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## Restauration des populations de moules perlières en Ardennes

### Technical Report II: Action D4 Control and survey of the water quality



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## 1. Introduction

The freshwater Pearl Mussel *Margaritifera margaritifera* is a threatened species (Cosgrave & Hastie, 2001) with critically low or absent juvenile stages throughout its distribution range in Europe. It is protected under Annexes II and V of the European Habitats Directive 92/43/EEC and the recovery of the species is promoted specifically under the Water Framework Directive 2000/60/EEC. Despite being afforded legal protection, it is also one of the most rapidly declining species in Europe. The major threats to the deteriorating quality of the river system and hence to the habitat of the Freshwater Pearl Mussel are industrial and agricultural pollution, river engineering projects such as bridge construction and river re-alignment as well as a declining population of suitable fish hosts.

The post-parasitic stage or juvenile mussel is highly vulnerable and most at risk to environmental changes in the river catchment. Juvenile mussels spend approximately five years in river gravels where their survival depends on good water quality (Buddensiek, 1993) and low levels of interstitial silt in gravel beds (Bogan, 1993). But only a few investigations (see Buddensiek, 1991 or Geist & Auerswald, 2007) analyzed the water parameters in the interstitial in different depths.

Despite many studies concerning the ecology of the Fresh Water Pearl Mussel very little is known about the physical and chemical water quality requirements (Young, 2005). Table 1 lists the water quality objectives for *Margaritifera margaritifera* that have become apparent during different studies in the past. The levels and ranges for each of the different parameters show the required measurements necessary for a healthy Freshwater Pearl Mussel river.

Table 1 Water quality objectives for *M. margaritifera*

	Target (Bauer, 1988)	Target (Moog et al., 1993)	Target (Oliver, 2000)	Target (Skinner et al., 2003)
Nitrate [mg/l] [NO <sub>3</sub> <sup>-</sup> ]	< 0.5	< 2.0	< 1.0	< 1.0
Nitrate - nitrogen [NO <sub>3</sub> -N]*	<0.11	<0.45	<0.22	<0.22
Phosphate [mg/l]	< 0.03	< 0.035	< 0.03	< 0.3
pH	N/A	N/A	6.5 – 7.2	< 7.5
Conductivity [μS/cm]	< 70	< 150	< 100	< 100
Calcium [CaCO <sub>3</sub> ]	2mg/l	N/A	< 10 mg/l	N/A
BOD [mg/l]	1.4	N/A	< 1.3	N/A
Dissolved oxygen [%]	N/A	N/A	90-110%	N/A
* Conversion factor 4.4mg/l NO <sub>3</sub> <sup>-</sup> = 1mg/l NO <sub>3</sub> -N				

The LIFE group have previously collected data regarding the physical and chemical water parameters of the river Our and eleven of its tributaries between June 2006 and July 2007. This scientific monitoring was published in July 2007 as “Restauration des populations de moules perlières en Ardennes Technical Report: Action D4 Control and survey of the water quality.” The purpose of the following report is to present the physical and chemical water parameters of the same sampling sites between June 2007 and June 2010.

## 2. Materials and Methodology

Prior to the commencement of the current project; the sole source of data regarding physical water parameters in the river Our was the laboratory of the national water management department. The following parameters were measured on every occasion by the national laboratory:

Temperature [°C]	Oxygen concentration O <sub>2</sub> [mg/l]
pH	Oxygen saturation Sat O <sub>2</sub> [%]
Carbonate hardness [°fH] (French degree)	Biological oxygen demand BOD <sub>5</sub> [mg/
Total hardness [°fH] (French degree)	Sulfate SO <sub>4</sub> <sup>2-</sup> [mg/l]
Conductivity [μS/cm]	Sodium Na <sup>+</sup> [mg/l]
Ammonium NH <sub>4</sub> <sup>+</sup> [mg/l]	Potassium K <sup>+</sup> [mg/l]
Nitrite NO <sub>2</sub> <sup>-</sup> [mg/l]	Magnesium Mg [mg/l]
Nitrate NO <sub>3</sub> <sup>-</sup> [mg/l]	Phosphate total [mg/l]
Chloride Cl <sup>-</sup> [mg/l]	Ortho-Phosphate [mg/l]

For further details about the methods used see:

[http://www.eau.public.lu/publications/rapports\\_activite/rapport\\_2006.pdf](http://www.eau.public.lu/publications/rapports_activite/rapport_2006.pdf)

Figure 1 shows the sampling sites of the national laboratory located in the river Our as well as the sampling sites in the river Our and the different tributaries that were analyzed by the LIFE group between 2007 and 2010. Water samples were collected and analysed weekly from the Our at Kalbermillen and the mill channel (Millegruef), located adjacent to this sampling site. The mill channel is the supply source for the mussel rearing channel constructed by the LIFE group. Water samples in each of the other sampling sites was collected and analysed fortnightly.

For every location and every sampling date the following parameters were measured with a WTW Multi 350i (Weilheim, Germany) handheld device.

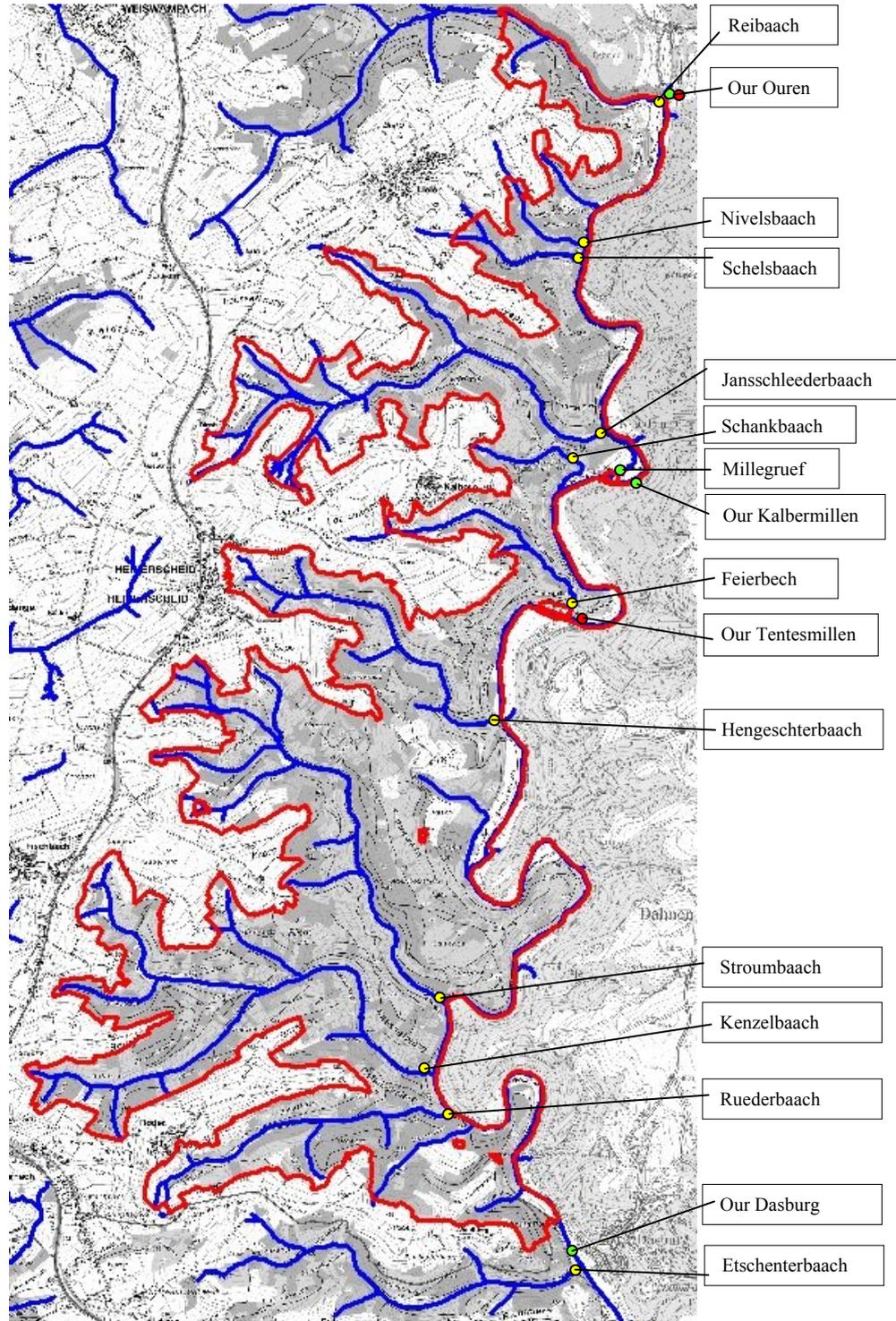
- pH
- Conductivity [μS/cm]
- Oxygen concentration [mg/l]
- Oxygen saturation [%]
- Temperature [°C]

During 2007; visible color tests (Merck Microquant, Aquamerck, Darmstadt, Germany) were used to determine the following parameters at the sampling sites:

- Ammonium NH<sub>4</sub><sup>+</sup> [mg/l]
- Nitrite NO<sub>2</sub><sup>-</sup> [mg/l]
- Nitrate NO<sub>3</sub><sup>-</sup> [mg/l]

Between 2008 and 2010 NO<sub>3</sub>-N (nitrate – nitrogen) was measured using a “Merck Spectroquant<sup>®</sup> test kit”.

In 2010 NH<sub>4</sub> (ammonia) was measured using a using a “Merck Spectroquant<sup>®</sup> test kit.



Base de données: TC 2, TC 4 1:20 000  
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Figure 1 Water parameter sampling sites

- Tributaries
- Our and Millegruef
- Our (measured by the national laboratory of the water management department)

### 3. Results and Discussion

#### 3.1 Our Ouren

##### 3.1.1 Results

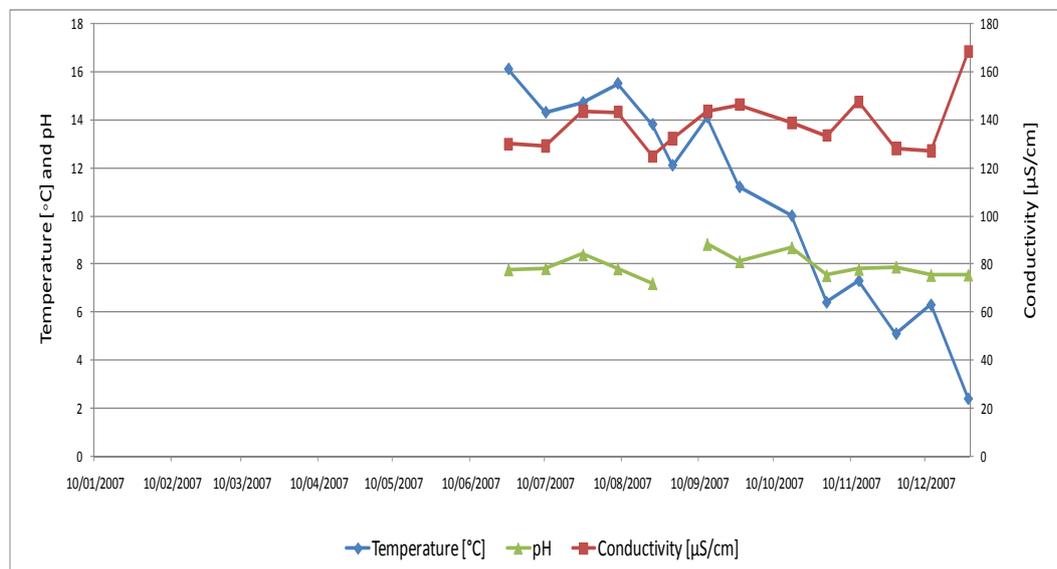


Figure 2 Water parameters Our Ouren 2007.

Figure 2 and Table 2 present the water parameters measured in the river Our Ouren from June to December 2007. The temperature of the river was recorded as 16.1°C in June which steadily decreases to 2.4°C in December with some intermittent increases. The pH ranges between pH 7.19 and pH 8.1. Conductivity readings for the period show a normal range between 124.7 µS/cm and 147.2 µS/cm but a peak of 168 µS/cm occurred in December. The levels of oxygen (O<sub>2</sub>) in the water samples range from 8.9 – 12.74 mg/l with a corresponding oxygen saturation range of 89.6 – 127.8%. The oxygen saturation is highest in July and lowest in December, during these months the minimum and maximum saturation the levels of oxygen are recorded. The levels of nitrate (NO<sub>3</sub><sup>-</sup>) range between 15 and 25mg/l. The level of nitrite (NO<sub>2</sub><sup>-</sup>) was recorded as 0.05mg/l on the 25<sup>th</sup> of July and was recorded as absent for the remainder of the year. Ammonia (NH<sub>4</sub>) was measured as absent in 2007.

Table 2 Water parameters Our Ouren 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
25/06/2007	10.53	114.6			
10/07/2007	12.29	123.6			
25/07/2007	12.05	122.2	25	0.05	0
08/08/2007	10.96	113.7	15	0	0
22/08/2007	8.9	89.6	20	0	0
30/08/2007	11.11	107.1	25	0	0
13/09/2007	9.94	101.3			
26/09/2007	13.6	127.8			
17/10/2007	10.9	100.3	25	0	0
31/10/2007	10.95	91.5	15	0	0
13/11/2007	10.56	94.4			
28/11/2007	12.19	98.9	17	0	
12/12/2007	12.18	100.4			
27/12/2007	12.74	91.4			

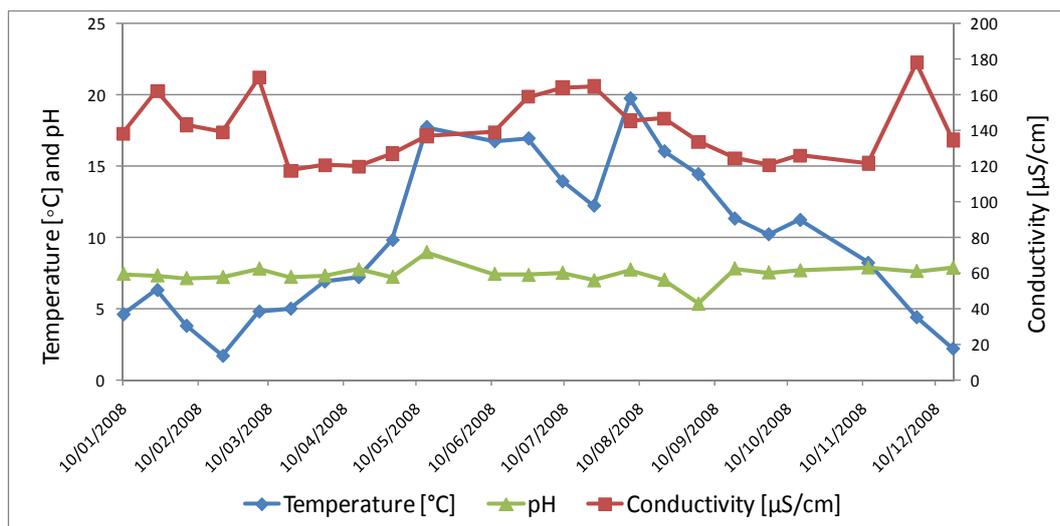


Figure 3 Water parameters Our Ouren 2008.

Figure 3 and Table 3 present the water parameters measured in the river Our Ouren for 2008. The temperature of the river ranges between 1.7°C and 19.7°C over the annual period. The highest temperatures occur during the summer months; however a downturn in temperatures occurred during July which was followed by the maximum temperature recorded in August. The pH ranges between pH 7.00 and pH 8.98; a reading of pH 5.37 was recorded in early September but is likely the result of a fault with equipment. Conductivity readings for the period show a normal range between 117.6 µS/cm and 169.3 µS/cm but a peak of 177.6µS/cm occurred in early December. The levels of oxygen in the water samples range from 7.84 mg/l to 13.87 mg/l with a corresponding oxygen saturation range of 78.2% – 138.4%. The oxygen saturation is highest in summer and lowest in winter. A low oxygen and oxygen saturation level of 7.84 mg/l and 86% respectively were recorded in June. The levels of NO<sub>3</sub>-N (nitrate – nitrogen) range between 5.80 mg/l and 10.2 mg/l.

Table 3 Water parameters Our Ouren 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
10/01/2008	11.25	91.1	
24/01/2008	9.93	81.8	
05/02/2008	11.57	91.6	
20/02/2008	10.85	78.2	
06/03/2008	13.11	103.6	
19/03/2008	13.03	106.1	
02/04/2008	11.7	99.2	6.97
16/04/2008	11.9	100.5	8.87
30/04/2008	11.9	111	7.29
14/05/2008		160	7.12
11/06/2008	7.84	86	7.00
25/06/2008	11.89	129.9	7.90
09/07/2008	13.87	138.4	7.10
22/07/2008	12.91	121.2	
06/08/2008	9.38	105.6	
20/08/2008	11.63	122.2	5.80
03/09/2008	8.66	87.6	6.30
18/09/2008	11.23	106.8	7.50
02/10/2008	10.27	95.8	
15/10/2008	9.94	94	
12/11/2008	10.94	96.5	7.2
02/12/2008	12.48	101	10.2
17/12/2008	14.33	107.9	7.2

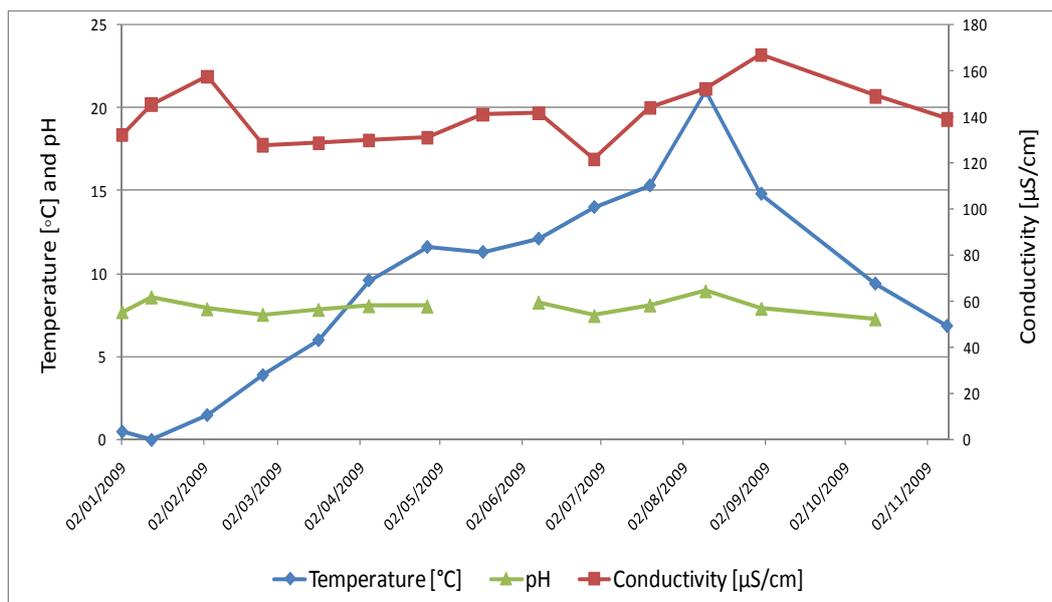


Figure 4 Water parameters Our Ouren 2009.

Figure 4 and Table 4 present the water parameters measured in the river Our Ouren for 2009. The temperature of the river ranges between 0°C and 21°C. The pH ranges between pH 7.27 and pH 8.95. The conductivity readings for the period show a range of values between 121.8 µS/cm and 166.9 µS/cm; the minimum and maximum readings were recorded in June and August respectively. The average level of oxygen in the water samples is 11.572 mg/l with a corresponding average oxygen saturation 105.166%. A very low oxygen and oxygen saturation level of 4.79 mg/l and 34.6% respectively were recorded in January. The levels of NO<sub>3</sub>-N range between 0.62 mg/l and 7.8 mg/l and are generally lowest during the summer months apart from a peak of 6.3 mg/l in June.

Table 4 Water parameters Our Ouren 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
02/01/2009	14.94	106.2	7.50
13/01/2009	4.79	34.6	7.80
03/02/2009	11.83	88.4	6.60
24/02/2009	8.87	68.8	6.90
17/03/2009	11.45	93.8	
05/04/2009	15.5	140	
27/04/2009	12.54	121.5	
18/05/2009	9.32	88.7	
08/06/2009	13.5	131.1	2.82
29/06/2009	9.34	93.4	6.3
20/07/2009	10.19	105.2	0.62
10/08/2009	13.6	158.2	1.01
31/08/2009	16.45	160.6	1.08
13/10/2009	11.49	103.2	5.1
09/11/2009	9.77	83.8	5.02

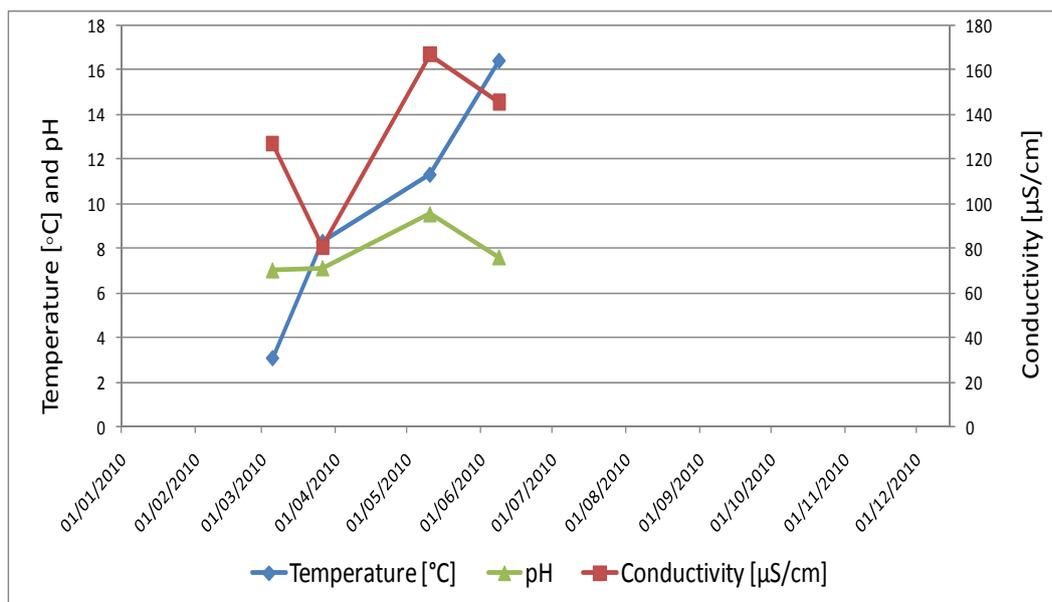


Figure 5 Water parameters Our Ouren 2010.

Figure 5 and Table 5 present the water parameters measured in the river Our Ouren for March to June 2010. The temperature of the river ranges between 3.1°C and 16.4°C with the normal increase trend occurring. The pH ranges between pH 7.013 and pH 9.53. The maximum value of 9.53 is exceptionally high for this site. The conductivity readings for the period show a range of values between 80.6 µS/cm and 166.7 µS/cm; the minimum reading of 80.6 µS/cm recorded in March is notably low and is due to a problem with the equipment. The level of oxygen ranges between 8.99 mg/l and 16.2 mg/l with a correlating trend for oxygen saturation levels. The levels of NO<sub>3</sub>-N range between 7.0 mg/l and 8.4mg/l. Ammonia levels (NH<sub>4</sub>) of 0.03 mg/l and 0.08 mg/l are recorded in May and June respectively.

Table 5 Water parameters Our Ouren 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			7.4	
26/03/2010	10.95	95.2	7	
10/05/2010	16.2	158.6	8.4	0.03
08/06/2010	8.99	95.4	8.2	0.08

### 3.1.2 Discussion

The water temperature reached its highest and lowest level in 2009 with a maximum reading of 21°C and a minimum reading of 0°C. The average yearly temperature was very similar showing 10.66°C for 2007 but 9°C for 2008-2010. Therefore a trend of decreasing temperatures is evident in recent years.

The ranges of values for the water pH remain relatively constant. The minimum pH reading for each of the four years is approximately pH 7.1, the maximum readings are generally high for a Freshwater Pearl Mussel river with a pH in excess of pH 8.8 over each of the years examined. The maximum value of pH 9.53 recorded in May 2010 is exceptionally high for this site. The average yearly pH reading was relatively high when the target of pH 6.5 to pH 7.2 stated by Oliver (2000) or pH <7.5 stated by Skinner *et al.* (2003) is taken into consideration. The average for 2008 is the only year that meets the requirements set out by Skinner *et al.* (2003) showing an average yearly reading of pH 7.47. The average for 2010 of pH 7.81 is being increased by a very high reading of pH 9.53. The phenomenon of high pH readings occurring late in the evening has been reported on previously (Thielen *et al.*, 2007) and (Gerhard Weidmann pers comm.). This reading for May 2010 was taken at 18:53 in the evening and could therefore be due to this occurrence. The average yearly pH readings for 2007 and 2009 were pH 7.91 and pH 7.97 respectively.

The conductivity readings of <70 µS/cm recommended by Bauer (1988) were never recorded between 2007 and 2010. The lowest measurement of 80.6 µS/cm taken in March 2010 is the only measurement that satisfies the recommendation of <100 µS/cm specified by Oliver (2000) and Skinner *et al.* (2003). The average yearly conductivity readings are similar showing a reading of 138 µS/cm, 140 µS/cm and 141 µS/cm for 2007, 2008 and 2009 respectively. This satisfies the recommendation by Moog *et al.* (1993) but is approximately twice that set out by Bauer (1988).

The annual average level of oxygen and oxygen saturation is 11 mg/l and 105% for 2007, 2008 and 2009. This meets the requirements of the dissolved oxygen set out by Oliver (2000). The average level of nitrate in 2007 was 20 mg/l with a range between 15 mg/l and 25 mg/l. This is exceptionally high as the highest permissible level set out for a Freshwater Pearl Mussel river is <2.0 mg/l as specified by Moog *et al.* (1993). A level of 0.05 mg/l of nitrite was recorded on the 25<sup>th</sup> of July 2007 showing that the river is slightly polluted. The average level of nitrate – nitrogen in 2008, 2009 and 2010 is 7.42 mg/l, 4.61 mg/l and 7.75 mg/l. The highest permissible level stated by Moog *et al.* (1993) allows 0.45 mg/l which is seventeen times lower than the highest average recorded. Low levels of ammonia were detected in May and June 2010 showing a sign of pollution. Under natural conditions ammonium is converted directly into nitrate. Ammonia levels (NH<sub>4</sub>) of 0.03 mg/l and 0.08 mg/l are recorded in May and June respectively.

### 3.2 Our Ouren – National Laboratory

Table 6 presents the water parameters of the river Our at the sampling site in Ouren (Figure Map) measured by the national laboratory of the water management department from 2002 to 2009. The samples were always taken between April and August and measured the same day.

#### 3.2.1 Results

The maximum summer temperature of 22.1°C was recorded on the 29th of July 2006. Summer water temperatures have been recorded as relatively low for this period between 2007 and 2009. The levels of conductivity over the period 2002 – 2009 range between 116  $\mu\text{S}/\text{cm}$  and 200  $\mu\text{S}/\text{cm}$ . The maximum level was recorded in August 2009. The levels of measured concentrations of ammonia ( $\text{NH}_4$ ) have decreased steadily from high readings of 0.18 mg/l and 0.25 mg/l recorded in 2002 and 2003 respectively to measurements of <0.07 mg/l over the period 2007-2009. The levels of nitrate ( $\text{NO}_3^-$ ) are variable but on average are similar over the period of 2007 to 2009 as they were between 2002 and 2006. The levels of nitrite ( $\text{NO}_2^-$ ) have decreased over the period 2002 - 2007 to less than or equal to 0.1 mg/l as compared to the maximum levels of 0.25 mg/l recorded in August 2003 and 0.16 mg/l in June 2005 and June 2006. The levels of total phosphate have steadily decreased over the eight year period from maximum values of 0.27 mg/l and 0.2 mg/l in June and July of 2006 to values less than or equal to 0.1 mg/l for 2009. In contrast; the levels of ortho-phosphate have increased over the same eight year period to maximum values of 0.15 mg/l and 0.13 mg/l in June and July 2006 respectively and 0.136 mg/l in June 2008 in comparison to lower values of 0.015 mg/l and 0.037 mg/l in May and June 2002. The average level in 2009 was 0.66 mg/l with a range between 0.043 mg/l and 0.08 mg/l.

Table 6 Water parameters in the river Our at the sampling site Ouren as measured by the national laboratory between 2002 and 2009.

Year	Date	Temperature [°C]	pH	Carbonate Hardness [°fH]	Total Hardness [°fH]	Conductivity [µS/cm]	NH <sub>4</sub> <sup>+</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NO <sub>3</sub> <sup>-</sup> [mg/l]	Cl <sup>-</sup> [mg/l]	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	BOD5 [mg/l]	SO <sub>4</sub> <sup>2-</sup> [mg/l]	Na <sup>+</sup> [mg/l]	K <sup>+</sup> [mg/l]	Mg [mg/l]	Phosphate total [mg/l]	Ortho-Phosphate [mg/l]
2002	15/05/2002	11.9	7.7	3.3	3.9	134	<0,10	0.1	13	13	12.5	119	3.6	9	7.7	2.1		0.034	0.015
	12/06/2002	14.3	7.4	3.6	4.7	149	<0,10	0.18	12	14	9.9	100	3.2	9	9	2.4		0.070	0.037
	17/07/2002	16.9	7.9	4.2	4.9	158	<0,10	0.09	9	15	9.3	99	1.7	9	9.8	3		0.112	0.088
	21/08/2002	17	7.7	4.1	4.4	151	0.15	0.09	7	13	8.4	89	1	9	8.4	4.8		0.095	0.061
2003	12/05/2003	13.9	8	2.6	4.1	136	<0,10	0.09	13	13	11.2	113	1.1	9	8.1	2.1		0.033	0.020
	08/07/2003	16.3	7.5	3.4	4.4	148	<0,10	0.06	10	14	10.3	108	0.8	8.9	9.8	2.8		0.080	0.050
	06/08/2003	21	7.7	4.8	5.4	180	<0,05	0.25	7.1	17	8.6	96	1	7.7				0.140	0.100
2004	11/05/2004	9.6	8.1	2.1	4.1	116	<0,05	<0,05	19	16	11.1	100	<0,5	9.7	7.2	4.4		0.030	0.020
	09/06/2004	17.8	7.7	4.1	5.5	142	0.13	0.14	14	20	9.2	98	2.2	9	10.5	8.9		0.090	0.060
	06/07/2004	14.8	7.8	4.6	5.5	172	<0,05	0.09	10	20	10.4	105	1.7	8.6	13.2	6.5		0.180	0.050
	29/07/2004	15.6	7.6	4.6	5.5	163	0.06	0.08	8.9	17	10.9	113	1.5	8.9	12	3.3		0.170	0.120
	16/08/2004	16.1	7.3	4.2	6.5	153	<0,05	0.06	11	19	9.2	99	2.4	9.7	11.7	8.5		0.090	0.060
2005	27/04/2005	10.5	7.5	2.3	4.4	135	0.06	0.06	19	18	10.9	102	2.1	9	9.7	5		0.060	0.050
	02/06/2005	13.5	7.8	3.4	5	162	<0,05	0.07	16	16	10.7	108	1.7	10	9.5	2.4		0.100	0.070
	29/06/2005	20.4	7.4	4.6	5.9	166	0.11	0.16	12	15	7.8	92	2.2	8	11	4		0.170	0.130
	27/07/2005	16.7	7.7	4.4	6	151	<0,05	0.07	9.9	21	9.5	101	1.7	7.3	11	7.4		0.110	0.080
	25/08/2005	14.3	7.5	3.7	4.7	122	0.06	<0,05	9.5	16	9.3	78	1.4	7.8	10	2.9		0.090	0.050
2006	26/04/2006	12.4	7.7	2.8	6	120	<0,05	0.07	20	17	10.6	103	1.9	8.9	9.4	3.6		0.03	0.016
	01/06/2006	8.7	8.1	2.5	4.8	134	<0,05	<0,05	24	13	10.8	105	1.6	9.1	7.8	2.4		0.030	0.010
	28/06/2006	16.1	7.8	3.5	4.9	135	0.12	0.16	13	15	9.1	97	2.6	7.7	8.9	3.8		0.270	0.150
	26/07/2006	22.1	7.8	5.4	5.8	172	0.13	0.14	9.9	18	8.6	102	1.7	8.1	14	3.6		0.200	0.130
	24/08/2006	13.6	7.8	2.7	4.8	107	<0,05	<0,05	19	12	10.3	103	1.1	9.1	7.9	2.4	4.7	0.080	0.016
2007	25/04/2007	14.2	7.9	3.8	4.9	151	<0,05	0.11	16	17	10	102	2.4	8.3	10	6.5	5.8	0.090	0.064
	27/06/2007	12.3	7.7	3.8	5	129	0.06	0.08	14	10	9.8	97	2	8.3	7.5	3	5.1	0.210	0.074
2008	29/04/2008	9.5	7.5	2.6	4.1	138	0.1	0.08	16	12	11.6	107	1.5	8.5	7.7	2.5	4.2	0.080	0.044
	24/06/2008	16	7.6	3.1	4.9	131	0.06	0.1	11	12	10.2	108	2.5	8.5	7.9	3.7	4.7	0.190	0.136
	25/08/2008	14.3	7.7	4.4	4.5	148	<0,05	0.04	9.7	12	9.5	95	1.4	7.9	9	3.4	5.2	0.08	0.053
2009	28/04/2009	10.3	7.6	2.7	4.4	128	<0,05	0.05	15	13	11	105	1.5	8.5	8.5	2.6	4.8	0.060	0.043
	17/06/2009	12.5	7.6	2.8	5.3	142	<0,05	0.07	21	14	10	101	0.6	8.9	8.9	3.3	5.5	0.100	0.075
	18/08/2009	16.2	7.5	4.4	5.6	200	<0,05	0.06	9.5	29	9.2	99	1	8	11	18	6.5	0.100	0.080

### 3.2.2 Discussion

The measurements recorded by the national laboratory of the water management department at the sampling site in Ouren show that this trend of decreasing temperatures in recent years is validated. The annual average temperature has decreased from 15.08°C in 2005 to 13°C in 2009. This however affected by the sampling regime have less sampling dates in 2007 – 2009. The recommendations set out by Oliver (2000) for the range of pH that a pearl mussel river should adhere to (pH 6.5 – pH 7.2) were not reached on any of the sampling dates. The measurements recorded were always higher than this. The target of pH <7.5 stated by Skinner *et al.* (2003) was only reached on three sampling occasions out of a total of thirty. The annual averages did not meet the requirements of either of these guidelines during this period.

The target conductivity levels outlined by Bauer (1988) specify <70 µS/cm, Oliver (2000) and Skinner *et al.* (2003) both specifying <100 µS/cm (Table 1). The annual averages for conductivity readings at the site in Ouren did not satisfy any of the above requirements for any year during the eight year period. The annual averages were compliant with the less strict guideline of <150 µS/cm stated by Moog *et al.* (1993) during six of the eight year period. This guideline was breached in 2003 and 2009.

The target nitrate (NO<sub>3</sub><sup>-</sup>) levels specified for a Freshwater Pearl Mussel river are <2.0 mg/l by Moog *et al.* (1993), <0.1 mg/l by Oliver (2000) and Skinner *et al.* (2003) and <0.5 mg/l by Bauer (1988). The annual averages recorded by the national laboratory show averages ranging from 10 mg/l to 17.18 mg/l with a reasonably even distribution. This level of nitrate is extremely elevated and not suitable for a Freshwater Pearl Mussel stream

The presence of ammonia (NH<sub>4</sub>) in river water is a strong pollution indicator. It would appear that the presence of ammonia has been decreasing over the eight year period but this view cannot be proven as the sampling regime has not remained constant over the period and fewer sample dates are evident in recent years, therefore a limited temporal scope is visible when analysing the results.

To reinforce this, the target levels of total phosphate set out by three of the four guidelines is <0.03 mg/l and 0.035 mg/l by Moog *et al.* (1993). The lowest annual average was over twice the stated guidelines of 0.078 mg/l in 2003 whereas the highest annual averages were 0.122 mg/l and 0.15 mg/l in 2006 and 2007 respectively.

This unacceptable level of elevated nutrient concentrations at this sampling site is due partly to agricultural land as a diffuse source but also from direct inputs by many towns and villages in the Belgian catchment area. The lack of sewage treatment plants is having a significant negative effect on the eutrophication of the river Our.

