Draft Report on the Dust Deposition Monitoring Programme for Silvermines Area, County Tipperary

Period – March 1999 to December 2004

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DRAFT REPORT ON THE DUST DEPOSITION MONITORING PROGRAMME FOR SILVERMINES AREA COUNTY TIPPERARY – PERIOD MARCH 1999 TO DECEMBER 2004

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1. Introduction

1.1 Background

A dust deposition monitoring programme was established by North Tipperary County Council around the perimeter of the Gortmore tailings management facility (TMF) in March 1999, in response to local concerns regarding the potential for dust blows from the TMF. The primary objective of the dust deposition study was to assess the concentration of heavy metals in dust being deposition from the TMF. The establishment of the dust deposition monitoring programme coincided with the death of three cattle from lead poisoning on lands adjacent to the TMF. These events resulted in the activation of a protocol for collaboration between public agencies dealing with issues such as human and animal health and the environment. An Inter-Agency Group (IAG) chaired by the Department of Agriculture and Food, was established and given the task to conduct an investigation into the presence and influence of lead in the Silvermines area. The IAG report was published in June 2000 making thirty nine recommendations in relation to human health, animal health and the environment including the recommendation for remediation of the historic mine sites in the area (DAFRD, 2000). Recommendation number thirty one of the report stated that the dust deposition monitoring programme, funded by North Tipperary County Council with technical assistance provided by the Environmental Protection Agency (EPA), should continue until the risk of dust blow from the TMF is eliminated.

In May 2002, consultants Steffan, Robertson and Kirsten (SRK) who were contracted by the Department of Communications, Marine and Natural Resources (DCMNR) to develop management and rehabilitation plans for the Silvermines area presented their report to the Silvermines community. The report included detailed plans for the remediation of the Gortmore TMF to address the issues such as vegetation die-back on the surface of the TMF and the risk of dust generation. Since June 2002, the DCMNR has been pursuing Mogul of Ireland Limited under Clause K of their state mining lease to develop remediation plans and undertake remediation of the sites which they are responsible for to a standard equal or better than what was recommend in SRK report.

However, in August 2005 the Minister for Communications, Marine and Natural Resources announced that the Government had agreed to assume responsibility for the rehabilitation of the former sites. Until definitive remediation has taken place on the Gortmore TMF, the potential for dust generation continues, therefore there is a need for dust deposition monitoring to continue.

This report provides an assessment of the dust deposition monitoring programme for the period March 1999 to December 2004. The results are evaluated and recommendations are made in relation to these findings for the Gortmore TMF.

1.2 Methodology and design

The dust deposition monitoring programme began on 15 March 1999 at four locations, i.e., the four compass points North (Na), South (Sa), East (Ea) and West Wa), each within 10-15m of the base of the TMF (see map on page 3). The analysis

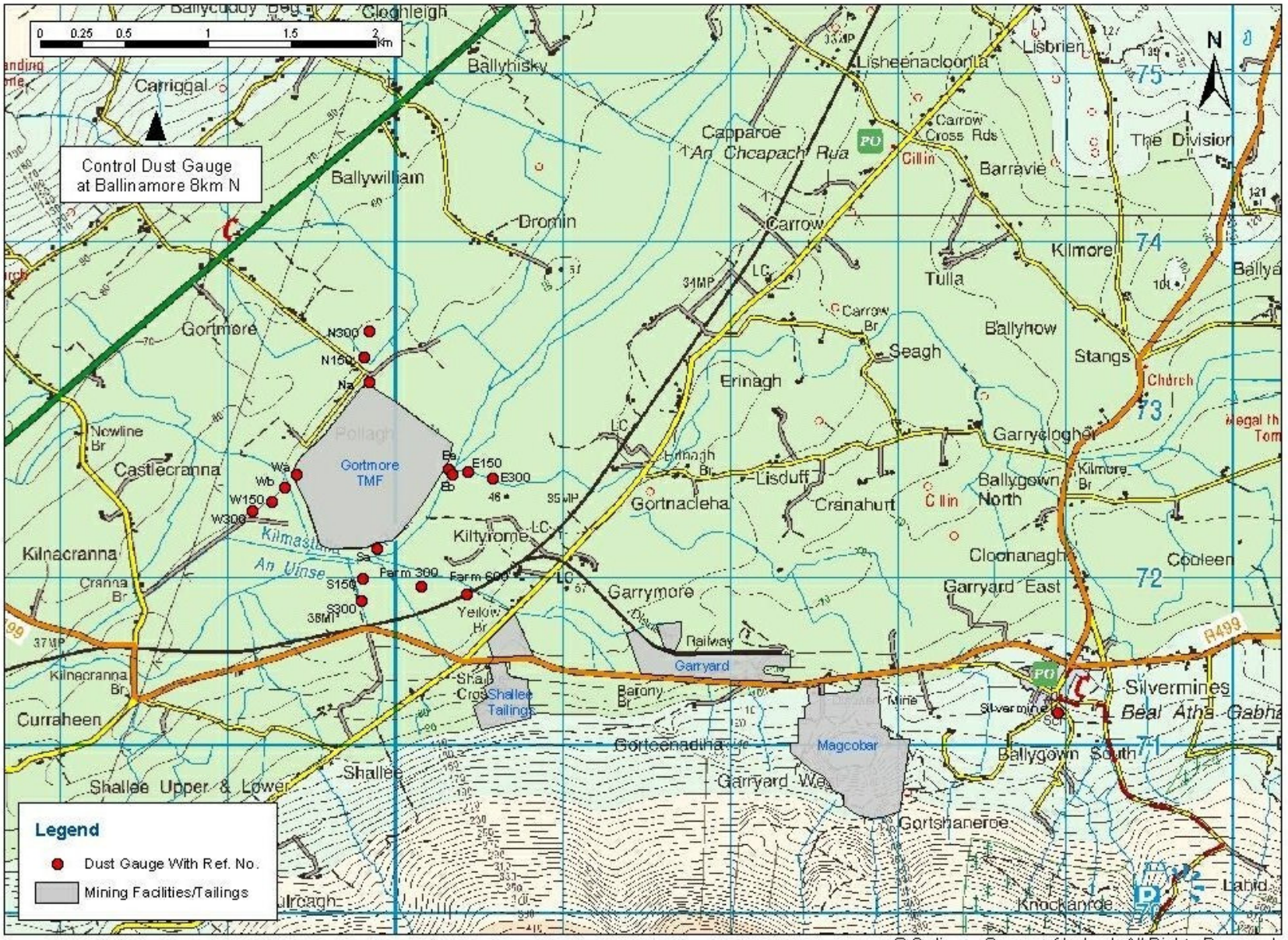
carried out on the dust samples collected is for total dust deposition reported in $mg/m^2/day$ and the concentration of heavy metals in the deposited dust in $\mu g/m^2/day$.

