Achmmach Project

Preliminary water and sediment quality assessment of creek lines within the Achmmach Project area

July 2007

KASBAH Resources

Outback Ecology

Preliminary water and sediment quality assessment of creek lines within the Achmmach Project

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Executive Summary

Outback Ecology was commissioned by Kasbah Resources to undertake a baseline assessment of water quality within the Achmmach project area located in Morocco. The objective of this study was to describe the baseline conditions in terms of water quality and sediments of aquatic systems within the Achmmach project.

The creek lines of the project have been historically impacted by various land uses. Most of the riparian (fringing) vegetation of the creek lines has been removed and replaced by plantation or crops. There was evidence that the creek lines in the project area were frequently used by sheep and goats, most likely compromising the water quality.

Considering the historical impacts, water quality was acceptable, being similar to filtered bottled water sold within the country, and within the limits of accepted water quality guidelines (World Bank Environment, Health and Safety Guidelines).

In terms of salinity, all sites were classified as fresh. Also, low concentrations of most metals and low turbidity in comparison to relevant guidelines were a characteristic of water quality at this site. It should be noted that given the shallow nature and drought conditions experienced within the project areas, the parameters measured were most likely elevated due to evapo-concentration, in comparison to what may be recorded in wetter seasons. In that regard, the concentrations reported probably represent upper concentration limits for water chemistry, but more data is required to validate this.

Ground water in the Achmmach project area was relatively high in As, Fe and Mn and should be considered further if discharged to the environment.

In terms of sediment, there was considerable variation within sites of the Achmmach project area, most likely associated with local geology. Concentrations of all metals in sediment were lower than Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for protection of most biota.

In Australia, ANZECC recommend the use of site specific data over the use of guidelines and the collection of baseline data is critical to building these data sets. It would also be advantageous to collect data over seasons and from surrounding areas that may contribute to water quality within the project areas, prior to the commencement of operations.

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1.0 INTRODUCTION

Outback Ecology was commissioned by Kasbah Resources to undertake a baseline assessment of water quality within their Achmmach project. The project is located in Morocco in the north-west of Africa. The Achmmach project is located approximately 45 km southwest of the regional city of Meknes. While the mining operations of this site have been limited to exploration activities, the land-use of the area is predominantly grazing. Clearing of the riparian (fringing) vegetation has been extensive within the creek lines of the project area.

The objective of this study is to describe the baseline conditions in terms of water quality and sediments of aquatic systems within the Achmmach project area.

2.0 MATERIALS & METHODS

Water and sediment samples were collected at the Achmmach mining tenements from the 2nd of May to the 4th of May 2007 by Outback Ecology staff.

2.1 Site Locations

Creek lines of the tenements were surveyed and water samples were taken where pooled water was present. Sediment samples were collected opportunistically except in those locations where the watercourse had a rocky base and there was insufficient sediment to sample. In addition, groundwater was sampled on two occasions.

Table 1 Sample site locations and components tested (grid (AGD84) and location – Achmmach 30S)

Sample ID	Component sampled		Easting	Northing
	Water	Sediment		
ACH01	X		242 063	371 3978
ACH02	X		241 761	371 4388
ACH03	X		243 858	371 4038
ACH04	X	X	243 546	371 3848
ACH05	X		NA	NA
ACH06	X		243 205	371 4111
ACH07		X	243 548	371 5547
ACH08		X	243 594	371 5630
ACH09		X	244 349	371 5423