### 3.3 Reibach

#### 3.3.1 Results

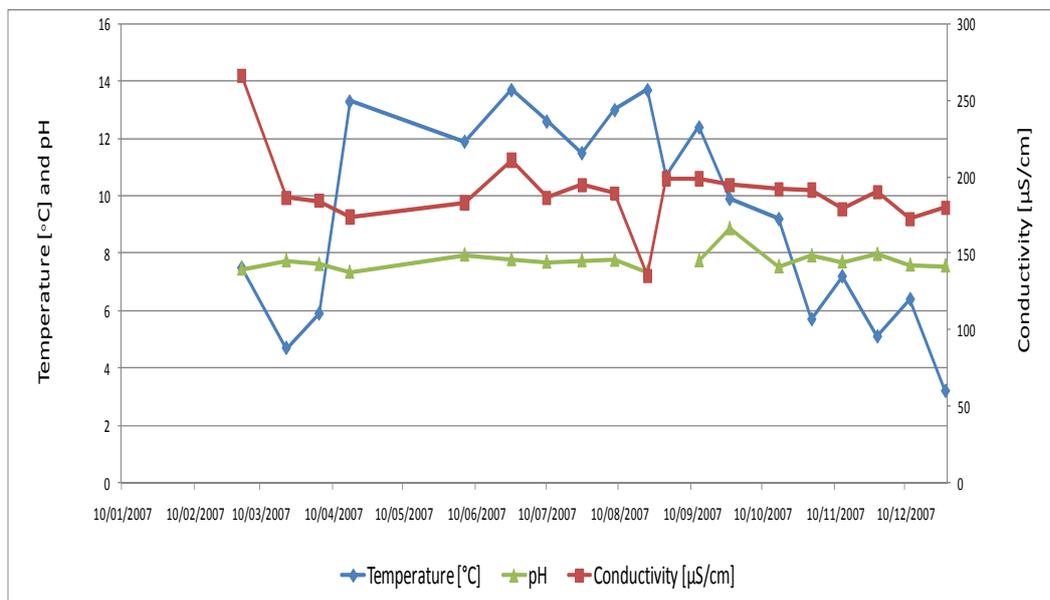


Figure 6 Water parameters Reibach 2007.

Figure 6 and Table 7 present the water parameters measured in the Reibach for March to December 2007. The temperature ranges between 3.2°C and 13.7°C. The pH ranges between pH 7.35 and pH 8.87. The maximum value of pH 8.87 is high for this site. The conductivity readings for the period show a range of values between 135.4 µS/cm and 266 µS/cm; the minimum reading of 135.4 µS/cm recorded in August is notably low. The level of oxygen ranges between 8.66 mg/l and 12.75 mg/l. The levels of NO<sub>3</sub><sup>-</sup> range between 20 mg/l and 75 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 7 Water parameters Reibach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
02/03/2007	10.59				
21/03/2007	9.81	79			
04/04/2007	12.18	101.7			
17/04/2007	9.68	96.1			
05/06/2007	11.82	112.2	25	0	0
25/06/2007	11.69	120			
10/07/2007	11.52	113			
25/07/2007	11.6	110.4	35	0	0
08/08/2007	12.03	120.5	25	0	0
22/08/2007	8.66	87.6	20	0	0
30/08/2007	10.51	97.2			
13/09/2007	9.55	92.2			
26/09/2007	12.75	118.2			
17/10/2007	10.47	94.2	75	0	0
31/10/2007	11.83	96.8	35	0	0
13/11/2007	12.09	104.3			
28/11/2007	11.84	99.7	50	0	0
12/12/2007	11.63	96.2			
27/12/2007	12.06	88.7			

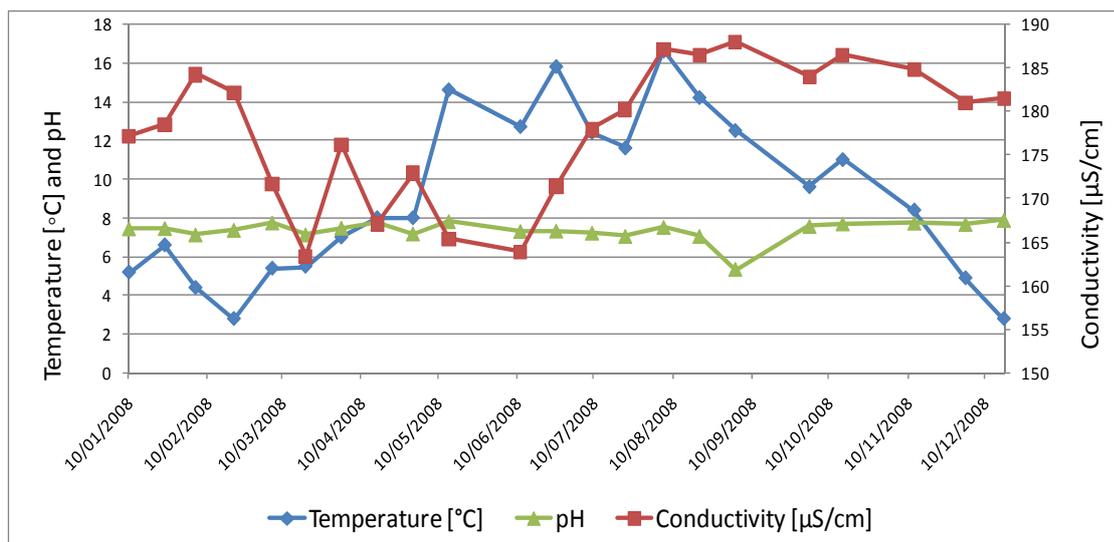


Figure 7 Water parameters Reibach 2008.

Figure 7 and Table 8 present the water parameters measured in the Reibach for 2008. The temperature of the river ranges between 2.8°C and 16.6°C with the normal increase trend occurring. However a slight decrease in temperatures was recorded in July. The pH ranges between pH 7.05 and pH 7.89. The minimum value of pH 5.33 is likely to be the result of a fault with equipment. The conductivity readings for the period show a range of values between 163.4 µS/cm and 187.9 µS/cm. The level of oxygen ranges between 9.07 mg/l and 17.89 mg/l. The oxygen saturation levels ranges between 91.4% and 136.9% and are generally higher during the summer months. The levels of NO<sub>3</sub>-N range between 6.9 mg/l and 14.1mg/l. The levels of nitrate are generally higher during the winter months.

Table 8 Water parameters Reibach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
10/01/2008	11.7	95.5	
24/01/2008	11.92	99.2	
05/02/2008	11.56	93.1	
20/02/2008	14.2	108.6	
06/03/2008	14.23	115.3	
19/03/2008	12.58	103.7	
02/04/2008	11.51	97.7	12.37
16/04/2008	11.88	103.7	11.84
30/04/2008	12.4	111.1	12.65
14/05/2008	11	105.7	10.41
11/06/2008	11.33	110.6	10.8
25/06/2008	12.26	129	9.4
09/07/2008	14.08	136.9	9.6
22/07/2008	11.82	111.9	8.1
06/08/2008	9.07	96	
20/08/2008	10.41	105.4	
03/09/2008	11.52	111.7	6.9
02/10/2008	10.76	99.4	12
15/10/2008	9.61	91.4	
12/11/2008	11.02	97.8	13.2
02/12/2008	14.4	122	14.1
17/12/2008	17.89	129.3	11.8

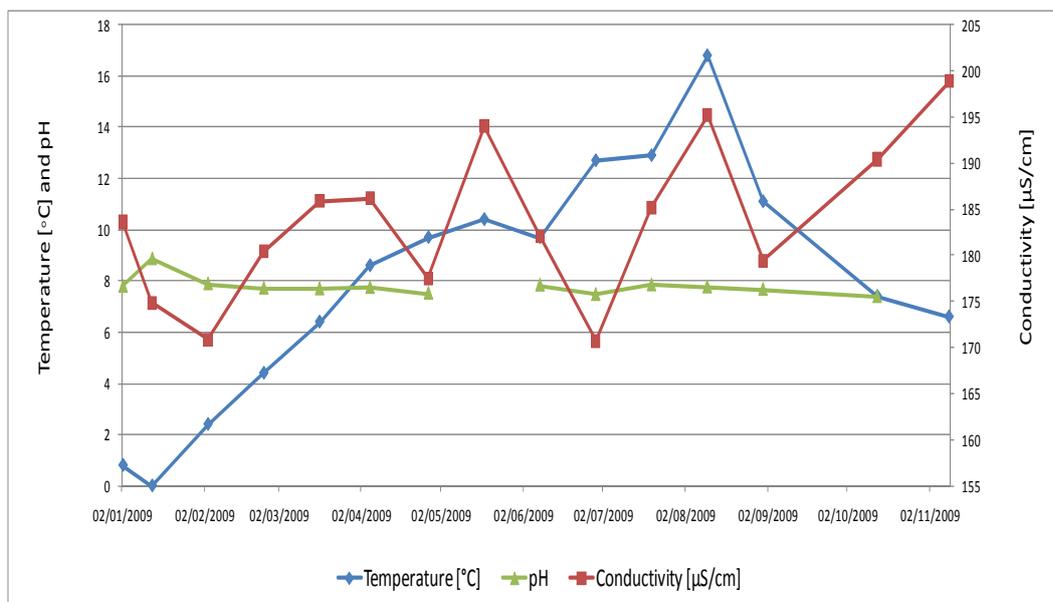


Figure 8 Water parameters Reibach 2009.

Figure 8 and Table 9 present the water parameters measured in the Reibach for 2009. The temperature of the river ranges between 0°C and 16.8°C with the normal annual trend occurring; the maximum temperature was recorded in August. The pH ranges between pH 7.4 and pH 8.89. The maximum value of pH 8.89 is very high for this site. The conductivity readings for the period show a range of values between 170.7 µS/cm and 198.9µS/cm. The trend is very variable throughout the annual period. The level of oxygen ranges between 4.82 mg/l and 17.87mg/l. The maximum level recorded in the beginning of January follows on from the reading of 17.89 mg/l in December 2008. The minimum level of 4.82 mg/l recorded in the middle of January is unusual and correlates to a oxygen saturation level of 38.7%. The maximum oxygen saturation level of 147.4% was recorded in August. The levels of NO<sub>3</sub>-N range between 0.2 mg/l and 10.9 mg/l. The levels of nitrate are generally higher during the winter months.

Table 9 Water parameters Reibach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
02/01/2009	17.87	125.6	10.9
13/01/2009	4.82	38.7	10.6
03/02/2009	12.1	93	10.9
24/02/2009	8.8	71	10.2
17/03/2009	11.12	92.2	
05/04/2009	13.83	123	
27/04/2009	11.79	109.1	
18/05/2009	9.7	90.6	
08/06/2009	13.07	120.3	0.66
29/06/2009	9.46	93.2	7.2
20/07/2009	9.92	97.3	0.2
10/08/2009	10.79	115.4	6.05
31/08/2009	15.64	147.4	1.02
13/10/2009	10.29	88.4	3.6
09/11/2009	9.53	87.9	1.35

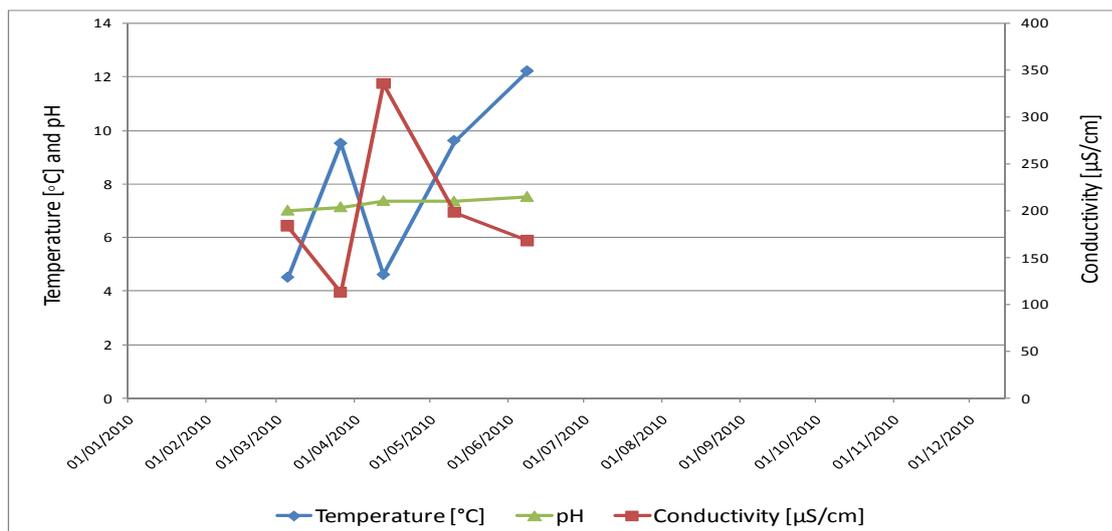


Figure 9 Water parameters Reibach 2010.

Figure 9 and Table 10 present the water parameters measured in the Reibach for March to June 2010. The temperature of the river ranges between 4.5°C and 12.2°C with the normal annual trend occurring; the maximum temperature was recorded in August. The pH ranges between pH 7.002 and pH 7.526. The conductivity readings for the period show a range of values between 112.8 µS/cm and 335 µS/cm. The maximum level recorded in April is exceptionally high for this site. The level of oxygen ranges between 9.18 mg/l and 14.72 mg/l. The level of oxygen saturation ranges between 91.9% and 118.4%. The levels of NO<sub>3</sub>-N range between 7.5 mg/l and 12.5 mg/l. Ammonia levels (NH<sub>4</sub>) of 0.03 mg/l and 0.11 mg/l are recorded in May and June respectively.

Table 10 Water parameters Reibach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			12.5	
26/03/2010	11.11	99.6	11.6	
12/04/2010	14.72	118.4		
10/05/2010	13.13	117.5	9.6	0.03
08/06/2010	9.18	91.9	7.5	0.11

### 3.3.2 Discussion

The average pH values in the Reibach were pH 7.74 and pH 7.79 in 2007 and 2009 respectively; there was a decrease to pH 7.35 and pH 7.27 for 2008 and 2010 respectively. This is however, an elevated level of pH for Freshwater Pearl Mussel habitat and does not adhere to the requirements outlined by Oliver (2000) as outlined in Table 1.

The annual averages for the conductivity readings show that the conductivity in the Reibach is approximately 185 µS/cm. This is an elevated average for this tributary. The stream is an ideal habitat for brown trout as it is well oxygenated showing an average oxygen saturation of 105%. The levels of nitrate are unacceptable as the average annual level recorded in 2007 was 37.85 mg/l, the standard required for this stream is at least <2 mg/l. The average annual levels of nitrate nitrogen in 2008 were 11 mg/l, the highest measurement was 14.1 mg/l whereas the target is approximately <0.45 mg/l. These figures show a polluted stream as levels of ammonia of 0.03 mg/l and 0.11 mg/l were recorded in May and June 2010 respectively.

### 3.4 Nivelsbaach

#### 3.4.1 Results

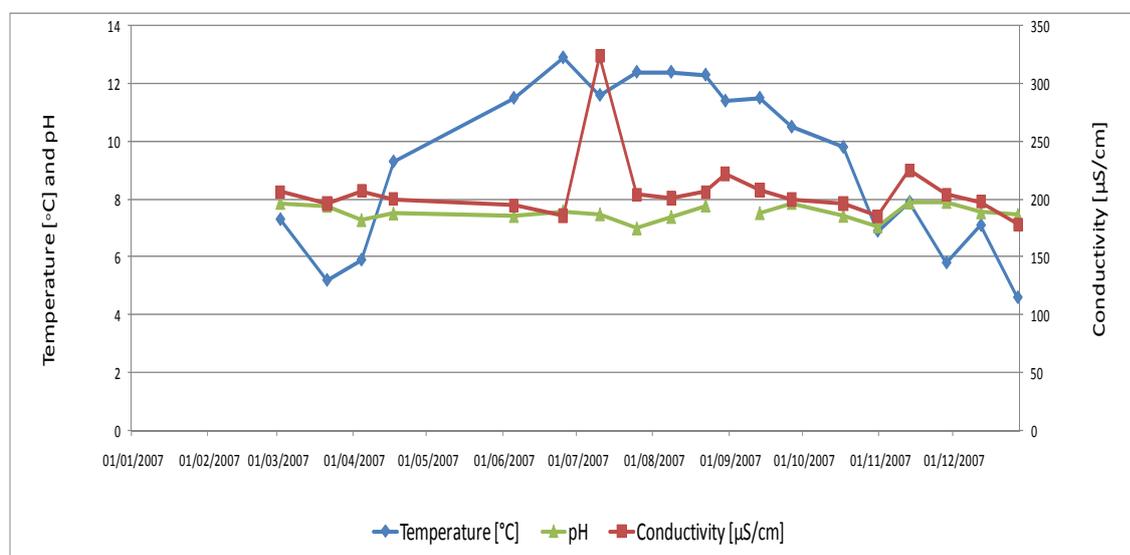


Figure 10 Water parameters Nivelsbaach 2007.

Figure 10 and Table 11 present the water parameters measured in the Nivelsbaach for March to December 2007. The temperature of the river ranges between 5.2°C and 12.9°C with the normal annual trend occurring; the maximum temperature was recorded in June. The pH ranges between pH 7.02 and pH 7.92. The conductivity readings for the period show a range of values between 178.3 µS/cm and 225µS/cm. The measurement of 324 µS/cm in July is likely to be the result of a fault with equipment. The level of oxygen ranges between 8.56 mg/l and 12.44 mg/l. The low range of values corresponds to the levels of oxygen saturation recorded during this period. The range of oxygen saturation levels is between 79.7% and 111.2%. The levels of NO<sub>3</sub>-N range between 20 mg/l and 75mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 11 Water parameters Nivelsbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
02/03/2007	10.68				
21/03/2007	9.71	80.4			
04/04/2007	11.59	96.2			
17/04/2007	10.3	92.9			
05/06/2007	11.06	105.6	50	0	0
25/06/2007	10.59	105.9			
10/07/2007	11.62	111.2			
25/07/2007	10.17	98.9	20	0	0
08/08/2007	10.61	103.2	55	0	0
22/08/2007	10.4	102.7	50	0	0
30/08/2007	9.4	89.3			
13/09/2007	8.62	81			
26/09/2007	11.46	107.4			
17/10/2007	8.56	79.7	75	0	0
31/10/2007	11.14	94	75	0	0
13/11/2007	11.92	105.4			
28/11/2007	12.27	100.5	35	0	0
12/12/2007	12.44	104.7			
27/12/2007	12	91.9			

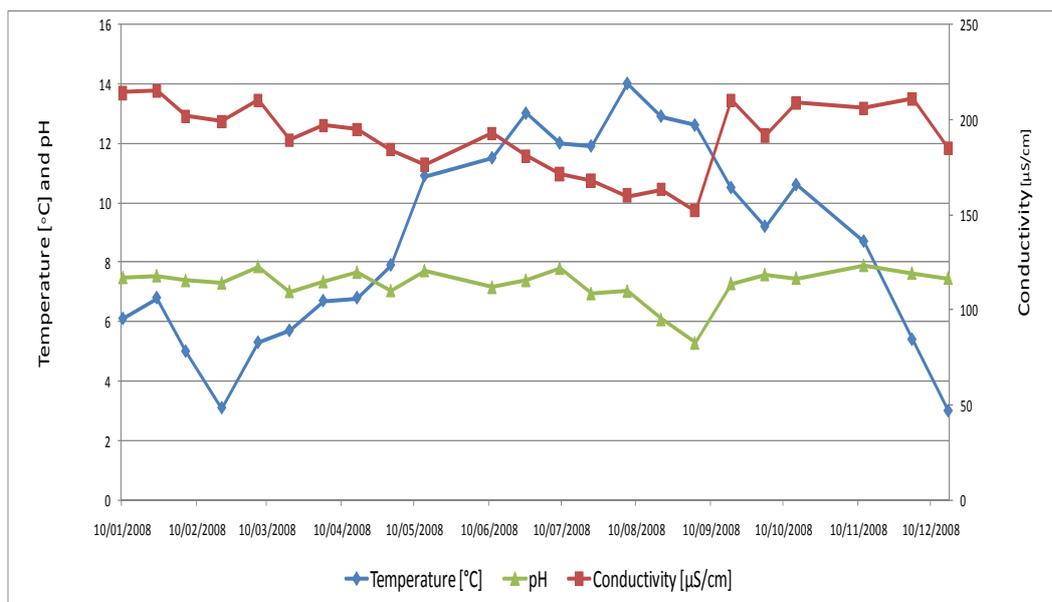


Figure 11 Water parameters Nivelsbaach 2008.

Figure 11 and Table 12 present the water parameters measured in the Nivelsbaach for 2008. The temperature of the river ranges between 3°C and 14°C. The pH ranges between pH 6.95 and pH 7.9. The measurements of pH 6.08 and pH 5.29 recorded in August and September are likely to be the result of a fault with equipment. The conductivity readings for the period show a range of values between 152.1 µS/cm and 211 µS/cm. The level of oxygen ranges between 8.71 mg/l and 16.88mg/l. The levels of oxygen saturation range between 85.9% and 135.4%. The maximum levels of 131.6% and 135.4% recorded in June and July respectively are high for this site. The levels of NO<sub>3</sub>-N range between 9.8 mg/l and 17.6 mg/l.

Table 12 Water parameters Nivelsbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
10/01/2008	11.07	92.7	
24/01/2008	12.86	104.8	
05/02/2008	11.83	97.1	
20/02/2008	14.32	110.4	
06/03/2008	13.7	110.6	
19/03/2008	12.75	105.5	
02/04/2008	12.07	102.2	13.64
16/04/2008	11.97	101.9	13.94
30/04/2008	11.88	106	13.31
14/05/2008	12.21	115.2	11.63
11/06/2008	12.38	118.5	14.1
25/06/2008	13.4	131.6	13.9
09/07/2008	13.96	135.4	12
22/07/2008	11.32	109.3	
06/08/2008	10.81	107.7	
20/08/2008	8.71	85.9	10
03/09/2008	10.1	100.5	9.8
18/09/2008	10.73	98.1	15.1
02/10/2008	10.52	96.6	
15/10/2008	10.01	93.7	
12/11/2008	11.84	104.9	17.6
02/12/2008	12	100.3	15.7
17/12/2008	16.88	130.6	11.8

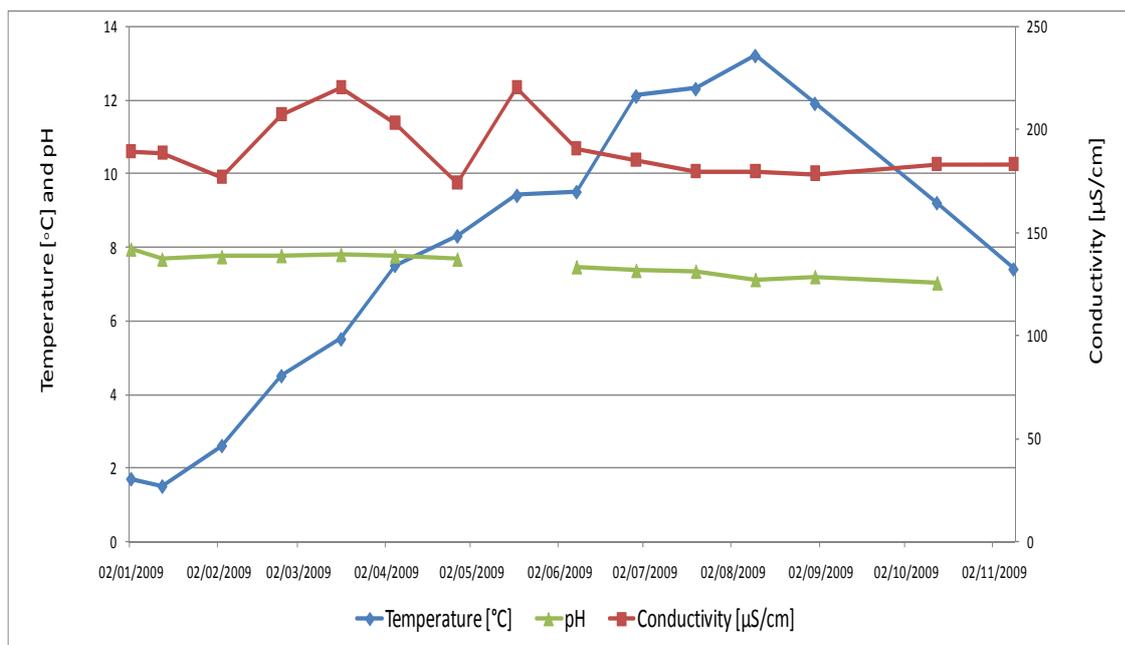


Figure 12 Water parameters Nivelsbaach 2009.

Figure 12 and Table 13 present the water parameters measured in the Reibach for 2009. The temperature of the river ranges between 1.5°C and 13.2°C with the normal annual trend occurring; the maximum temperature was recorded in August. The pH ranges between pH 7.01 and pH 7.94. The conductivity readings for this site show a range of values between 173.9 µS/cm and 220 µS/cm. The level of oxygen ranges between 7.63 mg/l and 16.63 mg/l. The maximum level recorded in the beginning of January follows on from the reading of 16.88 mg/l in December 2008. The minimum level of 7.63 mg/l recorded in the middle of January is unusual and correlates to a low oxygen saturation level of 56.3%. The maximum oxygen saturation level of 122.8% was also recorded in January. The levels of NO<sub>3</sub>-N range between 0.11 mg/l and 14.1 mg/l.

Table 13 Water parameters Nivelsbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
02/01/2009	16.63	122.8	14.1
13/01/2009	7.63	56.3	13.4
03/02/2009	11.66	89.7	11.2
24/02/2009	8.16	64.7	12.7
17/03/2009	10.93	89.5	
05/04/2009	14.28	122.7	
27/04/2009	11.6	103.8	
18/05/2009	8.94	81.2	
08/06/2009	12.17	111.8	0.11
29/06/2009	8.87	85.5	11
20/07/2009	8.65	84	6.54
10/08/2009	10.3	101.8	4.52
31/08/2009	10.21	98.2	
13/10/2009	10.58	95	
09/11/2009	9.77	85.2	0.78

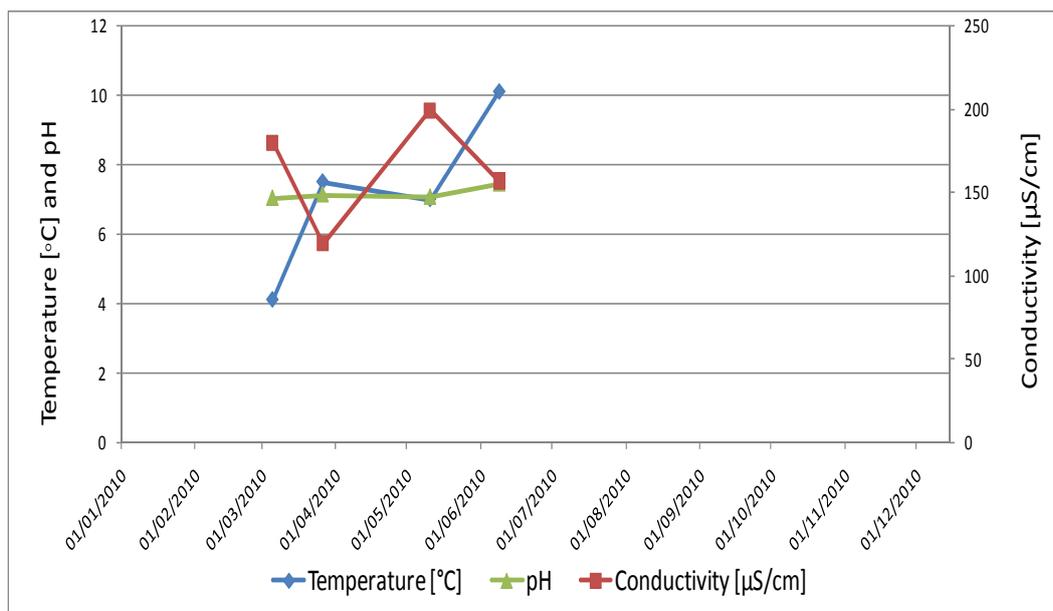


Figure 13 Water parameters Nivelsbaach 2010.

Figure 13 and Table 14 present the water parameters measured in the Nivelsbaach for March to June 2010. The temperature of the river ranges between 4.1°C and 10.1°C. The pH ranges between pH 7.028 and pH 7.443. The conductivity readings for this site show a range of values between 119.2 µS/cm and 199µS/cm. The level of oxygen ranges between 8.53 mg/l and 12.46 mg/l. The oxygen saturation levels range between 76.8% and 114.2%. The levels of NO<sub>3</sub>-N range between 9.7mg/l and 11.2 mg/l. Ammonia levels were measured as 0.03 mg/l and 0.04 mg/l in May and June respectively.

Table 14 Water parameters Nivelsbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			11.2	
26/03/2010	10.95	95.8	11.8	
10/05/2010	12.46	114.2	10.5	0.03
08/06/2010	8.53	76.8	9.7	0.04

### 3.4.2 Discussion

A trend of falling temperatures in the Nivelsbaach is evident when analysing the annual averages. The temperature has fallen from 9.27°C in 2007 to 7.17°C in 2010. The average pH was similar in 2007 and 2009 showing pH 7.56 and pH 7.51 respectively. Similarly in the other tributaries the pH was lower in both 2008 and 2010 showing readings of pH 7.28 and pH 7.16. The annual averages for the conductivity readings show that the conductivity in the Nivelsbaach is approximately 195 µS/cm. The average reading for 2007 was 200.9 µS/cm and 190 µS/cm for both 2008 and 2009. The average for 2010 is much lower at 163.6 µS/cm but higher readings are expected in the winter months therefore this cannot be used to show a reduction in conductivity readings. These readings are very much elevated and are twice the standard recommended for a Freshwater Pearl Mussel habitat. The level of dissolved oxygen in the stream is good with an average reading of 98% but this is lower than many of the other streams flowing into the river Our. The annual average level of nitrate is very much elevated in the Nivelsbaach showing a reading of 51.42 mg/l in 2007. This is over 25 times greater than the guideline specified by Moog *et al.* (1993) and over 50 times greater than the recommendation stated by Oliver (2000). The levels of nitrate – nitrogen measured in 2008, 2009 and 2010 all exceed the requirements of each of the authors specified in Table 1 to a great extent. The greatest annual average was recorded in 2008 showing a reading of 13.27 mg/l NO<sub>3</sub>-N. This is extremely high as the target level is <0.45 (Moog *et al.*, 1993).

### 3.5 Schelsbaach

#### 3.5.1 Results

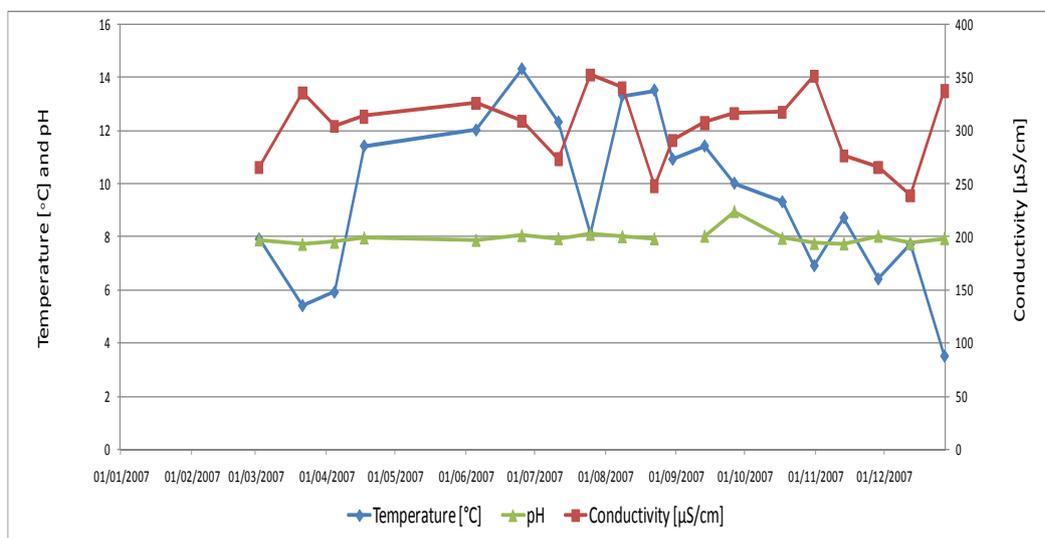


Figure 14 Water parameters Schelsbaach 2007.

Figure 14 and Table 15 present the water parameters measured in the Schelsbaach for 2007. The temperature of the river ranges between 3.5°C and 14.3°C with the normal annual trend occurring apart from a downturn in July with a measurement of 8.08°C, the maximum temperature was recorded in June. The pH ranges between pH 7.72 and pH 8.94. The maximum reading of pH 8.94 recorded in September is high for this site. The conductivity readings for the period show a range of values between 239 µS/cm and 352 µS/cm. The level of oxygen ranges between 9.56mg/l and 12.94 mg/l. The range of oxygen saturation levels is between 83.7% and 120.2%. The levels of NO<sub>3</sub><sup>-</sup> range between 50 mg/l and 85 mg/l. The level of nitrite (NO<sub>2</sub><sup>-</sup>) was measured as 0.05 mg/l on both the 25<sup>th</sup> of July and the 22<sup>nd</sup> of August. Ammonia (NH<sub>4</sub>) was measured as absent in 2007.

Table 15 Water parameters Schelsbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
02/03/2007	10.56				
21/03/2007	10.09	83.7			
04/04/2007	11.72	96.9			
17/04/2007	10.39	98.4			
05/06/2007	12.19	117.3	50	0	0
25/06/2007	10.96	112.5			
11/07/2007	11.73	114.2			
25/07/2007	11.24	110	75	0.05	0
08/08/2007	12.07	120.2	60	0	0
22/08/2007	11.03	111.6	75	0.05	0
30/08/2007	10.3	96.5	60		0
13/09/2007	9.56	90.4			
26/09/2007	13.9	127			
17/10/2007	10.12	92.6	50	0	0
31/10/2007	11.44	96.3	75	0	0
13/11/2007	12.94	118			
28/11/2007	11.6	96.2	85	0	0
12/12/2007	12.46	106.5			
27/12/2007	13.48	104			

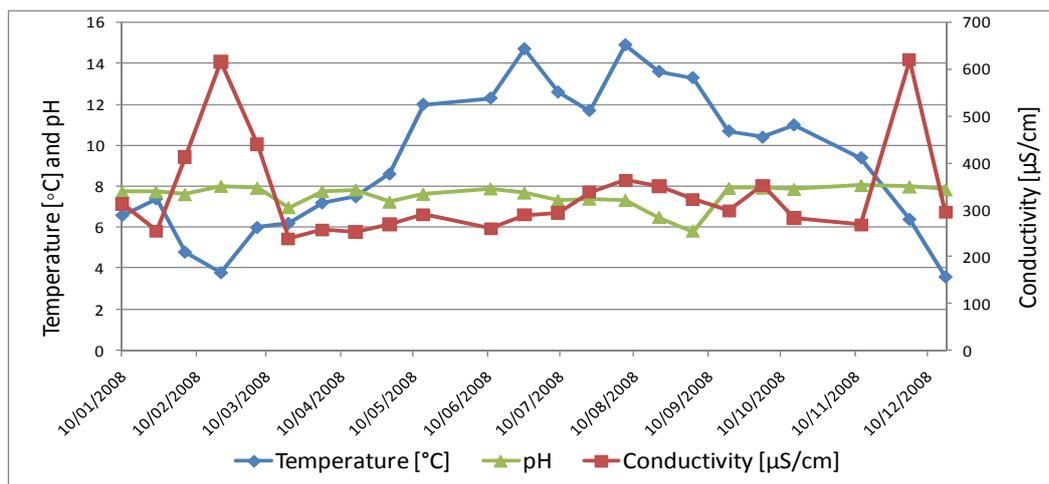


Figure 15 Water parameters Schelsbaach 2008.

