

CHAPTER 6

Site Scores

6.1 Classification system

The classification system devised from the HMS-IRC scoring system is based on an analysis of the scores of all the sites. Natural breaks analysis was performed within ArcGIS on the total site score for all 27 sites and districts. The number of classes chosen was five. The actual numbers chosen for the break points between classes was adjusted to the nearest 100. This did not change the classification of any site. The natural breaks out of the values are 100, 300, 1,000 and 2,000 resulting in five classes, as follows:

- <100
- 100–300
- 300–1,000
- 1,000–2,000
- >2,000

Descriptions of the various classes are given in Table 6.1.

Class	Score	Description
I	>2,000	Sites that should have a full risk assessment carried out. These sites should be monitored on an ongoing basis.
II	1,000–2,000	Sites requiring general monitoring of most or all waste piles, discharges or stream sediments on an annual basis.
III	300–1,000	Sites requiring general monitoring of most or all waste piles, discharges or stream sediments on a biennial basis.
IV	100–300	Sites requiring specific monitoring on particular waste piles, discharges or stream sediments on a five-yearly basis.
V	<100	Sites generally not requiring any specific monitoring.

Table 6.1 HMS-IRC scoring system – site score classes.

6.2 Classification of sites

Table 6.2 shows the classification of the sites scored in the HMS-IRC project. Of the 27 sites scored, three are assigned to Class I (11%), one to Class II (4%), two to Class III (7%), four to Class IV (15%) and 17 to Class V (63%). Figure 6.1 shows the distribution of the classified sites.

6.2.1 Class I sites

The three sites assigned to Class I are Tynagh, Silvermines and Avoca. The final scores for each of the three sites are similar (Tynagh – 2,712; Silvermines – 2,545; and Avoca – 2,439). All three mines operated as mechanised mines in the latter part of the 20th century, although both Silvermines and Avoca have a long history of production. All three mines have large tailings impoundments and significant waste rock piles. Both Tynagh and Silvermines produced Zn and Pb sulphides from Carboniferous limestones while Cu and pyrite was produced from the Avoca deposit, which was hosted primarily in volcanic rocks.

6.2.2 Class II sites

Glendalough–Glendasan is the single site assigned to Class II. The score for the site is 1,122 – significantly different than the scores in Class I sites – less than half their scores – and Class III sites – approximately double the top scoring site in Class III. Glendalough–Glendasan was primarily worked in the 19th century but operations did continue intermittently into the 20th century when the mine finally closed in 1957. The mine mainly worked Pb sulphide and tailings were generated in the 20th century operation and deposited in a non-engineering pile beside the Glendasan River.

6.2.3 Class III sites

The two sites assigned to Class III are Caim and Glenmalure. The score for Caim is 559 while that for Glenmalure is 335. Both were Pb veins, with the Glenmalure site similar to the Class II Glendalough–Glendasan site. At Glenmalure, Pb was worked from a Pb vein associated with the Leinster Granite. There are significant waste piles at each site which do not support vegetation and which contain elevated levels of lead. At Caim there is a large unvegetated waste pile with elevated Pb levels.

