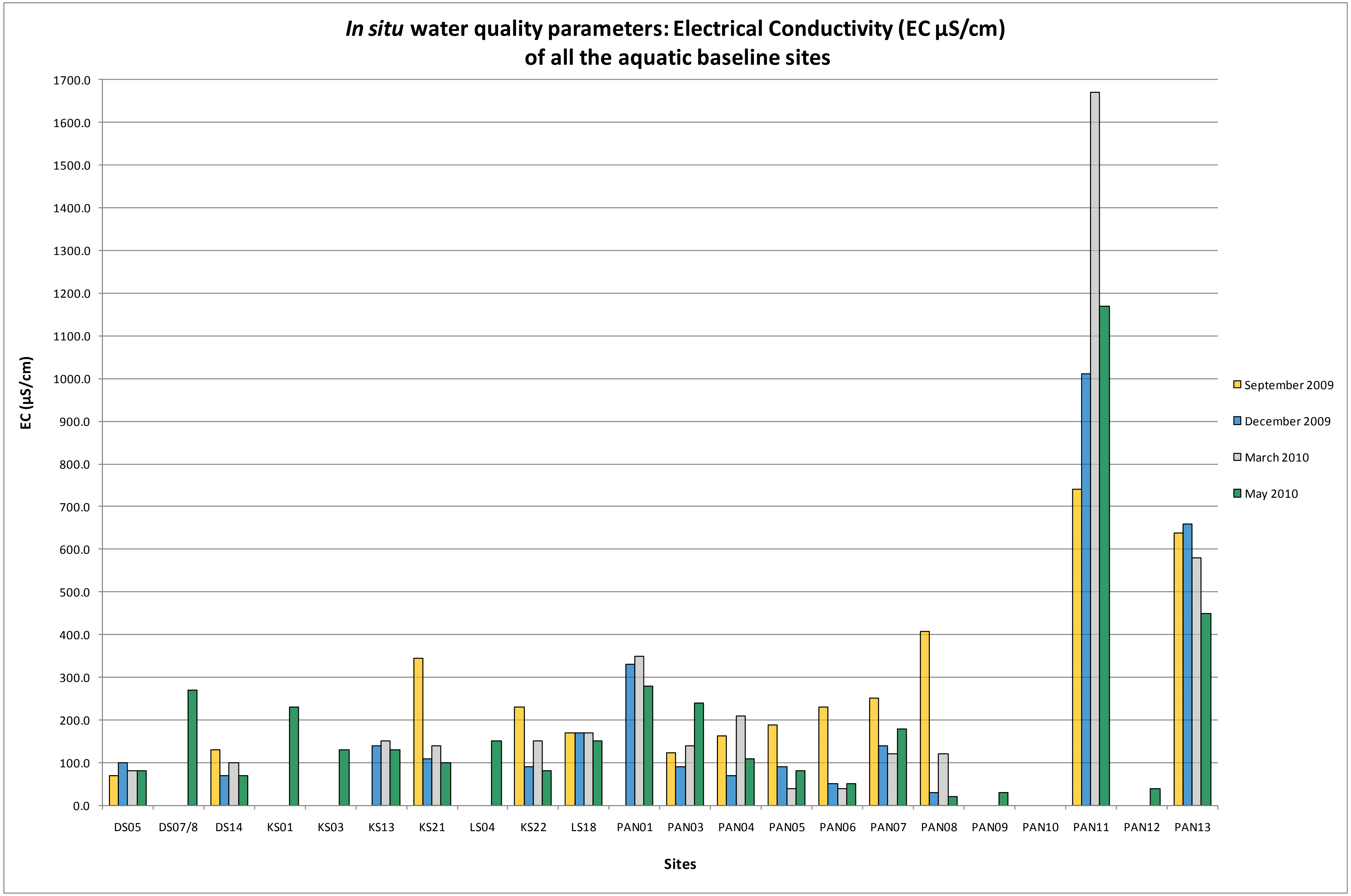

Figure 93: In situ EC concentrations of all the baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

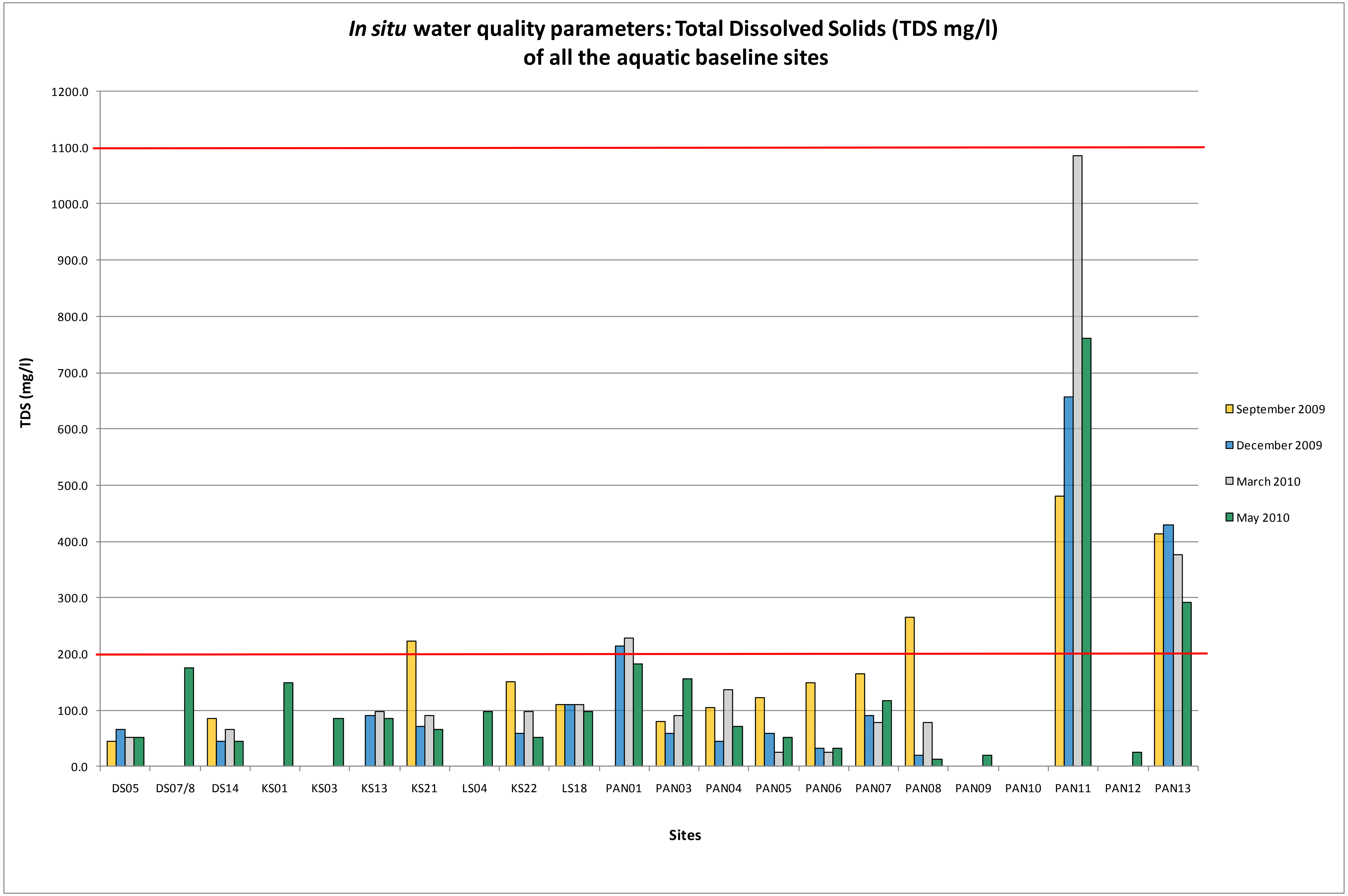

Figure 94: Calculated TDS concentrations of all the baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

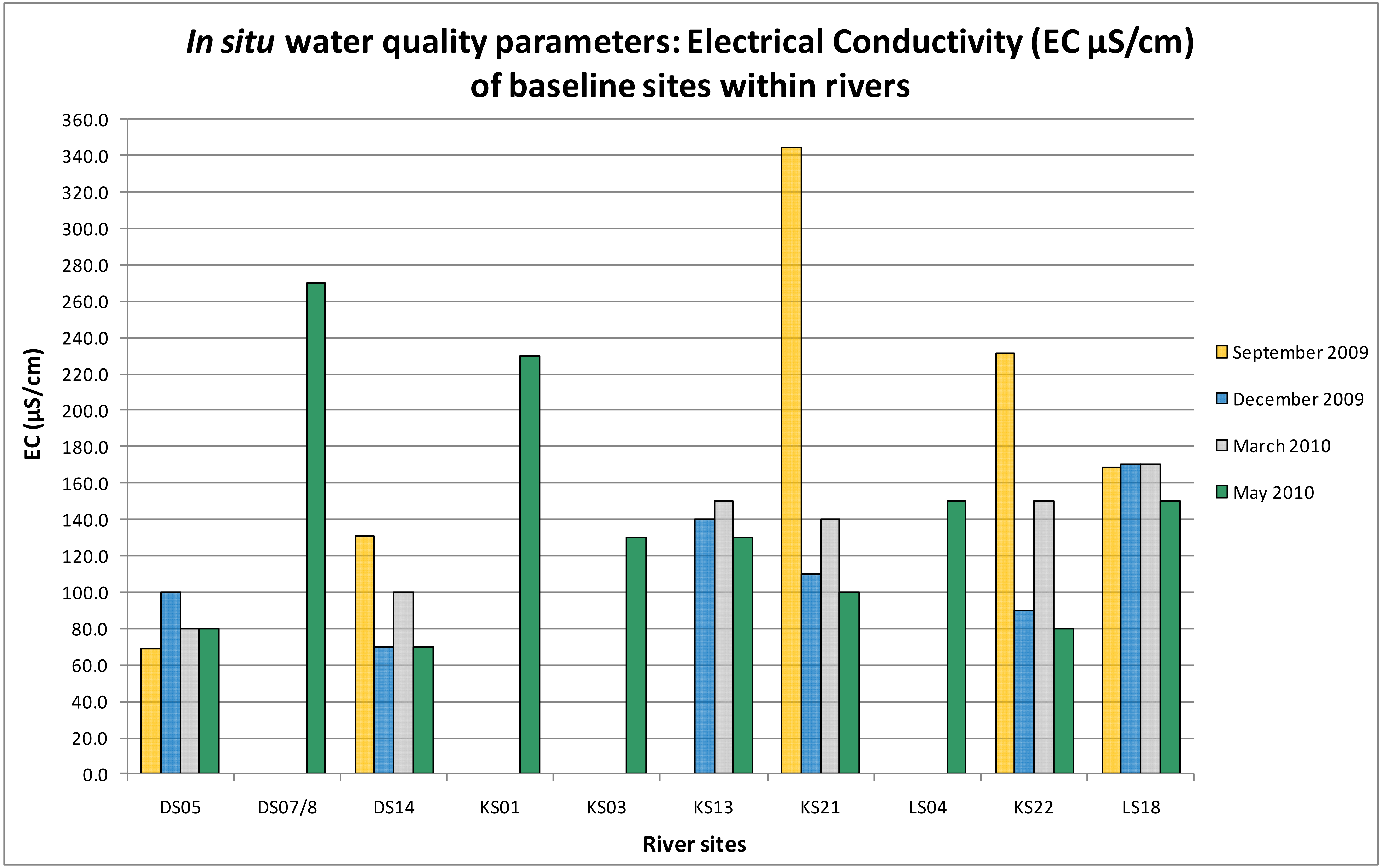

Figure 95: In situ EC concentrations of the river baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

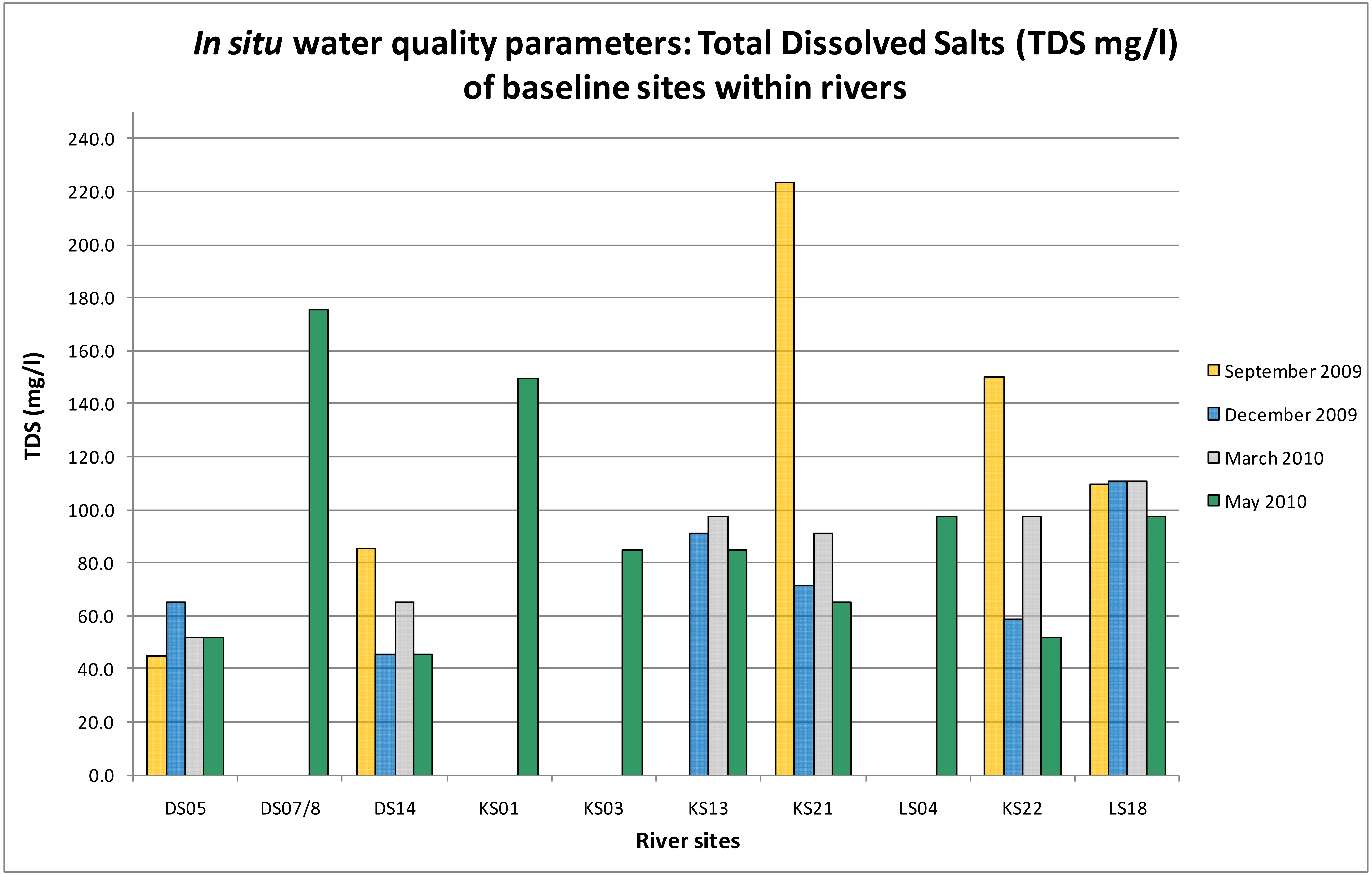

Figure 96: Calculated TDS concentrations of the river baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

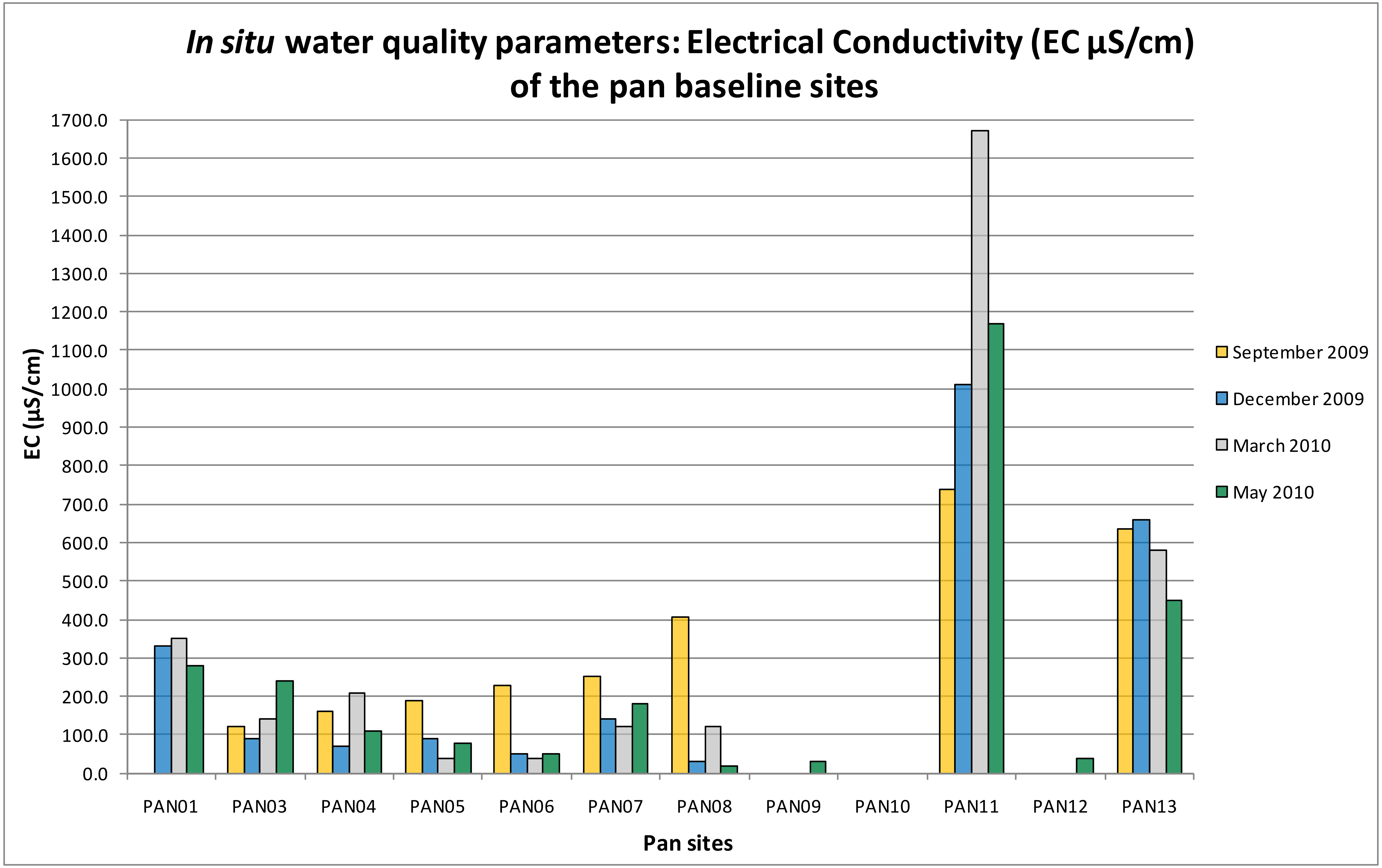

Figure 97: In situ EC concentrations of the pan baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

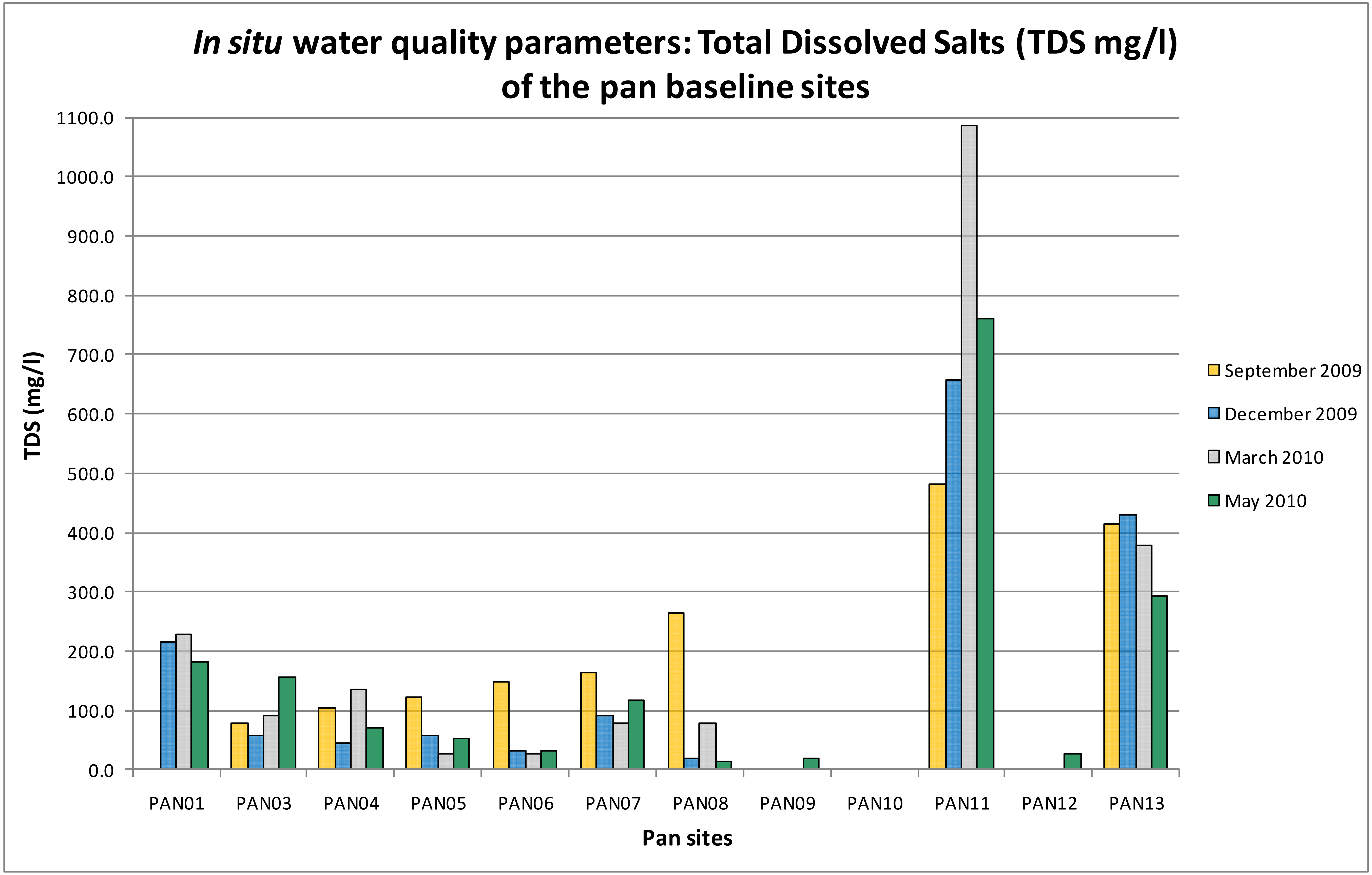

Figure 98: Calculated TDS concentrations of the pan baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

In situ Water Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (DWAF, 1996). Temperature affects the rate of development, reproductive periods and emergence time of organisms (Davies & Day, 1998). The temperatures of inland waters generally range from 5 to 30 ˚C (DWAF, 1996).

In situ water temperatures of the baseline aquatic sites ranged from 8.3˚C to 30.4˚C over the four seasonal surveys (APPENDIX N). A graphical comparison of the *in situ* water temperatures of all of the aquatic baseline sites between the four surveys is presented in Figure 99. From the water temperature results of all the baseline sites, seasonal fluctuations can be seen with the highest *in situ* water temperatures recorded at sites PAN04 during the December 2009 survey, and the lowest water temperature recorded at site KS22 during the May 2010 survey (Figure 99).

With the exception of site PAN04, in situ water temperatures were within the general range of 5 to 30 ˚C. Where temperatures were higher, this correlated to shallower depths of the rivers and pans (Figure 99. This suggests that seasonal fluctuations in water temperature are seasonal and thus considered to be normal.

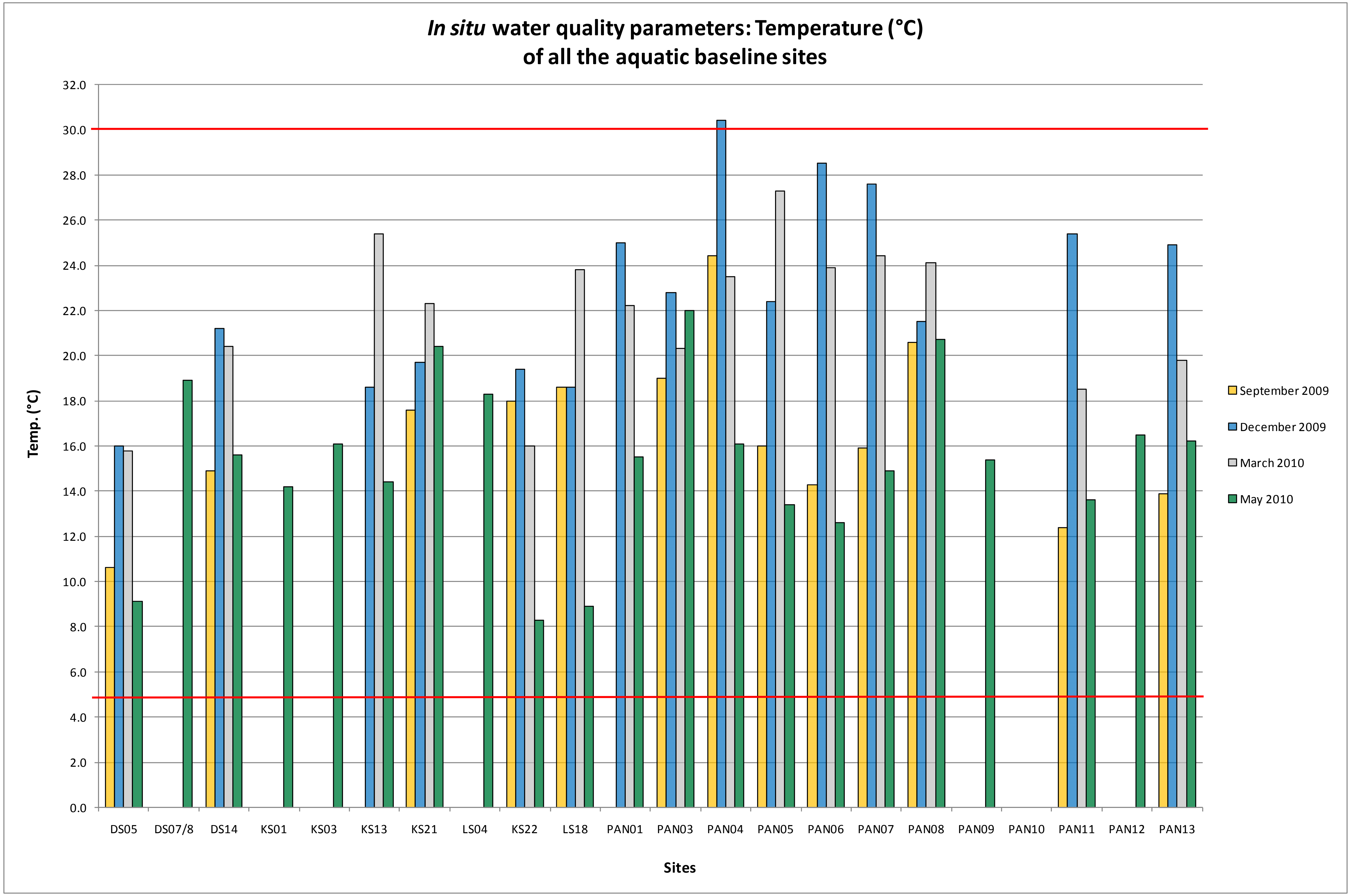

Figure 99: In situ water temperatures of all the baseline sites for the September and December 2009 as well as the March and May 2010 baseline surveys

7.3.2 Aquatic habitat assessment

The quality of the in-stream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore evaluation of habitat availability is critical to any assessment of aquatic biota. General habitat descriptions were compiled and photographs taken of each of the aquatic sampling sites. Habitat availability for aquatic macroinvertebrates was assessed by means of the Invertebrate Habitat Assessment System (IHAS).

General aquatic habitat assessment

Photographs of the aquatic sampling sites taken during the September and December 2009 and the March and May 2010 surveys are shown in APPENDIX A. The general habitat characteristics of the sites were recorded and are presented below.

Driehoekspruit

DS05 consists of a large inundated wetland area with a deep channel. A large amount of aquatic macrophytes and wetland grasses are present. Poor surface water flow was observed at this site during the four seasonal surveys.

Access to DS 07/08 was restricted during the September and December 2009 and the March 2010 surveys, but was granted during the May 2010 survey. This site consists of a small farm dam (Site DS08) on a tributary the used to flow into a large wetland pan on the downstream side of the dam wall (Site DS07). The wetland pan area was dry during the May 2010 survey and was therefore not included in the aquatic assessment.

DS14 is located downstream of a small farm dam within the Driehoekspruit. Evidence of recent flooding and damage to the dam wall was present during the September 2009 survey. Rocks had been dumped on the existing breach for the passage of vehicles over the dam wall. The downstream channel had large amounts of erosion along the banks, directly downstream of the breach. Further downstream, the active channel was narrow and surface flow was poor during the September 2009 survey. Limited vegetation was available and the substrate was predominantly sand dominated. During the December 2009 survey, strong flow was present in the channel as well as increased inundated marginal vegetation. During the March and May 2010 surveys, the habitats at this site remained the same.

Kleinkomatispruit

Access to KS01 was restricted during the September and December 2009 and the March 2010 surveys, but was granted during the May 2010 survey. This site consists of a small drainage channel upstream of a large farm dam, near a guest cabin. This drainage channel has an upstream waterfall and originally used to flow into a large wetland on the downstream side of the dam wall.

Access to KS03 was also restricted during the September and December 2009 and the March 2010 surveys, but was granted during the May 2010 survey. This site consists of a small drainage channel located between two large farm dams, within a wetland area that flows into the Kleinkomatispruit.

