Client

Envirosure

ASSESSMENT OF THE GROOT RIVER, MEIRINGSPOORT FOLLOWING DIESEL CONTAMINATION

2ND MONITORING REPORT

Prepared by

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1 INTRODUCTION

1.1 Background

On the 15th August 2017, 41 000 litres of diesel was accidentally spilled from an overturned tanker into a roadside stormwater drain which discharges runoff directly in the Meirings River as it flows through the Meiringspoort Pass. The bulk of the diesel flowed down the drain and discharged into the sandy river bank, entering the Meirings River immediately downstream of the bridge crossing the river.

In response to an initial evaluation of the potential impacts of the incident on the ecological integrity of the Meirings River, The Breede Gouritz Catchment Management Agency (BGCMA) issued a directive indicating quarterly monitoring of the affected environment for at least one year.

Freshwater Consulting cc were contracted by Envirosure Underwriting Managers (Pty) Ltd who insure the Kelrn Vervoer vehicle responsible for the spillage, to fulfil the requirements outlined in the directive.

1.2 Terms of Reference

Accordingly, the Freshwater Consulting Group was commissioned to:

1. Undertake a baseline assessment of the Meirings River to understand its condition and integrity prior to the spill and to establish a baseline for evaluating the potential impacts of surfactants, if necessary, on the biota associated with clean-up operations.
2. Undertake a site visit to guide the removal of sediments and vegetation (if necessary).
3. Establish the extent and need for rehabilitation through collaboration with the clean-up team to understand the proposed Action Plan and the timeframe for implementation of the Action Plan.
4. Following on from the baseline assessment, compile a monitoring plan for fish and macroinvertebrates.
5. Monitor key biological (fish and invertebrates), physical (habitat) and chemical indicators for a minimum period of one year at key sites within the catchment. Monitoring to be undertaken every 3 months and the need for longer term monitoring to be addressed after this period.
6. Compile quarterly reports that provide details of the recovery of the aquatic ecosystem based on data collected in the field with recommendations for ongoing monitoring or the need to adapt the monitoring approach.

The first four of these TORs have been addressed and are included in several communiques to the client, the most detailed being the Baseline Assessment Report submitted in October 2017. During the baseline site survey undertaken in September 2017, five key monitoring sites were identified as part of the monitoring plan and the first set of ecological data was collected. A second set of ecological and physico-chemical data was collected in December 2017 to address the monitoring requirements detailed in point 5 above. The first quarterly report on recovery of the aquatic ecosystem was submitted in January 2018 based on an assessment of the monitoring data collected in December 2017 and compared with the baseline data collected previously.

1.3 Findings of the First Monitoring Report

Despite evidence of a severe negative impact on the water quality and aquatic biota of the Meirings River immediately following the spill event (Ewart-Smith 2017), the data presented in the First Monitoring Report (Ewart-Smith and Van Der Walt 2018) showed significant recovery of the system in the short term. The evaluation of ecological integrity was however complicated by particularly low flow or no flow conditions at the time of the survey and it was suggested that abstraction in the upper catchment and resulting low flow conditions may account in part for poor ecological conditions within the system. The findings suggest however that the surface water clean-up operations had been effective in removing diesel contamination from the water column. Nevertheless, the channel banks and bed of the Meirings River were still contaminated with slicks of diesel visible on disturbance of the substrate at the time of the survey in December 2017.

While the December 2017 survey indicated that fish populations had recovered in the short term, the long term impacts on the population are still of some concern and thus it was recommended that fish monitoring be extended over a three year period so that reproductive success of the populations of redfin within the impact zone can be established.

1.4 The contents of this report

According to the TORs, a second monitoring survey was scheduled for March 2018. Failed rains however meant that the river was dry and thus the survey was delayed indefinitely. The rains did not materialise and thus the drought conditions prevailed through the winter and continue indefinitely.

Nevertheless, it was considered prudent to undertake a survey one year following the spill event (i.e. August 2017) to evaluate the condition of the system within a similar season.

This report therefore constitutes the Second Monitoring Report based on data collected in early August 2018. As it was recommended in the first monitoring report that the fish survey be extended, no fish sampling was undertaken during the August 2018 survey but will be undertaken again in December 2018 in accordance with the recommendations.

1.5 Limitations

The assessment of ecosystem health for any river is dependent on an understanding of the reference state or condition of the system, prior to any anthropogenic impacts. There is no primary data set that provides an indication of the reference condition of the Groot/Meirings River. Interpretation of the biophysical data in this study is therefore limited to comparison with control sites upstream and downstream of the impacted reaches. Interpretation of these data is complicated by the significant difference in flow encountered at these sites during the Baseline Assessment and the two monitoring surveys to date. In particular, the lack of water at most sites during August 2018 limited the collection of biophysical and significantly curtailed an assessment of recovery following the oil spill a year prior to the survey.

1.6 Use of this Report

This report reflects the professional judgement of its author. It is Freshwater Consulting's policy that the full and unedited contents thereof should be presented to the client and included in any application to relevant authorities. Any summary of the findings should only be produced with the approval of the author.