Mine / District	No. of Sites	Hazard	Groundwater	Surface water	Air	Direct Contact	Direct Contact (Stream Sediments)	Total Score	Class
Tynagh	4	9,772	1,239	1,294	60	82	37	2,712	I
Silvermines	6	6,565	701	1,133	64	351	296	2,545	I
Avoca	7	5,009	1,102	1,114	19	161	42	2,438	I
Glendalough/Glendasan	8	3,795	185	491	13	87	345	1,122	II
Caim	1	1,204	126	295	2	45	91	559	III
Glenmalure	2	1,944	76	214	3	19	24	335	III
Ballycorus	1	371	96	35	5	79	29	244	IV
Gortdrum	1	612	24	69	7	35	22	157	IV
Leinster Coalfield	7	389	58	69	0	2	3	133	IV
Slieve Ardagh Coalfield	10	451	36	41	0	1	37	118	IV
Clements (Connemara Pb)	1	292	19	69	0	0	9	97	V
Connacht Coalfield	7	342	19	70	0	1	0	91	V
Kilbricken (Clare Pb)	1	158	29	47	0	12	0	89	V
Allihies	6	245	22	32	0	0	22	76	V
Abbeytown	1	156	32	31	1	6	n/a	70	V
Tassan (Monaghan Pb)	1	199	16	1	0	1	26	44	V
Ballyvergin (Clare Pb)	1	115	18	24	0	1	n/a	43	V
Ballyhickey (Clare Pb)	1	80	13	0	0	6	n/a	19	V
Keeldrum (Donegal Pb)	1	74	6	11	0	0	n/a	17	V
West Cork Cu-Ba	8	154	7	7	0	0	4	17	V
Clare Phosphate (Doolin)	1	83	6	9	0	0	0	15	V
Bunmahon	1	48	5	9	0	0	0	14	V
Hope (Monaghan Pb)	1	43	13	0	0	1	n/a	13	V
Clontibret (Monaghan Pb)	1	60	n/a	n/a	n/a	n/a	12	12	V
Glentogher (Donegal Pb)	1	24	0	1	n/a	n/a	4	5	V
Benbulbin	1	34	4	0	0	0	n/a	5	V
Hollyford (Tipperary Minor Cu)	1	11	1	3	0	0	n/a	4	V

Table 6.2 Site score for Historic Mine Sites in Ireland.

