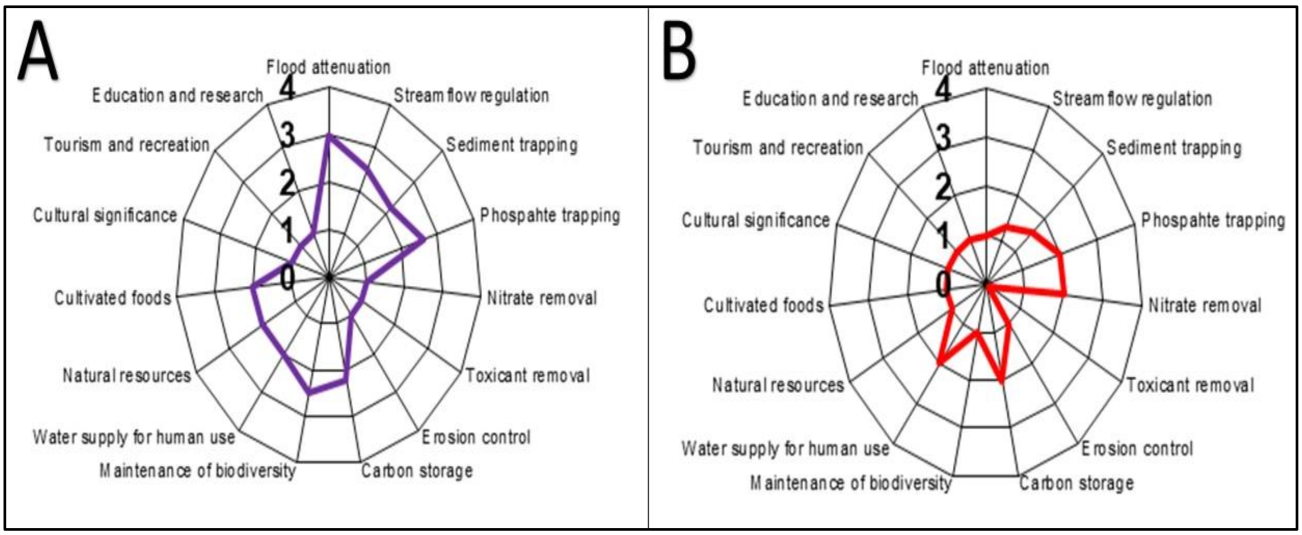

Figure 28: WET-Eco Services results for (A) HGM 2 and (B) HGM 3.

Figure 29: Channelled valley bottom wetland (HGM 2).

Figure 30: Channelled valley bottom wetland (HGM 3).

5 IMPACTS AND RISK ASSESSMENT

5.1 Impact Assessment

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of the impact assessment is to identify and assess the significance of the current and proposed impacts caused by the Transalloys Ashplant and Powerplant to the aquatic system and to provide a description of the mitigation required in order to minimise or offset any such potential impacts on the natural environment.

Impacts that have been identified are predominantly associated with cumulative impacts include increased levels of erosion, proliferation of alien invasive species. Mitigation measures stated must be used to minimise the ecological impacts of the operational process.

The management phase of the development must include water quality surveys a monitoring of aquatic habitats and biota to determine the extent of functionality of the mitigation measures provided. Mitigation actions and scores are listed in **Table 27 and Table 28**, which outlines the construction and operational impacts before and after mitigation actions have been imposed.

The proposed Ashplant and Powerplant will be a surface operation consisting of a Coal Fired Power Plant. The proposed power plant will have a generation capacity of 120 MW to 150 MW in order to meet Transalloys current electricity demands and future expansion electricity requirements. The proposed Powerplant will make use of Circulating Fluidised Bed (CFB) boiler technology which allows for the use of low-grade coal and coal discards, to be sourced from various coal mines in the area

<u>Construction/Establishment Phase</u>

Construction/establishment activities associated with bulk earthworks (such as excavations, reshaping, back-filling and compaction) can alter natural patterns of surface runoff reaching water resources downslope/downstream. Excavations may impound and redirect water, starving downstream water resources. Infilling, compaction and rutting of soils caused by construction/establishment alter the patterns of diffuse surface and sub-surface flows by altering micro-topography and the permeability of soil profiles. Changes in flow patterns within aquatic ecosystems will affect hydrological functionality and ecosystem integrity. Increased runoff velocities linked to concentrated flow paths created during construction/establishment will lead to erosion and sedimentation. Should temporary damming and abstraction of water take place, a short-term reduction of flows to downstream habitat will also result in alterations of the sediment balance (Macfarlane *et al*., 2014).

