

Review of Dioxins and Furans 1992 to 2006
Wildwood Landfill, Catalyst Paper Powell River
Appendix A

This Appendix reviews in detail all the dioxin and furan information found in the available 1992 to 2006 reports. The most complete information is from 1994 and 1995.

After 1996 the available information is unfortunately far more limited and is mainly from the recovery wells 95-1, 8 & 9, 99-2, 4 & 5 and wells 89-5, AH6, 94-1, AH3, 94-16 and Spring S1 and the lake. Wells AH6 to 94-16 are generally down the middle of the slope.

The 1996 to 2006 data ignores areas of high dioxin and furan concentration such as the western toe wells. The lack of data from the western and eastern sides of the slope to the lake precludes a more complete understanding of the pattern of the dioxins and furans migrating towards the lake during this period.

1. Landfill Wells

1.1 Landfill North to South – Background Info

For the landfill, the well results will be displayed from North (Wildwood) to South (edge of the slope by Powell Lake) unless otherwise noted.

They are generally discussed and/or displayed from west to east along the section line identifiers employed by Agra Earth & Environmental in 1994.

The discussed results are from all available samples. The graphed results are selected to represent the patterns found.

The Figures display Dioxin & Furan results. The left graph generally illustrates the total dioxans and furans in each family. The right graph is generally their TEQ values for the toxic forms.

For the transition from total weight to the TEQ value please see the additional graphs and discussion with Figures A8 & A9 and A16 and A17.

Before looking at the landfill the measured results for the ash in 2007 are reviewed for reference and comparison. Figure A1's left hand graph is total dioxins and furans in each family from the measured ash. The right graph is their TEQ values for the toxic forms.

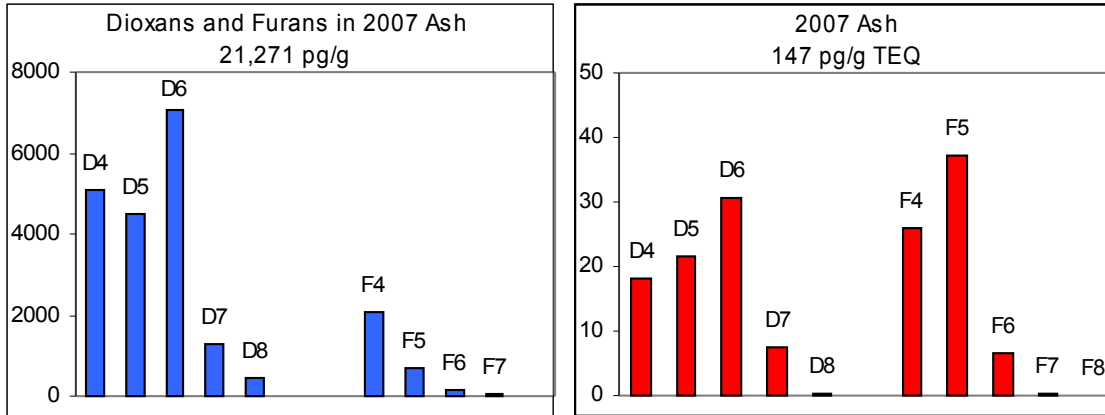


Figure A1 – Total Weight of all Dioxins & Furans and TEQ of Toxic Dioxins & Furans Ash

It should be noted that in reviewing the results for the 2007 ash that the ash is dominated by the more toxic D4, D5 and D6 dioxans and the most toxic F5 furan. The ash results are different in pattern than those anything found in analysis of the existing landfill or slope data.

1.2 North Line (Wildwood)

The first western well on the north line is AH1.

In the available data AH1 was sampled only once, in March 1994. For AH1 the total weight data is incomplete and not displayed. The soils at AH1 were analyzed in 1992 with no dioxins or furans being detected.

The next well is 93-2. It has three sample depths A, B and C.

No data was available for depth C at 20 metres.

14 samples were available for Well 93-2 at either Depth B at 40 metres or Depth A at 50 metres; the depth was most often not identified.

2 samples are from Jan & April 1994. 1 sample from 1994 contains only F4 with the toxic forms dominant; the second contains F4 with only the toxic form and D8.

Three samples in 1995, one in 1996, 1998, 2001 and 2005 are dominated by low levels of D8 with 1995's 31 pg/l total being the highest result.

No dioxins or furans were detected in 1997, 1999, 2002, 2003, 2004 and 2006.

The Dec 2000 results for depth B are shown in Figure A2 below.

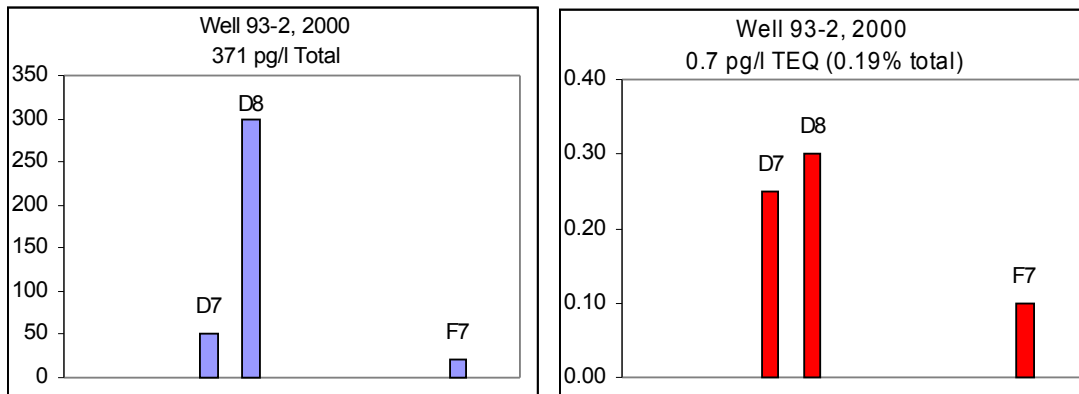


Figure A2 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Well 93-2 Depth B Dec 2000

In Figure A2, the 2000 results for 93-2B are dominated by dioxins. The TEQ graph result reflects the higher toxicity of D7 compared to D8.

2 samples were available for Well 93-2A, Depth A at 50 metres, from Jan and April 1994. F4 and F8 were detected in the Jan 94 sample and D6, D7, D8 and F6 were detected in April 94.

The only other well on the north line is O6 at the eastern corner. It is a newer well added later. In its 3 available samples from Dec 2006, no dioxins or furans were detected. This tends to indicate that dioxins and furans from the landfill are not migrating in this direction.

1.3 Section B-B, Well AH2

The next 2 section cuts moving south are D-D which contains two destroyed wells and C-C which contains no wells.

There is only one well on the next section cut B-B: well AH2.

AH2 is an important well because it is approximately the centre of the landfill.

Oddly considering its strategic location, in the available data AH2 was only sampled once in 1992 and twice in 1994. The AH2 well was later destroyed.

The 1992 results are the highest found in sampling of AH2. However 1992's data is tabular with only totals given. A total of 2860 pg/l dioxans and furans was detected with 93% of this being dioxans. Note that this is 9 times higher than the 1994 results. Two 1992 soil samples at AH2 were also analyzed with the results being poorer than the water sample at 6090 and 8800 pg/g with 99.5 and 96% respectively being dioxans. See Appendix B. The March 94 results are shown in Figure A3.

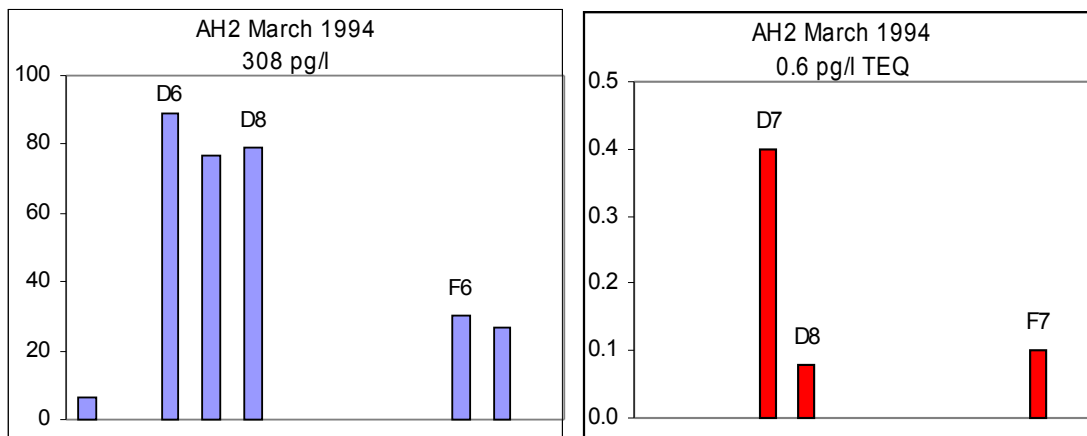


Figure A3 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Well AH2 March 1994

Note the results are again dominated by dioxins. Also note the absence of the toxic forms of D6 and F6. Their toxic forms should be present and their absence is not easily explained.

The next AH2 results are from April 94 and are in Figure A4 below. The sample was analyzed twice with the results not being identical, particularly for F4.