2 THE AFFECTED RIVER ECOSYSTEM

A full description of the Groot River catchment and the Meirings River within the study area is given in the Baseline Assessment Report (Ewart-Smith 2017). Essentially, the Groot /Meirings River is a river ecosystem which supports two threatened native freshwater fish species, namely smallscale redfin *Pseudobarbus asper* and the slender redfin *Pseudobarbus tenuis*. *P. asper* is listed as endangered and only occurs in the Gouritz and Gamtoos catchments, while *P. tenuis* is listed as near threatened and is endemic to the Gouritz catchment (van der Walt 2017). Thus the Groot/Meirings River is an ecosystem of very high conservation importance and a listed priority for the conservation and protection of aquatic ecosystems.

3 ASSESSMENT APPROACH AND METHODOLOGY

The basic approach to this study was to select sites upstream and downstream of the impact zone as controls against which to monitor recovery over time within the impacted zone. Also, sites were selected both within the impact zone and with distance downstream to establish whether the biological effects extended beyond what was visibly evident as the impacted zone.

3.1 Sampling sites

Five monitoring sites (Figure 3.1) were selected as part of the Baseline Survey in September 2017 when water levels and flow in the system provided a diversity of different habitats for aquatic biota. During December 2017, flows were reduced to a slight trickle at Middelwater and Derde Tol Drif while no flow was encountered at Ontploffings Drif. By August 2018, Middlewater, Derde Tol Drif and Ontploffings Drif were completely dry with only standing pools present at the Spiltech Camp site (Figures 3.2 to 3.4). The only site with similar water levels and flow conditions to that encountered in September 2017 was Aalwyn Drif (Figure 3.5). Table 3.1 provides a summary of the available habitats between the baseline survey and that sampled in December 2017 and August 2018. A full description of site characteristics is given in the Baseline Assessment Report (Ewart-Smith 2017).

Figure3.1 Location of the 5 monitoring sites on the Groot/Meirings River showing the impact zone (red).

Table 3.1 Comparison of habitat availability during September 2017 (Baseline), December 2017 (first monitoring survey) and August 2018 (second monitoring survey) due to differences in flow between sampling surveys.

Site	Available habitats		
	September 2017	**December 2017**	**August 2018**
Site 1: Middelwater (Control)	Stones-in-current (SIC) include mostly shallow riffles and runs over gravel and small cobble, marginal vegetation (mostly sedges) both in current and out of current (pool margin) and stones-out-of-current (SOOC) within a large pool. Habitat availability moderate.	SIC limited to slow trickle over small cobble and gravel; marginal vegetation included sedges along the pool margin but poor availability; no submerged SOOC; GSM included in pool habitat. Habitat availability in flowing biotopes is poor.	Completely dry. No flowing or standing water available at this site and thus no water quality or SASS samples could be collected. .
Site 2: Spiltech (impact)	SIC includes runs and riffles over boulders and cobbles, SOOC includes cobbles in pool; GSM includes gravels in runs and slackwater margins; marginal vegetation (mostly sedges) in current and out of current with some gravel in the pool. Habitat availability is good.	SIC includes runs and riffles over boulders and cobbles, SOOC includes cobbles in pool; GSM includes gravels in runs and slackwater margins; marginal vegetation (mostly sedges) in current and out of current with some gravel in the pool. Although water level is low, habitat availability is relatively good.	Riffles and Runs were completely dry with no flowing biotopes available. The site is reduced to a large pool at the downstream extent. SASS and water quality sampling is not comparable but a macroinvertebrate sample and water chemistry samples were collected for future reference with similar conditions in the future, if applicable.
Site 3: Derde Tol Drif (impact)	SIC included runs and riffles over cobble; SOOC includes cobbles in the downstream pool; GSM includes gravels and fine sediments in the upstream pool; Marginal vegetation includes sedges both in current and out of current. Habitat availability is good.	SIC includes a slow trickle through cobble; SOOC includes cobbles in the downstream pool; GSM includes gravels and fine sediments in the pool; Marginal vegetation includes sedges but only out of current. Habitat availability is marginal in terms of flowing biotopes.	Riffles, runs and pools were completely dry and thus no water quality or macroinvertebrate samples could be collected. .
Site 4: Ontploffings Drif (unknown)	SIC includes riffles and runs over boulders and bedrock; SOOC included cobble substrates in large pools. Some gravel and sand is present in slackwaters but the channel is dominated by large material. Marginal vegetation is sparse with isolated patches of sedge along pools (only vegetation out of current sampled). Habitat availability is moderate to good.	No flowing biotopes available. The site is reduced to a series of stagnant pools and thus SASS and water quality sampling is not applicable.	Riffles, runs and pools were completely dry and thus no water quality or macroinvertebrate samples could be collected. .

Site	Available habitats		
	September 2017	**December 2017**	**August 2018**
Site 5: Alwyns Drif (control)	SIC includes cobbled runs and riffles; SOOC includes cobbles in large pools. GSM is limited as the substrate is predominantly stony. Marginal vegetation includes both sedges and shrubs with aquatic macrophytes both in and out of current. Habitat availability is good.	SIC includes cobbled runs and riffles; SOOC includes cobbles in large pools. GSM is limited as the substrate is predominantly stony. Marginal vegetation includes both sedges and shrubs with aquatic macrophytes but only out of current. Habitat availability is good.	SIC includes cobbled runs and riffles; SOOC includes cobbles in large pools. GSM is limited as the substrate is predominantly stony. Marginal vegetation includes both sedges and shrubs with aquatic macrophytes but only out of current. Habitat availability is good.