During the September 2009 survey, KS13, located at a small culvert on a dirt road, consisted of a small wetland channel with no surface water. During the December 2009 survey, flow was strong in the wetland channel as a result of recent flooding. Marginal vegetation was inundated. The flow was minimal during the March 2010 survey, however increased marginally during the May 2010 survey.

KS21, located upstream of the small bridge, consists of a small stream channel with a shallow depth and limited riparian vegetation (grasses and sedges). The substrate was comprised of boulders and mud. Aquatic macrophytes were abundant during both the September and December 2009 surveys. A small artificially inundated area was noted further upstream. Flow and cover habitats were limited in the September 2009 survey, however were optimal for fish habitat. The habitats at this site remained constant during the four surveys.

Site KS22 is situated at upstream and downstream of the R33 Bridge. Downstream the channel is defined by a large bedrock cascade through a small shallow gorge which flows into a large pool at the base. Riparian vegetation was limited (grasses). Beneath the bridge, the river flows through artificially created channels. Upstream of the bridge, the river flows through a narrow gorge with a boulder substrate. Flow was limited at the time of the September 2009 survey, but very strong during the December 2009 survey. The habitats remained constant during the four surveys.

Leeuwbankspruit

Site LS18 on the Leeuwbankspruit is situated on a small farm road to the east of the main dirt road. The channel was characterised by moderate amounts of erosion and undercutting. Riparian vegetation was limited and consisted primarily of grasses and sedges. The substrate consisted of a boulder and mud composition. Flow was limited during the September 2009 survey, but strong during the December 2009 survey as a result of heavy rainfall. The habitats remained constant during the four surveys.

Pans

Pan 01 is located to the east of site PAN03 along the N4 motorway. This pan was dry during the September 2009 survey. A small amount of wet mud was recorded. During the December 2009 survey, the pan was inundated with water and showed good pan habitat. The habitats remained constant during the four surveys.

Pan 03 is located on the northern side of the N4 motorway, this site was accessed via a small dirt track along the western margin of the pan. This site was characterised by deep water and a large abundance of aquatic macrophytes. During the December 2009 survey, construction impact to the vegetation from the road on the western margin of the pan was evident. Sediment runoff into the pan was recorded as well. The habitats remained constant during the four surveys.

Pan 04 is located directly to the west of site PAN03. A minimal amount of surface water was present during the September 2009 survey. The site was characterised by large bedrock areas within the pan. During the December 2009 survey, this pan had increased inundation. The habitats remained constant during the four surveys.

Pan 05 is located on a large farm and was characterised by being fenced off from the rest of the farm. The pan is characterised by abundant growth of aquatic vegetation and deep inundation. The site was accessed via a farm gate on the northern side of the pan. Numerous bird species were noted. The habitats remained constant during the four surveys.

Site **Pan 06** is located to the east of a small informal settlement. The site was accessed via a dirt track on the northern side of the fence at the south of the settlement. During the September 2009 survey, the site was characterised by shallow depth and a muddy substrate. A large herd of cattle had previously moved across the pan. This pan was badly degraded on the majority of the inundated area due to cattle; however a farm fence dividing the pan indicated that a small section, on the other side of the fence, was undamaged, and indicated better habitat conditions. During the December 2009 survey, this pan was inundated with water with a shallow depth and increased wetland vegetation. The habitats remained constant during the four surveys.

Pan 07 is one of the largest pans in the project area. This site is characterised by abundant growth of aquatic vegetation and deep inundation. Numerous bird species were noted as well as the presence of a high abundance of aquatic macroinvertebrates. The site was accessed through a farm gate to the north of the pan and accessible via a small dirt road from site PAN06 to the north of the site. The habitats remained constant during the four surveys.

Pan 08 was the southernmost pan in the project area. This site was characterised by a large and deep pan. Access to the pan was via a small dirt track on the edge of a maize field. Two crowned cranes (*Balearica regulorum*) were recorded at this site during the September 2009 survey. The habitats remained constant during the four surveys.

Pan 09 was dry during the September and December 2009 and the March 2010 survey, but was inundated with shallow water during the May 2010 survey. Grass was observed throughout the pan, as well as cattle paths.

Site **Pan 10** is located to the east of site PAN01 along the N4 motorway. This site was dry during the September 2009 survey. A large number of cattle were observed crossing the pan in search of water. A shallow trench had been dug in the pan, leading from the centre of the pan to the margin. During the December 2009 survey, the pan substrate was wet, but did not have adequate surface water present for an aquatic assessment. This pan was dry during the two 2010 surveys.

Pan 11 is one of the largest pans in the area and is characterised by typical grey pan water with grass marginal vegetation. A small dirt road circumnavigates the margin of the pan. A large wetland area is present to the north and east of the pan. During the December 2009 survey, increased inundation was recorded. The habitats remained constant during the four surveys.

Pan 12 was dry during the September and December 2009 surveys. PAN12 is located directly to the east of site PAN13. Access to the site was via a farm fence to the east of the pan. Partial inundation was observed during the May 2010 survey.

Site **Pan 13** is located on a small farm. A large excavation is present to the southwest of the margin of the pan. Artificial watering of the pan was evident with a wind mill and pipes into the pan. A large abundance of aquatic vegetation was present in the pan and very little open water was present. The depth of the pan ranged from 0.5 to 1.5 m. The habitats remained constant during the four surveys.

IHAS habitat availability assessment

The Invertebrate Habitat Assessment System (IHAS, version 2) was applied at each of the sampling sites to assess the availability of habitats for aquatic macroinvertebrates (McMillan, 1998). The IHAS scores recorded during the September and December 2009 and the March and May 2010 surveys are presented in Table 11.

Table 11: IHAS scores recorded at the river sites during the four surveys

Site	September 2009		December 2009		March 2010		May 2010	
	IHAS Score	Description	IHAS Score	Description	IHAS Score	Description	IHAS Score	Description
DS05	30	Poor	35	Poor	42	Poor	40	Poor
DS07/8	0	-	0	-	0	-	30	Poor
DS14	53	Poor	68	Good	62	Adequate	69	Good
KS01	0	-	0	-	0	-	45	Poor
KS03	0	-	0	-	0	-	45	Poor
KS13	0	-	67	Good	44	Poor	43	Poor
KS21	61	Adequate	44	Poor	43	Poor	60	Adequate
KS22	58	Adequate	68	Good	59	Adequate	61	Adequate
LS04	0	-	0	-	0	-	42	Poor
LS18	69	Good	72	Good	62	Adequate	61	Adequate

- Site dry at time of survey

The IHAS score is a measure of the habitat availability for aquatic macroinvertebrates. This availability may fluctuate depending on seasonality, biotopes present as well as amount of flow at any particular time (McMillan, 1998). The fluctuations in the habitat availability at the sites between the four surveys suggest that flow and inundation of channel banks are the main factor for increases or decreases in the IHAS scores (Table 11).

A graphical comparison of the IHAS scores (Figure 100) shows that the lowest scores were recorded at site DS05. This site was characterised by a single mono-habitat (aquatic vegetation with no flow), limiting habitat availability for a diversity of aquatic macroinvertebrates. The naturally poor flow conditions observed at most sites throughout the four surveys was reflected in the low habitat availability at most of the sites (Figure 100). This low habitat availability is a limiting factor to the aquatic macroinvertebrates at these sites.

Increase habitat availability was shown to be present at the downstream sites on each of the tributaries (Figure 100). This was considered to be natural of streams in the upper catchments of systems with wetland characteristics. As more tributaries confluence, increased flow and geomorphological processes would naturally result in greater habitat diversity, due to erosion and sediment transport.

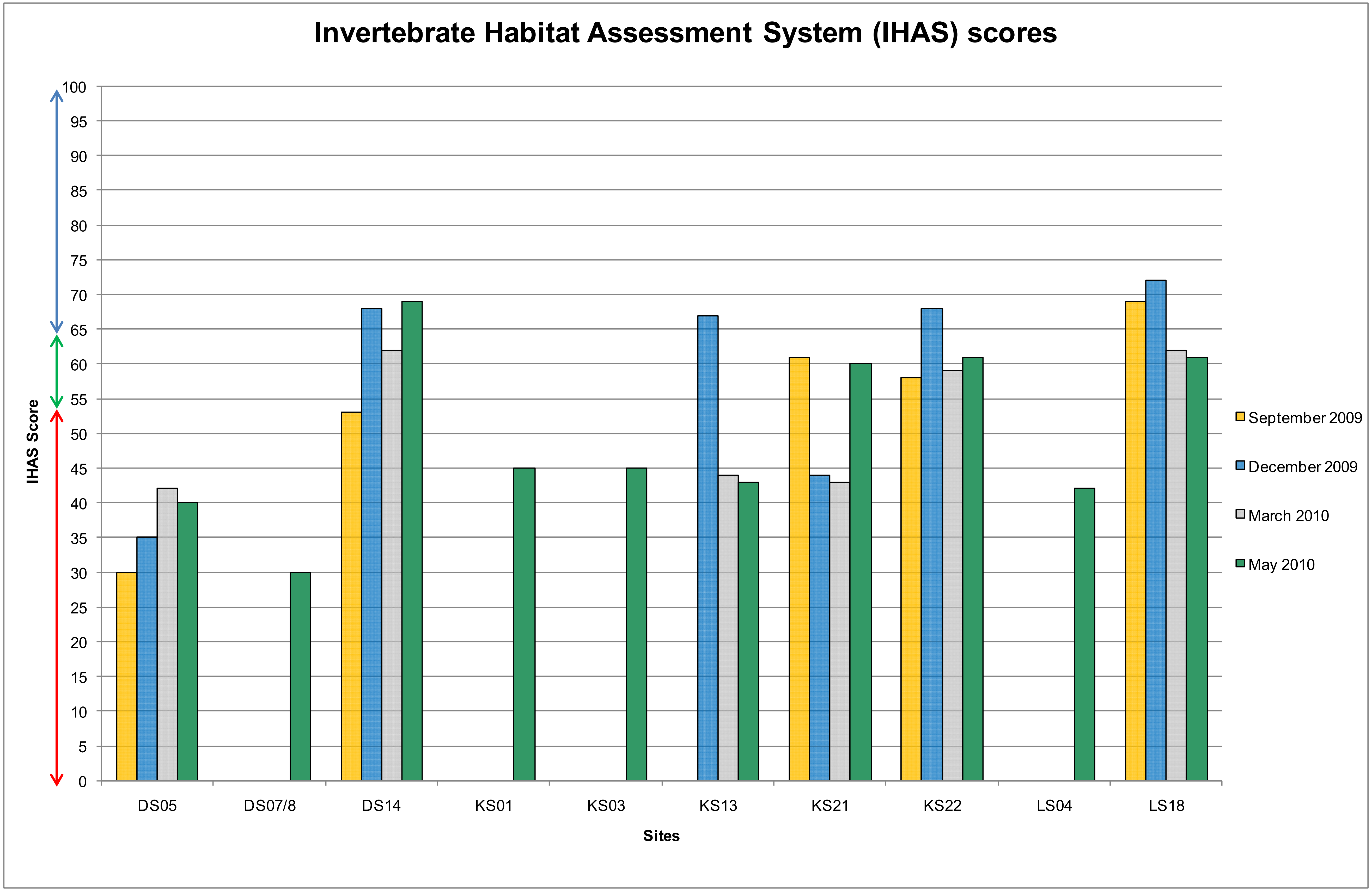

Figure 100: Comparative IHAS scores recorded during the September and December 2009 and the March and May 2010 survey

7.3.3 Aquatic macroinvertebrates

The list of aquatic macroinvertebrates recorded in the project area is presented in APPENDIX O. The aquatic macroinvertebrates were divided into those sampled in the river sites and those sampled in the pans. The biotic integrity of the aquatic macroinvertebrates from the pan sites were assessed using Univariate Diversity Indices (UDIs) and by displaying community patterns through Cluster Analysis and Non-metric Multi-dimensional Scaling (MDS).

Aquatic macroinvertebrates of the river sites

The results of the aquatic macroinvertebrate assessment for the river sites are summarized in Figure 101 to Figure 103.

The highest SASS score was recorded at site LS18 in all four surveys (Figure 101), and the lowest at site DS05 and KS01 (Figure 101). The lowest scores at all of the sites were recorded during the May 2010 survey within the dry season. This was considered to be normal as a result of decreased flows through the sites and the resultant decrease in habitat availability, as shown by the IHAS results (Figure 100). Site KS21 and KS22 indicate the opposite results to the IHAS scores (Figure 100). This indicates that habitat availability was not the primary reason for the increased SASS score at site KS21 and the decreased SASS score at site KS22 during the December 2009 survey (Figure 101). The Average Score per Taxa (ASPT) values for these two sites indicate increased sensitivity of the taxa at site KS21 during the December 2009 survey and decreased sensitivity at site KS22 (Figure 103). This suggests that water quality improvement at site KS21 in the December 2009 survey and decreased water quality at site KS22. The baseline SASS5 data thus indicates seasonal fluctuations in the SASS data as well as links to the habitat availability at the sites during the surveys.

The highest taxa diversity was recorded at sites KS13 and LS18 during the December 2009 survey (Figure 29). The results of the aquatic macroinvertebrate diversity indicate that habitat and water quality limitations directly influence the taxa. These results are considered to be normal are a reflection of the complexity of the aquatic ecosystem to abiotic and biotic relationships.

ASPT scores increased at all of the sites during the December 2009 survey except at site KS22 (Figure 103. This indicates that the increased flow, observed at all of the sites improved the water quality conditions as increased taxa sensitivity was shown. However, at site KS22, this sensitivity decreased, thus suggesting that decreased water quality was present at this site during the December 2009 survey.

It is possible that water with a poor quality flowed into this site from upstream, or that the increased flow caused a ‘catastrophic drift’ scenario, whereby sensitive taxa were dislodged by the flow and removed from the site to downstream areas.

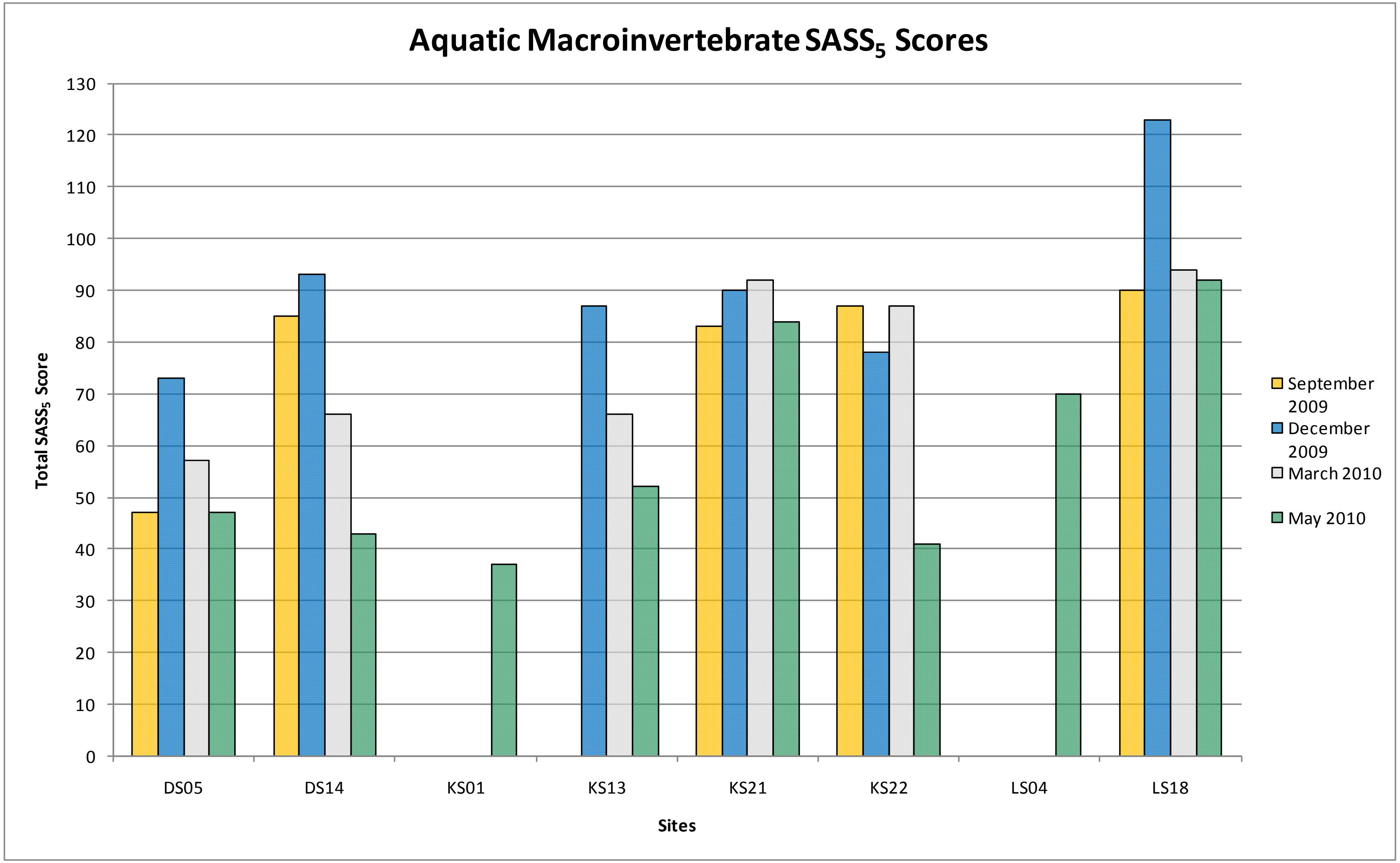

Figure 101: SASS5 data for the September and December 2009 and March and May 2010 surveys

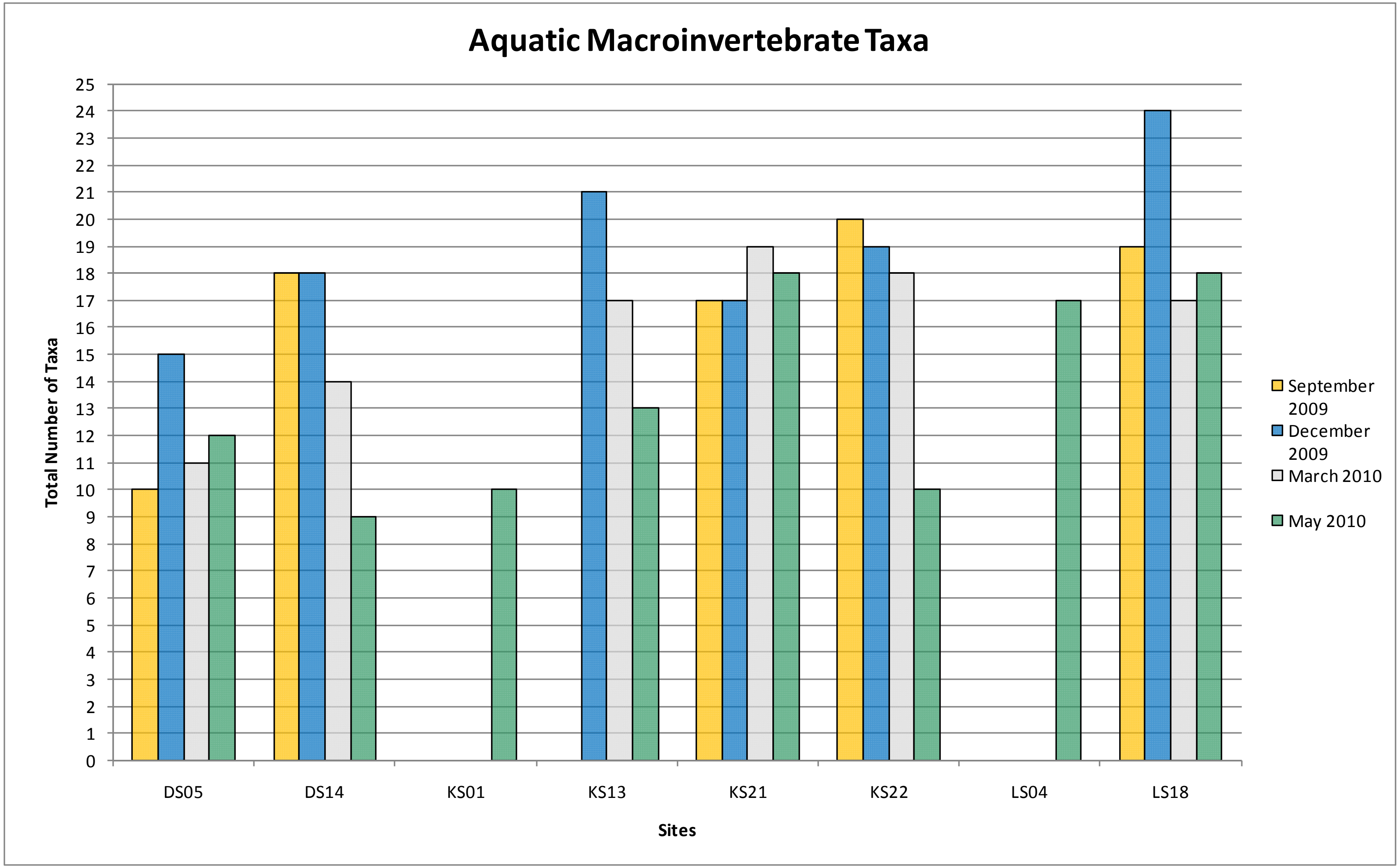

Figure 102: Total number of taxa for the September and December 2009 and March and May 2010 surveys

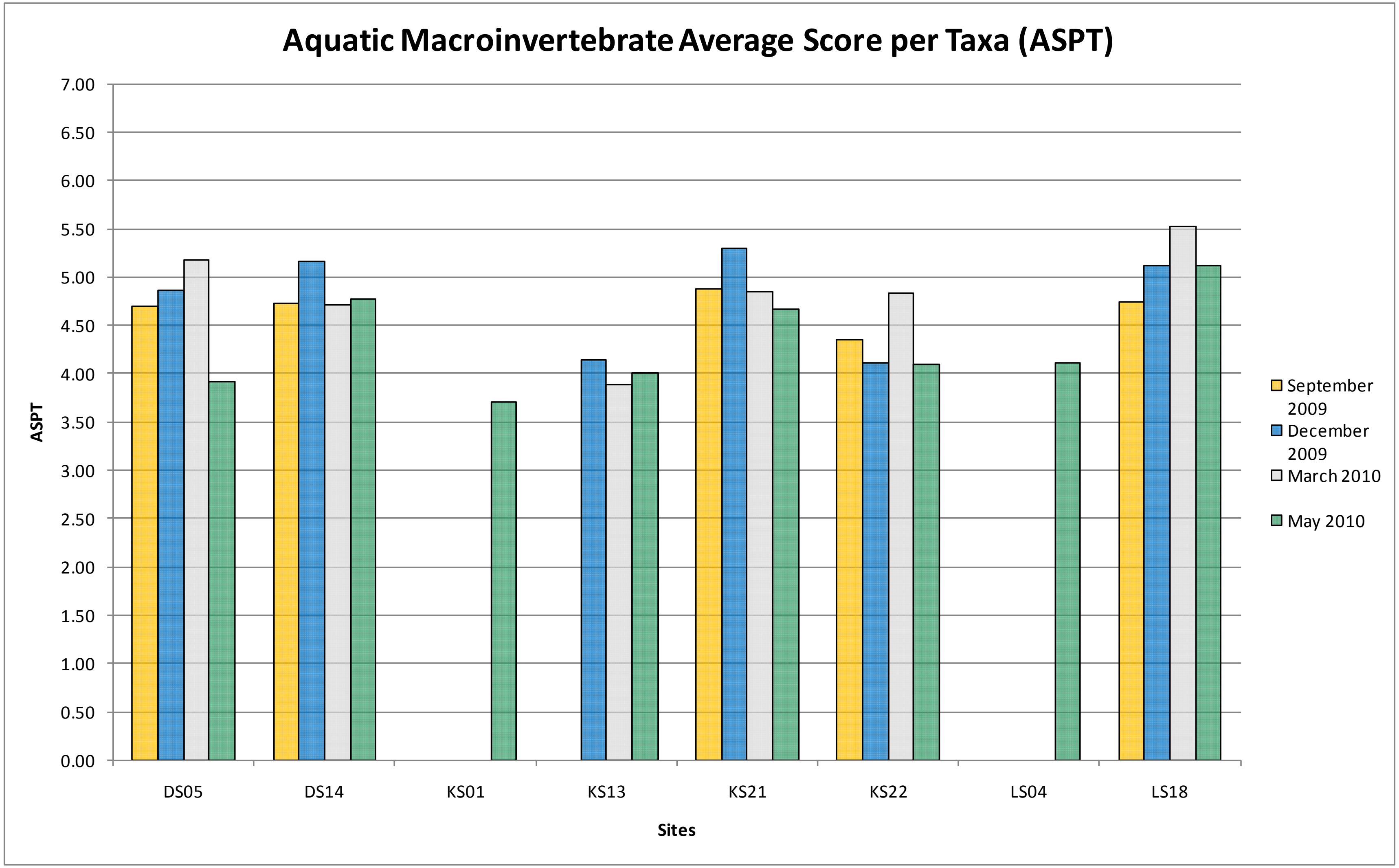

Figure 103: Average score per taxa (ASPT) for the September and December 2009 and March and May 2010 surveys

Biotic integrity of the river sites based on SASS5 results

Based on the SASS interpretation guidelines for the lower Highveld eco-region, the biotic integrity, in terms of the ecological category of the different sites in the study area was derived. These are presented for the September (Table 12) and December 2009 surveys.

Table 12: Ecological categories of the sites for the September 2009 survey, based on SASS interpretation guidelines (Dallas, 2007)

Site	September 2009	
	Ecological Category	**Description**
DS05	D	Fair – Largely impaired; fewer families present then expected, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
DS14	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS13	-	-
KS21	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS22	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
LS18	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged

- Site Dry at time of survey

The results of the biotic integrity assessment indicated that sites KS21, KS22, DS14 and LS18 were in a B ecological category, described as having very good biotic integrity with few modifications (Table 12). This also correlates with the IHAS data. Site DS05, indicated a D ecological category, thus having fair biotic integrity and being largely impaired (Table 12).

During the December 2009 survey, the sites indicated similar results (Table 13). Improved biotic integrity was shown at site DS05 which improved from a D to a C ecological category (Table 13). This increase was attributed to the improved flow and habitat availability at the site, which was seen in the SASS scores. A decrease in biotic integrity at site KS22, from a B to a C ecological category was attributed to the lower ASPT scores (Table 13).

Table 13: Ecological categories of the sites for the December 2009 survey, based on SASS interpretation guidelines (Dallas, 2007)

Site	December 2009	
	Ecological Category	**Description**
DS05	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
DS14	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS13	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged

Site	December 2009	
	Ecological Category	Description
KS21	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS22	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
LS18	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged

Biotic integrity at was similar between the December 2009 and March 2010 surveys (Table 14). Decreases in biotic integrity at sites DS14 and KS13 were as a result of decreased flow and habitat availability at these two sites during the March 2010 survey. Site KS22 increased during the March 2010 survey (Table 14).

Table 14: Ecological categories of the sites for the March 2010 survey, based on SASS interpretation guidelines (Dallas, 2007)

Site	March 2010	
	Ecological Category	Description
DS05	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
DS14	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
KS13	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
KS21	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS22	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
LS18	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged

During the May 2010 survey, biotic integrity decreased at all of the sites except sites KS21 and LS18 (Table 15). This was attributed to the decrease in flow and habitat availability during the dry season survey.

Table 15: Ecological categories of the sites for the March 2010 survey, based on SASS interpretation guidelines (Dallas, 2007)

Site	May 2010	
	Ecological Category	Description
DS05	E/F	Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
DS14	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
KS01	E/F	Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
KS13	D	Fair – Largely impaired; fewer families present then expected, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
KS21	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged
KS22	E/F	Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
LS04	C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
LS18	B	Very Good – Minimally impaired; largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged

These results corresponded with the historical data where it was concluded that at the time of sampling within X11D, the Klein-Komati River was generally unimpaired (Table 16), thus the system was in a B ecological category with similar SASS and ASPT scores. Natural fluctuations in the biotic integrity, due to flow and habitat availability, are expected between the seasons and flow regimes.

Table 16: Historical desktop SASS5 data

Quaternary Catchment (River)	SASS5 Score	Number of Taxa	ASPT[1]	Ecological Category	Year
X11D (Klein-Komati)	172	27	6.01	A	1995
	94	15	5.98	B	1994
	134	17	6.18	A	1994
X11D (Komati)	127	19	6.30	A	1995
	112	18	5.90	B	1994
	115	20	5.51	B	1994
B41A (Steelpoort)	31	7	4.57	E/F	1995
	47	9	5.20	E/F	1994
	62	13	4.74	D	1994

Quaternary Catchment (River)	SASS5 Score	Number of Taxa	ASPT[1]	Ecological Category	Year
	89	20	4.47	B	1993
	51	14	3.86	D	1993

[1]ASPT – Average Score per Taxa

Univariate Diversity Indices (UDIs)

The results of the September 2009, December 2009, March 2010 and May 2010 surveys were combined in order to conduct the PRIMER Analysis.

Univariate Diversity Indices were used to analyse community based data between sampling sites.

A total of 36 taxa were recorded in the pans associated with Exxaro Belfast during the September 2009, December 2009, March 2010 and May 2010 surveys (Figure 104). The number of taxa ranged from 2 at pans 5 and 6 during the September 2009 survey to 16 at pans 3, 4, 7 and 8 during the December 2009 survey (Figure 104). The average number of taxa per pan ranged from 8.4 during the September 2009 and March 2010 surveys to 11 during the May 2010 survey and 14 during the December 2009 survey.

The number of aquatic macroinvertebrate organisms in the pans ranged from 21 at pan 5 during the September 2009 survey to 995 at pan 7 during the December 2009 survey (Figure 105). The lowest aquatic macroinvertebrate abundance was recorded during the March 2010 survey (average of 54 organisms per pan) and the highest during the December 2009 survey (average of 415 organisms per pan). Factors that could influence the abundance of aquatic macroinvertebrates in the pans include climatic conditions, water levels and habitat availability.

Margalef's Richness Index is a measure of the number of taxa present at a site for a given number of individuals (Clarke & Warwick, 1994). Based on Margalef's Index results the highest taxa richness was recorded at pan 8 during the May 2010 survey and the lowest at pan 6 during the September 2009 survey (Figure 106). The highest average richness (2.3) was recorded during the December 2009 survey and the lowest (1.5) during the September 2009 survey with moderate richness (1.9) recorded during the March 2010 and May 2010 surveys (Figure 106).