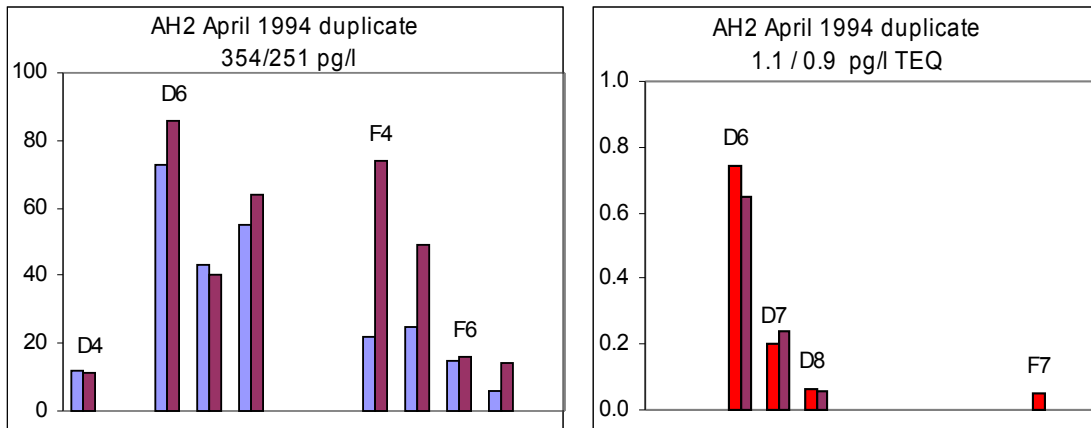


Figure A4 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Well AH2 April 1994 – Analyzed twice

Note the results are again dominated by dioxins. Also note the absence of the toxic forms of F4, F5 and F6. Their toxic forms should be present and their absence is again not easily explained.

1.4 Section A-A

The next section cut moving south is A-A which contains no wells. However, Well 93-1 on the eastern edge of the landfill is closest to section A-A.

It has two sample depths A and B at 45 metres and 30 metres respectively.

Samples were available for 93-1 from Jan and April 1994 for both depths A&B.

In the results for both samples at the lower depth A and for the January sample at depth B, only F4 and its common toxic form was detected.

In the April sample from the higher level B: D8, F4 and F5 were detected. In this sample no common toxic forms of F4 and F5 were detected.

The results from 93-1 level B in April 1994 can be seen in Figure A5.

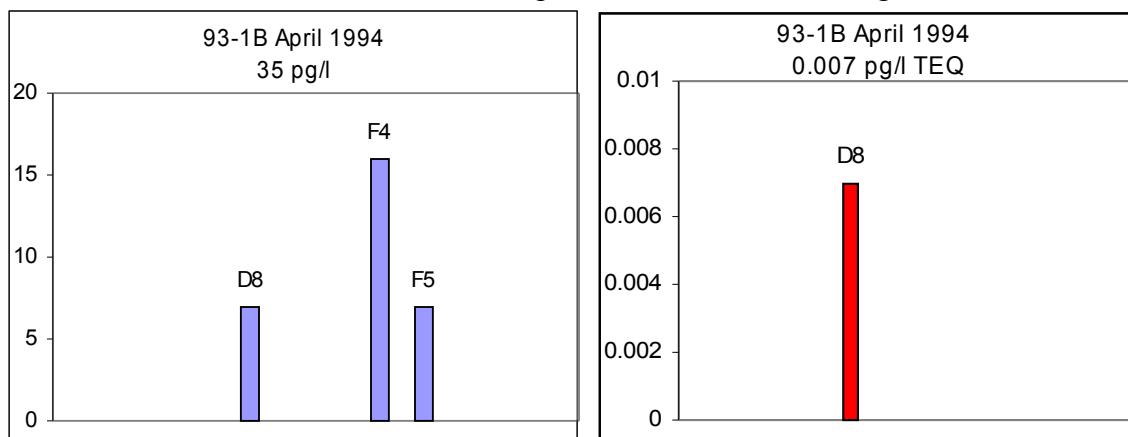


Figure A5 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Well 93-1 April 1994

In Figure A5 note the absence of the toxic forms of F4 and F5. This is inconsistent with the predicted result and again not easily explained. In the right TEQ graph, D8 is the only toxic form detected. The toxic fraction (0.007 pg/l) is 0.7% of the total dioxins and furans (35 pg/l).

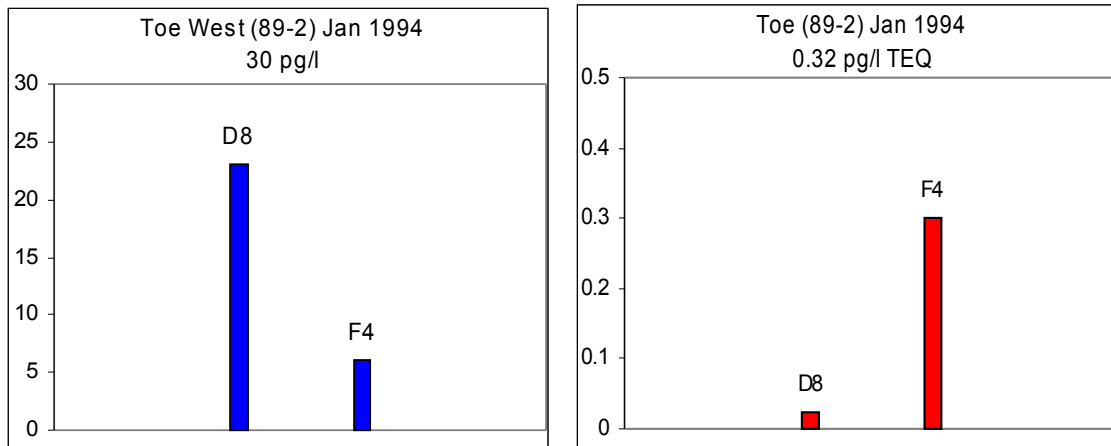
1.5 The Toe of the Landfill

The Toe of the landfill is just above the slope to Powell Lake. The results at the Toe are also important as they likely represent the landfill leachate running down the slope to the lake.

The results at the Toe include the highest values found in the landfill.

There are 18 wells at the toe of the landfill. 5 are 89 series wells, predating 1994. 12 of the other 13 wells are the 95 series, installed later. Of these wells 95-1, 95-9 and 95-8 are used as recovery wells in the leachate collection system. There was no data available for several of the 95 series wells. Wells 99-2, 99-4 and 99-5 were installed in 1999 to try to deal with the toxic results around well 89-5. Of these three, well 99-4 is on the landfill toe next to well 89-5.

The first western well at the toe is 89-2. In the available data 89-2 was sampled six times: once in 1992 and 93, twice in 1994 in Jan and April and twice in 1995 in May and July. The 1992, 93 and 1995 results are all low results dominated by dioxins, mainly D8, with no furans detected. The Jan 94 results are shown in Figure A6.



**Figure A6 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
Toe Well 89-2 Jan 1994**

Note the dominance of D8 in the total results. The only molecule detected in the F4 family was the toxic form with a TEQ of 0.1, thus the high TEQ F4 result. D8's TEQ is 0.001, thus its lower toxic value result.

Well 89-2's April 94 results can be seen in Figure A7 below.

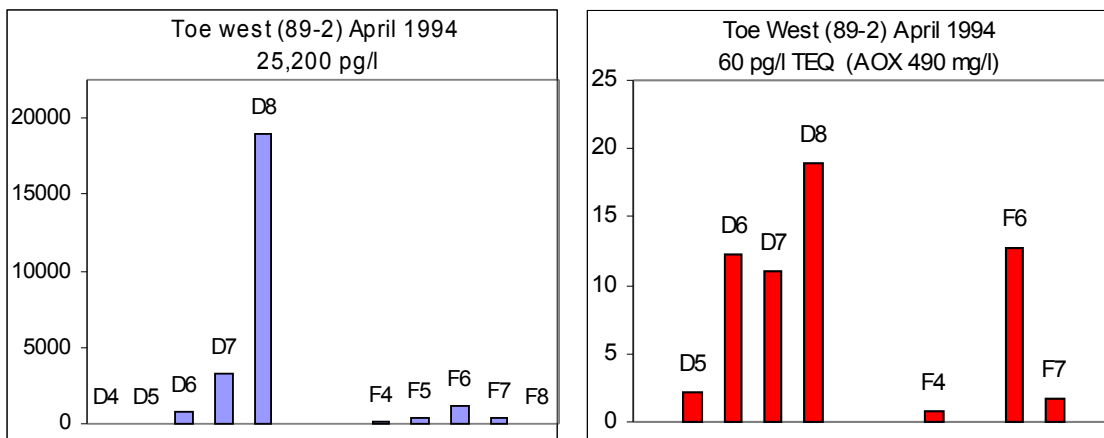


Figure A7 – Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Toe Well 89-2 April 1994

D8 again dominates the total results.

These results are extremely different from those of Figure A6 from the same well in Jan 1994. The total results of dioxins and furans are 840 times higher. The toxic results in the right graph are 188 times higher.

These April 94 results are some of the highest found in the available landfill samples. This result found directly above the slope to Powell Lake is of concern.

Considering the high results and its position on the toe above the slope, the lack of data from this well after 1995 is puzzling.

The large change in the results indicates that it would be difficult and expensive to develop a reliable fingerprint pattern for the landfill dioxans and furans without extensive higher interval sampling.

The dominance of D8 in the lower Jan 1994 results could be explained by higher rainfall and dilution with only the high D8 still detectable.

The next two wells are 95-4 and 95-10, with no available data.

The next well towards the east is 89-3.

In the available data 89-3 was sampled six times: once in 1992 and Dec 93, twice in 1994 in Jan and April and twice in 1995 in May and July. The April 1994 result is a low result dominated by D8. The remaining five sample are very high results, all dominated by D8. The Jan 94 results are shown in Figures A8 and A9.