NA – not applicable, trip blank

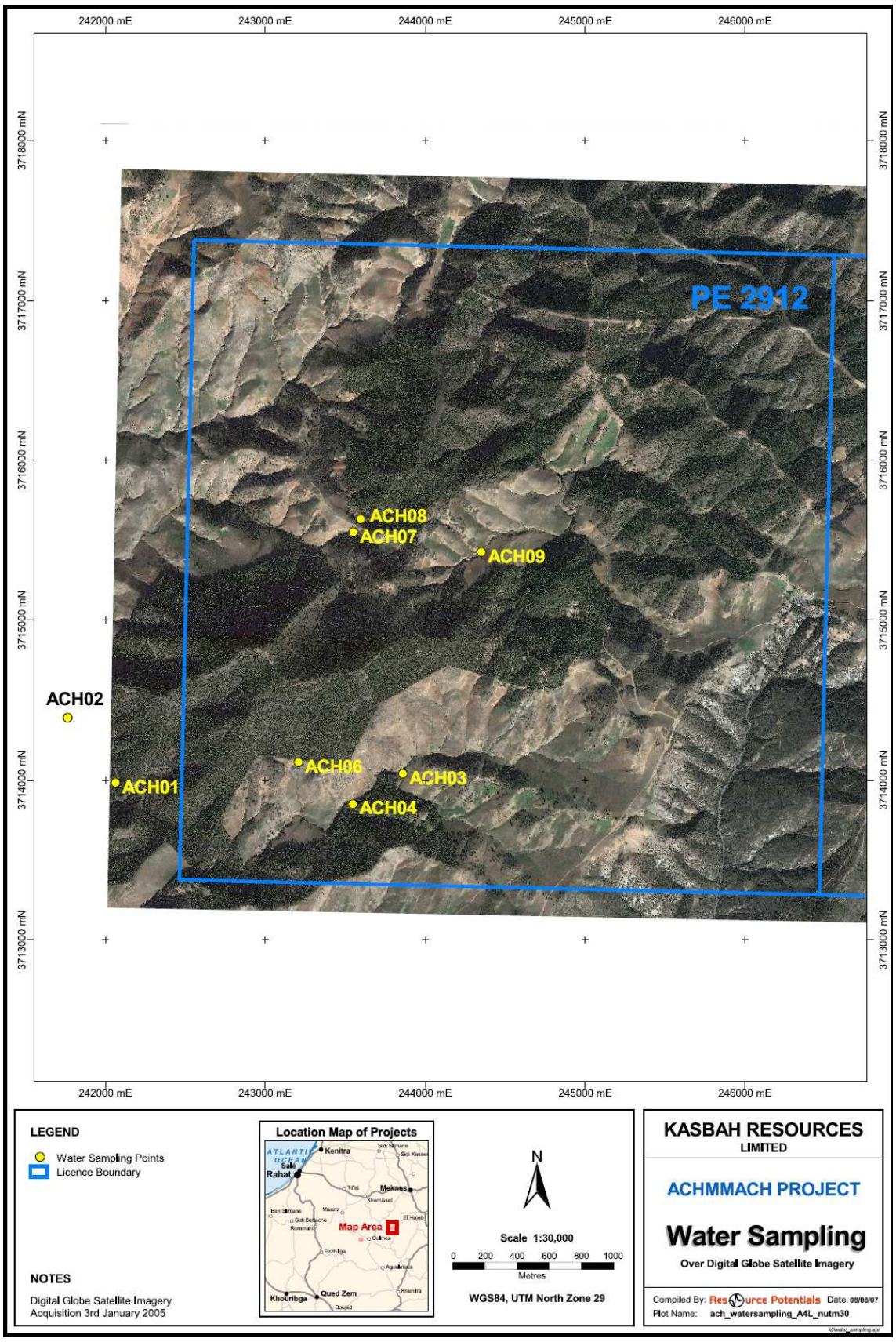

Figure 1 Map of sample sites

2.2 Climate

The climate of Morocco is defined as sub-tropical. In Meknès, the closest major town, the average maximum temperature in the summer months ranges between 30℃ and 33℃. In contrast during the winter months the average minimum values range between 6℃ and 12℃ (Weather to travel.com 2007). The annual average rainfall for Meknes is 575 mm, with a large portion of this rain falling in the winter months (Figure 2).

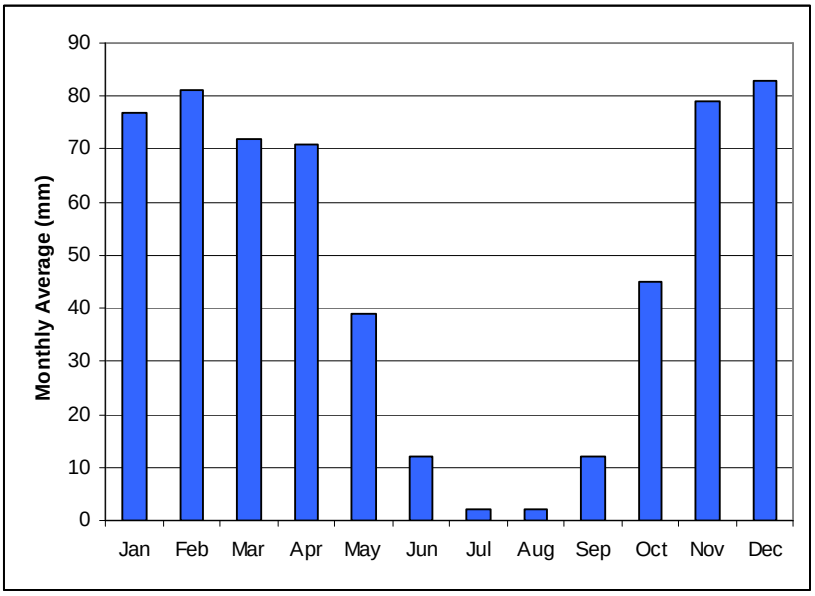

Figure 2 Long-term average monthly rainfall recorded at Meknes

2.3 Surface Water and Sediment Chemistry

Three sterilized sample bottles were filled with water, with all air excluded from each bottle, at each site. One of the bottles (125 mL) was filtered through an acetate cellulose 45 µm filter. For sediments, approximately 100 g of sediment was taken in a zip lock bag. Samples were stored in eskis, with ice-bricks and kept refrigerated until transported to the laboratory in Rabat.

In situ analysis of pH, electrical conductivity (EC), dissolved oxygen (DO) and temperature was conducted using the appropriate Windhaus calibrated handheld meters.

Bottled filtered water was sampled, which constituted a field blank sample (ACH05). The purpose of a blank sample is to determine if any external pollutants are contaminating the samples. Also a duplicate sample (i.e. two samples taken at the same location) was collected to test the reproducibility of the laboratory results.

Two laboratories were contracted to complete the analysis of the samples. The Onhym laboratory in Rabat analysed water samples for the following;

- pH, EC, total dissolved solids (TDS), total suspended solids (TSS), total alkalinity, mercury (Hg), sulphate (SO4) and chloride (Cl)

Onhym analysed sediment samples for;

- Moisture content (mc), sulphur (S), mercury (Hg), carbonate (CO3), chloride (Cl), sulphate (SO4), gold (Au), aluminium (Al), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), manganese (Mn), iron (Fe) and phosphorus (P)

Due to machine malfunctions at Onhym, the National Centre for Scientific and Technical Research (CNSTR) laboratory was commissioned to perform the following analysis in water;

- calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), gold (Au), aluminium (Al), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe (total)), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), vanadium (V), Zinc (Zn), Tin (Sn), arsenic (As) and silver (Ag)

The following analysis were completed within sediments

- barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), lithium (Li), molybdenum (Mo), nickel (Ni), lead (Pb), vanadium (V), Zinc (Zn), Tin (Sn), arsenic (As), silver (Ag)

While not presented in the original proposal, some additional parameters in surface water were tested and assessment of sediments occurred due to the lack of surface water at some sites.

Laboratory reports are presented in **Appendix A**.

Results for each parameter were compared to the World Bank Environment, Health and Safety standards where appropriate (World Bank 1995). Due to the absence of World Bank sediment guidelines, sediments were compared to Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for protection of aquatic biota.

In addition to the comparison with World Bank Guidelines, water quality at each site was compared to Moroccan guidelines which rate the water quality of certain toxicants as excellent, good, average, below average and poor (Appendix B). The average score was tabulated to give an overall rating for water quality at each particular site. Parameters which did not reach that standard were noted. For example Mn at some sites was higher than suggested to acheive excellent water quality.

2.4 Statistical Analysis

Multivariate analysis of data such as principal components analysis (PCA) was performed using the PRIMER (version 6) package. This procedure generates a graph (plot) on which sites with similar quality are located close together, while those with different chemistries are located further apart. Vectors representing the influence of the parameters are also present, with longer vectors indicating a

greater influence. The strength of the PCA results are explained in terms of percentage variation, a value that should exceed 60 % over the first two axes, in order to adequately represent the data set (Clarke and Warwick 2001).