In order to assess the spatial spread as well as the occurrence of dust deposition, the monitoring programme was extended on 20 July 1999, with four gauges being located at 150m (i.e., N_{150}, S_{150}, E_{150}, W_{150}) and four at 300m (i.e., N_{300}, S_{300}, E_{300}, W_{300}) out on compass axis from the base of the TMF. On September 10, 1999 a further two gauges were added at distances of 300m and 600m (i.e., $Farm_{300}$, $Farm_{600}$) from the TMF on adjacent farmland. In October 1999, a control gauge was established eight kilometres north of the TMF in the townland of Ballinmoe. In January 2000, a gauge was also located at the national school in Silvermines. On 23 March 2001 an additional gauge was located 20 metres out from the gauge located at the base of the TMF (i.e., Ea) at the East boundary (Eb) and on the 13 December 2001 an additional gauge was located approx. 20 metres out from the base of the Wa gauge located on the western boundary (Wb). Sixteen gauges are now used to collect the dust being deposited from around the perimeter of the TMF, one at the Silvermines national school and one at a control site. Map 1 illustrates the location of the eighteen dust gauges located around the Silvermines area.

The gauges collect the dust fall in accordance with the German VDI method 2119 part 2:1972, i.e., Bergerhoff gauges. The Bergerhoff method is a well established international methodology used extensively to assess the potential toxic effects on soil and herbage from dust deposition. The Bergerhoff gauges collect dust that is deposited on a monthly basis and are sufficient to identify if any significant dust events have occurred during the monitoring period.

It is important to note that the current dust deposition programme does not measure lead concentrations in ambient air in relation to human health. The dust deposition monitoring programme was initiated due to concerns raised over potential risks to animal health where livestock graze fields adjacent to the TMF and to try an determine the area impacted by dust from the TMF. The TA Luft standards used to assess the significance of the quantity of dust and the concentration of heavy metals in the dust are derived to protect against the harmful effects of the deposition of air pollutants on the environment, including the protection against adverse soil alterations. The purpose of the German TA Luft limits for heavy metals is soil protection and therefore they cannot be used to assess the likely impacts on human health or human health protection. The issues of human health protection in relation to ambient dust is addressed in section five of this report.

It should also be noted that it is not possible with the Bergerhoff gauges to relate hourly wind data information with monthly deposition concentrations.


Control Dust Gauge at Ballinamore 8km N
0 0.25 0.5 1 1.5 2 Km
N
Legend
Dust Gauge With Ref. No.
Mining Facilities/Tailings
Gortmore TMF
Shallee Tailings
Magcobar
Garryard
Carriggal
Ballywilliam
Dromin
Capparoe
An Chcapach Rua
Carrow
Tulla
Kilmore
Ballyhow
Seagh
Erinagh
Stangs
Church
Garrycloghen
Lisduff
Gortnacleha
Cranahurt
Ballygown North
Kilnacranna
Kiltyrome
Garrymore
Garryard East
Cooleen
Cloonanagh
Silvermines
Beal Atha Gabha
Ballygown South
Curraheen
Shallee
Shallee Upper & Lower
Gortcenadiha
Garryard West
Gortshaneroe
Knockanroe
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Cranna Br
Kilnacranna Br
Carrow Br
Erinagh Br
Kilmore Br
Barony Br
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1.3 Standards used

There are no EU Air Quality Standards in existing or pending EU Directives, for dust deposition and its heavy metal concentration. However, in 1989, the Department of Environment recommended that local authorities adopt as a source of reference the German TA Luft Regulations (DoE, 1989). These were detailed in the German TA Luft Regulations of 1986 which set standards for protection against significant nuisances due to dust deposition and standards for concentration of heavy metals in dust deposition. Prior to October 2002, the standard for dust deposition was 350mg/m^2/day. The standard limit for concentration for lead was 250 µg/m^2/day, for cadmium was 5 µg/m^2/day and for thallium was 10 µg/m^2/day in deposited dust.

The German TA Luft Regulations were revised in October 2002. The standard for dust deposition remained at 350mg/m^2/day; however, new limit concentrations were set for lead, cadmium and thallium. In addition, the new TA Luft regulations specify limit concentrations for arsenic, nickel and mercury. The current TA Luft limits for dust deposition and for concentration of heavy metals in deposited dust is given in Table 1.1

Table 1.1 TA Luft limits for dustfall and heavy metals

Dustfall	**TA Luft Limits**
Dust deposition	350mg/m^2/day
Substance/Group of substances	**µg/m^2/day**
Arsenic and its inorganic compounds	4
Lead and its inorganic compounds	100
Cadmium and its inorganic compounds	2
Nickel and its inorganic compounds	15
Mercury and its inorganic compounds	1
Thallium and its inorganic compounds	2

During the assessment of the monitoring results for this report, it was felt that as the averaging period for the TA Luft limits for total dust and heavy metals in deposited dust is one year, a rolling twelve monthly average[1] should be calculated for each month which will then be compared against the TA Luft limit. To assist in the interpretation of the rolling annual exceedances reported on a monthly basis, the monthly average for a specific monitoring period was also assessed.