Evenness is a measure of how evenly individuals are distributed over the species in a sample (Clarke & Warwick, 1994). Increasing levels of environmental stress are generally considered to decrease evenness due to the reduction in specialized species and favouring of generalist/ opportunistic species (Clarke & Warwick, 1994). The highest average evenness was recorded during the March 2010 survey suggesting low levels of anthropogenic disturbance (Figure 107). The lowest average evenness was recorded during the December 2009 survey suggesting increased levels of environmental stress at some of the pans (Figure 107). The lowest evenness scores were recorded at pans 5, 1 and 11 during the December 2009 survey suggesting some form of environmental perturbation (Figure 107).

Shannon-Wiener's Diversity Index is the most commonly used measure of diversity and incorporates both species richness and evenness components (Clarke & Warwick, 1994). The lowest levels of taxa diversity were measured at pans 5 and 6 during the September 2009 survey (Figure 108). The highest taxa diversity was measured at pan 13 during the December 2009 survey (Figure 108). The highest average diversity per pan was measured during the March 2010 survey and the lowest during the September 2009 survey (Figure 108). Shifts in taxa diversity may be attributed to the seasonal changes in water levels and habitat availability with the September survey coinciding with the end of the dry season and the March 2010 survey coinciding with the end of the wet season.

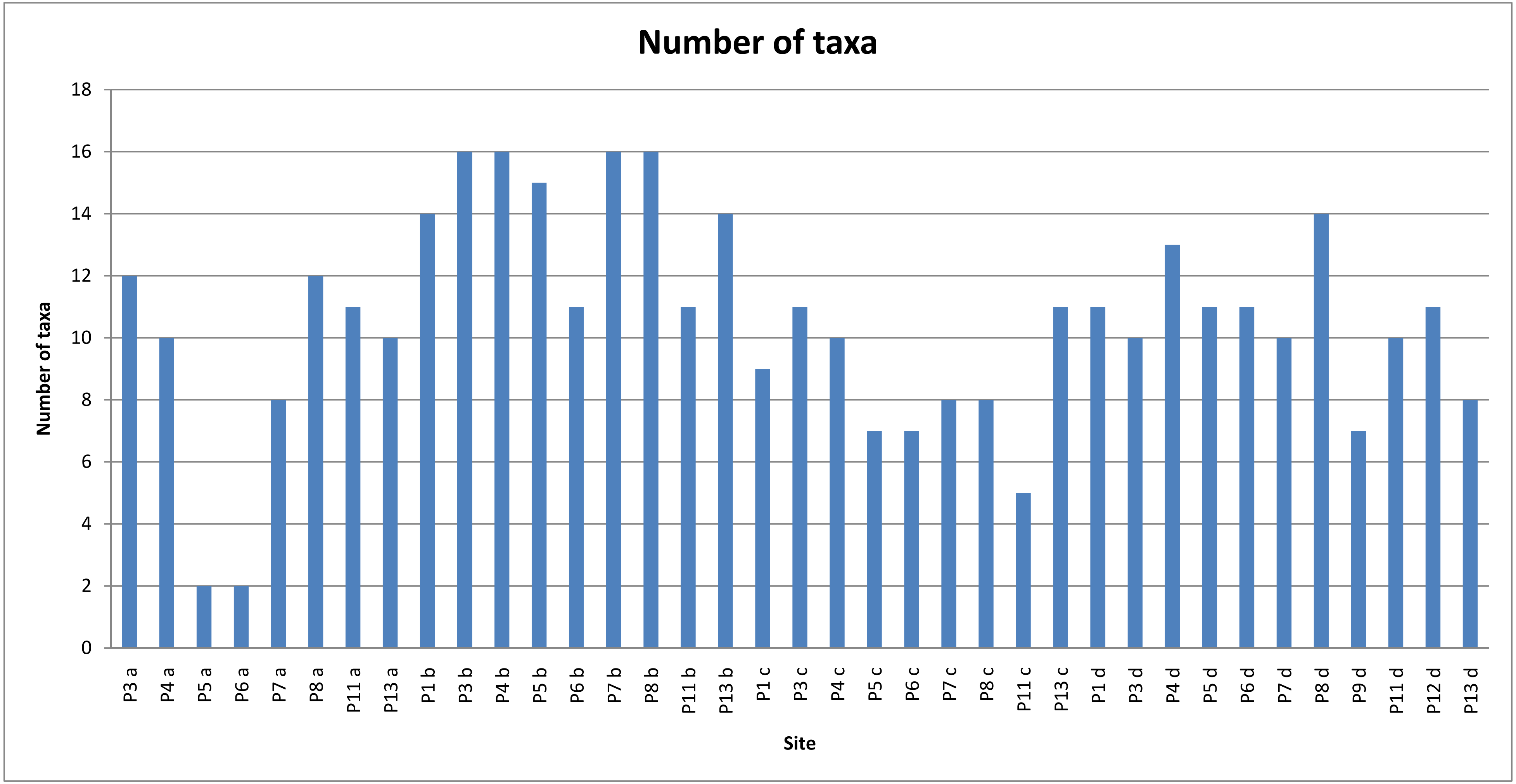

Figure 104: Number of taxa recorded at pan sites associated with Exxaro Belfast during the September 2009, December 2009, March 2010 and May 2010 surveys

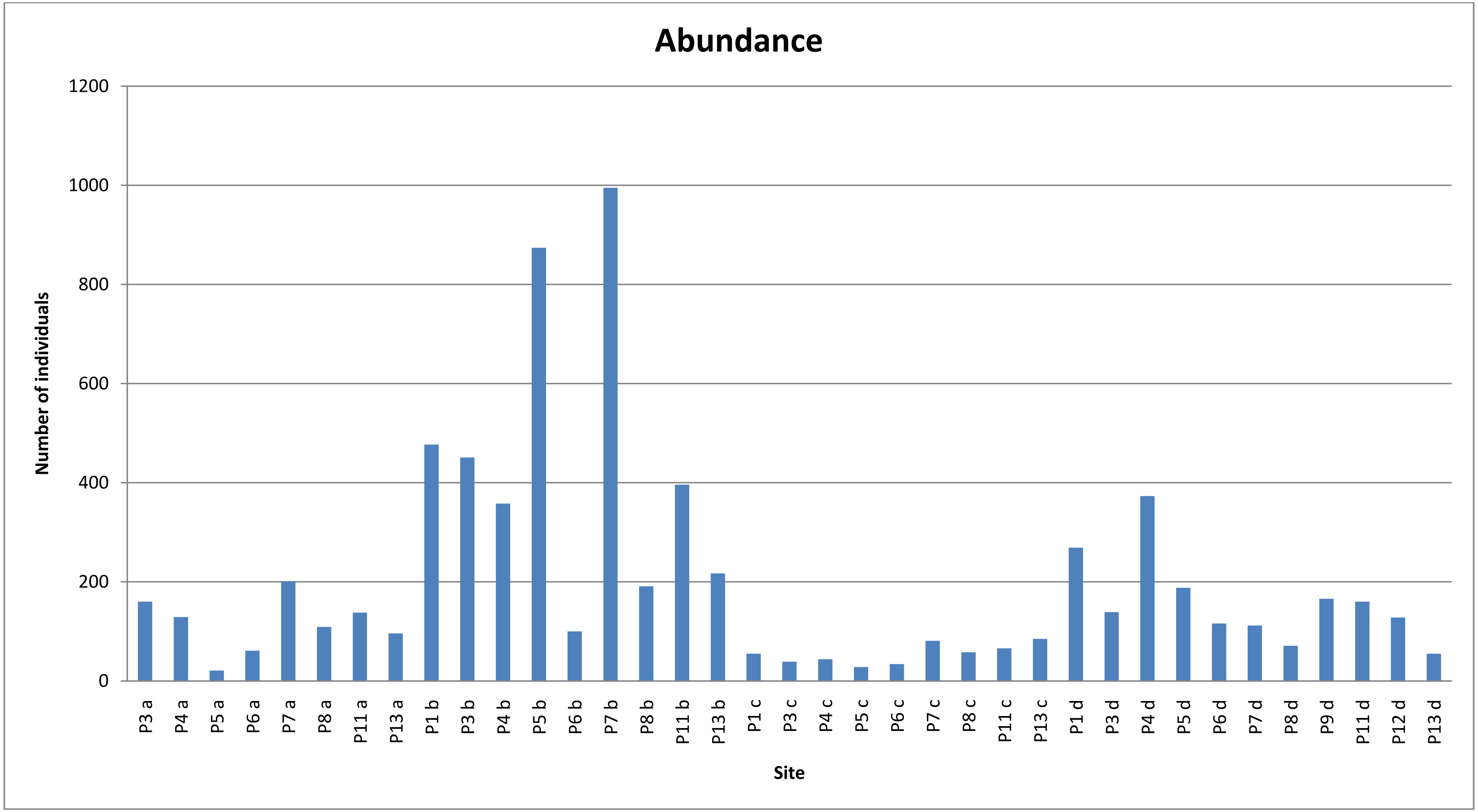

Figure 105: Total abundance of taxa during the September 2009, December 2009, March 2010 and May 2010 surveys

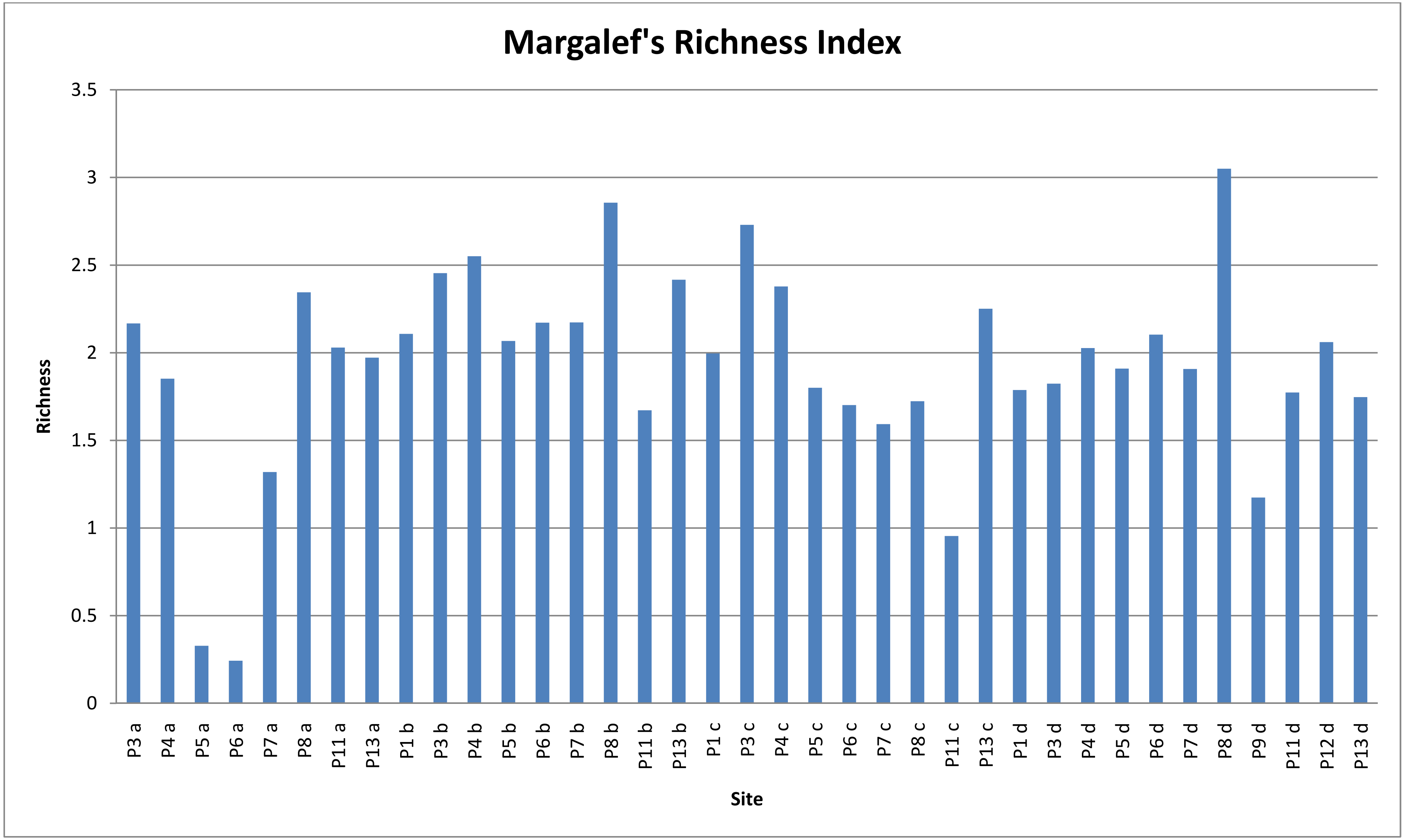

Figure 106: Margalef's Richness Index for pans associated with the September 2009, December 2009, March 2010 and May 2010 surveys

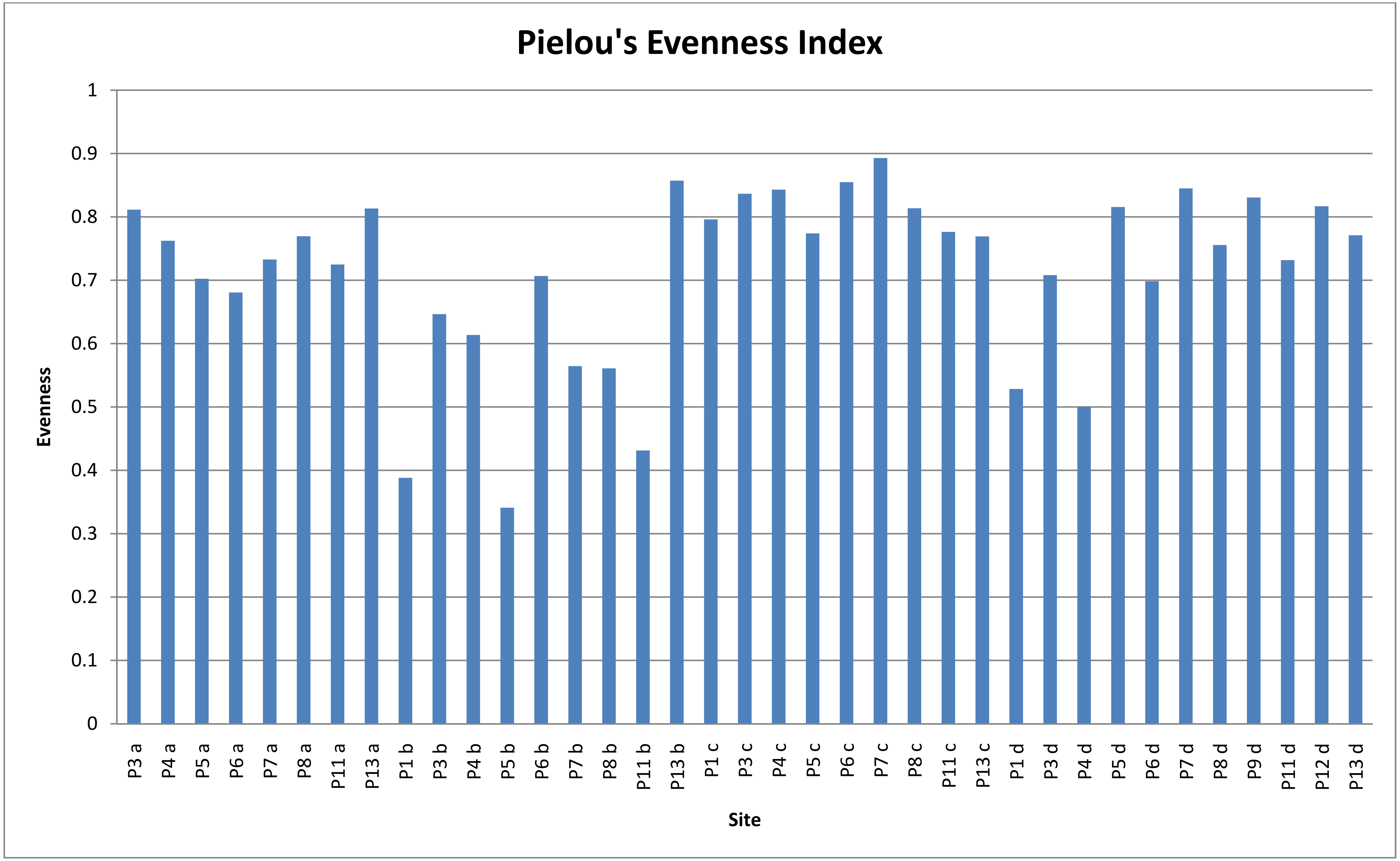

Figure 107: Pielou's Evenness Index recorded for pans associated with the September 2009, December 2009, March 2010 and May 2010 surveys

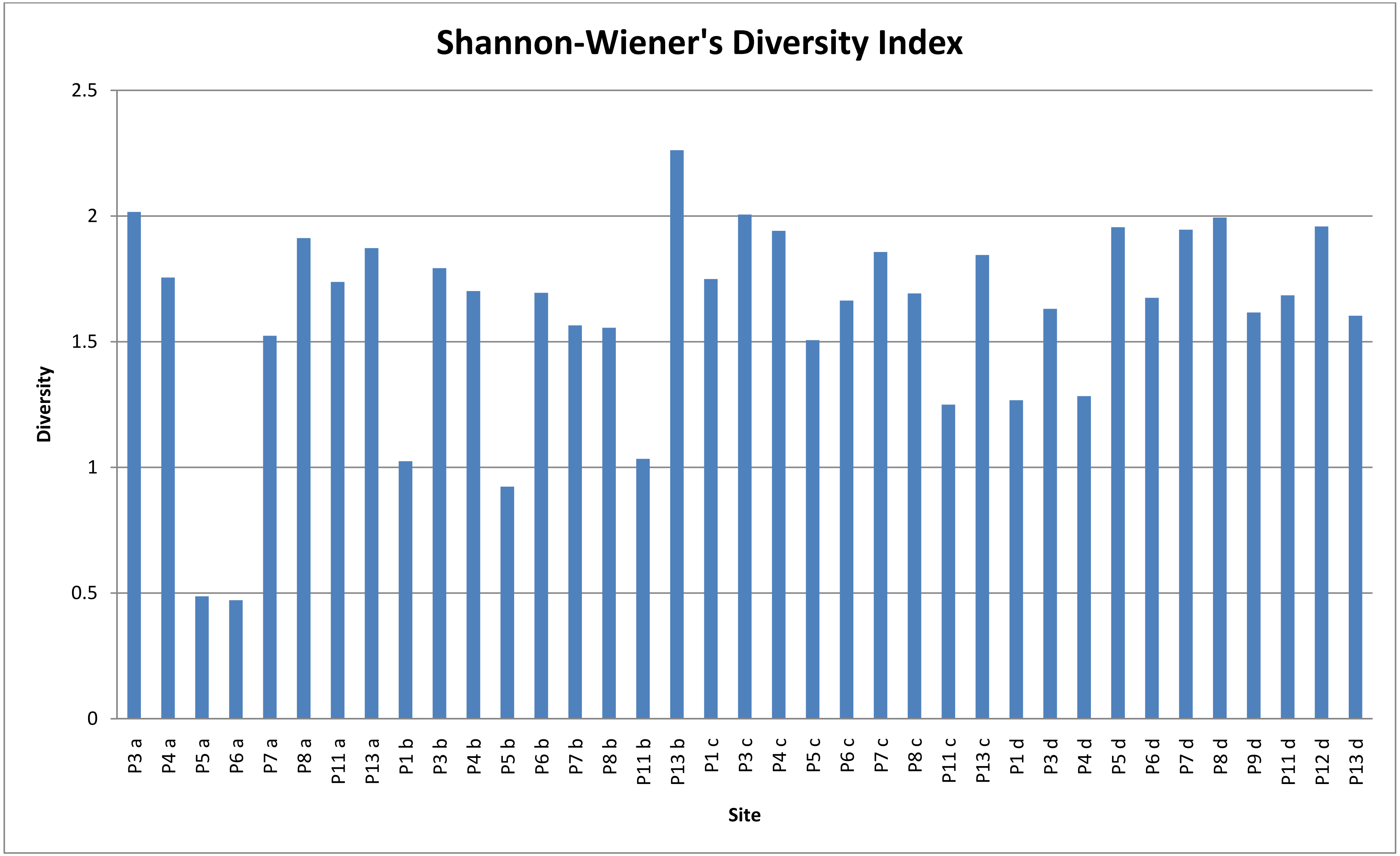

Figure 108: Shannon-Wiener's Diversity Index recorded for pans associated with the September 2009, December 2009, March 2010 and May 2010 surveys

Displaying community patterns through Cluster Analysis and Non-metric Multi-dimensional Scaling (MDS)

The data was analysed using Hierarchical Cluster analysis and Non-metric Multi-dimensional Scaling (NMDS). The result of the cluster analysis is provided in Figure 109. At a high level of similarity (80%) no groupings or linkages exist between the sites (Figure 109).At a low to moderate level of similarity (30%) five groups of sites are distinguished (Figure 109).

The relatedness between the groups was also reflected in the NMDS ordination (Figure 110). At a stress level of 0.21 the NMDS provides a potentially useful 2d picture of relatedness between the pans (Figure 110) (Clarke & Warwick, 1994).

The results of the various surveys are presented as follows in the Cluster analysis and NMDS ordination:

- September 2009 survey denoted by a;
- December 2009 survey by b;
- March 2010 survey by c; and
- May 2010 survey by d.

The groups of pans identified in the Cluster analysis and NMDS ordination consist of the following:

- Group I: pans 3a, 7a, 11c and 11d;
- Group II: pans 1b, 3 b; 4b, 5b, 7b, 1d and 4d;
- Group III: pans 1c, 4c, 6c and 13c;
- Group IV: pans 5d, 7d, 9d, 12d, 13d, 8b, 13b and 8a; and
- Group V: pans 4a, 5a, 6a, 11a, 13a, 6b, 3c, 5c, 7c, 8c, 3d, 6d and 8d (Figure 110).

Pan 11b (December 2009 survey) showed very low levels of similarity (<10%) to any of the other pans and is not included in any of the groupings that are discussed further (Figure 109).

The groupings identified in the Cluster analysis and NMDS ordination do show some level of relatedness based on survey with:

- 50% of Group I consisting of September 2009 survey results;
- 71% of Group II consisting of December 2009 survey results;
- 100% of Group III consisting of March 2010 results;
- 69% of Group IV consisting of September 2009 and March 2010 results; and
- 63% of Group V consisting of March 2010 results.

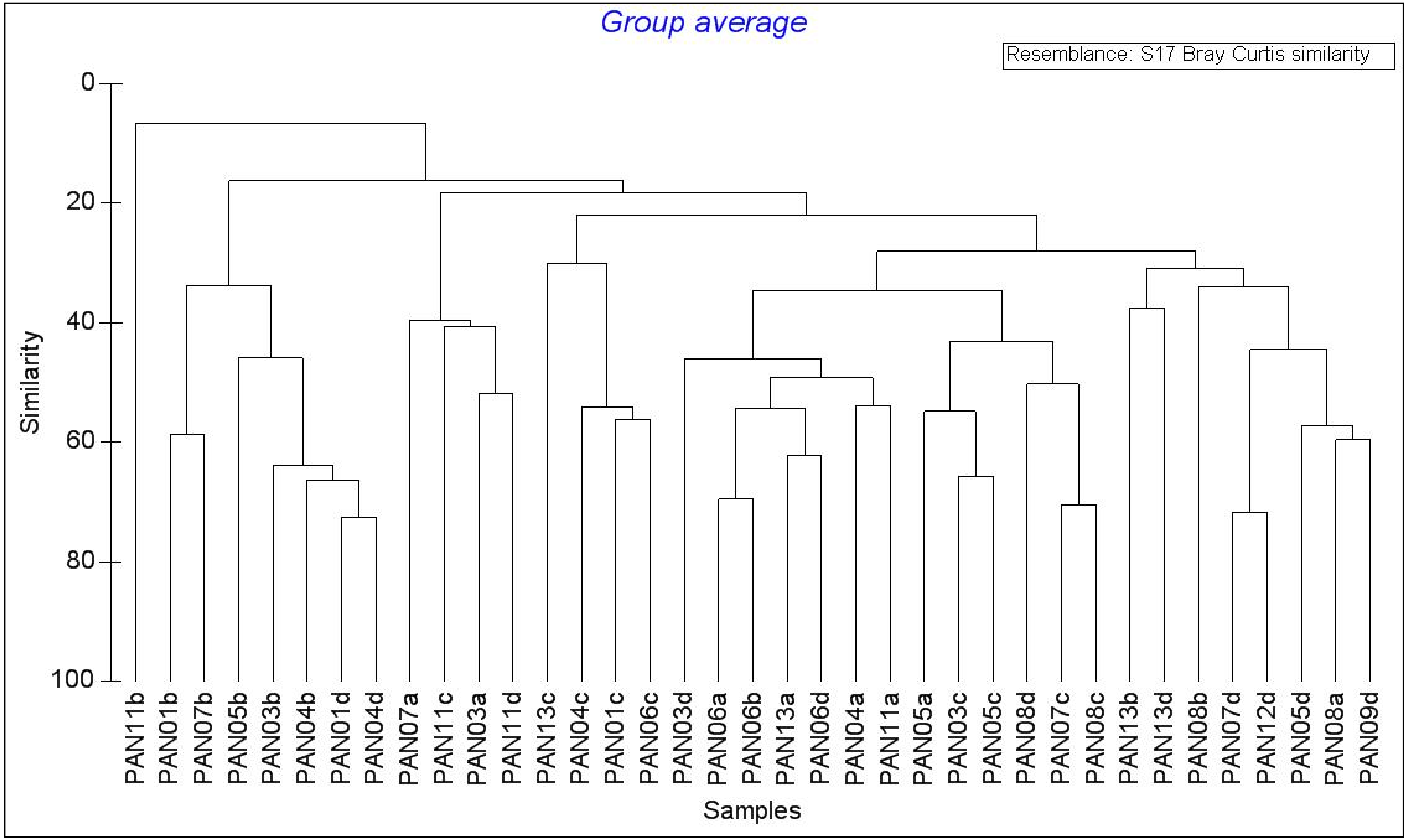

Figure 109: Cluster analysis showing Bray Curtis similarity between groups of pans from various surveys based on aquatic macroinvertebrate abundance and diversity (September 2009 survey denoted by a, December 2009 survey by b, March 2010 survey by c and May 2010 survey by d)

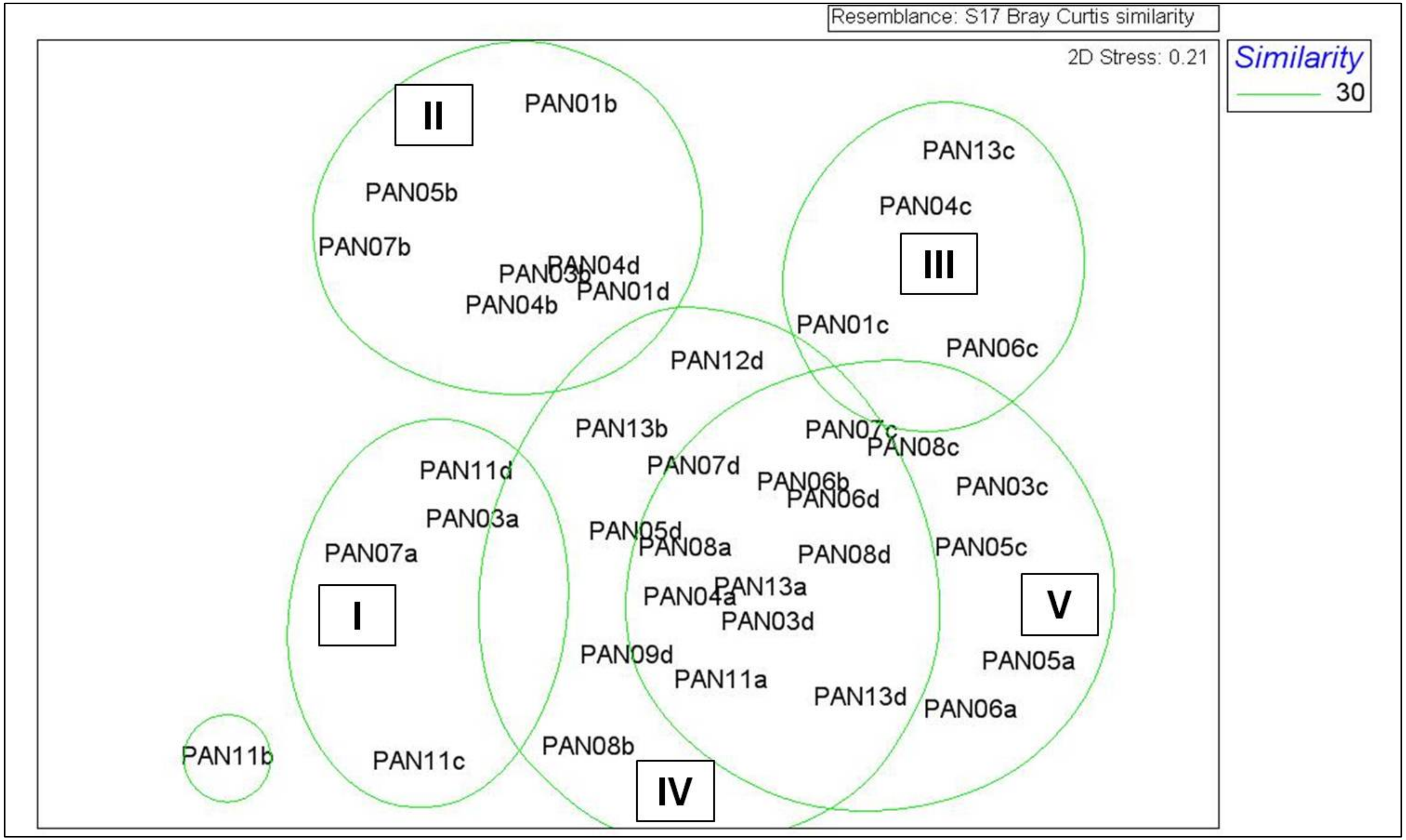

Figure 110: NMDS ordination showing groupings of pans identified based on Bray Curtis similarity (September 2009 survey denoted by a, December 2009 survey by b, March 2010 survey by c and May 2010 survey by d)

Testing the significance of observed spatial trends

In order to provide statistical validity to the groups identified in Figure 109 and Figure 110 a permutation procedure was applied to the original similarity matrix (Table 17). The analysis of similarity (ANOSIM) compares every sampling site to yield a test statistic and a level of significance (Clarke & Green, 1988). To interpret this, *R* is taken as a degree of similarity between groups and ranges between 1 and -1. The deviation from zero is the significance level and a negative *R* statistic suggests that the similarity between groups is higher than those within the groups (Cyrus *et al.,* 2000).