Figure 3.2 Site 1: Middelwater in a) September 2017 and b) August 2018

Figure 3.3 Site 2: Spiltech Camp in a) September 2017 and b) August 2018

Figure 3.4 Site 3: DerdeTol Drif in a) September 2017 and b) August 2018

Figure 3.5 Site 5: Aalwyn Drif in a) September 2017 and b) August 2018

3.2 Sample collection

Dry conditions experienced in August 2018 meant that biophysical sampling of the water column was limited largely to sites with either standing water or flow. *In situ* measurements of Electrical Conductivity (EC) (mS m^{-1}), pH, Dissolved Oxygen (DO) (mg/l) and temperature (^{0}C) could only be carried out at the pool downstream of the Spiltech Camp Site and at Aalwyn Drif (Site 5). Water samples for the analysis of various water quality components were also only collected at these two points.

The South African Scoring System version 5 (SASS5) is the standard approach to assessing macroinvertebrate communities in flowing river ecosystems. Aalwyn Drif was the only site with flowing water in August 2018 and thus SASS sampling could only be undertaken at one site during this survey. Details of the method are included in the Baseline Assessment Report (Ewart-Smith 2017). Aquatic macroinvertebate samples were however collected from the pool downstream of the Spilltech Site to provide some indication of the presence or absence of taxa to inform the condition

Soil samples for the analysis of hydrocarbons were collected from all five monitoring sites, as well as from the source area and the substrate in the river at the point of entry of the diesel. These additional points of sample collection are shown in Figure 3.6, relative to Site 2 (i.e. Spiltech Camp).

Figure3.6 Additional sediment samples from the active channel of the river within the impact zone were taken in August 2018.

4 KEY FINDINGS

4.1 Hydrocarbon analysis

Relatively low concentrations of Diesel Range Organic (DRO) in the range C_{10}-C_{14} and C_{15}-C_{36} were found in the substrate of the Meirings River at the point of entry into the river as well as within the channel immediately upstream of site 2 (Spiltech Camp) during August 2018 (Table 4.1). Despite the presence of hydrocarbons at the upper extent of the impact zone in August 2018, the concentrations were significantly lower than those measured immediately following the spill in August 2017 and in December 2017 when DROs were detected at both the Spiltech Camp Site (Site 2) and at Derde Tol Drif (Site 3). Even on disturbance of the substratum in the pool downstream of the Spiltech Camp Site, no slicks or sheens typical of refined fuels such as diesel were evident throughout the study area. This suggests a significant improvement in conditions observed in December 2017 when the presence of hydrocarbons was still visibly present in the substratum throughout the impact zone.

Relatively high concentrations of DROs in the range C_7-C_9 and, to some extent C_{10}-C_{14} are however still present in the sand bank at the point of entry into the Meirings River (Table 4.1 – Source Area). The significant reduction in DROs a few meters away within the channel itself (Table 4.1 – Spill entry) suggests that the drain within the sandbank is effectively capturing a significant portion of the hydrocarbons that remain within the sand bank. Nevertheless, in the event of flood flows, these hydrocarbons may become mobilised and re-contaminate the water column of the Meirings River.

Table 4.1 Hydrocarbon concentrations measured in the sediments at the 5 biomonitoring sites with additional samples collected within the impact zone during August 2018.

				08 August 2018					
Compound	**Soil screen values Standards**	**Middlewater**	**Source Area**	**Spilltech**			**Derdertol**	**Ontplof**	**Aalwyn**
				Spill entry	*Spilltech u/s*	*Spilltech d/s*			
Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Unit	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**			**µg/kg**	**µg/kg**	**µg/kg**
Benzene	**30**	< 8	< 80	< 8	< 8	< 8	< 8	< 8	< 8
Toluene	**250**	<20	< 200	80	<20	<20	<20	<20	<20
Ethyl Benzene	**260**	< 8	< 80	< 8	41	< 8	< 8	< 8	< 8
Xylene(*m + p + o*)	**450**	< 8	< 80	< 8	< 8	< 8	< 8	< 8	< 8
Xylene - *m + p*	**450**	<16	<160	<16	<16	<16	<16	<16	<16
1,3,5-Trimethyl Benzene	**280**	< 8	130	< 8	< 8	< 8	< 8	< 8	< 8
1,2,4-Trimethy Benzene		< 8	< 80	23	< 8	< 8	< 8	< 8	< 8
Naphthalene	**280**	< 8	< 80	< 8	< 9	< 8	< 8	< 8	< 8
Unit	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**			**mg/kg**	**mg/kg**	**mg/kg**
C7-C9	**2300**	< 200	12000	< 200	< 200	< 200	< 200	< 200	< 200
C10-14	**440**	< 20	490	45	<20	< 20	< 20	< 20	< 20
C15-36	**45000**	< 22	930	370	77	< 22	< 22	< 22	< 22

Table 4.2 Hydrocarbon concentrations measured in the water column at site 2 (Spiltech Camp in the isolated pool downstream) and at Aalwyn Drift during August 2018.