3.0 RESULTS AND DISCUSSION

3.1 Site Descriptions

Site descriptions are provided for the different habitat types sampled at Achmmach.

3.1.1 Creek Line Sample Sites

Site ACH01

This site was located downstream of the historical mine shaft of the Achmmach mine. It was characterized by a wide rocky creek bed with steep rocky banks (**Plate 1**). Sediments of the site consisted of medium cobbles of granite and siltstone. The wetted creek bed was approximately 1.8 m wide to a depth of 0.25 m. The flow rate of the creek at this site was estimated to be approximately 0.1 m/sec. A brown filamentous algae was present, mainly on the fringes of the water body. Some *Oleanders* were present in the creek bed, however riparian vegetation was depauperate. In terms of biota a small frog, possibly *Rana ?saharica* was observed at this site.

(a) **(b)**

Plate 1 Sample site ACH01 facing (a) downstream and (b) upstream

Site ACH03

Site ACH03 was located approximately 1.8 km upstream of site ACH01. A small pool was present at this site (**Plate 2**). The creek bed was characterised by thinly bedded siltstone, covered by coarse sandy sediment. The creek line itself was discontinuous and approximately 6 m long, 1.1 m wide and 0.2 m deep. The riparian vegetation was dominated by dense stands of *Oleander*. Some filamentous algae was present in the water column. A frog (*Rana ?saharica)* was also observed.

Plate 2 Sample site ACH03

Site ACH04

Similar to site ACH03, this site was located on incised siltstone, covered in coarse gravel (**Plate 3**). There were no algae or macrophytes present, and riparian vegetation consisted of *Oleander* plants within the creek bed. The site consisted of a small discontinuous pool approximately 0.6 m wide by 0.1 m deep.

Plate 3 Sampling site ACH04

Site ACH07

Sample site ACH07 was dry during the site assessment (**Plate 4**). The banks were steep, estimated to range between 60° – 70°. The riparian vegetation consists of cork oak with grassy understorey. The sediments were characterised by coarse sandy material. Rounded cobbles were also present in the creek bed of this site.

Plate 4 Sample Site ACH07

Site ACH08

Like site ACH07, site ACH08 was dry during the assessment. Sediments of this site consisted of a greater clay fraction in comparison to the other Achmmach sites. A thick layer of litter was also present.

Plate 5 Sample Site ACH08

Site ACH09

This site was situated in a large incised gully with a rocky base (**Plate 6**). There was no water present at this site since during the assessment. Erosion was active at this site and bank slopes were very unstable. There was no riparian vegetation recorded, but planted crops were present on the surrounding slopes.

Plate 6 Sample site ACH09

3.1.2 Groundwater Sample Sites

Site ACH02

This site was located at a flowing drill hole (Plate 7). According to a drilling supervisor who was at the site at the time the groundwater sample was recovered, water was encountered at approximately 200 m depth during drilling of this bore. Water continues to flow freely from the bore. Some discolouration had occurred around the hole and this may be related to the presence of the concrete collar. White filamentous algae occurred at the bore entrance. Dissolved oxygen (DO) was very low (<0.4 ppm) in the groundwater as it exited the bore, however higher levels (around 8 ppm) were recorded in water approximately 2 m from the collar. The flow of water from the pipe was estimated to be around 2.5 L/min.

Plate 7 Sample site ACH02

Site ACH06

This site was located at the old mine shaft. Groundwater was collected from the tap just above the shaft.

Plate 8 Sampling water from the shaft at ACH06

3.1.3 Blank Sample

Site ACH05

Filtered water, bottled in the region, was used for this sample to constitute a blank sample. The typical analysis of the water, conducted in 1998, was the following;

- Na – 25.5 mg/L
- K – 2.8 mg/L
- Mg – 8.7 mg/L
- Ca – 12.02 mg/L
- Cl – 14.2 mg/L
- HCO_3 – 103.7 mg/L
- SO_4 – 41.7 mg/L
- NO_3 – 0.10 mg/L

3.2 Surface Water Chemistry

A number of basic water quality parameters were collected *in situ*, as it was unlikely that holding times would be met for some laboratory-assessed analytes (**Table 2**). All water samples collected from Achmmach reported an alkaline pH and salinity was classified as fresh (i.e. < 900 µS/cm). All surface water samples recorded dissolved oxygen (DO) concentrations exceeding 6.5 ppm. An artesian groundwater sample recovered at ACH04 recorded a dissolved oxygen reading of 0.4 ppm, however DO increased rapidly downstream of the bore entrance. All surface water sampling sites were shallow in terms of water depth with the maximum depth of creek lines within the project area not exceeding 0.25 m.

Table 2 *In situ* water data collected at Achmmach

Site	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (ppm)	Temperature (ºC)	Depth (m)
ACH01	7.54	487	7.37	17.2	0.25
ACH02	7.35	467	0.4	19.6	NA
ACH03	8.01	232	8.5	18.2	0.1
ACH04	7.25	197	6.85	17.4	0.1
ACH05			BLANK		
ACH06	7.77	474	NA	23.8	NA

There were some slight variations in water quality between sites in terms of other parameters such as metals and salts within the creek lines and groundwater of the project area (**Table 3**). Total suspended solids (TSS) remained below detection within all sites, indicating that the sediment load of the system was fairly minimal during the assessment.

Typically the major anions and cations of temporary streams record a standard ionic balance, with little change in this balance being recorded during seasons (Hart and McKelvie 1986). For the cations in this system all sites were dominated by calcium, with decreasing concentrations of cations in the order; Ca>Mg>Na>K (**Table 1**). For the anions, concentrations of Cl were lower than SO_4 in all samples, except at ACH01, where sulphate recorded the higher concentration.

Table 3 Water quality (in mg/L) recorded during the assessment of creek lines within the Achmmach project area during May 2007.

