

- Upstream of the Tutuka Power Station at DWA gauging station C11_177960, which is situated downstream of the New Denmark Colliery and upstream of the confluence of the tributary of the Leeuspruit, and
- Downstream of the Tutuka Power Station at DWA gauging station C11_90587 at Welbedacht 382 upstream of the Grootdraai Dam (**Figure 6.21**).

These monitoring stations provide minimum, maximum, median and 90th percentile values for the variables (**Table 6.10**) measured between the periods 1999 to 2007 (C11_177960) and 1974 to 2007 (C11_90587). The water quality at DWA site C11_90587 (downstream of the Tutuka Power Station) shows a decrease in quality compared to the upstream site. Constituents of concern are noted as: pH, electrical conductivity (EC), sodium, chloride, fluoride and sulphate (**Table 6.10**).

Table 6.10: Historical water quality for two DWA monitoring sites on the Leeuspruit (C11K)

Variable	Abbreviation	Unit	C11_177960			C11_90587		
			Min	90th percentile		Min	90th percentile	
			Max	Median		Max	Median	
Position in relation to Tutuka Power Station			Upstream			Downstream		
pH		H ⁺ ions	8.6	8.25		10.39	8.65	
			6.5	7.7	n=65	6.07	8.1	n=1240
Electrical Conductivity	EC	mS/m	239	46		491	159	
			17	33	n=65	10.8	44.2	n=1307
Total Dissolved Solids	TDS	ppm	-	-		3711	1072	
			-	-	n= -	73	340	n=1181
Calcium	Ca	mg/l	240	35.19		161	38.25	
			5.1	19.1	n=41	5.2	23.14	n=1212
Magnesium	Mg	mg/l	211	26.82		79.3	33.94	
			8.2	16.2	n=41	3.6	18.18	n=1212
Potassium	K	mg/l	-	-		13.45	7.83	
			-	-	n= -	0.43	5.3	n=1212
Sodium	Na	mg/l	57.8	34.65		983	252	
			3	20.5	n=27	5.41	33.23	n=1210
T Alkalinity	Tal	mg/l	182	180		496	289	
			170	176	n=2	20.7	138	n=1211
Chloride	Cl	mg/l	85	29.2		639	203	
			3	18	n=59	1.5	25.34	n=1217
Fluoride	F	mg/l	0.5	0.4		4.66	1.76	
			0.05	0.3	n=49	0.05	0.34	n=1211
Silica	Si	mg/l	-	-		12.82	9.62	
			-	-	n= -	0.2	6.42	n=1213

Variable	Abbreviation	Unit	C11_177960			C11_90587		
			Min	90th percentile		Min	90th percentile	
			Max	Median		Max	Median	
Position in relation to Tutuka Power Station			Upstream			Downstream		
Sulphate	SO4	mg/l	1360	86.5		1501	175	
			5	38	n=65	2	44.5	n=1215
Ammonia	NH4(N)	mg/l	7.5	0.55		10	0.1	
			0.05	0.3	n=65	0.015	0.04	n=1213
Nitrate	NO3(N)	mg/l	1.6	0.59		5	0.27	
			0.05	0.1	n=65	0.005	0.04	n=1237
Phosphate	PO4(P)	mg/l	3.4	0.3		2.6	0.15	
			0.05	0.05	n=64	0.003	0.05	n=1237
Total Phosphate	TP	mg/l	-	-		3.56	0.34	
			-	-	n= -	0.015	0.16	n=860

- **Expected Macroinvertebrate Species**

A list of macroinvertebrates expected to occur in the study area or indicating the possibility of occurrence was determined for the major drainage lines (**Table 6.11; Figure 6.24**). Each taxon was allocated a rating score of either 1, 3 or 5: a rating of 5 indicates that the specific taxon has been sampled within that sub-quaternary (SQ) reach and is likely to be sampled; a rating of 3 indicates that the taxon has not been sampled in the SQ reach but has been sampled in a similar SQ reach and the probability of occurrence has been extrapolated; a rating of 1 indicates that the taxon has not been sampled in the SQ reach or any other similar SQ reach but is thought to be potentially present taking into account the available habitat, water quality and associated land use activities. Only one relatively sensitive taxon is expected to occur within the study area, namely Leptophlebiidae, which has a sensitivity score of 9 out of a possible 15 (Gerber & Gabriel, 2002), representing a taxon that is moderately intolerant to alterations in water quality (pollution).