[1] The rolling annual exceedances for total dust deposition or heavy metals is calculated as follows - the monthly monitoring result is multiplied by the number of days for that period. This is then added to the previous eleven monthly monitoring results each multiplied by the number of days in each month, this sum is then divided by the total number of days for that 12 month period to give you a rolling annual exceedances for that specific month.

2. Monitoring results

2.1 Introduction

From March 1999 to December 2004, 67 monthly monitoring periods have been recorded, with a total of 1031 samples collected from the 18 Bergerhoff gauges located around the Gortmore TMF, at the Silvermines national school and at the control site. The total number of samples collected was influenced by the expansion of the programme over time, the Foot and Mouth crises that occurred from February 2001 until July 2001 which restricted access to farmlands and occasional problems with frost and accidental damage to the glass Bergerhoff gauges during manual handling for collection, transport and laboratory analyses.

For the purpose of this report the monitoring results will be dealt with under the following headings:

1) Results for total dust deposition rolling annual exceedances against the TA Luft annual limit of 350 mg/m^2/day; and
2) Results for rolling annual exceedances for heavy metals in deposited dust against TA Luft annual limits.

2.2 Total dust deposition

While analyses for the concentration of heavy metals in deposited dust commenced in March 1999, when the dust monitoring programme was established, analyses for total dust did not commence until February 2001. Since then, a total of 619 samples have been taken during this period and analysed for total dust. The TA Luft limit for dust deposition is 350 mg/m^2/day and it is set to protect against significant nuisances or disadvantages due to physical dustfall. The averaging period for the TA Luft limit for dust deposition is one year.

2.2.1 Total dust rolling annual exceedances

The TA Luft limit for total dust calculated on rolling annual basis for the monitoring period February 2001 to December 2004 was exceeded eighty six times which represents an exceedances rate of fourteen percent for all samples collected and analysed for total dust (i.e., 619). Table 2.1 provides a summary of the number and location of the exceedances for total dustfall.

Table 2.1 Summary of rolling annual exceedances for total dust deposition

Gauge	Total dust deposition
TA Luft limit	350 mg/m^2/day
Sa	13
Ea	13
Na	12
Wa	12
North 150	12
East boundary	12
East 300	12
North 300	0
South 150	0
South 300	0
East 150	0

Gauge	Total dust deposition
West boundary	0
West 150	0
West 300	0
Farm 300	0
Farm 600	0
School	0
Control	0
Total	86

Seventy two percent of the exceedances (62 out of 86) occurred in gauges located adjacent to the perimeter of the TMF, i.e., North (Na), South (Sa), East (Ea), E boundary (Eb) and West (Wa). This demonstrates that dust deposition is generally very localised and occurs at or within 10 metres of the TMF, however there are exceptions to this with the remaining exceedances, i.e., 28 percent being recorded in gauge N150 and E300.

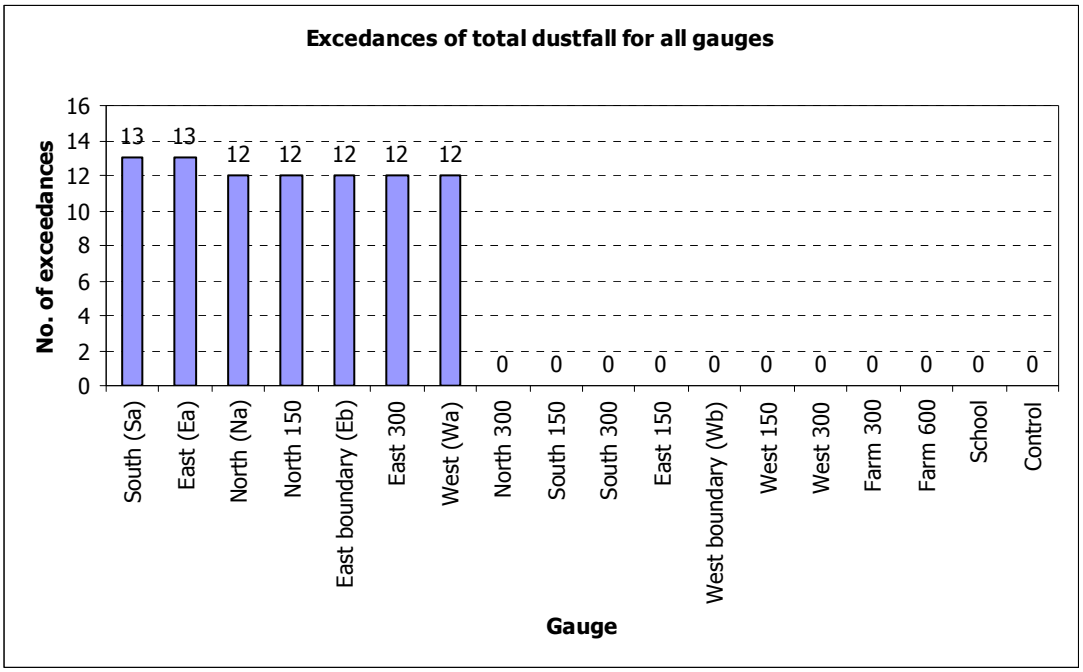

Figure 2.1 Exceedances recorded for total dustfall for all gauges

2.3 Heavy metal deposition

The dust which is collected in the Bergerhoff gauges is analysed for 26 parameters, including heavy metals which are then compared against the TA Luft limits for heavy metals in deposited dust. A total of 1031 samples were collected and analysed for heavy metals in the period March 1999 to December 2004.