Site	Creek Line			Blank	Groundwater		World Bank**
	ACH01	ACH03	ACH04	ACH05	ACH02	ACH06	
pH	7.4	7.6	7.1	7.8	7.5	7.8	6 - 9
EC (µS/cm)	370	240	250	250	440	480	
TDS	289	190	209	227	306	349	
TSS	< 20	< 20	< 20	< 20	< 20	< 20	50
Ag	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	
Al	0.026	0.054	0.071	0.031	0.041	0.046	
As	0.002	0.006	0.004	<0.0036	0.118	0.066	1
Au	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	0.002	
Ba	0.014	0.01	0.001	0.032	0.078	0.082	
Be	0.0002	0.0003	0.0001	0.0002	0.0003	0.0001	
Bi	7.34	3.85	3.93	0.53	2.39	2.91	
Cd	0.0002	<0.0002	0.0001	0.0004	0.0002	0.0013	0.1
Co	0.0007	<0.0006	<0.0006	0.0007	<0.0006	<0.0006	
Cr	<0.0006	<0.0006	<0.0006	0.0006	0.0006	0.0007	1
Cu	0.024	0.011	0.012	0.008	0.012	0.009	0.3
Fe	0.01	0.02	0.01	<0.0006	0.53	0.17	2
Hg (µg/L)	< 1	< 1	< 1	< 1	< 1	< 1	0.002
Li	0.03	0.011	0.012	0.059	0.076	0.078	
Mn	0.006	0.004	0.003	0.001	0.178	0.172	
Mo	0.0006	0.0006	<0.0006	<0.0006	0.0008	<0.0006	
Ni	0.001	0.001	0.002	0.001	0.003	0.002	0.5
Pb	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	0.6
Sn	0.006	<0.0039	0.004	<0.0039	<0.0039	0.004	
V	0.001	0.001	<0.0006	0.006	0.001	<0.0006	
Zn	0.07	0.029	0.015	0.003	0.009	0.024	1
Ca	23	17.8	19	17.5	52	54	
K	1.1	1.2	1.5	1.4	2.5	2.4	
Mg	8.9	8.2	8.5	6.4	12.4	15.6	
Na	5.1	5.2	5.1	5.1	5.2	5.2	
SO4	59	20	27	21	34	26	
Cl	51	35	42	28	44	42	

** World Bank Environment, Health and Safety Guidelines for surface water discharge from Mining and Milling (in both open pit and underground operations)

In terms of metal concentrations, concentrations of all parameters were below World Bank Environment, Health and Safety Guidelines for Mining and Milling (in both open pit and underground operations) (**Table 3**).

There were some distinct differences between sample types (i.e. creek, groundwater and blank) as shown by the PCA analysis (**Figure 3**). For example the groundwater sites (ACH02 and ACH06) were similar to each other, and were different from the other site types on the plot. The groundwater samples were characterised by higher concentrations of salinity (measured as EC), Mg, Ni, Fe, As, Cd, Na, K, Ba and Li in comparison to the other sites. In contrast the creek line samples reported higher concentrations of Cl, SO_4, Zn and Al in comparison to the groundwater and blank. The blank

(ACH05) reported high concentrations of Be, V and a more alkaline pH in comparison to the Achmmach sites.

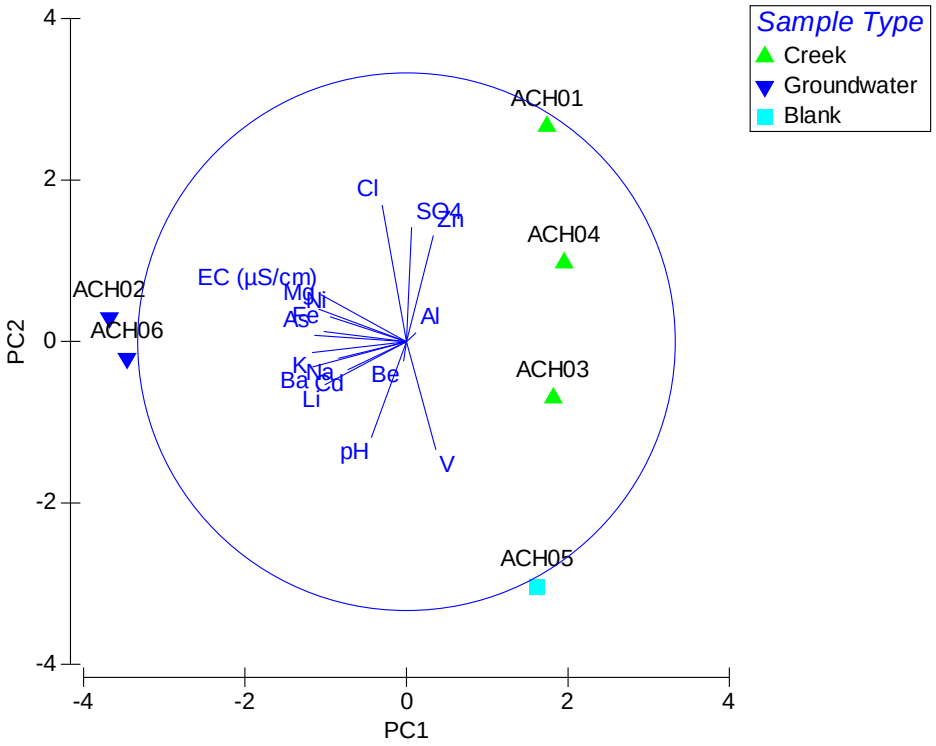

Figure 3 **PCA plot of water quality within the Achmmach samples. 66% of variation in the plot is defined by the two PCA axes.**

Water quality at all Achmmach sites was classified as excellent (**Table 4**),according the Moroccan classification system for surface waters. However it should be noted that concentrations of As, Cu and Mn were slightly elevated in some samples and fell within the good and average categories.

Table 4 **Water quality rating using environmental water quality guidelines (Appendix B)**

Site	Rating*	Exceptions
ACH01	Excellent	Cu
ACH02	Excellent	As, Mn
ACH03	Excellent	NA
ACH04	Excellent	NA
ACH05	Excellent	NA
ACH06	Excellent	As, Mn

NA – Not applicable i.e. all parameters fell within the excellent category

3.3 Sediment Chemistry

Generally sediment acts as a sink for metals and contaminants and is an important component of the aquatic ecosystem (Peterson *et al.* 1995). In terms of sediment characteristics, the sediments of ACH01 consisted of medium cobbles, while sites ACH04, ACH07 and ACH09 consisted of coarse sand. In contrast, sediments of ACH08 consisted of fine sand and clay. It was expected that parameters of most metals would be highest in ACH08, given the higher proportion of clays present in the sediments and the general affinity of clay soils for metals adsorption. However, this was not the case within sediments of the Achmmach creek lines. Generally concentration of most metals was highest in ACH07 (**Table 5**).