Figure 15 and Table 16 present the water parameters measured in the Schelsbaach for 2008. The temperature of the river ranges between 3.6°C and 14.9°C with the normal annual trend occurring accompanied with a slight decrease in July. The pH ranges between pH 6.96 and pH 8.05. The low readings of pH 6.48 and pH 5.8 recorded in August and September are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 252 µS/cm and 618 µS/cm. The levels of 614 µS/cm and 618 µS/cm recorded in February and December respectively are extremely high for this site. The level of oxygen ranges between 8.73 mg/l and 18.99 mg/l. The maximum level recorded in December is notably high for this site. The oxygen saturation level ranges between 90.1% and 134.2%. The levels of NO<sub>3</sub>-N range between 9 mg/l and 19.2 mg/l. The levels of nitrate in the Schelsbaach are generally very high particularly in November and December.

Table 16 Water parameters Schelsbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
10/01/2008	10.96	93.2	
24/01/2008	11.34	97.1	
05/02/2008	11.5	96.2	
20/02/2008	13.82	108.8	
06/03/2008	13.87	114.3	
19/03/2008	13.18	111.6	
02/04/2008	12.15	104.6	16.01
16/04/2008	11.7	100.4	16.37
30/04/2008	11.78	107	13.99
14/05/2008	12.39	120	16.05
11/06/2008	12.48	120.6	15.40
25/06/2008	13.11	134.2	13.70
09/07/2008	13.64	134.1	9.00
22/07/2008	12.41	118.8	
06/08/2008	8.73	90.1	
20/08/2008	10	100.4	9.50
03/09/2008	10.38	104.5	10.60
18/09/2008	10.54	98.1	16.00
02/10/2008	14.12	105.7	
15/10/2008	10.34	97.8	
12/11/2008	10.77	98.1	19.20
02/12/2008	12.66	106.5	17.30
17/12/2008	18.99	125.8	14.60

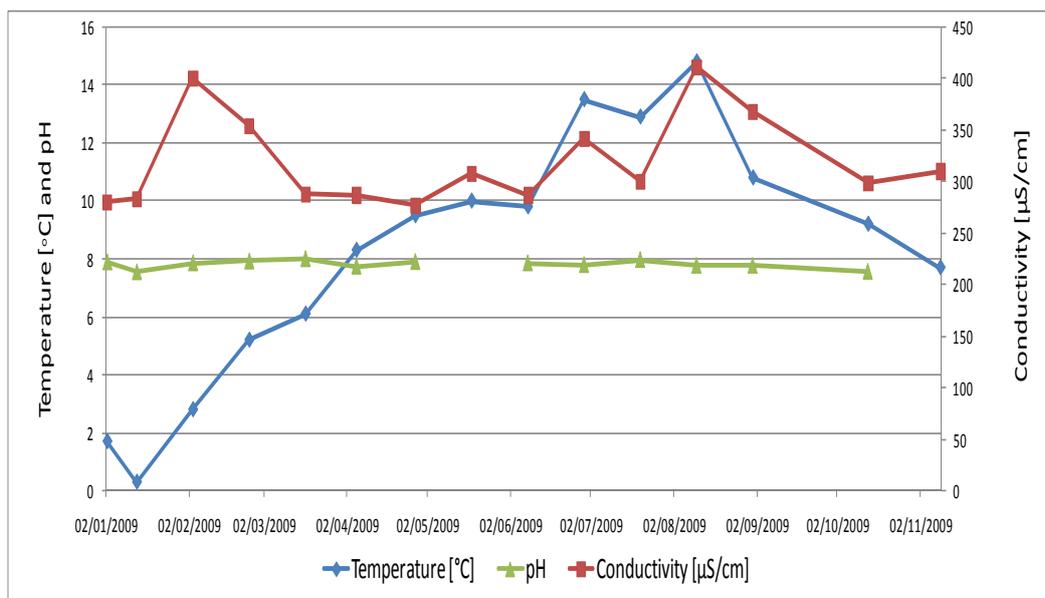


Figure 16 Water parameters Schelsbaach 2009.

Figure 16 and Table 17 present the water parameters measured in the Schelsbaach for 2009. The temperature of the river ranges between 0.3°C and 14.8°C with the normal annual trend occurring. The pH ranges between pH 7.57 and pH 8.01. The conductivity readings for this site show a range of values between 277 µS/cm and 411 µS/cm. The maximum readings of 400 µS/cm and 411 µS/cm recorded in February and August are notably high for this site. The level of oxygen ranges between 4.73 mg/l and 16.26 mg/l. The minimum level recorded in January is notably low and corresponds to a very low oxygen saturation level of 32.9% for this site particularly when high readings were recorded two weeks before and after this. The maximum oxygen saturation level of 150.4% was recorded in August. The levels of NO<sub>3</sub>-N range between 0.92 mg/l and 17 mg/l. The levels of nitrate in the Schelsbaach are generally very high in January and February.

Table 17 Water parameters Schelsbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
02/01/2009	15.77	116.7	17.00
13/01/2009	4.73	32.9	14.90
03/02/2009	11.72	91.2	15.20
24/02/2009	8.36	64.9	14.30
17/03/2009	11	90.5	
05/04/2009	13.87	122.4	
27/04/2009	12.09	110.4	
18/05/2009	8.95	82.3	
08/06/2009	12.13	111.7	0.92
29/06/2009	9.27	92.8	11.3
20/07/2009	9.58	94.3	1.69
10/08/2009	11.99	123.7	1.94
31/08/2009	16.26	150.4	1.12
13/10/2009	11.23	100.1	12.1
09/11/2009	10.31	90.3	2.9

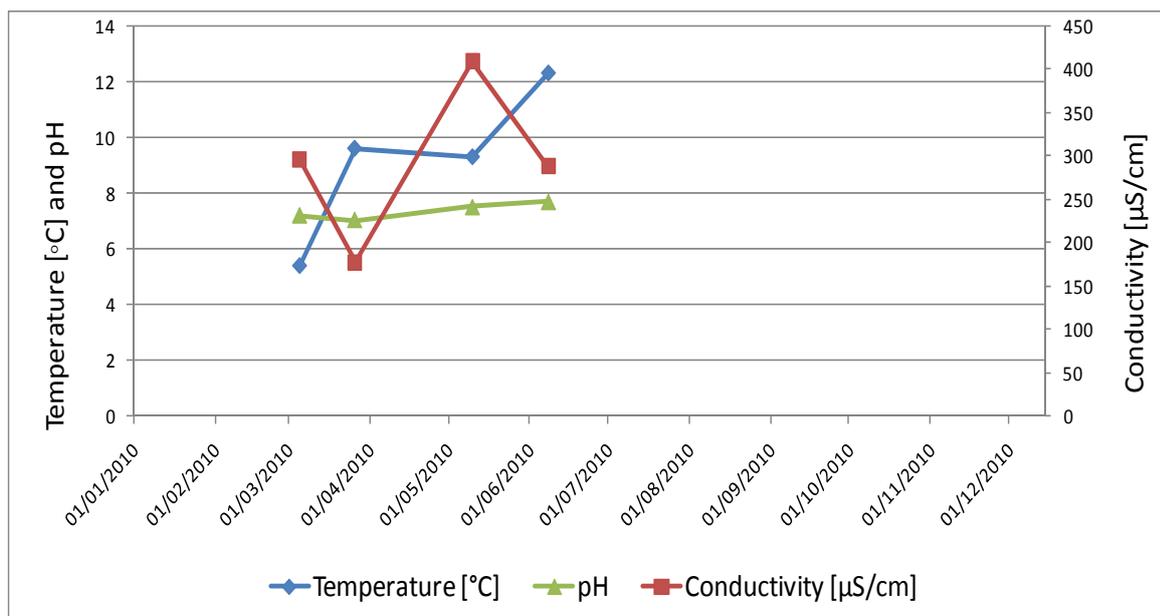


Figure 17 Water parameters Schelsbaach 2010.

Figure 17 and Table 18 present the water parameters measured in the Schelsbaach for March to June 2010. The temperature of the river ranges between 5.4°C and 12.3°C. The pH ranges between pH 7.021 and pH 7.681. The conductivity readings for this site show a range of values between 177.5 µS/cm and 408 µS/cm. The level of oxygen ranges between 9.69 mg/l and 15.78 mg/l. The oxygen saturation levels range between 90.9% and 138.4%.. The levels of NO<sub>3</sub>-N range between 11.9mg/l and 16.3 mg/l. Ammonia levels were measured as 0.03 mg/l and 0.04 mg/l in May and June respectively.

Table 18 Water parameters Schelsbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			16.3	
26/03/2010	15.78	138.4	16.1	
10/05/2010	12.46	114.2	13.5	0.03
08/06/2010	9.69	90.9	11.9	0.04

### 3.5.2 Discussion

The average pH was similar in 2007 and 2009 showing pH 7.94 and pH 7.82 respectively. Similarly in the other tributaries the pH was lower in both 2008 and 2010 showing readings of pH 7.55 and pH 7.34. The annual averages for the conductivity readings show that the conductivity in the Schelsbaach is extremely elevated showing an average reading of 318  $\mu\text{S}/\text{cm}$ . The average for 2010 is lower at 292  $\mu\text{S}/\text{cm}$  but higher readings are expected in the winter months therefore this cannot be used to show a reduction in conductivity readings. These readings are extremely high and are three times the standard recommended for a Freshwater Pearl Mussel habitat (Oliver, 2000). The level of dissolved oxygen in the stream is good with an average reading of 106% which is good for the stocks of brown trout in the river Our. However the annual average level of nitrate is very much elevated in the Schelsbaach showing an average reading of 66.25 mg/l in 2007. This is the highest reading of eutrophication for all of the tributaries within the project area. The levels of nitrate – nitrogen measured in 2008, 2009 and 2010 all exceed the requirements of the authors shown in Table 1. The greatest annual average was recorded in 2008 showing a reading of 14.44 mg/l  $\text{NO}_3\text{-N}$ . This is closely followed by the average reading of 14.45 mg/l recorded to date in 2010. This is extremely high as the target level for a Freshwater Pearl Mussel habitat is  $<0.45$  mg/l (Moog *et al.*, 1993). According to the previous report by the LIFE group; the wastewater from the village of Lieler was once discharged directly into the Schelsbaach. This problem was remediated in 2007 with the installation of a wastewater treatment facility (Thielen *et al.*, 2007). Taking the results for the levels of nitrate and conductivity into consideration it would appear that the functionality of this facility comes into question. The water quality in this stream must be very carefully observed as it poses a serious risk to the health status of the river Our.

### 3.6 Jansschederbaach

#### 3.6.1 Results

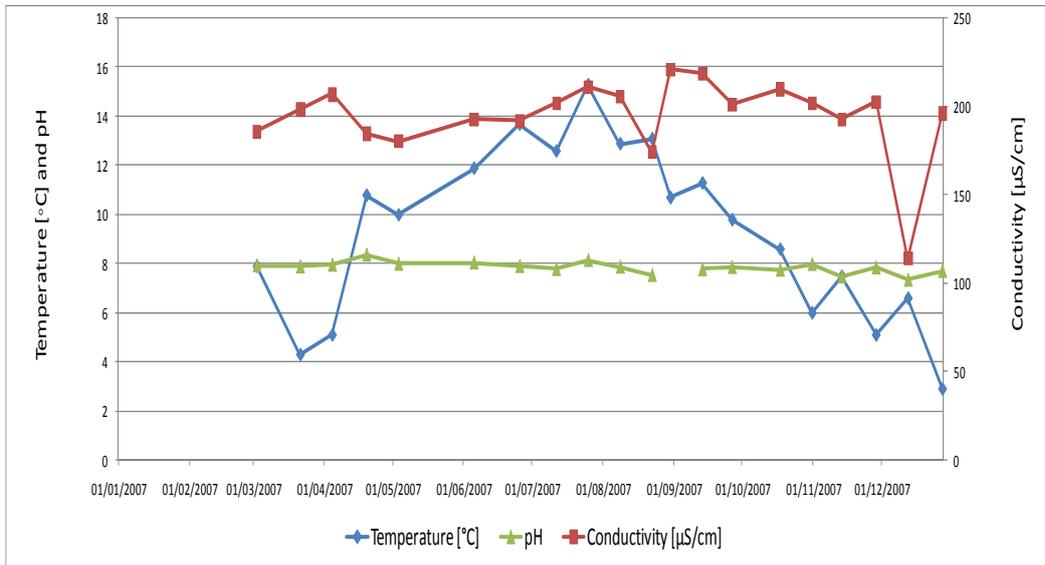


Figure 18 Water parameters Jansschederbaach 2007.

Figure 18 and Table 19 present the water parameters measured in the Jansschederbaach for March to December 2007. The temperature of the river ranges between 2.9°C and 15.3°C; the maximum temperature was recorded in July. The pH ranges between pH 7.37 and pH 8.37. The conductivity readings for the period show a range of values between 174.3 µS/cm and 221 µS/cm. The low measurement of 114.1 µS/cm recorded in December is likely to be the result of a fault with equipment. The level of oxygen ranges between 9.64 mg/l and 12.88 mg/l. The range of oxygen saturation levels is between 77.6% and 127.1%. The levels of NO<sub>3</sub><sup>-</sup> range between 25 mg/l and 75 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 19 Water parameters Jansschederbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
02/03/2007	10.89				
21/03/2007	9.64	77.6			
04/04/2007	12.2	101			
19/04/2007	10.2	98.8			
03/05/2007	11.9	110.1			
05/06/2007	11.81	113.2	25	0	0
25/06/2007	10.57	106.7			
11/07/2007	11.37	112.7			
25/07/2007	10.84	113.2	35	0	0
08/08/2007	12.5	123.1	25	0	0
22/08/2007	10.2	102.5	35	0	0
30/08/2007	13.59	127.1			
13/09/2007	9.7	91.5			
26/09/2007	13.13	122.7			
17/10/2007	10.74	95.9	75	0	0
31/10/2007	11.81	97.1	75	0	0
13/11/2007	13.42	113.6			
28/11/2007	13.15	106.9	75	0	0
12/12/2007	11.73	97			
27/12/2007	12.88	97.5			

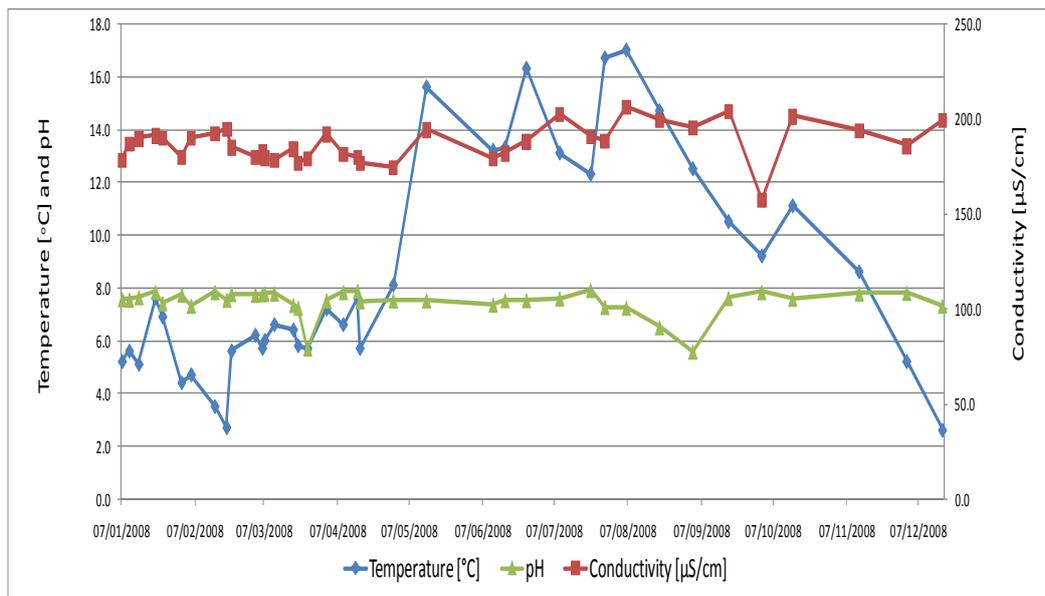


Figure 19 Water parameters Jansscheederbaach 2008.

Figure 19 and Table 20 present the water parameters measured in the Jansscheederbaach for 2008. The temperature of the river ranges between 2.6°C and 17°C with the normal annual trend occurring accompanied with a slight decrease in both June and July. The pH ranges between pH 5.7 and pH 7.91. The low readings of pH 5.7, pH 6.5 and pH 5.58 recorded in March, August and September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 157.2 µS/cm and 206 µS/cm. The level of oxygen ranges between 8.38 mg/l and 16.06 mg/l. The maximum level recorded in June corresponds to a maximum level of oxygen saturation of 158%. The minimum level recorded in August corresponds to a minimum oxygen saturation of 90.4%. The levels of NO<sub>3</sub>-N range between 7.7 mg/l and 15.6 mg/l.

Table 20 Water parameters Jansscheederbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
07/01/2008	13.29	108	
10/01/2008	11.77	97.4	
14/01/2008	12.37	101.3	
21/01/2008	10.95	94.9	
24/01/2008	12.1	102.6	
01/02/2008	10.56	95.9	
05/02/2008	11.72	95.5	
15/02/2008	13.42	101.7	
20/02/2008	13.57	103.7	
22/02/2008	13.91	113.9	
03/03/2008	13.72	110.2	
06/03/2008	13.64	111.2	
07/03/2008	13.08	102.3	
11/03/2008	12.1	104.6	
19/03/2008	13.33	114	
21/03/2008	12.25	105.3	
25/03/2008	12.2	105.4	
02/04/2008	11.83	101.7	14.01
09/04/2008	10.76	93	
15/04/2008	10.63	92.1	
16/04/2008	11.26	92.9	13.89
30/04/2008	12.41	110	9.25
14/05/2008	11.2	117.5	12.61
11/06/2008	12.4	122.4	13.2
16/06/2008	16.06	159	
25/06/2008	12.9	135.9	10.4
09/07/2008	13.07	128.7	10.2
22/07/2008	12.18	118.3	
28/07/2008	11.21	119.7	
06/08/2008	8.38	90.4	
20/08/2008	10.2	104.9	9.2
03/09/2008	10.69	105.7	7.7
18/09/2008	10.5	99.2	14.1
02/10/2008	10.39	93.4	
15/10/2008	9.17	87.6	
12/11/2008	10.84	96.6	15.1
02/12/2008	12.41	102.4	15.6
17/12/2008	14.99	118.6	13

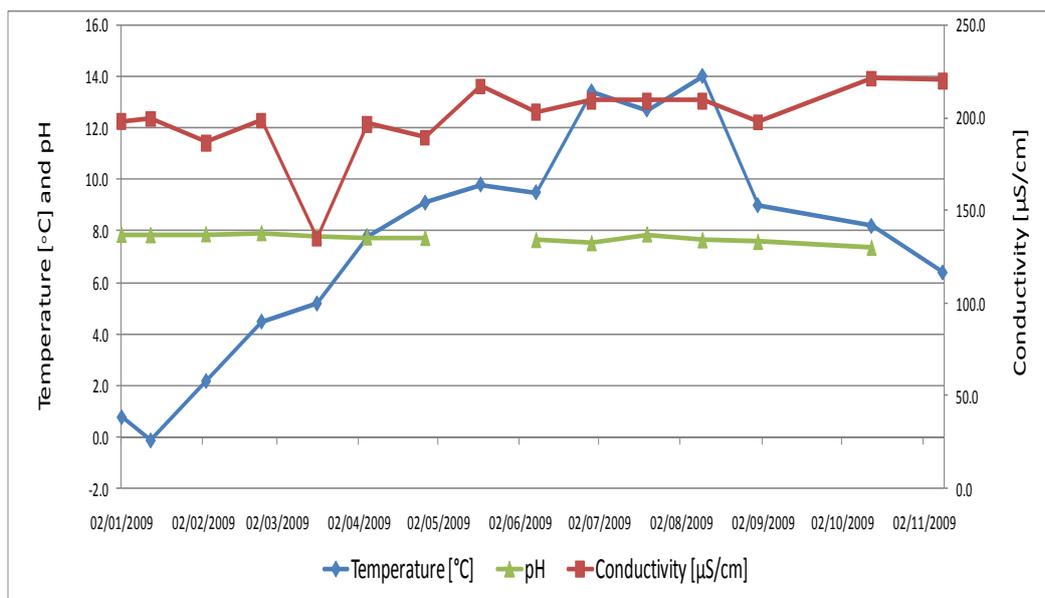


Figure 20 Water parameters Jansscheederbaach 2009.

Figure 20 and Table 21 present the water parameters measured in the Jansscheederbaach for 2009. The temperature of the river ranges between  $-0.1^{\circ}\text{C}$  and  $14^{\circ}\text{C}$  with the normal annual trend occurring. The pH ranges between pH 7.35 and pH 7.90. The conductivity readings for this site show a range of values between  $135\ \mu\text{S}/\text{cm}$  and  $221\ \mu\text{S}/\text{cm}$ . The level of oxygen ranges between  $8.26\ \text{mg}/\text{l}$  and  $15.36\ \text{mg}/\text{l}$ . The oxygen saturation levels range between 64.4% and 134.2%. The levels of  $\text{NO}_3\text{-N}$  range between  $0.63\ \text{mg}/\text{l}$  and  $13.1\ \text{mg}/\text{l}$ .

Table 21 Water parameters Jansscheederbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
02/01/2009	14.27	103.2	13.1
13/01/2009	9.02	64.4	12.3
03/02/2009	12.2	93.8	9.4
24/02/2009	10.96	89.9	11.9
17/03/2009	11.4	92.1	
05/04/2009	15.15	133.2	
27/04/2009	12.1	110.1	
18/05/2009	8.26	74.6	
08/06/2009	11.31	103.5	0.63
29/06/2009	8.31	82.5	8.5
20/07/2009	9.52	93.5	1.45
10/08/2009	11.23	115.4	2.23
31/08/2009	15.36	134.2	1.11
13/10/2009	8.93	73.1	5.4
09/11/2009	10.53	89	1.4

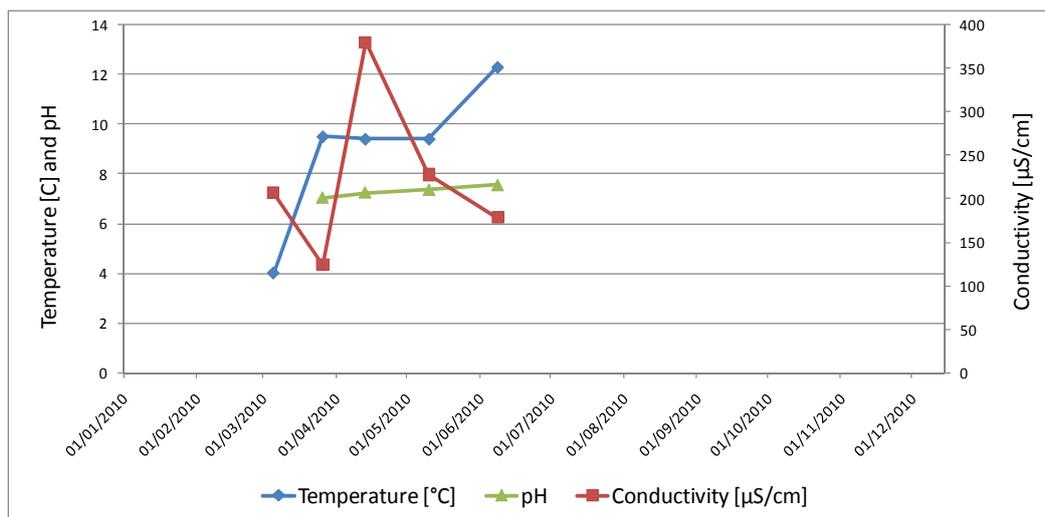


Figure 21 Water parameters Jansscheederbaach 2010.

Figure 21 and Table 22 present the water parameters measured in the Jansscheederbaach for March to June 2010. The temperature of the river ranges between 4°C and 12.3°C. The pH ranges between pH 7.041 and pH 7.564. The conductivity readings for this site show a range of values between 124.5 µS/cm and 380µS/cm. The level of oxygen ranges between 9.44 mg/l and 12.09 mg/l. The oxygen saturation levels range between 87.7% and 111.5%. The levels of NO<sub>3</sub>-N range between 7.6 mg/l and 13.5 mg/l. Ammonia levels were measured as 0.03 mg/l in both May and June respectively.

Table 22 Water parameters Jansscheederbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			13.4	
26/03/2010	12.09	111.5	12.4	
13/04/2010	9.64	87.7		
10/05/2010	10.62	99.8	9.6	0.03
08/06/2010	9.44	93.1	7.6	0.03

### 3.6.2 Discussion

The average pH values in the Jansscheederbaach are similar to that of the other tributaries. The readings for 2007 and 2009 were pH 7.86 and pH 7.7 respectively. Similarly the pH was lower in both 2008 and 2010. As with the other tributaries, this measurement of acidity is too alkaline for that of a Freshwater Pearl Mussel stream and is not compliant with the guidelines set out by Oliver (2000) in Table 1. The annual averages for the conductivity readings show that the conductivity in the Schelsbaach is elevated showing an average reading of approximately 200 µS/cm. The average for 2010 is higher at 223 µS/cm but as higher readings are expected in the latter part of the year, the annual average may increase significantly. The current readings are extremely high and are twice the standard recommended for a Freshwater Pearl Mussel habitat (Oliver, 2000). The level of dissolved oxygen in the stream is good with an average reading of 101% which is good for this tributary. However, as with many of the tributaries; the annual average level of nitrate is very much elevated showing a reading of 49.28 mg/l NO<sub>3</sub><sup>-</sup> in 2007. The levels of nitrate – nitrogen measured in 2008, 2009 and 2010 all exceed the requirements of the authors shown in Table 1. The greatest annual average was recorded in 2008 showing a reading of 12.17 mg/l NO<sub>3</sub>-N.

### 3.7 Schankbaach

#### 3.7.1 Results

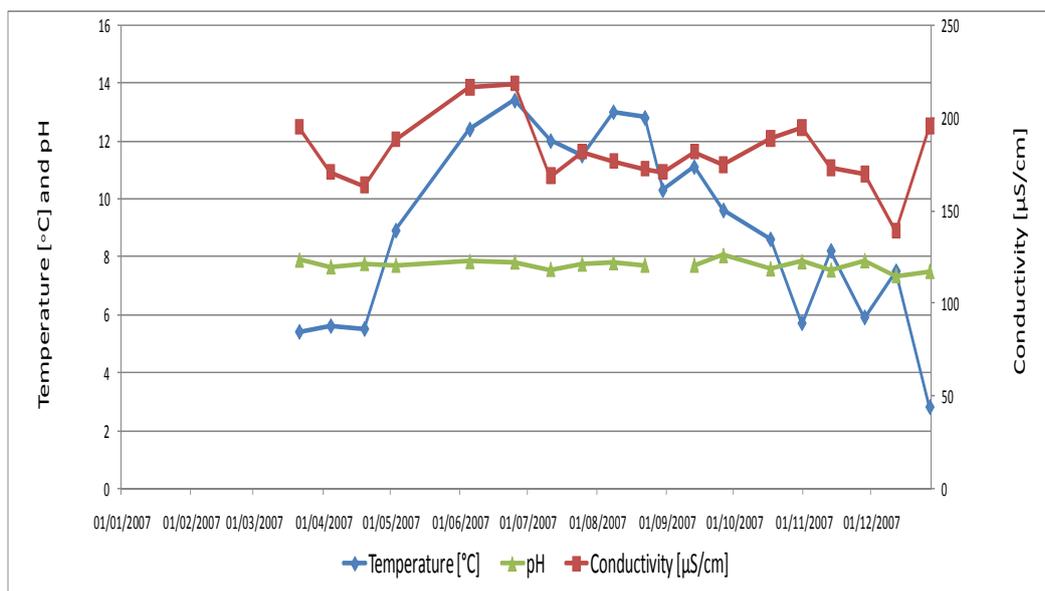


Figure 22 Water parameters Schankbaach 2007.

Figure 22 and Table 23 present the water parameters measured in the Schankbaach for March to December 2007. The temperature of the river ranges between 2.8°C and 13.4°C. The pH ranges between pH 7.34 and pH 8.05. The conductivity readings for the period show a range of values between 139 µS/cm and 218 µS/cm. The level of oxygen ranges between 8.6 mg/l and 14.28 mg/l. The range of oxygen saturation levels is between 81.6% and 118.3%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 25 mg/l and 75 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 23 Water parameters Schankbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
21/03/2007	9.84	81.6			
04/04/2007	12.02	99.3			
19/04/2007	11.76	96.7			
03/05/2007	11.78	106.4			
05/06/2007	12.01	117.2	25	0	0
25/06/2007	10.95	111.3			
11/07/2007	11.77	111.7			
25/07/2007	10.49	102.2	35	0	0
08/08/2007	10.18	101.3	25	0	0
22/08/2007	10.9	108.8	35	0	0
30/08/2007	8.89	82.1			
13/09/2007	8.6	82.1			
26/09/2007	12.9	118			
17/10/2007	10.04	89.7	75	0	0
31/10/2007	11.63	95.3	50	0	0
13/11/2007	12.49	112.9			
28/11/2007	14.28	118.3	50	0	0
12/12/2007	12.96	111			
27/12/2007	12.49	94.8			

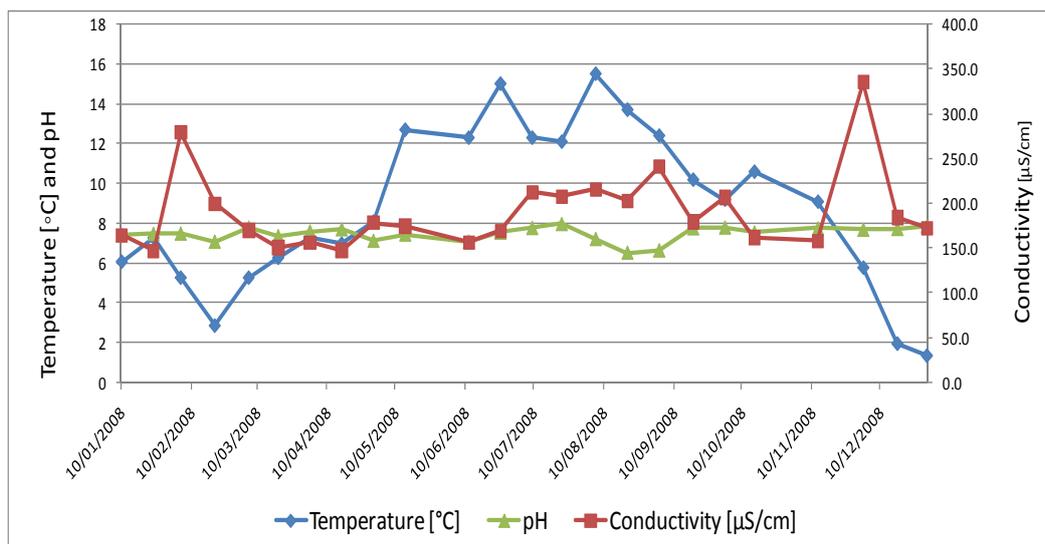


Figure 23 Water parameters Schankbaach 2008.

Figure 23 and Table 24 present the water parameters measured in the Schankbaach for 2008. The temperature of the river ranges between 1.4°C and 15.5°C with the normal annual trend occurring accompanied with a slight decrease in July. The pH ranges between pH 6.51 and pH 7.98. The low readings of pH 5.1 and pH 6.62 recorded in August and September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 147.4 µS/cm and 335 µS/cm. The maximum level recorded in December is notably high for this site. The level of oxygen ranges between 8.05 mg/l and 17.62 mg/l. The oxygen saturation levels range between 83.8% and 135.5%. The levels of NO<sub>3</sub>-N range between 6.8 mg/l and 13.9 mg/l.

Table 24 Water parameters Schankbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
10/01/2008	10.89	91.3	
24/01/2008	11.85	100.8	
05/02/2008	12.92	108	
20/02/2008	14.3	110.2	
06/03/2008	13.45	109.9	
19/03/2008	13.75	117.2	
02/04/2008	11.89	103.5	11.43
16/04/2008	11.49	98.1	11.14
30/04/2008	12.1	108.2	7.91
14/05/2008	12.29	121.1	9.75
11/06/2008	12.37	119.8	10.3
25/06/2008	11.27	117	9.5
09/07/2008	13.9	135.5	12.8
22/07/2008	11.92	114.4	
06/08/2008	8.05	83.8	
20/08/2008	9.48	95.7	7.2
03/09/2008	10.31	101.5	6.8
18/09/2008	10.47	96.8	9
02/10/2008	10.93	99.8	
15/10/2008	9.96	93.4	
12/11/2008	10.77	97.3	12.9
02/12/2008	12.06	101.4	13.9
17/12/2008	16.93	128.6	11
30/12/2008	17.62	129.8	12.1

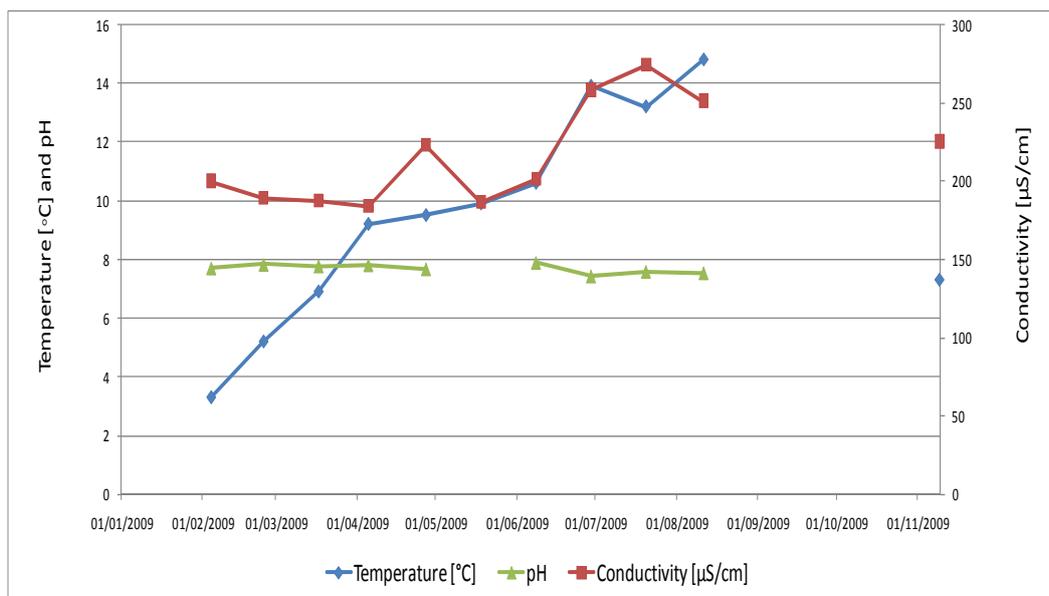


Figure 24 Water parameters Schankbaach 2009.

Figure 24 and Table 25 present the water parameters measured in the Schankbaach for February to August 2009. A single set of measurements was taken in November 2009. The temperature of the river ranges between 3.3°C and 14.8°C. The pH ranges between pH 7.42 and pH 7.89. The conductivity readings for this site show a range of values between 184 µS/cm and 274 µS/cm. The level of oxygen ranges between 8.06 mg/l and 16.16 mg/l. The oxygen saturation levels range between 68.9% and 133.7%. The levels of NO<sub>3</sub>-N range between 0.02 mg/l and 12.5 mg/l.

Table 25 Water parameters Schankbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
04/02/2009	10.07	80.3	10.5
24/02/2009	8.82	68.9	12.5
17/03/2009	10.73	90.4	
05/04/2009	16.16	151	
27/04/2009	8.99	83.6	
18/05/2009	8.06	73.9	
08/06/2009	14.1	133.7	0.02
29/06/2009	8.42	84.7	6.9
20/07/2009	9.32	92.4	0.01
11/08/2009	11.11	113.4	1.86
31/08/2009			
13/10/2009			
09/11/2009	9.57	84.4	2.11

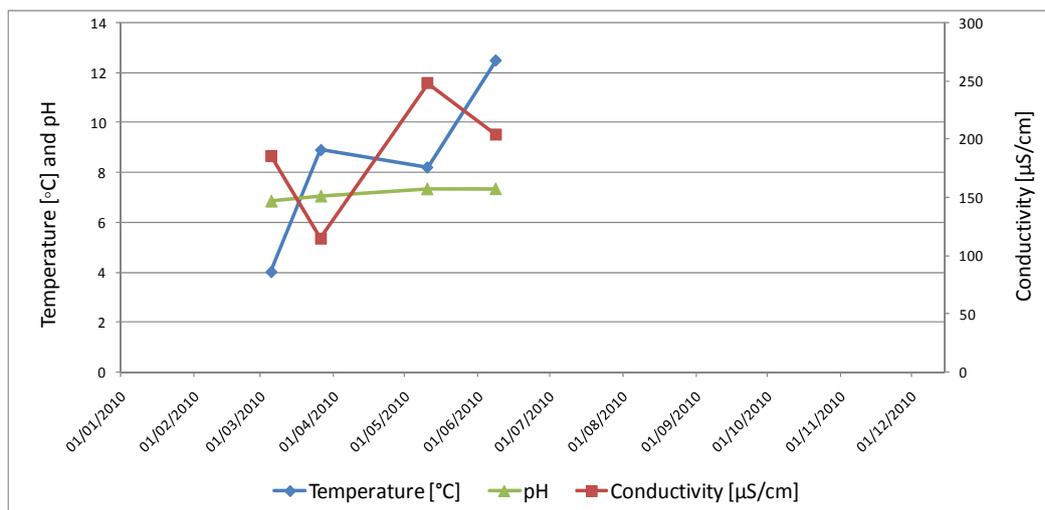


Figure 25 Water parameters Schankbaach 2010.