Upgrading and construction/establishment of infrastructure will result in increased sediment runoff and sedimentation in the aquatic habitat. Site preparation and all associated infrastructure will entail blasting, drilling, dewatering, clearing, grubbing, grading and ground preparation as well as the creation of containment facilities that will eliminate some stream reaches and intercept all surface run-off within the proposed area. Impacts associated with this activity include increased erosion and sediment deposition in the receiving aquatic environment.

Operational Phase

Increased sedimentation may occur as a result from the runoff from the waste rock dump. This has the potential to change habitat structure within the receiving environment and this will in turn result in changes in ecosystem function. Changes in habitat structure due to sedimentation would result in changes in the species composition. Water quality impairment has the potential to change ecosystem function, change community structure as species sensitive to water quality impairment are eliminated and tolerant species increase in number. This results in a loss of biodiversity of sensitive aquatic species.

Alteration of natural flow patterns will occur as a result of discharged pit water. These flow modifications within a river will have significant impacts on the aquatic biota found within these systems and increase the pressure on aquatic resources. Increased clearing of vegetation, especially the riparian habitats, would result in changes in ecosystem function due to changes in the inputs of organic material into the rivers.

Infrastructure construction/establishment/maintenance will introduce unnatural disturbance, enhancing the “edge effect” promoting establishment of disturbance-tolerant species, including colonisation by alien invasive species in areas adjacent to the work servitude. While this impact is initiated during the construction/establishment phase the impacts will persist into the operational phase. Invasive alien plants have far reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, and promote erosion, change litter accumulation and soil properties. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flow thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses. These impacts negatively affect areas that are largely natural (with low existing weed levels) greater than for areas already characterised by dense infestations of alien plants with low indigenous plant diversity (Macfarlane *et al*., 2014).

5.1.1 Sedimentation and soil erosion

Soil erosion will result in the deposition of sediment into the wetland and Brugspruit system; posing a risk to the river's geomorphological/functional integrity. Subsequent impacts that are likely to result are: a loss of instream flow including aquatic refugia and flow dependent taxa; sedimentation of the watercourse that will be destructive to many faunal species affecting their habitat; breeding and feeding cycles. Preventing any spatial footprint of the plant must be implemented, especially erosion, silting and sedimentation next to the aquatic system during both construction/establishment and operation.

Construction/Establishment Phase

The habitat availability and the quality thereof, are major determinants of the aquatic community structure. When naturally vegetated landscapes are cleared, physical and biological relationships with adjacent streams are affected, usually resulting in stream bank erosion and increased sedimentation of the river channel. Changes in habitat structure due to sedimentation would result in changes in the species composition. Fish and aquatic macroinvertebrate species that prefer fast flowing riffle and rapid habitats will disappear due to the deposition of sediment in these habitats. Whereas species that are tolerant of modified habitat structure or that have wide range of habitat preferences would benefit. Increased erosion of river banks may also occur as a result of concentrated flows, particularly during the summer months when runoff is high.

Some of the key biological effects related to the deposition of sediment and suspension of fine sediment within the water column of river includes:

- Habitat alteration downstream of crossing points due to increased sediment deposition (degradation of coarse riverbed habitats by the infilling of interstitial spaces and the reduction of inter-granular flow for example);
- Reductions in photosynthetic activity and primary production caused by sediments impeding light penetration;
- Reduced density and diversity in benthic invertebrate communities as a result of habitat degradation, blanketing of fish spawning sites and the establishment of more tolerant taxa or exotic species; and
- Changes to the behaviour and feeding ability of fish at low levels of suspended sediments, while physiological damage and mortality can occur at very high concentrations of suspended sediment (e. as a result of clogging of fish gills, interference in embryogenesis and larval development of amphibians and mortality of filter-feeding macro-invertebrates).

Operational Phase

During the operational phase of the plants rainfall is likely to filter through into the waste dump. This water is likely to accumulate particles and pollutants that will pose a risk to the surrounding water courses. Sediment that washes off the waste dump during periods of rainfall will also contribute to increased sedimentation in the aquatic environment.