Concentrations of Be and Ag remained below detection at most sites (**Table 5**). In contrast, concentrations of As, Ba, Cr, Cu, V and Zn were comparatively high in the sediments of Achmmach, however all were below ANZECC guidelines.

The major anions and cations of the sediments of Achmmach were dominated by K and Cl (**Table 5**). For the cations, sites ACH01, ACH04 and ACH07 showed the following pattern K>Mg>Na>Ca. At site ACH08, concentrations of Ca were greater than Na and the major anions followed K>Mg>Ca>Na. For the anions all sites except for ACH04 had concentrations of Cl greater than SO_4.

Table 5 Concentration of parameters within sediments of the Achmmach project area in comparison to ANZECC interim sediment quality guidelines likely to be highly toxic to biota

Parameter	Units	ACH01	ACH04	ACH07	ACH08	ACH09	ANZECC guidelines
Ag	mg/kg	1.07	<0.55	1.35	<0.47	<0.35	
As	mg/kg	112	153	96	81	66	
Au	ppb	<5	<5	<5	<5	<5	
Ba	mg/kg	994	1028	554	692	684	
Be	mg/kg	<0.04	<0.05	<0.03	<0.04	<0.03	
Bi	mg/kg	17490	16503	23018	21039	18967	
Cd	mg/kg	0.47	0.37	0.67	0.23	0.37	10
Co	mg/kg	27	30	23	24	22	
Cr	mg/kg	124	132	133	136	103	350
Cu	mg/kg	89	67	54	44	51	270
Li	mg/kg	124	136	76	88	99	
Mo	mg/kg	0.61	<0.18	1.96	0.59	<0.12	
Ni	mg/kg	43	45	33	34	39	52
Pb	mg/kg	46	59	339	73	211	220
Sn	mg/kg	29	31	34	19	17	
V	mg/kg	151	149	127	123	143	
Zn	mg/kg	194	146	192	181	174	410
Moisture Content	%	12	7	15	25	22	
Total S	%	0.06	0.07	0.07	0.07	0.05	
Hg	ppb	3	4	5	12	2	
CO_3	%	2.8	1.9	2.2	2.2	2.2	
Cl	%	0.4	0.1	0.5	0.4	0.5	
SO_4	%	0.2	0.1	0.2	0.2	0.2	
Al	%	10.0	9.7	8.4	9.0	10.1	
Ca	%	0.3	0.2	0.2	0.4	0.2	
Mg	%	1.2	1.0	0.8	0.9	0.9	
Na	%	0.4	0.3	0.3	0.3	0.3	
K	%	2.8	2.6	2.3	2.8	2.9	
Mn	%	0.1	0.2	0.1	0.1	0.1	
Fe	%	6.9	7.4	6.4	4.6	6.4	
P	%	0.1	0.1	0.1	0.1	0.1	

The PCA plot of sediment chemistry shows that sediments of the Achmmach creek lines were quite dissimilar, as demonstrated by the distance from each other, within the plot (**Figure 4**). This was expected given that the samples were collected from a number of different creek lines with different geological traits. In terms of differences between sites ACH07 reported higher concentrations of Mo, Cd, Pb and Bi in comparison to the other sites. In contrast ACH09 reported higher concentrations of K and Cl, while ACH08 recorded higher concentrations of Ca and Zn in comparison to the other sites. ACH04 reported the highest concentrations of As, Zn Fe, P and Mn in comparison to the other sediments tested. ACH01 reported higher concentrations of CO_3, Al, Mg and Ni.