Table 6.11: Macroinvertebrate species expected to occur, or indicating the possibility of occurrence, in the different sub-tertiary reaches located within the study area. Taxa in red are considered sensitive taxa

ID	SS	A Leeuspruit	B Tributary of Leeuspruit	C Tributary of Vaal
Turbellaria	3	1	1	1
Oligochaeta	1	1	1	1
Hirudinea	3	1	1	1
Potamonautidae	3	1	1	1
Atyidae	8	1	1	1
Hydracarina	8	1	1	1
Baetidae > 2 Sp.	12	1	1	1
Caenidae	6	1	1	1
Leptophlebiidae	9	1	1	1
Coenagrionidae	4	1	1	1
Aeshnidae	8	1	1	1
Gomphidae	6	1	1	1
Libellulidae	4	1	1	1
Belostomatidae	3	1	1	1
Corixidae	3	1	1	1
Gerridae	5	1	1	1
Hydrometridae	6	1	1	1
Naucoridae	7	1	1	1
Nepidae	3	1	1	1
Notonectidae	3	1	1	1
Pleidae	4	1	1	1
Veliidae/Mesoveliidae	5	1	1	1
Hydropsychidae 1 Sp.	4	1	1	1
Hydroptilidae	6	1	1	1
Leptoceridae	6	1	1	1
Dytiscidae	5	1	1	1
Elmidae/Dryopidae	8	1	1	1
Gyrinidae	5	1	1	1
Hydrophilidae	5	1	1	1
Ceratopogonidae	5	1	1	1
Chironomidae	2	1	1	1
Culicidae	1	1	1	1
Muscidae	1	1	1	1
Simuliidae	5	1	1	1
Tabanidae	5	1	1	1
Ancyliidae	6	1	1	1
Physidae	3	1	1	1
Planorbinae	3	1	1	1
Corbiculidae	5	1	1	1
Sphaeriidae	3	1	1	1
SS = Sensitivity Score (Dickens & Graham, 2001)				