The important message of the test is the *R* value, since that gives an absolute measure of how separated the groups are, on a scale of 0 (indistinguishable) to 1 (all similarities within groups are less than any similarity between groups) (Clarke & Gorley, 2001).

Table 17: Analysis of Similarity (ANOSIM) results between groups I, II, III, IV and V

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
I, V	0.9	0.1	2380	999	0
I, IV	0.5	0.2	495	495	1
I, II	0.9	0.3	330	330	1
I, VI	1.0	20	5	5	1
I, III	1.0	2.9	35	35	1
V, IV	0.6	0.1	203490	999	0
V, II	0.9	0.1	77520	999	0
V, VI	1.0	7.1	14	14	1
V, III	0.7	0.1	2380	999	0
IV, II	0.8	0.1	6435	999	0
IV, VI	1.0	11.1	9	9	1
IV, III	0.7	0.2	495	495	1
II, VI	1.0	12.5	8	8	1
II, III	1.0	0.3	330	330	1
VI, III	1.0	20	5	5	1

Based on the ANOSIM results significant differences exist between all the groups ($R > 0.5$) (Table 17). Therefore all replicates within groups are more similar to each other than to other replicates from different groups.

Spatial differences in species associations

Table 18 presents the results of breaking down the similarity within Group I into taxa contributions. The more abundant a species is within a group, the more it contributed to the intra-group similarity and was said to typify a site (Clarke & Warwick, 1994). Only those species responsible for 90% of the cumulative contribution are listed.

In Group I, Baetidae (Mayflies) contributed to 64.55% to the intra-group similarity 4 aquatic macroinvertebrate taxa contributed to 91% of the intra-group similarity (Table 18).

Table 18: Contribution of aquatic macroinvertebrate taxa to the intra-group similarity within Group I (Intra-group similarity = 42%)

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Baetidae	49.5	27.11	64.55	64.55
Daphnia	27.75	7.04	16.76	81.31
Coenagrionidae	8.25	2.25	5.35	86.66
Copepoda	13.5	2.21	5.26	91.92

Figure 111 presents the NMDS ordination with abundance of Baetidae (Mayflies) superimposed showing the contribution of this taxa to the intra-group similarity within Group I.

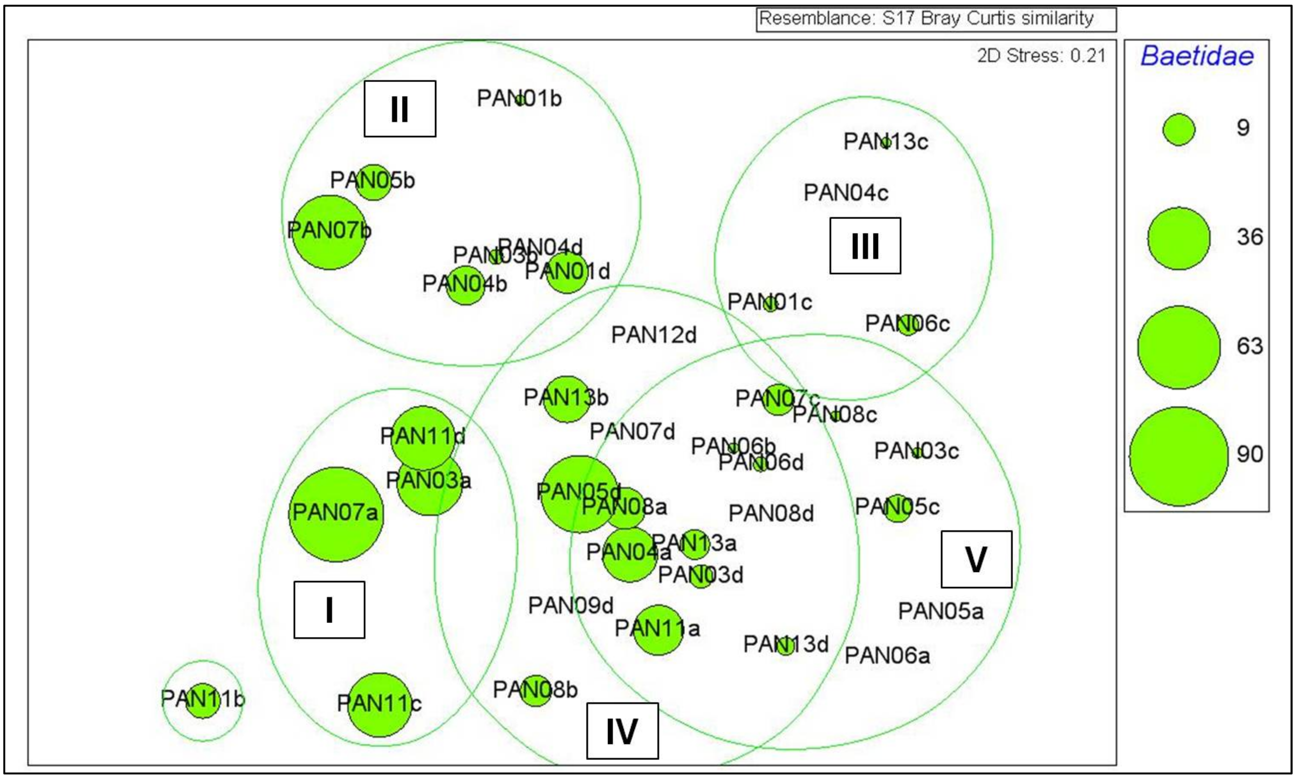

Figure 111: NMDS ordination with abundance of Baetidae (Mayflies) superimposed showing the contribution of this taxa to the similarity within Group I

In Group II Cypridoidea sp.1 (Seed shrimps) contributed to 63.46% of the intra-group similarity and 5 taxa contributed to 92.23% of the intra-group similarity (Table 3).

Table 19: Contribution of aquatic macroinvertebrate taxa to the intra-group similarity within Group II (Intra-group similarity = 46.5%)

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Cypridoidea sp.1	257.43	29.51	63.46	63.46
Planorbinae	132.86	6.61	14.21	77.68
Chironomidae	19.71	3.1	6.67	84.34
Daphnia	48.86	2.07	4.45	88.8

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Coenagrionidae	21.43	2.06	4.43	93.23

Figure 112 presents the NMDS ordination with the abundance of Cypridoidae sp. 1 (Seed shrimps) superimposed showing the contribution of this taxa to the intra-group similarity and the inter-group differences.

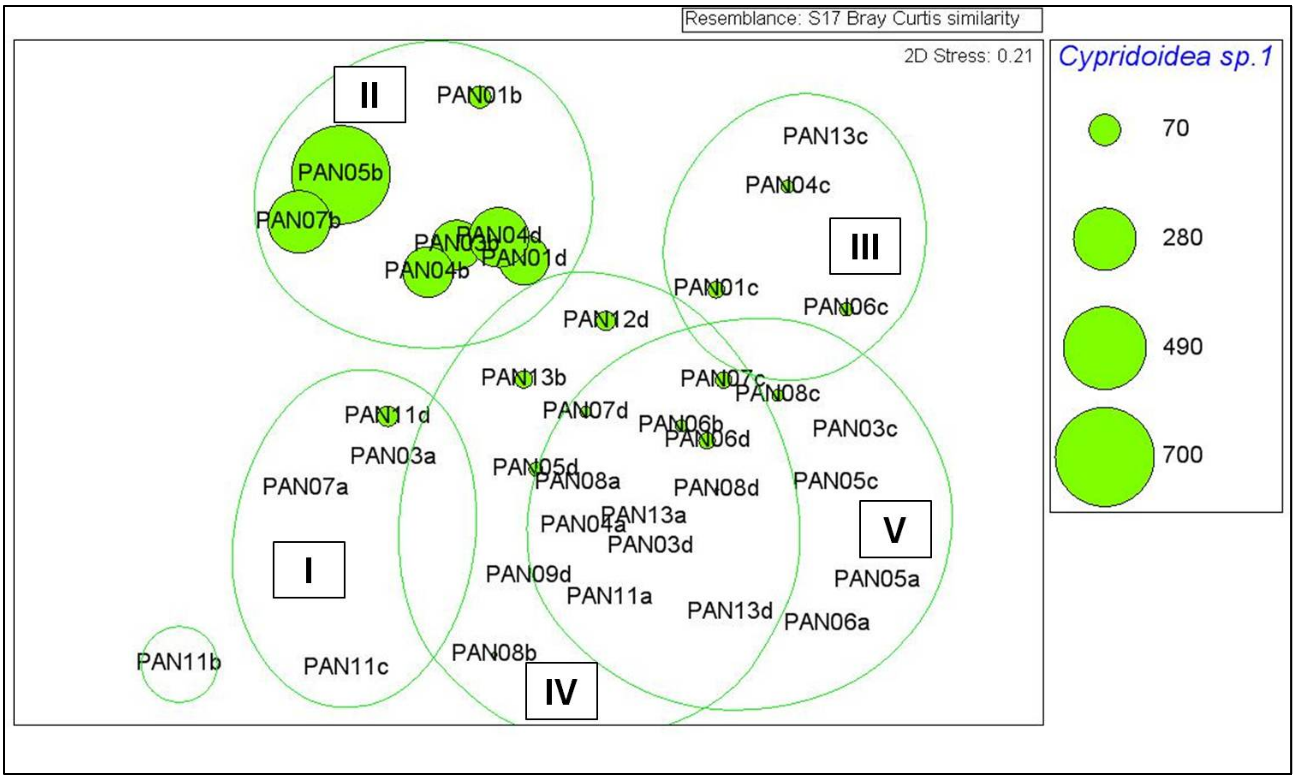

Figure 112: NMDS with abundance of Cypridoidae sp.1 superimposed showing the contribution of this taxa to the intra-group similarity within Group II

Table 20 presents the results of breaking down the similarity within Group III into taxa contributions. In Group III the abundance of Cypridoidae sp. 1 contributed to 33% of the intra-group similarity and 7 taxa contributed to 94% of the intra-group similarity (Table 20).

Table 20: Contribution of aquatic macroinvertebrate taxa to the intra-group similarity within Group III (Intra-group similarity = 42.5%)

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Cypridoidea sp.1	11.25	14.04	33.01	33.01
Hirudinea	6	7.68	18.06	51.07
Planorbinae	6.75	6.03	14.19	65.25
Naucoridae	3.75	4.27	10.05	75.3
Belostomatidae	3	3.14	7.38	82.69
Chironomidae	3	2.91	6.84	89.53
Aeshnidae	1.25	1.92	4.5	94.03

In Group IV, Corixidae (Water boatmen) contributed to 26.78% of the intra-group similarity and 8 taxa contributed to 92.65% of the intra-group similarity (Table 21). Corixidae are typically associated with slow flowing marginal vegetation and substrate habitats in ponds and pools (WRC, 2003).

Table 21: Contribution of aquatic macroinvertebrate taxa to the intra-group similarity within Group IV (Intra-group similarity = 38.94%)

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Corixidae	36.25	10.43	26.78	26.78
Coenagrionidae	20.75	7.25	18.61	45.39
Chironomidae	12.63	6.18	15.87	61.26
Daphnia	14.38	5.08	13.05	74.32
Baetidae	12.88	2.01	5.17	79.49
Dytiscidae/Noteridae	5.5	1.94	4.98	84.47
Cypridoidea sp.1	9.13	1.82	4.68	89.15
Planorbinae	8.13	1.36	3.5	92.65

Figure 113 presents the NMDS ordination with the abundance of Corixidae (Water boatmen) superimposed showing the contribution of this taxa to the intra-group similarity within Groups IV.

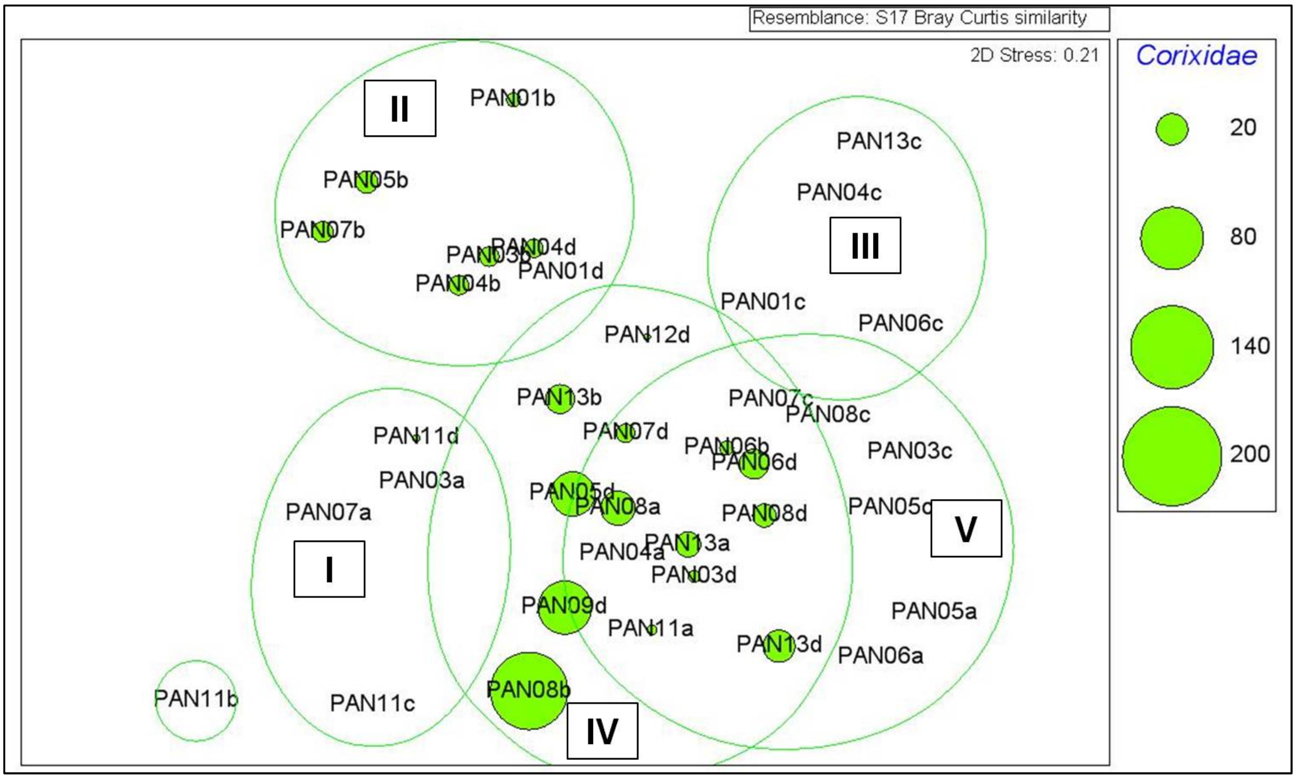

Figure 113: NMDS ordination with abundance of Corixidae superimposed showing the contribution of this taxa to the intra-group similarity within Group IV

In Group V, Chironomidae (Midges) contributed to 70.78% of the intra-group similarity and 6 taxa contributed to 90.66% of the intra-group similarity (Table 22).

Table 22: Contribution of aquatic macroinvertebrate taxa to the intra-group similarity within Group V (Intra-group similarity = 41.79%)

Species	Average Abundance	Average Similarity	Contribution %	Cumulative %
Chironomidae	32.85	29.58	70.78	70.78
Hirudinea	6.38	2.15	5.14	75.92
Baetidae	6.54	2.11	5.04	80.96
Coenagrionidae	4.08	1.79	4.28	85.24
Oligochaeta	3	1.2	2.87	88.11
Cypridoidea sp.1	4.54	1.07	2.55	90.66

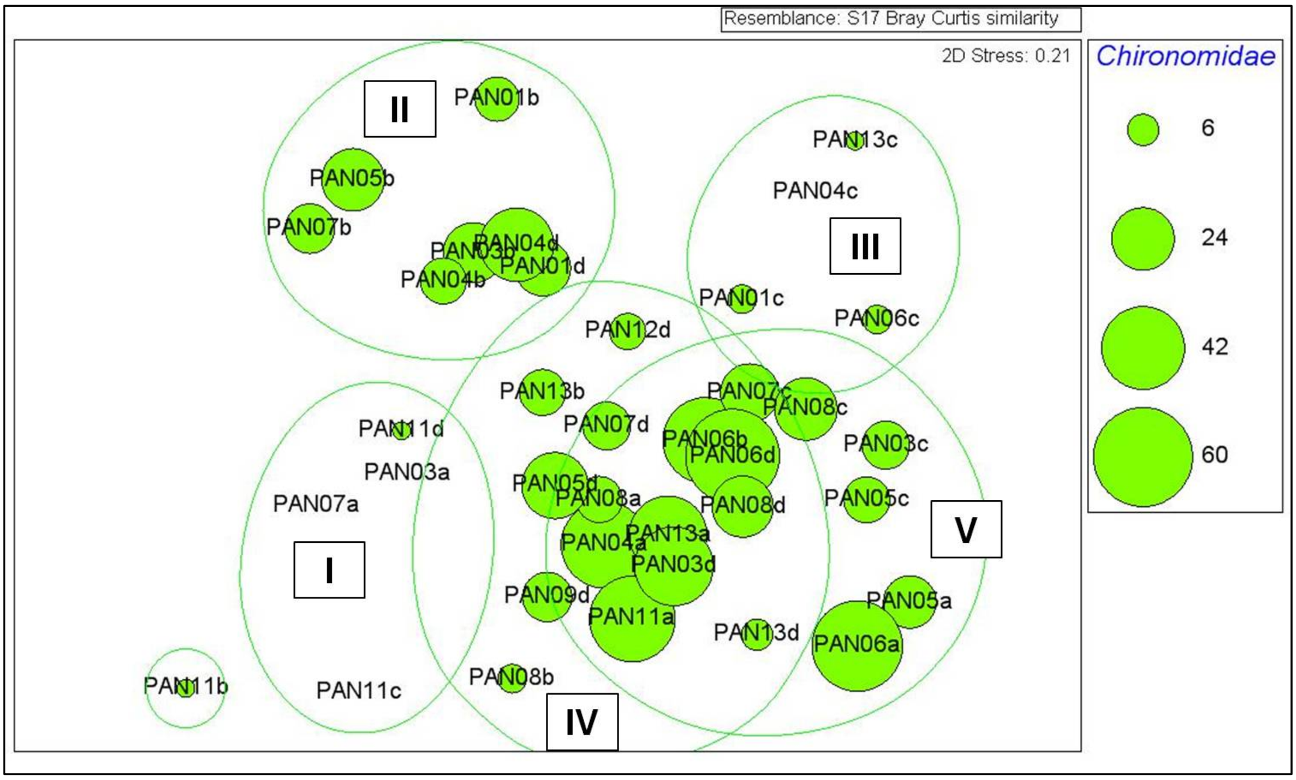

Figure 114: NMDS ordination with abundance of Chironomidae superimposed showing the contribution of this taxa to the intra-group similarity within Group V

7.3.4 Ichthyofauna (fish)

The results of the September and December 2009 fish assessments are presented in this section.

Observed fish species

The observed fish species results are presented in APPENDIX P. Of the 12 expected fish species (APPENDIX O), two indigenous fish species (*Barbus anoplus, and Pseudocrenilabrus philander*) and one introduced fish species (*Micropterus salmoides*) were recorded during the four surveys. A *Clarias gariepinus* (Sharptooth Catfish) was observed by a local farmer at site LS18 during the September 2009 survey. No fish were recorded at any of the pan sites.

A comparison of the observed fish diversity recorded during the four is presented in Figure 116, and the observed fish abundance in Figure 117.

The highest number of fish species was recorded at site KS21 during the September 2009 survey, where three species were sampled (Figure 116). A high number of individuals were also sampled at this site (Figure 117), however the most abundance was recorded at site DS14 during the March 2010 survey (Figure 117). The project area has clearly poor fish diversity, although the stream habitats should support more diverse fish populations under natural conditions.

B. anoplus (Chubbyhead Barb) has a wide distribution from the Highveld tributaries of the Limpopo to the highlands of KwaZulu-Natal, Transkei and the middle- and upper Orange River basins including the Karoo. It prefers cool waters and occurs in a wide range of habitats (Skelton, 2001). This is a widespread and hardy species that prefers quiet well vegetated waters in lakes, swamps and marshes or marginal areas of larger rivers and slow-flowing streams (Skelton, 2001). Recent work on this species by the South African Institute of Aquatic Biodiversity (SAIAB) indicates that this species may currently consist of numerous species (even two species may occur in the same river but in different habitats). *B. anoplus* in this area may require additional taxonomic assessments (Engelbrecht *pers. comm*., 2009).

P. philander (Southern Mouthbrooder) is regarded as being tolerant species that are widespread throughout Southern Africa and is common (Skelton, 2001). This species was only sampled at site KS21, which is cause for concern.

Of the 12 expected species, only two indigenous species were sampled in the project area and one observed catfish. This is cause for concern in the project area and indicates an existing impacted baseline state.

Impacts attributed to possible historical water quality changes, habitat and flow modifications and invasive alien fish species may be the reason for the lack of fish diversity within the project area.

One of the indications for this low fish diversity is possibly from the known historical presence of *Micropterus salmoides* (Largemouth Bass) throughout the project area. *M. salmoides* (Largemouth Bass) was introduced into South African water from North America between 1928 and 1938 and quickly became established in natural waters. Although this species is primarily piscivorous, it is a voracious predator that will take virtually any animal food it encounters including crabs, frogs, snakes and even small mammals. In many areas they have caused extensive damage to indigenous fish populations (Skelton, 2001). This species competes with indigenous fish species for food and habitat. The destructive influence of this species is generally considered to be responsible for the elimination of some indigenous species of barbs from South African tributaries (Davies & Day, 1998).

This species was recorded at site KS21 during the September 2009 survey, and a large number of individuals were recorded at site KS13 during the December 2009 survey (APPENDIX B). No other fish species was sampled at this site, after several attempts and it was decided to investigate what the bass were feeding on as it was suspected that they were preying on indigenous fish species. The contents of the stomach revealed the partially digested remains of a *B. anoplus* which was one third the length of the bass (Bass: 17 cm and barb: 7 cm). This is shown in Figure 115. This shows the voracious nature of this exotic fish species and indicates why this species has such a devastating impact on the indigenous fish diversity.

Figure 115: M. salmoides adult with partially digested B. anoplus, recorded at site KS13 during the December 2010 survey

IUCN red list of threatened fish species

Only one listed fish species was recorded within the project area (APPENDIX P):

- *B. anoplus* is currently listed as Least Concern (LC) (IUCN, 2010), therefore considered to be widespread and abundant (IUCN, 2001).

Fish health assessment

After thorough external examination, it was determined that all individuals were free of apparent diseases, parasites and body injuries during the September 2009 survey. During the December 2009, March and May 2010 surveys, individual *B. anoplus* had observed 'black spot' skin parasites. This however was a small percentage of the sampled populations.

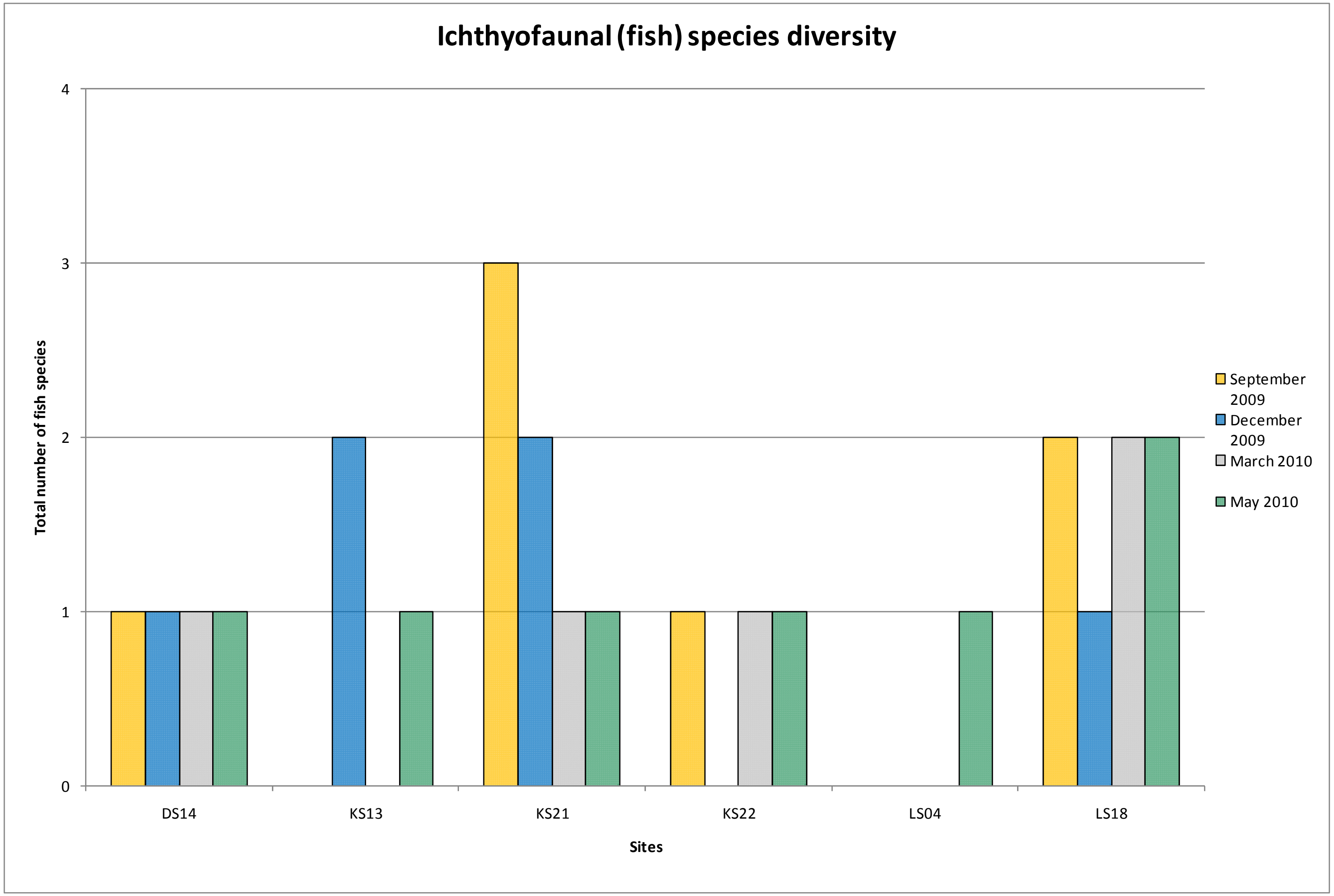

Figure 116: Observed fish species diversity recorded during the September and December 2009 and March and surveys

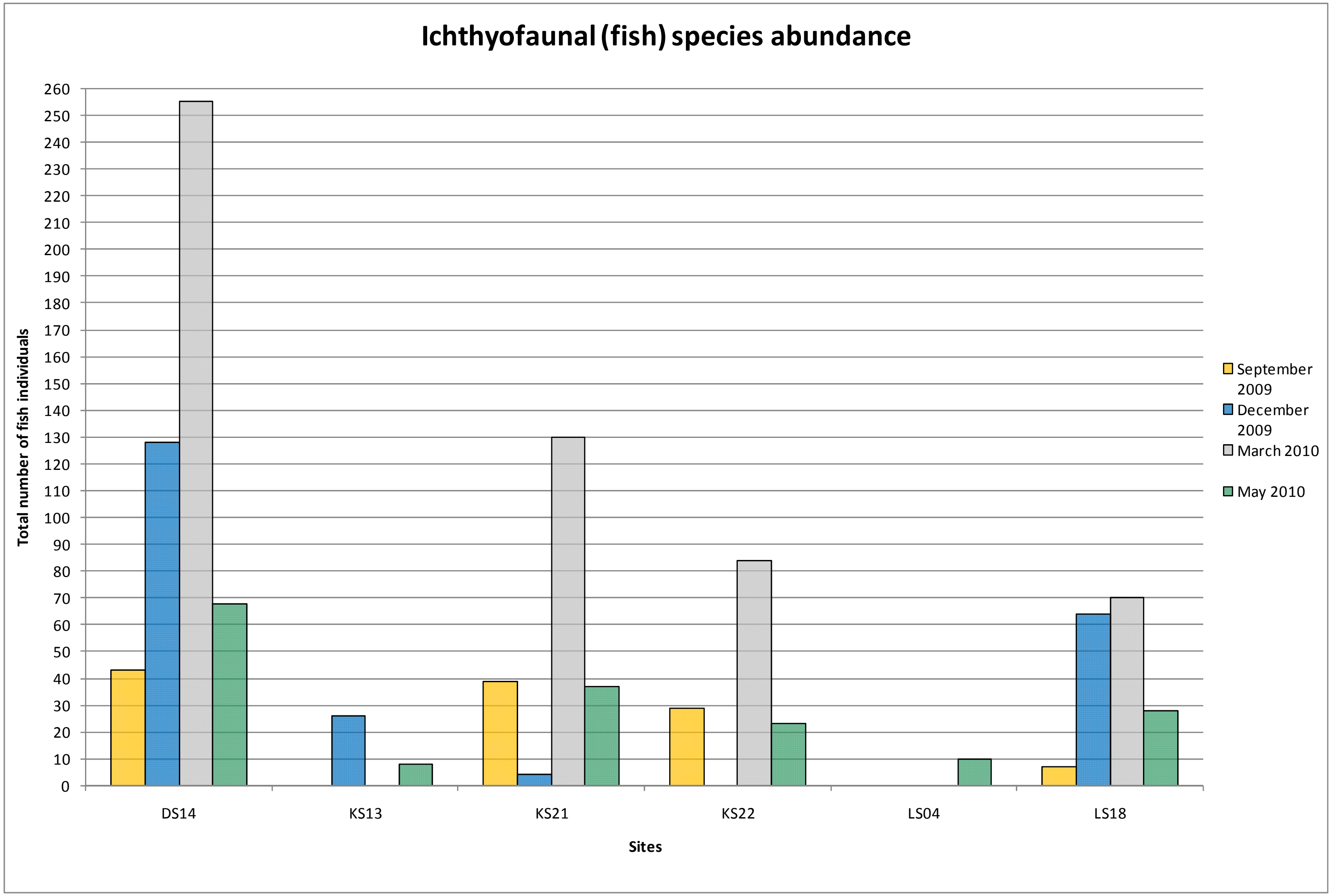

Figure 117: Observed fish species abundances during the September and December 2009 and March and surveys

8.0 IMPACT ASSESSMENT

Having established a baseline characterisation of the study area the proposed project plan was overlayed on the receiving terrestrial, aquatic, and wetland ecosystems (

Figure 118). The assessment of impacts on the terrestrial ecosystems will be addressed first. Following this the assessment of the impacts on the aquatic and wetland ecosystems will be discussed under one section. This is due to the fact that as ecological systems they are strongly linked and impacts and mitigations often overlap.