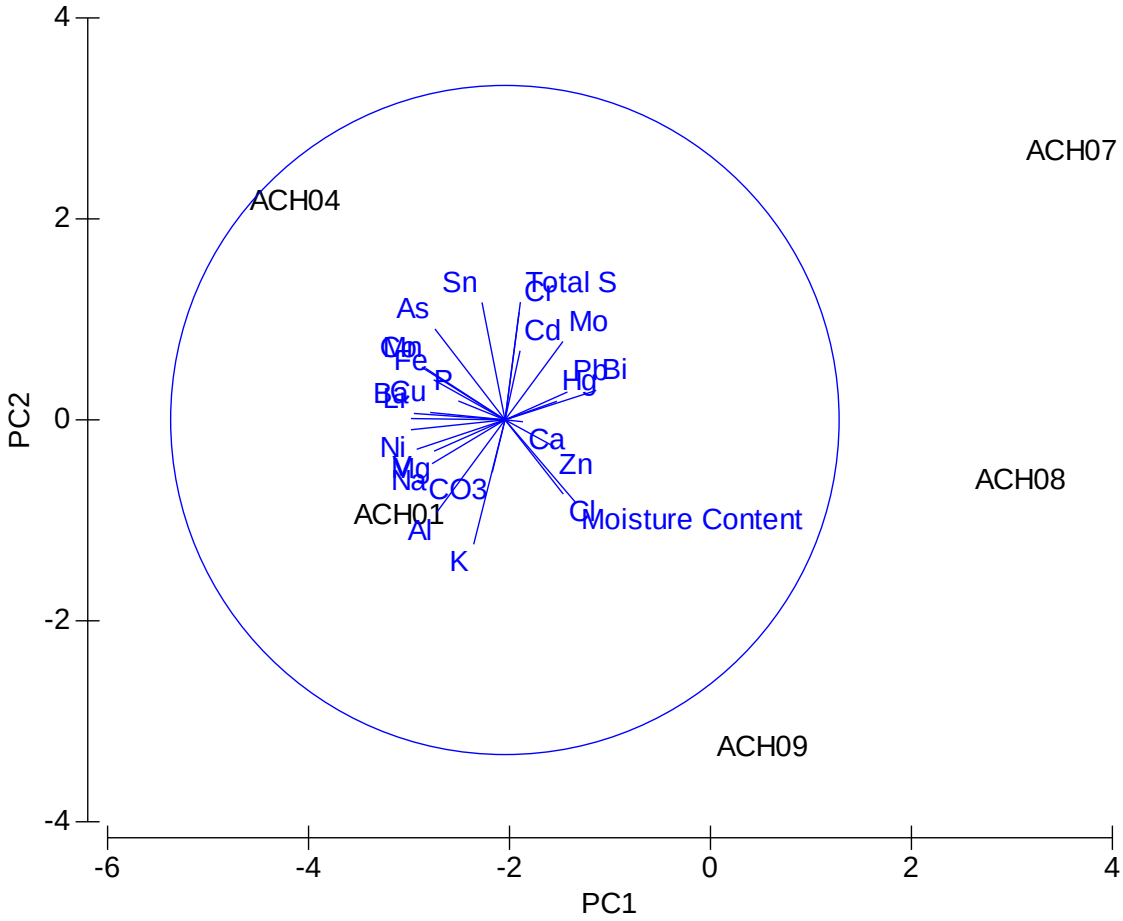

Figure 4 PCA plot of sediment chemistry within the creek lines of the Achmmach project area. 67.9% of variation within the plot is demonstrated by the first two axes.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The creek lines of the project have been historically impacted by various land uses. Most of the original riparian (fringing) vegetation of the creek lines has been removed. There was evidence that the creek lines in both project areas were frequently used by sheep and goats, most likely compromising the water quality.

Despite the historical impacts, water quality was excellent, being similar (from a chemical perspective) to filtered bottled water sold within the country, and within the limits of accepted water quality guidelines (ANZECC and World Bank). The water of all sites was classified as fresh, with low concentrations of most metals and turbidity in comparison to relevant guidelines. It should be noted that given the shallow nature and drought conditions experienced within the project areas, parameters were likely to be higher due to evapo-concentration in comparison to what may be recorded in wetter seasons. In that regard, the concentrations reported in this survey probably represent the upper concentration limits for water chemistry, but more data is required to validate this.

Ground water in the Achmmach project area was relatively high in As, Fe and Mn and should be considered further if discharged to the environment.

In terms of sediment quality, there was considerable variation within the Achmmach sites, most likely associated with local geology. Concentrations of all metals in sediment were lower than ANZECC guidelines for protection of most biota.

Given the degree of pastoral land use within the vicinity of the creek lines at Achmmach, the testing of nutrients should be conducted prior to the commencement of the operations. This was planned for this study, however the laboratories were unable to test these parameter.

In Australia, ANZECC recommends the use of site-specific data over the use of guidelines and the collection of baseline data is critical to building these data sets. It would be advantageous to collect water quality data from Achmmach over a variety of seasons, to obtain a good understanding of the variety of water and sediment chemistry between seasons prior to the commencement of operations.

Key recommendations from this study are:

- Water and sediment chemistry should be collected in different seasons, to
  - Gain an understanding of the seasonal variation in water and sediment chemistry
  - Contribute to a site-specific data set that could be used for future reference, for example, in terms of setting license limits or assessing impact
  - If further sampling is undertaken for the purpose of building a site-specific data set, surrounding areas that might contribute catchment inputs to the project area should be sampled to provide context for the results.

5.0 REFERENCES

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Appendix A
Laboratory Reports

(*) : Appareil utilisé :Ultima 2 JY
(**) si ces résultats font l'objet d'une communication, veuillez utiliser la mention suivante :
Mlle.OUADDARI, from UATRS-CNRST, is acknowledged for his technical assistance.

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Laboratoire d'analyse élémentaire ICP AES

Rapport d'analyse

Echan	Ag	As	Ba	Be	Bi	Cd	Co	Cr	Cu	Li	Mo	Ni	Pb	Sn	V	Zn
ELK06 A	≤0,6188	70,4016	736,5702	6,0158	16091,9418	0,0997	12,9253	101,8899	40,4947	312,8885	0,5500	17,1535	60,2608	45,4792	67,5141	140,0470
ELK03	≤0,4430	47,5756	699,2849	7,0145	11281,7686	≤0,0492	13,7829	152,8178	40,3642	257,0755	2,7074	19,2222	28,2303	32,9805	67,3885	95,7419
ELK02B	≤0,2506	35,4070	490,2128	10,1919	5677,0540	≤0,0278	5,3048	198,5885	27,4150	137,2005	5,0263	6,6414	32,8451	15,9979	23,9342	48,7317
ELK02A	≤0,4117	37,3769	564,1312	9,6759	8420,3372	≤0,0457	6,4735	153,2592	20,7472	191,7341	3,0423	6,5879	30,7205	37,2626	28,5703	70,5221
ACH09	≤0,3469	65,7096	684,1971	≤0,0289	18967,0533	0,3662	23,3039	102,5062	51,2724	98,9210	≤0,1156	38,9940	210,6986	16,9623	143,3892	174,2490
ACH08	≤0,4654	80,7545	692,4253	≤0,0388	21039,0268	0,2327	23,7118	136,3233	43,5966	87,9689	0,5921	33,8740	72,9971	18,8505	122,8255	181,4714
ACH07	1,3465	96,3275	553,7784	≤0,0348	23018,1123	0,6744	22,5586	133,4212	53,6057	76,1178	1,9559	32,8844	338,5416	34,2332	126,9327	192,2829
ACH04	≤0,5535	152,5755	1028,0242	≤0,0461	16502,5119	0,3690	30,3183	131,7278	67,4628	136,2171	≤0,1845	44,9547	59,3759	30,8410	148,7626	145,5648
ACH01	1,0741	112,2809	993,8082	≤0,0415	17490,0841	0,4706	26,9352	123,9907	89,4427	123,9354	0,6090	42,5206	46,2854	28,7900	150,8429	149,4034

(*) : Appareil utilisé :Ultima 2 JY

(**) si ces résultats font l'objet d'une communication, veuillez utiliser la mention suivante :

Mlle.OUADDARI, from UATRS-CNRST, is acknowledged for his technical assistance.