Figure 25 and Table 26 present the water parameters measured in the Schankbaach for March to June 2010. The temperature of the river ranges between 4°C and 12.5°C. The pH ranges between pH 6.848 and pH 7.325. The conductivity readings for this site show a range of values between 114.7 µS/cm and 248 µS/cm. The level of oxygen ranges between 8.2 mg/l and 12.97 mg/l. The oxygen saturation levels range between 79.9% and 117.7%. The levels of NO<sub>3</sub>-N range between 7.9 mg/l and 12.5 mg/l. Ammonia levels were measured in May as 0.05 mg/l.

Table 26 Water parameters Schankbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			12.5	
26/03/2010	11.52	106.1	11.1	
10/05/2010	12.97	117.7	9.1	
08/06/2010	8.1	79.9	7.9	0.05

### 3.7.2 Discussion

The average pH was similar in 2007 and 2009 showing pH 7.71 and pH 7.68 respectively. Similarly in the other tributaries the pH was lower in both 2008 and 2010 showing readings of pH 7.47 and pH 7.133. The annual averages for the conductivity readings show that the conductivity in the Schelsbaach is extremely elevated showing an average reading of 180 µS/cm in 2008 and 190 µS/cm in 2009. This increased to 216 µS/cm in 2009. These readings are extremely high and are twice the standard recommended for a Freshwater Pearl Mussel habitat (Oliver, 2000). The level of dissolved oxygen in the stream is good with an average reading of 101% which is good for the stocks of brown trout in the river Our. However the annual average level of nitrate is very much elevated in the Schelsbaach showing a reading of 42 mg/l in 2007. This is over twenty times greater than the standards recommended by Moog *et al.* (1993). The levels of nitrate – nitrogen measured in 2008, 2009 and 2010 all exceed the requirements of the authors shown in Table 1. The greatest annual average was recorded in 2008 showing a reading of 10.4 mg/l NO<sub>3</sub>-N. The average annual level for 2009 is much improved showing a reading of 4.84 mg/l. This is still regarded as high as the target level for a Freshwater Pearl Mussel habitat is <0.45 mg/l (Moog *et al.*, 1993). However, very high levels of nitrate were again detected in 2010 showing an average reading of 10.15 mg/l.

### 3.8 Our Kalbermillen

#### 3.8.1 Results

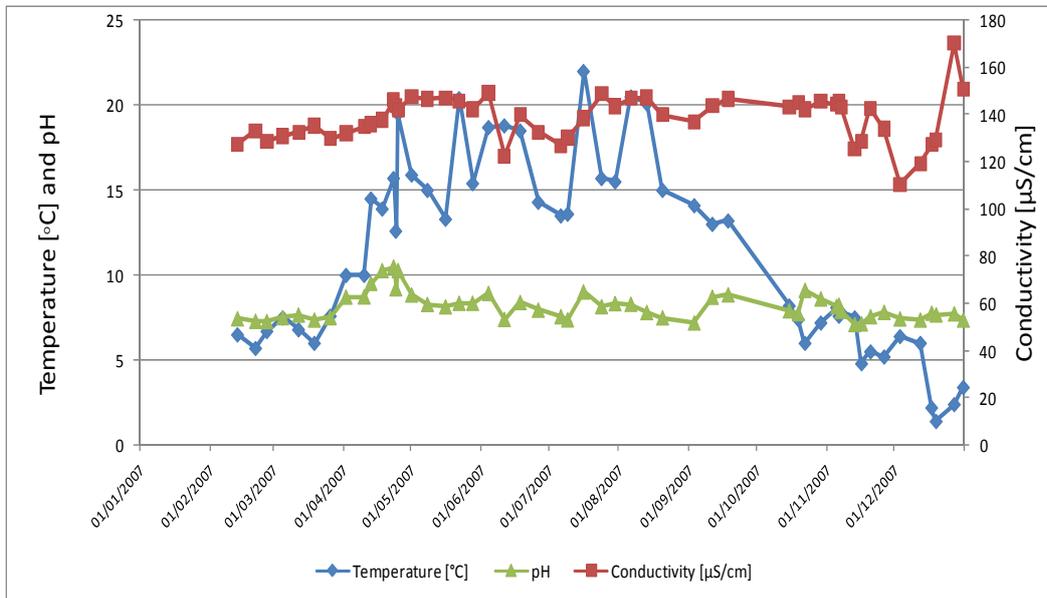


Figure 26 Water parameters Our Kalbermillen 2007.

Figure 26 and Table 27 present the water parameters measured in the Our Kalbermillen for February to December 2007. The temperature of the river ranges between 1.4°C and 22°C. The maximum temperature was recorded in July. The pH ranges between pH 7.11 and pH 10.46. The pH readings were very alkaline (high) in April when the maximum measurement was recorded. The conductivity readings for the period show a range of values between 119.3 µS/cm and 170 µS/cm. The level of oxygen ranges between 7.33 mg/l and 15.13 mg/l. The range of oxygen saturation levels is between 64% and 157%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 10 mg/l and 20 mg/l. The levels of nitrite (NO<sub>2</sub><sup>-</sup>) were consistently measured as 0.05 mg/l between April and August and then became absent when it was tested in October and December. Ammonia (NH<sub>4</sub>) was measured as absent during 2007.

Table 27 Water parameters Our Kalbermillen 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
13/02/2007	13.63				
21/02/2007	12.12				
26/02/2007	11.16				
05/03/2007	11.28	97.6			
12/03/2007	11.35	95.8			
19/03/2007	10.58	90.0			
26/03/2007	7.33	64.0			
02/04/2007	12.26	112.0			
10/04/2007	12.93	118.2			
13/04/2007	12.01	122.8			
18/04/2007	11.23	112.0	10	0.05	0
23/04/2007	13.51	141.1			
24/04/2007	13.29	143.5			
25/04/2007	13.90	157.3			
01/05/2007	12.78	133.9			
08/05/2007	11.00	113.7			
04/06/2007	12.28	135.9	15	0.05	0
11/06/2007	7.85	87.7			
18/06/2007	11.15	123.4			
26/06/2007	11.63	119.6			
06/07/2007	9.67	99			
09/07/2007	10.65	112.8			
16/07/2007	11.15	140.1			
24/07/2007	10.51	110.4	20	0.05	0
30/07/2007	12.47	129.4	15	0.05	0
06/08/2007	9.47	109.4			
13/08/2007	9.71	111.3			
20/08/2007	9.14	94.7	20	0.05	0
03/09/2007	8.71	87.7			
11/09/2007	10.50	103.1			
18/09/2007	10.39	102.6			
15/10/2007	11.74	102.8	20	0	0
19/10/2007	11.07	94.2			
22/10/2007	13.70	112.1			
29/10/2007	12.10	104.7			
05/11/2007	12.65	109.6			
06/11/2007	12.32	107.1			
07/11/2007	13.25	115.2			
13/11/2007	11.11	95.3			
16/11/2007	13.45	106.7			
20/11/2007	13.35	110.8			
26/11/2007	13.02	113.2			
03/12/2007	12.71	108.7	17	0	0
12/12/2007	11.96	99.1			
17/12/2007	14.80	109.5			
19/12/2007	15.13	108.3			
27/12/2007	13.79	102.7			
31/12/2007	11.83	91.7			

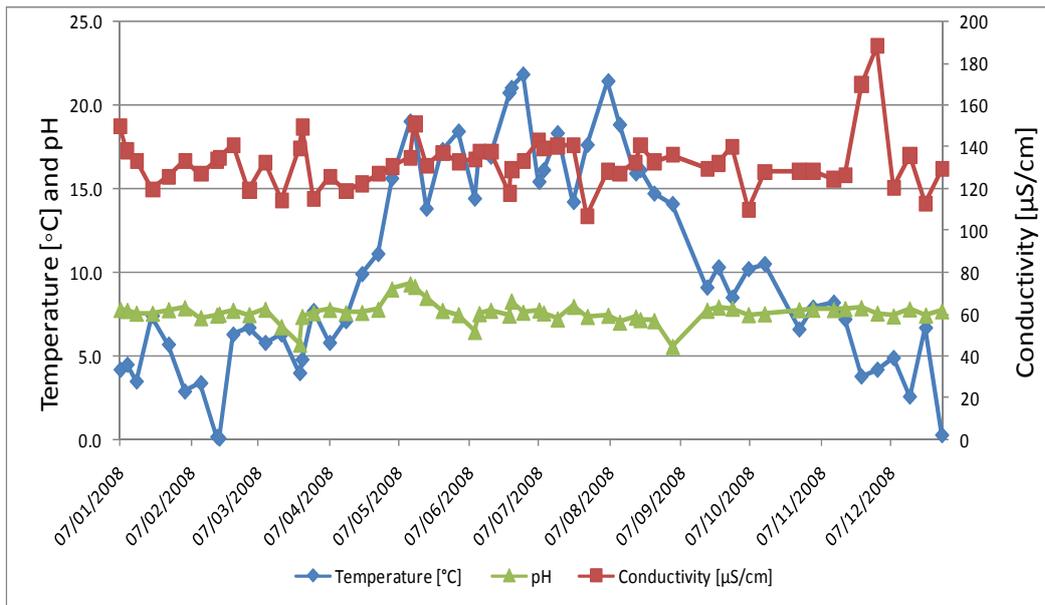


Figure 27 Water parameters Our Kalbermillen 2008.

Figure 27 and Table 28 present the water parameters measured in the Our Kalbermillen for 2008. The temperature of the river ranges between 0.1°C and 21.8°C. The pH ranges between pH 6.48 and pH 9.31. The low readings of pH 5.72 and pH 5.58 recorded in March and September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 113.1 µS/cm and 187.9 µS/cm. The maximum level recorded in December is notably high for this site. The level of oxygen ranges between 8.63 mg/l and 16.54 mg/l. The oxygen saturation levels range between 86.9% and 162.8%. The levels of NO<sub>3</sub>-N range between 7.1 mg/l and 17 mg/l.

Table 28 Water parameters Our Kalbermillen 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
07/01/2008	12.49	99.5	
10/01/2008	11.35	90.8	
14/01/2008	12.76	100.7	
21/01/2008	10.20	86.9	
28/01/2008	11.25	92.1	
04/02/2008	12.70	98.4	
11/02/2008	14.01	108.5	
18/02/2008	15.32	106	
19/02/2008	16.53	114.9	
25/02/2008	14.16	117.9	17
03/03/2008	12.56	106.6	
10/03/2008	13.15	112.5	
17/03/2008	11.53	99.8	
25/03/2008	12.65	100.5	
26/03/2008	11.94	98.1	
31/03/2008	11.62	108.4	7.76
07/04/2008	12.16	100.8	
14/04/2008	11.14	96.2	9.61
21/04/2008	12.26	114.4	
28/04/2008	11.30	127.1	8.54
04/05/2008	10.82	112.2	
12/05/2008	10.91	122	
14/05/2008	13.91	153	7.12
19/05/2008	12.51	127.1	
26/05/2008	11.48	124.7	
02/06/2008	9.71	105.9	
09/06/2008	11.43	115.2	
11/06/2008	11.14	111.9	8.4
16/06/2008	12.25	131.2	
24/06/2008	10.61	117.8	
25/06/2008	10.69	123.5	6.8
30/06/2008	9.42	110.2	
07/07/2008	12.44	131.3	
09/07/2008	13.77	145.2	7.9
15/07/2008	14.96	162.8	
22/07/2008	12.70	127.9	
28/07/2008	9.94	106.7	
06/08/2008	8.86	104.2	
11/08/2008	8.63	96.6	
18/08/2008	10.11	105.9	
20/08/2008	11.25	119.3	5.3
26/08/2008	11.11	113.3	
03/09/2008	9.72	99.8	7.1
18/09/2008	11.82	105.5	7.7
23/09/2008	11.45	105.9	
29/09/2008	12.31	109.9	
06/10/2008	9.96	91.7	
13/10/2008	10.85	100.3	
28/10/2008	11.09	94.6	
03/11/2008	11.41	100.2	
12/11/2008	11.09	97.6	
17/11/2008	11.19	94.6	7.5
24/11/2008	11.94	103	
01/12/2008	11.58	94.9	9
08/12/2008	13.99	112.1	7.6
15/12/2008	13.59	104	
22/12/2008	12.62	105.7	
29/12/2008	16.54	116.8	7.3

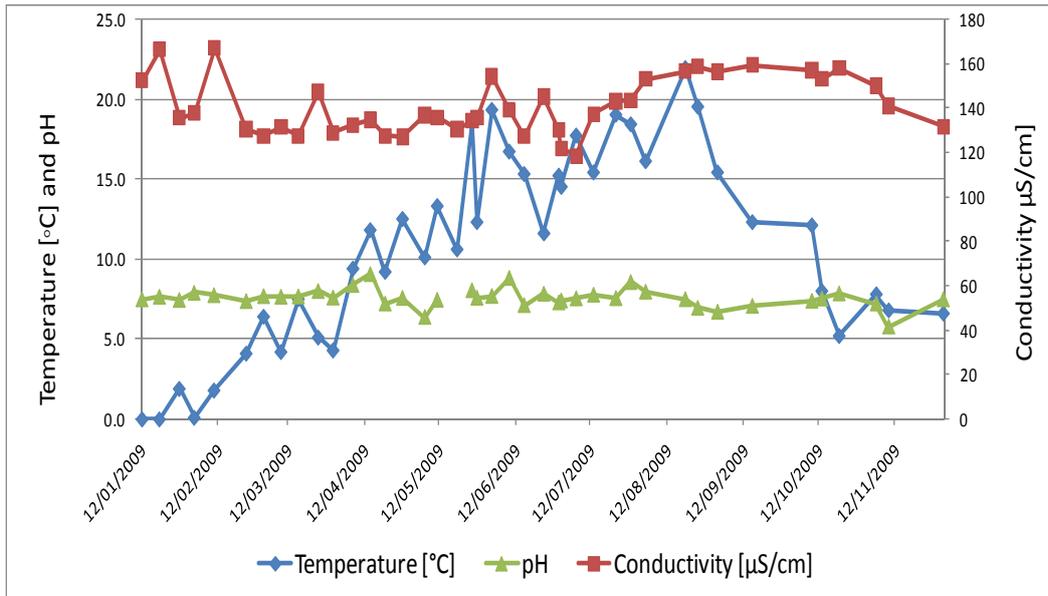


Figure 28 Water parameters Our Kalbermillen 2009.

Figure 28 and Table 29 present the water parameters measured in the Our Kalbermillen for 2009. The temperature of the river ranges between 0°C and 21.9°C. There were two periods of a pronounced decrease in temperatures during June followed by a variable trend to the maximum measurement of 21.9°C in August. The pH ranges between pH 6.37 and pH 9.08. The very low reading of pH 5.76 in November is likely to be the result of a fault with the pH meter. The conductivity readings for this site show a range of values between 118.5 µS/cm and 166.8 µS/cm. The level of oxygen ranges between 3.69 mg/l and 16.5 mg/l. The minimum level of oxygen of 3.69 mg/l recorded in January corresponds to a low oxygen saturation level of 28.1%. This is very low for this site. The maximum oxygen saturation level is 164.6% and was recorded during August. The levels of NO<sub>3</sub>-N range between 3.19 mg/l and 7.8 mg/l.

Table 29 Water parameters Our Kalbermillen 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
12/01/2009	3.69	28.1	7.6
19/01/2009	10.91	86.7	
27/01/2009	12.80	96.3	
02/02/2009	14.65	105.8	7.8
10/02/2009	9.87	75.6	
23/02/2009	9.12	72	6.7
02/03/2009	6.98	59.3	
09/03/2009	8.28	66.1	
16/03/2009	13.88	118.4	
24/03/2009	11.92	97.8	
30/03/2009	7.85	62.3	
07/04/2009	14.25	129.6	
14/04/2009	17.23	163.8	
20/04/2009	13.43	120.6	
27/04/2009	9.69	95	5.3
06/05/2009	13.45	127.8	
11/05/2009	9.09	90.7	
19/05/2009	7.97	73.8	
25/05/2009	10.05	111.5	
27/05/2009	10.02	95.2	
02/06/2009	13.43	151.6	
09/06/2009	9.24	99.1	3.41
15/06/2009	7.51	76.8	
23/06/2009	13.80	130.9	
30/06/2009	7.19	74.2	5.5
06/07/2009	9.70	105.9	
13/07/2009	8.56	89.1	
22/07/2009	7.92	90.2	
28/07/2009	9.97	109.3	3.19
03/08/2009	9.60	101.2	
19/08/2009	12.59	148	3.84
24/08/2009	14.43	164.6	
01/09/2009	13.81	143.9	3.78
15/09/2009	13.32	127.9	
09/10/2009	11.75	115.3	
13/10/2009	10.12	82.2	
20/10/2009	14.80	120	4
04/11/2009	10.68	94.1	
09/11/2009	10.03	107.3	6.51
01/12/2009	16.50	140	

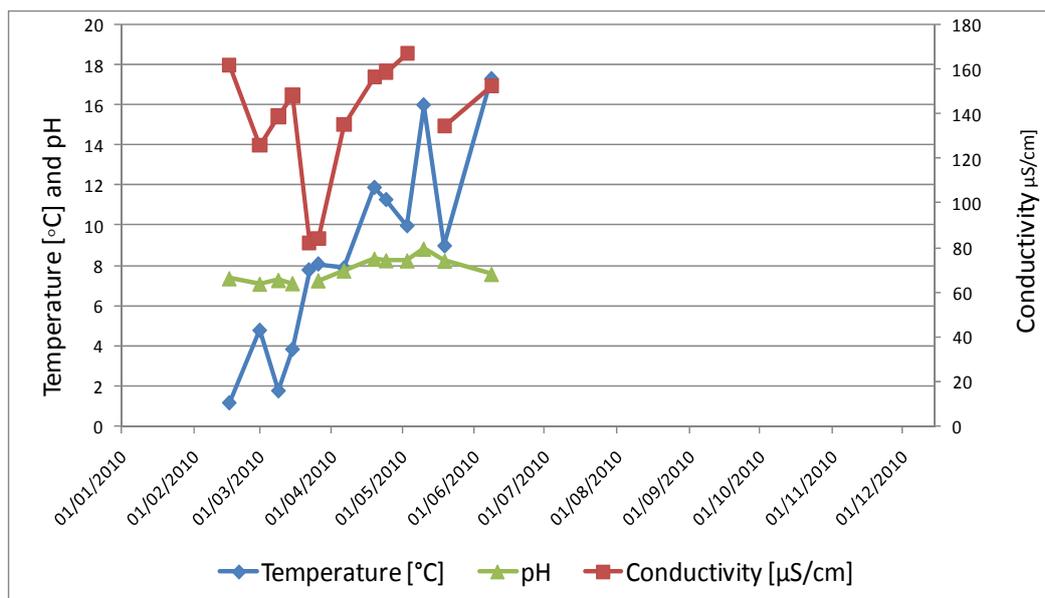


Figure 29 Water parameters Our Kalbermillen 2010.

Figure 29 and Table 30 present the water parameters measured in the Our Kalbermillen for February to June 2010. The temperature of the river ranges between 1.2°C and 17.3°C. The pH ranges between pH 7.102 and pH 8.847. The conductivity readings for this site show a range of values between 82.1 µS/cm and 167 µS/cm. The level of oxygen ranges between 8.96 mg/l and 16.74 mg/l. The oxygen saturation levels range between 87% and 129.8%. The levels of NO<sub>3</sub>-N range between 5.4 mg/l and 7.8 mg/l. Ammonia levels were measured as 0.03mg/l in May and 0.08 mg/l in June.

Table 30 Water parameters Our Kalbermillen 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
16/02/2010	15.59	114.7		
01/03/2010	13.31	109		
09/03/2010	16.74	124.4	7.8	
15/03/2010	10.01	87		
22/03/2010	16.13	123.4		
26/03/2010	14.25	129.8	7.1	
06/04/2010	14.56	126.8		
19/04/2010	12.83	122		
24/04/2010	13.7	128.9		
03/05/2010	10.03	102		
10/05/2010			5.8	0.03
19/05/2010	11.26	101.9		
08/06/2010	8.96	101.1	5.4	0.08

### 3.8 Millegruef

#### 3.8.2 Results

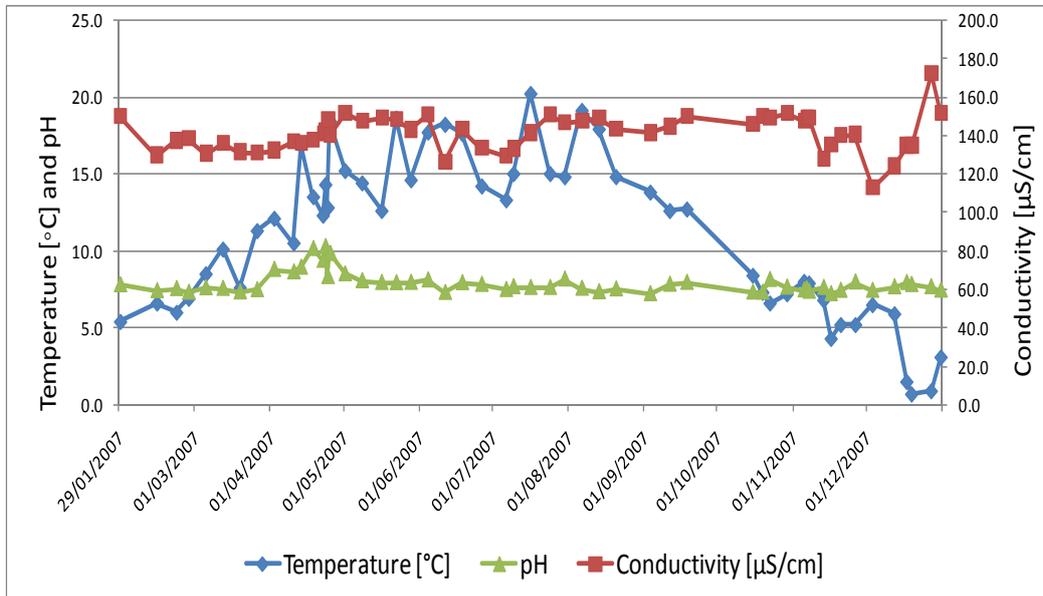


Figure 30 Water parameters Millegruef 2007.

Figure 30 and Table 31 present the water parameters measured in the Millegruef for 2007. The temperature of the river ranges between 0.7°C and 20.2°C. The maximum temperature was recorded in July. The pH ranges between pH 7.22 and pH 10.3. The pH readings were very alkaline (high) in April when the maximum measurement was recorded. The conductivity readings for the period show a range of values between 113 µS/cm and 171.8 µS/cm. The level of oxygen ranges between 6.49 mg/l and 15.56 mg/l. The range of oxygen saturation levels is between 55.9% and 138.1%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 10 mg/l and 60 mg/l. The average level of nitrate over each of the dates when nitrate was measured is 25 mg/l; all readings excluding the maximum are less than or equal to the mean. Therefore the maximum reading of 60 mg/l is exceptionally high for this site. The levels of nitrite (NO<sub>2</sub><sup>-</sup>) were consistently measured as 0.05 mg/l between April and August and then became absent when it was tested in October and December. Ammonia (NH<sub>4</sub>) was measured as absent during 2007.

Table 31 Water parameters Millegruef 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
29/01/2007	15.56				
13/02/2007	13.36				
21/02/2007	12.35				
26/02/2007	11.01				
05/03/2007	10.61	94.40			
12/03/2007	12.10	110.60			
19/03/2007	11.44	101.90			
26/03/2007	9.74	93.10			
02/04/2007	12.22	117.10			
10/04/2007	12.56	119.00			
13/04/2007	11.53	123.10			
18/04/2007	11.01	108.40	10	0.05	0
22/04/2007	13.37	129.00			
23/04/2007	12.99	131.40			
24/04/2007	12.77	126.00			
25/04/2007	12.53	138.10			
01/05/2007	12.31	127.00			
08/05/2007	10.85	110.90			
04/06/2007	11.27	122.00	15	0.05	0
11/06/2007	7.68	84.50			
18/06/2007	10.31	113.00			
26/06/2007	11.43	116.00			
06/07/2007	10.93	109.10			
09/07/2007	10.97	113.30			
16/07/2007	10.67	122.90			
24/07/2007	9.83	102.00	60	0.05	0
30/07/2007	11.75	120.10	20	0.05	0
06/08/2007	8.31	93.80			
13/08/2007	8.89	98.30			
20/08/2007	8.63	89.20	20	0.05	0
03/09/2007	8.17	82.00			
11/09/2007	9.60	93.50			
18/09/2007	9.97	96.90			
15/10/2007	8.25	71.90	25	0	
19/10/2007	9.31	79.10			
22/10/2007	10.46	89.50			
29/10/2007	8.33	71.90			
05/11/2007	7.73	67.70			
06/11/2007	6.49	55.9			
07/11/2007	9.78	81			
13/11/2007	12.60	108.8			
16/11/2007	14.20	112.9			
20/11/2007	14.25	117.9			
26/11/2007	12.53	101.7			
03/12/2007	13.30	113.3	25	0	0
12/12/2007	11.89	96.7			
17/12/2007	12.00	87.8			
19/12/2007	15.09	118.8			
27/12/2007	12.32	86.9			
31/12/2007	9.20	70.2			

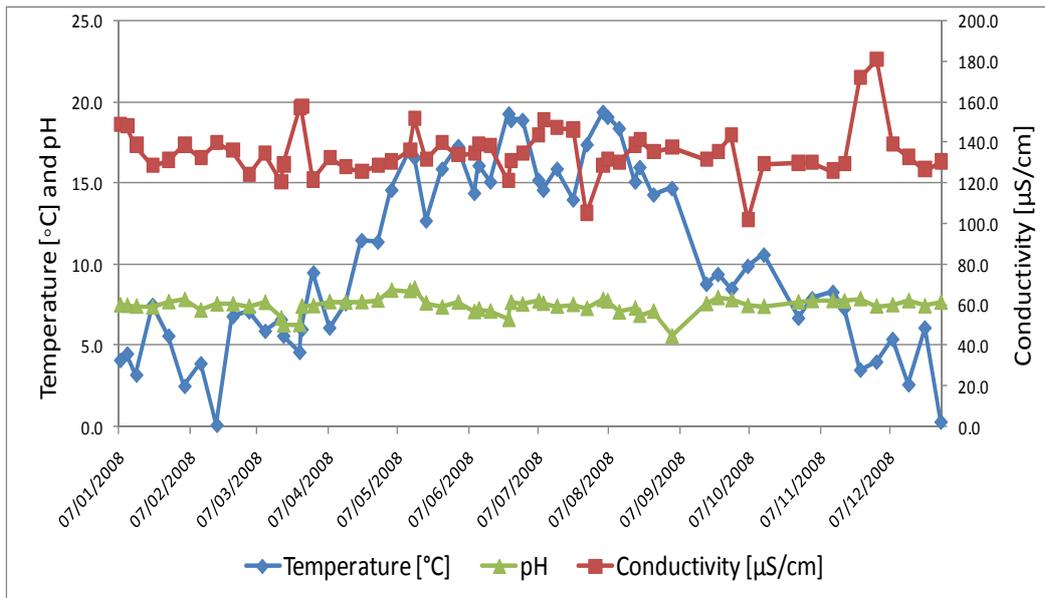


Figure 31 Water parameters Millegruef 2008.

Figure 31 and Table 32 present the water parameters measured in the Millegruef for 2008. The temperature of the river ranges between 0.1°C and 19.3°C. The pH ranges between pH 6.64 and pH 8.56. The low readings of pH 6.72, pH 6.3 and pH 6.32; all recorded in March, pH 6.89 recorded in August and pH 6.3 recorded in September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 120.5 µS/cm and 181 µS/cm. The maximum level recorded in December is notably high for this site. The low readings of 105.2 µS/cm and 102 µS/cm recorded in July and October are suspected to be due to a fault with the conductivity meter. The level of oxygen ranges between 6.8 mg/l and 17.26 mg/l. The oxygen saturation levels range between 76.6% and 146.2%. The levels of NO<sub>3</sub>-N range between 5.7mg/l and 12.3 mg/l.

Table 32 Water parameters Millegruef 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
07/01/2008	12.96	101.3	
10/01/2008	11.11	89.1	
14/01/2008	12.03	94.9	
21/01/2008	11.27	97.7	
28/01/2008	11.49	92.8	
04/02/2008	11.68	90.5	
11/02/2008	13.37	101.6	
18/02/2008	10.37	95.7	
25/02/2008	13.64	115	
03/03/2008	11.76	100.6	
10/03/2008	12.98	111.2	
17/03/2008	11.91	101.3	
18/03/2008	12.69	105	
25/03/2008	12.37	100.2	
26/03/2008	12.26	104.3	
31/03/2008	14.45	127.2	8.44
07/04/2008	12.17	121.1	
14/04/2008	12.27	107.4	10.83
21/04/2008	13.41	128.9	
28/04/2008	11.11	106.4	9.73
04/05/2008	12.55	123.6	
12/05/2008	11.06	118.6	
14/05/2008	13.57	146.2	7.38
19/05/2008	12.87	126.6	
26/05/2008	11.16	119.3	
02/06/2008	10.07	110	
09/06/2008	10.85	112.8	
11/06/2008	11.88	126.1	9
16/06/2008	11.31	118.1	
24/06/2008	6.80	76.6	
25/06/2008	7.40	83.3	6.8
30/06/2008	11.82	132.2	
07/07/2008	12.98	137.3	
09/07/2008	12.96	128.1	7.3
15/07/2008	13.48	139.9	
22/07/2008	8.63	86.7	
28/07/2008	10.21	121.7	
04/08/2008	11.00	112.7	
06/08/2008	8.15	91.8	
11/08/2008	9.74	109	
18/08/2008	10.31	105.9	
20/08/2008	10.87	112.6	5.7
26/08/2008	10.05	100.1	
03/09/2008	9.55	99	6
18/09/2008	11.93	104.7	7.8
23/09/2008	11.91	107.9	
29/09/2008	11.31	99.8	
06/10/2008	10.33	95.3	
13/10/2008	10.54	97.3	
28/10/2008	11.12	94.9	
03/11/2008	11.90	105.9	
12/11/2008	10.56	92.5	
17/11/2008	10.97	93.2	7.8
24/11/2008	12.92	102.9	
01/12/2008	12.96	104.4	12.3
08/12/2008	14.06	110.7	
15/12/2008	14.26	108.7	7.8
22/12/2008	11.60	95.4	
29/12/2008	17.26	117	7.7

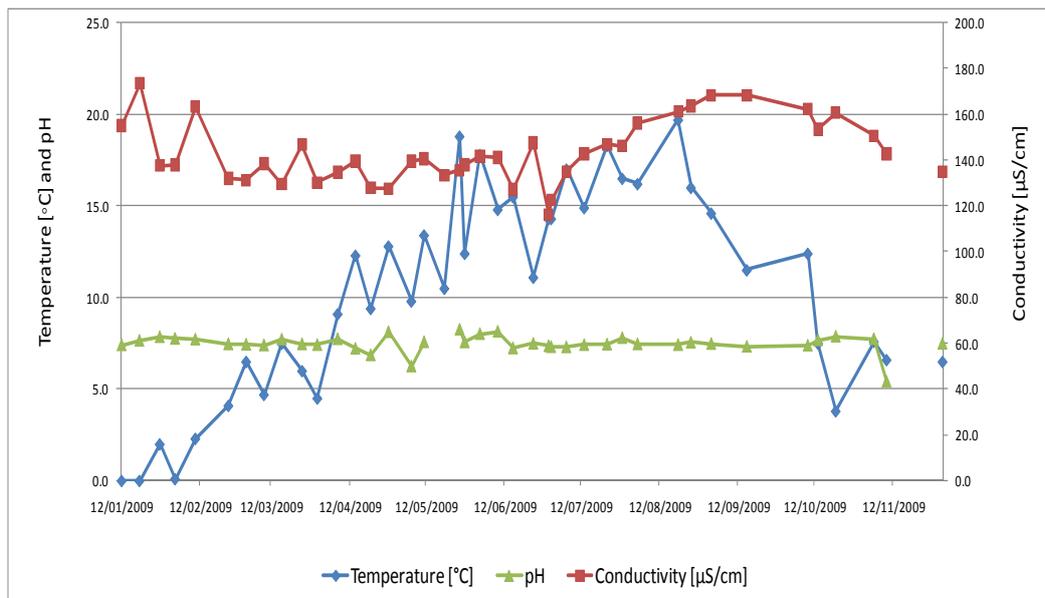


Figure 32 Water parameters Millegruef 2009.

Figure 32 and Table 33 present the water parameters measured in the Millegruef for 2009. The temperature of the river ranges between 0°C and 19.7°C. There is a pronounced decrease in the temperature during June followed by a variable trend leading to the maximum measurement of 19.7°C in August. The pH ranges between pH 6.28 and pH 8.28. The very low reading of pH 5.44 in November is likely to be the result of a fault with the pH meter. The conductivity readings for this site show a range of values between 116.3 µS/cm and 173.5 µS/cm. The maximum level recorded in January is notably high for this site. The level of oxygen ranges between 7.27 mg/l and 16.1 mg/l. The oxygen saturation levels range between 61.5% and 157.8%. The levels of NO<sub>3</sub>-N range between 3.56 mg/l and 7.8 mg/l.

Table 33 Water parameters Millegruef 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]
12/01/2009			7.7
19/01/2009	11.50	83.3	
27/01/2009	12.82	96.6	
02/02/2009	13.54	97.7	7.8
10/02/2009	9.65	74.7	
23/02/2009	8.87	70.1	6.5
02/03/2009	8.93	74.9	
09/03/2009	7.56	61.5	
16/03/2009	12.50	102.3	
24/03/2009	10.74	90.2	
30/03/2009	7.92	63.3	
07/04/2009	14.87	136.8	
14/04/2009	13.80	136.9	
20/04/2009	13.06	117.8	
27/04/2009	11.09	111.2	5.5
06/05/2009	14.96	135.7	
11/05/2009	10.73	107	
19/05/2009	8.09	73.2	
25/05/2009	10.19	113.5	
27/05/2009	8.90	85.7	
02/06/2009	10.48	113.7	
09/06/2009	9.09	94	4.76
15/06/2009	7.63	80.2	
23/06/2009	12.12	113.2	
30/06/2009	6.63	66.9	5.8
06/07/2009	8.05	87.1	
13/07/2009	7.27	74.9	
22/07/2009	7.28	79.3	
28/07/2009	9.63	101.4	7.45
03/08/2009	7.33	77.2	
19/08/2009	10.10	114.9	1.61
24/08/2009	14.95	157.8	
01/09/2009	13.44	138.1	5.17
15/09/2009	12.98	121.9	
09/10/2009	11.81	116.4	
13/10/2009	10.56	88.6	
20/10/2009	16.10	130.8	4.3
04/11/2009	9.88	87.6	
09/11/2009	9.52	82.1	
12/11/2009			3.56
01/12/2009	15.70	132	

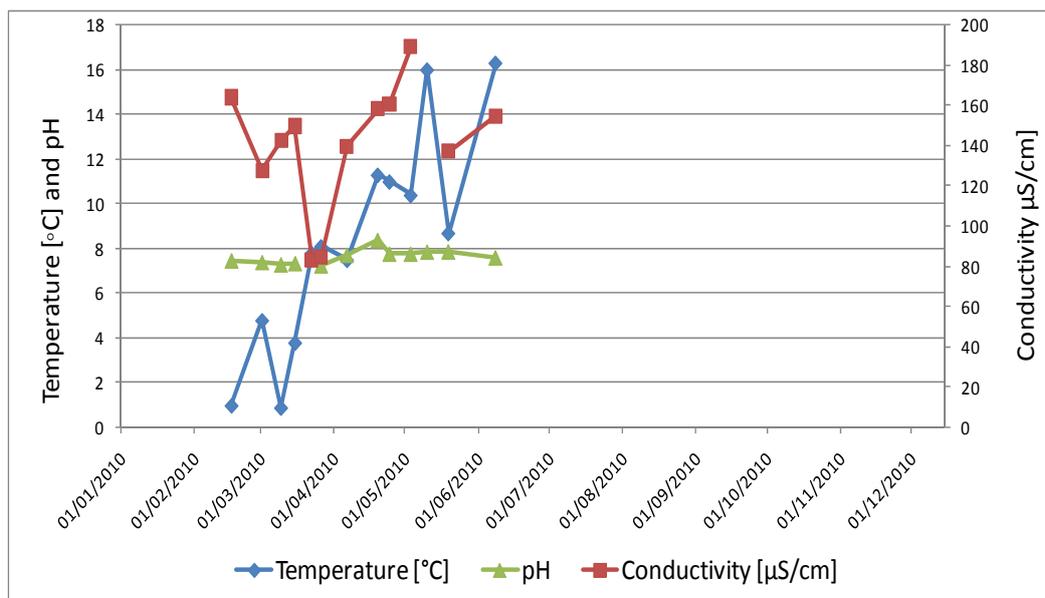


Figure 33 Water parameters Millegruef 2010.