Figure 118: Proposed project layout in relation to ecological features.

8.1 Impact Assessment

Any development in a natural system will impact on the environment, usually with adverse effects. From a technical, conceptual or philosophical perspective the focus of impact assessment ultimately narrows down to a judgment on whether the predicted impacts are significant or not (DEAT, 2002). Alterations of the natural variation of flow by river regulation through decreasing or increasing the flows can only have a profound influence upon almost every aspect of river ecological functioning (Davies & Day, 1998).

Current South African legislation, as indicated at the outset of this report, requires that the necessary aquatic, wetland and terrestrial ecosystem impact assessment be conducted and mitigation measures assessed so as to reduce or prevent the degradation of habitats and biotic populations due to alterations that may impact on ecosystem functioning.

8.1.1 Identification of Potential Impacts

The identified impacts on the terrestrial ecosystems are as follows:

- Loss of plant communities. Plant communities occurring in the grassland portions of the mining area will be lost due to the disturbance caused by total clearing of the land for the construction of mine infrastructure and open pit mining activity.
- Loss of plant red data species. Red data floral species that may occur in sites to be disturbed will be destroyed by project activities.
- Reduction of plant diversity. Sites cleared of vegetation will destroy species restricted to that particular site of operation. Due to the extent of this project, sites where plants with limited habitat preference occur, such as on wetland fringes, those plants will be destroyed, thereby diminishing species diversity in the mining area.
- Loss of faunal communities. Faunal communities will be lost due to the destruction of vegetation and soil structure that provide the habitat for the fauna occurring in the region.
- Loss of faunal red data species. Many of the faunal red data species potentially occurring in the mining area have limited tolerance for disturbance due to specific habitat requirements that will be de destroyed by the removal of plants and soil.
- Reduction of faunal diversity. Sites cleared of vegetation will destroy animal species restricted to that particular site of operation. Due to the extent of this project, sites where animals with limited habitat preference occur, such as on wetland fringes, those animals will be destroyed, thereby diminishing species diversity in the mining area.
- Increase in dust. Wind driven dust that settle on the vegetation will have effects such as reduced vigour of growth due to reduced transpiration of plants and reduced reproductive capacity caused by dust settling on the leaves and flowers.

- Increase in invasive species. Sites disturbed by the mining activity will be prone to infestation by a variety of invasive exotic species, thereby diminishing natural biodiversity and limiting natural ecosystem processes.
- Loss of grazing land. Grazing land serves as habitat for the faunal species of the area, including red data species. Animals that are dormant, burrowing, and territorial females with young in nests will not move away.
- Loss of crop fields. Crop fields serve as habitat for the faunal species of the area, including red data species. Animals that are dormant, burrowing, and territorial females with young in nests will not move away.
- Increased human activity. Increased human movement, vehicular traffic, heavy machinery and noise will drive sensitive species such as birds, including the Vulnerable Blue and Crowned cranes away.
- Cumulative impact. Cumulative impacts are those impacts that are caused by a combination of activities in a region and that result in an incremental build-up of lasting impacts that will destroy the natural environment

The assessments of potential impacts on the aquatic and wetland ecosystems are discussed according to the ecological impacts on water quality, habitat (loss and alteration) and biotic communities (aquatic macroinvertebrates, fish, vegetation and other aquatic-dependant fauna).

Most of the impacts identified relate to increased dust and sediment. When the latter settles in the aquatic ecosystems, the water becomes turbid thus reducing the photosynthetic capacity of the water flora. Even the dust settling on the plants reduces the photosynthetic capacity. Thus less food and habitat becomes available. The suspended matter could also smother the small invertebrates, thus triggering hardier species to dominate. Some particles carry an electric charge, adsorbing nutritive substances, subsequently making it unavailable for plants and organisms (Davies & Day, 1998).

Water quality impacts

Water quality of the aquatic and wetland ecosystems, both the river sites and pans, will be impacted on in two aspects; instream impacts as well as from bank disturbances.

Fluctuations in the *in situ* water quality parameters (pH, Electrical Conductivity (EC), TDS, DO, and temperature) may occur during the construction phase, the mining operational phase as well as during the decommissioning and mine closure phase. These will have impacts on the aquatic ecosystem biotic communities and vegetation.

The impacts on the water quality may occur due to the fact that the following proposed activities will impact the adjacent pans and wetlands, the upper catchments, headwaters and tributaries of the Leeuwbankspruit, the Klein Komati River and the Driehoekspruit within the project area, as well as the downstream river ecosystems outside of the project area:

- Dust generation and transportation due to the clearing of vegetation prior to construction, the construction phase, the mining operation phase and the decommission and closure phase, which will settle on the riparian vegetation and in-stream habitats, leading to:
  - Reduced photosynthesis and transpiration in flora;
  - An increase in fine-particulate sediments into the water;
  - A decrease in visibility and light penetration;
  - An increase in potential EC and TDS;
  - Fluctuation changes in the pH values; as well as

- Fluctuations in the surface water quality monitoring parameters.
- This impact will be greatly increased during the drier months of April through to September;

- Increased soil sediment loads and coal sediments via surface water runoff into the adjacent pans and wetlands as well as the tributaries and rivers within the project area and downstream aquatic ecosystems, via the clearing of vegetation prior to construction, the construction activities and the removal of topsoil, coal seams 2, 3, 4 and 5 as well as the parting geological layers between the seams during the mining operation processes, leading to:
  - Reduced photosynthesis and transpiration in the in-stream aquatic macrophytes;
  - An increase in fine-particulate sediments into the water;
  - A decrease in visibility and light penetration;
  - An increase in potential EC and TDS;
  - Fluctuation changes in the pH values; as well as
  - Fluctuations in the surface water quality monitoring parameters.

This impact will be greatly increased in the wet months of October to March and during flood events;

- Loss of catchment water yield in the three river ecosystem catchments within the project area, due to the proposed mining operations, leading to;
  - A reduction in dilution factor from a reduction in ground water recharge at the springs, eyes and fountains in the pans, wetlands and tributaries of the three river catchments;
  - A reduction in dilution factor from a reduction in natural surface water runoff recharge in the wetlands and tributaries of the three river catchments; as well as
  - Fluctuations in the surface water quality monitoring parameters.

This impact will be greatly increased during the drier months of April through to September;

- Regional water quality conditions indicate existing high suspended solid concentrations for the majority of the monitoring localities, coupled with elevated suspended metal concentrations. Neutral pH levels indicate that the metal concentrations are not in solution. Increases in this due to the proposed project impacts may result in:
  - Increased possibility for microbial growth;
  - Decreased sunlight for photosynthesis leading to decreased food production;
  - Interference with the feeding mechanisms of filter feeding organisms;
  - . Reduced gill functioning and foraging efficiency (due to visual disturbances); and
  - Reduced growth in fish.
- Contamination of groundwater resources as a result of mining activities reaching the underlying water table; Contamination of spring, eye and fountain source zones of the pans, wetlands and tributaries of the three river catchments within the project area;
  - Acid mine drainage entering aquatic ecosystems;
  - Heavy metal toxicity;
  - Fluctuations in *in situ* water quality parameters; and

- Fluctuations in surface water monitoring parameters.

- Contamination of the wetlands and tributaries of the three river catchments as a result of mine water release from dewatering of the mine pits, leading to:
  - Acid mine drainage entering aquatic ecosystems;
  - Heavy metal toxicity;
  - Fluctuations in *in situ* water quality parameters; and
  - Fluctuations in surface water monitoring parameters.
- Oil from generators and vehicles may also enter the systems;
- Bank disturbances, resulting in increased sediment input from erosion; and
- Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, leading to;
  - Increased erosion, flooding, sedimentation and bank instability;
  - Fluctuations in *in situ* water quality parameters; and
  - Fluctuations in surface water monitoring parameters.

Habitat impacts

The impacts on the habitat may occur due to the fact that the following proposed activities will impact the adjacent pans and wetlands, the upper catchments, headwaters and tributaries of the Leeuwbankspruit, the Klein Komati River and the Driehoekspruit within the project area, as well as the downstream river ecosystems outside of the project area:

Macro-channel habitat loss or alteration

The largest impact on the macro-channel and riparian vegetation is expected to occur during the construction period. The following proposed activities will impact on the macro-channel and riparian vegetation:

- Removal/destruction of aquatic ecosystem (especially pans within the proposed coal footprint areas);
- Riparian vegetation removal;
- Bank disturbances;
- Drainage pattern changes; and
- River diversion.

These activities may result in possible bank destabilization, increased erosion potential and exotic vegetation encroachment.

In-stream channel habitat loss or alteration

- Dust that enters the in-stream channel will impact on the following habitats:
  - Decreased visibility due to clouding of water column;
  - Decreased light penetration;
  - Siltation of fine sediment substrates, gravel substrates and inter-substrate spaces; and

  - Decrease in habitat availability.

This impact will be greatly increased during the drier months of April through to September;

- Soil sediment loads and coal sediments entering the aquatic ecosystems via surface water runoff into the adjacent pans and wetlands as well as the tributaries and rivers within the project area and downstream aquatic ecosystems, leading to:
  - An increase in fine-particulate sediments into the water;
  - A decrease in visibility;
  - A decrease in light penetration;
  - Increased siltation; and
  - Decreased habitat availability.

This impact will be greatly increased in the wet months of October to March and during flood events;

- Loss of catchment water yield in the three river ecosystem catchments within the project area, due to the proposed mining operations, leading to;
  - A reduction in ground water recharge;
  - A reduction in natural surface water runoff recharge; as well as
  - A reduction in stream flow, discharge and velocity of flow; and
  - A reduction in hydraulic biotopes and in-stream habitat availability.

This impact will be greatly increased during the drier months of April through to September;

- Bank disturbances, resulting in increased sediment input from erosion;
- Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, leading to increased erosion, flooding, sedimentation and bank instability.

Aquatic macroinvertebrate habitat availability

Due to likely impacts on sedimentation, siltation and reduction of flow, the following impacts may occur on the aquatic macroinvertebrate habitat availability:

- Loss or reduction of habitats, whereby certain flow habitats are lost or reduced (Stones-in-Current, Vegetation in current); certain habitats may be silted up or have sediment deposited over them (Stones, gravel, aquatic macrophytes), thus not being available for colonisation for certain aquatic macroinvertebrates taxa; and
- Adult stages, breeding and survival, whereby the adult stages have reduced habitat available for breeding due to marginal vegetation and aquatic macrophytes being covered in dust, exotic vegetation encroachment and bank instability.

Ichthyofaunal habitat availability

Due to likely impacts on sedimentation, siltation and reduction of flow, the following impacts may occur on the fish habitat availability:

- Loss or reduction of habitats, whereby certain flow habitats are lost or reduced (fast shallow and slow shallow biotopes, cover from suitable water column and marginal vegetation); certain habitats may be silted up or have sediment deposited over them (Stones, gravel, aquatic macrophytes and marginal vegetation); and

- Breeding and spawning areas may also be lost due to siltation, in-stream modifications, flow reductions or water quality changes;

Biotic changes

Riparian and marginal vegetation, aquatic macrophyte and diatom diversity and abundances

Changes to the vegetation community structure of the aquatic ecosystems may take place due to the likelihood that the following may occur as a result of the abovementioned impacts:

- Fluctuations in water chemistry may directly impact on the ability of certain vegetation species to survive;
- Toxicity of water may be lethal to sensitive vegetation;
- Increased possibility for microbial growth and algal blooms;
- Sedimentation of marginal vegetation habitats and aquatic macrophytes;
- Shifts in aquatic macrophyte communities, favouring tolerant or invasive species;
- Decreased sunlight for photosynthesis leading to decreased food production;
- Shifts in marginal vegetation communities, favouring non-flow dependants species, tolerant species or exotic species;
- Shifts in riparian vegetation communities, favouring pioneer species, disturbance tolerant species or exotic species;
- Shifts in diatom communities, favouring tolerant species; and
- Exotic riparian vegetation encroachment.

Aquatic macroinvertebrate diversity and abundance

Changes to the aquatic macroinvertebrate community structure may take place due to the likelihood that the following may occur as a result of the abovementioned impacts:

- Fluctuations in water chemistry may directly impact on the ability of certain taxa to survive;
- Toxicity of water may be lethal to sensitive taxa;
- Increased possibility for microbial growth;
- Decreased sunlight for photosynthesis leading to decreased food production;
- Interference with the feeding mechanisms of filter feeding organisms;
- Reduced gill functioning and foraging efficiency (due to visual disturbances);
- Flow dependant taxa may decrease or be lost due to reduced flows;
- Taxa requiring specific habitats may decrease or be lost due to siltation of substrates, aquatic macrophytes and marginal vegetation habitats;

- Adult stages of certain taxa may fail to find suitable breeding habitats due to settlement of dust on the marginal vegetation and aquatic macrophytes, thus reducing the abundance or presence of certain taxa.

Ichthyofaunal diversity and abundance

Changes to the fish community structure may take place due to the likelihood that the following may occur as a result of the abovementioned impacts:

- Reduced growth in fish
- Fluctuations in water chemistry may directly impact on the ability of certain fish species to survive;
- Toxicity of water may be lethal to sensitive species;
- Increased possibility for microbial growth;
- Decreased sunlight for photosynthesis leading to decreased food production;
- Reduced gill functioning and foraging efficiency (due to visual disturbances);
- Flow dependant species may decrease or be lost due to reduced flows;
- Fish species requiring specific habitats may decrease or be lost due to siltation of the water column, substrates, aquatic macrophytes and marginal vegetation habitats;
- Certain species may decrease in abundance due to loss of food sources (aquatic macroinvertebrates, aquatic macrophytes);
- Exotic species competition or invasion, already identified as an impact within the Klein-komati River ; and
- Decrease in abundance of certain species that rely on specific habitats for breeding and spawning.

8.1.2 Development of mitigation measures for identified impacts.

For the **terrestrial ecosystems** the following mitigation options were considered and discussed:

No mitigation

This will result in the greatest impact by destroying the terrestrial biota on a permanent basis. Should no mitigations be put in place, the identified impacts will result in the following:

- Loss of plant communities. Plant communities occurring in the grassland portions of the mining area will be lost due to the disturbance caused by total clearing of the land for the construction of mine infrastructure and open pit mining activity.
- Loss of plant red data species. Red data floral species that may occur in sites to be disturbed will be destroyed by project activities.
- Reduction of plant diversity. Sites cleared of vegetation will destroy species restricted to that particular site of operation. Due to the extent of this project, sites where plants with limited habitat preference occur, such as on wetland fringes, those plants will be destroyed, thereby diminishing species diversity in the mining area.
- Loss of faunal communities. Faunal communities will be lost due to the destruction of vegetation and soil structure that provide the habitat for the fauna occurring in the region.

- Loss of faunal red data species. Many of the faunal red data species potentially occurring in the mining area have limited tolerance for disturbance due to specific habitat requirements that will be de destroyed by the removal of plants and soil.
- Reduction of faunal diversity. Sites cleared of vegetation will destroy animal species restricted to that particular site of operation. Due to the extent of this project, sites where animals with limited habitat preference occur, such as on wetland fringes, those animals will be destroyed, thereby diminishing species diversity in the mining area.
- Dust. Wind driven dust that settle on the vegetation will have effects such as reduced vigour of growth due to reduced transpiration of plants and reduced reproductive capacity caused by dust settling on the leaves and flowers.
- Invasive species. Sites disturbed by the mining activity will be prone to infestation by a variety of invasive exotic species, thereby diminishing natural biodiversity and limiting natural ecosystem processes.
- Loss of grazing land. Grazing land serves as habitat for the faunal species of the area, including red data species. Animals that are dormant, burrowing, territorial and females with young in nests will not move away.
- Loss of crop fields. Crop fields serve as habitat for the faunal species of the area, including red data species. Animals that are dormant, burrowing, territorial and females with young in nests will not move away.
- Increased human activity. Increased human movement, vehicular traffic, heavy machinery and noise will drive sensitive species such as birds, including the Vulnerable Blue and Crowned cranes away.

Avoidance

- Due to the nature of the proposed mining method (Strip mining) this is not considered to be an appropriate option.

Minimization

- Dust suppression. Reduce dust generating areas by tarring road surfaces, avoid large areas of cleared vegetation and revegetate cleared areas.
- Invasive species. Implement an invasive species eradication program immediately after disturbance of the environment starts in order to prevent or limit numbers of invasive plants and invasive species.
- Loss of grazing land. Catch and release, in another suitable area, small mammals and herpetofauna.
- Increased human activity. Impose speed limits and restrict human and vehicular movement to specific demarcated areas.

Rectification

- Loss of plant communities. Relocate and maintain a representative sample of plant species in a nursery for use in rehabilitation during the life of the project.
- Loss of red data plant species. Search for red data species and relocate them to a nursery during the active growth season. Use relocated species in the rehabilitation program.
- Reduction of plant diversity. Search for species with restricted distribution and relocate them to a nursery during the active growth season. Use relocated species in the rehabilitation program.
- Loss of faunal communities. Catch and release small mammals and herpetofauna in other suitable habitat close by.

- Loss of faunal red data species. Catch and release red data small mammals and herpetofauna in other suitable habitat close by.
- Reduction in faunal diversity. Catch and release small mammals and herpetofauna in other suitable habitat close by.
- Dust. Rehabilitate exposed areas immediately after completion of activity.
- Invasive species. Implement a rehabilitation program immediately after mining activity ceases on disturbed sites and continue rehabilitation and monitoring throughout the mining period.
- Loss of grazing land. Rehabilitate land with an objective to restore biodiversity to a predetermined state or to a land use which conforms to the generally accepted principle of sustainable development
- Loss of croplands. Rehabilitate land with an objective to restore biodiversity to a predetermined state or to a land use which conforms to the generally accepted principle of sustainable development.
- Cumulative impacts. Rehabilitate on a continuous basis for the full duration of the project and continue there-after until such time as other activities can be resumed.

Reduction

- Not considered to be an appropriate option.

Compensation

- Dust. Compensate neighbours for loss of reproductive capacity.

Mitigations for the identified **aquatic ecosystem** impacts were discussed. These arise from an attempt to avoid, minimise, rectify, reduce or compensate for a specific impact. No mitigation was also accounted for in the development of the mitigations.

None

Should no mitigations be put in place, the identified impacts will result in the following:

- Pans within the proposed coal footprint will be lost;
- Impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota;
- Impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota;
- Impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota;
- Impacts to the habitat availability will be greatest, with further impacts on the water quality and wetland and aquatic biota;
- Impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem;
- Impacts to the aquatic macroinvertebrate taxa will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; and
- Impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem.

No mitigation is therefore considered to be a worst-case scenario and will result in the greatest impact to the aquatic ecosystems both within the project area and the areas adjacent to and downstream of the project area. These impacts will be permanent and may result in a complete collapse of the aquatic ecosystems within the local area, impacting further downstream on the Komati River catchment.

Avoidance

The following avoidance mitigations were identified in the impact assessment:

- Preservation of riparian zones, marginal vegetation and the macro channel banks of rivers;
- All breeding, spawning and critical life-stage habitats within the project area must be identified and protected from any negative impacts as a result of the project;
- All breeding and or nesting sites and critical life-stage habitats within the project area must be identified and protected from any negative impacts as a result of the project;
- Limit river and or wetland diversions, additional river and or wetland crossings, and invasive construction into river and or wetlands throughout the project area and only have entrances and road access to sites from existing roads and infrastructure;
- Prevent any oils from entering the aquatic ecosystem. No oils or fuels from vehicles, machinery or generators should be allowed to enter the aquatic ecosystems, if accidiently allowed to enter, immediate clean-up action must be initiated to prevent further spread into the aquatic ecosystem;
- Prevent ground water and surface water recharge points from shifting locations due to mining activities;
- Prevent mine dewatering discharge into sensitive aquatic ecosystems, or wetlands;
- Prevention of runoff from site entering aquatic ecosystem. Suitable stormwater management, erosion prevention and runoff control measures should be constructed and managed so as to prevent any runoff into the aquatic ecosystems;
- Prevention of contaminated water entering the aquatic and wetland ecosystem. All contaminated water; both groundwater and surface water sourced, should be adequately contained or treated before being allowed to enter the aquatic ecosystem. Failure to do so will result in high impacts to the receiving environment;
- Remove water to storage dam for treatment or disposal. Water collected in the proposed mine pits should not be allowed to enter the aquatic and wetland ecosystems untreated. This water should be pumped and piped to a water treatment facility or storage dam for treatment before being allowed to be discharged or released into the aquatic ecosystems; and
- Create a buffer around the catchment of the pans outside the coalpit footprint area and create an adequate buffer zone around the riparian zone of the aquatic ecosystems and prevent any activities occurring within these buffer zones.

Minimization

The following minimization mitigations were identified in the impact assessment:

- Limit of cattle from entering rivers and wetlands in the project area, and mitigate and manage local cattle impacts on erosion;
- Create an adequate buffer zone around the wetland and riparian zone - in consultation with the aquatic and wetland ecologist, and prevent any activities within this buffer zone;
- Plan the location of river and wetland crossing structures and its design to minimise the impact on wetlands in consultation with the river and wetland ecologists.

- Minimise the amount of activity allowed within the created buffer zone of the pans, wetlands and river ecosystems;
- Avoid large-scale vegetation clearing;
- Clear only areas necessary for immediate construction;
- Storage of top soils, subsoils, overburden and coal in a way to prevent erosion, runoff and seepage into wetland ecosystems;
- Dam spills and introduction of exotic fish species should be prevented at all costs and if found, exotic species should be destroyed immediately;
- Implement good construction practices, whereby waste, degradation or destruction of the aquatic ecosystems is minimised or prevented;
- Construction of bridges, roads and other river crossing structures to be minimised and planned, designed and constructed in consultation with the aquatic and wetland ecologists
- Construction of silt traps, runoff storage dams and water clarification treatment plants for silted / sedimented water;
- Vehicles and generators must be kept away from wetlands, river and pans, all equipment must be properly maintained to prevent oils and fuels from accidently entering the aquatic ecosystems;
- Strip mining areas should not be left exposed or be contaminated with mine water or chemicals, treat all contaminated water to approved standards before release in the environment;
- Adhere to properly managed strip mining procedures;
- Proposed strip mining activities must be rehabilitated correctly;
- Strip mining areas should not be left exposed or be contaminated with mine water or chemicals;
- Storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic and wetland ecosystems;
- Prevent the indiscriminate use of groundwater or surface water within the project area;
- Untreated mine water should not enter the aquatic and wetland ecosystem;
- Controlled release of treated mine; and
- Containment of all groundwater and surface water and the treatment thereof before release into the aquatic ecosystems.

Implementation of these mitigations will minimise the impact to the aquatic ecosystems, however, an impact will still occur, these impacts will have to be rectified or rehabilitated.

Rectification

The following rectification mitigations were identified in the impact assessment:

- Rehabilitate the wetlands, pans and the buffer zones within the proposed mining rights area, outside of direct strip mining activities, on a continual basis during the operation phase of the project and during the closure phase. This will manage the impacts that are likely to occur from the immediate surrounding mining activities;

- Implement natural revegetation of exposed areas, using indigenous vegetation that was found in the baseline assessments in consultation with specialists;
- Revegetate all cleared land and strip mine areas as quickly as possible;
- Spills into the wetland and aquatic ecosystem must be contained effectively and immediately;
- Any sediment spills and chemical or mine water contamination into the wetland and aquatic ecosystem must be cleaned up immediately;
- Parking lots and fuel storage areas should be correctly bermed and storm water management systems constructed for protection from surface water runoff into the wetland and aquatic ecosystem;
- Rehabilitate strip mine areas and pits adequately and correctly;
- Rehabilitate any bank disturbances along the aquatic and wetland ecosystems;
- Red Data relocation actions of fauna and flora should be implemented during the construction phase and land-clearing phases of the strip mining operations;
- Set up of a nursery to house, maintain and grow indigenous unique, scarce and protected and Red Data floral species. This nursery should be contracted out to be maintained and managed by a horticulturalist;
- Exotic vegetation removal actions for introduced or encroaching exotics as a result of the project;
- Revegetation of all construction areas,
- Correct restructuring of geology, soils and specific layers within the mining footprint area so as to mimic the natural groundwater drainage and lateral movement; ;
- Rehabilitate the wetland and aquatic ecosystems in and around any river diversions on a continual basis during the construction, operation and closure phase;
- Rehabilitate any erosion or scouring immediately to prevent further impacts, rehabilitate strip mine areas and pits adequately;
- Large-scale impacts to specific marginal or breeding habitats of wetland bird and mammal species must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems;
- Large-scale impacts to specific wetland bird breeding and nesting habitats on pans and wetlands outside of the coal-pits, must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems;
- Large-scale impacts to specific aquatic habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems;
- Large-scale impacts to specific marginal or breeding habitats of aquatic macroinvertebrates must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems;
- Large-scale impacts to specific fish breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems;
- Reintroduce lost vegetation species once rehabilitation has taken place;

- Large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations (specifically the Conchostraca, Ostracoda and Copopoda groups in the pans), reintroduce species once rehabilitation has taken place;
- Large-scale impacts to specific marginal or breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; and
- Large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems. Rescue and relocate birds in similar habitats with active nests, owls (juveniles), moulting birds, etc.

While restoration of the original habitats, vegetation and systems is not possible, rehabilitation mitigations should try to mimic or resemble the original baseline states as far as possible. It is of utmost importance that the functionality of the project areas aquatic ecosystems is not lost or degraded to a state of ecosystem compromise or non-functionality. Therefore, all rectification mitigations need to be implemented in consultation with the aquatic, wetland and terrestrial ecologists.

Reduction

The following reduction mitigations were identified in the impact assessment:

- Avoid aquifer water transfer and seepage within the proposed coal footprint and strip mining areas;
- Wetting of dirt roads with water on a daily basis or sealing with dust sealant,
- Wetting of soil and coal stockpiles, and cleared areas during the drier months
- Placing speed limits on all dirt roads within the project area (e.g. Set a maximum speed limit of 20 km/hr);
- Use of wind buffering structures around exposed mining sites or open strip areas;
- Land not used for strip mining should not be cleared and all mining areas should be rehabilitated immediately;
- Vehicle and construction activity near the wetland and aquatic ecosystems should be kept to a minimum;
- Leave large trees and natural areas for offices, plant site gardens around dams and other infrastructure,
- Map and monitor groundwater and surface water recharge points;
- Monitor the water quality of the boreholes, springs, eyes and fountain source zones within the project area during the construction, operation and closure phases on a quarterly basis and mitigate immediately, should any contamination occur;
- Monitor groundwater recharge locations and seepage areas throughout the project;
- Institute a long-term riparian vegetation biomonitoring programme to monitor the success of vegetation rehabilitation. Mitigate further impacts;
- Institute a long-term habitat biomonitoring programme to monitor the success of habitat rehabilitation; Mitigate further impacts;
- Monitor the habitat availability of water birds and mammals within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases;

- Monitor sediment loads and water quality and metals concentrations in the adjacent and downstream aquatic ecosystems on a quarterly basis;
- Monitor the terrestrial, wetland and aquatic ecosystems of the pans and buffer zones within the coal footprint area, but not yet mined,on a a bi-annual (wet and dry season) basis and mitigate any further impacts immediately, restrict access to pans and the buffer zones;
- Monitor the channels banks of wetland and aquatic ecosystems and pans within the project area and mitigate any further impacts immediately, restrict access to the buffer zones;
- Monitoring any river diversions during construction and operation phases and mitigate any further impacts immediately;
- Monitor the health of the wetland and riparian systems and channel banks within the project area and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the riparian systems and macro channel habitats
- Monitor the habitat availability of the aquatic macroinvertebrates and fish within the project area on a bi-annual basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases;
- Monitor the species composition of the wetland and riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases; and
- Institute a long-term biomonitoring programme of the project aquatic ecosystems and mitigate any further impacts.

The reduction of the identified impacts requires the monitoring and management of all aspects of the aquatic ecosystems during the construction, operation and closure phases. Local or unforeseen impacts can therefore be mitigated immediately and the effects monitored and rehabilitation implemented. This will result in a reduction in impact.

Compensation

One compensation mitigation was identified in the impact assessment:

- To purchase, rehabilitate, monitor and manage three similar, but degraded or poorly-functioning pans and their catchments, for every pan lost on the project (Ferrar & Lotter, 2007), which are nearby the project area and obtain protected status for each pan within the Protected Areas Act. This entails that one pan and its catchments with similar water quality, habitat and biotic characteristics are indefinitely protected and restored to optimal functionality and integrity for every pan lost with the proposed project area. This will mean that Exxaro purchase, fence off and physically rehabilitate the pans and their catchments and then obtain protected status for each pan within the Protected Areas Act. No mining activities will be allowed to occur on these pans or catchments of the pans.

8.1.3 Assessment of significance of identified impacts

The impact assessment of the terrestrial sites is presented in Table 23.

The impact assessment of the rivers, wetlands and pans sites is presented in Table 25 to Table 29.