2.3.1 Heavy metal rolling annual exceedances

The rolling annual exceedances for TA Luft limits for the heavy metals lead, cadmium, thallium, nickel and arsenic were exceeded a total of 159 times during the

period March 1999 to December 2004. Table 2.2 provides a summary of the results which also ranks the gauges according to the number of rolling annual exceedances recorded per gauge. With 1031 samples being collected during this period, the rolling annual exceedances for heavy metals results in a fifteen percent exceedance rate over the monitoring period. The TA Luft limit for arsenic is exceeded most frequently, followed by lead, with only a few exceedances being recorded for the other metals, i.e., thallium, cadmium and nickel.

Table 2.2 Summary of heavy metal rolling annual exceedances

TA Luft limit	100ug/m^2/d	2 ug/m^2/d	2 ug/m^2/d	15 ug/m^2/d	4 ug/m^2/d	Total no. of exceedances
	Lead	Cadmium	Thallium	Nickel	Arsenic	
East (Ea)	36	0	6	0	37	79
West (Wa)	12	3	3	3	43	64
North	0	0	0	0	7	7
West 300	0	0	0	0	5	5
South 300	0	4	0	0	0	4
North 150	0	0	0	0	0	0
North 300	0	0	0	0	0	0
South (Sa)	0	0	0	0	0	0
South 150	0	0	0	0	0	0
E boundary (Eb)	0	0	0	0	0	0
East 150	0	0	0	0	0	0
East 300	0	0	0	0	0	0
W boundary (Wb)	0	0	0	0	0	0
West 150	0	0	0	0	0	0
Farm 300	0	0	0	0	0	0
Farm 600	0	0	0	0	0	0
School	0	0	0	0	0	0
Control	0	0	0	0	0	0
Total for metals	48	7	9	3	92	159

The gauge at which most exceedances were recorded was Ea recording 79 exceedances followed by Wa where 64 exceedances were recorded. There is then a dramatic fall off in exceedances, with 7 exceedances at Na, 5 at West 300and 4 exceedances at South 300. No exceedances were recorded at the remaining gauges. Figure 2.2 illustrates the gauges where the TA Luft limit for the metals lead, cadmium, thallium, nickel and arsenic were exceeded on a rolling annual basis.

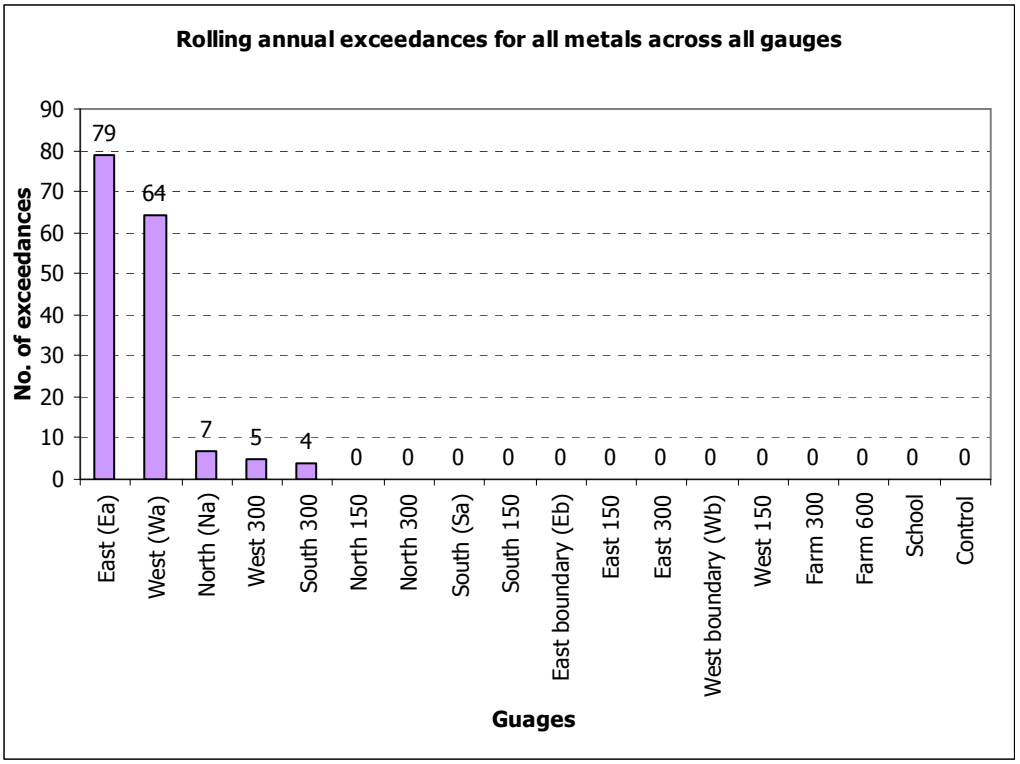

Figure 2.2 Rolling annual exceedances for all metals across all gauges

The most significant gauges in relation to exceedances of the TA Luft limits for metals in deposited dust are gauges East (Ea) and West (Wa). Exceedances for total dustfall were also recorded at these gauges, 13 exceedances at gauge Ea, and 12 exceedances at gauge Wa. Twelve exceedances were also recorded at gauge Na. No exceedances for total dustfall were recorded at gauges W300 and the S300. There appears to be a weak correlation between the total dustfall recorded and the quantity of metals contained in it. For example, exceedances for total dustfall were recorded at gauges Eb, N150 and E300 without recording any exceedances of the TA Luft limits for heavy metal in deposited dust. Conversely, exceedances for heavy metals were recorded at gauges W300 and S300 but there was no exceedances for total dustfall. This anomaly could be explained however by the fact that tailings and mine wastes are heterogeneous in nature and their chemical and physical properties can vary significantly both vertically and horizontally within a very small volume of material. The Gortmore TMF was also operational from 1968 to 1982 during which ore processing operations may have changed resulting in variations in the chemical and physical properties of tailings, e.g., tailings ranging from fine to coarse sand-sized, improved efficiencies in processing techniques resulting in increased metal recovery rates etc. Figure 2.3 provides a breakdown of the number of exceedances recorded for each metal for each gauge.