August 2018			
		Spiltech Downstream pool	***Alwyns Drif pool***
	Matrix	Water	Water
Group	**Compound**	μg/liter	μg/liter
GRO's	**Benzene**	<1	<1
	Toluene	<10	<10
	Ethyl Benzene	<2	<2
	Xylene(*m + p + o*)	<2	<2
	Xylene - *m + p*	<2	<2
	1,3,5-Trimethyl Benzene	<2	<2
	1,2,4-Trimethyl Benzene	<2	<2
PAH's	**Naphthalene**	<2	<2
	Acenaphthylene	<1	<1
	Acenaphthene	<1	<1
	Fluorene	<1	<1
	Phenanthrene	<1	<1
	Anthracene	<1	<1
	Pyrene	<1	<1
	Fluoranthene	<1	<1
DRO's	**C10**	<1	<1
	C11	<1	<1
	C12	<1	<1
	C13	<1	<1
	C14	<1	<1
	C15	<1	<1
	C16	<1	<1
	C17	<1	<1
	C18	<1	<1
	C19	<1	<1
	C20	<1	<1
Total VPH's (identified)		<10	<10
Estimated VPH's (Unidentified)		<10	<10
Estimated Total VPH's		<10	<10

4.2 Water Quality

In situ measurements of pH, Electrical Conductivity (EC), water temperature and Dissolved Oxygen (DO) were measured in the isolated pool downstream of Site 2 (Spiltech Camp) and at Site 5 (Aalwyn Drif) in August 2018. These were the only sites with either standing (Site 2) or flowing (Site 5) water at the time of the site visit.

The oxygen concentration at the downstream control site (i.e. Site 5: Aalwyn Drif) in August 2018 (Table 4.3) was similar to that measured during the Baseline Study as well as in December 2017 and, with a value of 10.1 mg/l, is indicative of a system that is well oxygenated and in good condition. Although oxygen concentrations dropped to 5 mg/l within the impacted zone immediately following the diesel spill (see Ewart-Smith 2017), concentrations of 9 mg/l were recorded at Site 2 (Spiltech) in December 2017 indicative of relatively unimpacted conditions. By contrast, a low DO concentration (i.e. 6.4 mg/l) was measured in the pool downstream of Spiltech Camp in August 2018 (Table 4.3). The low DO concentration is coupled with a relatively high Chemical Oxygen Demand (COD) of 67 mg/l. This suggests that the low DO concentration may be a result of the breakdown of certain chemicals and decomposition of organic matter. Immediately following the diesel spill in August 2017, the DO concentration within the same pool was 7.2 mg/l with a COD of 133 mg/l but recovered quickly such that COD in December 2017 at all monitoring sites was below the detectible limit of 10 mg/l (Figure 4.1). Although no hydrocarbons were detected in either the water column or sediments at this site during August 2018 (Table 4.1 and Table 4.2), the elevated COD at the Spiltech pool site may be indicative of ongoing breakdown of hydrocarbons from the sediments, possibly not detected by a single grab sample of the substratum, although no slicks or surface sheens were evident on disturbance of the substratum. Considering that hydrocarbons are still present in the substratum a short distance upstream (Table 4.1, Spiltech u/s), this may be a possibility but is nevertheless unclear.

Table 4.3 ***In situ*** **measurements of physico-chemistry from the biomonitoring sites on 8th August 2018**

Site	Description	pH	EC (mSm)	Temp (^{0}C)	Dissolved Oxygen (mg/l)
Site 1	Middelwater	-	-	-	-
Site 2	Spiltech Camp – d/s pool	7.86	85.7	8.8	6.4
Site 3	Derde Tol Drif	-	-	-	-
Site 4	Ontploffings Drif	-	-	-	-
Site 5	Aalwyn Drif	7.25	8.4	9.8	10.1

Table 4.4 Water chemistry results taken from water samples collected at two biomonitoring sites on 8th August 2018

Site	Site Description	TDS (mg/l)	TSS (mg/l)	NO_3 - N (mg/l)	NO_2 - N (mg/l)	PO_4.P (mg/l)	COD (mg/l)	Tot. Oil & Grease (ppm)	$NH4^+$ + NH_3 [mg/l]	NH_3 - N [mg/l]	TIN (mg/l)
Site 1	Middelwater	-	-	-	-	-	-	-	-	-	-
Site 2	Spiltech	588	47	<0.13	0.007	0.006	67	5.5	0.095	0.001569	0.117
Site 3	Derde Tol Drif	-	-	-	-	-	-	-	-	-	-
Site 4	Ontploffings Drif	-	-	-	-	-	-	-	-	-	-
Site 5	Alwyns Drif	58.9	<20	<0.13	0.004	0.008	<10	7.5	0.063	0.000888	0.09