Figure 33 and Table 34 present the water parameters measured in the Millegruef for February to June 2010. The temperature of the river ranges between 0.9°C and 16.3°C. The pH ranges between pH 7.246 and pH 8.39. The conductivity readings for this site show a range of values between 83.5 µS/cm and 189.1 µS/cm. The level of oxygen ranges between 7.51 mg/l and 15.88 mg/l. The oxygen saturation levels range between 81.8% and 140.6%. The levels of NO<sub>3</sub>-N range between 5.6 mg/l and 7.9 mg/l. Ammonia levels were measured as 0.077 mg/l in May and 0.09 mg/l in June.

Table 34 Water parameters Millegruef 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
16/02/2010	14.90	110		
01/03/2010	14.24	116.3		
09/03/2010	15.09	125	7.9	
15/03/2010	11.11	89.2		
22/03/2010	15.28	128.4		
26/03/2010	14.99	138.4	7.2	
06/04/2010	15.88	140.6		
19/04/2010	13.06	125.6		
24/04/2010	13.17	123.2		
03/05/2010	10.03	102		
10/05/2010			6.1	0.077
19/05/2010	10.19	93		
08/06/2010	7.51	81.8	5.6	0.09

### 3.8.3 Discussion

The sampling site at Our Kalborn is located 135 metres from the pearl mussel rearing station established by the LIFE group. The Millegruef or mill channel runs adjacent to the rearing station. The Millegruef is 430 metres long and is a main water supply for the rearing station. Due to this association, the water quality in the Millegruef is of utmost importance. It is supplied directly from and discharges directly into the river Our. Therefore these two sampling sites will be discussed together.

The temperature in the Our and Millegruef are generally similar over the sampling period. The results show that the average annual temperature is slightly higher in the Our than in the Millegruef. The highest maximum temperature recorded in each site for each year is consistently higher in the Our. This is not important for the rearing station as the water used for rearing juvenile mussels is allowed to increase to room temperature. It is however important in the river Our as values of temperature rarely exceed 20°C and this can be problematic for the reproduction of Freshwater Pearl Mussel.

The same contrast is evident when evaluating the pH for both sites; it is always slightly higher in the Our than in the Millegruef. The annual average measurement for pH exceeded the recommendation stated by Oliver (2000) of a range of pH 6.5 – pH 7.2. In fact a reading within this range was only reached ten times in the river Our during the four year period or 6% of the samples taken. This reading was reached in the Millegruef five times over the four year period or 3% of the sampling dates. The guideline of pH <7.5 set out by Skinner *et al.* (2003) is less stringent, yet none of the annual averages for either site reached this target level. The highest annual average for both sites was recorded in 2007 showing an average reading of pH 8.14 for the Our and pH 7.91 in the Millegruef.

With regard to conductivity readings, a contrasting correlation between both sites is evident; conductivity is always higher in the Millegruef than in the Our by approximately 3 µS/cm when comparing the annual averages. The annual averages are also too elevated when taking the guidelines set out by Bauer (1988), Oliver (2000) and Skinner *et al.* (2003) into account. Each of the annual averages are similar but are non compliant with the above guidelines by a range of 32 µS/cm to 43 µS/cm over the target of 100 µS/cm. The range of readings presented in the results show that the conductivity readings taken from the Our or the Millegruef were non compliant with these guidelines at any time in 2007, 2008 or 2009. The only time these sites were compliant was during March 2010 which is not sufficient for a Freshwater Pearl Mussel river.

Each of the annual averages are however compliant with the guideline of <150 µS/cm stated by Moog *et al.* (1993). But this guideline threshold is breached during 12% of the sampling regime in the river Our and 17% in the Millegruef.

The guideline level of dissolved oxygen outlined by Oliver (2000) specifies an optimum saturation of 90 – 110%. The annual average in each of the sites for 2007, 2008 and 2009 meets this standard. The 2010 annual average for the river Our and the Millegruef both show 114% which is very good but also only accounts for four months of the annual period.

The levels of nitrate (NO<sub>3</sub><sup>-</sup>) measured in both sites in 2007 greatly exceeds the target requirements outlined by all four authors presented in Table 1.

The least stringent target of <2.0 mg/l is stated by Moog *et al.* (1993). The annual average in the river Our is 16.71 mg/l for 2007 and 25 mg/l in the Millegruef. An exceptionally high level of 60 mg/l was measured in the Millegruef on the 24<sup>th</sup> of July 2007, the corresponding value in the river Our was 20 mg/l. Nitrate – nitrogen (NO<sub>3</sub>-N) was measured in each site during 2008, 2009 and 2010. The corresponding guideline for this parameter is shown in Table 1. The highest value permissible is <0.45 mg/l outlined by Moog *et al.* (1993). The annual average for each site is 8 mg/l, 5 mg/l and 6 mg/l for 2008, 2009 and 2010 respectively. The average level recorded in the river Our and the Millegruef for 2008 is 18 times greater than that of the least strict guideline and 75 times greater than the strictest guideline set by Bauer (1988).

### 3.9 Feierbech

#### 3.9.1 Results

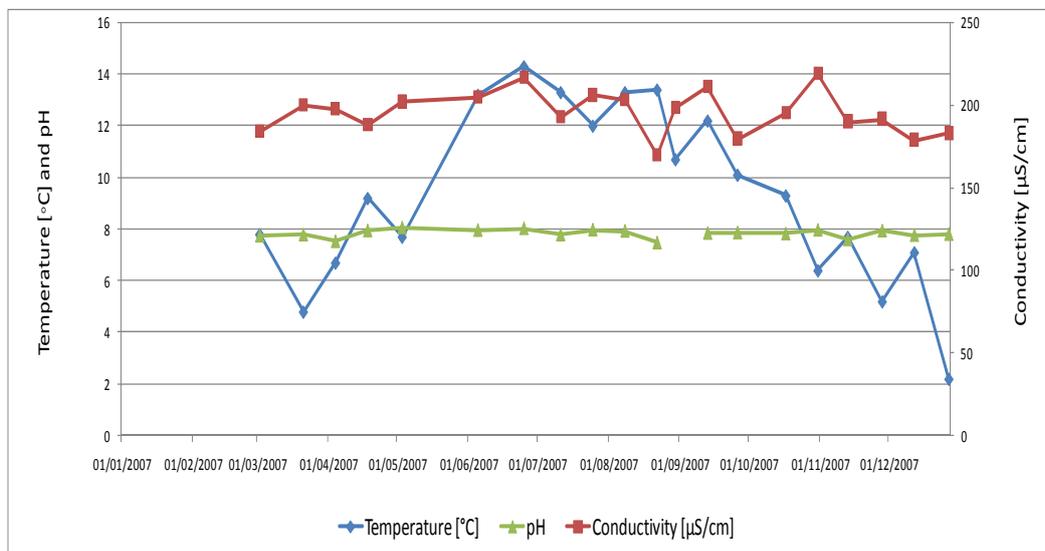


Figure 34 Water parameters Feierbech 2007.

Figure 34 and Table 35 present the water parameters measured in the Feierbech for March to December 2007. The temperature of the river ranges between 2.2°C and 14.3°C. The maximum temperature was recorded in June. The pH ranges between pH 7.48 and pH 8.05. The conductivity readings for the period show a range of values between 169.8 µS/cm and 219 µS/cm. The level of oxygen ranges between 8.78 mg/l and 13.18 mg/l. The range of oxygen saturation levels is between 82.1% and 121%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 35 mg/l and 75 mg/l. The maximum reading of 75 mg/l recorded in October is exceptionally high for this site. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 35 Water parameters Feierbech 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
02/03/2007	10.7				
21/03/2007	10.08	82.1			
04/04/2007	12.0	101.9			
18/04/2007	11.12	99.4			
03/05/2007	12.16	105.7			
05/06/2007	12.32	121.0	50	0	0
25/06/2007	10.96	111.8			
11/07/2007	11.89	117.5			
25/07/2007	11.46	109.8	35	0	0
08/08/2007	11.81	117.4	35	0	0
22/08/2007	9.25	91.9	35	0	0
30/08/2007	8.78	82.3			
13/09/2007	9.31	89.3			
26/09/2007	9.49	87.7			
17/10/2007	10.41	94.3	75	0	0
31/10/2007	11.82	98.2	35	0	0
13/11/2007	13.18	114.2			
28/11/2007	11.71	95.0	50	0	0
12/12/2007	12.22	103.5			
27/12/2007	12.09	90.0			

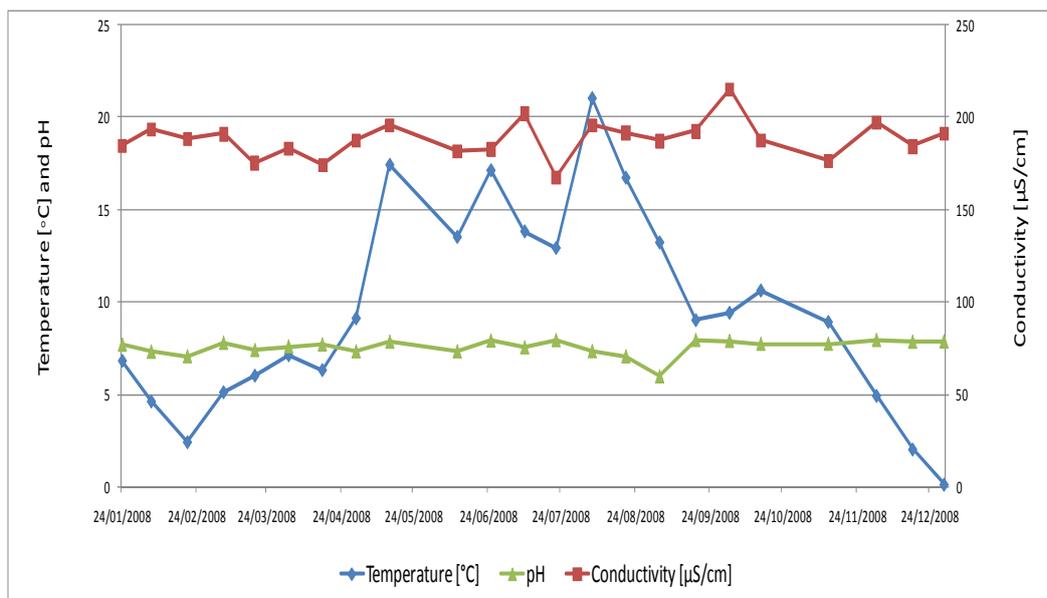


Figure 35 Water parameters Feierbech 2008.

Figure 35 and Table 36 present the water parameters measured in the Feierbech for 2008. The temperature of the river ranges between 0.1°C and 21°C. There was a decrease in temperatures in both June and July. The maximum temperature was recorded in August. The pH ranges between pH 7.05 and pH 7.92. The low readings of pH 6.00 recorded in September is suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 167.7 µS/cm and 215 µS/cm. The level of oxygen ranges between 7.57 mg/l and 15.18 mg/l. The oxygen saturation levels range between 87.5% and 131.2%.

Table 36 Water parameters Feierbech 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
24/01/2008	12.04	103.1
05/02/2008	11.78	95.1
20/02/2008	13.73	104.3
06/03/2008	13.84	111.1
19/03/2008	13.65	114.2
02/04/2008	12.07	103.1
16/04/2008	11.79	99.0
30/04/2008	11.74	107.5
14/05/2008	10.84	117.3
11/06/2008	13.07	130.3
25/06/2008	10.65	112.0
09/07/2008	13.04	131.2
22/07/2008	11.16	109.1
06/08/2008	7.57	87.5
20/08/2008	8.6	91.8
03/09/2008	10.24	102.3
18/09/2008	12.15	107.2
02/10/2008	10.87	99.7
15/10/2008	9.64	89.7
12/11/2008	10.34	93.0
02/12/2008	12.6	102.7
17/12/2008	15.18	114.4
30/12/2008	13.9	97.6

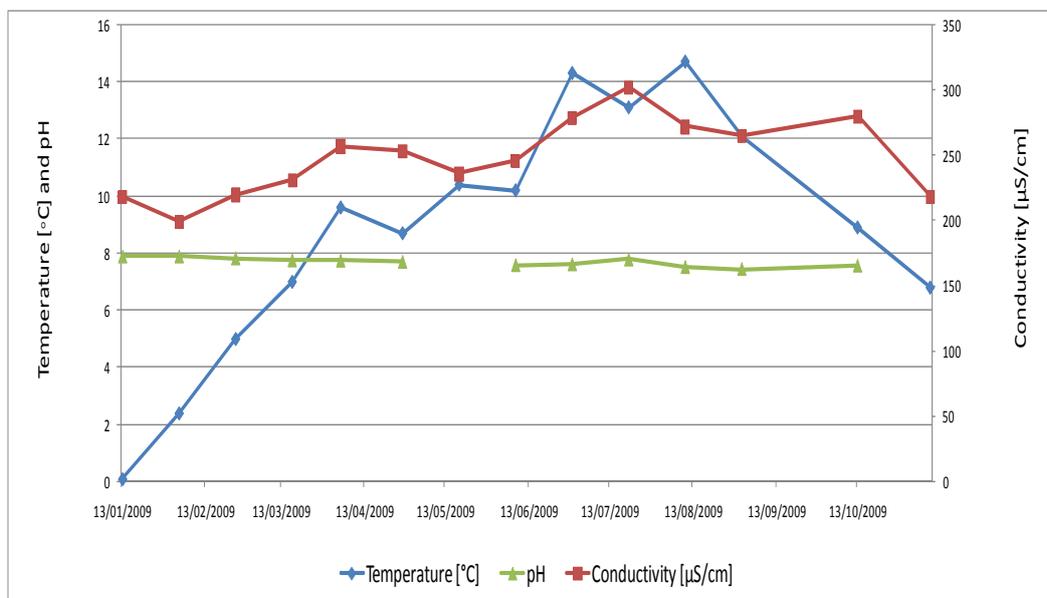


Figure 36 Water parameters Feierbech 2009.

Figure 36 and Table 37 present the water parameters measured in the Feierbech for 2009. The temperature of the river ranges between 0.1°C and 14.7°C. The maximum measurement of 14.7°C was recorded in August. The pH ranges between pH 7.44 and pH 7.89. The conductivity readings for this site show a range of values between 199.4 µS/cm and 302 µS/cm. The levels of conductivity are generally high at this site. The level of oxygen ranges between 8.18 mg/l and 14.72 mg/l. The oxygen saturation levels range between 73.2% and 142.1%.

Table 37 Water parameters Feierbech 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
13/01/2009	11.15	79.9
03/02/2009	10.81	84.5
24/02/2009	8.56	73.2
17/03/2009	10.68	90.3
04/04/2009	10.38	94.2
27/04/2009	11.41	103.7
18/05/2009	8.18	76.2
08/06/2009	12.41	116.5
29/06/2009	8.43	86.0
20/07/2009	9.26	91.8
10/08/2009	10.84	111.5
31/08/2009	14.72	142.1
13/10/2009	11.2	99.5
09/11/2009	8.56	73.8

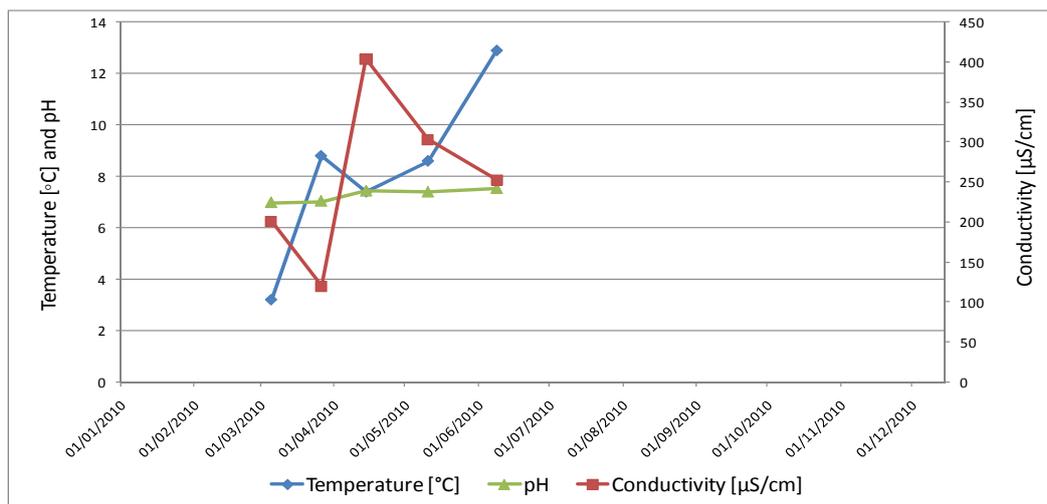


Figure 37 Water parameters Feierbech 2010.

Figure 37 and Table 38 present the water parameters measured in the Feierbech for March to June 2010. The temperature of the river ranges between 3.2°C and 12.9°C. The pH ranges between pH 6.991 and pH 7.537. The conductivity readings for this site show a range of values between 120.7 µS/cm and 404 µS/cm. The maximum level recorded in April is notably high for this site. The level of oxygen ranges between 8.45 mg/l and 14.44 mg/l. The oxygen saturation levels range between 83.7% and 127.7%. The levels of NO<sub>3</sub>-N range between 8.2 mg/l and 10.3 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.06 mg/l in June.

Table 38 Water parameters Feierbech 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			10	
26/03/2010	9.31	85.5	10.3	
14/04/2010	10.24	89		
10/05/2010	14.44	127.7	9.1	0.03
08/06/2010	8.45	83.7	8.2	0.06

### 3.9.2 Discussion

The annual averages for the conductivity readings in the Feierbech show that the conductivity is generally elevated. The average level in 2007 was 195 µS/cm and decreased slightly to 188 µS/cm in 2008. This however increased to 248 µS/cm for 2009 and continued to 256 µS/cm for 2010. These readings are extremely high and are over twice the standard guideline levels recommended for a Freshwater Pearl Mussel habitat (Oliver, 2000). The level of dissolved oxygen in the stream shows an average reading of 100% which is good for this tributary. However, as with many of the tributaries; the annual average level of nitrate is very much elevated showing a reading of 45 mg/l NO<sub>3</sub><sup>-</sup> in 2007. The average level of NO<sub>3</sub>-N of 9.4 mg/l measured in 2010 exceeds the requirements of the authors outlined in Table 1. According to Thielen *et al.* (2007) the wastewater from the village of Kalborn was discharged directly into the Feierbech in the past. This wastewater is now treated at a facility in Tintesmühle. The conductivity and nitrate levels are elevated and are not suitable for the requirements of a Freshwater Pearl Mussel habitat. However they are not as elevated as the level measured in the Schelsbaach that carries the wastewater from the treatment facility in Lieler.

### 3.10 Tintesmillen

#### 3.10.1 Results

Table 39 presents the water parameters of the river Our at the sampling site at Tintesmillen (Figure 1) measured by the national laboratory of the water management department from 2002 to 2009. The samples were always taken between April and August and measured the same day.

The maximum summer temperature of 21.9°C was recorded on the 26<sup>th</sup> of July 2006. Summer water temperatures have been recorded as relatively low for this period between 2007 and 2009. The levels of conductivity over the period 2002 – 2009 range between 110 µS/cm and 182 µS/cm. The maximum level was recorded in August 2003. The levels of measured concentrations of ammonia (NH<sub>4</sub>) have decreased slightly over the period 2002-2009 to minimal values. The levels of nitrate (NO<sub>3</sub><sup>-</sup>) are variable but on average are similar over the period of 2007-2009 as they were between 2002 and 2006.

The levels of nitrite (NO<sub>2</sub><sup>-</sup>) have decreased over the period 2002-2007 to less than or equal to 0.1 mg/l as compared to the maximum levels of 0.2 mg/l in June 2002 and 0.16 mg/l in June 2006. The levels of total phosphate increased over the period from 2002 – 2007 with a maximum values of 0.107 mg/l in August 2002 which increased to a maximum value of 0.25 mg/l in June 2007. The levels of total phosphate have steadily decreased from the maximum value of 0.25 mg/l to a maximum value of 0.12 mg/l in April 2009. This corresponds to an increase in levels of ortho-phosphate for the period 2002 – 2008. The maximum recorded value recorded in August 2002 was 0.081 mg/l which increased to a maximum recorded value of 0.153 mg/l in June 2008. The maximum value of ortho-phosphate for 2009 was 0.078 mg/l which was recorded in August. The number of sampling dates within the sampling regime has decreased over the years which could be contributing to the false appearance of improving water quality.

Table 39 Water parameter in the river Our at the sampling site at Tintsmillen as measured by the national laboratory between 2002 and 2009.

Year	Date	Temperature [°C]	pH	Carbonate Hardness [°fH]	Total Hardness [°fH]	Conductivity [µS/cm]	NH <sub>4</sub> <sup>+</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NO <sub>3</sub> <sup>-</sup> [mg/l]	Cl <sup>-</sup> [mg/l]	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	BOD5 [mg/l]	SO <sub>4</sub> <sup>2-</sup> [mg/l]	Na <sup>+</sup> [mg/l]	K <sup>+</sup> [mg/l]	Mg [mg/l]	Phosphate total [mg/l]	Ortho-Phosphate [mg/l]
2002	15/05/2002	13.3	7.7	3.2	4.2	131	<0,10	0.08	13	11	10.8	107	1.7	10	7.1	2		0.03	0.013
	12/06/2002	14.8	7.4	3.8	4.8	154	<0,10	0.2	12	14	10.1	103	3.2	9	9.2	2.5		0.076	0.044
	17/07/2002	17	8	4.2	4.8	157	<0,10	0.05	9	15	9.8	105	1.6	9	9.5	2.9		0.099	0.08
	21/08/2002	17.2	7.7	4	4.6	154	0.16	0.09	8	14	8.5	91	2	9	9	4.2		0.107	0.081
2003	12/05/2003	13	8	2.8	4.1	142	<0,10	0.08	12	14	11.4	113	1.2	9	8.5	3.9		0.03	0.014
	08/07/2003	16.8	7.8	3.6	4.6	150	<0,10	0.04	9.3	14	10.5	110	0.8	9.1	10	2.9		0.08	0.05
	06/08/2003	21	7.6	5.1	5.7	182	<0,05	<0,01	5.7	17	9	100	1.4	7.2				0.09	0.06
2004	11/05/2004	10.2	8.1	2	4.1	120	<0,05	<0,05	20	16	11	100	0.7	10	7.6	4.7		0.04	0.02
	09/06/2004	18.3	7.8	3.6	5.1	141	0.09	0.11	13	18	9.4	102	1.9	9.3	10.2	7.2		0.08	0.06
	06/07/2004	14.8	8	4.6	5.3	160	<0,05	0.05	9.2	18	10.5	107	1.4	8.6	13	4.8		0.09	0.06
	29/07/2004	15.6	7.8	4.5	5.9	160	<0,05	<0,05	8.7	17	11	114	1.4	8.8	11.6	3.1		0.12	0.08
	16/08/2004	16	7.4	3.8	6.1	154	<0,05	0.07	12	22	9.9	107	2.2	10	10.7	11.9		0.09	0.07
2005	27/04/2005	10.4	7.6	2.4	4.5	135	0.06	0.06	19	17	10.7	98	2.5	9.2	9.6	5		0.06	0.05
	02/06/2005	13.6	7.9	3.3	5	163	<0,05	0.05	17	16	10.7	105	1.4	8.2	9.3	2.6		0.04	0.02
	29/06/2005	20.7	7.5	4.4	6	163	0.07	0.1	11	17	8.2	95	1.6	9.5	11	4.1		0.16	0.12
	27/07/2005	17.3	7.8	4.2	5.2	144	<0,05	<0,05	9.7	19	9.6	105	1.4	8.4	11	5.2		0.1	0.06
	25/08/2005	14.7	7.4	3.9	6.4	128	0.05	<0,05	9.5	17	9.3	97	1.4	8	10	3.2		0.06	0.05
2006	26/04/2006	12.5	7.8	2.7	5.7	121	<0,05	0.06	20	17	10.6	103	1.6	9.2	9.7	2.9		0.05	0.03
	01/06/2006	8.8	8.1	2.4	6.2	138	<0,05	<0,05	24	13	10.8	105	1.6	9.3	8	2.3		0.05	0.02
	28/06/2006	16.3	7.9	3.7	4.7	144	0.08	0.16	15	17	9.2	98	2.9	8.2	10	3.7		0.22	0.08
	26/07/2006	21.9	7.8	5.5	6.4	175	<0,05	0.05	9.3	18	8.6	101	1.5	8.6	15	4.1		0.17	0.1
	24/08/2006	13.8	7.7	2.8	4.2	110	<0,05	<0,05	19	12	10.1	102	1.2	9.1	8.1	2.7	4.8	0.1	0.016
2007	25/04/2007	14.6	8	4.2	5	152	<0,05	0.09	16	15	10.1	102	2.3	8.6	10	4.3	6.1	0.07	0.052
	27/06/2007	12.3	7.6	3.8	4.5	128	0.05	0.08	14	10	9.8	98	2.2	8.3	7.5	3	5.1	0.25	0.109
2008	29/04/2008	9.7	7.4	2.6	4	142	0.1	0.08	17	13	12	111	1.4	8.7	8	2	8.1	0.09	0.057
	24/06/2008	16.1	7.5	3.2	3.9	130	<0,05	0.09	11	10	10.2	107	2.4	7.6	7.3	3.4	4.6	0.18	0.153
	25/08/2008	14.4	7.7	3.8	4.6	151	<0,05	0.04	9.6	13	9.8	99	1.7	8.1	8.9	3.5	4.9	0.07	0.047
2009	28/04/2009	10.5	7.5	2.7	4.1	130	<0,05	0.05	14	14	11	104	1.7	8.7	8.8	2.2	4.9	0.12	0.076
	17/06/2009	13	7.6	2.8	4.9	142	0.05	0.07	20	14	10.1	101	1	8.9	9	3.1	5.6	0.076	0.069
	18/08/2009	16.4	7.8	4.5	5.4	162	<0,05	0.03	9.2	17	9.2	98	1.5	8	12	4.3	6.5	0.1	0.078

### 3.10.2 Discussion

The measurements recorded by the national laboratory of the water management department show a trend in temperatures of a continuous decrease in annual averages from 15.34°C in 2005 to 13.3°C in 2009.

The recommendations set out by Oliver (2000) for the range of pH that a pearl mussel river should adhere to (pH 6.5 – 7.2) were not reached on any of the sampling dates. The measurements recorded were always higher than this. The target of pH <7.5 stated by Skinner *et al.* (2003) was only reached on four sampling occasions out of a total of thirty or 13% over the eight year period. The annual averages did not meet the requirements of either of the guidelines during this period.

The annual average for conductivity readings was between 140 µS/cm and 149 µS/cm for all years apart from a minimum annual average of 137.6 µS/cm in 2006 and a maximum of 158 µS/cm in 2003. This shows that for all eight years, the annual average does not satisfy the recommendations set out by three of the four published guidelines of <100 µS/cm. The annual average does however satisfy the recommendations set out by Moog *et al.* (2003) for seven of the eight year period.

The target nitrate (NO<sub>3</sub><sup>-</sup>) levels specified for a Freshwater Pearl Mussel river are <2.0 mg/l by Moog *et al.* (1993), <0.1 mg/l by Oliver (2000) and Skinner *et al.* (2003) and <0.5 mg/l by Bauer (1988). The annual averages recorded by the national laboratory show averages ranging from 9 mg/l to 17.46 mg/l with an even distribution. These are totally unacceptable levels of eutrophication in a Freshwater Pearl Mussel river but the measurements taken by the LIFE group show a worse case. The presence of ammonia in river water is a strong pollution indicator. It would appear that the presence of ammonia has been decreasing over the eight year period but this view cannot be proven as the sampling regime has not remained constant over this period and fewer sample dates are evident in recent years, therefore a limited temporal scope is visible when analysing the results.

To reinforce this, the target levels of total phosphate set out by three of the four guidelines is <0.03 mg/l and 0.035 mg/l by Moog *et al.* (1993). The lowest annual average was almost twice the stated guidelines of 0.066 mg/l in 2003 whereas the highest annual averages were 0.12 mg/l and 0.16 mg/l in 2006 and 2007 respectively.

### 3.11 Hengeschterbaach

#### 3.11.1 Results

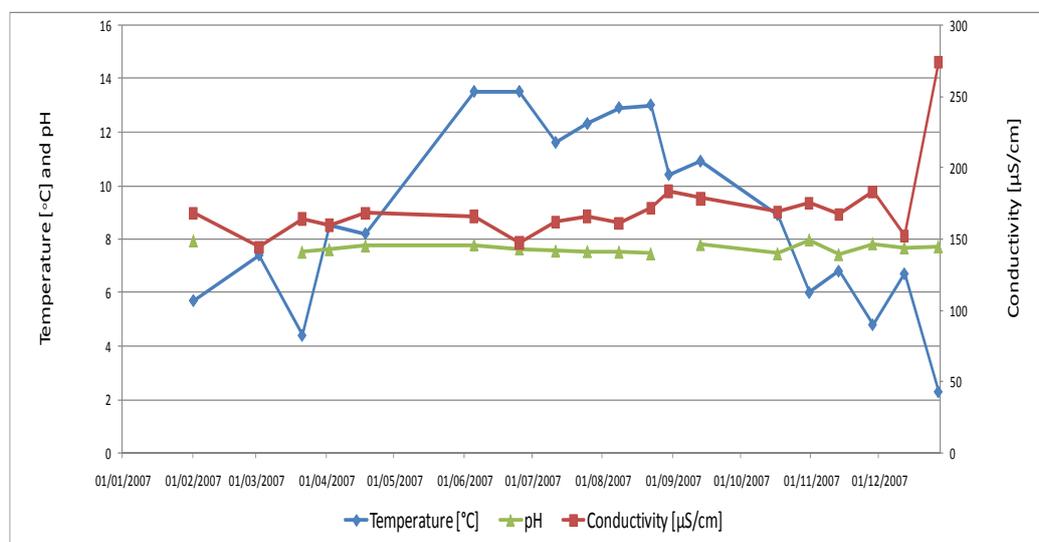


Figure 38 Water parameters Hengeschterbaach 2007.

Figure 38 and Table 40 present the water parameters measured in the Hengeschterbaach for February to December 2007. The temperature of the river ranges between 2.3°C and 13.5°C. The maximum temperature was recorded in June. The pH ranges between pH 7.43 and pH 7.97. The conductivity readings for the period show a range of values between 144.6 µS/cm and 274 µS/cm. The maximum level recorded in December is very high for this site. The level of oxygen ranges between 9.46 mg/l and 13.07 mg/l. The range of oxygen saturation levels is between 83.4% and 118%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 25 mg/l and 75 mg/l. The maximum reading of 75 mg/l recorded in October is high for this site. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 40 Water parameters Hengeschterbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
01/02/2007	14.3				
02/03/2007	10.75				
21/03/2007	10.35	83.4			
02/04/2007	11.31	98.9			
18/04/2007	10.93	95.9			
05/06/2007	12	118	35	0	0
25/06/2007	11.26	113			
11/07/2007	11.8	113.3			
25/07/2007	11.39	110.2	35	0	0
08/08/2007	11.57	113.5	30	0	0
22/08/2007	9.46	94.6	30	0	0
30/08/2007	11.68	107.6	40	0	0
13/09/2007	9.65	89.5			
17/10/2007	9.96	88.8	75	0	0
31/10/2007	11.5	94.7	25	0	0
13/11/2007	11.68	99.6			
28/11/2007	13.07	108.8	50	0	0
12/12/2007	11.08	92.2			
27/12/2007	12.77	95.1			

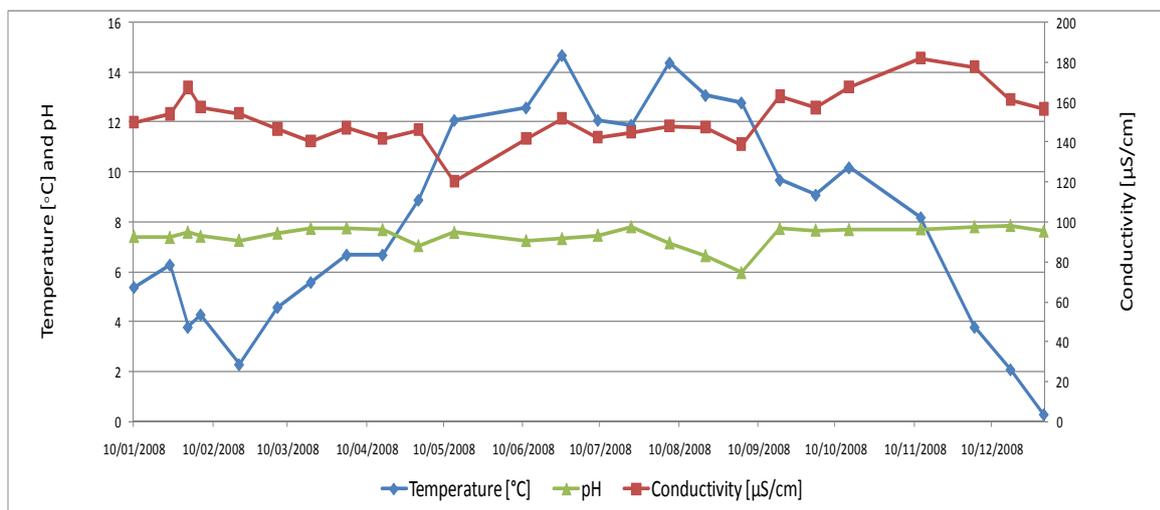


Figure 39 Water parameters Hengeschterbaach 2008.

Figure 39 and Table 41 present the water parameters measured in the Hengeschterbaach for 2008. The temperature of the river ranges between 0.3°C and 14.7°C. The trend followed a normal pattern but there was a slight decrease in temperatures in July. The maximum temperature was recorded in June. The pH ranges between pH 7.07 and pH 7.86. The low readings of pH 6.68 and pH 6.01 recorded in August and September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 120.6 µS/cm and 182.1 µS/cm. The level of oxygen ranges between 8.23 mg/l and 21.2 mg/l. The maximum value recorded in December is exceptionally high for this site and corresponds to a maximum oxygen saturation level of 162%. The minimum oxygen saturation of 84% corresponds to the minimum oxygen level of 8.23 mg/l.