	Ag	Al	As	Au	Ba	Be	Bi	Cd	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Pb	Sn	V
ELK6	≤0,0018	0,0893	0.0057	0.0028	0.0226	0.0001	4,7620	0.0003	0,0007	≤0,0006	0.0078	0.5435	0.0123	0.3048	≤0,0006	0.0045	≤0,0045	≤0,0039	0.0010
ELK5	≤0,0018	0,1590	0.0056	0.0019	0.0197	0.0003	3,95575183	≤0,0002	0.0009	0,00073	0.0105	0.3261	0.0119	0.1411	0.0006	0.0016	≤0,0045	≤0,0039	0,00132
ELK4	≤0,0018	0,1850	0,0073	0,0018	0.0206	0,0002	4,32781114	≤0,0002	0,0014	0.0038	0.0090	0.3064	0.0112	0.1374	0,0008	0.0040	≤0,0045	0.0036	0,00216
ELK3	≤0,0018	0,1370	0.0076	0.0024	0.0159	0.0001	1,11287298	0.0003	≤0,0006	0,0013	0.0097	0.1894	0.0132	0.0056	≤0,0006	0.0014	≤0,0045	≤0,0039	0,003
ELK2	≤0,0018	0,0798	0.0109	≤0,0018	0.0170	0.0003	1,2613	0,0002	0,0008	0,0009	0.0105	0.1244	0.0133	0.0111	≤0,0006	0.0011	≤0,0045	0.0039	0,0021
ELK1	≤0,0018	0,1280	0.0104	0,0020	0.0202	0.0002	2,3159	0,0003	≤0,0006	≤0,0006	0.0120	0.1747	0.0131	0.0139	0,0007	0,0016	≤0,0045	≤0.0039	0.0022
ACH6	≤0,0018	0,0464	0.0660	0,0018	0.0822	0.0001	2,9111	0.0013	≤0,0006	0,0007	0.0091	0.1658	0.0780	0.1717	≤0,0006	0.0017	≤0,0045	0.0037	≤0,0006
ACH5	≤0,0018	0,0314	≤0,0036	≤0,0018	0.0318	0.0002	0,52548451	0.0004	0,0007	0,000673	0.0083	≤0,0006	0.0589	0,0006	≤0,0006	0,0013	≤0,0045	≤0,0039	0,0006
ACH4	≤0,0018	0,0715	0,0036	≤000018	0.0099	0.0001	3,93401553	0.0001	≤0,0006	≤0,0006	0.0123	0.0125	0.0119	0.0025	≤0,0006	0,00201	≤0,0045	0,0040	≤0.0006
ACH3	≤0,0018	0.0543	0,0060	≤0,0018	0.0092	0.0003	3,84986683	≤0,0002	≤0,0006	≤0,0006	0.0107	0.0153	0.0111	0.0041	0.0006	0.0014	≤0,0045	≤0,0039	0,00134
ACH2	≤0,0018	0.0414	0.1183	≤0,0018	0.0779	0.0003	2,3891	0,0002	≤0,0006	0,0006	0.0124	0.5311	0.0760	0.1777	0.0008	0.0030	≤0,0045	≤0,0039	0,0012
ACH01	≤0,0018	0.0262	0.0024	≤0,0018	0.0136	0.0002	7,3447	0,0002	0,0007	≤0,0006	0.0238	0,0078	0.0306	0.0062	0,0006	0,0012	≤0,0045	0,0061	0,0008

	Zn	Ca	K	Mg	Na
ELK6	0.0358	26.1022	4.2637	5.8611	5.2032
ELK5	0.0370	26.2077	4.7411	5.5414	5.1014
ELK4	0.0368	26.0374	4.9461	5.4228	5.1177
ELK3	0.0094	8.5482	3.1123	2.8102	5.1763
ELK2	0.0106	8.5258	2.8743	2.8492	5.1527
ELK1	0.0178	9.0234	3.2080	2.9020	5.1836
ACH6	0.0239	53.9995	2.3668	15.6317	5.2003
ACH5	0,0025	17.4980	1.3656	6.3771	5.1157
ACH4	0.0153	18.9944	1.4744	8.4950	5.1398
ACH3	0.0291	17.8326	1.2336	8.2175	5.1541
ACH2	0.0091	51.9681	2.4530	12.4011	5.1539
ACH01	0.0697	22.9604	1.1193	8.9689 m	5.0812

(*) : Appareil utilisé :Ultima 2 JY

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Mlle.OUADDARI, from UATRS-CNRST, is acknowledged for his technical assistance.

NB1 :≤ chiffre veut dire inférieur à la Limite de détection
NB2 : L'or dans les solides n'est pas analysable par notre service

N° du dossier : F uatrs07	Date de l'analyse : 13-14/06/07	Date demande :08/06/07

Résultas** fournis par :	☒ E-mail	☐ Fax	☒ Imprimés	☐ CD

Responsable du Laboratoire :
H.Ouaddari

(*) : Appareil utilisé :Ultima 2 JY
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Mlle.OUADDARI, from UATRS-CNRST, is acknowledged for his technical assistance.

Le 07/06/2007

Demandeur : Outback Ecology (Kasbah Resources)
Adresse : Kasbah Resources, PO Box 457, West Perth WA 6872, Australia
Tél. / Fax : + 61 8 93888799 ⋖➢ + 61 8 93888633
Archivage : **T070084**
N°Réception : R07/215
N°Facture : 083/2007

Déterminations	Humidité	S_{total}	Hg	CO_3	Cl
Réf. échts sediments	%	%	ppb	%	%
ACH01	11.8	0.06	3	2.8	0.42
ACH04	6.5	0.07	4	1.9	0.10
ACH07	15.0	0.07	5	2.2	0.45
ACH08	25.4	0.07	12	2.2	0.38
ACH09	22.2	0.05	2	2.2	0.49
ELK02A	26.4	< 0.05	8	1.5	0.38
ELK02B	12.7	< 0.05	6	1.5	0.45
ELK03	27.3	0.05	13	2.5	0.49
ELK06A	39.7	0.21	13	2.1	0.42

Déterminations	Al	Ca	Mg	Na	K	Mn	Fe	P
Réf. échts sediments	%	%	%	%	%	%	%	%
ACH 01	10,04	0,30	1,15	0,44	2,83	0,11	6,90	0,07
ACH 04	9,66	0,22	0,97	0,33	2,63	0,15	7,38	0,07
ACH 07	8,39	0,22	0,77	0,27	2,33	0,07	6,43	0,07
ACH 08	8,99	0,38	0,92	0,26	2,78	0,09	4,64	0,06
ACH 09	10,14	0,17	0,86	0,33	2,93	0,07	6,35	0,07
ELK 02A	8,28	0,44	0,77	1,44	4,12	<0,01	1,66	0,07
ELK 02B	6,26	0,23	0,40	0,91	4,14	<0,01	1,46	0,05
ELK 03	9,51	0,29	0,73	0,70	3,23	<0,01	3,87	0,05
ELK 06A	11,77	0,45	0,98	0,63	3,28	0,18	3,95	0,10