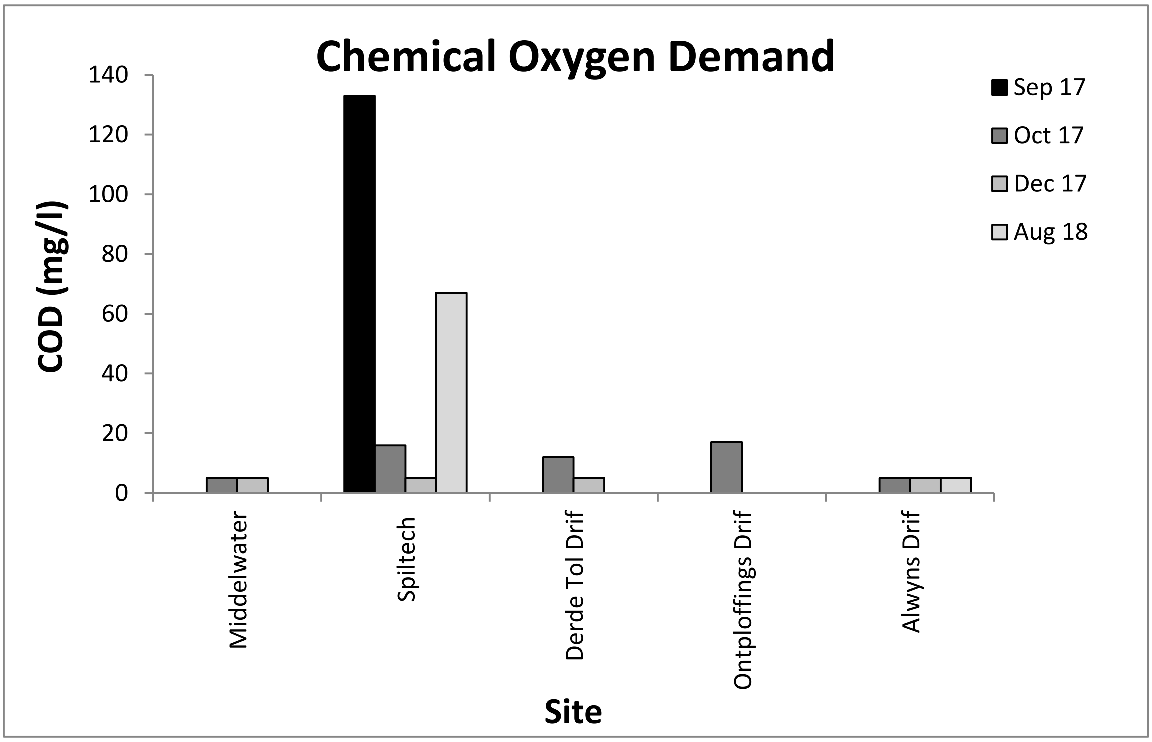

Figure 4.1 Chemical Oxygen Demand (COD) measured between September 2017 and August 2018.

In August 2018, Total Oils and Grease (TOG) were lower within the impact zone at Spiltech compared with that at the downstream control site (Aalwyns Drif) (Table 4.4 and Figure 4.2). These concentrations are below the United Nations Environmental Programme (UNEP 1992) maximum permissible limit of 10 ppm (or mg/l) for oils and thus the presence of soluble hydrocarbons in the water column at the time of sampling in August 2018 do not pose a risk to freshwater ecosystems. These concentrations are significantly lower than those measured at sites within the impact zone (Spiltech) and downstream as far as Aalwyns River in October 2017, although TOG concentrations were of insignificant concern by December 2017 (Figure 4.2)

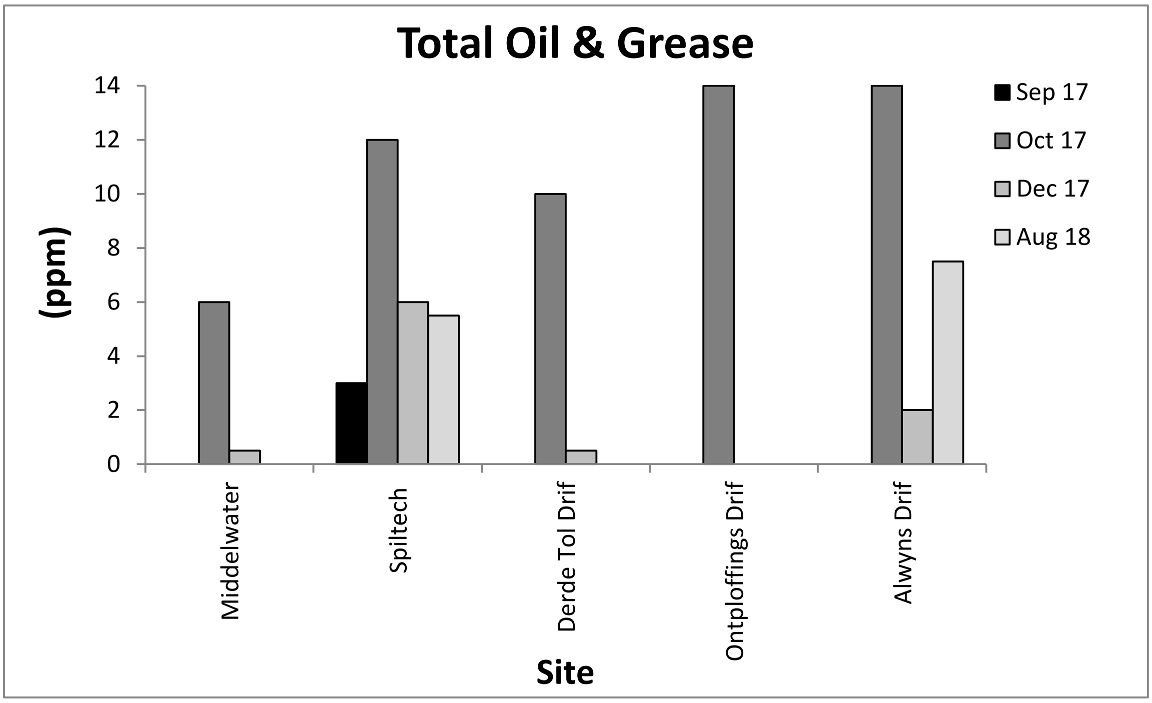

Figure 4.2 Total Oil and Grease measured between September 2017 and August 2018.