Erosion and sedimentation impacts are linked to alterations in hydrological regimes as a result of increased storm water floodpeaks associated with increased impermeable surfaces and the concentration of flows. Increases in peak discharge may significantly increase stream power, increasing the risk of erosion (localised scouring and incision) and resultant sedimentation of watercourses. Local site factors such as soil erodibility, vegetation cover, gradient of local slopes and regional rainfall/runoff intensity will affect the probability and intensity of erosion impacts (Macfarlane *et al*., 2014). Typical results of erosion & sedimentation on water resources may include:

- Locally increased channel slopes;
- Loss of in-stream biotope diversity due to scouring or blanketing of sites with sediment;
- Localised scouring at stormwater discharge points into watercourses;
- Headcut migration upstream and subsequent deepening of river channels (where base level lowering has occurred);
- Lowering of the local water table and subsequent desiccation of adjacent to the river and riparian areas;
- Relatively higher channel banks that may exceed critical height resulting in bank failure/collapse;
- Addition of sediment to the water column (increased turbidity) affecting suitability for aquatic organisms; and
- Deposition of large masses of sediment downstream causing localised channel braiding, instability of the river banks and alterations in water distribution.

5.1.2 **Pollution of water resources and soil**

Changes to the water quality will result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality pollution leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure. Any substances entering and polluting the wetland systems and Brugspruit will directly impact downstream ecology through surface runoff during rainfall events, or subsurface water movement, particularly during the wetter summer months.

Contaminants such as hydrocarbons, solids, pathogens and hazardous materials may be generated during the construction/establishment phase from a number of potential sources (examples include petrol/diesel, oil/grease, paint, cement/concrete and other hazardous substances). These contaminants negatively affect aquatic ecosystems including sensitive or intolerant species of flora and fauna. Where significant changes in water quality occur, this will ultimately result in a shift in aquatic species composition, favouring more tolerant species, and potentially resulting in the localised exclusion of sensitive species. Sudden drastic changes in water quality can also have chronic effects on aquatic biota leading to localised extinctions. Deterioration in water quality will also affect its suitability for human domestic/agricultural use and have far reaching impacts for local communities who may rely on rivers as water supply (Macfarlane *et al*., 2014).

5.1.3 **Alien Invasive Species**

There are minimal alien invasive plant species currently present within the area. Any ground disturbance provides an opportunity for alien invasive plant species to spread and for new species to establish themselves in the areas. Alien invader plant species pose an ecological threat as they alter habitat structure, lower biodiversity (both number and “quality” of species), change nutrient cycling and productivity, and modify food webs (Zedler & Kercher, 2004). Such changes on the ecology of the riparian habitat have/will have a detrimental impact on its ability to maintain both floral and faunal biodiversity. Invasive alien plant species, particularly woody species, have much increased water usage compared with indigenous vegetation. Many alien invasive plant species are particularly found in riparian ecosystems and their invasion results in the destruction of indigenous species; increased inflammable biomass (high fire intensity); erosion; clogging of waterways such as small streams and drainage channels causing decreased river flows and incision of river beds and banks. This results in an overall impact on the hydrological functioning of the system.

Construction/Establishment Phase

Habitat will be impacted directly through the complete removal or partial disturbance of existing indigenous riverine vegetation during construction by machinery and workers accessing the site or directly were the development intersects aquatic habitats, impacting directly on the ecological condition of vegetation and availability of natural habitat. The impact from clearing and disturbance is not limited to the construction/establishment zone of the plants and associated infrastructure but however and will include areas used by machinery and workers to access the site and to construct ancillary infrastructure such as drainage structures and erosion control measures. The result is either the complete loss (construction/establishment zone of the plants and associated infrastructure) or the disturbance and partial loss of indigenous vegetation communities impacting directly on the ecological condition and functionality of these ecosystems.

Construction/Establishment activities in the vicinity of the rivers on site will result in decreased bank stability within the construction/establishment zone, potentially resulting in localised erosion and increased lateral sediment delivery to aquatic resources. Associated vegetation removal can also destabilise banks, leaving them more prone to erosion and collapse.

Soils comprising the river banks are likely to be disturbed and compacted should an access road cross the river channel. Physical alteration of cross-sectional and longitudinal profiles of rivers may also result from bulk earthworks associated with the plants for example, altering natural water flow and sediment dynamics within rivers, having a knock-on effect on habitat and ecosystem dynamics. These impacts can stimulate erosion, as well as potential sedimentation of downstream habitats and a change to water regimes of adjoining riverine and riparian habitat. Areas that are mainly natural/intact would be most affected by these impacts (Macfarlane *et al*., 2014).