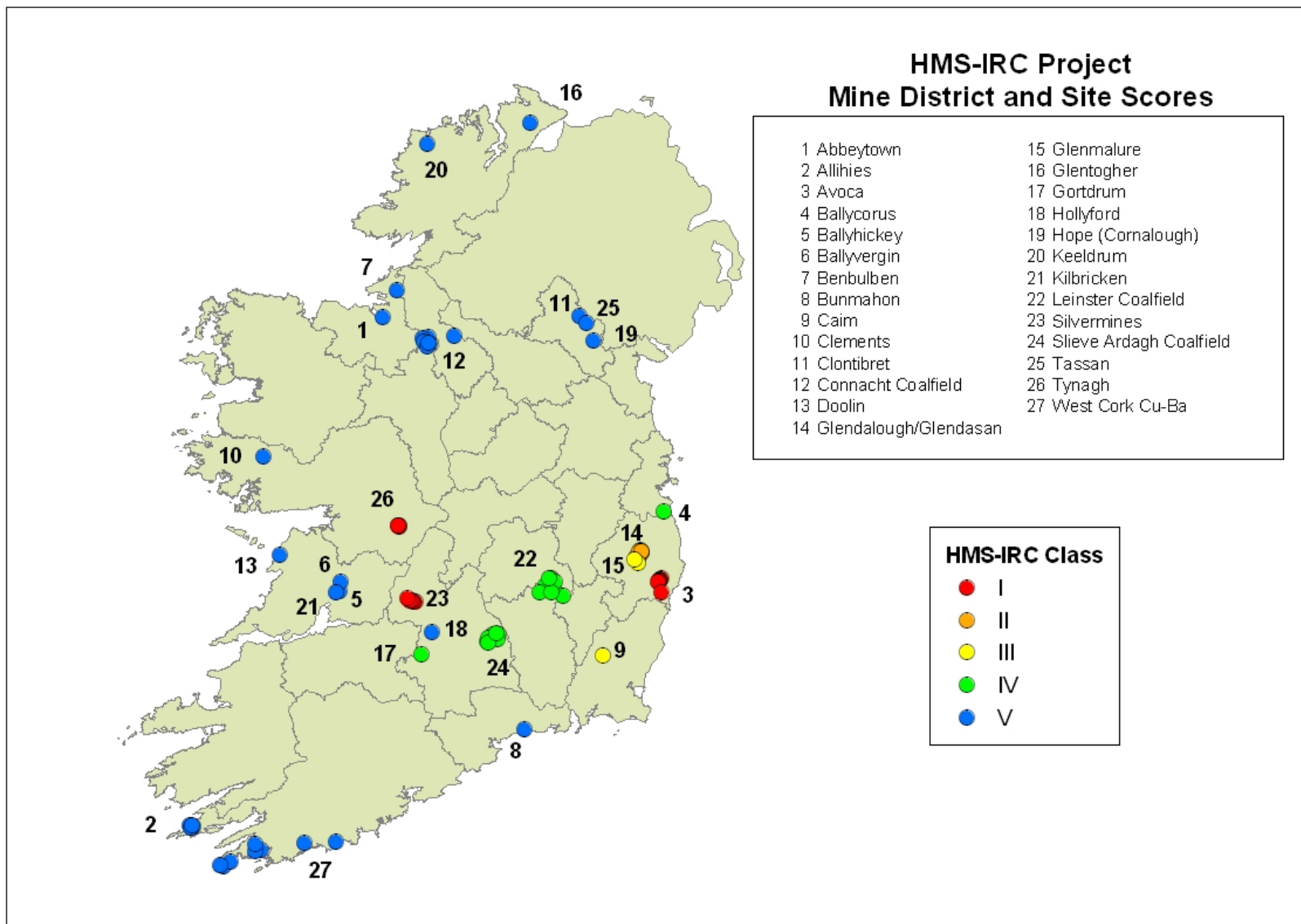


Figure 6.1 Map showing sites colour coded by historic mine site scoring system class.

6.2.4 Class IV sites

Four sites are assigned to Class IV – Ballycorus with a score of 244, Gortdrum 157, the Leinster Coalfield with an aggregate score of 133 and the Slieve Ardagh Coalfield with an aggregate score of 118. The two lower scores are for coalfields, while Ballycorus is a site similar to Glendalough–Glendasan and Glenmalure – it is a Pb vein associated with the Leinster Granite. The Ballycorus vein however was much smaller than the others but a significant feature of the Ballycorus is that a smelter operated at the site which acted as a smelter for almost all of the Pb concentrate produced in Ireland in the 19th century. A specially constructed flue was built to take the fumes from the smelting process up to a chimney on an adjacent hill. This flue may be accessed at several points and deposits of Pb-rich material occur along its interior.

In the 1960s and 1970s, the Gortdrum deposit worked Cu from the basal part of the Carboniferous succession. Although there are significant waste rock piles and a large tailings impoundment (which has been rehabilitated), the absence of high relatively toxic elements results in the site receiving a low score. Nevertheless there are some site-specific issues that need to be addressed on the site.

Two of the three coalfields scored in this exercise are assigned to Class IV. The third coalfield (Connacht) scored 91 and is close to the cut-off point between Class IV and Class V sites. Although the sites contain large amounts of waste they are relatively benign and hence have low scores.

6.2.5 Class V sites

The remaining 17 sites are assigned to Class V. Their scores range from a high of 97 (Clements (Pb), Connemara) to a low of 4 (Hollyford (Cu), Tipperary). The commodities produced at these sites were as follows:

Deposit Type	No.	Site Names
Pb Veins in Precambrian Rocks	3	Clements, Glentogher, Keeldrum
Pb Veins in Carboniferous Rocks	3	Ballyhickey, Ballyvergin, Kilbricken
Pb Veins in Lower Palaeozoic Rocks	3	Clontibret, Hope, Tassan
Copper (Ba) Veins in Devonian Rocks	3	Allihies, Hollyford, West Cork
Coalfield	1	Connacht
Industrial Minerals	2	Benbulbin (Ba), Doolin (phosphate)

With the exception of the Connacht Coalfield and to a lesser extent the Abbeytown Pb–Zn deposit, the deposits worked in this class were all small. Nevertheless, there are some features at some of the sites that require further investigation or action.

6.3 Discussion

6.3.1 Hazard score

The hazard score for each site is the threat to the environment from solid waste and mine discharges. These have been added together to give an accumulated total for each site and they are shown in Table 6.2. The hazard is a combination of the volume of waste, the amount of a particular contaminant and the relative toxicity of the contaminant to different human and environmental receptors.