Table 23: Impacts related to terrestrial ecosystems

	Significance Score						Discussion	Possible mitigation measures
	Mag	**D**	**SS**	**P**	**Total**	**Significance**		
Loss of plant communities	**SBM**						Areas cleared of vegetation will destroy vegetation communities.	**NONE**- Plant communities will be lost; **AVOIDANCE**- N/a.; **MINIMIZATION**- N/a.; **RECTIFICATION**- Relocate and maintain a representative sample of plant species in a nursery to be contracted to a horticulturist contractor for use in rehabilitation during the life of the project; **REDUCTION**- N/a.; **COMPENSATION**- N/a.
	10	5	1	5	80	**High**		
	SAM							
	8	5	1	5	70	**Medium**		
Loss of plant red data species	**SBM**						Areas cleared of vegetation may contain red data species which will be destroyed.	**NONE**- Red data species will be lost; **AVOIDANCE**- N/a; **MINIMIZATION**-N/a; **RECTIFICATION**- Search for red data species and relocate them to a nursery to be contracted to a horticulturist contractor during the active growth season. Use relocated species in the rehabilitation program; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	4	5	1	5	50	**Medium**		
	SAM							
	2	5	1	5	40	**Low**		
Reduction of plant diversity	**SBM**						Areas cleared of vegetation will destroy species restricted to those areas.	**NONE**-Diversity will be lost; **AVOIDANCE**- N/a; **MINIMIZATION**; **RECTIFICATION**-Search for species with restricted distribution in the area and relocate them to a nursery to be contracted to a horticulturist contractor during the active growth season. Use relocated species in the rehabilitation program. **REDUCTION**- N/a; **COMPENSATION**-N/a.
	10	5	1	5	80	**High**		
	SAM							
	10	5	1	5	80	**High**		
Loss of faunal communities	**SBM**						Habitat of faunal communities, especially small mammals, birds, reptiles and arthropods will be destroyed	**NONE**- Faunal communities will be lostN/a; **AVOIDANCE**- N/a; **MINIMIZATION**- N/a; **RECTIFICATION**- **REDUCTION**-N/a; **COMPENSATION**-
	10	5	1	5	80	**High**		

	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	SAM						by removal of vegetation. Animals that are dormant, burrowing, and territorial and females with young in nests will not move away during mining.	N/a.
	10	5	1	5	80	**High**		
Loss of faunal red data species	SBM						Habitat of faunal red data species will be destroyed by removal of vegetation. Burrowing species with specialised requirements such as the golden moles will not be able to relocate in rehabilitated land.	**NONE**- Red Data faunal species will be lostN/a; **AVOIDANCE**- N/a; **MINIMIZATION**- N/a; **RECTIFICATION**- by; **REDUCTION**-N/a; **COMPENSATION**- N/a.
	10	5	1	5	80	**High**		
	SAM							
	10	5	1	5	80	**High**		
Reduction in faunal diversity	SBM						Habitat of faunal species will be destroyed by vegetation removal and construction activities. Rehabilitated land may never be suitable for burrowing species with specialised requirements, such as the golden moles.	**NONE**- Faunal diversity will be lostN/a; **AVOIDANCE**- N/a; **MINIMIZATION**- N/a; **RECTIFICATION**-N/a **REDUCTION**- N/a; **COMPENSATION**- N/a.
	10	5	1	5	80	**High**		
	SAM							
	10	5	1	5	70	**High**		
Dust	SBM						Activities associated with this mining operation will create dust that will settle in the environment within the mining area and areas surrounding the mining area, especially those areas of the dominant wind direction, thereby reducing vegetation growth vigor and generally reducing habitat integrity. Crop production and grazing quality will be negatively impacted.	**NONE**- Dust that settle in the surrounding environment will result in negative impact; **AVOIDANCE**- N/a; **MINIMIZATION**- Reduce dust generating areas by tarring road surfaces, avoid large areas of cleared vegetation, revegetate cleared areas; **RECTIFICATION**- Rehabilitate exposed areas immediately after completion of activity; **REDUCTION**- regular wetting of all exposed areas with potential of creating dust, impose speed limits on roads to reduce dust generation by traffic, use wind buffering structures or wind-row vegetation surrounding
	8	4	2	5	70	**Medium**		
	SAM							
	4	4	2	3	30	**Low**		

	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								appropriate areas; **COMPENSATION**- N/A
Invasive species	**SBM**						All disturbed areas will be susceptible to invasion by undesirable species.	**NONE**- Disturbed areas will be invaded by invasive plants; **AVOIDANCE**- N/a; **MINIMIZATION**- implement an invasive species eradication program immediately after disturbance of the environment starts in order to prevent or limit numbers of invasive plant species; **RECTIFICATION**- Implement a rehabilitation program immediately after mining activity ceases on disturbed areas and continue rehabilitation and monitoring throughout the mining period; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	8	5	1	5	70	**Medium**		
	SAM							
	2	5	1	5	40	**Low**		
Loss of grazing land, including pastures and grassland areas	**SBM**						Grazing land serves as habitat for the faunal species of the area, including Vulnerable birds such as Blue Crane and Crowned Crane and other red data species such as the Golden Moles. Animals that are dormant, burrowing territorial and females with young in nests will not move away during mining.	**NONE**- Habitat of faunal species will be lost; **AVOIDANCE**- N/a; **MINIMIZATION**- Catch and release in another suitable area small mammals and herpetofauna; **RECTIFICATION**- Rehabilitate land with an objective to restore biodiversity to a predetermined state or a land use which conforms to the generally accepted principle of sustainable development; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	10	5	1	5	80	**High**		
	SAM							
	10	5	1	5	80	**High**		
Loss of cropfields	**SBM**						Cropfields serve as habitat for the faunal species of the area, such as Blue crane and Crowned crane which are Vulnerable as well as other species such as Guinea fowl, Shelley's francolin and rodents.	**NONE**- Habitat of faunal species will be lost; **AVOIDANCE**- N/a; **MINIMIZATION**- N/a; **RECTIFICATION**- Rehabilitate land with an objective to restore biodiversity to a predetermined state or a land use which conforms to the generally accepted principle of sustainable development production potential to pre-mining standard; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	10	5	1	5	80	**High**		
	SAM							
	8	5	1	5	70	**Medium**		

	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Increased human activity	SBM						Disturbance caused by increased human movement, vehicular traffic, heavy machinery and noise will drive sensitive species such as birds, including the Vulnerable Blue crane and Crowned crane away.	**NONE**- Habitat of faunal species will be lost; **AVOIDANCE**- N/a; **MINIMIZATION**-Impose speed limits and restrict human and vehicular movement to specific demarcated areas; **RECTIFICATION**- N/a; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	8	5	3	5	80	**High**		
	SAM							
	6	5	3	5	70	**Medium**		
Cumulative impact	SBM						Cumulative impacts are those impacts that are caused by a combination of this project with other actions that occur in the region or that has lasting impact and which contribute to an incremental build-up of impacts.	**NONE**- Environment will be degraded, limiting other future activity; **AVOIDANCE**- N/a; **MINIMIZATION**- N/a; **RECTIFICATION**- Rehabilitate on a continuous basis for the full duration of the project and continue there-after until such time as biodiversity is restored to a predetermined state or a land use which conforms to the generally accepted principle of sustainable development.; **REDUCTION**- N/a; **COMPENSATION**- N/a.
	10	5	3	5	90	**High**		
	SAM							
	8	5	3	5	80	**High**		

Table 24: : Impact assessment of the water quality impacts to the aquatic ecosystems

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the aquatic ecosystems								
Loss or destruction of pans	SBM						Pans within the proposed coal footprints will be lost during the strip mining process.	**None** - the pans will be lost; **Avoidance** - create a buffer around the catchment of the pans and prevent any activities occurring within this buffer zone; **Minimization** - minimise the amount of activity within the buffer zone of the pans; **Rectification** - rehabilitate the pan and the buffer zone on a continual basis during the operation
	10	5	2	5	**85**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	8	5	2	5	**75**	**High**		phase of the project and during the closure phase; **Reduction** - monitor the aquatic ecosystem of the pans on a annual basis and restrict access to pans and the buffer zones. **Compensation** - purchase, rehabilitate and monitor and manage three similar, but degraded or poorly-functioning pans, for every pan lost on the project, which are nearby the project area and obtain protected status for each pan within the Protected Areas Act.
Dust generation and transportation	**SBM**						Clearing of vegetation, construction activities, the mining operations and storage of coal and stockpiles will generate dust that may settle on or enter the aquatic ecosystems, impacting water quality, especially during the drier months from April to September. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - N/A; **Minimization** -, avoid large-scale vegetation clearing, and protection of natural riparian vegetation around the aquatic ecosystems; **Rectification** - natural revegetation of exposed areas with consultation with the terrestrial ecologist; **Reduction** - wetting of dirt roads with water on a daily basis or sealing with dust sealant, wetting of soil and coal stockpiles, and cleared areas during the drier months, placing speed limits on all dirt roads (maximum 20 km/hr), use of wind buffering structures around exposed mining sites or open strip areas. **Compensation** - N/A
	8	4	2	5	**70**	**Moderate**		
	SAM							
	4	1	1	3	**18**	**Low**		
Increased soil sediment loads and coal sediments	**SBM**						Clearing of vegetation prior to construction, the construction activities and the removal of topsoil, coal seams 2, 3, 4 and 5 as well as the parting geological layers between the seams during the mining operation processes will generate sediment what may enter	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - prevention of runoff from site; **Minimization** - clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic ecosystems; create an adequate buffer zone around the
	8	4	3	5	**75**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	6	2	3	3	**33**	**Low**	the aquatic ecosystems, especially during the wet months from October to March. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment; **Rectification** - revegetate all cleared land as quickly as possible, clean up any sediment spills or contamination immediately; **Reduction** - monitor sediment loads and water quality and metals concentrations in the adjacent and downstream aquatic ecosystems; **Compensation** - N/A
Loss of catchment water yield	**SBM**						Groundwater and surface water recharge into the aquatic ecosystems may be reduced due to the mining activities, leading to impacts on dilution factor and water quality. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - N/A; **Minimization** - clearing of land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - N/A; **Reduction** - land not used for strip mining should not be cleared and all mining areas should be rehabilitated immediately, long term monitoring of rehabilitated areas and downstream aquatic and wetland ecosystems, to mitigate any long term impacts; **Compensation** - N/A
	8	5	3	5	**80**	**High**		
	SAM							
	6	4	3	3	**39**	**Low**		
Increased suspended solid concentrations	**SBM**						Increase in suspended solid concentrations at sites already characterised by high concentrations, which may lead to further water quality impacts. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - prevention of contaminated water entering the aquatic ecosystem; **Minimization** - containment of all groundwater and surface water contamination and the treatment thereof before release into the aquatic ecosystems, protection and rehabilitation of impacted riparian vegetation, and wetland vegetation, prevention of cattle from entering rivers and wetlands in the project area; **Rectification** - initiate immediate clean up of any
	8	3	2	5	**65**	**Moderate**		
	SAM							
	6	2	2	4	**40**	**Low**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								spills or contamination; **Reduction** - monitoring of water quality and metals; **Compensation** - N/A
Contamination of groundwater resources	**SBM**						Contamination of spring, eye and fountain source zones of the pans, wetlands and tributaries of the three river catchments, leading to toxicity, water quality impacts and metal contamination. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - prevention of groundwater seepage, aquifer contamination from mine pits and borehole contamination; **Minimization** - strip mining areas should not be left exposed or be contaminated with mine water or chemicals, treat all contaminated water before release in the environment; **Rectification** - clean up any spills immediately, rehabilitate strip mine areas and pits adequately; **Reduction** - avoid aquifer water transfer and seepage, monitor water of the boreholes, springs, eyes and fountain source zones; monitor groundwater recharge locations and seepage areas throughout the project area; **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	6	4	3	4	**52**	**Moderate**		
Mine water release from dewatering of mine pits	**SBM**						Contamination of the aquatic ecosystems from mine water release and dewatering of mine pits, leading to water toxicity and contamination. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - remove water to storage dam for treatment or disposal; **Minimization** - mine water should not enter the aquatic ecosystem; **Rectification** - clean up any spills immediately, rehabilitate strip mine areas and pits adequately; **Reduction** - water quality monitoring of the aquatic ecosystems; **Compensation** - N/A
	10	4	3	5	**85**	**High**		
	SAM							
	8	3	3	3	**42**	**Low**		
Oil from generators and vehicles	**SBM**						Oil from generators and vehicles may enter the aquatic ecosystem and lead to contamination of the water. This will impact on the pans within the proposed coal footprints, the pans outside of the	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - prevent any oils from entering the aquatic ecosystem; **Minimization** - vehicles and generators must be kept away from wetlands, river and pans, all
	8	3	2	4	**52**	**Moderate**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	SAM						coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	equipment must be properly maintained; **Rectification** - any spill should be cleaned up immediately, spills should be contained, parking lots and fuel storage areas should be correctly bermed and storm water management systems constructed for protection from surface water runoff; **Reduction** - vehicles activity near the aquatic ecosystems should be kept to a minimum; **Compensation** - N/A
	4	1	1	2	**12**	**Low**		
Bank disturbances	SBM						Bank disturbances, resulting in increased sediment input from erosion and subsequent water quality changes due to bank instability. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - preservation of riparian zones, marginal vegetation and the banks of rivers; **Minimization** - create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone; **Rectification** - rehabilitate any bank disturbances; **Reduction** - reduce the amount of activity near aquatic ecosystems, construction activities to be optimally rehabilitated near aquatic ecosystems; **Compensation** - N/A
	10	5	2	4	**68**	**Moderate**		
	SAM							
	6	2	1	3	**27**	**Low**		
Cumulative impacts	SBM						Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, leading to; increased erosion, flooding, sedimentation and bank instability; fluctuations in *in situ* water quality	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate
	8	5	3	5	**80**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	6	4	2	4	**48**	**Low**	parameters; and fluctuations in surface water monitoring parameters. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic ecosystems; create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - rehabilitate and cleanup any spills or disturbances to the aquatic ecosystems; **Reduction** - monitor the water quality of the project area on a quarterly basis; **Compensation** - N/A

Table 25: Impact assessment of the water quality impacts to the wetland ecosystems

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
Loss or destruction of pans and some wetland area.	**SBM**						Pans and some wetland area within the proposed coal footprints will be lost during the strip mining process. Wetlands in Section C will not be influenced by the mining operation.	**None** - the pans and some wetland area will be lost; **Avoidance** - create a buffer around the catchment of the pans and prevent any activities occurring within this buffer zone and create a buffer zone around wetland area; **Minimization** - minimise the amount of activity within the buffer zone of the pans and the wetlands; **Rectification** - rehabilitate pans and wetlands and buffer zones on a continual basis during the operation phase of the project and during the closure phase; **Reduction** - monitor the wetland ecosystem and pans on a quarterly year basis and restrict access to pans, wetlands and the buffer zones. **Compensation** - purchase, rehabilitate, monitor and
	10	5	2	5	85	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
	8	5	2	5	75	**Medium**		manage three similar pans or in the case of wetlands three time the size of wetlands that will be destroyed, but degraded or poorly-functioning pans and wetlands, for every pan and wetland lost on the project, that are nearby the project area and obtain protected status for each pan and wetland within the Protected Areas Act. This with the objective to achive a no net loss and it should result in a net gain for biodiversity and wetland functions over time (Ferrar and Lotter 2007).
Dust generation and transportation	**SBM**						Clearing of vegetation, construction activities, the mining operations and storage of coal and stockpiles will generate dust that may settle on or enter the wetland ecosystems, thus impacting water quality, especially during the drier months from April to September. This will impact on the pans and wetlands within the proposed coal foot prints, the pans and wetlands outside the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	**None** - impacts to the water quality will be greatest, with further impacts on the wetland habitats and wetland biota; **Avoidance** - N/A; **Minimization** - tarring of all roads within the project area, covering exposed stockpiles of soil and coal with plastic covers, avoid large-scale vegetation clearing, and protect natural wetland vegetation; **Rectification** - natural revegetation of exposed areas in consultation with the wetland ecologist; **Reduction** - wetting of dirt roads with water on a daily basis or sealing with dust sealant, wetting of soil and coal stockpiles, and cleared areas during the drier months, placing speed limits on all dirt roads (maximum 20 km/hr), use of wind buffering structures around exposed mining sites or open strip areas. **Compensation** - N/A
	8	5	2	5	75	**Medium**		
	SAM							
	6	2	2	3	30	**Low**		
Increased soil	**SBM**						Clearing of vegetation prior to	**None** - impacts to the water quality and habitat will be

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
sediment loads and coal sediments	10	5	3	5	90	**High**	construction, construction activities and removal of topsoil, coal seams 2, 3, 4 and 5 as well as the parting geological layers between the seams during the mining operation processes will generate sediment that may enter the wetland ecosystems, especially during the wet months from October to March. This can impact on the pans, Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. In the Section B wetlands the significance will be low after mitigation. The Section C wetlands will not be influenced by this impact.	the greatest, with further impacts on the wetland biota; **Avoidance** - prevention of runoff from site; **Minimization** - clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland ecosystems; create an adequate buffer zone around wetland ecosystems, specific to that system - in consultation with the wetland ecologist, and prevent any activities within this buffer zone, Construction of silt traps, runoff storage dams and water clarification treatment; **Rectification** - revegetate all cleared land as quickly as possible, clean up any sediment spills or contamination immediately; **Reduction** - monitor sediment loads and water quality and metals concentrations in the adjacent and downstream wetland ecosystems; **Compensation** - N/A.
	SAM							
	8	4	3	4	60	**Medium**		
Loss of catchment water yield	**SBM**						Groundwater and surface water recharge into the wetland ecosystems will be reduced due to the mining activities, leading to impacts on water yield, drainage patterns, dilution factor and water quality. This will impact on the pans within the proposed coal foot prints, the pans outside of the coal footprint, the	**None** - impacts to the water quality and water yield will be greatest, with further impacts on the wetland habitats and aquatic biota; **Avoidance** - N/A; **Minimization** - clearing of land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - N/A; **Reduction** - land not used for strip mining should
	10	5	3	5	90	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
	8	5	3	5	80	**High**	Leeuwbankspruit, Klein-komati River and the Driehoekspruit wetlands. The Section C wetlands should not be influenced by this impact.	not be cleared and all mining areas should be rehabilitated immediately, long term monitoring of rehabilitated areas and downstream aquatic and wetland ecosystems, to mitigate any long term impacts; **Compensation** - N/A
Increased suspended solid concentrations	**SBM**						Increase in suspended solid concentrations at sites already characterised by high concentrations, which may lead to further wetland habitat and water quality impacts. This will impact on the pans and wetlands within the proposed coal foot prints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. The Section C wetlands should not be influenced by this impact.	**None** - impacts to the wetland habitat and water quality will be greatest, with further impacts on the wetland biota; **Avoidance** - prevention of contaminated water entering the aquatic ecosystem; **Minimization** - containment of groundwater and surface water and the purification treatment thereof before release into the wetland ecosystems, protection and rehabilitation of impacted wetland vegetation, manage cattle entering rivers and wetlands in the project area according to relevant carrying capacities and after discussions with farmers; **Rectification** - initiate immediate clean up of any spills or contamination; **Reduction** - monitoring of water quality and metals; **Compensation** - N/A
	10	4	3	5	85	**High**		
	SAM							
	8	2	3	4	52	**Medium**		
Contamination of groundwater resources	**SBM**						Contamination of seepage, and spring, eye and fountain water source zones of the pans, wetlands and tributaries of the three river catchments, leading to water quality impacts such as toxiticity and metal contamination (Acid Mine Drainage). This can impact on the pans and wetlands within the proposed coal	**None** - impacts to the water quality and aquatic biota will be greatest, with further impacts on the aquatic habitats; **Avoidance** - prevention of groundwater seepage, aquifer contamination from mine pits and borehole contamination; **Minimization** - strip mining areas should not be left exposed or be contaminated with mine water or chemicals, treat all contaminated water to approved standards before release in the
	10	5	3	5	90	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
	10	5	3	5	90	**High**	foot prints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. The Section C wetlands should not be influenced by this impact.	environment; **Rectification** - clean up any spills immediately, rehabilitate strip mine areas and pits adequately; **Reduction** - avoid aquifer water transfer and seepage, monitor water of the boreholes, springs, eyes and fountain source zones; monitor groundwater recharge locations and seepage areas throughout the project area; **Compensation** - N/A
Mine water release from dewatering of mine pits	**SBM**						Contamination of the wetland ecosystems from mine water release and dewatering of mine pits, leading to water toxicity and contamination can occur. This can impact on the pans and wetlands within the proposed coal foot prints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and wetland biota; **Avoidance** - remove water to storage dam for treatment or disposal; **Minimization** - mine water should not enter wetland ecosystems; **Rectification** - clean up any spills immediately, rehabilitate strip mine areas and pits adequately; **Reduction** - water quality monitoring of the aquatic ecosystems; **Compensation** - N/A
	10	4	3	5	85	**High**		
	SAM							
	8	4	3	4	60	**Medium**		
Oil from generators and vehicles	**SBM**						Oil from generators and vehicles may enter the wetland ecosystem and lead to contamination of the water and habitat. This will impact on the pans and wetlands within the proposed coal foot prints, and can also impact on the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River -	**None** - impacts to the water quality will be greatest, with further impacts on the aquatic habitats and wetland biota; **Avoidance** - prevent any oils from entering the aquatic ecosystem; **Minimization** - vehicles and generators must be kept away from wetlands, river and pans, all equipment must be properly maintained; **Rectification** - any spill should be cleaned up immediately, spills should be contained,
	8	3	2	4	52	**Medium**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
	4	1	1	2	12	**Low**	and the Driehoekspruit wetlands.	parking lots and fuel storage areas should be correctly bermed and storm water management systems constructed for protection from surface water runoff; **Reduction** - vehicles activity near the aquatic ecosystems should be kept to a minimum; **Compensation** - N/A
Channel bank disturbances	**SBM**						Channel bank disturbances can cause bank instability, resulting in increased sediment input from erosion and subsequent water quality changes. This will impact on the wetlands within the proposed coal foot prints, and can also impact on the wetlands outside of the coal footprint, the wetlands in the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	**None** - impacts to the water quality and wetland habitat will be greatest, with further impacts on the wetland biota; **Avoidance** - preservation of riparian zones, marginal vegetation and the banks of rivers; **Minimization** - create an adequate buffer zone around the wetland zone of wetland ecosystems - in consultation with the wetland ecologist, and prevent any activities within this buffer zone; **Rectification** - rehabilitate any bank disturbances; **Reduction** - reduce the amount of activity near wetland ecosystems, construction activities to be optimally rehabilitated near aquatic ecosystems; **Compensation** - N/A
	10	5	2	4	68	**Medium**		
	SAM							
	6	2	1	3	27	**Low**		
Cumulative impacts	**SBM**						Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, leading to; increased erosion, flooding, sedimentation and bank instability; fluctuations in in situ water quality parameters; and fluctuations in surface water monitoring parameters.	**None** - impacts to the water quality and wetland habitat will be greatest, with further impacts on the wetland biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate construction, storage of
	10	5	3	5	90	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Water quality impacts to the wetland ecosystems								
	10	5	3	5	90	**High**	This will impact on the pans and wetlands within the proposed coal foot prints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland ecosystems; create an adequate buffer zone around the edge of wetland ecosystems - in consultation with the wetland ecologist, and prevent any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - rehabilitate and cleanup any spills or disturbances to the aquatic ecosystems; **Reduction** - monitor the water quality of the project area on a bi-annual (wet and dry season) basis; **Compensation** - N/A
Wetland Section A: Wetlands KS 01 - 20 and Pans 05-07,09,11-13								
Wetland Section B: Wetlands LS 08 - 16 and DS 06 - 08								
Wetland Section C: Wetlands DS 01 - 05, 09 - 14, LS 02 - 07, 17 and Pans 1-4, 10								

Table 26: Impact assessment of the habitat impacts to the aquatic ecosystems

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Macro-channel habitat loss or alteration								
Removal/destruction of aquatic ecosystem	**SBM**						Areas close to the coal footprint areas and the proposed plant construction sites will be cleared during the construction phases and certain areas of aquatic ecosystem habitats may be lost. Pans will be lost within the coal footprint area. Riparian zones may be impacted on near the boundaries of the coal footprint area. This will impact on the pans within the proposed coal footprints, some pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - the pans will be lost and impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - create a buffer around the catchment of the pans within the coal footprint area and prevent any activities occurring within this buffer zone; **Minimization** - minimise the amount of activity within the buffer zone of the pans, create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone; **Rectification** - rehabilitate the pans and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species; **Reduction** - monitor the terrestrial, wetland and aquatic ecosystems of the pans and buffer zones within the coal footprint area on a quarterly year basis and mitigate any further impacts immediately, restrict access to pans and the buffer zones. **Compensation** - purchase, rehabilitate and monitor and manage three similar, but degraded or poorly-functioning pans, for every pan lost on the project, which are nearby the project area and obtain protected status for each pan within the Protected Areas Act.
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	3	4	**64**	**Moderate**		
Riparian	**SBM**						Clearing of vegetation during the	**None** - impacts to the macro channel habitat will be