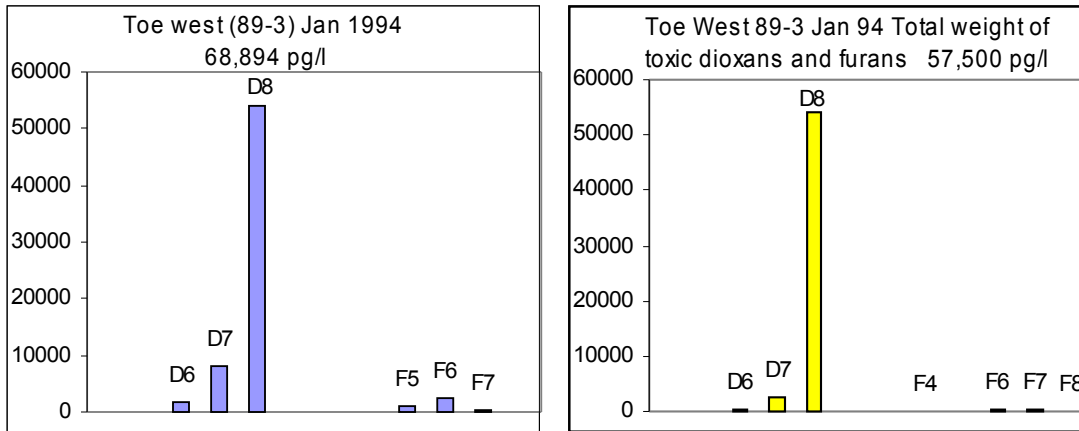


Figure A8 – Total Weight of all Dioxins and Furans and Total Weight of Toxic Dioxins and Furans Toe Well 89-3 Jan 1994

Jan 1994's results are very high and strongly dominated by D8. As the only form of D8 is toxic, the total toxic weight graph on the right is even more strongly dominated by D8.

Again, considering the very high results and its position on the toe above the slope, the lack of data from this well after 1995 is puzzling.

The yellow total toxic weight results are shown here to allow comparison with well 89-5 results in Figures A16 and A17.

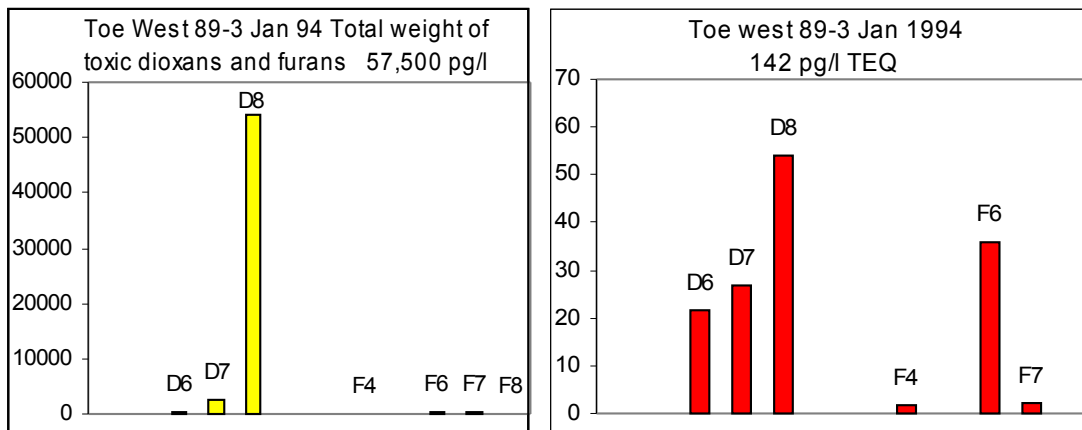
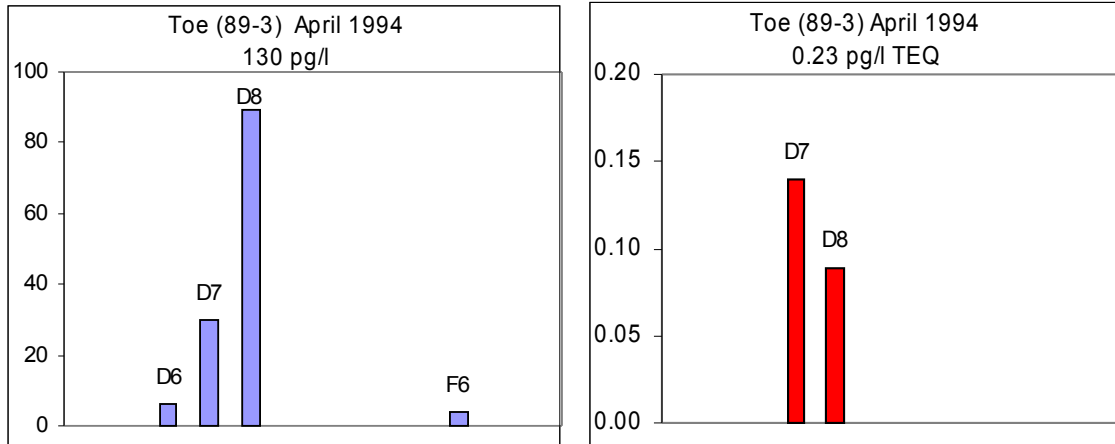


Figure A9 – Total Weight and TEQ of Toxic Dioxins and Furans Toe Well 89-3 Jan 1994

These results are similar in pattern but at much higher levels than those of Figure A7 for well 89-2 on Jan 25, 1994. As well 89-2 was sampled on the same day it makes the explanation of additional rainfall and dilution unlikely. Potentially flow through and or under the landfill is shifting.

These Jan 94 89-3 results are also very different from those of the same well in April 94 shown below in Figure A10. The pattern of very large change seen for well 89-2 from Jan to April 94 is reversed for well 89-3.



**Figure A10– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
 Toe Well 89-3 April 1994**

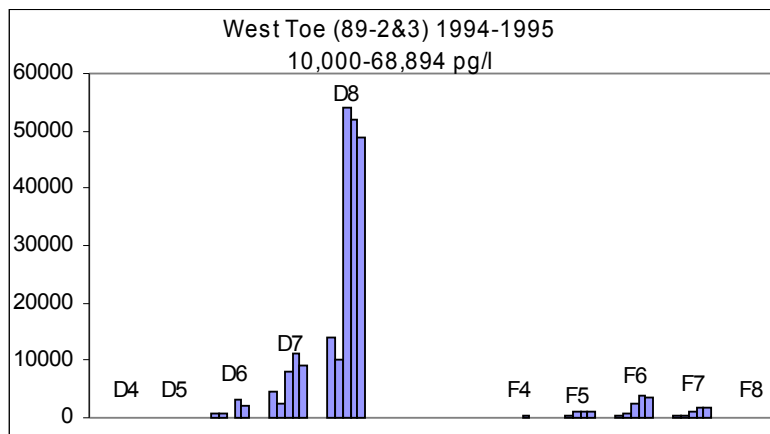
D8 again dominates both these 1994 samples from 89-3.

In the right graph of toxic values, D7 is higher than D8 because its toxicity is 10 times greater.

The total results of dioxins and furans for well 89-3 are 534 times higher in January than in April. The toxic results in the right graph are 624 times higher.

The large variation in the results again indicates that establishing a reliable fingerprint pattern for the landfill dioxins and furans would need extensive higher interval sampling.

As the dioxin and furan results at well 89-3 are consistently some of the highest at the landfill’s western toe they are grouped together in Figure A11 in combination with the high value from 89-2. In Figure A10 the data order is 89-3’s 1992, Dec 93, Jan 94, May 95 July 95 and well 89-2’s April 94 results.



**Figure A11– Total Weight of all Dioxins and Furans
 Toe Well 89-3 1992 to 1995 and Well 89-2 April 1994**

These D8 dominated results are some of the highest found in the available landfill samples and being found directly above the slope to Powell Lake are of concern.

Neither well was analyzed after 1995.

The next well to the east is 95-1. This is a leachate recovery well installed in 1995. As its content were mixed with those of wells 95-8 & 9, it will be discussed with those wells.

The next well to the east is 95-5. It has no available data.

The next well is 1995 recovery well 95-9. It is discussed below with 95-1 & 8.

The next well to the east is 89-1. In the available data 89-1 was sampled five times: in 1992, April 1994 and in May, July and Nov 1995. The 1992 results show mid range (1043 pg/l total) levels of a widespread of dioxans and furans. In April 94 to July 95's samples, only low levels (max 15 pg/l) of D8 were detected. Nov 1995's sample was dominated by D8 (at 180 pg/l).

The next well to the east is 95-8. This is a leachate recovery well installed in 1995. As its sample contents were mixed with those of wells 95-1 & 9, it is discussed below with those wells.

The available data for the mix of 95-1, 8 & 9 is five samples from 1995 to Dec 2000.

After Dec 2000, the leachate recovery was concentrated on 1999's wells 99-2, 4 & 5 which are more targeted at collecting leachate from the more toxic area of the landfill surrounding well 89-5.

The samples are from Nov 95, Dec 97, Dec 98, Dec 99 and Dec 2000. The 1995, 98, 99 and 2000 results are similar and generally dominated by D8 as would be expected with the results seen at the western toe at wells 89-2 and 89-3. The Nov 95 results are shown in Figure A12.

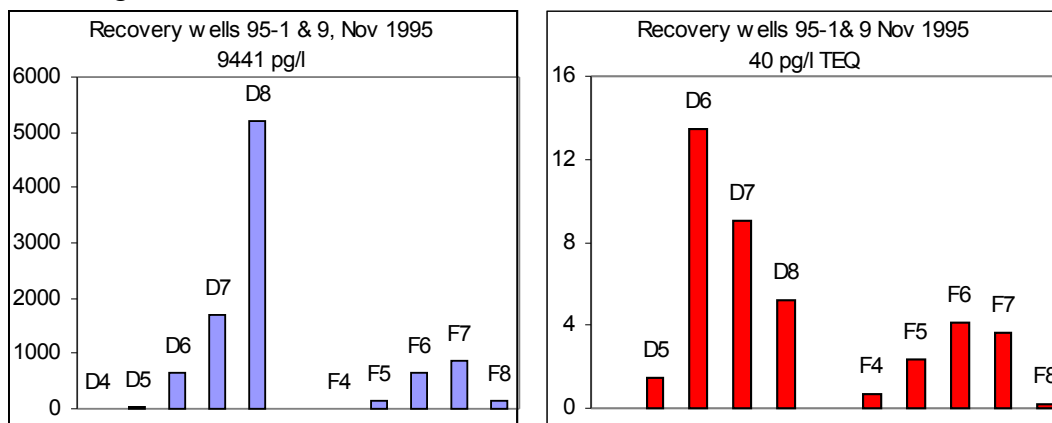


Figure A12– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Recovery Wells 95-1 & 95-9 Nov 1995

In Figure A12 the total result is strongly dominated by D8 as expected from these two more westerly recovery wells. The higher TEQ toxic results for D6 and D7 reflect their 100 and 10 times higher levels of toxicity compared to D8.