The highest hazard score is 9,772 and occurs at Tynagh followed by Silvermines (6,565) and Avoca (5,009). These three sites maintain this order when the full HMS-IRC score is developed for each although the three final scores are much closer together, indicating that there are mitigating factors at work, particularly at Tynagh. If the final score is represented as a percentage of the hazard score we get an indication of how well the hazard at each site has been remediated or managed – lower percentages indicate better management or natural regeneration while higher

percentages indicate poorer management or natural regeneration (Table 6.3). We refer to this as the **Regeneration Index (RI)**. The original colour coding for classes has been retained in Table 6.3.

The range of values for RI is from 11 (West Cork Cu–Ba District) to 66 (Ballycorus) with an overall average of 31. Within Class I sites, Avoca ranks as the least regenerated site with an RI of 49, followed by Silvermines at 39 and Tynagh at 28. With the exception of Tynagh both the other Class I sites are well above the RI average. Overall sites in Table 6.3 with an RI less than or equal to the average number 17 (from the West Cork Cu–Ba District to Allihies) possibly indicate a level of regeneration that is acceptable. The sites with RI values greater than the average are:

- Clements (Connemara Pb)
- Leinster Coalfield
- Hollyford (Tipperary Minor Cu)
- Ballyvergin (Clare Pb)
- Silvermines
- Abbeytown
- Caim
- Avoca
- Kilbricken (Clare Pb)
- Ballycorus

Mine / District	No. of Sites	Hazard	Total Score	Class	Regeneration Index
West Cork Cu-Ba	8	154	17	V	11
Benbulbin	1	34	5	V	15
Glenmalure	2	1,944	335	III	17
Clare Phosphate (Doolin)	1	83	15	V	18
Clontibret (Monaghan Pb)	1	60	12	V	20
Glentogher (Donegal Pb)	1	24	5	V	21
Tassan (Monaghan Pb)	1	199	44	V	22
Keeldrum (Donegal Pb)	1	74	17	V	23
Ballyhickey (Clare Pb)	1	80	19	V	24
Gortdrum	1	612	157	IV	26
Slieve Ardagh Coalfield	10	451	118	IV	26
Connacht Coalfield	7	342	91	V	27
Tynagh	4	9,772	2,712	I	28
Bunmahon	1	48	14	V	29
Glendalough/Glendasan	8	3,795	1,122	II	30
Hope (Monaghan Pb)	1	43	13	V	30
Allihies	6	245	76	V	31
Clements (Connemara Pb)	1	292	97	V	33
Leinster Coalfield	7	389	133	IV	34
Hollyford (Tipperary Minor Cu)	1	11	4	V	36
Ballyvergin (Clare Pb)	1	115	43	V	37
Silvermines	6	6,565	2,545	I	39
Abbeystown	1	156	70	V	45
Caim	1	1,204	559	III	46
Avoca	7	5,009	2,438	I	49
Kilbricken (Clare Pb)	1	158	89	V	56
Ballycorus	1	371	244	IV	66

Table 6.3 Regeneration index for sites scored in the HMS-IRC project.

It should be remembered that these are aggregate values for the site as a whole and there could still be issues with individual waste piles, contamination or mine discharges.

The RI could be used in conjunction with the Class designation to assist in prioritising sites for further study or action. Table 6.4 presents a possible prioritisation. On this basis within the Class I sites, Avoca is prioritised followed by Silvermines and Tynagh. Within Class II sites there is only Glendalough–Glendasan. Within Class III sites, the order is the same as the initial ranking – Caim followed by Glenmalure. For Class IV sites, Ballycorus remains on top but Gortdrum drops to the last place in this class with the two included coalfields jumping above Gortdrum and staying in the same order (Gortdrum is classed lower as there rounding without decimal places has been carried out). Within Class V sites the priority sites are Kilbricken, Abbeytown, Ballyvergin, Hollyford and Clements.