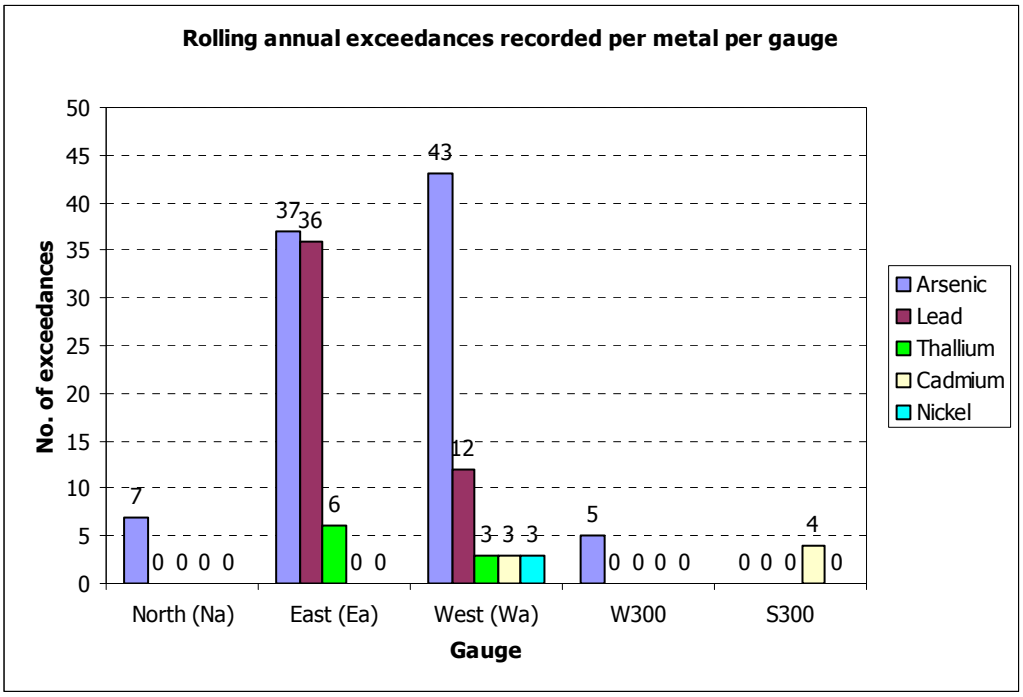

Figure 2.3 Number of rolling annual exceedances per metal per gauge

Ninety four percent or 150 of total 159 exceedances were recorded in the gauges immediately adjacent to the TMF, with a further 6 percent recorded at gauges West 300 and South 300. The rolling annual heavy metal exceedance results demonstrate the very localised nature of the dust deposition around the perimeter of the TMF at Gortmore. The range of heavy metal concentrations in the tailings can explain why certain gauges record exceedances for one metal more than another metal, e.g. prevalence of arsenic exceedances at gauge Wa. The Ea gauge had roughly the same number of exceedances for lead and arsenic while the Wa gauge had significantly more exceedances for arsenic than for lead. The extent of the vegetation cover across the surface of the TMF also influences the amount of dust being generated and captured in the Bergerhoff gauges.

The various sampling programmes undertaken of the tailings to characterise their chemical and physical properties indicate that the concentration of heavy metals is high, particularly for lead, zinc and arsenic. The tailings at the Gortmore TMF has been sampled and analysed for heavy metals as part of the work of the Inter-Agency Group investigation (DAFRD, 2000), during work undertaken by SRK in the preparation of their report on the *Management and Rehabilitation of the Silvermines area* (SRK, 2002) and by Mogul of Ireland Limited (Mogul, 2004) in their report *Clause K – remediation design report for the Garryard and Gortmore Sites, Silvermines, Co. Tipperary*. A summary of the results from tailings samples taken from the Gortmore TMF is provided in Table 2.3.

Table 2.3 Summary of concentration of heavy metals in tailings sampled at Gortmore TMF

Source	Sample No.	Lead	Arsenic	Cadmium	[1]Thallium	[2]Nickel
[3]IAG	8	2609	124	6.88		
	10	9680	552	23.52		
	12	8210	425	30.88		
	61	3288	156	12.37		
	9/78	10380	800	33.71		
	11/79	11420	1060	46.48		
	96	5400	110	1.48		
	97	15540	192	1.92		
[4]SRK	Gort 19	6162	395	24		11
	Gort 20	8396	650	36		51
	Gort 22a	14615	865	14		8
	Gort 22b	12276	790	13		4
	Gort 30	11769	835	12		<1
	Gort 31	15395	501	19		<1
	Gort 32	14417	974	22		<1
	Gort 33	8183	626	9		<1
	Gort 34	8086	625	10		<1
[5]Mogul	TMF1	8676	590	36	<38	46
	TMF2	12375	939	13	52	24
	TMF3	6467	810	18	59	76
	TMF4	7956	1083	36	31	57
	TMF5	5815	717	22	61	56
	TMF6	10313	928	36	71	78
	TMF7	11831	1205	7	99	48
	TMF8	19703	1146	26	118	58
	TMF9	11123	543	21	38	54
	TMF10	9727	2464	13	82	46
	TMF11	7248	747	45	52	77

The high concentration of lead and arsenic in the tailings is reflected in the dust being captured by the dust deposition monitoring programme which is resulting in the TA Luft limit for arsenic (4ug/m^2/day) and lead (100ug/m^2/day) being exceeded most frequently. The higher number of exceedances for arsenic recorded at the Wa gauge is probably due to a higher concentration of arsenic in the tailings in that area.