Dec 1997's results are quite different from the other four results. They are seen in Figure A13.

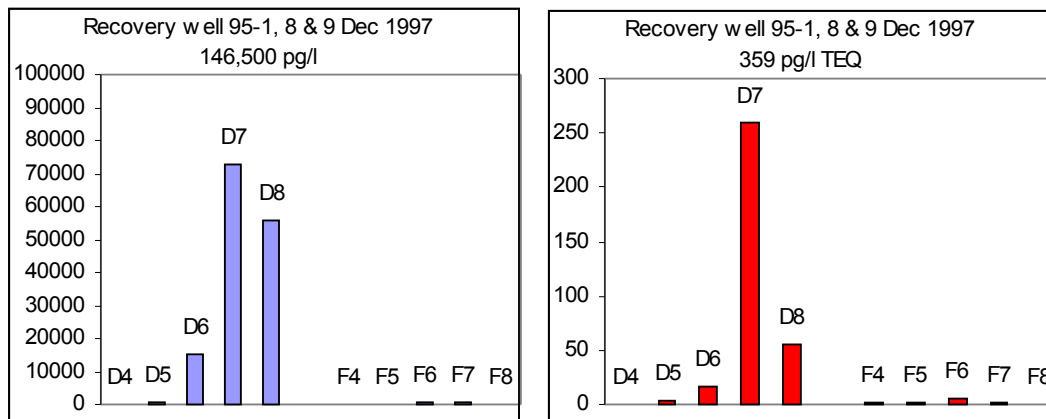


Figure A13– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Recovery Wells 95-1, 95-8 & 95-9 Dec 97

Dec 97's results in Figure A13 are very high. The dominance of D7 is unusual. This sample is associated with a very high pH of 12.1 and high levels of phenols at 171 ug/l, both also very unusual. The very high levels of phenols, such as creosote, may be affecting the accuracy of the dioxin and furan detection, especially for D8.

Note that there is no evidence of these three 1995 recovery wells capturing any significant amount of the high D6 – F6 toxins from the well 89-5 area.

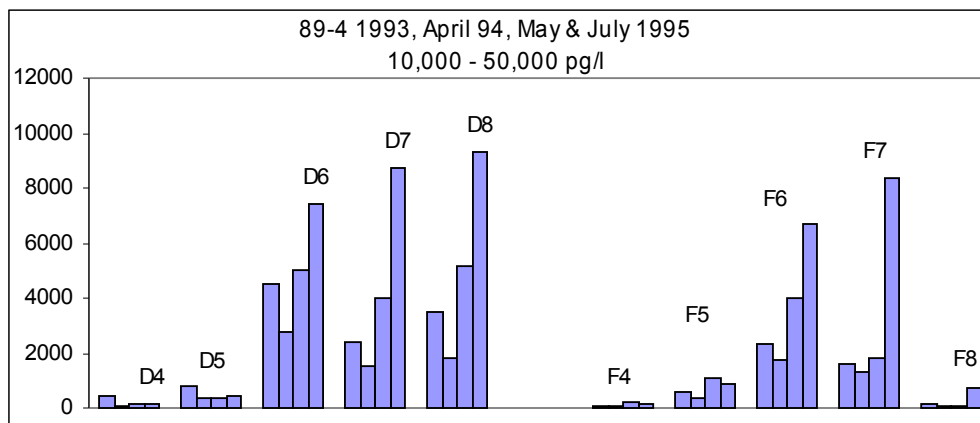
Unfortunately there is no data from these 95-1, 8 & 9 recovery wells after 2000 when the leachate recovery was concentrated on well 99-5 below the toxic 89-5 area. Information on the pattern of the D8 dominant results working their way down the slope from the western toe was lost.

The next two wells to the east are 95-3 and 95-7. Both have no available data.

The next well is 89-4.

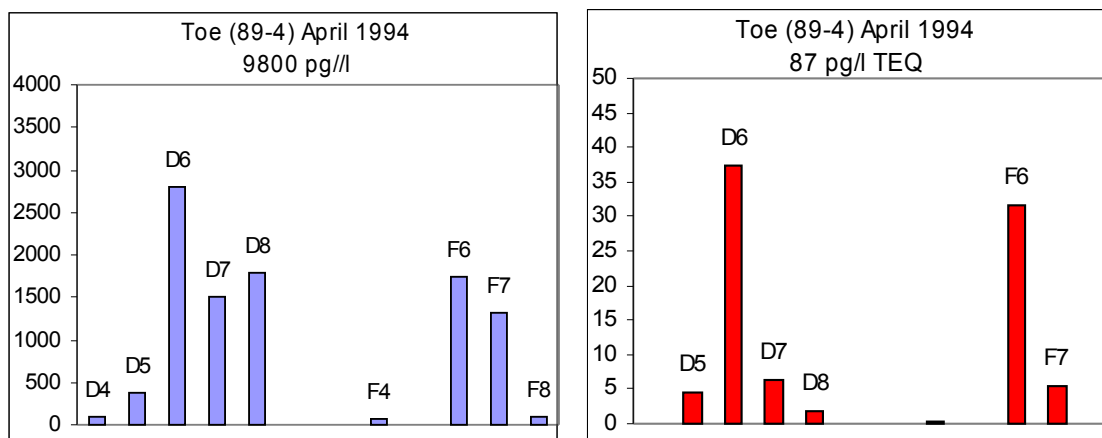
In the available data 89-4 was sampled 6 times: in 1992, 1993, in Jan and April 1994 and in May and July 1995. 1992's low results are dominated by D6 and F6. The Jan 94 sample was analyzed twice with both analysis results being very low.

1993, April 94 and the May and July 1995 results are all much higher. The 1995 results are only given as totals with no TEQ data for the toxic forms. The total weight results for these four samples are shown sequentially in Figure A14.



**Figure A14– Total Weight of all Dioxins and Furans
Toe Well 89-4 1993, April 1994, May and July 1995**

The April 94 results including their TEQ are shown in Figure A15.



**Figure A15– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
Toe Well 89-4 April 1994**

In this Figure D6 is the highest result with F6 dominant in the furans. This is a change from the more common D8 dominant fingerprint pattern.

As the following results will show, this change in pattern is due to the highly toxic results at well 89-5.

The next two wells to the east are 95-2 and 95-12. Both have no available data.

The next well is 89-5. It is near the eastern edge of the landfill. This well has the most samples among the landfill toe wells.

This is due to the severe toxic results around this well.

Background information on the severe toxicity around well 89-5 is first available in 1992 and 93. A Sept 1993 HBT Agra Limited report discusses a dense, heavier than water, viscous liquid found in the well 89-5 area. Its analysis found “very high levels of a number of contaminants”. “The sample had extremely high levels of dioxins and furans as well as very high concentrations of organic compounds and tannins and lignins.

Mercury levels were also high. Our working hypothesis is that the very high levels of organic compounds has enhanced solution of dioxins, furans and some other contaminants, probably from the ashes disposed of on site. The presence of this viscous liquid must be considered in the remediation plan for the site.”

The July 2007 Golder Associates report states ”At the time of closure, the southeastern portion of the Phase 1 landfill contained sand and gravel containing Bunker C oil and cutting oil. These materials were stored in a lined and covered cell and the majority was used as aggregate for the asphalt cap discussed below.” Closure of the Phase 1 landfill in 1995 consisted of covering the landfill with a low permeability asphalt cap.

It should be noted that several contaminants (eg creosote) makes the more highly chlorinated forms, such as D8, difficult to detect. (Environment Canada EPS-5-AR-81-2).

In the available data well 89-5 was sampled 18 times from 1992 to 2006.

The highest available results are from 1993 with a very severe result of 3,500,000 pg/l total weight of dioxins and furans and a TEQ result of 31,000 pg/l.

Feb 94’s and March 2004’s results at 500,000 and 160,000 pg/l total weight of dioxins and furans are also very severe and have the same pattern.

The 1993 results are shown in Figures A16 and A17.