Déterminations	pH	Conductivité à 22℃	Résidu à sec	Matières en suspension	TA	TAC	Hg	SO_4	Cl
Réf. échts eaux	-	µS/cm	mg/l	mg/l	meq/l	meq/l	µg/l	mg/l	mg/l
ACH01	7.4	370	289	< 20	< 0.1	1.55	< 1	59	51
ACH02	7.5	440	306	< 20	< 0.1	2.85	< 1	34	44
ACH03	7.6	240	190	< 20	< 0.1	1.35	< 1	20	35
ACH04	7.1	250	209	< 20	< 0.1	1.55	< 1	27	42
ACH05	7.8	250	227	< 20	< 0.1	1.25	< 1	21	28
ACH06	7.8	480	349	< 20	< 0.1	3.35	< 1	26	42
ELK1	7.4	157	130	< 20	< 0.1	0.75	< 1	<20	51
ELK2	7.2	157	136	26	< 0.1	0.70	< 1	<20	40
ELK3	7.5	159	135	< 20	< 0.1	0.75	< 1	<20	39
ELK4	8.3	290	239	< 20	< 0.1	1.60	< 1	<20	37
ELK5	8.0	292	242	26	< 0.1	1.50	< 1	22	49
ELK6	7.2	295	222	20	< 0.1	1.70	< 1	<20	47

N.B : Les analyses des sulfates dans les sédiments et l'or dans tous les échantillons vous seront transmises ultérieurement.

Appendix B
Environmental Water Quality Guidelines

GRILLE DE QUALITE DES EAUX DE SURFACE

			CLASSE 1	CLASSE 2	CLASSE 3	CLASSE 4	CLASSE 5
	Paramètres	Unités	Excellente	Bonne	Moyenne	Mauvaise	Très mauvaise
Organoleptiques				0			
1	Couleur (échelle Pt)	mg Pt/L	<20	20-50	50-100	100-200	>200
2	Odeur (dilu à 25° C)		<3	3-10	10-20	>20	-
Physico-chimiques							
3	Température	°C	<20	20-25	25-30	30-35	>35
4	PH		6,5-8,5	6,5-8,5	6,5-9,2	<6,5ou>9,2	<6,5ou>9,2
5	Conductivité à 20° C	us/cm	<750	750-1300	1300-2700	2700-3000	>3000
6	Chlorures (Cl-)	mg/l	<200	200-300	300-750	750-1000	>1000
7	Sulfates (SO4-)	mg/l	<100	100-200	200-250	250-400	>400
8	MES	mg/l	<50	50-200	200-1000	1000-2000	>2000
9	O2 dissous	mg/l	>7	7-5	5-3	3-1	<1
10	DBO 5	mg/l	<3	3-5	5-10	10-25	>25
11	DCO	mg/l	<30	30-35	35-40	40-80	>80
12	Oxydabilité KMnO4	mg/l	≤2	2-5	5-10	>10	-
Substances Indésirables							
13	Nitrates (NO3-)	mg/l	≤10	10-25	25-50	>50	-
14	NTK	mgN/l	≤1	1-2	2-3	>3	-
15	Ammonium	mgNH4/l	≤0,1	0,1-0,5	0,5-2	2-8	>8
16	Baryum	mg/l	≤0,1	0,1-0,7	0,7-1	>1	-
17	Phosphates (PO4- -)	mg/l	≤0,2	0,2-0,5	0,5-1	1-5	>5
18	P total (Pt)	mg/l	≤0,1	0,1-0,3	0,3-0,5	0,5-3	>3
19	Fe total (Fe)	mg/l	≤0,5	0,5-1	1-2	2-5	>5
20	Cuivre (Cu)	mg/l	≤0,02	0,02-0,05	0,05-1	>1	-
21	Zinc (Zn)	mg/l	<0,5	0,5-1	1-5	>5	-
22	Manganèse (Mn)	mg/l	≤0,1	0,1-0,5	0,5-1	>1	-
23	Fluorure (F-)	mg/l	≤0,7	0,7-1	1-1,7	>1, 7	-
24	Hydrocarbures	mg/l	≤0,05	0,05-0,2	0,2-1	>1	-
25	Phénols	mg/l	≤0,001	0,001-0,005	0,005-0,01	>0,01	-
26	Détérgents anioniques	mg/l	≤0,2	≤0,2	0,2-0,5	0,5-5	>5
Substances Toxiques							
27	Arsenic (As)	ug/l	≤10	≤10	10-50	>50	-
28	Cadmium (Cd)	ug/l	≤3	≤3	3-5	>5	-
29	Cyanures (CN-)	ug/l	≤10	≤10	10-50	>50	-
30	Chrome total (Cr)	ug/l	≤50	≤50	≤50	>50	-
31	Plomb (Pb)	ug/l	≤10	≤10	10-50	>50	-
32	Mercure (Hg)	ug/l	≤1	≤1	<1	>1	-
33	Nickel (Ni)	ug/l	≤20	≤20	20-50	>50	-
34	Selenium (Se)	ug/l	≤10	≤10	≤10	>10	-
35	Pesticides par subst	ug/l	≤0,1	≤0,1	≤0,1	>0,1	-
36	Pesticides totaux	ug/l	≤0,5	≤0,5	≤0,5	>0,5	_
37	H.P.A. totaux	ug/l	≤0,2	≤0,2	≤0,2	>0,2	-
Bactériologiques							
38	Coliformes fécaux	/100ml	≤20	20-2000	2000-20.000	>20,000	-
39	Coliformes totaux	/100ml	≤50	50-5000	5000-50.000	>50,000	-
40	Streptoco. Fécaux	/100ml	≤20	20-1000	1000-10.000	>10.000	-
							Biologique
41	Chlorophylle a	ug/l	<2,5	2,5-10	10-30	30-110	>110