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
vegetation removal	8	5	2	5	**75**	**High**	construction and mining operations phases for the plant site, roads, railway and strip mining areas. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - avoid large-scale vegetation clearing, and protection of natural riparian vegetation around the aquatic ecosystems; **Rectification** - natural revegetation of exposed areas with consultation with the terrestrial, aquatic and wetland ecologist, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions; **Reduction** - only clear areas needed for immediate construction, leave large trees and natural areas for offices, plant site gardens and around dams and other infrastructure, monitor the aquatic and wetland vegetation on a bi-annual basis and mitigate any further impacts immediately. **Compensation** - N/A
	SAM							
	8	5	2	4	**60**	**Moderate**		
Bank disturbances	**SBM**						Construction of the mining infrastructure as well as the operational functions of the mine may result in disturbances to the wetland and river channel banks from vehicles, surface water runoff, sedimentation, exotic vegetation, and dust and vegetation removal. This will result in impacts to the aquatic and wetland ecosystems, especially during the wet months from October to March. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - create a buffer around the catchment of the pans within the coal footprint area, create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within these buffer zones; **Minimization** - minimise the amount of activity within the buffer zone of the pans and aquatic ecosystems, construction of bridges, roads and other river crossing structures to be minimised and planned, designed and constructed in consultation with the aquatic and wetland ecologists, manage cattle entering rivers and wetlands in the project area; **Rectification** - rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation
	8	5	2	5	**75**	**High**		
	SAM							
	6	2	5	4	**52**	**Moderate**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions; **Reduction** - monitor the channels banks of wetland and aquatic ecosystems and pans and mitigate any further impacts immediately, restrict access to the buffer zones. **Compensation** - N/A
Drainage pattern changes	**SBM**						Groundwater and surface water recharge into the aquatic ecosystems may be reduced due to the mining activities, leading to impacts on the catchment water yield and drainage patterns of the project area. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - prevent ground water and surface water recharge points from shifting locations due to mining activities, prevent mine dewatering discharge into sensitive aquatic ecosystems, or wetlands; **Minimization** - clearing of land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - natural revegetation of all construction areas and rehabilitated mining areas, correct restructuring of geology, soils and specific layers within the mining footprint area so as to mimic the natural groundwater drainage and lateral movement - this should be done in consultation with the geologists, geohydrologists, soil scientists and surface water specialists; **Reduction** - land not used for strip mining or immediate construction should not be cleared and all mining areas should be rehabilitated immediately, map and monitor groundwater and surface water recharge points, and long term monitoring of rehabilitated areas and downstream aquatic and wetland ecosystems, to mitigate any long term impacts; **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	2	4	**68**	**Moderate**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
River diversions	SBM						River diversions will be created at points where bridges, river crossings and other infrastructure need to be constructed or where the mining footprint enters the aquatic ecosystem. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - limit invasive construction throughout the project area and only have entrances and road access to sites from existing roads and infrastructure; **Minimization** - construction of bridges, roads and other river crossing structures to be minimised and planned, designed and constructed in consultation with the aquatic and wetland ecologists, protection and rehabilitation of impacted riparian vegetation, and wetland vegetation; **Rectification** - rehabilitate the wetland and aquatic ecosystems in and around the diversions on a continual basis during the construction, operation and closure phase , Red Data relocation actions, nursery to grow indigenous Red Data species; **Reduction** - monitoring the impacts on the rivers during construction and operation and mitigate any further impacts immediately, monitor rehabilitated river and wetland sections during the closure phase and institute a long-term biomonitoring programme to monitor the success of the rehabilitation; **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	3	4	**64**	**Moderate**		
In-stream channel habitat loss or alteration								
Dust generation and transportation	SBM						Clearing of vegetation, construction activities, the mining operations and storage of coal and stockpiles will generate dust that may settle on or enter the aquatic ecosystems, impacting on sedimentation and siltation of habitats, water column and habitat availability,	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - avoid large-scale vegetation clearing, and protection of natural riparian vegetation around the aquatic ecosystems; **Rectification** - natural revegetation of exposed areas with consultation with the terrestrial
	8	4	2	5	**70**	**Moderate**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	6	2	2	4	**40**	**Low**	especially during the drier months from April to September. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	ecologist; **Reduction** - wetting of dirt roads with water on a daily basis or sealing with dust sealant, wetting of soil and coal stockpiles, and cleared areas during the drier months, placing speed limits on all dirt roads (maximum 20 km/hr), use of wind buffering structures around exposed mining sites or open strip areas. **Compensation** - N/A
Increased soil sediment loads and coal sediments	**SBM**						Clearing of vegetation prior to construction, the construction activities and the removal of topsoil, coal seams 2, 3, 4 and 5 as well as the parting geological layers between the seams during the mining operation processes will impacting on sedimentation and siltation of habitats, water column and habitat availability, especially during the wet months from October to March. This will impact on the pans as well as the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - prevention of runoff from sites; **Minimization** - clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic ecosystems; create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment; **Rectification** - revegetate all cleared land as quickly as possible, clean up any sediment spills or contamination immediately; **Reduction** - monitor sediment loads in the adjacent and downstream aquatic ecosystems; **Compensation** - N/A
	8	4	3	5	**75**	**High**		
	SAM							
	6	4	3	4	**52**	**Moderate**		
Loss of catchment water yield	**SBM**						Groundwater and surface water recharge into the aquatic ecosystems may be reduced due to the mining activities, leading to impacts on dilution factor and water quality, resulting in a reduction in-stream flow, discharge and velocity of flow; and a reduction or shift in hydraulic	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - prevent ground water and surface water recharge points from shifting locations due to mining activities, prevent mine dewatering discharge into sensitive aquatic ecosystems, or wetlands; **Minimization** - clearing of
	10	5	3	5	**90**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	SAM						biotopes and in-stream habitat availability. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - natural revegetation of all construction areas and rehabilitated mining areas, correct restructuring of geology, soils and specific layers within the mining footprint area so as to mimic the natural groundwater drainage and lateral movement - this should be done in consultation with the geologists, geohydrologists, soil scientists and surface water specialists; **Reduction** - land not used for strip mining or immediate construction should not be cleared and all mining areas should be rehabilitated immediately, map and monitor groundwater and surface water recharge points, and long term monitoring of rehabilitated areas and downstream aquatic and wetland ecosystems, to mitigate any long term impacts; **Compensation** - N/A
	10	5	2	4	**68**	**Moderate**		
Mine water release from dewatering of mine pits	SBM						Uncontrolled release or discharge of water from the mine pits into pans, wetlands or the aquatic ecosystems will resulting in unnatural flushing of the aquatic ecosystems, unnatural flow regimes and scouring of downstream habitats. This will impact on the pans and the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - remove water to storage dam for treatment or disposal instead of discharging or releasing into aquatic ecosystem; **Minimization** - controlled release of treated mine water - in consultation with aquatic and wetland ecologists as well as surface water specialists; **Rectification** - rehabilitate any erosion or scouring immediately to prevent further impacts, rehabilitate
	10	4	3	5	**85**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	8	4	2	4	**56**	**Moderate**		strip mine areas and pits adequately; **Reduction** - habitat monitoring of the aquatic ecosystems on a bi-annual basis during construction and operation phases; **Compensation** - N/A
Bank disturbances	**SBM**						Bank disturbances, resulting in increased sediment input from erosion and subsequent bank instability. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - preservation of riparian zones, marginal vegetation and the banks of rivers; **Minimization** - create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer zone; **Rectification** - rehabilitate any bank disturbances; **Reduction** - reduce the amount of activity near aquatic ecosystems, construction activities to be optimally rehabilitated near aquatic ecosystems; **Compensation** - N/A
	8	5	2	5	**75**	**High**		
	SAM							
	6	4	1	4	**44**	**Low**		
Cumulative impacts	**SBM**						Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, leading to; increased erosion, flooding, sedimentation and bank instability; shifts in hydraulic biotopes, habitat losses or alterations and habitat availability changes. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the in-stream channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic ecosystems; create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within this buffer
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	2	4	**60**	**Moderate**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - rehabilitate and cleanup any spills or disturbances to the aquatic ecosystems; **Reduction** - monitor the habitats of the wetland and aquatic ecosystems of the project area on a seasonal basis, during construction, operation and closure phases; **Compensation** - N/A
Riparian vegetation habitat availability								
Bank instability	**SBM**						Clearing of vegetation, construction activities, the mining operations will lead to impacts on bank stability through erosion, scour, bank collapse, and groundwater reduction. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - avoid large-scale vegetation clearing, and protection of natural riparian vegetation around the aquatic ecosystems; **Rectification** - natural revegetation of exposed areas with consultation with the terrestrial, aquatic and wetland ecologists; **Reduction** - Monitor the health of the riparian systems and channel banks within the project area and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the riparian systems and macro channel habitats. **Compensation** - N/A
	10	5	2	5	**85**	**High**		
	SAM							
	8	5	2	4	**60**	**Moderate**		
Exotic vegetation encroachment	**SBM**						Clearing of vegetation, construction activities, the mining operations will lead to impacts on bank stability through erosion, scour, bank collapse, and groundwater reduction. This will result in exotic vegetation invasion and encroachment, with further impacts to bank instability or water quality changes.	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - create a buffer around the catchment of the pans within the coal footprint area, create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in consultation with the aquatic ecologist, and prevent any activities within these buffer zones; **Minimization** - minimise the
	10	5	3	5	**90**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	6	5	3	4	**56**	**Moderate**	This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	amount of activity within the buffer zone of the pans and aquatic ecosystems, construction of bridges, roads and other river crossing structures to be minimised and planned, designed and constructed in consultation with the aquatic and wetland ecologists, limit cattle from entering rivers and wetlands in the project area; **Rectification** - rehabilitate the pan, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions; **Reduction** - monitor the channels banks of wetland and aquatic ecosystems and pans and mitigate any further impacts immediately, restrict access to the buffer zones. **Compensation** - N/A
Aquatic macroinvertebrate habitat availability								
Loss or reduction of aquatic macroinvertebrate habitats	**SBM**						Impacts on sedimentation, siltation and flow reduction may result in certain flow habitats being lost or reduced (Stones-in-Current, Vegetation in current); certain habitats may be silted up or have sediment deposited over them (Stones, gravel, aquatic macrophytes), thus not being available for colonisation for certain aquatic macroinvertebrates taxa. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement macro channel and instream mitigations as far as possible; **Rectification** - a new habitat equilibrium will result due to shifts in habitat availability, however, large-scale impacts to specific habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability of the aquatic macroinvertebrates within the project area on a bi-annual basis and mitigate any further impacts immediately, this should be done during the construction, operation and
	10	4	2	5	**80**	**High**		
	SAM							
	8	4	1	5	**65**	**Moderate**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								closure phases, long-term biomonitoring of the aquatic macroinvertebrate habitat availability. **Compensation** - N/A
Adult or breeding stage habitat impacts	SBM						Adult stages have reduced habitat available for breeding due to marginal vegetation and aquatic macrophytes being covered in dust, exotic vegetation encroachment and bank instability. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement macro channel, riparian and instream mitigations as far as possible; **Rectification** - large-scale impacts to specific marginal or breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the riparian vegetation and habitat availability of the aquatic macroinvertebrates within the project area on a bi-annual basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the aquatic macroinvertebrate habitat availability and riparian vegetation. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	6	5	3	4	**56**	**Moderate**		
Ichthyofaunal (fish) habitat availability								
Loss or reduction of ichthyofaunal habitats	SBM						Loss or reduction of habitats, whereby certain flow habitats are lost or reduced (fast shallow and slow shallow biotopes, cover from suitable water column and marginal vegetation); certain habitats may be silted up or have sediment deposited over them (Stones, gravel, aquatic	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement macro channel and instream mitigations as far as possible; **Rectification** - a new habitat equilibrium will result due to shifts in habitat availability, however, large-scale impacts to specific
	10	5	3	5	**90**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	6	4	1	4	**44**	**Low**	macrophytes and marginal vegetation). This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability of the fish within the project area on a bi-annual basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the fish habitat availability. **Compensation** - N/A
Breeding, spawning and critical life-stage habitat impacts	**SBM**						Breeding, spawning and critical life-stage habitat may also be lost due to siltation, in-stream modifications, flow reductions or water quality changes. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - all breeding, spawning and critical life-stage habitats within the project area must be identified and protected from any negative impacts as a result of the project; **Minimization** - implement macro channel, riparian and instream mitigations as far as possible; **Rectification** - large-scale impacts to specific breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the flow regime and habitat availability of fish species within the project area on a bi-annual basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the fish habitat availability and seasonal flow regime. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	6	4	1	4	**44**	**Low**		

Table 27: Impact assessment of the habitat impacts to the wetland ecosystems

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
Channel, Permanent wet, seasonal wet and temporary wet habitat loss or alteration (This accounts for wetlands and pans)								
Removal/destruction of wetland ecosystem	**SBM**						Areas close to the coal footprint areas and the proposed plant construction sites will be cleared during the construction phases and certain areas of wetland ecosystem habitats may be lost. Pans and wetlands will be lost within the coal footprint area. Wetlands may be impacted on near the boundaries of the coal footprint area. This will impact on the pans and wetlands within the proposed coal footprints, some pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation the significance impact on wetlands in Section B will be medium and not applicable in Section C.	**None** - the pans and some wetland area will be lost; **Avoidance** - create a buffer around the catchment of the pans and prevent any activities occurring within this buffer zone and create a buffer zone around wetland area; **Minimization** - minimise the amount of activity within the buffer zone of the pans and the wetlands; **Rectification** - rehabilitate pans and wetlands and buffer zones on a continual basis during the operation phase of the project and during the closure phase; **Reduction** - monitor the wetland ecosystem and pans on a bi-annual (wet and dry season) basis and restrict access to pans, wetlands and the buffer zones. **Compensation** - purchase, rehabilitate, monitor and manage three similar pans or in the case of wetlands three time the size of wetlands that will be destroyed (Ferrar and Lotter 2007), but degraded or poorly-functioning pans and wetlands, for every pan and wetland lost on the project, that are nearby the project area and obtain protected status for each pan and wetland within the Protected Areas Act. This with the objective to achive a no net loss and it should result in a net gain for biodiversity and wetland functions over time.
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	3	5	**90**	**High**		
Wetland	**SBM**						Clearing of vegetation will take place	**None** - impacts to the wetland habitat will be greatest,

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
vegetation removal	10	5	2	5	**85**	**High**	during the construction and mining operations phases. This can impact on the wetlands and pans within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact should not influence wetlands in Section C.	with further impacts on the water quality and wetland biota; **Avoidance** - N/A; **Minimization** - avoid large-scale vegetation clearing, and protection of natural wetland vegetation around the wetland ecosystems; **Rectification** - revegetate exposed areas (making use of local indigenous vegetation) in consultation with an wetland ecologist, pursuit wetland Red Data species relocation actions, nursery to grow indigenous Red Data species, eradicate exotic vegetation; **Reduction** - monitor the wetland revegetated areas on a quarterly basis and mitigate any further impacts immediately. **Compensation** - N/A.
	SAM							
	8	5	2	4	**60**	**Medium**		
Wetland channel bank disturbances	**SBM**						Construction of the mining infrastructure as well as the operational functions of the mine may result in disturbances to the wetland and river channel banks. Resulted from vehicle movement, surface water runoff, sedimentation, exotic vegetation, dust and vegetation removal. This can impact on aquatic and wetland ecosystems, especially during the wet months from October to March. This can also impact on the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact may not influence wetlands in Section C.	**None** - impacts to the macro channel habitat will be greatest, with further impacts on the water quality and wetland biota; **Avoidance** - create an adequate buffer zone around the edge of the temporary wet zone of wetland ecosystems - in consultation with the wetland ecologist, and prevent any activities within these buffer zones; **Minimization** - minimise the amount of activity within the buffer zones of wetland ecosystems, the construction of bridges, roads and other wetlands crossing structures to be minimised and planned, it must be designed and constructed in consultation with the aquatic and wetland ecologists, Environmental officer and farmers to manage live stock (cattle) entering rivers and wetlands in the project area; **Rectification** - rehabilitate wetlands ecosystems on a
	10	5	3	5	**90**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	8	4	3	5	**75**	**Medium**		continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions; **Reduction** - monitor all rehabilitation in wetlands and channel banks and mitigate any further impacts immediately, restrict and manage access to all buffer zones around wetland areas. **Compensation** - N/A
Drainage pattern changes	**SBM**						Groundwater and surface water recharge and drainage patterns into wetland ecosystems may be influenced by mining activities, leading to impacts on the catchment water yield and drainage patterns of the project area. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact may have no influence on Section C wetlands.	**None** - impacts to the macro channel habitat will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - prevent ground water and surface water recharge points from shifting locations due to mining activities, prevent mine dewatering discharge into sensitive aquatic ecosystems, or wetlands; **Minimization** - clearing of land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - natural revegetation of all construction areas and rehabilitated mining areas, correct restructuring of geology, soils and specific layers within the mining footprint area so as to mimic the natural groundwater drainage and lateral movement - this should be done in consultation with the geologists, geohydrologists, soil scientists and surface water specialists; **Reduction** - land not used for strip mining or immediate construction should not be cleared and all mining areas should be rehabilitated immediately, map and monitor groundwater and surface water recharge points, and long term monitoring of rehabilitated areas and downstream aquatic and wetland ecosystems, to mitigate any long
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	3	5	**90**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								term impacts; **Compensation** - N/A.
River and wetland diversions	**SBM**						River and or wetland diversions will be created at points where bridges, river crossings and other infrastructure need to be constructed or where the mining footprint enters the wetland ecosystem. This can impact on the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact should not have influence on Section C wetlands.	**None** - impacts to the channel habitat will be greatest with further impacts to the different wet zones in the wetlands as well, water quality and wetland biota will be negatively influenced; **Avoidance** - prevent wetland diversions throughout the project area and only have entrances and road access to sites from existing roads and infrastructure; **Minimization** - Plan the location of river and wetland crossing structures and its design to minimise the impact on wetlands in consultation with the river and wetland ecologists. **Rectification** - rehabilitate the wetland and aquatic ecosystems in and around the diversions on a continual basis during the construction, operation and closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species; **Reduction** - monitoring the river diversions during construction and operation and mitigate any further impacts immediately, place temporary sediment trap structures to prevent sediment spillage during construction, monitor rehabilitated river and wetland sections during the closure phase and institute a long-term biomonitoring programme to monitor the success of the rehabilitation; **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	8	3	3	4	**56**	**Medium**		
Dust generation	**SBM**						Clearing of vegetation, construction	**None** - possible impacts on in-stream channel habitat

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
and transportation	8	4	3	5	**75**	**Medium**	activities, the mining operations and storage of coal and stockpiles will generate dust that may settle on or enter the wetland ecosystems, impacting on sedimentation and siltation of wetland and pan habitats and its water column, especially during the drier months from April to September. This may impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	and open water in pans will be greatest, with further impacts on wetland habitat, its water quality and wetland biota; **Avoidance** - N/A; **Minimization** - avoid large-scale vegetation clearing, and protection of natural riparian vegetation around the wetland and pan ecosystems; **Rectification** - natural revegetation (make use of local indigenous vegetation) of exposed areas in consultation with the terrestrial ecologist; **Reduction** - wetting of dirt roads with water on a daily basis or sealing with dust sealant, wetting of soil and coal stockpiles, and cleared areas during the drier months, placing speed limits on all dirt roads (maximum 20 km/hr), use of wind buffering structures around exposed mining sites or open strip areas. **Compensation** - N/A.
	SAM							
	6	3	4	4	**52**	**Medium**		
Increased soil sediment loads and coal sediments	**SBM**						Clearing of vegetation, removal of topsoil and mining processes will increase the availability of sedimentation to wetland and pan ecosystems especially during the wet months from October to March. An increase in sediment can smother wetland habitat that can lead to the loss of wetland functions. This will impact on the pans and wetlands within the proposed coal	**None** - impacts to wetland habitats and the edge habitat of pans will be great, with further impacts on the water quality and wetland biota; **Avoidance** - prevention of runoff from sites; **Minimization** - clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the aquatic ecosystems; create an adequate buffer zone around the riparian zone of the aquatic ecosystems - in
	10	5	3	5	**90**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	8	4	3	4	**60**	**Medium**	footprints, the wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This influence should not have influence on Section C wetlands.	consultation with the aquatic ecologist, and prevent any activities within this buffer zone, construction of silt traps, and water clarification treatment; **Rectification** - revegetate all cleared land as quickly as possible, clean up any sediment spills or contamination immediately; **Reduction** - monitor sediment loads in the adjacent and downstream aquatic ecosystems; **Compensation** - N/A.
Loss of catchment water yield	**SBM**						Groundwater and surface water recharge into the wetland ecosystems will be reduced and or changed due to mining activities removing catchment areas, leading to possible negative impacts on the water discharge pattern and position, velocity of flow; and a reduction or shift in wetland hydrology resulting in changes of wetland habitat availability. Further influences can be on the water dilution factor and eventually water quality. This should impact on the pans and wetlands within the proposed coal footprints, the wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact should not have influence on Section C wetlands.	**None** - impacts to wetland habitat and specifically channel habitat will be great, with further impacts on the water quality and aquatic biota; **Avoidance** - prevent ground water and surface water recharge points from shifting locations due to mining activities, prevent mine dewatering discharge into pans, sensitive aquatic ecosystems, or wetlands; **Minimization** - clearing of land kept to a minimum, proposed strip mining activities managed properly and rehabilitated correctly, prevention of indiscriminate groundwater or surface water usage; **Rectification** - natural revegetation of all construction areas and rehabilitated mining areas, correct restructuring of geology, soils and specific layers within the mining footprint area so as to mimic the natural groundwater drainage and lateral movement - this should be done in consultation with the geologists, geohydrologists, soil scientists and surface water specialists; **Reduction** - land not used for strip mining or immediate construction should not be cleared and all mining areas should be rehabilitated immediately, map and monitor groundwater and surface water recharge points, and long term monitoring of rehabilitated areas and downstream aquatic and
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	3	5	**90**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								wetland ecosystems, to mitigate any long term impacts; **Compensation** - N/A.
Mine water release from dewatering of mine pits	**SBM**						Uncontrolled release or discharge of water from the mine pits into pans, wetlands or the aquatic ecosystems will resulting in unnatural flushing of the aquatic ecosystems, unnatural high energy regimes and scouring of downstream habitats. This can have impacts on the pans and wetlands within the proposed coal footprints, the wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands.	**None** - impacts to wetland channel habitat and pans will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - remove mine water to storage dam for treatment or disposal instead of discharging or releasing into wetland and pan ecosystems; **Minimization** - controlled release of treated mine water in sustainable manner - in consultation with aquatic and wetland ecologists as well as surface water specialists; **Rectification** - rehabilitate any erosion or scouring immediately to prevent further impacts, rehabilitate strip mine areas and pits adequately; **Reduction** - habitat monitoring of the aquatic ecosystems on a quarterly basis during construction and operation phases; **Compensation** - N/A
	10	4	3	5	**85**	**High**		
	SAM							
	10	4	3	4	**68**	**Medium**		
Exotic	**SBM**						Clearing of vegetation, construction	**None** - impacts to wetland habitat will be great, with

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
vegetation encroachment	10	5	3	5	**90**	**High**	activities, the mining operations will lead to impacts on bank stability through erosion, scour, bank collapse, and groundwater reduction. This will result in exotic vegetation invasion and encroachment, with further impacts to wetland habitat such as habitat destruction, changes in the hydrological regime and the loss of wetland functions. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact should have low significance in Section C wetlands.	further impacts on the water quality and aquatic biota; **Avoidance** - create a buffer around the catchment of the pans within the coal footprint area, and the wetland ecosystems - in consultation with the wetland ecologist, and prevent mining activities within these buffer zones; **Minimization** - minimise and manage the amount of activity within the buffer zone of the pans and wetland ecosystems thus to prevent the spread of exotic invasive species, limit and manage cattle from entering rivers and wetlands in the project area; **Rectification** – Implement an invasive species eradication program immediately after disturbance took place in order to prevent or limit numbers of invasive plants and invacive species, rehabilitate pans, wetlands and aquatic ecosystems on a continual basis during the operation phase of the project and during the closure phase, exotic vegetation removal actions; **Reduction** - monitor wetland and aquatic ecosystems and pans and mitigate any further impacts immediately, restrict and/or manage access to the buffer zones. **Compensation** - N/A.
	SAM							
	6	5	3	4	**56**	**Medium**		
Cumulative impacts	**SBM**						Cumulative impact from existing agriculture impacts, surrounding mining activities as well as the proposed Exxaro Belfast project, on wetlands can lead to; increased erosion, flooding, sedimentation and bank instability; shifts in hydrological wet zones, habitat losses or alterations and habitat availability changes. This should impact on the pans and wetlands	**None** - impacts to wetlands and pans will be great, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent
	10	5	3	5	**90**	**High**		
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	10	5	3	5	**90**	**High**	within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact should have a low significance impact in Section C wetlands.	erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - rehabilitate and cleanup any spills or disturbances immediately to the wetland ecosystems; **Reduction** - monitor the habitats of the wetland and aquatic ecosystems of the project area on a quarterly basis, during construction, operation and closure phases; **Compensation** - N/A.
Water bird habitat availability								
Loss or reduction of water bird habitat	**SBM**						Impacts on wetland and pan removal, further sedimentation, siltation and flow reduction may result in certain wetland and pan habitats being lost or reduced (open water, grass/sedge, hydrophyte, sedge, etc); certain habitats may be silted up or have sediment deposited over them (grass/sedge, sedge, etc), thus not being available for colonisation for certain water birds. Specialist bird species such as flamingo's, certain ducks, cranes, and migratory species has got specific habitat needs; if habitat is altered or destroyed these species will also disappear. Generalist species such as Egyptian goose, yellow billed ducks, Spurwing Goose can still make use of degraded wetlands. This should impact on the pans	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - a new habitat equilibrium will result due to shifts in
	10	4	3	5	**85**	**High**		
	SAM							
	10	4	3	5	**85**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
							and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact may have a medium significance score on Section B wetlands and a low significance score on Section C wetlands after mitigation.	habitat availability, however, large-scale impacts to specific habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability of the water bird within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases. Long term monitoring should also take place; **Compensation** - N/A.
Small mammal habitat availability								
Loss or reduction of small mammal habitats	**SBM**						Loss or reduction of wetland and pan habitats (open water, grass/sedge, sedge, hydrophyte, etc); can result in a decrease in small mammal diversity and numbers. Specialist species has got specific habitat needs; if habitat is altered or destroyed these species will also disappear. Generalist species can still make use of degraded wetlands. This should impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, rehabilitate all cleared areas and strip mine pits progressively and immediately upon completion of activity, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within
	10	5	3	5	**90**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	SAM						impact will have a low significance score on Sections B and C wetlands after mitigation.	this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - a new habitat equilibrium will result due to shifts in habitat availability, however, large-scale impacts to specific habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability of small mammals within the project area on a quarterly basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases. Long term monitoring should also take place. **Compensation** - N/A.
	8	4	2	4	**56**	**Medium**		
Wetland Section A: Wetlands KS 01 - 20 and Pans 05-07,09,11-13								
Wetland Section B: Wetlands LS 08 - 16 and DS 06 - 08								
Wetland Section C: Wetlands DS 01 – 05, 09 - 14, LS 02 - 07, 17 and Pans 1-4, 10								

Table 28: Impact assessment of the biotic impacts to the aquatic ecosystems

	Significance Score							
Impacts	**Mag**	**D**	**SS**	**P**	**Total**	**Significance**	**Discussion**	**Possible mitigation measures**
Riparian and marginal vegetation, aquatic macrophyte and diatom diversity and abundances								
Loss of species diversity	**SBM**						Fluctuations in water chemistry, toxicity of water, microbial growth and algal blooms, sedimentation of marginal vegetation habitats, aquatic macrophytes and diatom covers areas, will result in a loss of sensitive vegetation species, thus impacting on the diversity of vegetation and diatom species in the project area. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions, reintroduce lost vegetation species; **Reduction** - Monitor the habitat availability and species composition of the riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a seasonal basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	10	3	2	5	**75**	**High**		
Change in species abundances	**SBM**						A loss of sensitive species or impacts to habitats may result in abundance changes, whereby numbers of individuals of certain species increase or decrease in response to the changes or impacts. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit,	**None** - impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost
	10	5	3	5	**90**	**High**		
	SAM							

	Significance Score							
	8	3	2	4	**52**	**Moderate**	Klein-komati River and the Driehoekspruit	habitat in critical areas of the aquatic and wetland ecosystems, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous Red Data species, exotic vegetation removal actions, reintroduce lost vegetation species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
Shifts in community structure	**SBM**						A loss of sensitive species and changes in species abundances will result in community structure changes to the vegetation within the project area. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations, reintroduce lost vegetation species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a bi-annual basis and
	10	5	3	5	**90**	**High**		
	SAM							
	8	3	3	4	**56**	**Moderate**		

	Significance Score							
								mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
Exotic species impacts	**SBM**						Disturbances to the vegetation within any of the aquatic or wetland ecosystems will result in invasion and encroachment of exotic plant species. This impact can give rise to further habitat changes such as increased bank stability or erosion potential and result in further impacts to the waster quality and biota. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, all vehicles must be washed before entering site to reduce exotic vegetation introductions; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations, reintroduce lost vegetation species once rehabilitation has taken place, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, exotic vegetation removal actions; **Reduction** - Monitor the habitat availability and species composition of the riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	3	4	**64**	**Moderate**		

	Significance Score							
Seed distribution and succession	**SBM**						Water quality and habitat impacts may lead to reduced seed distribution, germination and plant succession in the riparian, marginal and aquatic macrophyte vegetation species. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the riparian and marginal vegetation, aquatic macrophytes and diatoms will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations, reintroduce lost vegetation species once rehabilitation has taken place, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, exotic vegetation removal actions; **Reduction** - Monitor the habitat availability and species composition of the riparian and marginal vegetation, aquatic macrophytes and diatoms species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
	6	5	3	5	**70**	**Moderate**		
	SAM							
	6	4	3	4	**52**	**Moderate**		
Aquatic macroinvertebrate diversity and abundance								
Loss of aquatic macroinvertebrate taxa diversity	**SBM**						Fluctuations in water chemistry and toxicity of water may be lethal to sensitive taxa, microbial growth and algal blooms, sedimentation of habitats, marginal vegetation aquatic macrophytes losses, food availability, interference with the feeding mechanisms and flow reductions,	**None** - impacts to the aquatic macroinvertebrate taxa will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of
	8	5	2	5	**75**	**High**		

	Significance Score							
	SAM						will result in a loss of sensitive taxa, thus impacting on the diversity of macroinvertebrate in the project area. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations (specifically the Conchostraca, Ostracoda and Copopoda groups in the pans), reintroduce species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the aquatic macroinvertebrates within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic macroinvertebrates. **Compensation** - N/A
	8	5	2	4	**60**	**Moderate**		
Change in taxa abundances	**SBM**						A loss of sensitive species or impacts to habitats may result in abundance changes, whereby numbers of individuals of certain species increase or decrease in response to the changes or impacts. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the aquatic macroinvertebrate taxa will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations (specifically the Conchostraca, Ostracoda and Copopoda groups in the pans), reintroduce species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the aquatic macroinvertebrates within the project area on a Bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic macroinvertebrates. **Compensation** - N/A
	8	5	2	5	**75**	**High**		
	SAM							
	8	5	2	4	**60**	**Moderate**		

	Significance Score							
Shifts in community structure	**SBM**						Within the pans, shifts towards more freshwater dominants species may occur should water quality and habitat changes impact on the pan-specific macroinvertebrates. Within the streams and wetland areas, a shift towards tolerant species may occur as a result of the impacts.	**None** - impacts to the aquatic macroinvertebrate taxa will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations (specifically the Choncostraca, Ostracoda and Copopoda groups in the pans), reintroduce species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the aquatic macroinvertebrates within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic macroinvertebrates. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	6	4	2	5	**60**	**Moderate**		
Decrease in biotic integrity	**SBM**						Within the pans, shifts towards more freshwater dominants species may occur should water quality and habitat changes impact on the pan-specific macroinvertebrates. Within the streams and wetland areas, a shift towards tolerant species may occur as a result of the impacts. This will decrease the biotic integrity of the aquatic and wetland ecosystems in terms of aquatic macroinvertebrates	**None** - impacts to the aquatic macroinvertebrate taxa will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations (specifically the Choncostraca, Ostracoda and Copopoda groups in the pans), reintroduce species once rehabilitation has taken place; **Reduction** -
	10	5	3	5	**90**	**High**		
	SAM							

	Significance Score							
	8	4	2	4	**56**	**Moderate**		Monitor the habitat availability and species composition of the aquatic macroinvertebrates within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic macroinvertebrates. **Compensation** - N/A
Adult or breeding stage habitat impacts	**SBM**						Adult stages have reduced habitat available for breeding due to marginal vegetation and aquatic macrophytes being covered in dust, exotic vegetation encroachment and bank instability. This will impact on the pans within the proposed coal footprints, the pans outside of the coal footprint, the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement macro channel, riparian and instream mitigations as far as possible; **Rectification** - large-scale impacts to specific marginal or breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the riparian vegetation and habitat availability of the aquatic macroinvertebrates within the project area on a seasonal basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term biomonitoring of the aquatic macroinvertebrate habitat availability and riparian vegetation. **Compensation** - N/A
	10	5	3	5	**90**	**High**		
	SAM							
	6	5	3	4	**56**	**Moderate**		
Ichthyofaunal (fish) diversity and abundance								
Loss of fish species diversity	**SBM**						Low species diversity in the project area already exists, however, further impacts to the water quality and habitats of the aquatic and wetland ecosystems within the project area may result in a loss of further fish species within the project area. *B. anoplus* may be represented by two or	**None** - impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species
	8	5	2	5	**75**	**High**		

	Significance Score							
	SAM						more varieties within the project area and loss of populations may result in a loss of fish biodiversity. Exotic species encroachment due to Bass, Carp or Mosquito fish may result in further loss of species within the project area. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	should be destroyed immediately; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a seasonal basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A
	4	4	2	4	**40**	**Low**		
Change in species abundances	**SBM**						Abundances of fish species may be impacted on if water quality and habitat impacts occur. Exotic species encroachment due to Bass, Carp or Mosquito fish may result in further changes in the abundances of fish species (especially fry or juveniles) within the project area. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species should be destroyed immediately; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A
	6	5	2	4	**52**	**Moderate**		
	SAM							
	4	3	1	4	**32**	**Low**		
Shifts in	**SBM**						A shift towards exotic species may occur.	**None** - impacts to the fish species will be greatest,

	Significance Score							
community structure	6	5	3	4	**56**	**Moderate**	This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species should be destroyed immediately; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A
	SAM							
	4	4	2	4	**40**	**Low**		
Exotic species impacts	**SBM**						A shift towards exotic species may occur. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species should be destroyed and replaced with indigenous species during the rehabilitation phase; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland
	10	5	3	5	**90**	**High**		
	SAM							