2.4 Dust deposition trends over time

A review of the dust deposition results from March 1999 to December 2004 on an annual basis was undertaken to try to establish if the amount of dust being generated is increasing or decreasing over time.

Figure 2.4 illustrates the rolling annual exceedances for total dustfall on a year by year basis. Exceedances for total dust fall creating a nuisance were recorded in seven

[1] Thallium was not analysed or reported in the IAG and SRK reports
[2] Nickel not analysed for IAG investigations
[3] Teagasc, 1999 – 0-10 cm depth, Aqua Regia, atomic adsorption spectrometry.
[4] SRK – samples taken from 0.1 to 0.25 metres depth. Aqua Regia, ICP.
[5] Aqua Regia ICP

gauges, i.e., Na, N150, Sa, Ea, Eb, E300 and Wa. It would appear from the graph that the number of exceedances peaked for the years 2001 and 2002 with a dramatic falloff since then. There were no exceedances for total dust deposition in 2003 or 2004.

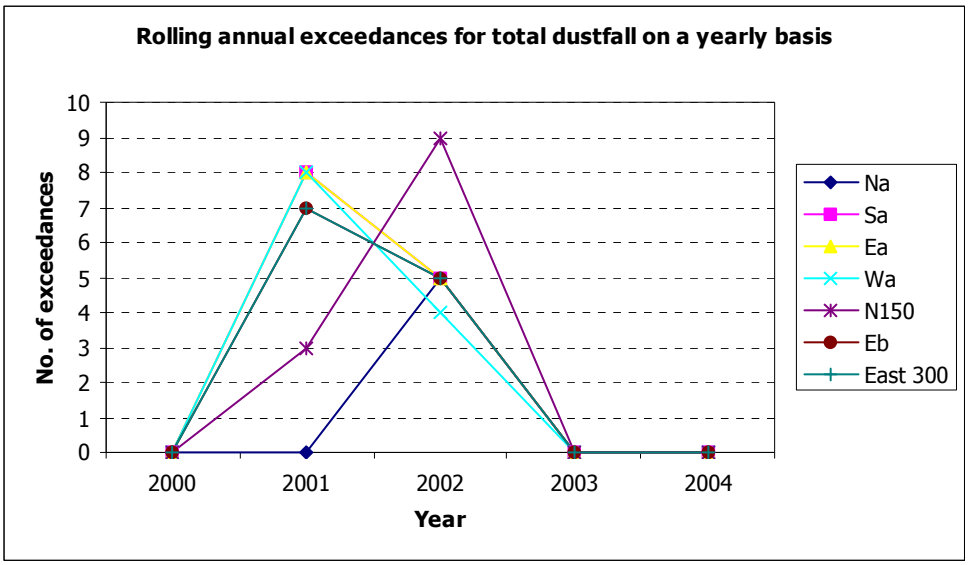

Figure 2.4 Rolling annual exceedances for total dust on a yearly basis

Figure 2.5 illustrates the rolling annual exceedances for all metals on a year by year basis. There appears to be a downward trend in the number of rolling exceedances for the gauges Wa, Na, W300, S300, with no exceedances recorded for Sa. The exception to this downward trend is in relation to gauge Ea where the number of rolling annual exceedances has increased consistently since 2001. This can be partially explained by a few monitoring periods which recorded significant concentrations of metals in the dust deposited which resulted in the TA Luft limits for lead and arsenic being exceeded for a substantial number of consecutive monitoring periods.

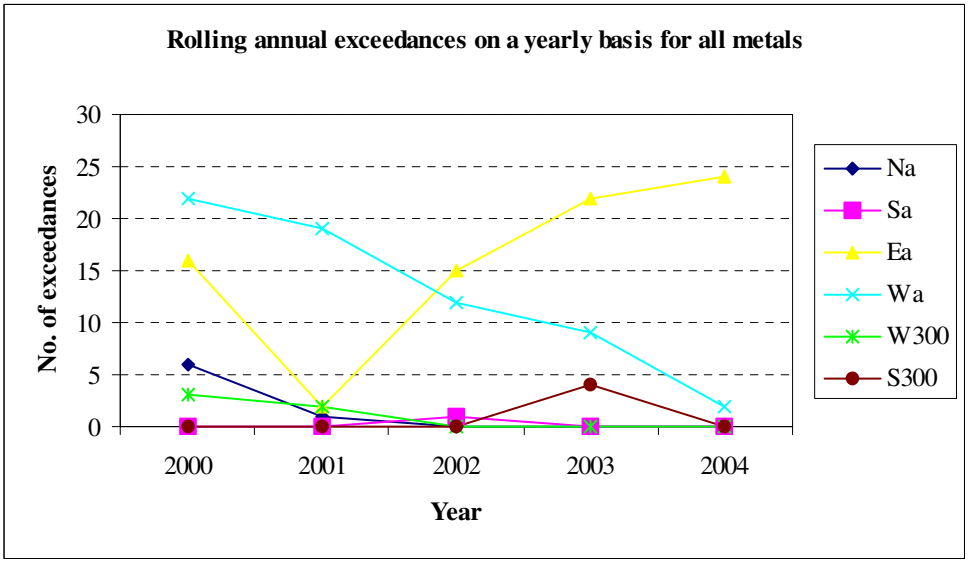

Figure 2.5 Rolling annual exceedances on a yearly basis for all metals

The increase in the number of exceedances at the Ea gauge is of concern. Unlike the general downward trend, the number of exceedances for heavy metals is increasing. The reason for the increases can be seen in Table 2.4 which shows the occurrence of significant heavy metal deposition events during specific monitoring periods, in particular April 2002 to March 2004. As the method of calculation is a rolling twelve monthly average, a high concentration of heavy metals recorded for a specific period such as that for lead in March-April 2004 will continue to influence the number of exceedances going forward.