Operational Phase

Changes to the water quality will result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality pollution often leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure. The uncontrolled release of tailings physically smothers habitats and organisms, and changes the chemical environment to the detriment of biota. The disposal of tailings is also frequently associated with a phenomenon known as acid mine drainage. Acid generation and metal mobilisation occur that may eventually find their way into the surrounding environment through runoff or seepage. Aquatic biota is severely affected by low pH.

The impacts of decreased water quality may range from subtle changes in community composition in less severe cases, to the complete elimination of aquatic fauna from the river systems. The confinement of tailings in a tailings dam will limit this from happening as solids that have the potential to pollute will settle out.

Run-off has been identified as a significant source of diffuse pollution contaminating receiving waters and may contain significant loads of nutrients, heavy metals, polycyclic aromatic hydrocarbons (PAHs), Volatile Organic Compounds (VOCs) such as benzene, toluene, ethylbenzene, xylene, and methyl tert-butyl ether (MTBE) (Macfarlane *et al*., 2014).

5.1.4 Mitigation

The proposed Transalloys Ashplant and Powerplant will have great detrimental effects on the environment. The following mitigation measures may marginally reduce the severe impacts.

Mitigation measures, aimed at minimising the afore-mentioned impacts, include (but are not limited to):

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;
- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during construction and operational phases; and
- Aquatic biomonitoring (SASS 5 and habitat assessments) where/if flow conditions allow for effective sampling) must take place bi-annually to determine any trends in ecology and hydrology.

Sedimentation and soil erosion

<u>Mitigation options</u>

- Attenuation of stormwater from any establishment of the Ashplant and Powerplant and its associated infrastructure is important to control the velocity of runoff towards the wetland systems. Attenuation structures must be placed between the development and associated infrastructure and the river.
- Attenuation measures during construction/establishment of the development and associated infrastructure include, but are not limited to - the use of sand bags, erosion control blankets, and silt fences.
- Long term attenuation measures, such as attenuation/infiltration trenches, swales must be established to control stormwater from hardened surfaces so as to Sustainable Urban Drainage Systems (SUDS): All storm water runoff from the site must be supplemented by an appropriate road drainage system that must include open, grass-lined channels/swales rather than simply relying on underground piped systems or concrete V-drains. SUDS will encourage infiltration across the site, provide for the filtration and removal of pollutants and provide for some degree of flow attenuation by reducing the energy and velocity of storm water flows through increased roughness when compared with pipes and concrete V-drains.

- Do not allow surface water or stormwater to be concentrated, or to flow down cut or fill slopes without erosion protection measures being in place.
- Vegetation clearing must be undertaken as and when necessary in phases. The entire area must not be stripped of vegetation prior to commencing construction/establishment activities.
- Materials or the plant and plant infrastructure, other than sourced from the approved quarries/pits, must be sourced from a licensed commercial source.
- Any topsoil removed from the project footprint must be stockpiled separately from subsoil material and be stored suitably for use in rehabilitation activities.
- Install sediment barriers (silt catchers and Reno mattresses) along any drainage construction areas to prevent the migration of silt towards the Brugspruit.
- All demarcated sensitive zones outside of the construction area are strictly off limits during any mining activity.
- The construction zone should be clearly demarcated and maintained (e.g. with danger tape, signs etc.) prior to the commencement of construction/establishment activities to ensure that construction vehicles do not unduly disturb riparian areas. Construction activity may not take place closer than 110 m from the wetlands, see buffer demarcation aerial photo on Page 85.
- Exposed soils must be rehabilitated as soon as practically possible to limit the risk of erosion. Erosion control measures must be employed where required.
- Stabilise, re-shape and rehabilitate disturbed areas as soon as practically possible (within 3 weeks of disturbance) with indigenous wetland and riparian vegetation. Such rehabilitation should be informed by a suitable replanting and re-vegetation programme, sand bags, silt fencing, etc. A mix of rapidly germinating indigenous vegetation must be used.
- Bank erosion must be monitored at regular intervals during the construction/establishment (and operational) phase in order to assess whether further river bank protection/stabilisation works are required.
- Riparian vegetation bordering on drainage lines and rivers will be considered environmentally sensitive and impacts on these habitats should be avoided.
- If erosion has taken place, rehabilitation will commence as soon as possible.
- All roads need to be maintained and any erosion ditches forming along the road filled and compacted.
- Berms/ earthen walls should be vegetated in order to avoid erosion and sedimentation.
- Runoff water from the waste dumps, stockpiles and contaminated stormwater will be channelled into pollution control dams to avoid effects on the aquatic ecosystem. The water in these pollution control dams will be reused during the mining operations.