The nutrient data for the pool downstream of Spiltech Camp as well as at the control site (Aalwyn Drif) are indicative of a system that is oligotrophic and typical of unpolluted systems in terms of both nitrates and phosphates (Table 4.4). The orthophosphates are surprisingly low, compared with previous data collected and reported in the Baseline Report (Ewart-Smith 2017) and first Monitoring Report (Ewart-Smith and van der Walt 2018). By contrast, Total Inorganic Nitrogen (TIN) concentraions within the pool downstream of the Spiltech Camp site were considerbly higher but still within the oligotrophic range. This is not unexpected as the pool is isolated and it is evident that the area is heavily utilised by wildlife as a drinking hole. Nevertheless, both these data and that collected previously suggest that there is no apparent effect of the diesel spill or use of surfactants on the trophic status of the Meirings River.

4.3 Macroinvertebrate fauna

SASS and ASPT scores, as a measure of macroinvertebrate community condition, could only be calculated at the control site downstream (i.e. Site 5: Aalwyn Drif) because all other sites were either dry or reduced to standing pools. While the lack of macroinvertebrate data limited the assessment of recovery of the Meirings River since the diesel spill, a comparison of the SASS and ASPT scores at the control site provides some insight into the effects of the drought on the integrity of the community over the last year (Figure 4.3; Appendix A). Both SASS and ASPT scores at Aalwyn Drif were lower in December 2017 compared with September 2017 and by August 2018, these scores were indicative of a system that has experienced substantial impairment. Thus a general shift in ecosystem integrity at this site, considered to be largely unaffected by the diesel spill, provides an indication of the negative effects of the drought on this system that are independent of any effects of the diesel spill.

While SASS and ASPT scores could not be determined from macroinvertebrate samples collected at the isolated pool downstream of Site 2 (Spiltech Camp), a total of eleven families from this single biotope were recorded. A total of twelve families were recorded at this site in December 2017 showing considerable recovery since the September 2017. All biotopes, including riffles, runs, vegetation and fine sediments were however available at this time thus the presence of eleven taxa within only a standing pool as available habitat in August 2018 is considered relatively high. While most of these are hardy, tolerant taxa, the presence of water mites (Hydracarina) suggests relatively good water quality, despite the stressed conditions at the time of sampling in August 2018.

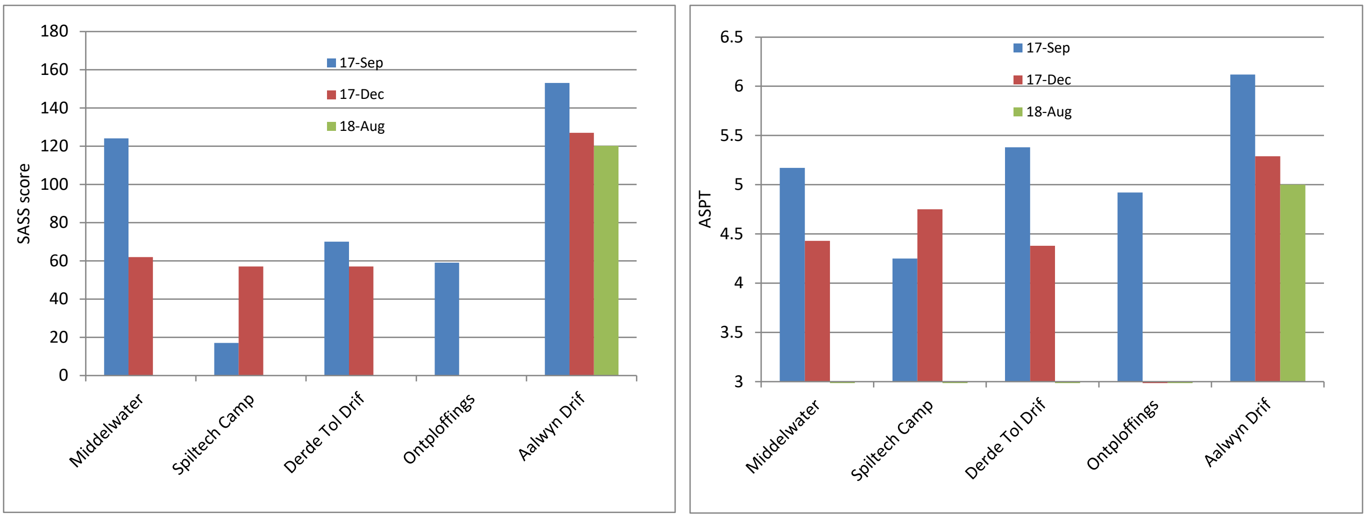

Figure 4.3 **SASS scores and ASPT values at Aalwyn Drif on August 2018, relative to values recorded in September 2017 and December 2017 indicate that the biota are significantly compromised by the current drought conditions within the Meirings River.**

4.4 General comments on site condition

There is no visual evidence of any adverse impacts to the wetbank marginal vegetation (mostly *Pseudoschoenus sp*.) that was coated with diesel fuel immediately following the spill within the impact zone (as far as Derde Tol Drif). *Pseudoschoenus* sp.was in full flower in October 2017 following the spill event and evidence of new buds present in August 2018 suggest that these plants will flower again this spring. The lack of high flow events that act to scour the active channel and maintain it free of vegetation has resulted in a clear invasion of the channel by wetbank plant species over the past year (Figure 4.4). The drought conditions, coupled with abstraction upstream therefore appear to have had a more detrimental effect on the biotic integrity of the channel compared with the effect of the diesel spill in the short term.