Table 41 Water parameters Hengeschterbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
10/01/2008	11.17	92.3
24/01/2008	11.31	99.1
31/01/2008	10.9	86.1
05/02/2008	11.69	95.6
20/02/2008	14.22	107.9
06/03/2008	13.54	106.7
19/03/2008	11.93	98.3
02/04/2008	11.35	96.3
16/04/2008	12.61	105.6
30/04/2008	11.71	106.4
14/05/2008	11.9	112.5
11/06/2008	11.32	110.1
25/06/2008	11.47	117.1
09/07/2008	13.84	135.5
22/07/2008	12.51	119.5
06/08/2008	8.23	84
20/08/2008	9.61	94.8
03/09/2008	10.15	100.4
18/09/2008	10.72	97
02/10/2008	10.65	96.7
15/10/2008	10.11	93.2
12/11/2008	11.18	97.6
03/12/2008	12.35	98.1
17/12/2008	21.2	162
30/12/2008	13.58	96.1

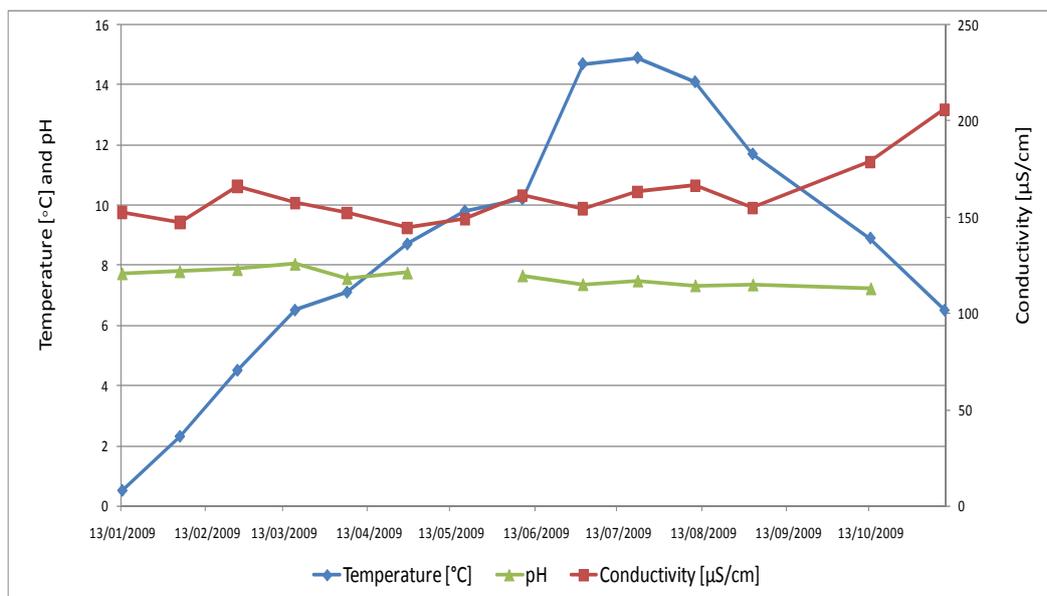


Figure 40 Water parameters Hengeschterbaach 2009.

Figure 40 and Table 42 present the water parameters measured in the Hengeschterbaach for 2009. The temperature of the river ranges between 0.5°C and 14.9°C. The maximum measurement was recorded in July. The pH ranges between pH 7.22 and pH 8.04. The conductivity readings for this site show a range of values between 144.4 µS/cm and 206 µS/cm. The level of oxygen ranges between 5.81 mg/l and 15.95 mg/l. The oxygen saturation levels range between 57.4% and 146.1%.

Table 42 Water parameters Hengeschterbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
13/01/2009	11.53	82.8
03/02/2009	13.26	99.9
24/02/2009	7.21	57.4
17/03/2009	10.49	87.6
05/04/2009	15.95	133.5
27/04/2009	12.34	111.3
18/05/2009	8.28	75.6
08/06/2009	15.64	146.1
30/06/2009	5.81	59.1
20/07/2009	7.71	77.8
10/08/2009	10.66	107.4
31/08/2009	14.27	136.7
13/10/2009	10.63	96
09/11/2009	10.82	92.3

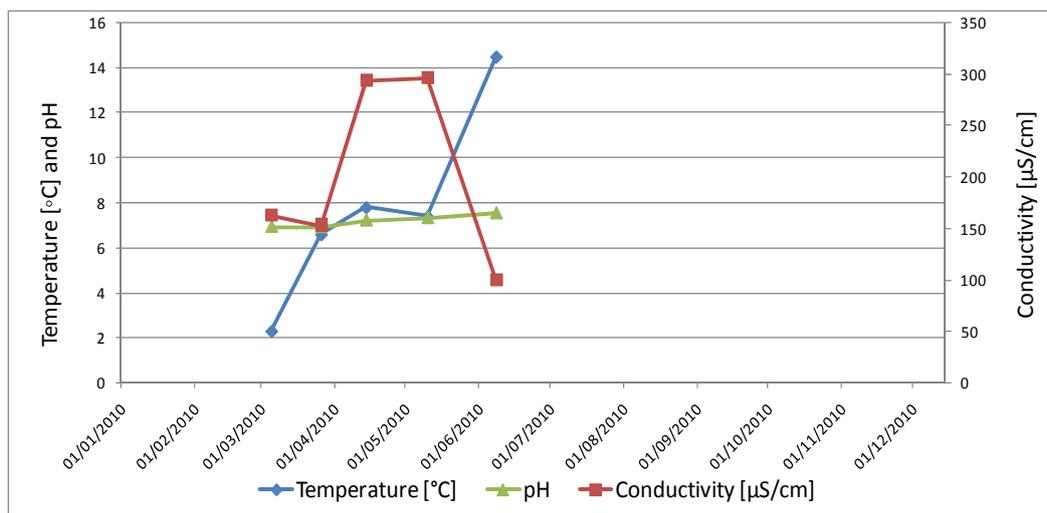


Figure 41 Water parameters Hengeschterbaach 2010.

Figure 41 and Table 43 present the water parameters measured in the Hengeschterbaach for March to June 2010. The temperature of the river ranges between 2.3°C and 14.5°C. The pH ranges between pH 6.924 and pH 7.531. The conductivity readings for this site show a range of values between 99.7 µS/cm and 296 µS/cm. The maximum level recorded in May and the value of 294 µS/cm recorded in April are notably high for this site. The level of oxygen ranges between 7.65 mg/l and 20 mg/l. The oxygen saturation levels range between 81.3% and 150.6%. The levels of NO<sub>3</sub>-N range between 6.5 mg/l and 11.9 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.04 mg/l in June.

Table 43 Water parameters Hengeschterbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010	20	150.6	10.5	
26/03/2010	10.3	88.5	11.9	
14/04/2010	10.31	89.4		
10/05/2010	11.79	100.7	8.2	0.03
08/06/2010	7.65	81.3	6.5	0.04

### 3.11.2 Discussion

The annual averages for the conductivity readings show that the conductivity in the Hengeschterbaach is approximately 160 µS/cm. This is a better situation when compared to some of the streams in the project area, yet it is not compliant with the guidelines specified by each of the four authors outlined in Table 1. The average for 2010 is much higher at 201 µS/cm due to elevated readings of 294 µS/cm and 296 µS/cm recorded in April and May respectively. This is an unacceptable level of conductivity in a Freshwater Pearl Mussel stream and is twice the limit specified by two of the four authors and three times that specified by Bauer (1988). Similarly as in many of the other streams; the level of dissolved oxygen in the stream is good with an average reading of 101% which is suitable for brown trout. However the average level of nitrate is elevated showing an average reading of 40 mg/l in 2007. The level of 9.275 mg/l NO<sub>3</sub>-N measured in 2010 also exceeds the requirements of the authors shown in Table 1. According to the previous report by the LIFE group; the wastewater from the village of Heinerscheid was once discharged directly into the Hengeschterbaach (Thielen *et al.*, 2007).

## 3.12 Stroumbaach

### 3.12.1 Results

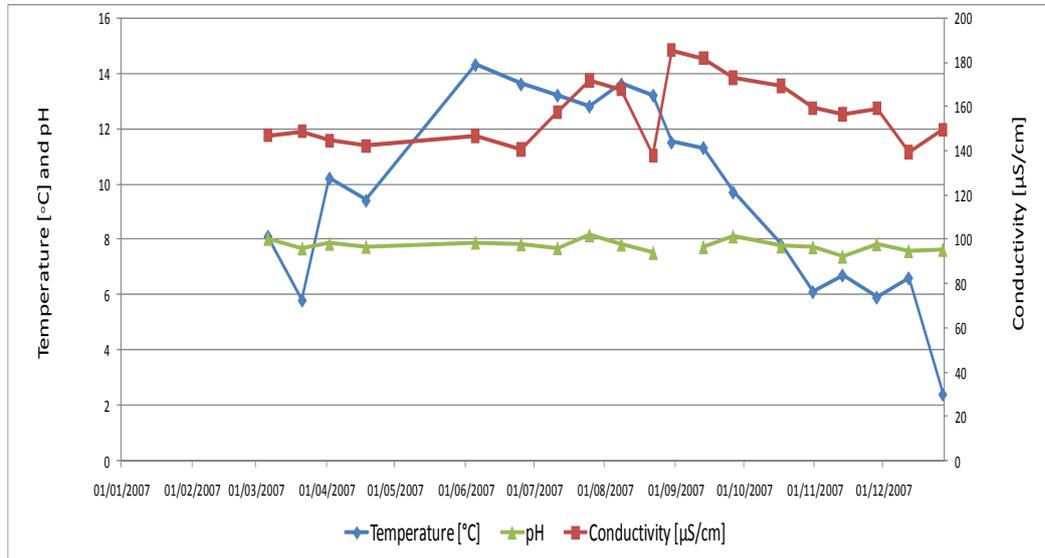


Figure 42 Water parameters Stroumbaach 2007.

Figure 42 and Table 44 present the water parameters measured in the Stroumbaach for March to December 2007. The temperature of the river ranges between 2.4°C and 14.3°C. The maximum temperature was recorded in June. The pH ranges between pH 7.38 and pH 8.16. The conductivity readings for the period show a range of values between 138 µS/cm and 185.1 µS/cm. The level of oxygen ranges between 9.42 mg/l and 13.29 mg/l. The range of oxygen saturation levels is between 79% and 121.3%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 20 mg/l and 35 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 44 Water parameters Stroumbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
06/03/2007	10.29	91.3			
21/03/2007	9.42	79			
02/04/2007	10.79	100.1			
18/04/2007	10.89	97.6			
05/06/2007	11.47	115.8	25	0	0
25/06/2007	11.28	113.5			
11/07/2007	11.92	118.2			
25/07/2007	11.33	110.5	35	0	0
08/08/2007	12.15	121.3	20	0	0
22/08/2007	9.7	97	30	0	0
30/08/2007	11.62	109.6			
13/09/2007	9.7	91.1			
26/09/2007	9.76	89.4			
17/10/2007	7.77	86	35	0	0
31/10/2007	11.67	96.1	35	0	0
13/11/2007	11.94	101.9			
28/11/2007	13.29	107.5	25	0	0
12/12/2007	12.65	105.5			
27/12/2007	12.51	93.2			

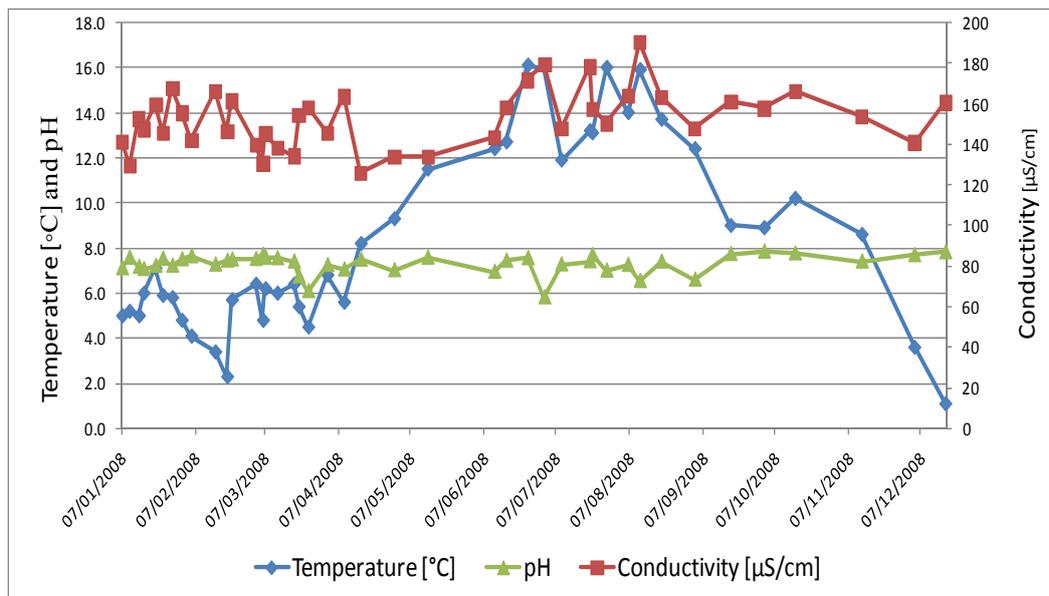


Figure 43 Water parameters Stroumbaach 2008.

Figure 43 and Table 45 present the water parameters measured in the Stroumbaach for 2008. The temperature of the river ranges between 1.1°C and 16.1°C. The trend followed a normal pattern but there was a decrease in temperatures in July. The maximum temperature was recorded in June. The pH ranges between pH 6.95 and pH 7.85. The low readings of pH 6.74 and pH 6.09 recorded in March, pH 5.81 recorded in July and pH 6.54 and pH 6.6 recorded in August and September respectively are suspected to be due to a fault with the pH meter. The conductivity readings for this site show a range of values between 125.8 µS/cm and 190.4 µS/cm. The level of oxygen ranges between 8.86 mg/l and 17.8 mg/l. The oxygen saturation levels range between 90.9% and 149.4%.

Table 45 Water parameters Stroumbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
07/01/2008	13.55	110.8
10/01/2008	11.54	93.6
14/01/2008	12.94	106.7
16/01/2008	12.06	102.7
21/01/2008	13.39	110.8
24/01/2008	11.14	91.2
28/01/2008	12.1	99.3
01/02/2008	11.99	99.3
05/02/2008	11.85	94.4
15/02/2008	16.31	127.5
20/02/2008	13.58	102.3
22/02/2008	13.37	110.4
03/03/2008	12.77	108.4
06/03/2008	14.13	112.6
07/03/2008	12.86	108.9
12/03/2008	12.78	108.9
19/03/2008	12.66	106.2
21/03/2008	12.37	106.4
25/03/2008	12.56	103.3
02/04/2008	11.75	99.2
09/04/2008	11.31	95.8
16/04/2008	11.33	99.1
30/04/2008	11.8	108.3
14/05/2008	10.39	99.5
11/06/2008	11.61	112
16/06/2008	9.65	123.2
25/06/2008	10.52	111
02/07/2008	10.48	111.7
09/07/2008	12.12	116.5
21/07/2008	11.66	116.6
22/07/2008	11.35	111.8
28/07/2008	10.75	116.9
06/08/2008	9.39	90.9
20/08/2008	10.07	100.9
11/08/2008	8.86	94.9
03/09/2008	10.7	104.8
18/09/2008	17.19	149.4
02/10/2008	11.01	99.9
15/10/2008	10.48	96.3
12/11/2008	10.9	96.2
04/12/2008	17.8	141.8
17/12/2008	14.38	106.8

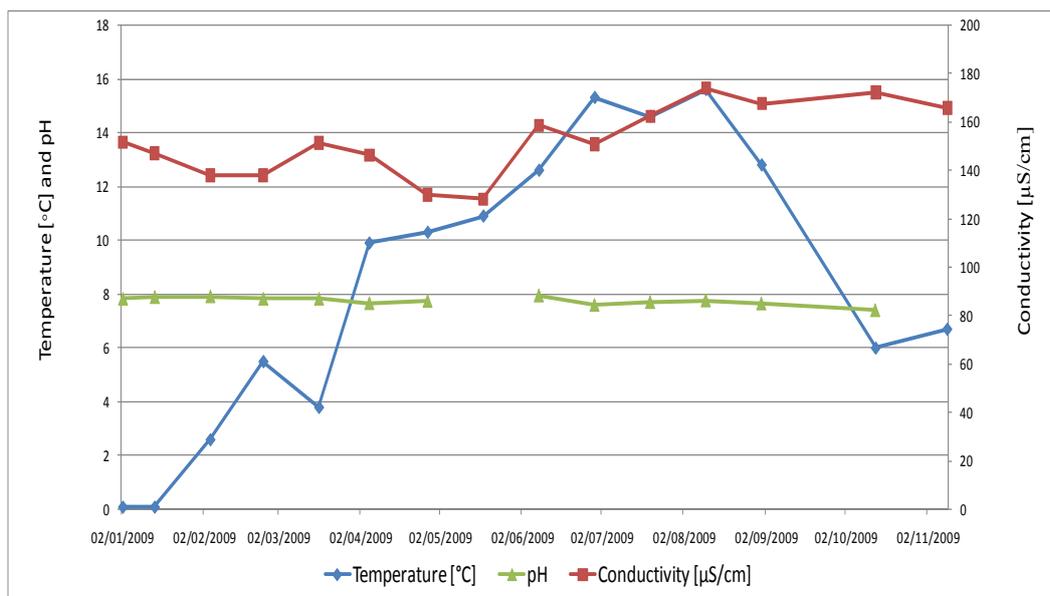


Figure 44 Water parameters Stroumbaach 2009.

Figure 44 and Table 46 present the water parameters measured in the Stroumbaach for 2009. The temperature of the river ranges between 0.1°C and 15.6°C. The pH ranges between pH 7.41 and pH 7.94. The conductivity readings for this site show a range of values between 128.1 µS/cm and 173.8 µS/cm. The level of oxygen ranges between 8.44 mg/l and 17.29 mg/l. The oxygen saturation levels range between 77.1% and 145.8%.

Table 46 Water parameters Stroumbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
02/01/2009	17.29	120.4
14/01/2009	11.76	83.3
04/02/2009	10.45	80.8
24/02/2009	9.1	77.6
17/03/2009	9.91	77.1
05/04/2009	12.9	117.1
27/04/2009	9.45	88.5
18/05/2009	8.44	78.8
08/06/2009	12.72	125.1
29/06/2009	8.44	87.4
20/07/2009	8.55	87.1
10/08/2009	10.79	111.9
31/08/2009	14.83	145.8
13/10/2009	11.07	90.5
09/11/2009	8.97	76.8

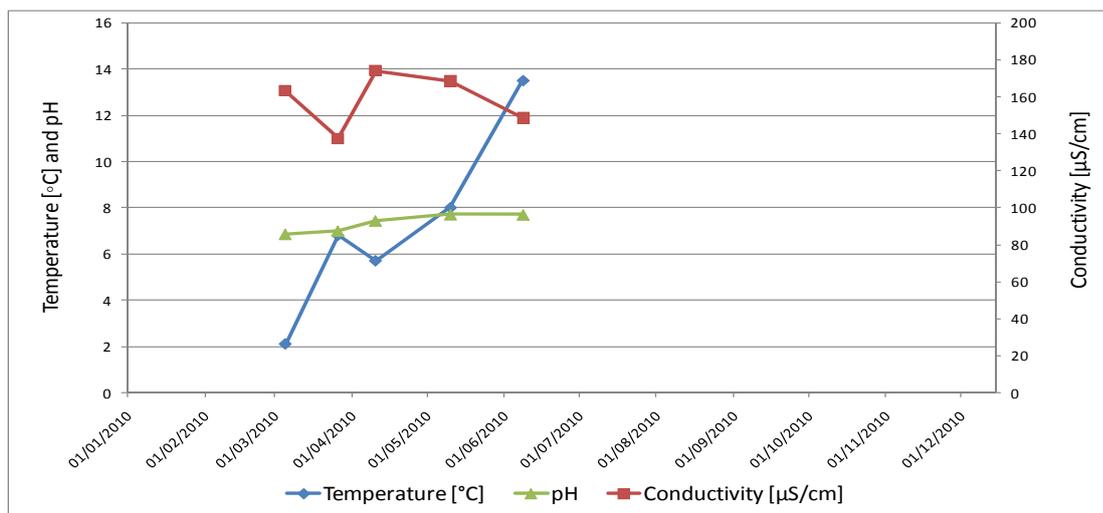


Figure 45 Water parameters Stroumbaach 2010.

Figure 45 and Table 47 present the water parameters measured in the Stroumbaach for March to June 2010. The temperature of the river ranges between 2.1°C and 13.5°C. The pH ranges between pH 6.859 and pH 7.708. The conductivity readings for this site show a range of values between 137.4 µS/cm and 174.1µS/cm. The level of oxygen ranges between 8.94 mg/l and 26 mg/l. The maximum level recorded in March is exceptionally high for this site. This corresponds to a maximum oxygen saturation level of 196%. The minimum oxygen saturation is 62.9% which was recorded in April. The levels of NO<sub>3</sub>-N range between 5.5 mg/l and 10.4 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.06 mg/l in June.

Table 47 Water parameters Stroumbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010	26	196	10.4	
26/03/2010	10.01	87.8	9.8	
10/04/2010	10.8	62.9		
10/05/2010	11.84	108.7	6.8	0.03
08/06/2010	8.94	89.3	5.5	0.06

### 3.12.2 Discussion

The average pH values in the Stroumbaach are similar to that of the other tributaries. The readings for 2007 and 2009 were pH 7.77 and pH 7.74 respectively. Similarly the pH was lower in both 2008 and 2010. As with the other tributaries, this measurement is too alkaline for that of a Freshwater Pearl Mussel stream and is not compliant with the guidelines set out by Oliver (2000) in Table 1. The average level of conductivity readings shows a reading of approximately 154.89 µS/cm. This is lower than many of the other streams in the project area. It is slightly too high to be compliant with the requirements set out by Moog *et al.* (1993) but is still 1.5 times higher than the requirements outlined by Oliver (2000) and Skinner *et al.* (2003) as outlined in Table 1. The level of dissolved oxygen in the stream is good with an average reading of 103.5% which provides a good habitat for brown trout.

However, the annual average level of nitrate is elevated showing a reading of 29.28 mg/l NO<sub>3</sub><sup>-</sup> in 2007. An average level of 8.125 mg/l NO<sub>3</sub>-N has been recorded so far in 2010. This is slightly lower than the recordings taken in many of the other tributaries, yet it is still extremely elevated and is over twenty times the level required.

### 3.13 Kenzelbaach

#### 3.13.1 Results

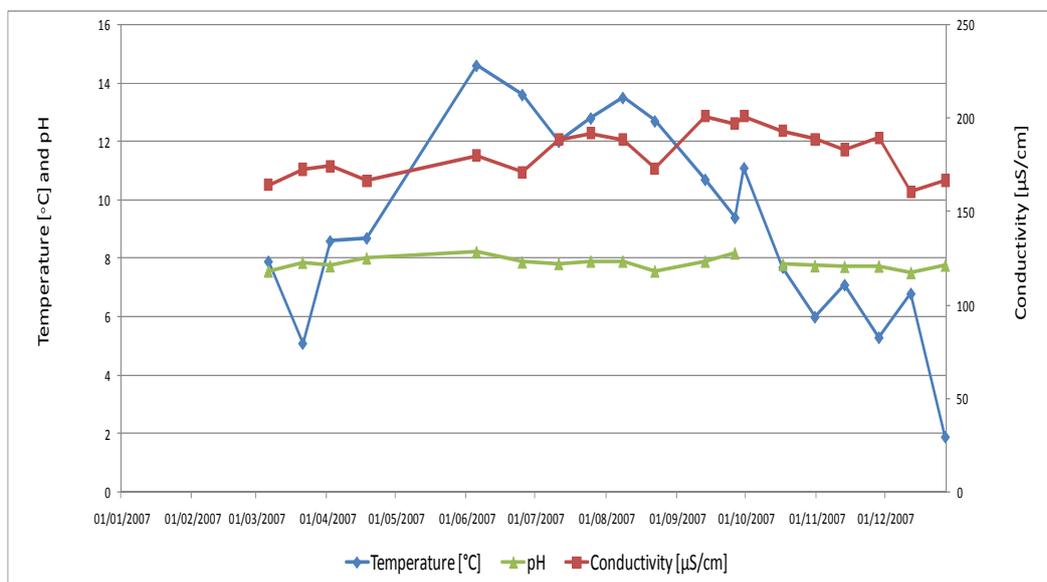


Figure 46 Water parameters Kenzelbaach 2007.

Figure 46 and Table 48 present the water parameters measured in the Kenzelbaach for March to December 2007. The temperature of the river ranges between 1.9°C and 14.6°C. The maximum temperature was recorded in June. The pH ranges between pH 7.51 and pH 8.22. The conductivity readings for the period show a range of values between 164.3 µS/cm and 201 µS/cm. The level of oxygen ranges between 9.46 mg/l and 13.74 mg/l. The range of oxygen saturation levels is between 81.4% and 124.4%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 25 mg/l and 50 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 48 Water parameters Kenzelbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
06/03/2007	11.37	99.8			
21/03/2007	9.98	81.4			
02/04/2007	11.5	101.3			
18/04/2007	11.13	97.9			
05/06/2007	11.85	120.4	35	0	0
25/06/2007	11.23	113			
11/07/2007	11.32	114.5			
25/07/2007	11.59	112.2	35	0	0
08/08/2007	12.56	124.4	35	0	0
22/08/2007	9.68	95.9	45	0	0
30/09/2007	10.74	100.8	40	0	0
13/09/2007	9.46	87.4			
26/09/2007	10.1	91.6			
17/10/2007	10.59	90	50	0	0
31/10/2007	11.76	96.8	25	0	0
13/11/2007	11.64	99.7			
28/11/2007	13.74	111.6	35	0	0
12/12/2007	12.83	106.4			
27/12/2007	12.97	95.2			

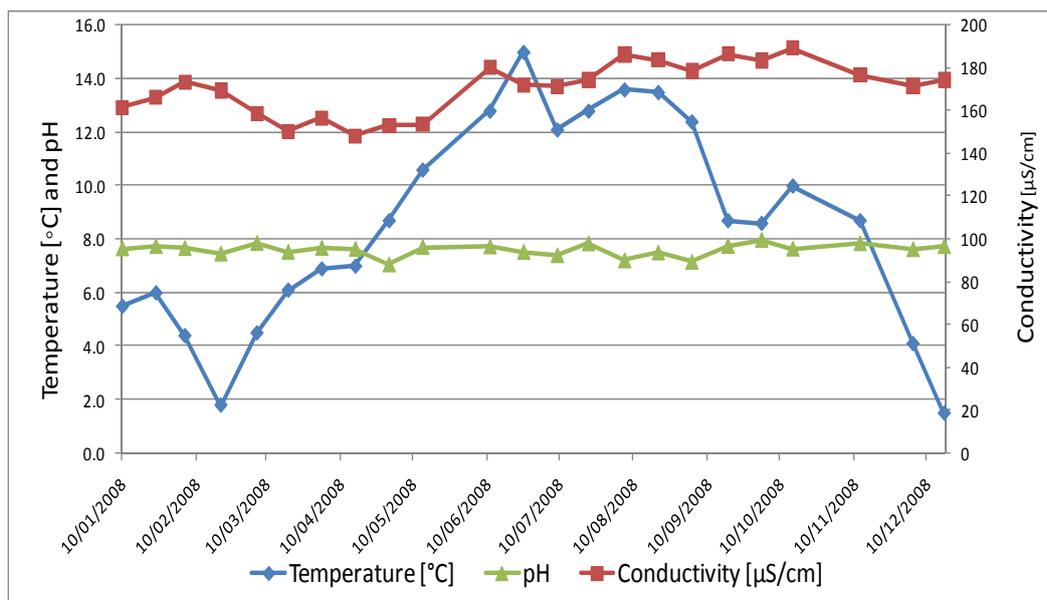


Figure 47 Water parameters Kenzelbaach 2008.

Figure 47 and Table 49 present the water parameters measured in the Kenzelbaach for 2008. The temperature of the river ranges between 1.5°C and 15°C. The maximum temperature was recorded in June. The pH ranges between pH 7.08 and pH 7.98. The conductivity readings for this site show a range of values between 148.2 µS/cm and 189.2 µS/cm. The level of oxygen ranges between 10.11 mg/l and 16.31 mg/l. The oxygen readings for this site during 2008 are generally high. The oxygen saturation levels range between 92.7% and 128.9%.

Table 49 Water parameters Kenzelbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
10/01/2008	11.29	92.7
24/01/2008	11.95	99.4
05/02/2008	12.26	98.3
20/02/2008	15.09	111.7
06/03/2008	14.45	113.6
19/03/2008	12.98	107.4
02/04/2008	11.02	93.2
16/04/2008	11.64	99
30/04/2008	11.81	106.5
14/05/2008	11.23	104.9
11/06/2008	11.52	112.3
25/06/2008	12.48	120.7
09/07/2008	13.21	128.9
22/07/2008	11.66	113.3
06/08/2008	10.11	101.2
20/08/2008	10.44	103.8
03/09/2008	11.34	111.2
18/09/2008	11.87	102.5
02/10/2008	11.73	105.2
15/10/2008	10.68	97.4
12/11/2008	11.01	98.1
04/12/2008	15.07	122
17/12/2008	16.31	119.6

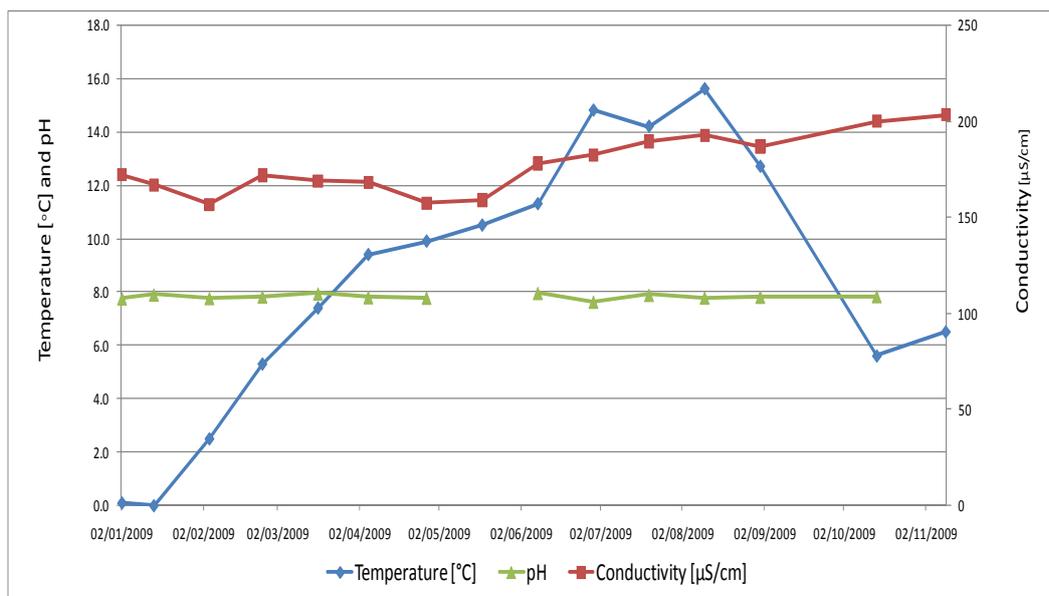


Figure 48 Water parameters Kenzelbaach 2009.

Figure 48 and Table 50 present the water parameters measured in the Kenzelbaach for 2009. The temperature of the river ranges between 0°C and 15.6°C. The maximum temperature was recorded in August. The pH ranges between pH 7.63 and pH 7.96. The conductivity readings for this site show a range of values between 156.7 µS/cm and 203 µS/cm. The level of oxygen ranges between 7.26 mg/l and 16.12 mg/l. The oxygen saturation levels range between 73.3% and 126.9%. The high readings for the oxygen level of 17.44 mg/l and oxygen saturation level of 169.3% recorded in August is suspected to be the result of a fault with the oxygen meter.

Table 50 Water parameters Kenzelbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
02/01/2009	16.12	112.3
14/01/2009	12.27	86.7
04/02/2009	12.43	96.5
24/02/2009	8.39	73.3
17/03/2009	10.27	87.2
05/04/2009	11.84	106.3
27/04/2009	10.5	97.78
18/05/2009	7.42	68.8
08/06/2009	12.27	126.9
29/06/2009	7.26	82.3
20/07/2009	9.1	91.7
10/08/2009	11.26	117.3
31/08/2009	17.44	169.3
14/10/2009	11.74	94.2
09/11/2009	10.78	90.8

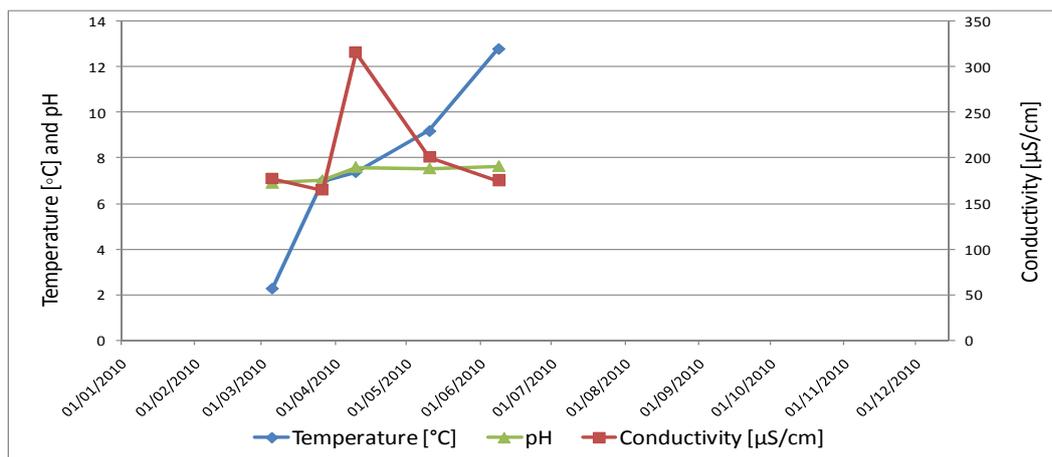


Figure 49 Water parameters Kenzelbaach 2010.

Figure 49 and Table 51 present the water parameters measured in the Kenzelbaach for March to June 2010. The temperature of the river ranges between 2.3°C and 12.8°C. The pH ranges between pH 6.914 and pH 7.653. The conductivity readings for this site show a range of values between 165 µS/cm and 316 µS/cm. The maximum value of 316 µS/cm recorded in April is exceptionally high for this site. The level of oxygen ranges between 8.81 mg/l and 27 mg/l. The maximum level recorded in March is exceptionally high for this site. The oxygen saturation levels range between 87% and 200%. The levels of NO<sub>3</sub>-N range between 6.8 mg/l and 10.2 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.07 mg/l in June.

Table 51 Water parameters Kenzelbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010	27	200	10.1	
26/03/2010	10.08	87	10.2	
09/04/2010	19.39	106.5		
10/05/2010	13.68	127.3	8.8	0.03
08/06/2010	8.81	89.3	6.8	0.07

### 3.13.2 Discussion

The annual average pH readings for both 2007 and 2009 were pH 7.82. The pH was lower in both 2008 and 2010 showing averages of pH 7.62 and pH 7.35 respectively. As with many of the other tributaries this is not sufficient for the requirements of a Freshwater Pearl Mussel stream and is not compliant with the guidelines set out by Oliver (2000) in Table 1.

The average level of conductivity shows a reading of approximately 176.29 µS/cm for the period 2007 – 2009. The annual average increased to 206.9 µS/cm for 2010. This is not compliant with the requirements set out by all four authors in Table 1. The level of dissolved oxygen in the stream is comparable with the Stroumbaach with an average reading of 103.1% which provides a good habitat for brown trout. This annual average level for 2010 has increased significantly due to a high reading of 200% recorded in January. However, the annual average level of nitrate is elevated showing a reading of 37.5 mg/l NO<sub>3</sub><sup>-</sup> in 2007. An average level of 8.975 mg/l NO<sub>3</sub>-N has been recorded so far in 2010. This is extremely elevated and similar to the Stroumbaach; it is over twenty times the guideline level required.