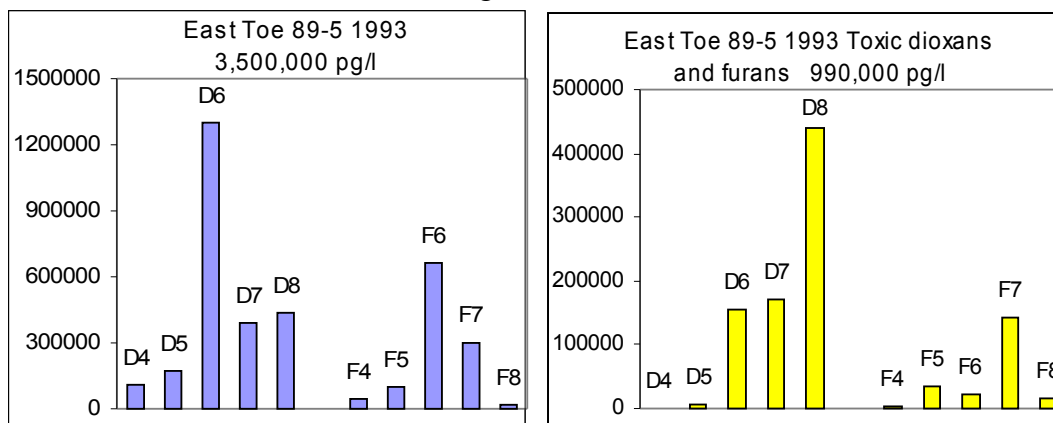
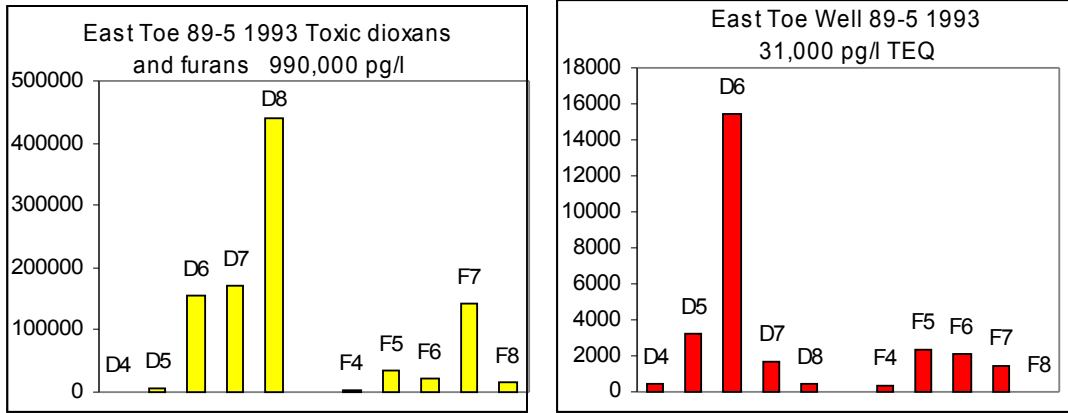


Figure A16– Total Weight of all Dioxins and Furans and Toxic Dioxins and Furans East Toe Well 89-5 1993

In Figure A16, the very severe results at well 89-5 are dominated by D6 and F6. This differs from the more common landfill pattern of dominance by D8.

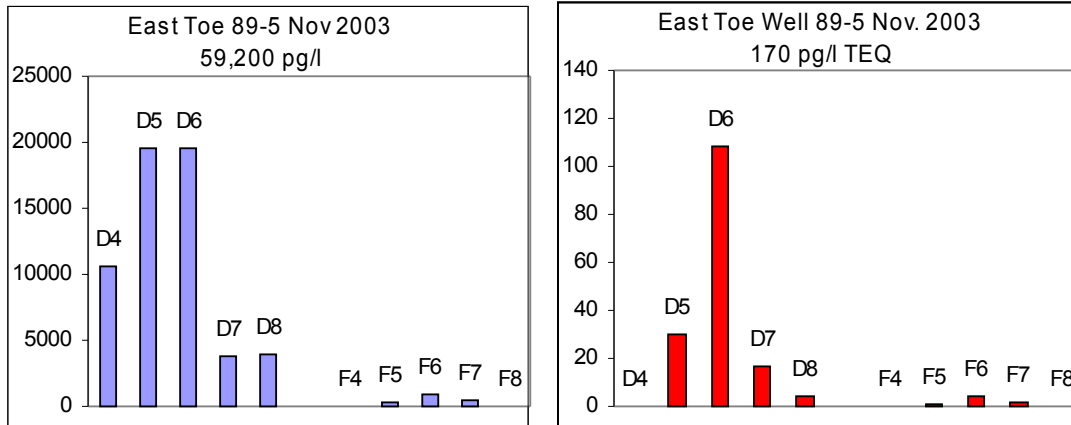
As in D8 the only form is the toxic form, D8 continues to dominate the total toxic dioxin and furan results in the right graph. This continues the pattern seen at the western toe in Figures A8 & A9.



**Figure A17– Total Weight and TEQ of Toxic Dioxins and Furans
 East Toe Well 89-5 1993**

In these very severe results, the TEQ is dominated by D6. D6 is 100 times more toxic than D8.

An exception to the pattern of dominance by D6 and F6 in the total and TEQ results at well 89-5 was found in the Nov 2003 results seen in Figure A18.



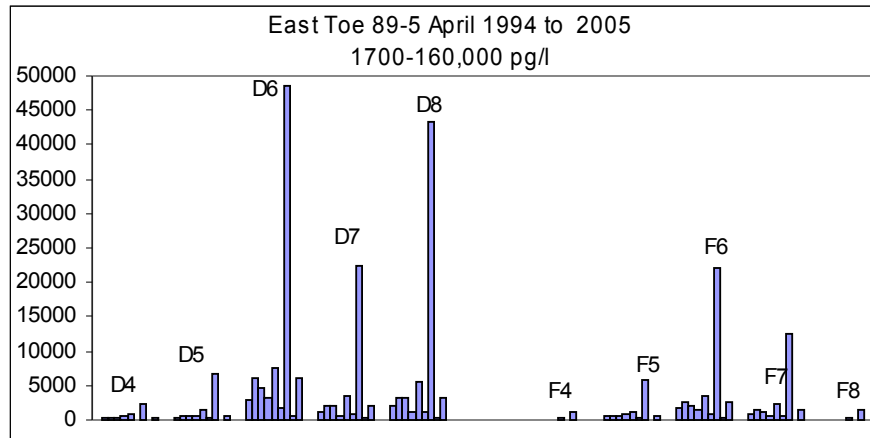
**Figure A18– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
 East Toe Well 89-5 Nov 2003**

89-5's Nov 2003 results are dominated by D5 and D6 with the most toxic forms. Oddly the most toxic form of D4 was not detected in the analysis.

This high D4, D5 and D6 pattern is similar to the pattern found in the 2007 ash in Figure A1 although there is no F4 and F5 and the TEQ is relatively lower.

Four samples from 1992, Dec 1999 and March and Dec 2005 have lower results from 238 to 2610 total pg/l.

Excluding the abnormal Nov 2003 results seen in Figure A18, the 11 sample results for total dioxins and furans from April 1994 to 2006 are displayed together in Figure A19.



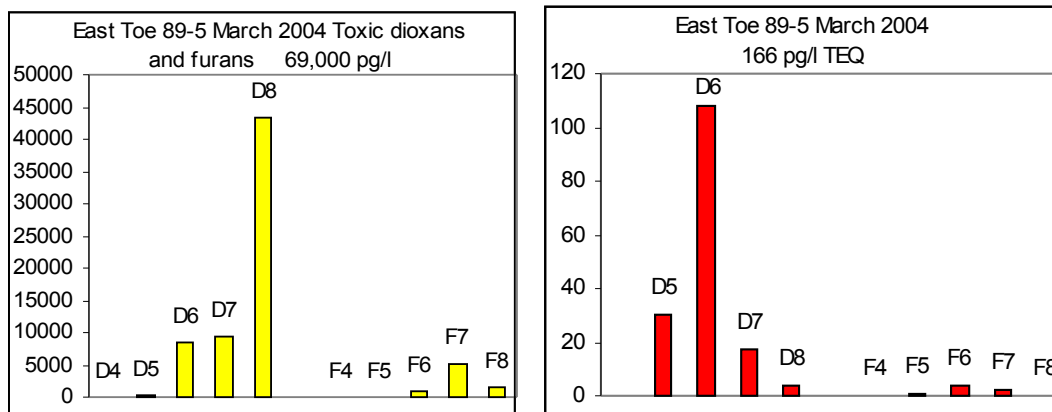
**Figure A19– Total Weight of all Dioxins and Furans
 East Toe Well 89-5 from April 1994 to 2006**

Figure A19 shows an ongoing similar pattern over 11 years with continued dominance by D6 dioxin and the F6 furan. The March 2004 results are very severe and more similar, in level to those of 1993 and Feb 1994.

The singular higher D4, D5, D7, D8, F8 and F7 results are all associated with Dec 2004’s single sample and very high D6 and F6.

Figure A19 indicates that the high toxic contamination surrounding landfill well 89-5 is an ongoing undiminished problem since 1994.

The March 2004 total toxic and TEQ results are displayed in Figure A20.



**Figure A20– Total Weight and TEQ of Toxic Dioxins and Furans
 East Toe Well 89-5 March 2004**

The toxic dioxins and furans are again dominated by D8 as seen in Figure A17. The TEQ/Total Toxic % of 0.24% is low as also seen in Figure A17.

The next well to the east is 99-4. This is a leachate recovery well installed adjacent to well 89-5 in 1999. As its sample contents were mixed with those of wells 99-2 & 5, it is discussed in the next section with those wells.

The next two wells are 95-13 and 95-6. Neither has available data.

2. The Slope to Powell Lake

2.1 Slope to Powell Lake North to South – Background Info

For the slope, the well results will also be displayed from North (Top of slope) to South (bottom of the slope) unless otherwise noted.

They are generally discussed and/or displayed from west to east along the section line identifiers employed by Agra Earth & Environmental in 1994.

The discussed results are from all available samples. The graphed results are selected to represent the patterns found.

The figures display Dioxin & Furan results. The left graph generally illustrates the total dioxins and furans in each family. The right graph is their TEQ values for the toxic forms.

For the transition from total weight to the TEQ value please see the additional graphs and discussion with Figures A8 & A9 and A16 and A17.

2.2 Section H-H (Top of the slope)

This line of wells only generally follows the H-H line.

The first western well on the north slope line is 94-4. No samples were available for this well.

The next well is 94-3.

In the available data 94-3 was sampled twice in March and April 1994. The March results are low with 248 pg/l total dioxins and furans, dominated by D8, as expected below the western toe. The April results are lower at 38 pg/l total.

The next well on the north slope line is 94-2.

In the available data 94-2 was sampled five times.

The March 1994 May and July 1995 results are all very similar. In April 1994 no dioxins or furans were detected. The March 1994 results can be seen in Figure A21 below.