Figure 4.4 The lack of high flows over the past year has permitted wetbank vegetation (mostly *Pseudoschoenus* sp. to invade the active channel of the Meirings River)

Sandbags and pipes used in the mechanical clean-up operations within the impact zone of the Meirings River remain within the channel (Figure 4.5). It is recommended that these items, as a source of litter to the system be removed while the system is dry and easily accessible.

Figure 4.5 Sandbags and pipes used in the clean-up operations of the Meirings River following the diesel spill should be removed from the channel.

5 CONCLUSIONS AND RECOMMENDATIONS

Prevailing drought conditions in the Meiringspoort Area and the consequent lack of water at most sites during August 2018 limited the collection of biophysical and significantly curtailed an assessment of recovery following the oil spill a year prior to this survey. Nevertheless, comparison of the hydrocarbon concentrations collected periodically since the spill event in August 2017 indicates a positive recovery trajectory over the last year. Low concentrations of Diesel Range Organics in August 2018 were limited to the first few hundred meters downstream of the spill entry point into the Meirings River (i.e. as far as the upstream extent of site 2 (Spiltech Camp) and no surface slicks or deposits on the substratum were evident. Relatively high concentrations of DROs are however still present in the sand bank at the point of entry into the Meirings River. The possibility of mobilisation and recontamination of the system with hydrocarbons following high flow events is therefore still of some concern from an ecological perspective.

Interpretation of the water chemistry data, particularly the elevated COD concentrations and low dissolved oxygen levels in the pool downstream of site 2 (Spiltech Camp) was complicated by the drought conditions in August 2018 but suggest the possibility that these adverse conditions may be a response to the breakdown of hydrocarbons still present in the system.

The lack of macroinvertebrate data, as a consequence of prevailing drought conditions, limited the assessment of biotic recovery of the Meirings River since the diesel spill. Indeed, the results suggest that the macroinvertebrate communities and riparian vegetation are significantly impacted by the loss of habitat associated with the drought and exacerbated by upstream abstraction, rather than the effects of the spill.

Residual components such as sandbags and pipes used in the mechanical clean-up operation impact on habitat quality of the Meirings River as far down as Derde Tol Drif and thus it is recommended that they are removed from the system while drought conditions prevail and the area is easily accessible.

While there is little evidence in the system of ongoing impacts associated with the diesel spill one year after the event, the long-term adverse effects of so-called bioaccumulation of hydrocarbon contaminants to the aquatic ecosystem are yet unknown. As previously recommended therefore, fish monitoring should be extended over a minimum three year period as an annual survey so that reproductive success of the populations of redfin within the impact zone can be established.

6 REFERENCES

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APPENDIX A: INVERTEBRATE TAX RECORDED IN EACH SASS BIOTOPE AT THE BIOMONITORING SITES DURING DECEMBER 2017

A1: Site 2: SPILTECH

DATE:	08-Aug-18					SITE:	Spilltech
Habitat: includes muddy bottom of pool and aquatic vegetation							
ORDER	FAMILY	SENSITIVITY	VEG/GSM	ORDER	FAMILY	SENSITIVITY	VEG/GSM
PORIFERA		5		TRICHOPTERA	Dipseudopsidae	10	
COELENTERATA		1			Ecnomidae	8	
TURBELLARIA		3			Hydropsychidae 1 sp.	4	
ANNELIDA	Oligochaeta	1			Hydropsychidae 2 sp.	6	
	Leeches	3	1		Hydropsychidae >2 sp.	12	
CRUSTACEA	Amphipoda	13			Philopotamidae	10	
	Potamonautidae	3			Polycentropodidae	12	
	Atydiae	8			Psychomyiidae	8	
	Palaemonidae	10			Barbarochthonidae	13	
HYDRACARINA		8	A		Calamoceratidae	11	
PLECOPTERA	Notonemourdae	14			Glossosomatidae	11	
	Perlidae	12			Hydroptilidae	6	
EPHEMEROPTERA	Baetidae 1 sp.	4	B		Hydrosalpingidae	15	
	Baetidae 2 sp.	6			Lepidostomatidae	10	
	Baetidae > 2 sp.	12			Leptoceridae	6	
	Caenidae	6			Petrothrinicidae	11	
	Ephemeridae	15			Pisuliidae	10	
	Heptageniidae	13			Sericostomatidae	13	
	Leptophlebiidae	9		COLEOPTERA	Dytiscid	5	
	Oligneuridae	15			Elmidae	8	
	Polymitarcyidae	10			Gyrinidae	5	
	Prosopistomatidae	15			Haliplidae	5	
	Teloganodidae	12			Helodidae	12	
	Tricorythidae	9			Hydraenidae	8	
ODONATA	Calopterygidae	10			Hydrophilidae	5	A
	chlorocyphidae	10			Limnichidae	10	
	Chlorolestidae	8			Psephenidae	10	
	Coenagrionidae	4		DIPTERA	Athericidae	10	
	Lestidae	8			Blepharoceridae	15	
	Platycnemidae	10			Ceratopogonidae	5	A
	Protoneuridae	8			Chironomidae	2	B
	aeshnidae	8			Culicidae	1	1
	Corduliidae	8			Dixidae	10	
	Gomphidae	6			Empiddidae	6	
	Libellulidae	4	1		Ephydridae	3	
LEPIDOPTERA	Pyralidae	12			Muscidae	1	
HEMIPTERA	Belostomatidae	3			Psychodidae	1	
	Corixidae	3	B		Simulidae	5	
	Gerridae	5			Syrphidae	1	
	Hydrometridae	6			Tabanidae	5	
	Naucoridae	7			Tipulidae	5	
	Nepidae	3		GASTROPODA	Ancylidae	6	
	Notonectidiae	3	B		Bulininae	3	
	Pleidae	4			Hydrobiidae	3	
	Veliidae/Mesoveliidae	5			Lymnaeidae	3	
MEGALOPTERA	Corydalidae	8			Physidae	3	A
	Sialidae	6			Planorbidae	3	
					Thiaridae	3	
					Viviparidae	5	
				PELECPODA	Corbiculidae	5	
					Sphaeriidae	3	
					Unionidae	6	
				OSTRACODA			A
				Total number of families			**11**