Mine / District	No. of Sites	Hazard	Total Score	Class	Regeneration Index
Avoca	7	5,009	2,438	I	49
Silvermines	6	6,565	2,545	I	39
Tynagh	4	9,772	2,712	I	28
Glendalough/Glendasan	8	3,795	1,122	II	30
Caim	1	1,204	559	III	46
Glenmalure	2	1,944	335	III	17
Ballycorus	1	371	244	IV	66
Leinster Coalfield	7	389	133	IV	34
Slieve Ardagh Coalfield	10	451	118	IV	26
Gortdrum	1	612	157	IV	26
Kilbricken (Clare Pb)	1	158	89	V	56
Abbeytown	1	156	70	V	45
Ballyvergin (Clare Pb)	1	115	43	V	37
Hollyford (Tipperary Minor Cu)	1	11	4	V	36
Clements (Connemara Pb)	1	292	97	V	33
Allihies	6	245	76	V	31
Hope (Monaghan Pb)	1	43	13	V	30
Bunmahon	1	48	14	V	29
Connacht Coalfield	7	342	91	V	27
Ballyhickey (Clare Pb)	1	80	19	V	24
Keeldrum (Donegal Pb)	1	74	17	V	23
Tassan (Monaghan Pb)	1	199	44	V	22
Glentogher (Donegal Pb)	1	24	5	V	21
Clontibret (Monaghan Pb)	1	60	12	V	20
Clare Phosphate (Doolin)	1	83	15	V	18
Benbulbin	1	34	5	V	15
West Cork Cu-Ba	8	154	17	V	11

Table 6.4 Possible prioritisation for further study or action at the HMS-IRC sites.

6.3.2 Pathways

Each pathway contributes differently for each site depending on the individual conditions at the site. The highest individual score for the groundwater pathway is at Tynagh (1,239), for the surface water pathway Tynagh (1,293), for the air pathway Silvermines (64), for the direct contact, waste piles pathway Silvermines (351) and for the direct contact, stream sediments pathway Glendalough–Glendasan (345).

At each site the relative proportion varies. The percentage contribution of each pathway to the final site score is presented in Figure 6.2. The predominant contribution comes from either the groundwater or surface water pathways. Table 6.5 provides a summary of the dominant pathway for each of the sites scored.

Pathway	No. of Sites where the Given Pathway is Dominant	Sites
Groundwater	6	Ballycorus, Abbeytown, Ballyhickey, West Cork Cu-Ba, Hope, Benbulbin
Surface Water	18	Tynagh, Silvermines, Avoca, Glendalough–Glendasan, Caim, Glenmalure, Gortdrum, Leinster Coalfield, Slieve Ardagh Coalfield, Clements, Connacht Coalfield, Kilbricken, Allihies, Ballyvergin, Keeldrum, Clare Phosphate (Doolin), Bunmahon, Hollyford
Air	0	
Direct Contact (waste piles)	0	
Direct Contact (stream sediments)	3	Tassan, Clontibret, Glentogher

Table 6.5 List of sites with their relevant dominant pathway.