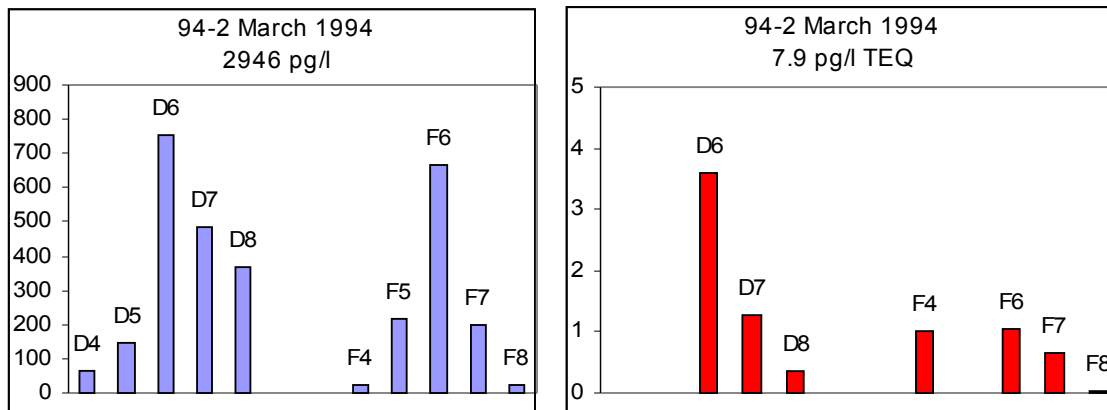


Figure A21– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Slope Well 94-2 March 1994

Slope well 94-2 is below toe well 89-1 and in the low point of Section H-H's contour line. Its results are very different from 89-1's April 94 results where only D8 was found.

The Nov 1995 results are shown in Figure A22 below.

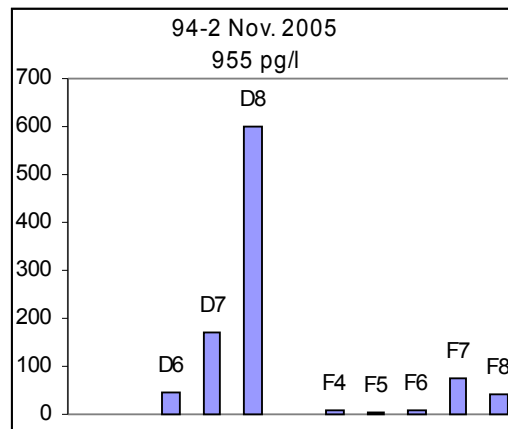


Figure A22– Total Weight of all Dioxins and Furans Slope Well 94-2 Nov 2005

This is the more expected result for a well below 89-1. No TEQs are available for the 1995 data.

The dioxins and furans from the landfill are moving down the slope.

The next well on the north slope line is 89-6. No data is available and this well was destroyed.

The next two wells on the north slope line are the recovery well 99-5 and AH6. They are adjacent and above Section H-H.

99-5 is a leachate recovery well installed in 1999. Its sample contents were mixed with those of wells 99-2 & 4.

With the installation of these recovery wells in 1999, the leachate recovery has concentrated on well 99-5. It has high water recovery rates and is below the very toxic area around well 89-5.

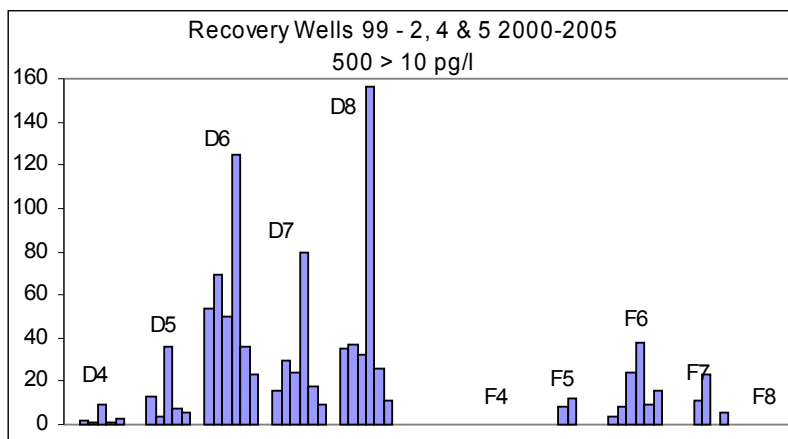
In 2003 a volume of 2505 cubic metres of leachate was removed from the landfill with over 99% of this recovered from well 99-5. Typical more recent % of recovery rates from well 99-5 are: 2002 – 97%, 2003 – 99%, 2005 – 93%, 2006 – 86% and 2007 – 90%.

As a result, the analysis results for the mix from wells 99-2, 4 & 5 will be discussed here.

With the commissioning of these wells, particularly 99-5, less emphasis was given to pumping from the 1995 recovery wells 95- 1, 8 & 9 more directly below the western toe.

The mix of wells 99-2, 4 & 5 was sampled seven times, once per year generally in Dec from 2000 to 2006.

The 2000 to 2005 total results can be seen in Figure A23 below. The 2006 results are very low and not shown.



**Figure A23– Total Weight of all Dioxins and Furans
Recovery Wells 99-2, 4 & 5 2000 to 2005**

Figure A23's total dioxin and furan results are low considering the location below the very toxic area around well 89-5. This appears mainly due to dilution with well 99-5's high water recovery rate.

The generally dominant D6 and F6 pattern matches the results from well 89-5 seen in Figure A19.

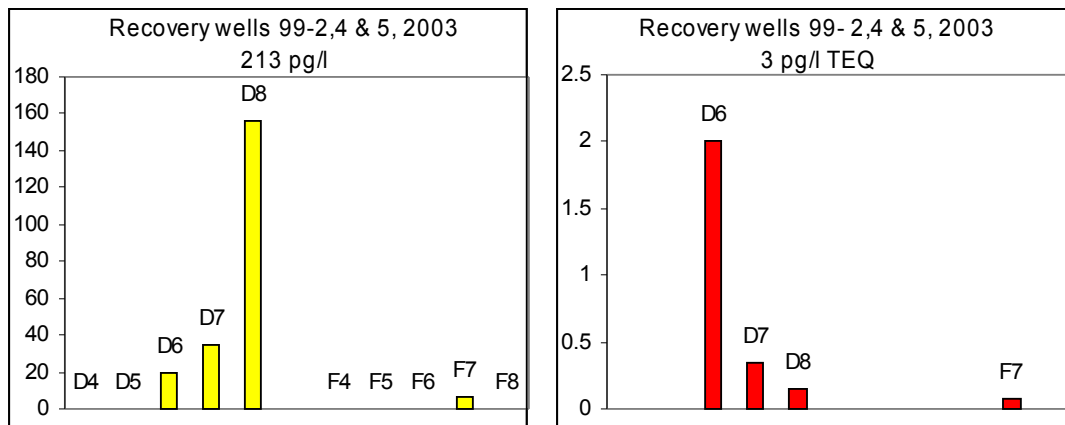
The main exception to this pattern is 2003 where D8 is dominant although the more toxic D6 and F6 remain high. This may be due to an influx of D8 dioxins from the western toe area.

The most important aspect of these results is that the toxic dioxins and furans from the landfill area around 89-5 are moving down the slope.

2003's results are the highest. The results then improve yearly to 2006. It is unclear whether this is due to dewatering of the toxic area around 89-5 or this is due to increasing dilution with increasing water flow and recovery rates.

The latter is the better possibility as dewatering of the toxic 89-5 area would leave its more highly toxic dioxins and furans in place.

The 2003 results, when 99% of the leachate was recovered from well 99-5, are examined further in Figure A24.



**Figure A24– Total Weight and TEQ of Toxic Dioxins and Furans
 Recovery Wells 99-2, 4 & 5 2003**

Figure A24's results are very similar to those for well 89-5 as seen in Figure A20. D8 dominates the total toxic weight and D6, which is 100 times more toxic, dominates the TEQ results.

Well AH6 is adjacent to Recovery well 99-5 and slightly above Section H-H.

In the available data AH6 was sampled fifteen times. Only one sample, Jan 94, was identified as from Depth A. The remaining 14 samples appear to be from depth B (or L) at 20 metres.

The Jan 94 results from Depth A at 10 metres are in Figure A25 below.

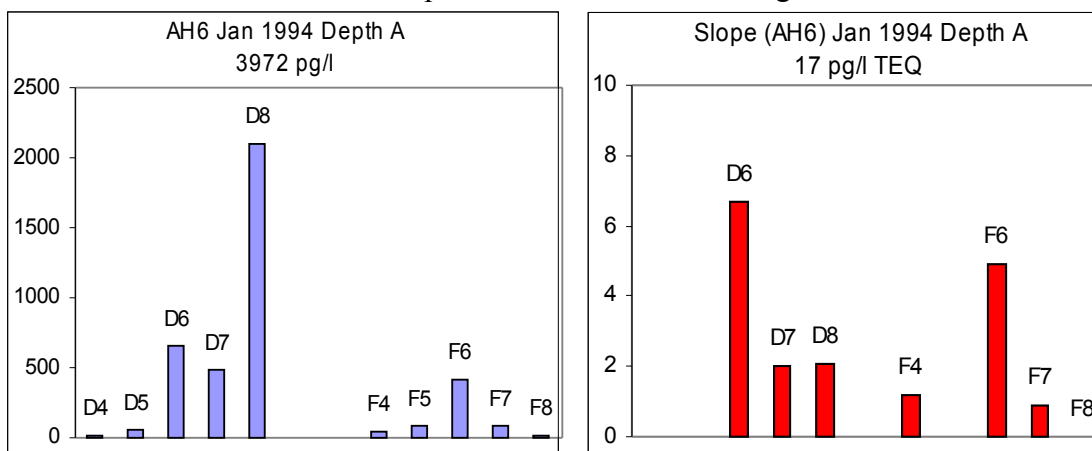


Figure A25– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Slope Well AH6 Depth A Jan 1994

Slope well AH6 is below toe wells 89-4 and 89-5. It is also in the low point of Section H-H’s contour line. AH6’s total results are clearly dominated by D8 similar to most of the landfill. The relatively more toxic components of D6 and F6 dominate the TEQ results.