	Significance Score							
	6	5	3	4	**56**	**Moderate**		ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A
Decrease in biotic integrity	**SBM**						Low species diversity in the project area already exists, however, further impacts to the water quality and habitats of the aquatic and wetland ecosystems within the project area may result in a loss of further fish species within the project area. Exotic species encroachment due to Bass, Carp or Mosquito fish may result in further loss of species within the project area. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species should be destroyed immediately; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A
	8	5	2	5	**75**	**High**		
	SAM							
	6	4	2	4	**48**	**Low**		
Breeding, spawning and critical life-stage habitat impacts	**SBM**						Breeding, spawning and critical life-stage habitat may also be lost due to siltation, in-stream modifications, flow reductions or water quality changes. This will impact on the Leeuwbankspruit, Klein-komati River and the Driehoekspruit	**None** - impacts to the fish species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement water quality and habitat mitigations as far as possible, dam spills and introduction of exotic species should be prevented at all costs and if found, exotic species
	10	5	3	5	**90**	**High**		

	Significance Score							
	SAM							
	6	4	1	4	**44**	**Low**		should be destroyed immediately; **Rectification** - large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems; **Reduction** - Monitor the habitat availability and species composition of the fish species within the project area on a bi-annual basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the fish. **Compensation** - N/A

Table 29: Impact assessment of the biotic impacts to the wetland ecosystems

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significanc e		
Riparian/marginal vegetation, sedge/aquatic macrophyte, sedge/grass and grass diversity and abundances								
	SBM							
Loss of species diversity	10	5	3	5	**90**	**High**	Fluctuations in water chemistry, toxicity of water, microbial growth and algal blooms, sedimentation of wetland vegetation habitats, sedge/aquatic macrophytes, can result in a loss of sensitive vegetation species and or communities, thus impacting on the diversity of vegetation species in the project area. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint,	**None** - impacts to the riparian and marginal vegetation will be greatest, with further impacts on the water quality and other aquatic biota within the wetland ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in
	SAM							

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	10	4	3	5	**85**	**High**	the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact can have a significance of medium on Section B wetlands and low on Section C wetlands.	consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous vegetation species and Red Data species, exotic vegetation removal actions, reintroduce lost vegetation species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the above species within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project. **Compensation** - N/A
	SBM							
Change in species abundances	10	5	3	5	**90**	**High**	A loss of sensitive species or impacts to habitats may result in abundance changes, whereby numbers of individuals of certain species increase or decrease in response to the changes or impacts. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-	**None** - impacts to the riparian and marginal vegetation will be greatest, with further impacts on the water quality and other aquatic biota within the wetland ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
	SAM						komati River - and the Driehoekspruit wetlands. This impact may be low on the Section C wetlands after mitigation.	ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous vegetation and Red Data species, exotic vegetation removal actions, reintroduce lost vegetation species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the vegetation species within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities. **Compensation** - N/A
	8	4	3	4	**60**	**Medium**		
Shifts in	**SBM**						A loss of sensitive species and changes	**None** - impacts to the riparian and marginal vegetation

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
community structure	10	5	3	5	**90**	**High**	in species abundances can result in community structure changes to the wetland vegetation within the project area. This may impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact may be low on the Section C wetlands after mitigation.	will be greatest, with further impacts on the water quality and other aquatic biota within the wetland ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, Red Data relocation actions, nursery to grow indigenous vegetation and Red Data species, exotic vegetation removal actions, reintroduce lost vegetation species once rehabilitation has taken place; **Reduction** - Monitor the habitat availability and species composition of the vegetation species within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the project aquatic vegetation and diatom communities.
	SAM							
	8	3	3	5	**70**	**Medium**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								Compensation - N/A.
Exotic species impacts	SBM						Disturbances to the vegetation within any of the aquatic or wetland ecosystems can possibly result in invasion and encroachment of exotic plant species. This impact can give rise to further habitat changes such as increased bank stability or erosion potential and result in further impacts to the water quality and biota. This may impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact can possibly be low on the Sections B and C wetlands after mitigation.	**None** - impacts to wetland habitat will be great, with further impacts on the water quality and aquatic biota; **Avoidance** - create a buffer around the catchment of the pans within the coal footprint area, and the wetland ecosystems - in consultation with the wetland ecologist, and prevent mining activities within these buffer zones; **Minimization** - minimise and manage the amount of activity within the buffer zone of the pans and wetland ecosystems thus to prevent the spread of exotic invasive species, limit and manage cattle from entering rivers and wetlands in the project area; **Rectification** – Implement an invasive species eradication program immediately after disturbance took place in order to prevent or limit numbers of invasive plants and invacive species, rehabilitate pans, wetlands and aquatic ecosystems on a continual basis during the operation phase of the project and during the closure phase, exotic vegetation removal actions; **Reduction** - monitor wetland and aquatic ecosystems and pans and mitigate any further impacts immediately, restrict and/or manage access to the buffer zones. **Compensation** - N/A.
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	3	4	**64**	**Medium**		
Seed distribution	SBM						Water quality and habitat impacts may	**None** - impacts to the riparian and marginal

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
and succession	10	5	3	5	**90**	**High**	lead to reduced seed distribution, germination and plant succession in the wetland vegetation species. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. This impact can possibly be low on the Sections B and C wetlands after mitigation.	vegetation, and sedge/aquatic macrophytes will be greatest, with further impacts on the water quality and other aquatic biota within the wetland ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations, reintroduce lost vegetation species once rehabilitation has taken place, rehabilitate the pans, wetlands and aquatic ecosystems banks and the buffer zones on a continual basis during the operation phase of the project and during the closure phase, exotic vegetation removal actions; **Reduction** - Monitor the habitat availability and species composition of the wetland species within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term biomonitoring of the wetland
	SAM							
	8	4	3	4	**60**	**Medium**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								vegetation communities. **Compensation** - N/A
Water Bird diversity and abundance								
Loss of water bird species diversity	**SBM**						Fluctuations in water chemistry and toxicity of water may be lethal to sensitive bird species, microbial growth and algal blooms, sedimentation of habitats, marginal vegetation aquatic macrophytes losses, food availability, interference with the feeding mechanisms and flow reductions, may result in a loss of sensitive species thus impacting on the diversity of bird species in the project area. This can further impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact can have a medium impact on Section B wetlands and a low impact on Section C wetlands.	**None** - impacts to the water birds will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue and relocation operations, release birds in similar habitats (specifically birds with active nests, owls
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	3	5	**90**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								(juveniles), moulting birds, etc.), **Reduction** - Monitor the habitat availability and species composition of the water birds within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term monitoring of the project water birds. **Compensation** - N/A
Change in water bird species abundances	**SBM**						A loss of sensitive species or impacts to habitats may result in abundance changes, whereby numbers of individuals of certain species increase or decrease in response to the changes or impacts. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact may have a low impact on Section B and C wetlands.	**None** - impacts to the water bird species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, all vehicles must be washed before entering site to reduce exotic vegetation introductions; implement water quality and habitat mitigations as far as possible; implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland
	10	5	3	5	**90**	**High**		
	SAM							
	10	5	3	5	**90**	**High**		

<table>
<tr><th rowspan="2">Impacts</th><th colspan="6">Significance Score</th><th rowspan="2">Discussion</th><th rowspan="2">Possible mitigation measures</th></tr>
<tr><th>Mag</th><th>D</th><th>SS</th><th>P</th><th>Total</th><th>Significance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>ecosystems, Red data and sensitive species rescue and relocation operations, release birds in similar habitats (specifically birds with active nests, owls (juveniles), moulting birds, etc.), Reduction - Monitor the habitat availability and species composition of the water birds within the project area on a quarterly basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term monitoring of the project water birds. Compensation - N/A.</td></tr>
<tr><td rowspan="4">Shifts in community structure</td><td colspan="6">SBM</td><td rowspan="4">Within the pans, shifts towards more freshwater dominants species may occur should water quality and habitat changes impact on the pan-specific water birds. Within the streams and wetland areas, a shift towards more generalist's species may occur as a result of the impacts. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact may have a low impact on Section B and C wetlands.</td><td rowspan="4">None - impacts to the water bird species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; Avoidance - N/A; Minimization - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, implement water quality and habitat mitigations as far as possible; implement water quality and habitat mitigations as far as possible; Rectification - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue</td></tr>
<tr><td>10</td><td>5</td><td>3</td><td>5</td><td>90</td><td>High</td></tr>
<tr><td colspan="6">SAM</td></tr>
<tr><td>8</td><td>5</td><td>3</td><td>5</td><td>80</td><td>High</td></tr>
</table>

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								and relocation operations, release birds in similar habitats (specifically birds with active nests, owls (juveniles), moulting birds, etc.), **Reduction** - Monitor the habitat availability and species composition of the water birds within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term monitoring of the project water birds. **Compensation** - N/A.
Decrease in biotic integrity	**SBM**						Within pans, shifts towards more freshwater dominants species may occur should water quality and habitat changes impact on the pan-specific water birds. Within the streams and wetland areas, a shift towards generalist species may occur as a result of the impacts. This may decrease the biotic integrity of the aquatic and wetland ecosystems in terms of water bird species. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact may have a low impact on Section B and C wetlands.	**None** - impacts to the water bird species will be greatest, with further impacts on the water quality and other aquatic biota within the aquatic ecosystem; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, implement water quality and habitat mitigations as far as possible; implement water quality and habitat mitigations as far as possible; **Rectification** - large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic and wetland ecosystems, Red data and sensitive species rescue
	10	5	3	5	**90**	**High**		
	SAM							
	10	4	2	5	**80**	**High**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								and relocation operations, release birds in similar habitats (specifically birds with active nests, owls (juveniles), moulting birds, etc.), **Reduction** - Monitor the habitat availability and species composition of the water birds within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately. This should be done during the construction, operation and closure phases, long-term monitoring of the project water birds. **Compensation** - N/A.
Breeding pair habitat impacts	**SBM**						Adult breeding pairs have reduced habitat available for breeding due to wetland vegetation being covered in dust, exotic vegetation encroachment and bank instability. This can impact on the pans and wetlands within the proposed coal footprints, the pans and wetlands outside of the coal footprint, the Leeuwbankspruit-, Klein-komati River - and the Driehoekspruit wetlands. After mitigation this impact may have a low impact on Section B and C wetlands.	**None** - impacts to the breeding habitat availability will be greatest, with further impacts on the water quality and aquatic biota; **Avoidance** - N/A; **Minimization** - implement good construction practices, adhere to properly managed strip mining procedures, clear only areas necessary for immediate construction, storage of topsoils, overburden and coal in a way to prevent erosion, runoff and seepage into the wetland and pan ecosystems; create an adequate buffer zone around wetland and the catchment of pans ecosystems - in consultation with the wetland ecologist, and limit and manage any activities within this buffer zone, construction of silt traps, runoff storage dams and water clarification treatment, manage local cattle impacts on erosion, implement water quality and habitat mitigations as far as possible; implement water quality and habitat mitigations as far as possible; implement macro channel, riparian and instream mitigations as far as possible; **Rectification** - large-scale impacts to specific marginal or breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic and wetland
	10	5	3	5	**90**	**High**		
	SAM							
	8	5	3	4	**64**	**Medium**		

Impacts	Significance Score						Discussion	Possible mitigation measures
	Mag	D	SS	P	Total	Significance		
								ecosystems; **Reduction** - Monitor the wetland vegetation and habitat availability of the water birds within the project area on a bi-annual (wet and dry season) basis and mitigate any further impacts immediately, this should be done during the construction, operation and closure phases, long-term water bird monitoring of the wetland habitat availability. **Compensation** - N/A.
Wetland Section A: Wetlands KS 01 - 20 and Pans 05-07,09,11-13								
Wetland Section B: Wetlands LS 08 - 16 and DS 06 - 08								
Wetland Section C: Wetlands DS 01 – 05, 09 - 14, LS 02 - 07, 17 and Pans 1-4, 10								

8.2 CONCLUSIONS OF THE IMPACT ASSESSMENt

From the results of the impact assessment, the following conclusions were made:

- The identified impacts to the aquatic and wetland ecosystems and pans consisted of impacts to the water quality, habitats and biotic components;
- Impacts associated with water quality are: loss or destruction of pans and wetlands; dust generation and transportation; increased soil sediment loads and coal sediments; loss of catchment water yield; increased suspended solid concentrations; contamination of groundwater resources; mine water release from dewatering of mine pits; oil from generators and vehicles; channel bank disturbances; and cumulative impacts;
- Impacts associated with channel, permanent wet, seasonal wet, temporary wet and aquatic macro-channel habitats are: removal/destruction of aquatic and wetland ecosystem; riparian and wetland vegetation removal; wetland channel bank disturbances; drainage pattern changes; river and wetland diversions; dust generation and transportation, increased soil sediment loads and coal sediments, loss of catchment water yield, Mine water release from dewatering of mine pits, exotic encroachment, and cumulative impacts.
- Impacts associated with Water bird habitat availability and aquatic in-stream channel habitats are: dust generation and transportation; increased soil sediment loads and coal sediments; loss of catchment water yield; mine water release from dewatering of mine pits; bank disturbances; and cumulative impacts.
- Impacts associated with Small mammal habitat availability are: dust generation and transportation; increased soil sediment loads and coal sediments; loss of catchment water yield; mine water release from dewatering of mine pits; bank disturbances; and cumulative impacts.
- Impacts associated with the aquatic riparian vegetation habitat availability are: bank instability and exotic vegetation encroachment;
- Impacts associated with the aquatic macroinvertebrate habitat availability are: loss or reduction of aquatic macroinvertebrate habitats; and adult or breeding stage habitat impacts;
- Impacts associated with the ichthyofaunal habitat availability are: loss or reduction of ichthyofaunal habitats; and breeding, spawning and critical life-stage habitat impacts;
- Impacts to the riparian and marginal vegetation, aquatic macrophyte and diatom diversity and abundances are: loss of species diversity; change in species abundances; shifts in community structure; exotic species impacts; and seed distribution and succession;
- Impacts to the aquatic macroinvertebrate diversity and abundance are: loss of aquatic macroinvertebrate taxa diversity; change in taxa abundances; shifts in community structure; decrease in biotic integrity; and adult or breeding stage habitat impacts;
- Impacts to the ichthyofaunal diversity and abundance are: loss of fish species diversity; change in species abundances; shifts in community structure; exotic species impacts; decrease in biotic integrity; and breeding, spawning and critical life-stage habitat impacts;
- Water quality impacts on the project area are rated as moderate to high before mitigations but were reduced to low for most of the impacts associated with the sites after mitigation, except for the loss of pans within the coal reserve and the contamination of the groundwater due to the mining activities;
- Aquatic, wetland and pan habitat impacts are rated as high, except for dust generation and transportation, which was rated as medium, before mitigation but were reduced in some cases to moderate to low significance after mitigations;

- Biotic impacts were rated as moderate to high before mitigations but after mitigations, which consisted of mostly water quality and habitat impact mitigations, the impacts are rated low to moderate, with the exception of the high impact of loss of biodiversity due to loss of natural resources; and

- Within the context of the project area, pans inside of the coal footprint area would be impacted higher than those outside of the coal footprint area; and that the Klein-komati River would be impacted higher than that of the Leeuwbankspruit- and Driehoekspruit as a result of being in-between the two proposed coal mining areas. The wetlands and pans occurring opposite and outside the catchments in which the coal mining will take place will have little to no impact.

9.0 HIGHLIGHTED IMPACT ASSESSMENT ITEMS

Based on the significance assessment of the identified impacts, the following items were highlighted as being the primary impacts where unique mitigations should be focused:

- Groundwater impacts to the aquatic ecosystems of the project area
  - Suitable rehabilitation of geological and soil layers to mimic the natural movement and drainage of water within the project area;
  - Monitoring of the seepage and source zone areas of the Leeuwbankspruit-, Klein-komati River - and Driehoekspruit; and
  - Construction of wetland habitat buffering areas where new seeps or groundwater recharge points may appear.

- Surface water impacts to the aquatic ecosystems of the project area
  - Construction of a water treatment plant required to treat the contaminated water of the proposed project and to protect the aquatic ecosystem from impacts associated with Acid Mine Drainage (AMD);
  - Use of pollution control dams bellow the mining site to act as traps for water quality and sediment impacts. These dams should be managed and regularly maintained, so as to allow for optimal trapping;
  - Surface flow reduction techniques must be investigated to prevent surface water erosion of river banks and channels. Release of treated water must also undergo flow reduction;
  - Silt traps should be constructed where farm dams or wetland areas will not cope with runoff impacts;
  - Wetland buffering areas should be constructed or rehabilitated where water quality and sediment impacts are concentrated;
  - Wetland rehabilitation should be done on all the wetlands in the project area. However, the focus should be in the Klein-komati River wetland area; and
  - Erosion control techniques must be investigated along the entire length of the three river channels within the project area and cattle must be prevented from creating erosion areas.

- Impacts to pans PAN7 and PAN11
  - Investigation into costs, feasibility and implementation of excluding these two pans from the coal footprint area and to rehabilitate them and maintain functionality is considered to be of importance; and

- Investigation into the abiotic systems that drive these two pans and to rehabilitate optimally in consultation with the geologists, soils scientists, geohydrologists, surface water specialist and the aquatic and wetland ecologists.

9.1 IMPACTS ASESSMENT RECOMMENDATIONS

Based on the conclusion and highlighted impacts of the project, the following recommendations were made:

- Inclusion of additional seasonal baseline data into the impact assessment;
- Exclusion of sites PAN7 and PAN11 from mining activities or to mine around them;
- Moving of plant site to outside of the catchment buffer of site PAN08 and outside the wetland seep zone occurring against the slope adjacent to the Klein Komati River valley bottom and hillslope seep wetland;
- Long-term seasonal biomonitoring of aquatic ecosystems on a quarterly basis, including water quality, aquatic habitats, riparian and wetland vegetation, diatoms, aquatic macroinvertebrates and fish;
- The development and implementation of a suitable Biodiversity Action Plan (BAP) for the project area, as stipulated in the Scope of Work;
- Red data rescue operations for fauna and flora that may be lost or degraded; and
- The set up of a suitable nursery for sensitive or Red data floral species and unique wetland plants that will be lost during the mining operation.

10.0 CONCLUSIONS

10.1 Terrestrial

The study area mostly consists of cultivated land with low ecological integrity, although these lands are used for foraging by several bird species, including birds classified as Vulnerable. The second largest area, namely grasslands, is used for grazing by livestock and includes areas containing pastures planted for grazing. Even though the results of the diversity survey indicated the diversity as “Reasonable” few typical highveld herbaceous plants that could be expected to occur were found. Wooded areas consist mainly of windbreaks planted with Eucalyptus trees although some areas seem to be utilised for small scale agro-forestry. These areas seem however to be poorly managed.

10.2 Wetland

The wetland systems associated with the study can be described as hillslope seepage wetlands feeding a water course, a valley bottom wetland with a well defined stream channel, a valley bottom wetland with no clearly defined channel and an endorheic pan.

In the valley bottom wetlands and seepage wetlands dominant vegetation consists mainly of Sporobolus africanus*, Arundinella nepalensis, Arundinella nepalensis, Monocymbium ceresiiforme, Eragrostis gummiflua Bulbostylis hispidula, Oxalis* spp.*, Nasturtium officinal, Crassula natans, Helichrysum aureonitens, Stoebe vulgaris, Schoenoplectus corymbosus, and Cyperus oxycarpus.* The pan systems hosted species such as *Cladium mariscus, Eriocaulon* spp.*, Typha capensis, Juncus effuses, Leersia hexandra, Eutricularia stilaris,* and *Schoenoplectus paliducola*. Exotic species posing a threat to the wetland systems are *Acacia mearnsii, Acacia decurrens, Eucalyptus spp., Populus canescens, Bidens pilosa* and *Verbena bonariensis and.*

Several small mammal species were identified such as Antbear, Serval, Bushpig, Water Mongoose and the Clawless Otter. Common bird species identified were Yellowbilled duck, Redbilled teal, Spurwinged goose, Egyptian goose, Blacksmith plover, Reed cormorant, Little grebe, Hadeda ibis, Cape shoveler, Purple swamphen, Sacred ibis, African spoonbill, Great white egret, White throated swallow, Cape wagtail and Redknobbed coots. The Hottentot teal identified is ranging on the edge of its distribution area. The Blue korhaan was also recorded several times during the survey. This bird is endemic to South Africa and parts of Lesotho, and is listed as Near Threatened on the IUCN Red List.

The biodiversity of the Driehoekspruit is not usually sensitive to flow and habitat modifications. These wetlands play a small role in moderating the quantity and quality of water of major rivers.

The headwaters of the Kleinkomati River are mostly not ecologically important and sensitive at any scale. However, the area downstream in the Kleinkomati River was rated as having a Moderate to High ecological importance and sensitivity, thus having biodiversity less sensitive to very sensitive to flow and habitat modifications and playing a role in moderating the quantity and quality of water of major rivers.

The source of the Leeuwbankspruit was rated as having biodiversity not usually sensitive to flow and habitat modifications and playing a small role in moderating the quantity and quality of water of major rivers. the wetlands downstream on the Leeubankspruit have biodiversity that is usually very sensitive to flow and habitat modifications. These downstream wetlands play a role in moderating the quantity and quality of water in major rivers.

The ecological importance and sensitivity of the pans ranged from Low/marginal to High, with the majority being Moderate.

The majority of the wetlands of the Driehoekspruit are moderately modified with some loss of natural habitat. The majority of the wetlands of the source of the Kleinkomati River are moderately modified with some loss of natural habitat. Thus the headwaters of the Kleinkomati River still has natural habitat left and still plays a role on the functioning of the system. The middle reaches, within the project area, of Kleinkomati River was rated as having a Very low present ecological status (falling outside of the acceptable range), little habitat and function remain in this area. The area further downstream, however, was less impacted and obtained a Moderate to High present ecological state.

The source of the Leeuwbankspruit ranged from Very low to Very high depending on the amount of agricultural impact upon each of the tributaries. From the confluence of the three uppermost tributaries the remainder of the Leeuwbankspruit within the project area obtained a High present ecological score.

The present ecological status of the pans and isolated hillslope seep zones ranged from Low to Very high, with the majority being High.

The poorest diversity (Using Shannons Diversity Index was recorded in the Driehoekspruit wetlands with average diversity status results encountered in the wetlands occurring in the Leeuwbankspruit and the Klein-komati River. The highest diversity was recorded in the Hillslope seep wetland at KS 16. The lowest status was recorded at DS 01 with a status of 0, this due to only *Leersia hexandra* recorded.

The Wetland Index of Habitat Integrity was applied to the three main valley bottom wetland with a clear channel that drains the study area. These systems can be described according to the standard DWAF ecological categories as C to C/D, indicating moderate modifications with a large loss of natural habitat, biota and basic ecosystem functions

The Driehoekspruit scored High for natural services, where the other two systems attained moderate natural services scores. Nine of the 15 pans received a high natural services rating, and the remaining six a moderate services rating. The Hillsope seep wetland attained a high score.

The Driehoekspruit and Kleinkomati River attained moderate scores for human services, while the Leeubankspruit attained a low score. Nine of the 15 pans and the hillslope seep received a low human services rating, two pans received a moderate score and the remaining four a very low services rating.

10.3 Aquatic

Based on the September and Decemeber 2009 survey results of the aquatic baseline assessment, the following conclusions were made:

- Due to the dry season conditions during the Septermber 2009 survey, limited flow was recorded within the rivers and streams within the project area. Many of the pan sites were dry. Flow increased during the December 2009 survey as well as the inundation of the pan sites. Sites PAN12 was still dry during the December 2009 survey

- Access to certain sites in the northern part of the project area (LS04, DS07, DS08, KS01 and KS03) was hindered due to access issues with a particular farmer and Exxaro;
- Water quality, based on the *in situ* parameters, indicated normal expected values at all of the sites. Increased flow due to recent rainfall and increased temparatures during the December 2009 survey were shown in the water quality parameters;
- Habitats of the sites within the project area indicated existing impacts and modified conditions due to agriculture and cattle impacts at all of the sites;
- Sites in the upper DriehoekspruitDriehoekspruit and in the pans, PAN3, PAN7 and PAN11 indicated the least modified habitat conditions, and near natural conditions;
- Habitat availability to aquatic macroinvertebrates indicated that poor availability was present at both sites within the DriehoekspruitDriehoekspruit. This was considered a result of poor flowing habitat availability at site DS05 and poor vegetation and flow habitats at site DS14. Habitat availability increased during the December 2009 survey, due to increased flow. The downstream sites on the Klein-komati River indicated adequate habitat availability and the downstream site in the Leeuwbankspruit indicated good habitat availability Habitat availability increased during the December 2009 survey due to increased flow;
- Aquatic macroinvertebrates in the river sites indicated very good biotic integrity at most of the sites except at one site in the upper Driehoekspruit which indicated largely impaired conditions. This was considered to be natural due to the fact that this site was predominantly a wetland area with minimal flow. The aquatic macroinvertebrate results corresponded with the IHAS results, except at site KS22, which indicated water quality impacts and a decrease in biotic integrity;
- Based on the Univariate Diversity Indices (UDIs) the highest levels of taxa richness and diversity were recorded at PAN03, PAN04, PAN08 and PAN13. The lowest levels of taxa richness and diversity were recorded at PAN05 and PAN01;
- The lowest levels of evenness were also recorded at PAN05 and PAN01 suggesting that these sites have been subject to high levels of anthropogenic impacts. The highest levels of evenness were recorded at PAN13, PAN03 and PAN04 suggesting that these sites have only been exposed to low levels of anthropogenic stress or that equilibrium has been reached after past impacts;
- Hierarchical Cluster analysis and Non-metric Multi-dimensional Scaling (NMDS) ordination of the aquatic macroinvertebrate revealed five groups of sites. The ANOSIM results confirmed that significant differences exist between the groups ($R > 0.75$);
- Sites PAN08 and PAN13 showed very low levels of similarity with the remaining sites;
- Ichthyofauna of the project area indicated that largely modified conditions were present in comparison to the expected fish species. One indigenous fish species (*Barbus anoplus*) was sampled throughout the project area, as the only species present. At site KS21, another indigenous fish species (*Pseudocrenilabrus philander*), as well as the highly invasive and exotic bass species: *Micropterus salmoides*, was sampled;
- B. anoplus may represent a range of species and is therefore considered to be of importance within the project area as populations of this species the upper tributaries of the Klein-komati River , may represent a different sub-species of populations further downstream in the Komati catchment. This may have significance for biodiversity of fish populations within Southern Africa;
- The presence of *M. salmoides* in the project area is considered to be of significance and may explain the poor fish species diversity in the area. Impacts as a result of the project may give rise to an increase in the population of *M. salmoides* and may reduce the indigenous fish populations further.

10.3.1 Aspects of ecological importance

Within the project area, aspects that are not be reflected as significant within the results of the aquatic ecosystem assessment may be of ecological importance or of critical conservation value due to specific ecological sensitivity or due to widespread loss of habitat within the national or regional context. A summary of these items from the results of the baseline assessment are presented in this section.

Unique pans based on macroinvertebrates

Pans PAN3, PAN7 and PAN11 are the only three pans in the project area with Choncostraca, Ostracoda and Copopoda macroinvertebrate groups. These three macroinvertebrate groups are unique to pans and temporary aquatic ecosystems within Southern Africa. These pans are considered to be of importance within the context of the project area due to the presence of these macroinvertebrate groups because of the food they provide to certain bird species that may use these pans along their migrational routes. Although not listed as endangered within the IUCN lists, temporary pans and freshwater ecosystems are under threat (Davis and Day, 1998), and thus the unique species such as the Choncostraca, Ostracoda and Copopoda macroinvertebrate groups and those that depend on them for food or survival are therefore also under threat.

Unique habitat types

Site PAN11 is considered to be unique in another aspect; this site indicated the highest EC and TDS values and the physical characteristics observed on site were unique to this pan only, within the project area. Shallow water depths and an oily, opaque water column with a hard substrate, typical of ephemeral, endorheic pans were observed. This site had typical pan macroinvertebrates, as shown in the results. This pan is thus considered to be of significance for migrational birds such as the Greater Flamingo (*Phoenicopterus roseus*) and the Lesser Flamingo (*Phoenicopterus minor*), both IUCN list species.

Aquatic biodiversity

The Choncostraca, Ostracoda and Copopoda macroinvertebrate groups are considered to be of biodiversity importance within the project area as these macroinvertebrates are unique to temporary systems within Southern Africa. Although not identified down to species level due to time and budget constraints, these groups may represent unique, rare or endangered species and should therefore be considered as important within the context of the project area.

B. anoplus, as discussed previously, may represent a range of fish species and is therefore considered to be of importance within the project area as populations of this species the upper tributaries of the Klein-komati River, may represent a different sub-species of populations further downstream in the Komati catchment. This may have significance for biodiversity of fish populations within Southern Africa

11.0 RECOMMENDATIONS

Based on the conclusion and highlighted impacts of the project, the following main recommendations were made:

- Move the plant site to outside of the catchment buffer of site PAN08 and off the wetland areas;
- Conduct long-term bi-annual biomonitoring of ecosystems including water quality, habitats, riparian vegetation, diatoms, aquatic macroinvertebrates, fish, as well as terrestrial fauna and flora;
- Develop and implement a Biodiversity Action Plan (BAP) for the project area once the seasonal baseline dataset is complete;
- Conduct Red data rescue operations for fauna and flora that may be lost or degraded during construction and operational phases;
- Construct a nursery for sensitive or Red data floral species which should be managed by a sub-contracted horticulturist; and
- Negotiate with landowners to gain access to properties not assessed during the baseline assessment in order to complete the study for the entire project area.

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APPENDIX A

SITE PHOTOS

APPENDIX B

AQUATIC MACROINVERTEBRATES

APPENDIX C

FLORAL SPECIES PREVIOUSLY FOUND IN THE STUDY AREA

APPENDIX D

RECORDED FLORAL SPECIES

APPENDIX E

PREVIOUSLY RECORDED HERPETOFAUNA

APPENDIX F

Previously recorded avifauna

Avifauna previously recorded in the grid squares 2529DD and 2530CC

APPENDIX G

AVIFAUNA FOUND DURING THE SURVEYS

APPENDIX H

Previously recorded mammals

Mammals that may be found in the grid squares 2529DD and 2530CC

APPENDIX I

MAMMALS RECORDED DURING THE SURVEY

APPENDIX J

WETLAND INTEGRITY

APPENDIX K

WETLAND IHI

APPENDIX L

WETLAND EIS

APPENDIX M

WETLAND SERVICES

APPENDIX N

IN SITU WATER QUALITY

APPENDIX O

EXPECTED ICHTHYOFAUNA

APPENDIX P

RECORDED ICHTHYOFAUNA

APPENDIX Q

DETAILED METHODOLOGY

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