- **Demarcated and bunded** stockpiles and waste dumps will also be placed in areas where groundwater and surface water pollution can be avoided.
- The runoff will be routinely monitored for acidity and salinity as an early warning for potential increases in salinity or acidic drainage water.

Pollution of water resources and soil

<u>Mitigation options</u>

- No washing of any construction equipment in close proximity to the Brugspruit or any wetlands is permitted.
- No releases of any substances that could be toxic to fauna or faunal habitats within the Brugspruit or any wetland areas is permitted.
- Do not locate the construction camp or any depot for any substance within a distance of 250 m from the wetland systems or 100 m from any drainage channels.
- Spillages of fuels, oils and other potentially harmful chemicals must be cleaned up immediately and contaminants properly drained and disposed of using proper 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.
- Portable toilets must be placed on impervious level surfaces that are lipped to prevent spillage. The general consensus is that they should be within 30 m to 50 m of a work face
- Cut-off trenches must be constructed to prevent any harmful substances from entering the wetland areas.
- Materials needed for construction must be stored in a construction camp in the applicable manner i.e. hazardous substances must be stored in bunded areas; sand and stone in such a manner to reduce wind and water pollution, etc.
- Education of workers is key to establishing good pollution prevention practices. Training programs must provide information on material handling and spill prevention and response, to better prepare employees in case of an emergency.
- Signs should also be placed at appropriate locations to remind workers of good housekeeping practices including litter and pollution control.
- The proper storage and handling of hazardous substances (hydrocarbons and chemicals) needs to been ensured. All employees handling fuels and other hazardous materials are to be properly trained. Storage containers must be regularly inspected so as to prevent leaks.
- Ensure that any rubbish/litter is cleared once a month as to minimise litter near the wetland areas. These will need to be cleaned out in accordance with a regular maintenance programme.

- Industry Best Practise Guidelines and Standards needs to be implemented in terms of tailings storage design. Built-in engineering designs such as drainage systems and decanting pools are recognised as mitigation measures.
- Water quality will be monthly monitored at aquatic ecosystems associated with the site activities. This includes sites upstream and downstream of the tailings storage facility so that further mitigation measures can be implemented.
- Ensure pollution sources are isolated through clean and dirty water separation and monitor this throughout the lifespan of the Ashplant and Powerplant.

Alien Invasive Species

Mitigation Options

- An alien invasive management programme must be incorporated into an Environmental Management Programme.
- Ongoing alien plant control must be undertaken during the construction/establishment and operational phase and particularly in the disturbed areas as these areas will quickly be colonised by invasive alien species, especially in the riparian zone, which is particularly sensitive to AIP infestation.
- Herbicides must be carefully applied, in order to prevent any chemicals from entering the river. Spraying of herbicides within or near to the wetland areas is strictly forbidden.
- Re-instate indigenous vegetation (grasses and indigenous trees) in disturbed areas directly after construction ceases so as to stabilise against erosion and sedimentation.

Table 27: Scoring of each impact with and without mitigation measures for the construction phase for the proposed Transalloys Ashplant and Powerplant and associated infrastructure.

Impacts associated with the pre-construction and construction phase of the activities										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation		
Construction Phase										
Water Quantity and Loss Of Water/Flow	3	3	2	2	3	2	8	6	**39 (MODERATE)**	**30 (LOW)**
Habitat Loss/Fragmentation	3	3	2	2	3	2	8	6	**39 (MODERATE)**	**30 (LOW)**
Sedimentation and Erosion	5	4	3	2	3	2	8	6	**70 (HIGH)**	**40 (MODERATE)**
Impacts to Water Quality	4	3	4	2	3	2	10	8	**68 (HIGH)**	**36 (MODERATE)**
Riparian Vegetation	4	3	5	4	3	2	8	6	**64 (HIGH)**	**36 (MODERATE)**

Table 28: Scoring of each impact with and without mitigation measures for the operational phase for the proposed Transalloys Ashplant and Powerplant associated infrastructure.