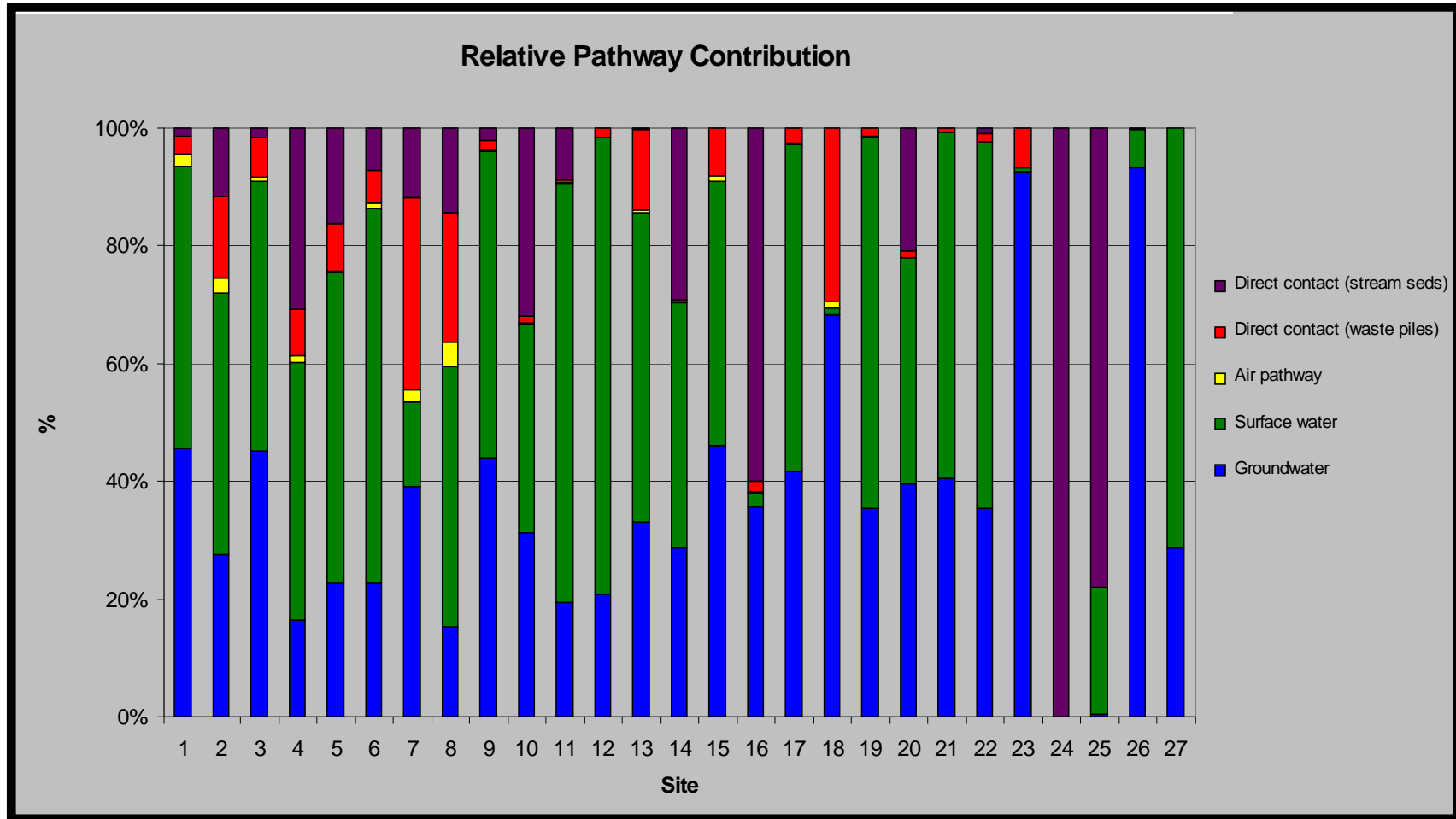


Figure 6.2 Relative contributions by pathway to the final score at each site. 1. Tynagh, 2. Silvermines, 3. Avoca, 4. Glendalough–Glendasan, 5. Caim, 6. Glenmalure, 7. Ballycorus, 8. Gortdrum, 9. Leinster Coalfield, 10. Slieve Ardagh Coalfield, 11. Clements (Connemara Pb), 12. Connacht Coalfield, 13. Kilbricken (Clare Pb), 14. Allihies, 15. Abbeytown, 16. Tassan (Monaghan Pb), 17. Ballyvergin (Clare Pb), 18. Ballyhickey (Clare Pb), 19. Keeldrum (Donegal Pb), 20. West Cork Cu-Ba, 21. Clare Phosphate (Doolin), 22. Bunmahon, 23. Hope (Monaghan Pb), 24. Clontibret (Monaghan Pb), 25. Glentogher (Donegal Pb), 26. Benbulbin, 27. Hollyford (Tipperary Minor Cu).

The dominant pathway for all Class I, II and III sites is the surface water pathway. In addition, the surface water pathway is the dominant pathway for 18 (67%) of the sites. The groundwater pathway is the next most dominant being the principal contributor to six sites (22%) and direct contact (stream sediments) is the dominant contributor in three sites (11%). Neither the air pathway nor the direct contact (waste piles) pathway is a dominant contributor to scores. Overall the air pathway contributes little to the scores while the direct contact (waste piles) is a significant contributor to only two sites – Ballycorus and Ballyhickey.