Nov 95’s results at the lower depth B are similar.

The May and July 1995 Depth B results are displayed in Figure A26. No TEQ values are available for the families in 1995.

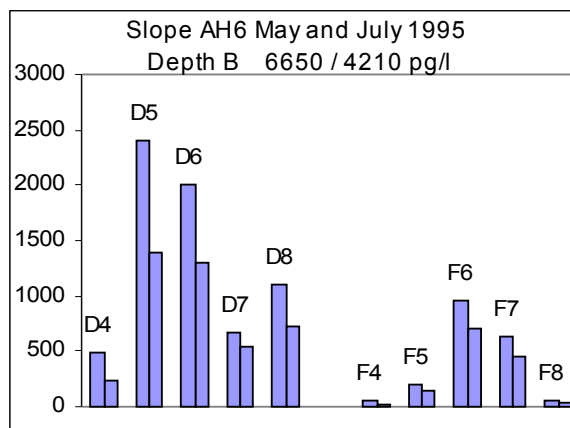
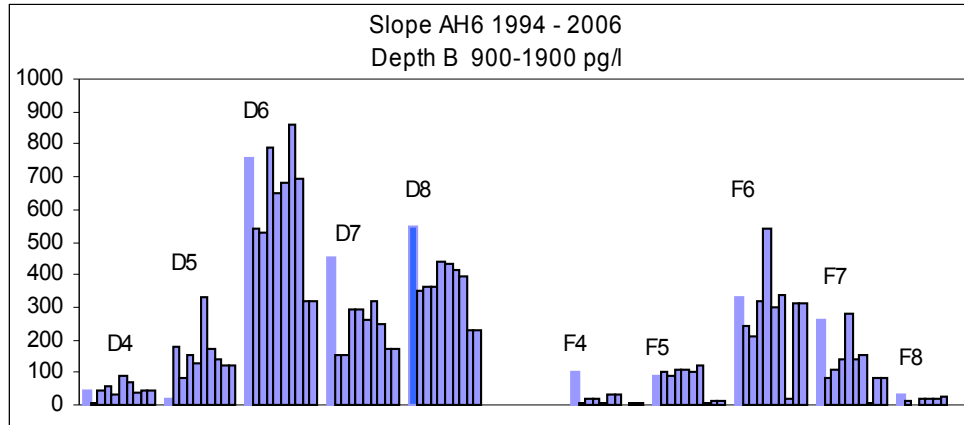


Figure A26– Total Weight of all Dioxins and Furans Slope Well AH6 Depth B May & July 1995

Figure A26 shows that, in May and July 1995, well AH6 is oddly dominated by dioxin D5. This appears to coincide with the asphalt cap of the landfill.

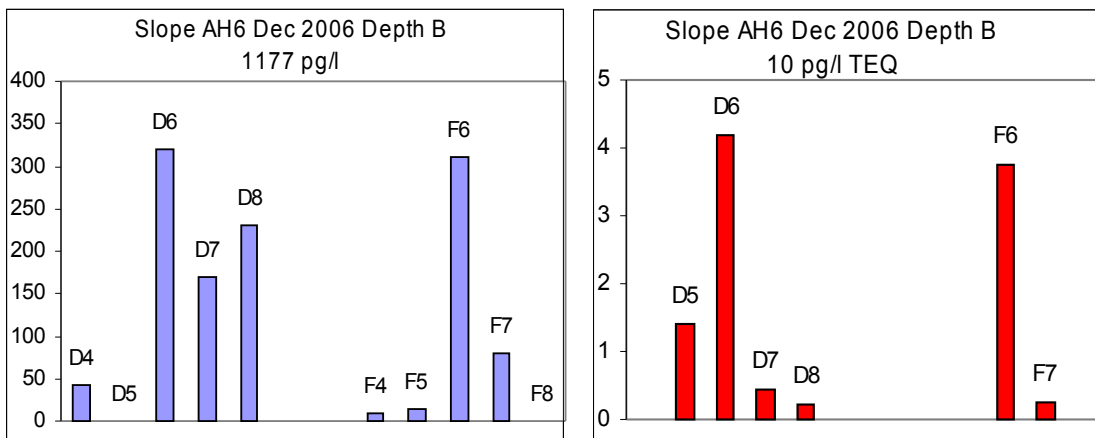
By Nov 95, the result has returned to Figure A25’s D8 dominance.

Ten samples from 1994 to 2006 show the more expected D6 – F6 dominance with this well’s location below the toxic area around well 89-5. 2005’s result is very low and not included. Their total dioxin and furan results are shown in Figure A27.



**Figure A27– Total Weight of all Dioxins and Furans
Slope Well AH6 Depth B 1994 to 1996**

Figure A28 displays AH6’s Dec 2006 results from Depth B at 20 metres.



**Figure A28– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
Slope Well AH6 Depth B Dec 2006**

Slope well AH6 is below toe wells 89-4 and 89-5. It is also in the low point of Section H-H’s contour line.

These AH6’s results are similar to those of the more toxic area around well 89-5.

In a north east direction above wells 99-5 and AH6 are wells 98-6, 98-4, leachate recovery well 99-2, 98-3, 94-6 and 94-7. There is no data available for these wells except for

- 94-6 which was sampled in 1994 with no dioxins or furans detected.
- 94-7 which was sampled in April 1994 with moderate D6 & F6 (420 pg/l total) detected.
- Recovery well 99-2 was mixed with the predominant samples from 99-5, discussed above.

Wells 94-1, 94-14 and AH4 are the closely grouped next wells to the east on Section H-H.

These three slope wells are below the leachate recovery well 99-5 which regularly comprises 90 to 99% of the leachate removed from the slope to Powell Lake below the landfill. These three wells are in a slight rise above 94-2's low point of Section H-H's contour line.

Some of the scatter and variability seen in the results at these wells is likely due to their positioning and the steady removal of leachate from well 99-5 above them irrespective of seasonal flow variation.

Well 94-1 is 65 metres deep and has five of six depths at which samples were taken. In the available data it was sampled 29 times at varying depths.

There was no available data for Depth 5 at 35 metres.

Well 94-1's Depth 4 at 40 metres has 1 available sample from March 94. It is dominated by D8 (47 pg/l) with significant levels of D5, D6 & F6 also detected.

Well 94-1's Depth 3 at 45 metres has 17 available samples.

It is unclear why 59% of the samples are from this depth as samples at lower depths such as B, the bedrock (the same height as the lake surface) at the base of the well are likely of equal or more importance.

The July and May 1995 Depth 3 results are incomplete and not discussed here.

In 5 samples - April 94, 1998, 2002, 2004 & 2006 - no dioxins or furans were detected. In 2001 and 2003 very low levels (<20 pg/l total) were detected.

4 samples are dominated by D8. They are March 94 - 245 pg/l D8, Nov 95 - 50 pg/l D8, May 2005 - 23 pg/l D8 and Nov 2005 - 50 pg/l D8. The 2003 sample has low levels (6 pg/l D8).

3 samples are dominated by D5. They are Dec. 1997 - 48 pg/l D5, 1999 - 380 pg/l D5 and 2001 - 6 pg/l D5.

Well 94-1's Depth 2 at 50 metres approximately has 4 available samples.

Only D8 is found in 3 of the 4 samples from March 1994 (195 pg/l D8), May (16 pg/l D8) and November (26 pg/l D8).

Very high levels of D6 & F6 (3730 pg/l total) occur in April of 1994. This likely originates from the toxic area around well 89-5.

Well 94-1's Depth 1 at 55 metres has 5 available samples.

No dioxins or furans were detected in July 95.

D8 is alone or dominant in March 95 (95 pg/l D8), May 95 (11 pg/l D8) and Nov. 95 (26 pg/l D8). D5 is relatively high in April of 1994 (76 pg/l D5).

Well 94-1's Depth B is in the bedrock at or near the level of Powell Lake. It has two available samples.

D8 dominates in March 1994 (61 pg/l D8). D5 clearly dominates in April 1994 (210 pg/l D5).

The patterns down the well are very scattered and variable. A much higher sampling interval would be needed to make any seasonal or changes in pattern clearer. In this data the dominant landfill D8 results and D6 & F6 from the 89-5 area are explainable even if the irregularity is not.

The odd result is the irregular new dominance by dioxin D5 with little or nothing else detected. This result is not explained and does not follow from anything in the landfill or above this well. D5 is highly toxic and the 1999 result of 380 pg/l at Depth 3 and 210 pg/l at bedrock are a concern on the slope to the lake below the recovery wells.

It should be noted that six samples analyzed from Powell Lake display this pattern.

Well 94-1's Depth 2 at 50 metres has 2 samples in March and April 94.

March 94's Depth 2 results also contain only D8 at high levels of 195 pg/l total and toxic.

April 94's Depth 2 (50m) results are displayed in Figure A29 below.

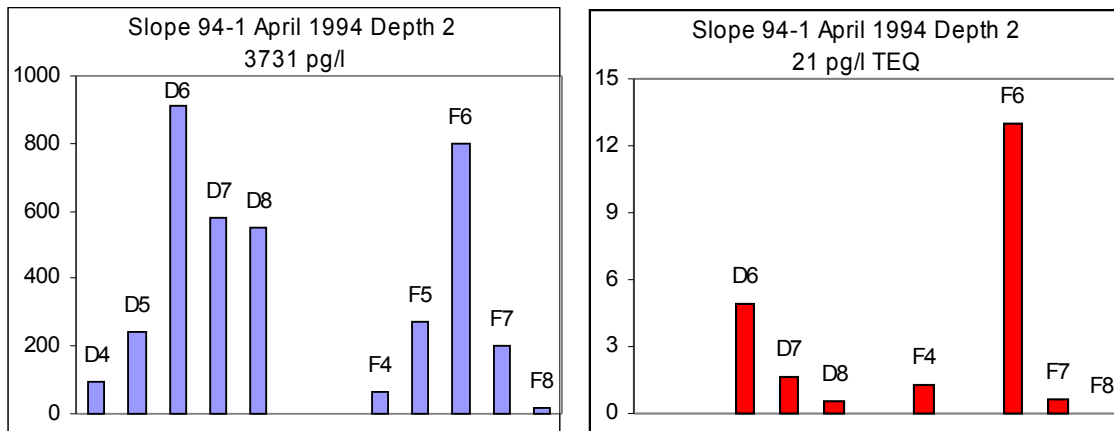


Figure A29– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Slope Well 94-1 Depth 2 April 1994

In April 94 well 94-1's Depth 2 result has the full range of dioxins and furans with D6 and F6 at the highest levels. As this well is below well 89-5 which strongly displays this pattern compared to the more common D8 dominance of the landfill this is, in some ways, the more expected result.