Impacts associated with the operational phase of the activities										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation		
Operational Phase										
Sedimentation and Erosion of Water Courses	4	3	5	4	3	2	10	8	**72 (HIGH)**	**42 (MODERATE)**
Impacts to Water Quality	5	4	5	4	3	2	10	8	**90 (HIGH)**	**56 (MODERATE)**
Loss of Indigenous Vegetation and Habitat	5	4	5	4	3	2	8	6	**80 (HIGH)**	**48 (MODERATE)**

5.2 Risk Assessment

The risk assessment focussed on the impacts which includes the construction and operation of the Ashplant and Powerplant of Transalloys as mentioned above.

During the construction phase vegetation and topsoil will be cleared for construction. This will lead to increased turbidity and sedimentation in the stream as well as altered flow patterns. The machinery used has a risk of hydrocarbon spills into the stream as discussed in the section above.

There are impacts on the flow patterns to the stream as well as possibly increased nutrient levels from the waste materials entering the water course. The operational phase has an overall high risk impact rating due to the duration of the impacts, whereas the construction phases were rated as a moderate risk impact.

This report highlights the findings for a one site survey, limiting the confidence for the risk assessment in **Table 29**.

Table 29: Significance ratings matrix for the impacts associated with the proposed Transalloys Ashplant and Powerplant.

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	**Transalloys Ash and Power Plant construction of offices, buidlings etc.**	Stream Diversion Work Revetments (Rock Platform) Culvert structures Access routes for culvert Vegetation clearing Use of heavy machinery	Flow alterations due to erosion and sedimentation	4	3	4	4	3,75	3	3	9,75	4	4	5	3	16	156	M	70
2	Construction phase	**Transalloys Ash and Power Plant construction of offices, buidlings etc.**	Culvert structures Use of heavy machinery using oils and fuels during vegatation clearing Accidental spillages of chemicals, cements, oils, etc.	Pollution of watercourse	2	4	2	4	3	2	3	8	4	4	5	3	16	128	M	70
3	Construction phase	**Transalloys Ash and Power Plant construction of offices, buidlings etc.**	Access routes for culvert construction Installation of drainage infrastructure Use of heavy machinery Bank trampling leading to erosion	Spread of alien vegetation	3	3	4	4	3,5	2	3	8,5	4	4	5	3	16	136	M	70
4	Operational phase	**Transalloys activities**	Increased traffic Burning and handling hazardous materials Bank Erosion	Flow alterations due to erosion and sedimentation	4	2	4	4	3,5	3	5	11,5	5	5	5	2	17	195,5	H	80
5	Operational phase	**Transalloys activities**	Increased traffic leading to potential accidential spills of hydrocarbon materials Hazardous materials entering the watercourses from the Ash and Power Plant Increased road runoff during rainfall events	Pollution of watercourse	3	4	3	3	3,25	3	5	11,25	5	5	5	2	17	191,3	H	80
6	Operational phase	**Transalloys activities**	Increased runoff from hardened surfaces Clearing of indigenous vegetation	Spread of alien vegetation	3	2	3	3	2,75	3	5	10,75	5	5	5	2	17	182,8	H	80

5.3 Wetland Buffer

The wetland assessed within the Transalloys boundary, namely the channelled valley bottom and seepage wetland systems and is associated with the Brugspruit and its tributary and covers a great area and the buffer calculated for the wetland study should be implemented and adhered to by Transalloys (Pty) Ltd.

The buffer tool aims to provide a method for determining appropriate buffer-widths for developments associated with wetlands, rivers or estuaries. This method takes into account a number of different factors in determining the buffer width including the impact of the proposed activity on the water resource, climatic factors and the sensitivity of the water resource

The calculated results indicate that a 110 m buffer is appropriate for the protection of the ecosystem services provided by the wetland systems (**Figure 31**). Any development must occur outside of the recommended 110 m buffer zone.