### 3.14 Ruederbaach

#### 3.14.1 Results

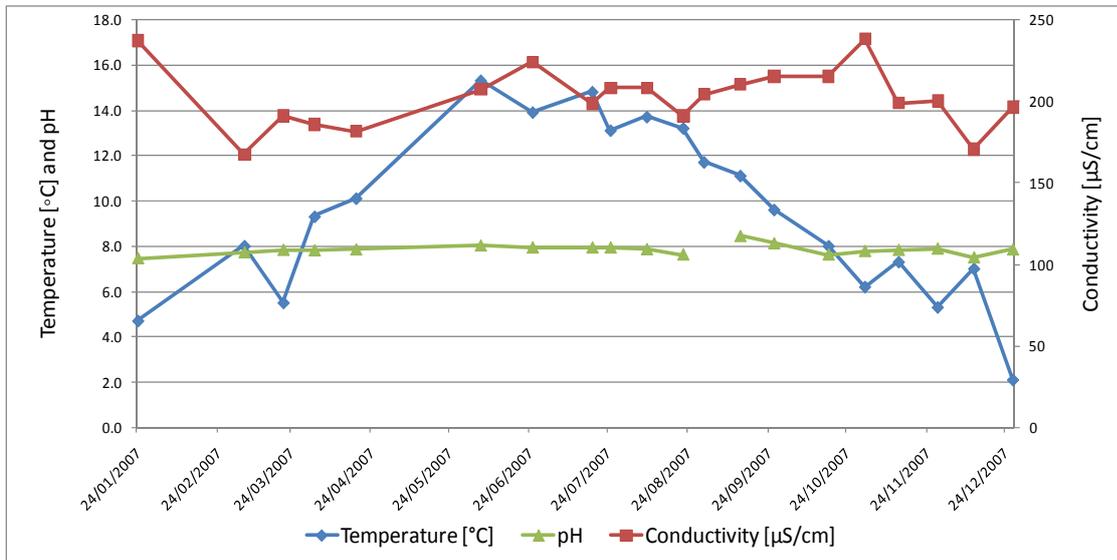


Figure 50 Water parameters Ruederbaach 2007.

Figure 50 and Table 52 present the water parameters measured in the Ruederbaach for 2007. The temperature of the river ranges between 2.1°C and 15.3°C. The maximum temperature was recorded in June. The pH ranges between pH 7.45 and pH 8.46. The maximum reading of pH 8.46 recorded in September is notably high for this site. The conductivity readings for the period show a range of values between 167.1 µS/cm and 238 µS/cm. The level of oxygen ranges between 9.54 mg/l and 13.43 mg/l. The range of oxygen saturation levels is between 83.9% and 120.4%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 25 mg/l and 75 mg/l. The maximum level recorded in November is very high for this site. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 52 Water parameters Ruederbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
06/03/2007	11.59	102.9			
21/03/2007	10.12	83.9			
02/04/2007	11.19	99.9			
18/04/2007	10.66	97.1			
05/06/2007	11.7	120.4	25	0	0
25/06/2007	10.91	110.9			
18/07/2007	10.61	106.9			
25/07/2007	10.99	109	35	0	0
08/08/2007	11.87	117	25	0	0
22/08/2007	9.54	95.4	30	0	0
30/08/2007	10.48	99.2			
13/09/2007	9.82	90.5			
26/09/2007	9.66	87.8			
17/10/2007	10.97	95.8	35	0	0
31/10/2007	11.96	98.5	35	0	0
13/11/2007	12.33	105.6			
28/11/2007	13.34	108.8	75	0	0
12/12/2007	13.43	112.9			
27/12/2007	12.57	92.6			

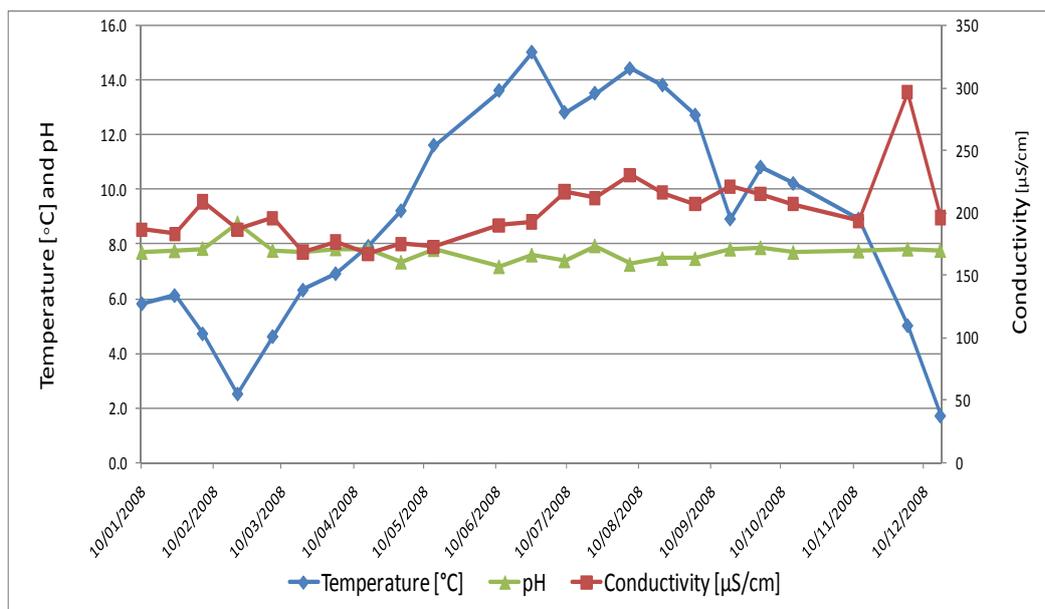


Figure 51 Water parameters Ruederbaach 2008.

Figure 51 and Table 53 present the water parameters measured in the Ruederbaach for 2008. The temperature of the river ranges between 1.7°C and 15°C. The maximum temperature was recorded in June. The pH ranges between pH 7.15 and pH 8.77. The maximum value recorded in February is very high for this site. The conductivity readings for this site show a range of values between 167.4 µS/cm and 296 µS/cm. The maximum reading of 296 µS/cm recorded in December is very high for this site. The level of oxygen ranges between 9.01 mg/l and 17.98 mg/l. The oxygen readings for this site during 2008 are generally high. The oxygen saturation levels range between 92.9% and 142.6%.

Table 53 Water parameters Ruederbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
10/01/2008	11.62	95.5
24/01/2008	11.47	94.7
05/02/2008	11.86	95.7
20/02/2008	15.01	111.6
06/03/2008	14.41	113.6
19/03/2008	12.13	101.5
02/04/2008	11.22	94.7
16/04/2008	12.51	107.1
30/04/2008	11.73	107.8
14/05/2008	10.93	104.5
11/06/2008	11.25	111.5
25/06/2008	11.07	115.9
09/07/2008	14.64	142.6
22/07/2008	11.55	114
06/08/2008	9.01	92.9
20/08/2008	10.09	100.8
03/09/2008	10.54	103.4
18/09/2008	12.15	107
01/10/2008	10.37	98
15/10/2008	10.3	94.6
12/11/2008	10.68	94.9
03/12/2008	12.47	102.8
17/12/2008	17.98	136.9

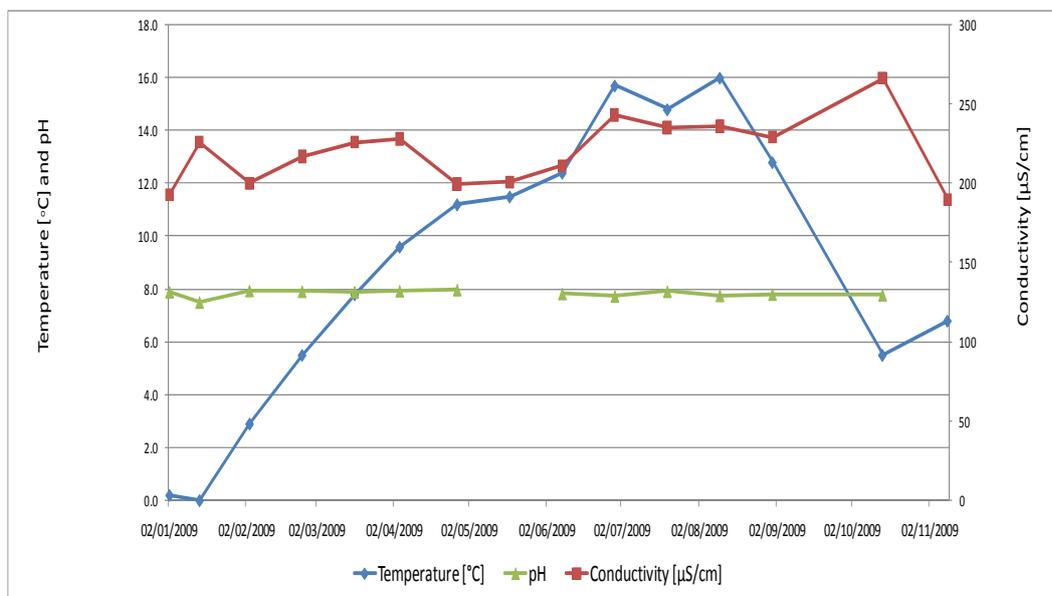


Figure 52 Water parameters Ruederbaach 2009.

Figure 52 and Table 54 present the water parameters measured in the Ruederbaach for 2009. The temperature of the river ranges between 0°C and 16°C. The maximum temperature was recorded in August. The pH ranges between pH 7.49 and pH 7.97. The conductivity readings for this site show a range of values between 190 µS/cm and 266 µS/cm. The level of oxygen ranges between 8.02 mg/l and 15.77 mg/l. The oxygen saturation levels range between 64.6% and 133.2%.

Table 54 Water parameters Ruederbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
02/01/2009	15.77	111.1
14/01/2009	13.24	93.3
03/02/2009	11.76	91.8
24/02/2009	8.02	64.6
04/04/2009	10.72	97.3
27/04/2009	9.83	94
18/05/2009	8.29	77.6
08/06/2009	13.63	133.2
29/06/2009	8.02	84.5
20/07/2009	9.12	92.9
10/08/2009	11.17	117.2
31/08/2009	11.67	114.1
14/10/2009	11.81	95.5
09/11/2009	10.99	94.5

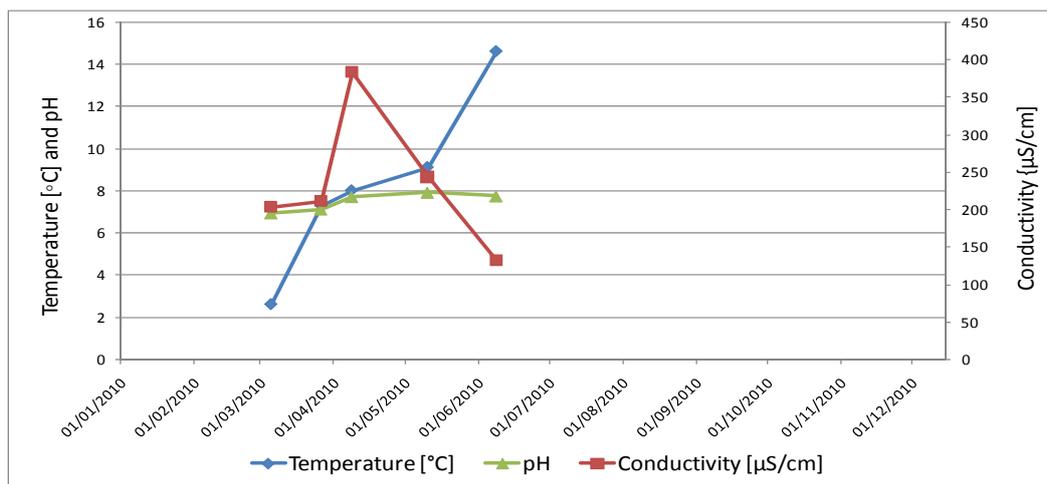


Figure 53 Water parameters Ruederbaach 2010.

Figure 53 and Table 55 present the water parameters measured in the Ruederbaach for March to June 2010. The temperature of the river ranges between 2.6°C and 14.6°C. The pH ranges between pH 6.93 and pH 7.91. The conductivity readings for this site show a range of values between 132 µS/cm and 383 µS/cm. The maximum value of 383 µS/cm recorded in April is exceptionally high for this site. The level of oxygen ranges between 8.07 mg/l and 27 mg/l. The maximum level recorded in March is exceptionally high for this site. The oxygen saturation levels range between 87.2% and 200%. The levels of NO<sub>3</sub>-N range between 7 mg/l and 10.6 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.06 mg/l in June.

Table 55 Water parameters Ruederbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010	27	200	10.6	
26/03/2010	9.73	87.2	10.1	
08/04/2010	13.24	117.8		
10/05/2010	14.27	125.5	9.4	0.03
08/06/2010	8.07	85.9	7	0.06

### 3.14.2 Discussion

The annual average pH readings for 2007 and 2009 were pH 7.84 and pH 7.83. The pH was lower in both 2008 and 2010 showing averages of pH 7.69 and pH 7.48 respectively. As with many of the other tributaries this does not meet the requirements specified by Oliver (2000) outlined in Table 1.

The annual average level of conductivity shows a reading of 202 µS/cm and 200 µS/cm for 2007 and 2008 respectively. The annual average increased to 220 µS/cm for 2009 and 234 µS/cm for 2010. This is over twice the requirements outlined by Oliver (2000) and Skinner *et al.* (2003) in Table 1. The level of dissolved oxygen in the stream is good with an average reading of 101.75% which provides a good habitat for brown trout. The annual average level for 2010 is 123.28% and this is partly due to an exceptionally high level of 200% recorded in January. However, the annual average level of nitrate is elevated showing a reading of 37.14 mg/l NO<sub>3</sub>-in 2007. An average level of 9.275 mg/l NO<sub>3</sub>-N has been recorded so far in 2010. This is extremely elevated and exceeds the requirements outlined by each of the four authors in Table 1 by a large margin.

### 3.15 Our Dasburg

#### 3.15.1 Results

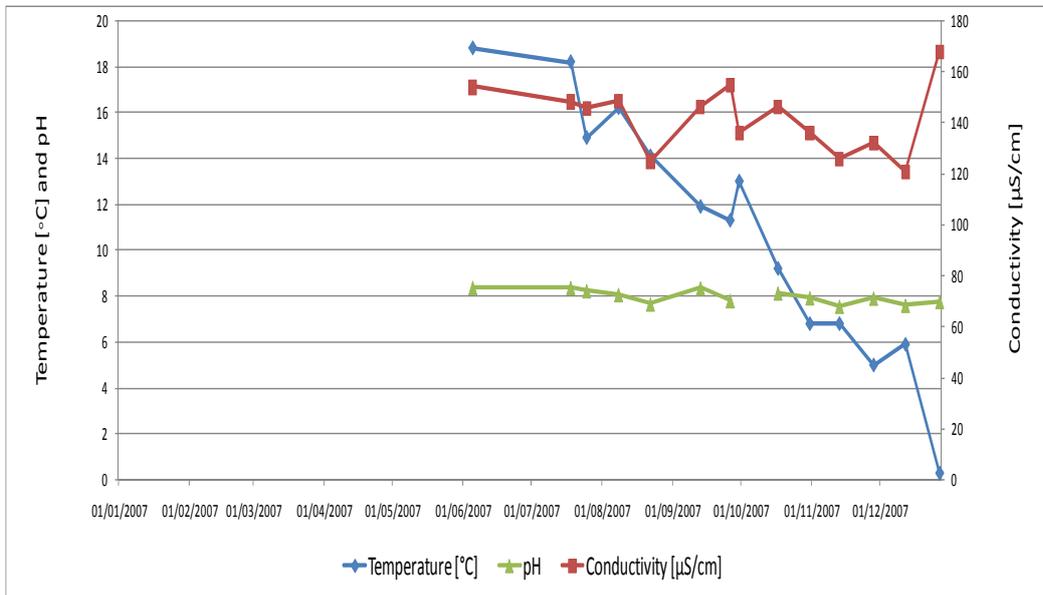


Figure 54 Water parameters Our Dasburg 2007.

Figure 54 and Table 56 present the water parameters measured in the Our Dasburg for June to December 2007. The temperature of the river ranges between 0.3°C and 18.8°C. The maximum temperature was recorded in June. The pH ranges between pH 7.52 and pH 8.35. The conductivity readings for the period show a range of values between 120.5 µS/cm and 167.6 µS/cm. The level of oxygen ranges between 8.15 mg/l and 14.81 mg/l. The range of oxygen saturation levels is between 69.8% and 130.9%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 15 mg/l and 35 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) was measured as 0.05mg/l on both the 5<sup>th</sup> of June and the 22<sup>nd</sup> of August. It was measured as absent on each of the other sampling dates. Ammonia (NH<sub>4</sub>) was measured as absent during 2007.

Table 56 Water parameters Our Dasburg 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
05/06/2007	12.53	139	15	0.05	0
18/07/2007	11.95	130.9			
25/07/2007	14.81	120.2	20	0	0
08/08/2007	12.03	126.7	15	0	0
22/08/2007	8.15	83.1	20	0.05	0
30/09/2007	10.49	102.5			
13/09/2007	10.28	96			
26/09/2007	9.75	92.4			
17/10/2007	11.09	100.5	25	0	0
31/10/2007	11.68	97.5	15	0	0
13/11/2007	10.18	102.4			
28/11/2007	13.65	109.8	35	0	0
12/12/2007	12.58	101.9			
27/12/2007	10.11	69.8			

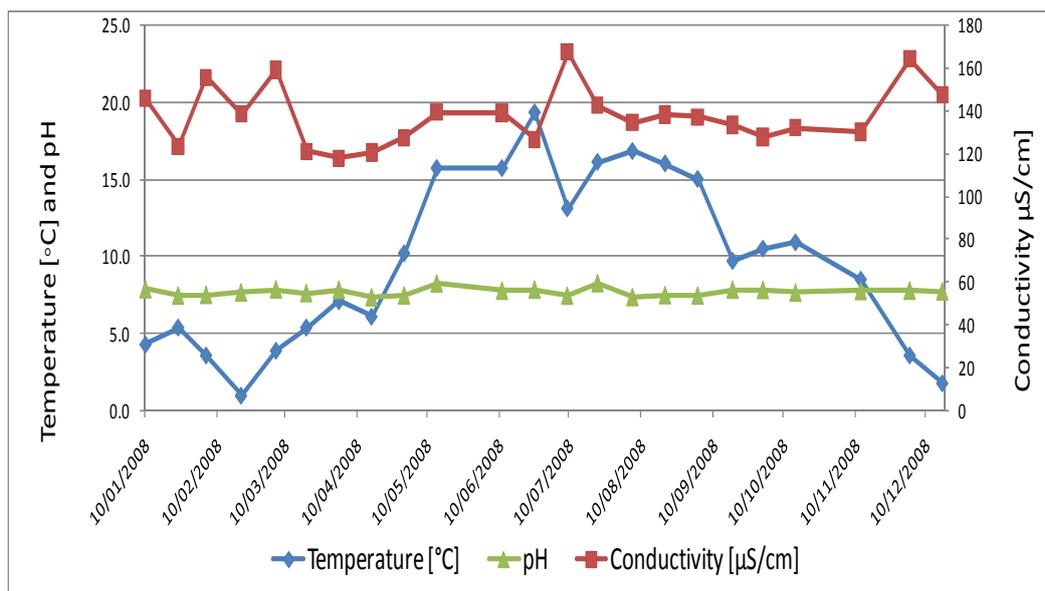


Figure 55 Water parameters Our Dasburg 2008.

Figure 55 and Table 57 present the water parameters measured in the Our Dasburg for 2008. The temperature of the river ranges between 1°C and 19.3°C. The maximum temperature was recorded in June. There was a decrease in temperatures in July showing a reading of 13.1°C. The pH ranges between pH 7.38 and pH 8.24. The conductivity readings for this site show a range of values between 120.4 µS/cm and 167.4 µS/cm. The level of oxygen ranges between 8.75 mg/l and 15.88 mg/l. The oxygen readings for this site during 2008 are generally high. The oxygen saturation levels range between 88% and 121.5%.

Table 57 Water parameters Our Dasburg 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
10/01/2008	11.39	90.5
24/01/2008	11.7	94.5
05/02/2008	12.49	95.2
20/02/2008	15.88	113.8
06/03/2008	14.32	109.7
19/03/2008	13.77	108.2
02/04/2008	11.14	95.2
16/04/2008	12.2	101
30/04/2008	11.7	109.6
14/05/2008	11.11	115.5
11/06/2008	11.111	115
25/06/2008	10.65	121.5
09/07/2008	11.41	111.2
22/07/2008	11.18	116.5
06/08/2008	8.75	92.8
20/08/2008	9.49	102
03/09/2008	9.84	99.9
18/09/2008	10.59	95.8
01/10/2008	10.31	96.1
15/10/2008	9.46	88
12/11/2008	10.26	89
03/12/2008	12.94	102.3
17/12/2008	14.47	107.5

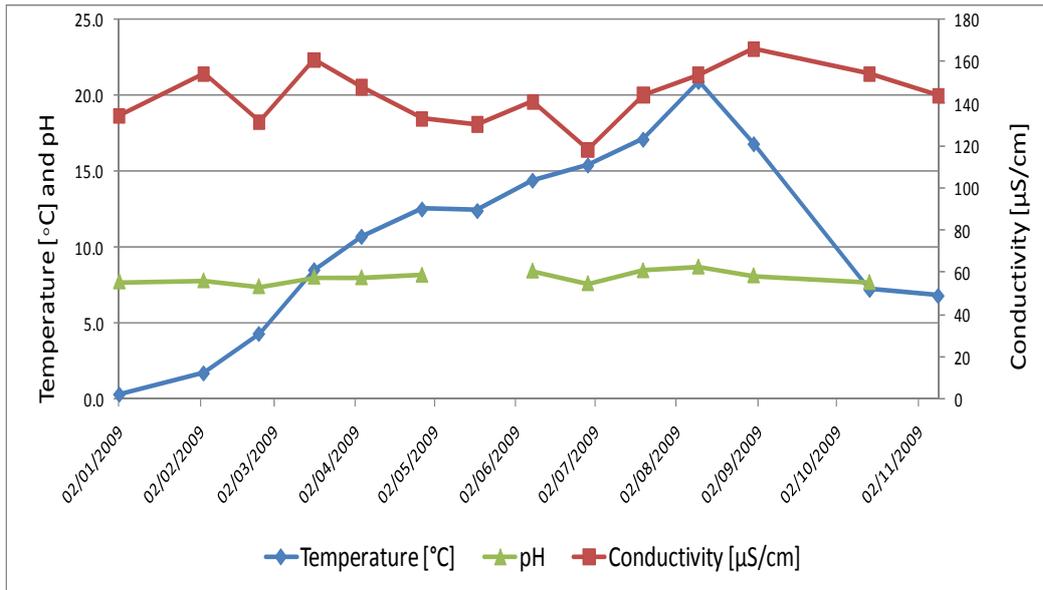


Figure 56 Water parameters Our Dasburg 2009.

Figure 56 and Table 58 present the water parameters measured in the Our Dasburg for 2009. The temperature of the river ranges between 0.3°C and 20.9°C. The maximum temperature was recorded in August. The pH ranges between pH 7.41 and pH 8.71. The conductivity readings for this site show a range of values between 130.4 µS/cm and 166 µS/cm. The level of oxygen ranges between 8.77 mg/l and 15.62 mg/l. The oxygen saturation levels range between 67.4% and 148.5%. The high oxygen level reading of 18.31 mg/l and oxygen saturation level of 191.5% are due to a fault of the oxygen meter.

Table 58 Water parameters Our Dasburg 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
02/01/2009	15.62	109.9
03/02/2009	11.8	89.1
24/02/2009	8.77	67.4
04/04/2009	11.7	108.2
27/04/2009	10.86	106.8
18/05/2009	9.24	89.2
08/06/2009	14.63	147.3
29/06/2009	9.27	95.2
20/07/2009	10.29	107.2
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31/08/2009	18.31	191.5
14/10/2009	12.4	105
09/11/2009	10.4	88.8

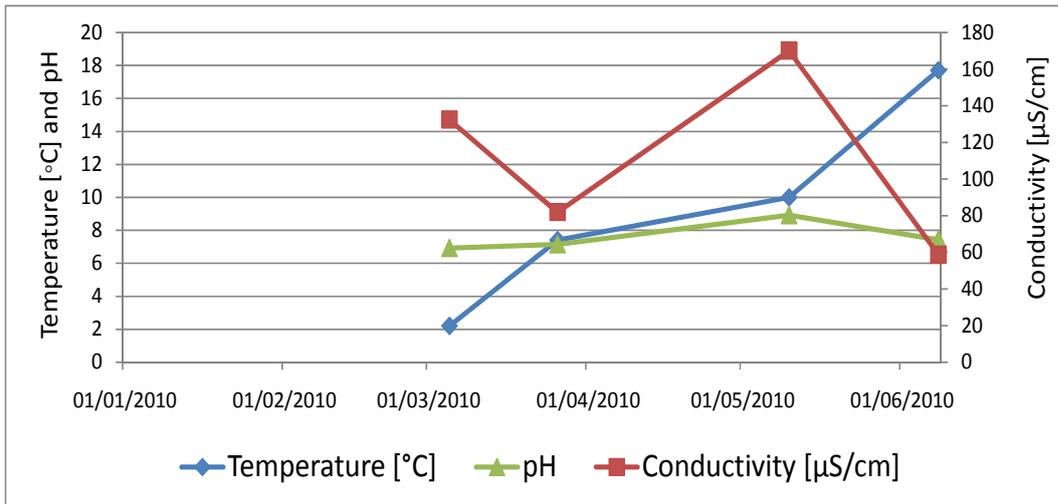


Figure 57 Water parameters Our Dasburg 2010.

Figure 57 and Table 59 present the water parameters measured in the Our Dasburg for March to June 2010. The temperature of the river ranges between 2.2°C and 17.7°C. The pH ranges between pH 6.925 and pH 8.91. The maximum reading for pH is notably high at this site. The conductivity readings for this site show a range of values between 58.7 µS/cm and 170 µS/cm. The level of oxygen ranges between 8.96 mg/l and 15.26 mg/l. The oxygen saturation levels range between 89% and 146%. The levels of NO<sub>3</sub>-N range between 4.8 mg/l and 8 mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.06 mg/l in June.

Table 59 Water parameters Our Dasburg 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010			8	
26/03/2010	10.17	89	7.6	
10/05/2010	15.26	146	5.4	0.03
08/06/2010	8.96	92.7	4.8	0.06

### 3.15.2 Discussion

The annual average temperature at this site was 10°C in 2007 and 2009 with a slightly cooler annual average of 9°C in 2008 and 2010. The pH readings are highly elevated over that of the guideline of pH 6.5 – pH 7.2 stated by Oliver (2000). In fact there were only two occasions in March 2010 where this site was compliant to the specified range. However this was followed by the highest reading of pH 8.91 being recorded in May. These readings were never recorded in 2007, 2008 or 2009 and hence the annual averages are always in breach of the guidelines including the average level for 2010.

A similar trend is evident when analysing the results for conductivity with regard to the limits specified in Table 1. A limit of <100 µS/cm is stated by both Oliver (2000) and Skinner *et al.* (2003). Readings adhering to this limit were not recorded at this site in 2007, 2008 or 2009, they were only recorded on two occasions during 2010 and similarly the annual averages were all in breach of these guidelines. However, all of the annual averages adhere to the guideline of <150 µS/cm stated by Moog *et al.* (2003); yet this limit was breached on many occasions. Each of the annual averages shown for dissolved oxygen adheres to the requirement specified by Oliver (2000). The annual average for 2009 was slightly higher showing 111.8% but this is not serious. The level of dissolved oxygen is very good at this site and suitable for brown trout. However the levels of nitrate in the river breach the guidelines set out by all four authors by a large margin. The annual average for 2007 is 20 mg/l which is ten times that of the least strict guideline stated by Moog *et al.* (1993) and the level of 6.45 mg/l NO<sub>3</sub>-N is fourteen times greater than the corresponding limit set by the same author.

Slight levels of ammonia were also detected at this site in May and June 2010 showing that there is a pollution problem.

### 3.16 Etschenterbaach

#### 3.16.1 Results

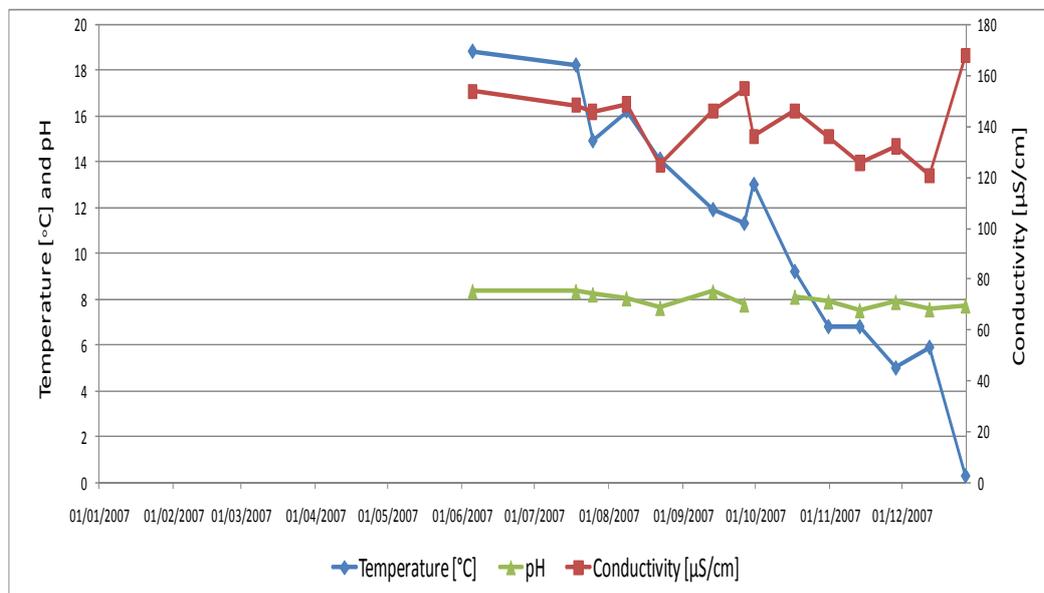


Figure 58 Water parameters Etschenterbaach 2007.

Figure 58 and Table 60 present the water parameters measured in the Etschenterbaach for June to December 2007. The temperature of the river ranges between 1.6°C and 14.4°C. The maximum temperature was recorded in July. The pH ranges between pH 7.59 and pH 8.08. The conductivity readings for the period show a range of values between 151.9 µS/cm and 192.7 µS/cm. The level of oxygen ranges between 9.5 mg/l and 14.34 mg/l. The range of oxygen saturation levels is between 82.9% and 122.4%. The levels of NO<sub>3</sub><sup>-</sup> (nitrate) range between 20 mg/l and 35 mg/l. Nitrite (NO<sub>2</sub><sup>-</sup>) and ammonia (NH<sub>4</sub>) were both measured as absent during 2007.

Table 60 Water parameters Etschenterbaach 2007.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> <sup>-</sup> [mg/l]	NO <sub>2</sub> <sup>-</sup> [mg/l]	NH <sub>4</sub> [mg/l]
06/03/2007	11.82	103.2			
21/03/2007	10.19	82.9			
03/04/2007	12.1	101.8			
18/04/2007	10.21	90.5			
05/06/2007	12.17	122.4	25	0	0
25/06/2007	11.3	112.1			
18/07/2007	11.26	113.1			
25/07/2007	11.13	107.8	30	0	0
08/08/2007	11.89	117	20	0	0
22/08/2007	9.51	94.5	25	0	0
30/08/2007	10.78	97.6			
13/09/2007	10.02	92			
26/09/2007	9.5	85.9			
17/10/2007	10.92	94.6	25	0	0
31/10/2007	11.86	96.2	25	0	0
13/11/2007	12.51	104.8			
28/11/2007	12.05	96.4	35	0	0
12/12/2007	13.52	111.3			
27/12/2007	14.34	104.1			

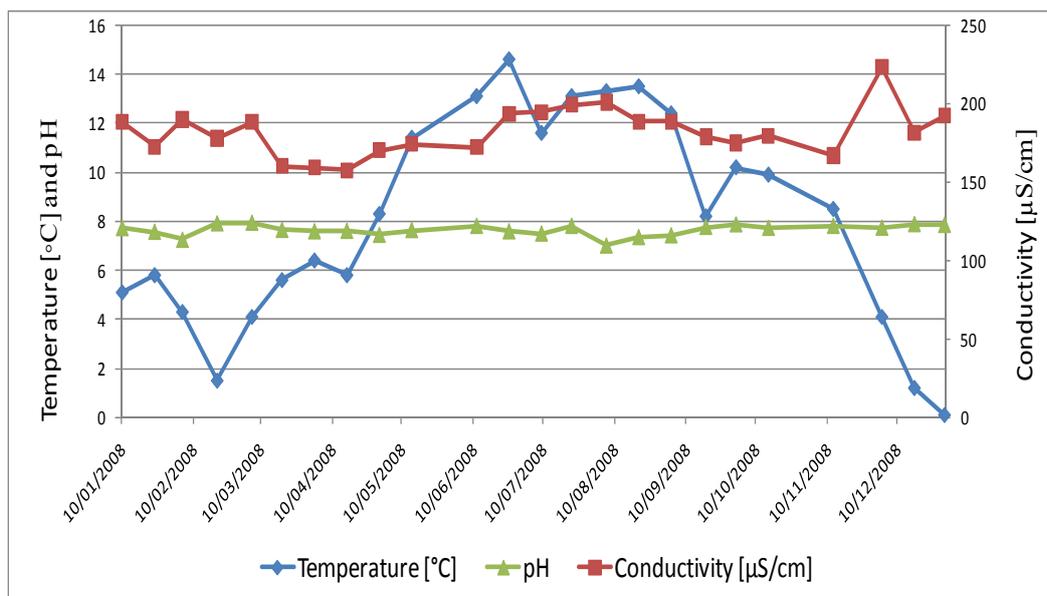


Figure 59 Water parameters Etschenterbaach 2008.

Figure 59 and Table 61 present the water parameters measured in the Etschenterbaach for 2008. The temperature of the river ranges between 0.1°C and 14.6°C. The maximum temperature was recorded in June. There was a decrease in temperatures in July showing a reading of 11.6°C. The pH ranges between pH 7.00 and pH 7.92. The conductivity readings for this site show a range of values between 157.8 µS/cm and 223 µS/cm. The level of oxygen ranges between 9.27 mg/l and 16.45 mg/l. The oxygen readings for this site during 2008 are generally high. The oxygen saturation levels range between 91.6% and 152.9%.

Table 61 Water parameters Etschenterbaach 2008.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
10/01/2008	10.69	94.7
24/01/2008	13.07	108.8
05/02/2008	13.22	104.3
20/02/2008	16.45	118.8
06/03/2008	14.82	115.6
19/03/2008	13.08	107.4
02/04/2008	11.64	97
16/04/2008	12.1	99.6
30/04/2008	11.65	104.6
14/05/2008	11.07	106.5
11/06/2008	11.02	105.3
25/06/2008	10.57	105
09/07/2008	12.55	118.6
22/07/2008	10.52	102.5
06/08/2008	9.27	91.6
20/08/2008	9.82	97.8
03/09/2008	10.48	102.3
18/09/2008	11.91	104.7
01/10/2008	11.2	104.7
15/10/2008	10.31	94.3
12/11/2008	10.92	96.8
03/12/2008	12.78	103.6
17/12/2008	12.3	152.9
30/12/2008	13.21	92.6

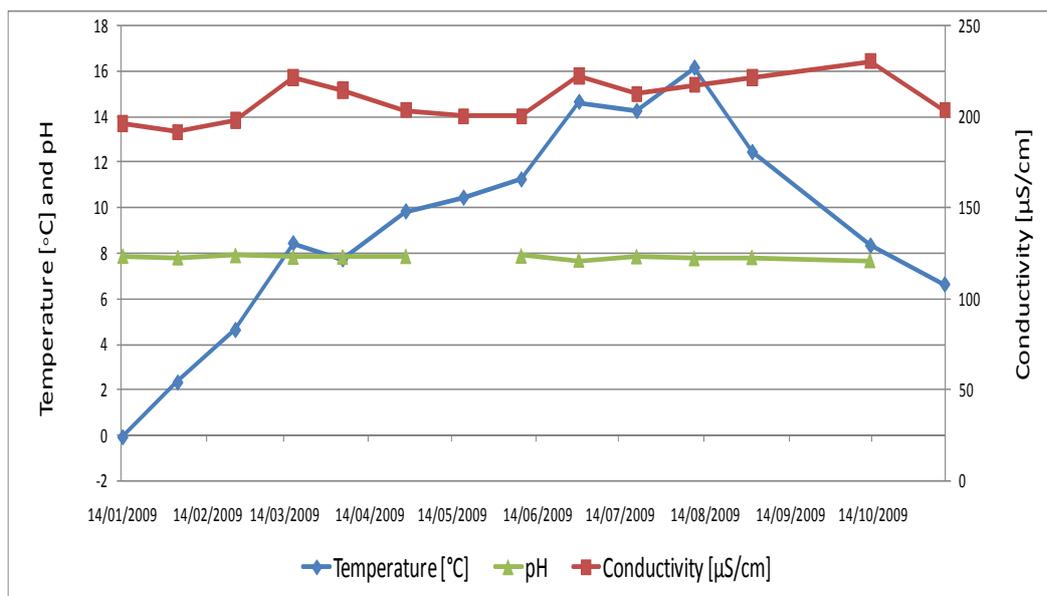


Figure 60 Water parameters Etschenterbaach 2009.