Table 2.4 Summary of significant heavy metal monthly exceedances for Gauge Ea

Gauge	Monitoring Period	Lead – 100 ug/m^2/day	Arsenic – 4 ug/m^2/day
East	26/11/99 - 30/12/99	240.39	12.49
	28/01/00 – 29/02/00	669.25	40.46
	08/04/02 – 08/05/02	731.81	44.88
	05/11/02 – 06/12/02	561	24.20
	08/03/04 – 08/04/04	2246.17	107.38
	08/06/04 – 06/07/04	394.14	23.49

3. Discussion

3.1 Interpretation and purpose of the dust monitoring programme

The dust deposition monitoring programme has been running since March 1999 and continues to date. It is important to re-emphasise that the dust deposition monitoring programme was originally established to try to delineate the extent of potential dustfall onto surrounding agricultural land to assess the potential risk to livestock grazing agricultural land adjacent to the perimeter of the TMF. The TA Luft limit of dustfall of 350mg/m^2/day is to protect against significant nuisances or significant disadvantages due to dustfall and this is ensured if the total dustfall is below 350mg/m^2/day. The TA Luft limits for the heavy metals is to protect against the harmful effects of the deposition of air pollutants on the environment, including the protection against adverse soil alterations. The TA Luft limits are not based on the protection of human health. The absence of ambient dust monitoring is addressed under the section on recommendations. To assist with the interpretation of the dust deposition monitoring programme and the writing of the report, a site visit to each gauge was undertaken in July 2005.

3.2 Total dustfall

In relation to total dustfall, exceedances of the TA Luft limit of 350mg/m^2/day have been recorded at seven gauges. Total dustfall from the TMF is creating a nuisance in the vicinity of gauges Na, Sa, Ea, Eb, Wa, N150 and E300. The location of the gauges would indicate that the dustfall is very localised, which would indicate that the dustfall occurs either very close to the base of the TMF or within 10 to 15 metres of the base of the TMF but within the site boundary. There are exceptions to this general trend with exceedances being recorded at gauges N150 and E300. In relation to N150, the gauge is located in a grassland field with tall vegetation growing between the gauge and the TMF. There were no other apparent sources of dust in the area, e.g., bare soils etc. In relation to E300, the surface and in particular the perimeter of the embankment wall are bare with little or no vegetation cover. The exceedance of the TA Luft for total dust at E300 is probably due to the lack of vegetation cover on the surface and the perimeter and the prevailing winds are from generally from a south westerly direction. It is important to state however, the while the total dust is exceeded, the TA Luft limits for heavy metals have not been exceeded at either N150 or E300.

It would appear from an assessment of total dustfall on a yearly basis that the number of exceedances per year is declining. There were no exceedances of the TA Luft limit for total dustfall in 2003 or 2004. The reason for the decline in the number of exceedances is unclear however, gorse invasion around the Ballywilliam area to the NW of the TMF and along the north-western boundary towards the southwest toe will have reduced the amount of dust being generated and blowing off from this side of the TMF. This area (Ballywilliam and perimeter road) along with a section on the south eastern side was covered with a poor quality gravely till in 1999 and 2000 by Mogul of Ireland Limited. This has became colonised by gorse in the intervening years. The gorse will be particularly effective in reducing the amount of dust leaving the surface of the TMF, particularly as the crests of tailings dam slopes, have been identified as a major source of dust when dams are not vegetated (SRK, 2002). Figure 3.1 shows a

photograph taken along the north-west boundary of the TMF where imported gravel till has been colonised by gorse and this has spread across the surface of the TMF and along the crest of the dam wall.

Figure 3.1 Gorse invasion on surface of TMF along north-west boundary

3.3 Heavy metal deposition

In relation to heavy metal deposition, the TA Luft limits for heavy metals and in particular for arsenic and lead are being exceeded at 5 gauges. The limits for lead, arsenic, cadmium, thallium and nickel have been exceeded 158 times during the period March 1999 to December 2004. This results in a fifteen percent exceedance rate which is of concern. The monitoring programme recorded 92 exceedances for arsenic, 48 for lead, 9 for thallium, 7 for cadmium and 3 for nickel. The greatest number of exceedances were recorded at gauges Ea and Wa for heavy metals in deposited dust. Figure 3.2 shows a photograph of the Ea gauge looking towards the TMF embankment. The photograph shows the exposed nature of the embankment along this side of the TMF. This would explain the reason for the greatest number of exceedances bring recorded at the Ea gauge. In relation to Wa while the surface of the TMF appears to be reasonably well vegetated, the embankment of the TMF in this location has no vegetative cover which could explain the number of exceedances occurring at this location. Figure 3.3 shows a photograph taken beside Wa, looking upwards towards the embankment wall of the TMF.