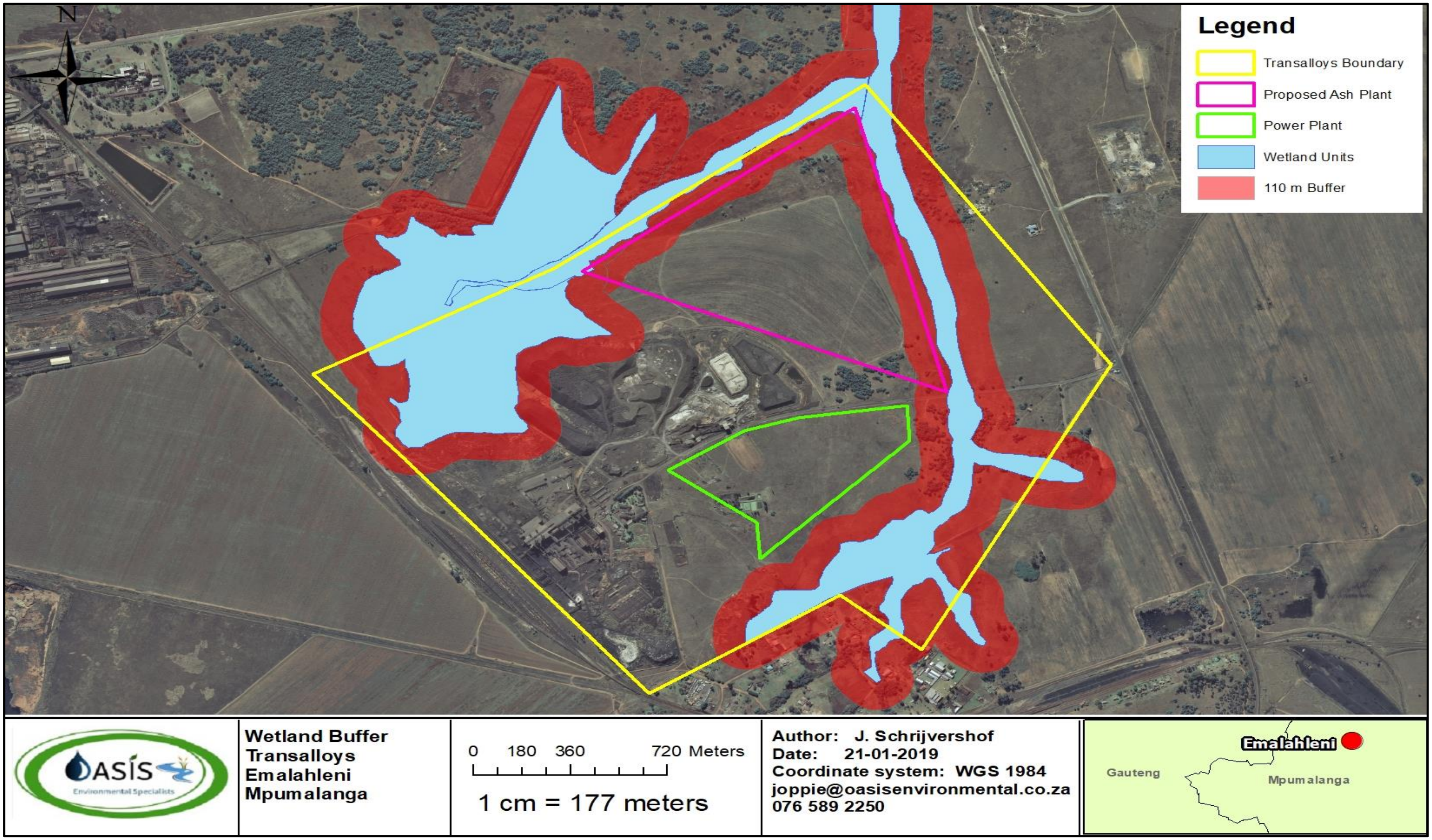

Figure 31: Transalloys – 110 m Wetland Buffer map.

6 Conclusion & Recommendations

According to the ecological importance classification for the quaternary catchments, the B11K catchment under the Olifants Water Management Area is classified as a seriously modified system in its present state and is considered to be a highly sensitive system in terms ecological sensitivity and a moderate important system. The *in situ* water quality assessment findings were found to be within an **unacceptable** range for all parameters. All sites had exceeding levels of electrical conductivity, except for the Brugspruit tributary. All sites illustrated low levels of dissolved oxygen and were below guideline levels for aquatic ecosystems, this is due to extensive water pollution in the area.