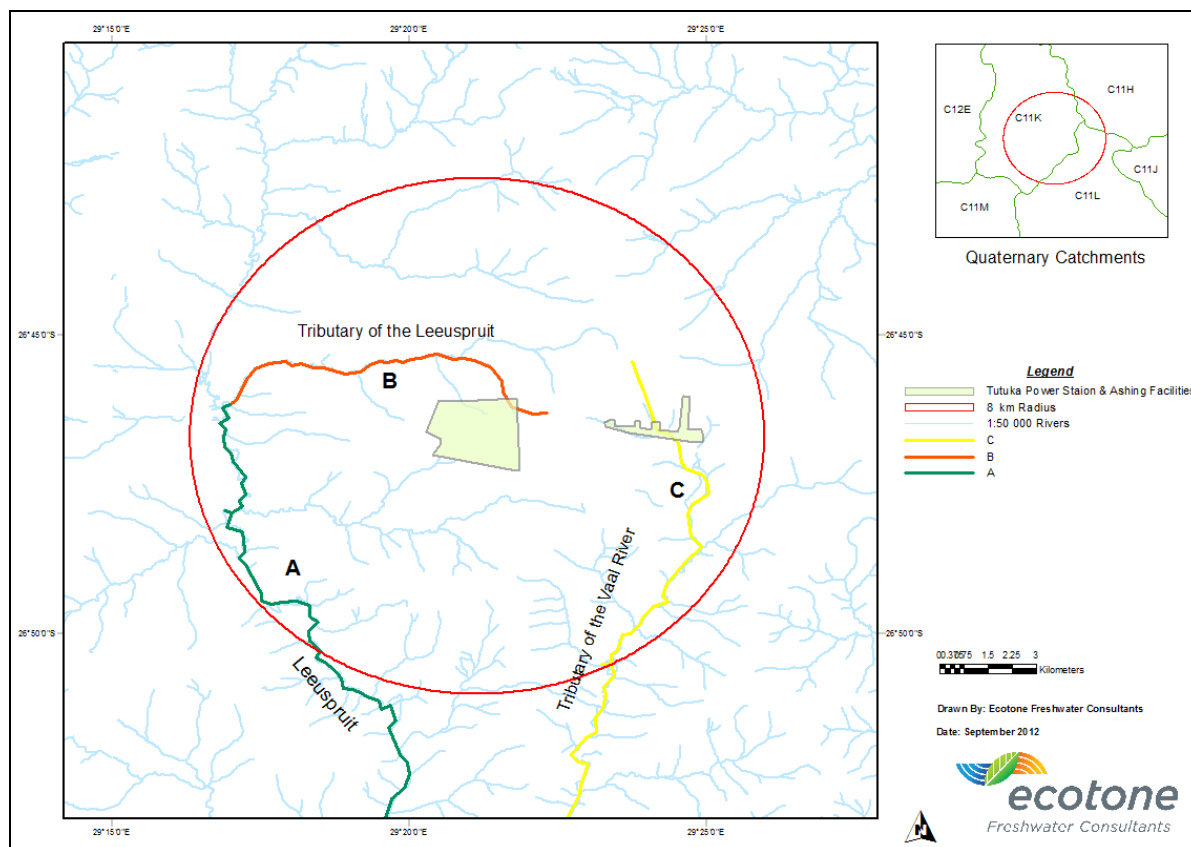


Figure 6.24: Sub-quaternary catchments related to the expected macroinvertebrate species list (Chief Directorate – Surveys and Mapping, 2629; Pers.Comm. Mrs. Christa Thirion, 2012).

• **Expected Fish Species**

A summary of the expected fish families, species and IUCN conservation status is provided in **Table 6.12**. The study area provides potential refuge for four fish families represented by approximately 12 species (Kleynhans et al., 2007; IUCN, 2012), none of which have conservation status and are listed as Least Concern (LC) by the IUCN (2012). *Barbus neefi* (Kleynhans et al., 2007) and *Barbus pallidus* (IUCN, 2012) are expected to occur in the study area and both species are moderately intolerant to alterations in water quality making them good indicators of ecosystem health.

Table 6.12: Fish species expected to occur, or indicating the possibility of occurrence, in the river systems located within the 8 km radius

Family	Genus and Species	Common Name	IUCN Status
Austroglanididae	<i>Austroglanis sclateri</i>	Rock Catfish	LC
Cyprinidae	<i>Barbus anoplus</i>	Chubbyhead Barb	LC
Cyprinidae	<i>Barbus neefi</i>	Sidespot Barb	LC
Cyprinidae	<i>Barbus pallidus</i>	Goldie Barb	LC
Cyprinidae	<i>Barbus paludinosus</i>	Straightfin Barb	LC
Clariidae	<i>Clarias gariepinus</i>	Sharptooth Catfish	LC

Family	Genus and Species	Common Name	IUCN Status
Cyprinidae	<i>Cyprinus carpio</i>	Common Carp	EX
Cyprinidae	<i>Labeobarbus aeneus</i>	Smallmouth Yellowfish	LC
Cyprinidae	<i>Labeo capensis</i>	Orange River Labeo	LC
Cyprinidae	<i>Labeo umbratus</i>	Moggel	LC
Cichlidae	<i>Pseudocrenilabrus philander</i>	Southern Mouthbrooder	LC
Cichlidae	<i>Tilapia sparrmanii</i>	Banded Tilapia	LC

LC: Least Concern; EX: Exotic

- **Expected Odonata (dragonflies) Species**

Approximately 60 Odonata species are expected to occur in the study area. All species are listed as LC according to the IUCN database (IUCN, 2012).

- **Expected Mollusca (snails, limpets) Species**

A total of 10 mollusc species are expected to occur in the study area, of which nine species are listed as LC. Only one species, namely *Burnupia caffra*, is listed as *Data Deficient (DD)* due to taxonomic uncertainty. *Burnupia caffra* are frequently unobserved during sampling surveys due to their extremely small size (2 - 4 mm). The genus *Burnupia* needs taxonomic revision as the numbers of species are extremely uncertain (Appleton et al., 2010).

Further detail can be obtained from the Surface Water Specialist Report in **Appendix K**.

6.3.10 Groundwater

The Department of Water Affairs (DWA) have produced a series of 1:500 000 scale hydrogeology maps (General Hydrogeology Map Series), that cover the whole of South Africa. Analysis of median borehole yields and aquifer types has allowed DWA to classify the aquifers of the country according to an alphanumeric code incorporating aquifer type and borehole yield, as presented in **Table 6.13** below.

Table 6.13: General Hydrogeology Map classification of South Africa

Aquifer Type	Borehole Yield Class (L/s)				
	Class "1" 0 - 0.1	Class "2" 0.1 - 0.5	Class "3" 0.5 - 2.0	Class "4" 2.0 - 5.0	Class "5" >5.0
Type "a": Inter-granular	A1	A2	A3	A4	A5
Type "b": Fractured	B1	B2	B3	B4	B5
Type "c": Karst	C1	C2	C3	C4	C5
Type "d": Inter-granular and fractured	D1	D2	D3	D4	D5

The DWA 1:500 000 scale hydrogeology map of the area (Sheet 2526 Johannesburg) shows that the area within an 8 km radius of the Tutuka power station is entirely classified