A2: Site 5: ALWYNS DRIF

DATE: 08-Aug-18 **SITE:** Aalwyn Drif **ECOREGION:** SFM-Upper

ORDER	FAMILY	SENSITIVITY	STONES	VEG	GSM	Overall	ORDER	FAMILY	SENSITIVITY	STONES	VEG	GSM	Overall
			BIOTOPE							BIOTOPE			
PORIFERA		5					TRICHOPTERA	Dipseudopsidae	10				
COELENTERATA		1						Ecnomidae	8	A		1	A
TURBELLARIA		3						Hydropsychidae 1 sp.	4	A			A
ANNELIDA	Oligochaeta	1	1			1		Hydropsychidae 2 sp.	6				
	Leeches	3						Hydropsychidae >2 sp.	12				
CRUSTACEA	Amphipoda	13						Philopotamidae	10				
	Potamonautidae	3	A			A		Polycentropodidae	12				
	Atydiae	8						Psychomyiidae	8				
	Palaemonidae	10						Barbarochthonidae	13				
HYDRACARINA		8						Calamoceratidae	11				
PLECOPTERA	Notonemourdae	14						Glossosomatidae	11				
	Perlidae	12						Hydroptilidae	6				
EPHEMEROPTERA	Baetidae 1 sp.	4						Hydrosalpingidae	15				
	Baetidae 2 sp.	6			B			Lepidostomatidae	10				
	Baetidae > 2 sp.	12	B	B		B		Leptoceridae	6	1			1
	Caenidae	6	A		A	A		Petrothrinicidae	11				
	Ephemeridae	15						Pisuliidae	10				
	Heptageniidae	13						Sericostomatidae	13				
	Leptophlebiidae	9					COLEOPTERA	Dytiscid	5	A			A
	Oligneuridae	15						Elmidae	8				
	Polymitarcyidae	10						Gyrinidae	5				
	Prosopistomatidae	15						Haliplidae	5				
	Teloganodidae	12						Helodidae	12				
	Tricorythidae	9						Hydraenidae	8				
ODONATA	Calopterygidae	10						Hydrophilidae	5			A	A
	chlorocyphidae	10						Limnichidae	10				
	Chlorolestidae	8						Psephenidae	10				
	Coenagrionidae	4		A		A	DIPTERA	Athericidae	10				
	Lestidae	8						Blepharoceridae	15				
	Platycnemidae	10						Ceratopogonidae	5			A	A
	Protoneuridae	8						Chironomidae	2		1	A	A
	aeshnidae	8	A			A		Culicidae	1			1	1
	Corduliidae	8		1		1		Dixidae	10		A		A
	Gomphidae	6						Empiddidae	6				
	Libellulidae	4			1	1		Ephydridae	3				
LEPIDOPTERA	Pyralidae	12						Muscidae	1				
HEMIPTERA	Belostomatidae	3						Psychodidae	1				
	Corixidae	3		A	1	A		Simulidae	5	A	A	1	A
	Gerridae	5						Syrphidae	1				
	Hydrometridae	6						Tabanidae	5			1	1
	Naucoridae	7						Tipulidae	5				
	Nepidae	3					GASTROPODA	Ancylidae	6				
	Notonectidiae	3		1	A	A		Bulininae	3				
	Pleidae	4	A	1		A		Hydrobiidae	3				
	Veliidae/Mesoveliidae	5		A	1	A		Lymnaeidae	3		1		1
MEGALOPTERA	Corydalidae	8						Physidae	3				
	Sialidae	6						Planorbidae	3				
								Thiaridae	3				
								Viviparidae	5				
							PELECPODA	Corbiculidae	5				
								Sphaeriidae	3				
								Unionidae	6				
								SASS		**62**	**59**	**58**	**120**
								Total number of families		**11**	**11**	**13**	**24**
								ASPT		**5.64**	**5.36**	**4.46**	**5.00**