The Transalloys property boundaries falls within the Eastern Highveld Grassland vegetation type. No plant species of conservation concern were identified during the site visit. The riparian vegetation (VEGRAI) associated with the stream is **seriously modified (Class E)**, due largely to mining, grazing and alien invasive plants within the marginal and non-marginal zone. Riparian plant species included *Cyperus spp.*, *Typha capensis*, and *Juncus spp.* Alien invasive plants observed onsite included Khaki Weed (*Tagetes minuta*), Castor Oil Plant (*Ricinus communis*), Black Wattle (*Acacia meansii*) Balloon Vine (*Cardiospermum grandiflorum*), Bugweed (*Solanum mauritianum*), Pom Pom Weed (*Campuloclinium macrocephalum*), Spiny Cocklebur (*Xanthium spinosum*) Pampas Grass (*Cortaderia jubata*) and Gumtrees (*Eucalyptus spp.*).

The Intermediate Habitat Integrity Assessment (IHIA) was found to be **seriously modified (Class E)**. Existing impacts include mining, erosion, alien invasive vegetation, grazing, water crossings and upstream impoundments. It is likely that small scale abstraction of water is occurring for irrigation purposes.

The macroinvertebrate assessment was found to be **seriously modified (Class E/F)**, but the results should be regarded with caution, due to a lack of sufficient stone and flow habitat conditions found in the IHAS assessment. SASS5 scores for the both the Brugspruit and its tributary were found to be in a **seriously modified (Category E/F)**. The MIRAI results show that water quantity, poor water quality and impoundments are the primary drivers for the loss of migratory and sensitive macroinvertebrates within the Brugspruit and its tributary and were found to be in a **seriously modified (Category E/F)**.

No fish are thought to occur within this stretch of stream according to the SQR data provided by Department Water and Sanitation, however one Chubbyhead barb (*Enteromius anoplus*) was collected at the downstream site of the Brugspruit and were considered to **be seriously modified (Category E/F)** according to the FRAI results.

Three wetland areas were delineated within a 500 m buffer surrounding the Transalloys boundary and associated infrastructure. The wetlands were classified into two separate hydrogeomorphic (HGM) units, comprising of one seepage wetland (HGM1) two channelled valley bottom wetland (HGM 2 and HGM 3). A wetland health assessment concluded the seep wetland to be **largely modified (Category D)** and the two valley bottom wetlands to be **moderately modified (Category C)**.

Modifications to all wetland systems stem from the use of the larger catchment area agricultural activities and livestock grazing. The Ecological Sensitivity and Importance of the wetlands has generally been recorded as low as a result of the provision of natural resources and the maintenance of biodiversity that many of these wetlands provide, where the Ecological Services were rated as intermediate.

The impact assessment for the Ashplant and Powerplant were rated as a moderate impact during construction and as a high impact during the operational phase units. Identified impacts pertaining to erosion, sedimentation, water quality and quantity alterations and the continued spread of alien invasive species. The proposed development for the Transalloys Ash Plant and Power Plant already lies within a heavily transformed landscape and if mitigation measures are being implemented appropriately, the possible impacts could be reduced immensely, where the proposed amendment is supported.

Provided mitigation measures are to be implemented within an environmental management programme (EMPr) and the significance of any negative impacts reduced.

i. Potential impacts on aquatic ecosystems during the establishment phase include:
- Increased sediment runoff;
- Decreased water quality due to accidental spills; and
- Habitat loss associated with the stream diversion.

ii. Potential impacts associated with the mining phase include:
- Increased sedimentation and water quality impairment due to runoff from waste dumps;
- Water quality contamination due to runoff or seepage from any tailings storage facility;
- Alteration of natural flow regime due to discharge of pit water; and
- Increased utilisation of aquatic resources by local population.

Mitigation measures, aimed at minimising the afore-mentioned impacts, include (but are not limited to):

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;
- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer was implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during construction and operational phases; and

- Aquatic biomonitoring (SASS 5 and habitat assessments) where/if flow conditions allow for effective sampling analysis) must take place bi-annually to determine any trends in ecology and hydrology.

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GLOSSARY

Catchment: The area where water from atmospheric precipitation becomes concentrated and drains downslope into a river, lake or wetland. The term includes all land surface, streams, rivers and lakes between the source and where the water enters the ocean.

Delineation: Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.

Invasive alien species: Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.

Mitigate/Mitigation: Mitigating wetland impacts refers to reactive practical actions that minimise or reduce *in situ* wetland impacts. Examples of mitigation include “changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites”. Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).

Water course: Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).