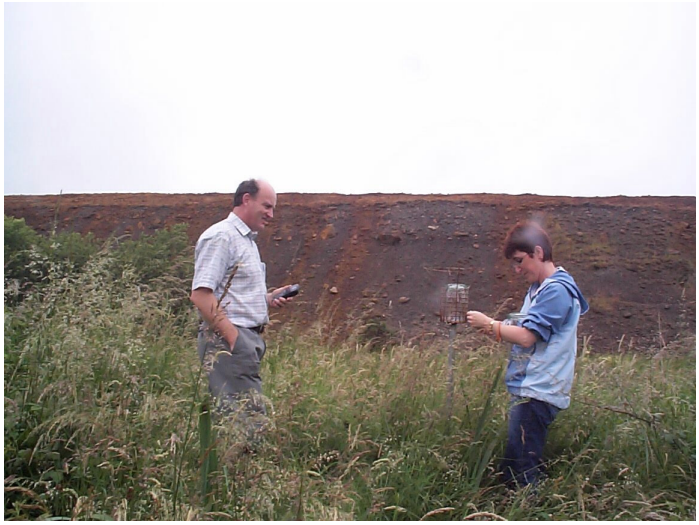

Figure 3.2 Gauge Ea, with view of embankment in background

Figure 3.3 Gauge Wa looking towards embankment of TMF

The spatial distribution of the heavy metal deposition is however very localised. This is demonstrated clearly in that the greatest number of exceedances were recorded at gauges Ea and Wa whilst gauges Eb and Wb which are located approximately 40-50 metres out from gauges Ea and Wa at the base, did not record any exceedances for heavy metals. In addition, the gauges located 150 metres out in the same direction, i.e., E150 and W150 similarly did not record any exceedances. There are however, exceptions to this trend with five exceedances for arsenic being recorded at W300 c and four exceedances for cadmium being recorded at gauge S300. The reason for these exceedances is not clear. From visual inspection of the W300, there is little to no tall vegetation occurring between the gauge and the TMF, thereby increasing the risk of dust carrying as far as the gauge. However, the TMF has a reasonable vegetation cover at the west/south boundary area. In relation to S300, there is plenty of vegetation cover in the form of hedges etc between the gauge and the TMF and there is no visible evidence of another source of tailings here, e.g., Shallee tailings, road dust etc. Whilst the spatial deposition is largely confined to within the boundary of the TMF, these exceedances are of concern.

The assessment of heavy metal deposition on a year to year basis has indicated that the number of exceedances for those gauges where exceedances have been recorded, i.e., Na, Wa, W300 and S300 are declining however, this is not the case for the Ea gauge. The number of rolling annual exceedances for the Ea gauge is increasing however, the heavy metal exceedances are very localised with Eb recording no exceedances for heavy metals in deposited dust. Once again, whilst the exceedances appear to be very localised, they are of concern. The surface and perimeter of the TMF at and around the location of the E gauge is very bare and therefore prone to dust generation and dispersion. Figure 3.4, Figure 3.5 and Figure 3.6 show photographs taken in July 2005 of the east perimeter of the TMF looking south. The tailings are exposed with very little vegetative cover. These photographs were taken on the surface of the TMF above the location of the Ea and Eb gauges.

Figure 3.4 Photograph of the east boundary of the TMF looking south

Figure 3.5 Photograph of surface of TMF above East gauge

Figure 3.6 View of east embankment from E150 gauge location looking towards Ea and Eb gauges

4. Conclusions

The dust deposition monitoring programme for the Silvermines area was established in March 1999. This report, which covers an assessment of the results for the period from March 1999 to December 2004, has shown that for:

4.1 Total Dustfall

- 619 samples have been collected and analysed for total dustfall.
- the TA Luft limit of 350mg/m^2/day was exceeded 86 times, which represents an exceedance rate of 14%.
- 72% of the exceedances occurred at gauges located on or close to the base of the TMF, i.e., Na, Sa, Ea, Wa, Eb.
- Exceedances were recorded at:
    - Sa 13
    - Ea 13
    - Na 12
    - Wa 12
    - N150 12
    - Eb 12
    - E300 12

4.2 Heavy metal deposition

- 1031 samples were collected and analysed for heavy metals.
- TA Luft limits for lead, cadmium, thallium, nickel and arsenic were exceeded 159 times, which represents an exceedance rate of 15%.
- Exceedances were recorded at:
    - Ea 79
    - Wa 64
    - Na 7
    - W300 5
    - S300 4
- 50% of the exceedances for heavy metals in deposited dust was recorded at gauge Ea.
- 40% of the exceedances for heavy metals in deposited dust were recorded in gauge Wa.
- Exceedances recorded for each heavy metal were:
    - Arsenic 92
    - Lead 48
    - Thallium 9
    - Cadmium 7
    - Nickel 3

4.3 Spatial distribution

The majority of exceedances recorded for total dustfall and heavy metals occurred at gauges located on or close to the base of the Gortmore TMF. The two gauges recording the most exceedances for the metals lead and arsenic were Ea and Wa.

4.4 Dust deposition trends over time

The number of exceedances for total dustfall has reduced significantly for all gauges since 2002. There appears to be a downward trend in the number of exceedances for heavy metals in all gauges recording exceedances, except for gauge Ea. The number of heavy metals exceedances for gauge Ea has increased consistently since 2001. This can be explained by a few monitoring periods which recorded significant concentrations of heavy metals and by the lack of vegetation cover on the surface and embankment wall of the TMF at this location.

5. Recommendations

1. The dust deposition monitoring programme should continue to operate during, and for a short period after, the remediation works are completed. This will help monitor the effectiveness of dust abatement measures implemented during the remediation works. It will also help test the effectiveness of the remedial measures and works undertaken to prevent dust generation in the future.

2. Selective chemical fertilisation of the surface of the TMF should be undertaken on an annual basis to ensure that a vegetative cover is maintained across as much of the surface area as possible of the TMF. The fertiliser and post remediation management requirements of the TMF will need to need to be considered as part of the remediation works scheduled for the area.

3. The TA Luft limits used in assessing the dust deposition programme are derived for determination of nuisance, and for the protection of soils. The current monitoring programme does not evaluate the potential impact of dust generation and dispersion in relation to human health. The EPA recommends that the Health Service Executive Mid-Western Area and North Tipperary County Council should consider undertaking ambient dust monitoring for particulate matter (PM^{10}), lead and other metals[1] during remediation works at the Gortmore TMF.

[1] EU Council Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air and Directive 2004/107 EC of the European Parliament and the Council relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air outline the methodology and provide limit values (24 hour and one calendar year) for the protection of human health for PM_{10}, lead, arsenic, cadmium, mercury and nickel. The methodology used for sampling requires air to be actively pumped through a filter which is then removed, weighted and digested in the laboratory. The digestate is then analysed for heavy metals.

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