Table 6.6 provides a list of the percentage contribution of the groundwater pathway to the overall site score for each of the sites scored. At Hope all of the final score is contributed

Mine / District	Groundwater
Hope (Monaghan Pb)	100
Benbulbin	89
Ballyhickey (Clare Pb)	68
Abbeytown	46
Tynagh	46
Avoca	45
Leinster Coalfield	44
Clare Phosphate (Doolin)	42
Ballyvergin (Clare Pb)	42
West Cork Cu-Ba	40
Ballycorus	39
Keeldrum (Donegal Pb)	36
Tassan (Monaghan Pb)	35
Bunmahon	35
Kilbricken (Clare Pb)	33
Hollyford (Tipperary Minor Cu)	32
Slieve Ardagh Coalfield	31
Allihies	29
Silvermines	28
Glenmalure	23
Caim	23
Connacht Coalfield	21
Clements (Connemara Pb)	19
Glendalough/Glendasan	17
Gortdrum	15
Glentogher (Donegal Pb)	0
Clontibret (Monaghan Pb)	0

Table 6.6 Percentage contribution of the groundwater pathway to the overall site score.

by the groundwater pathway while this pathway also contributes significantly (>40%) to the final scores for Benbulben, Ballyhickey (Clare Pb), Abbeytown, Tynagh, Avoca, the Leinster Coalfield, Clare Phosphate (Doolin), Ballyvergin (Clare Pb), and the West Cork Cu–Ba District. At the opposite end of the spectrum the groundwater pathway does not contribute to the final score for either Clontibret or Glentogher.

Table 6.7 provides a list of the percentage contribution of the surface water pathway to the overall site score for each of the sites scored. Hollyford is at the top of the list with an overall contribution of 80% from the surface water pathway. Other sites to which the

Mine / District	Surface water
Hollyford (Tipperary Minor Cu)	80
Connacht Coalfield	77
Clements (Connemara Pb)	71
Keeldrum (Donegal Pb)	64
Glenmalure	64
Bunmahon	62
Clare Phosphate (Doolin)	61
Ballyvergin (Clare Pb)	56
Caim	53
Kilbricken (Clare Pb)	53
Leinster Coalfield	52
Tynagh	48
Avoca	46
Abbeytown	45
Silvermines	45
Gortdrum	44
Glendalough/Glendasan	44
Allihies	42
West Cork Cu-Ba	39
Slieve Ardagh Coalfield	35
Glentogher (Donegal Pb)	21
Ballycorus	14
Benbulben	6
Tassan (Monaghan Pb)	2
Ballyhickey (Clare Pb)	1
Hope (Monaghan Pb)	1
Clontibret (Monaghan Pb)	0

Table 6.7 Percentage contribution of the surface water pathway to the overall site score.

surface water pathway is a significant (>40%) contributor to the final score are: the Connacht Coalfield, Clements, Keeldrum, Glenmalure, Bunmahon, Clare Phosphate (Doolin), Ballyvergin, Caim, Kilbricken, the Leinster Coalfield, Tynagh, Avoca, Abbeytown, Silvermines, Gortdrum, Glendalough–Glendasan, and Allihies. The surface water pathway does not contribute significantly to the total score for Benbulben, Tassan, Ballyhickey, Hope, and Clontibret.

Table 6.8 provides a list of the percentage contribution of the air pathway to the overall site score for each of the sites scored. The air pathway is the least significant pathway and

Mine / District	Air
Gortdrum	4
Silvermines	3
Tynagh	2
Ballycorus	2
Ballyhickey (Clare Pb)	1
Glendalough/Glendasan	1
Abbeytown	1
Glenmalure	1
Avoca	1
Kilbricken (Clare Pb)	0
Caim	0
Tassan (Monaghan Pb)	0
Clements (Connemara Pb)	0
Ballyvergin (Clare Pb)	0
Leinster Coalfield	0
Slieve Ardagh Coalfield	0
West Cork Cu-Ba	0
Hope (Monaghan Pb)	0
Bunmahon	0
Keeldrum (Donegal Pb)	0
Connacht Coalfield	0
Allihies	0
Clare Phosphate (Doolin)	0
Clontibret (Monaghan Pb)	0
Glentogher (Donegal Pb)	0
Benbulben	0
Hollyford (Tipperary Minor Cu)	0