Figure 60 and Table 62 present the water parameters measured in the Etschenterbaach for 2009. The temperature of the river ranges between  $-0.1^{\circ}\text{C}$  and  $16.1^{\circ}\text{C}$ . The maximum temperature was recorded in August. The pH ranges between pH 7.66 and pH 7.89. The conductivity readings for this site show a range of values between  $191.2\ \mu\text{S}/\text{cm}$  and  $230\ \mu\text{S}/\text{cm}$ . The level of oxygen ranges between  $7.15\ \text{mg}/\text{l}$  and  $18.87\ \text{mg}/\text{l}$ . The oxygen saturation levels range between  $74.5\%$  and  $131.9\%$ . The high oxygen level reading of  $18.04\ \text{mg}/\text{l}$  and oxygen saturation level of  $175.6\%$  are due to a fault of the oxygen meter.

Table 62 Water parameters Etschenterbaach 2009.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]
14/01/2009	12.84	89.2
03/02/2009	11.21	85.6
24/02/2009	9.49	74.5
04/04/2009	11.27	97.4
27/04/2009	10.82	99.7
18/05/2009	7.15	68.8
08/06/2009	18.87	131.9
29/06/2009	8.56	87.2
20/07/2009	8.82	88.9
10/08/2009	10.6	111.6
31/08/2009	18.04	175.6
13/10/2009	10.9	95.6
09/11/2009	10.37	87.2

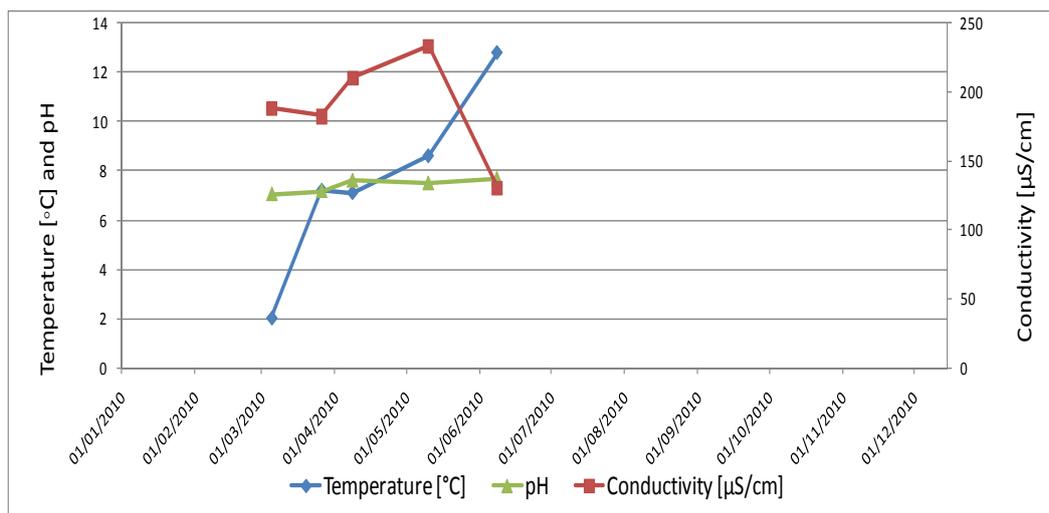


Figure 61 Water parameters Etschenterbaach 2010.

Figure 61 and Table 63 present the water parameters measured in the Etschenterbaach for March to June 2010. The temperature of the river ranges between 2.0°C and 12.8°C. The pH ranges between pH 7.035 and pH 7.68. The conductivity readings for this site show a range of values between 130.1 µS/cm and 233 µS/cm. The level of oxygen ranges between 9.76 mg/l and 20 mg/l. The maximum level recorded in March is exceptionally high for this site. The oxygen saturation levels range between 87% and 150%. The levels of NO<sub>3</sub>-N range between 5.5 mg/l and 8.9mg/l. Ammonia levels were measured as 0.03 mg/l in May and 0.06 mg/l in June.

Table 63 Water parameters Etschenterbaach 2010.

Date	O <sub>2</sub> [mg/l]	Sat O <sub>2</sub> [%]	NO <sub>3</sub> -N [mg/l]	NH <sub>4</sub> [mg/l]
05/03/2010	20	150	8.9	
26/03/2010	9.76	87	8.9	
08/04/2010	13.62	118.6		
10/05/2010	15.54	138.7	6.5	0.03
08/06/2010	11.37	110.3	5.5	0.06

### 3.16.2 Discussion

The annual average pH reading for the Etschenterbaach is approximately pH 7.66. As with many of the other tributaries this is not sufficient for the requirements of a Freshwater Pearl Mussel stream and is not compliant with the guidelines set out by Oliver (2000) in Table 1.

The annual average level of conductivity shows a trend of increase with a reading of 179 µS/cm for 2007, increasing to 182 µS/cm for 2008 and 209 µS/cm 2009. The annual average for 2010 is 188 µS/cm but higher readings are expected in the colder winter months. This is almost twice the requirements for measurements of conductivity outlined by Oliver (2000) and Skinner *et al.* (2003) in Table 1. The level of dissolved oxygen in the stream is good with an average reading of 102.1% which provides a good habitat for brown trout. The annual average level for 2010 is 120.92% and this is partly due to an exceptionally high level of 150% recorded in January. However, the annual average level of nitrate is elevated showing a reading of 26.43 mg/l NO<sub>3</sub><sup>-</sup> in 2007. An average level of 7.45 mg/l NO<sub>3</sub>-N has been recorded so far in 2010. This is lower than many of the tributaries in the project area, yet it still exceeds the requirements outlined by each of the four authors in Table 1.

### 3.17 Overall view

This report presents the results and detailed analysis of different measurable parameters of the river Our and eleven of its tributaries for the period 2007 – 2010. This report follows on from the previous report “Restauration des populations de moules perlières en Ardennes Technical Report: Action D4 Control and survey of the water quality (2007)” completed by the LIFE group in July 2007. The aim of each of these reports is to provide a basis for scientific monitoring of the water quality in the river Our. The river Our was once a prominent habitat for Freshwater Pearl Mussel *Margaritifera margaritifera* and therefore a certain habitat was created and maintained by a strict range for each of the measured water parameters. The ranges and levels presented in Table 1 show the general suitable requirements for such a habitat. The levels of each of these parameters have changed in the last century due to changes in land-use and eutrophication pressures from industrial and agricultural sources. The direct result of this is an aged and diminishing population of *Margaritifera margaritifera* as well as negative implications for many other species.

The pH readings for all four years are generally higher than the range specified by Oliver (2000). The annual average readings for 2007 and 2009 are very similar in all sampling sites. The levels of conductivity are generally 150 – 200  $\mu\text{S}/\text{cm}$  or higher. This level is twice that specified by Oliver (2000) and Skinner *et al.* (2003) and unfortunately three times the requirement outlined by Bauer (1988). The levels of oxygen and the saturation levels in the Our and the tributaries are generally very good and are suitable for the requirements of brown trout and Freshwater Pearl Mussel. On a few occasions such as January 2009 and March 2010 there have been exceptionally high levels of oxygen and oxygen saturation recorded up to 200% as seen in the Kenzelbaach and the Ruederbaach. But also very low levels have also been recorded and this usually coincides with high levels of nitrate particularly in the streams. It is perhaps that due to these high levels of eutrophication, there is an increased level of biological activity and this causes the dissolved oxygen to become depleted. If so, this can be very harmful for the fish and invertebrates living in the stream. The concentrations of nitrate in the river Our is a very serious problem. It is often twenty times or more the specified level in many of the tributaries and fifteen times that in the river Our itself. The annual average levels are highest in all sites during 2008 and in general it appears to be highest during the cold winter months. This is possibly due to the lower amount of biological activity that would normally be present in a stream during colder temperatures. Levels of ammonia were detected in May and June 2010 due to the utilisation of a more accurate chemical test (Merck Spectroquant<sup>®</sup> test kit) as opposed to the German fast test which were used in 2007. This method shows that ammonia is present in the river Our and its tributaries and therefore it is classified as being slightly polluted as ammonium is transformed by bacteria over nitrite to nitrate under natural conditions (Thielen *et al.*, 2007). The levels of nitrate, phosphate, ammonia and the high conductivity levels are each an important factor which are contributing to the deterioration of the river Our and its biological associations. The intensification of land-use for agricultural, industrial and residential purposes is resulting in a cumulative negative effect on the river Our catchment. The work of the LIFE group through the LIFE project “LIFE05 NAT/L/000116” has enhanced certain areas of the Our catchment. But there is a lot of progress yet to be made and many problems rectified before the river Our can be classified as a restored Freshwater Pearl Mussel river.

## 4. Siltation

### 4.1 Introduction

A river is a very dynamic system with many processes occurring simultaneously to create a complex and ever changing environment. The single process of transporting sediment is one of these processes and occurs in different stages and at different rates depending on other environmental factors. The erosion of material, its transportation and deposition are dependent on the environmental factors controlling the river system. This process is natural and although it changes spatially and temporally, it has a natural rate which is referred to as a reference condition. When this reference condition is altered and appears excessive due to natural phenomenon but more frequently due to human activity, the survival of certain aquatic species is put at risk. Each species can tolerate a certain amount of fine sediment within the riverbed but the Freshwater Pearl Mussel is the least tolerant of this as the juvenile mussels occupy the interstitial spaces of the riverbed for the first five years of their life compared to other species such as fish and insect larvae which occupy these areas for a relatively short period of time. A sediment particle range of  $<0.2$  mm was clearly defined as a threat to the Freshwater Pearl Mussel (Naden *et al.*, 2003). This range encompasses fine sand, silt and clay which are derived from the erosion of rock and are a large component of naturally occurring soils that enter watercourses naturally in variable amounts. This fine sediment travels down the watercourse as suspended sediment in the water column (Naden *et al* 2003). The deposition of the fine particles on the surface or within the stream bed is referred to as siltation. The existing knowledge regarding siltation and the level of turbidity and suspended solids in the water column is quite poor. This has a major effect on the river environment, yet our understanding of this is somewhat lacking.

## 4.2 Materials and Methodology

The aim of this pilot project is to provide data on the level of siltation occurring in both the river Our and the Millegruef at Kalbermillen. The LIFE group began measuring the turbidity and suspended solids by taking water samples in each of the sites shown in Figure 1. Two water samples were collected from each sampling site daily from Monday to Friday for a period of four months. The first sample was used to measure turbidity and the second for suspended solids.

### 4.2.1 Turbidity

The water samples were collected using a 250 ml plastic bottle. The bottle was first filled with sample water and then removed in order to clean it. A 250 ml sample was then taken. This was brought to the laboratory immediately. A 20 ml glass vial was washed three times with sample water. The water sample was shook in order to make it turbid; a 20ml sample was then poured and sealed using the cap. This was then placed into the “WTW Series Turb430IR” turbidity meter and measured three times. The sample was again shook and measured a fourth time. This measurement was then recorded in Nephelometric Turbidity Units (NTU).

### 4.2.2 Suspended Solids

The water samples were collected using a two litre plastic bottle. The bottle was first filled with sample water and then removed in order to clean it. A two litre sample was then taken. This was brought to the laboratory immediately and placed into a refrigerator at 2°C. Ten 110 mm diameter filter papers were placed in an oven and dried at 105°C for 24 hours. They were then weighed using a balance to two decimal places, this weight was recorded. Each filter paper was placed into a strainer which was placed onto a large round bottomed flask. 50ml of distilled water was passed through the filter paper and the apparatus was then connected to a suction pump. The two litre water sample was firstly measured with a large graduated cylinder to ensure the volume was correct. Each two litre water sample was then passed through the corresponding filter paper. The filter paper was then placed in the oven and dried at 105°C for a further 24 hours. It was then weighed using the balance and the weight was recorded. The difference between this weight and the dry weight of the filter paper is equal to the weight of the sample. This was divided by two to give the volume of suspended solids in milligrams per litre (mg/l).

### 4.2.3 Precipitation data

The precipitation data was sourced from the weather station in the village of Reuler. The data is presented as daily totals in millimetres (mm). The weather station is located 8.5 km from both of the sampling sites.

## 4.3 Results

### 4.3.1 February 2010

Table 64 Siltation parameters Our Kalbermillen February 2010

Date	Precipitation [mm]	Turbidity [NTU]	Suspended Solids [mg/l]
20/02/2010	0.2		
21/02/2010	3.9		
22/02/2010	4.2		
23/02/2010	6.7	72.6	120
24/02/2010	5.8	22.8	10
25/02/2010	10.5	24.5	25
26/02/2010	7.9	19	15
27/02/2010	0.8		
28/02/2010	15.9		

Table 64 and Table 65 present the siltation parameters measured in February 2010 for the Our Kalbermillen and the Millegruef respectively. The levels of precipitation in later part of February 2009 were generally consistent with approximately 5 mm of precipitation per day. There were notable heavy showers on the 25<sup>th</sup> and 28<sup>th</sup> of February of 10.5 mm and 15.9 mm respectively. The turbidity reached a maximum of 72.6 NTU in the Our with a maximum of 52 NTU in the Millegruef for the same day (23/02/2010). The lowest measurement for turbidity was taken in each site on the 26<sup>th</sup> of February. The level of suspended solids in the river Our dropped from a maximum of 120 mg/l on the 23<sup>rd</sup> of February to a minimum measurement of 10 mg/l the next day. This extensive change was not observed in the Millegruef where a decrease of 55 mg/l to 40 mg/l was recorded.

Table 65 Siltation parameters Millegruef February 2010

Date	Precipitation [mm]	Turbidity [NTU]	Suspended Solids [mg/l]
20/02/2010	0.2		
21/02/2010	3.9		
22/02/2010	4.2		
23/02/2010	6.7	52	55
24/02/2010	5.8	49.1	40
25/02/2010	10.5	26.6	25
26/02/2010	7.9	18.2	25
27/02/2010	0.8		
28/02/2010	15.9		

### 4.3.2 March 2010

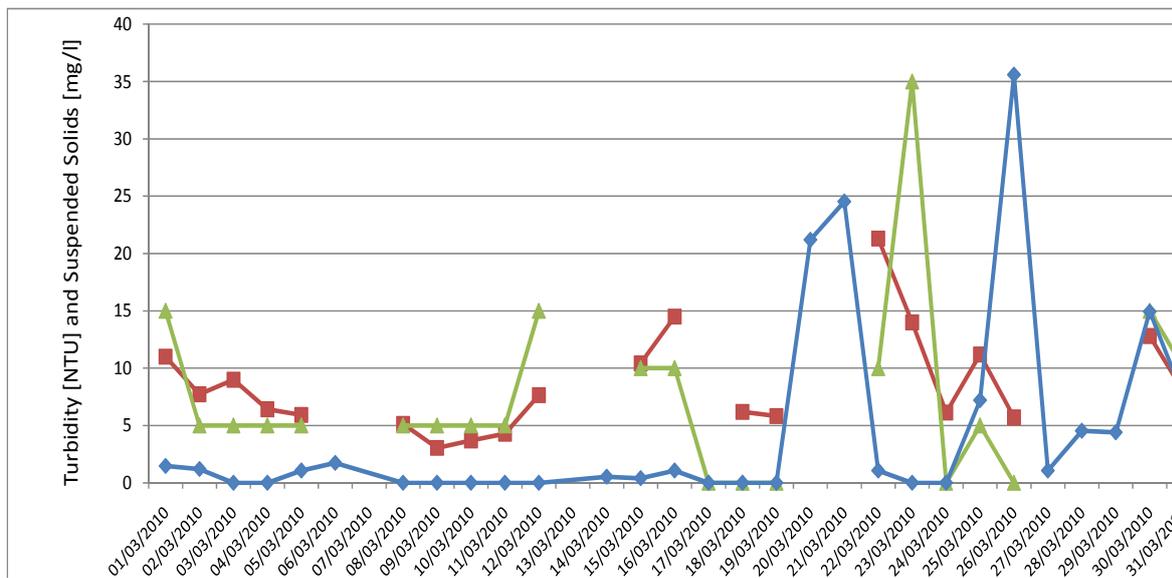


Figure 62 Siltation parameters Our Kalbermillen March 2010.

Figure 62 and Figure 63 present the siltation parameters measured in March 2010 for the Our Kalbermillen and the Millegruef respectively. The level of precipitation for the first three weeks was very low. However the levels of turbidity and suspended solids were elevated due to melting snow within the river catchment. The last week showed days with high levels of rainfall commencing with an initial two day period with 15.9 mm and 18.4 mm. The turbidity reached a maximum of 21.3 NTU in the Our and a maximum of 13.7 NTU in the Millegruef following the two day period of heavy rainfall. The highest level of suspended solids of 35 mg/l was recorded in the river Our two days after the initial period of rainfall. This increase was not observed in the Millegruef. The maximum level of precipitation recorded was 26.7 mm five days after the initial heavy rainfall.

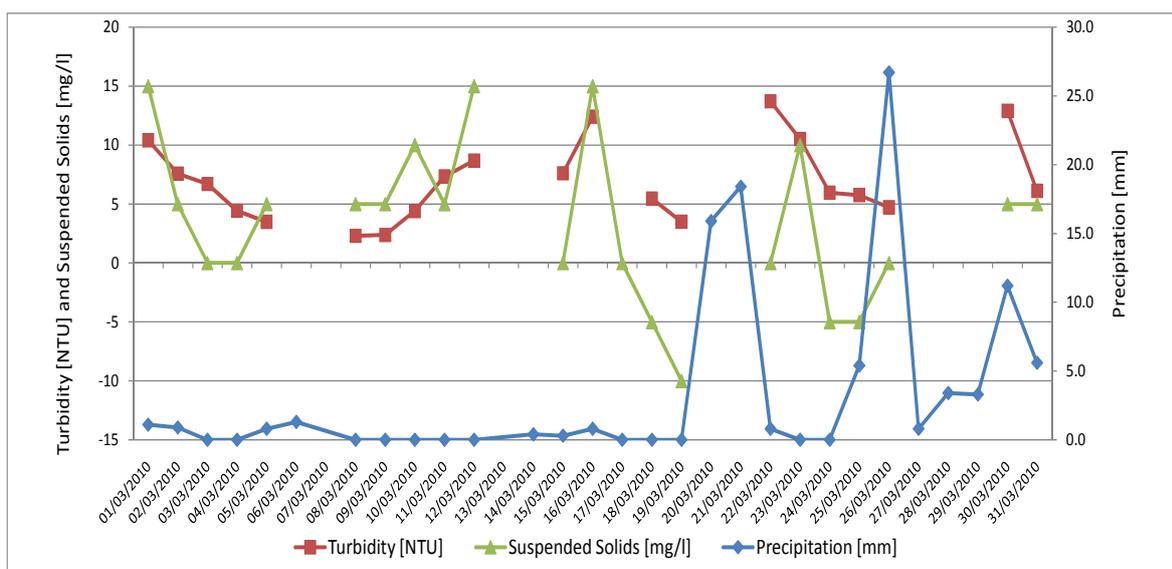


Figure 63 Siltation parameters Millegruef March 2010.

### 4.3.3 April

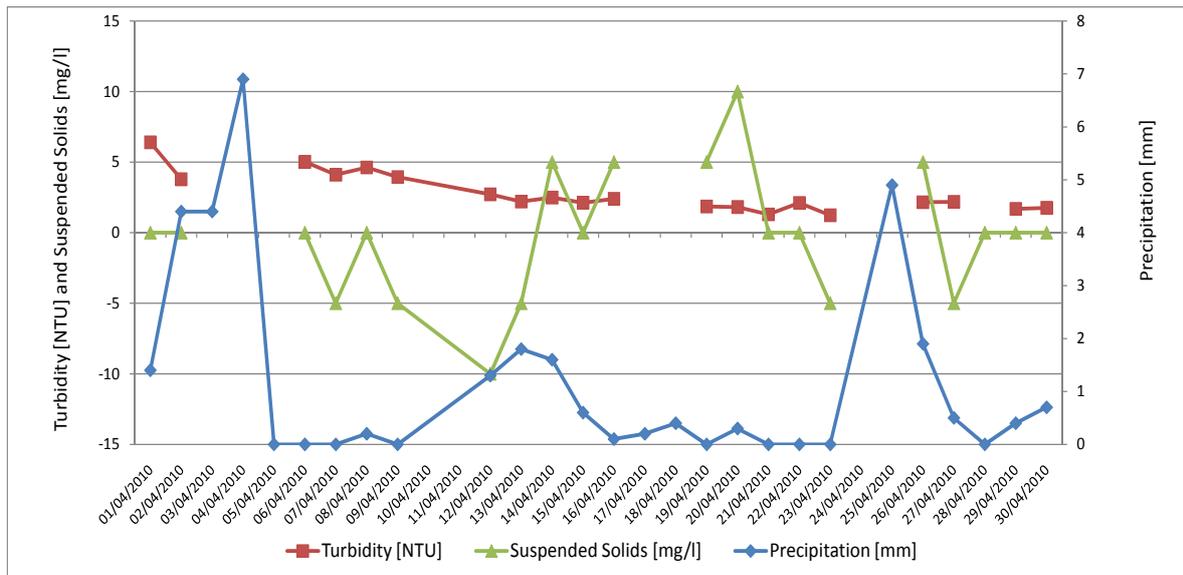


Figure 64 Siltation parameters Our Kalbermillen April 2010.

Figure 64 and Figure 65 present the siltation parameters measured in April 2010 for the Our Kalbermillen and the Millegruef respectively. The levels of precipitation in April were generally low with a peak of 6.9 mm in the first week and 4.9 mm in the final week. These low levels of precipitation showed baseline levels of turbidity in both sites of <5 NTU. The levels of suspended solids show negative values during April which is a fault of the equipment.

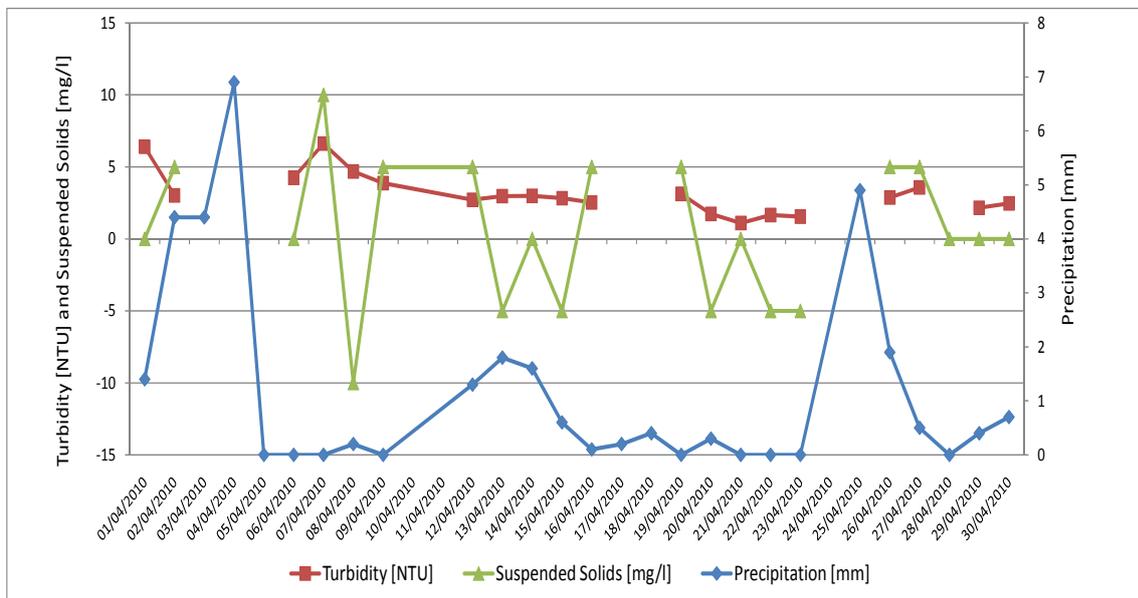


Figure 65 Siltation parameters Millegruef April 2010.

### 4.3.4 May

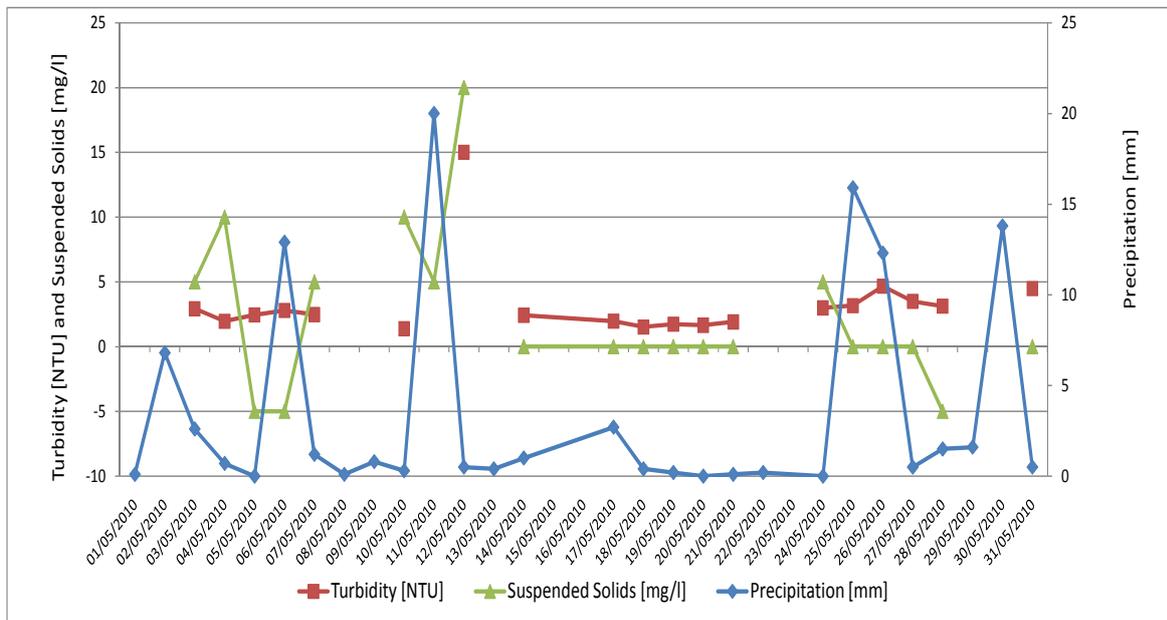


Figure 66 Siltation parameters Our Kalbermillen May 2010.

Figure 66 and Figure 67 present the siltation parameters measured in May 2010 for the Our Kalbermillen and the Millegruef respectively. The levels of precipitation were intermittently high. There were days of high rainfall recorded in each of the first two and the last week of the month. The highest level of 20 mm was recorded on the 11<sup>th</sup> of May. This was followed by the highest level of turbidity of 15 NTU and 15.4 NTU being recorded in the river Our and Millegruef respectively. A corresponding high level of suspended solids of 20 mg/l was recorded in the river Our but this increase did not correlate to the reading of 5mg/l in the Millegruef.

The high levels of precipitation of 15.9 mm and 12.3 mm seemed to show no effect on the levels of turbidity or suspended solids in either site.

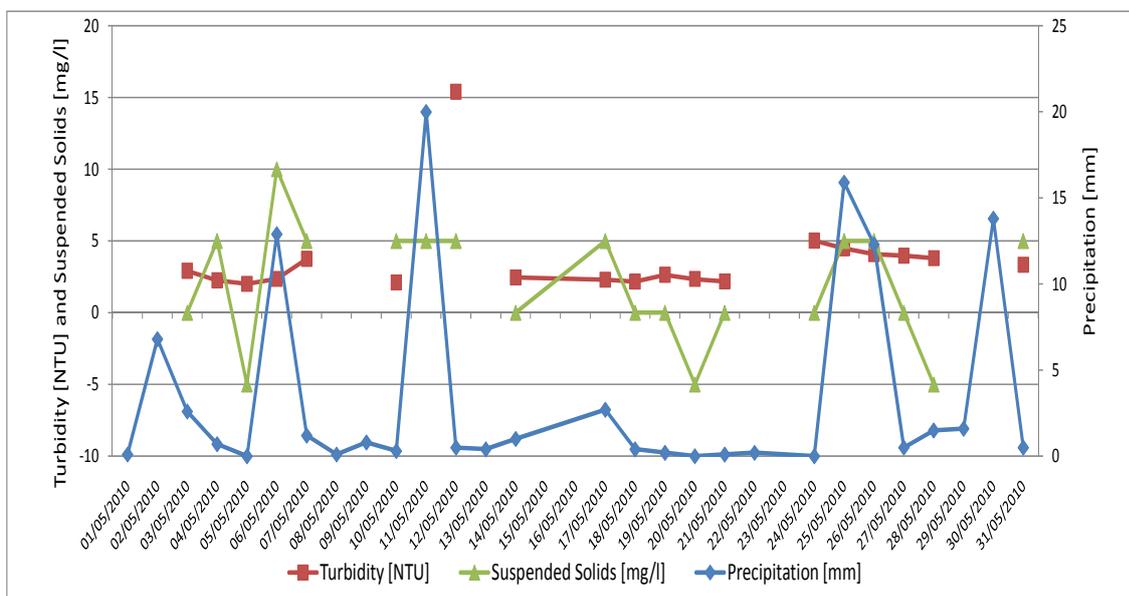


Figure 67 Siltation parameters Millegruef May 2010.

### 4.3.5 June

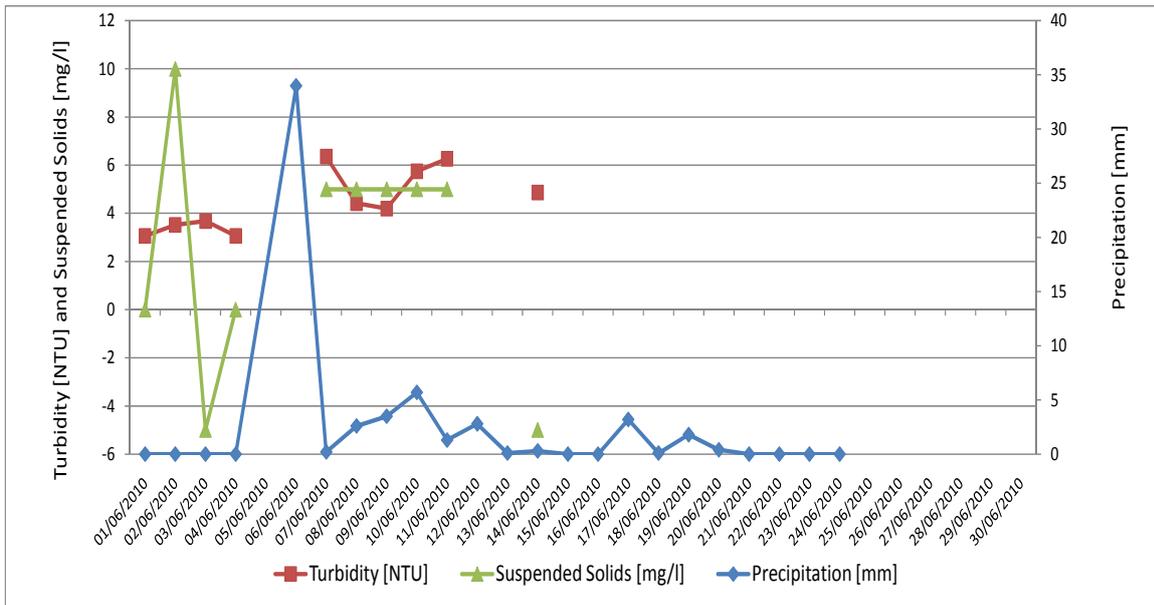


Figure 68 Siltation parameters Our Kalbermillen June 2010.

Figure 68 and Figure 69 present the siltation parameters measured in June 2010 for the Our Kalbermillen and the Millegruef respectively. The levels of precipitation were relatively low with an average of 1 mm per day. However this average is not including the heavy rainfall of 34 mm recorded on the 6<sup>th</sup> of June. This resulted in a slight increase in turbidity of 6.36 NTU which is the highest measurement in the Our for the month of June. The level of suspended solids in the Millegruef increased to 10 mg/l and remained at this level for three days with an increase to 15 mg/l on the fourth day following this heavy precipitation. The highest level of suspended solids of 10 mg/l in the Our was recorded on the 2<sup>nd</sup> of June which may be the result of the precipitation of 13.8 mm recorded on the 30<sup>th</sup> of May.

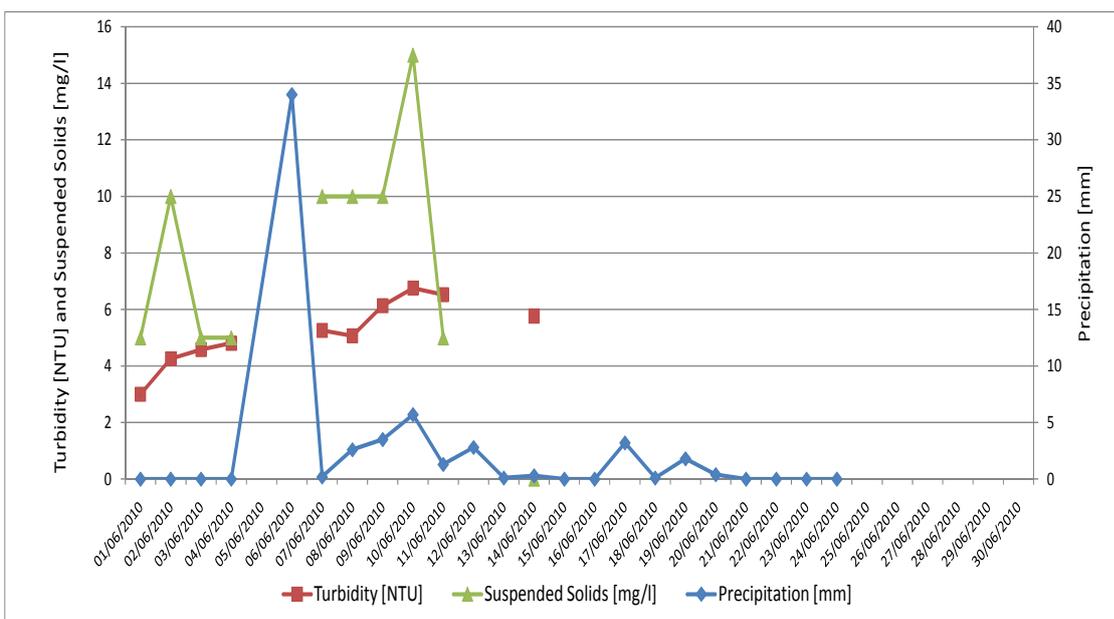


Figure 69 Siltation parameters Millegruef June 2010.

#### 4.4 Discussion

The elevated levels of turbidity in the river Our observed in February and the slightly elevated readings for March despite very little precipitation were due to a large snow-melt. However the data collected by the LIFE group show differences of turbidity and suspended solids in the river Our and Millegruef. This at first seems difficult to understand as the Millegruef is a short artificial stream fed directly by the river Our. After periods of heavy rainfall there is an increase in turbidity and suspended solids at both sites but the increase in the river Our is generally more pronounced. The dramatic increase in suspended solids in the river Our does not occur in the Millegruef as was observed during March 2010. This is possibly due to the lower velocity in the Millegruef in comparison to the river Our.

A time delay of 24 - 48 hours from the time of heavy precipitation to an increase in both turbidity and suspended solids in the river Our is evident from the data. This phenomenon could be tested in the future by using precipitation and water level data from an upstream point in the Our catchment.

The occurrence of negative values for levels of suspended solids at both sites during periods of baseline siltation is a fault of the equipment used. The balance is not sensitive enough in detecting very small amounts of sediment; the use of a micro-balance would remedy this.

The results of this pilot project show interesting correlations and differences to the levels of turbidity and suspended solids for the two sites. The value of a long term uninterrupted data set is also evident due to the observations outlined above. This information is useful for realising the functional use of the Millegruef as source of water for the Freshwater Pearl Mussel rearing station at Kalbermillen. The amount of available data for siltation in many pearl mussel streams across Europe is severely limiting. This data will prove valuable in the future as it will serve as a source of data for the process of siltation in the Our catchment.

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