Table 6.8 Percentage contribution of the air pathway to the overall site score.

does not contribute significantly to any site score. For most sites the contribution is nil. Only nine sites registered a score (within the bounds of rounding errors), namely, Gortdrum, Silvermines, Tynagh, Ballycorus, Ballyhickey (Clare Pb), Glendalough–Glendasan, Abbeytown, Glenmalure and Avoca.

Table 6.9 provides a list of the percentage contribution of the direct contact (waste piles) pathway to the overall site score for each of the sites scored. The site that had the greatest contribution from the direct contact pathway is Ballycorus, with 33%. Only two other sites had a significant contribution from this pathway – Ballyhickey and Gortdrum.

Mine / District	Direct Contact
Ballycorus	33
Ballyhickey (Clare Pb)	29
Gortdrum	22
Silvermines	14
Kilbricken (Clare Pb)	14
Abbeytown	8
Caim	8
Glendalough/Glendasan	8
Hope (Monaghan Pb)	7
Avoca	7
Glenmalure	6
Tynagh	3
Ballyvergin (Clare Pb)	2
Tassan (Monaghan Pb)	2
Connacht Coalfield	2
Leinster Coalfield	2
Keeldrum (Donegal Pb)	2
West Cork Cu-Ba	1
Bunmahon	1
Slieve Ardagh Coalfield	1
Clare Phosphate (Doolin)	1
Allihies	1
Clements (Connemara Pb)	0
Benbulbin	0
Clontibret (Monaghan Pb)	0
Glentogher (Donegal Pb)	0
Hollyford (Tipperary Minor Cu)	0

Table 6.9 Percentage contribution of the direct contact (waste piles) pathway to the overall site score.

Table 6.10 provides a list of the percentage contribution of the direct contact (stream sediments) pathway to the overall site score for each of the sites scored. Three sites have a percentage contribution greater than 50% – Clontibret, Glentogher and Tassan. All three sites are small. Other sites with a significant contribution include the Slieve Ardagh Coalfield, Glendalough–Glendasan, Allihies and the West Cork Cu–Ba District. For most sites, this is not a significant pathway. The principal impact from direct contact (stream sediments) is for watering livestock and wildlife.

Mine / District	Direct Contact (Stream Sediments)
Clontibret (Monaghan Pb)	99
Glentogher (Donegal Pb)	77
Tassan (Monaghan Pb)	59
Slieve Ardagh Coalfield	32
Glendalough/Glendasan	31
Allihies	29
West Cork Cu-Ba	21
Caim	16
Gortdrum	14
Ballycorus	12
Silvermines	12
Clements (Connemara Pb)	9
Glenmalure	7
Leinster Coalfield	2
Avoca	2
Tynagh	1
Bunmahon	1
Kilbricken (Clare Pb)	0
Connacht Coalfield	0
Abbeytown	0
Ballyvergin (Clare Pb)	0
Ballyhickey (Clare Pb)	0
Keeldrum (Donegal Pb)	0
Clare Phosphate (Doolin)	0
Hope (Monaghan Pb)	0
Benbulbin	0
Hollyford (Tipperary Minor Cu)	0

Table 6.10 Percentage contribution of the direct contact (stream sediments) pathway to the overall site score.

6.3.3 Specific risks

The HMS-IRC scoring system provides an effective ranking of mine sites investigated in terms of their potential to affect human or animal health or to have a negative impact on the environment. One effect of the ranking system, however, is that, by focusing attention on a few Class I, II or III sites, it can draw attention away from specific problems on smaller, low-ranking sites. Ranking is a relative concept and a low ranking does not mean that any given site is free of significant health or environmental risks that may need to be addressed. For example at Ballyvergin, a Class V site, Pb concentrations in excess of 20% were measured in fine-grained mine waste in an area used by cattle for feeding. These and other instances are detailed in the individual site reports.