Well 94-1's April 94 Depth 1 result is unusual with its dominance by D5. The reasons for the large difference between this result and the same day sample 5 metres higher in the same well at Depth 2 in Figure A29 is odd.

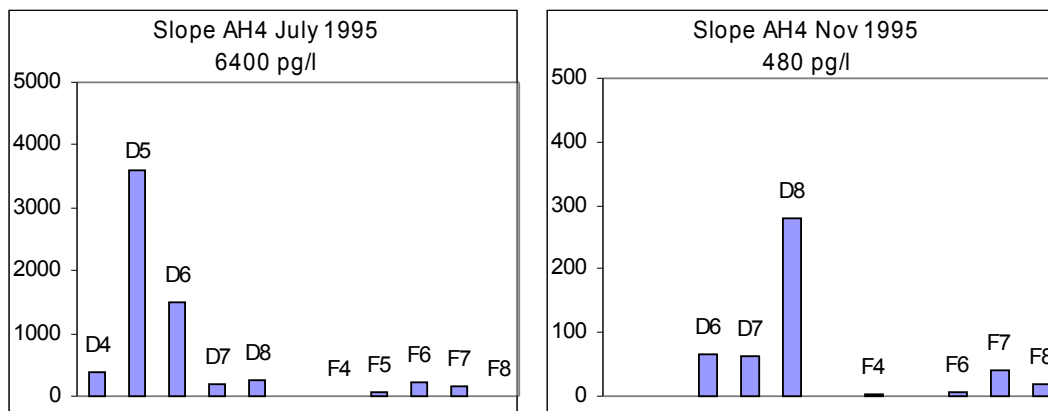
There are no samples available for well 94-14, adjacent to well 94-1.

Adjacent well AH4 was sampled 6 times from 1993 to 1995. It is approximately 10 metres higher than well 94-1's most shallow well sample depth 5 of 35 metres.

AH4's results are oddly higher than well 94-1. This may be due to lower dilution.

In the 1993 to May 1995 results D6 (230-410 pg/l) and F6 are the highest dioxins and furans detected with significant results in other forms. The Nov 1995 result is lower and dominated by D8 at 280 pg/l.

The July 1995 and Nov 1995 total results can be seen in Figure A30.



**Figure A30– Total Weight of all Dioxins and Furans
Slope Well AH4 July & Nov 1995**

In Figure A30 well AH4's July 95 results are dominated by D5. As discussed with well 94-1 this is an unusual result. The Nov 1995 results in the right graph return to a more normal, for the landfill, D8 dominant result. The furans are low and variable.

This pattern in 1995 occurs with some regularity further down the slope. It appears that it may be related to the capping of the landfill in 1995 and the work around well 89-5 incorporating some its toxic landfill material into the cap with the D5 running off the new cap and onto the slope.

This change, irrespective of source, illustrates the flow down the slope.

There is no TEQ data for the individual families in the 1995 data. The total TEQ for July is 18.2 and for Nov is 9.1 pg/l. For Nov 95's lower total 480 pg/l result dominated by the less toxic D8 this may be reasonable. However, for July 95's higher 6400 pg/l total result, dominated by D5 with a portion of the family being a toxic form 500 times more toxic than D8, the TEQ result appears low.

The last two wells on the H-H line are 94-5 and 94-13 on the eastern boundary of the slope. They are adjacent and are higher in the rise above 94-2's low point of Section H-H's contour line than wells 94-1 and AH2.

There is no data available for well 94-5.

Well 94-13 on the east margin is sampled in April of 1994. It is dominated by the D6 and F6 pattern (340 pg/l total) originating with the toxic area around well 89-5.

This importantly indicates that the toxic contamination from well 89-5 has migrated down the slope to and potentially beyond the eastern margin. Leachate in this area is not well addressed with the present recovery wells. This well and area was not sampled after 1994.

The TEQ result for this sample is 1.05% of the total. This is the expected result for a D6 & F6 pattern. 10 to 15% of the total in each family is toxic and the TEQ value assigned to D6 and F6 is 0.1.

2.3 Mid Slope between Sections H-H & I-I

The first well on this line is 94-9. It has no available data. This is unfortunate as it would provide data on the flow down the western slope from the high D8 results found at the western toe of the landfill.

The next mid slope well to the east is AH3.

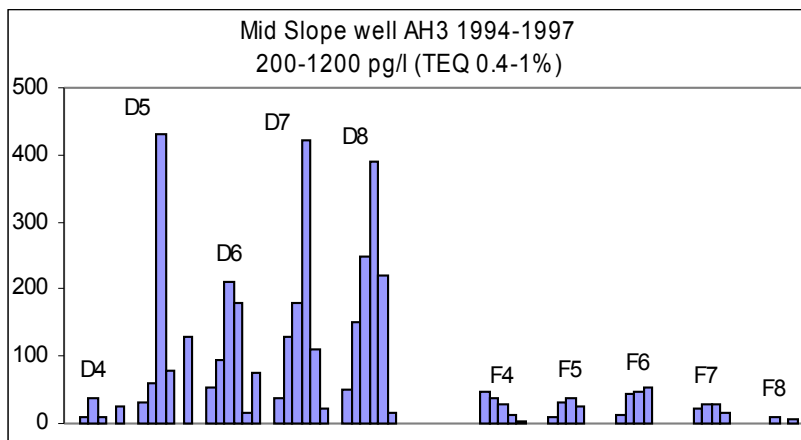
It is a shallow 10 metre deep well.

In the available data AH3 was sampled 18 times from 1992 to 2006.

In one 1992 sample a total of 3900 pg/l dioxins and furans has a TEQ of 39 pg/l (1% of the total), with 84% (34 pg/l) of this originating with dioxins.

1993's result is 219 pg/l total with D7 at 80 pg/l higher than the more normal D6, D8 and F6 results.

The 1994 to 1997 results show a variety of patterns. The Jan and April 1994, May, July and Nov 1995 and Dec 1997 results are shown in Figure A31 below. There was no available data for 1996.



**Figure A31– Total Weight of all Dioxins and Furans
Mid Slope Well AH3 1994 to 1997**

1994's results are similar to 1992 and 93.

In 1995 a very high D5 appears in May, begins to die away in July and is gone by Nov 1995. This appears to match the pattern of high D5 dominance appearing on the slope in 1995 with the capping of the landfill as seen in Figure 30 at well AH4. D5 levels increase in 1997 but do not approach the May 1995 result.

D6 and F6 remain the most consistent underlying pattern, likely originating with down slope contamination from the well 89-5 area.

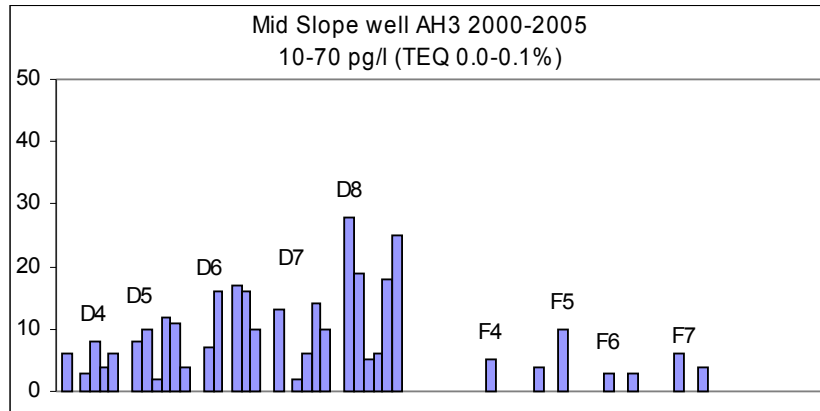
D7 is surprisingly high, build slowly and spikes in July 1995 to very high levels. Further sampling would have been required to identify an origin for this D7 result. It also appears strongly in the Recovery well mix from wells 95-1, 8 & 9 in 1997 in Figure A13. After July 95, D7's levels diminish.

Excluding the high D5 and D7 results discussed above, D8 dominance remains a consistent underlying pattern, likely originating with down slope contamination from the western toe area.

After 1995 the results generally diminish further. This may reflect the leachate removal concentrated at recovery wells 95-1, 8 & 9 during this period.

In the 1998 and 1999 samples, only D4 was detected at 400 and 13 pg/l. These results are abnormal and difficult to discuss further. However, it should be noted that D4 is appearing here mid way down the slope in 1998 & 99 and appears in the lake in two 2001 samples.

The Dec 2000, 2001, 2002, Nov 2003, Nov 2004 and 2005 sample results are shown in Figure A32. No dioxins and furans were detected in Dec 2006.



**Figure A32– Total Weight of all Dioxins and Furans
Mid Slope Well AH3 2000 to 2005**

Generally, the 2000 to 2005 results are much lower than those seen previously at this well. This likely reflects the increased leachate recovery rate with the advent of recovery wells 99-2, 4 & 5, particularly 99-5 in 2000.

The last well to the east on this line is 94-8. It has no available data. This is again unfortunate as it might provide data on the flow down the eastern slope from the more toxic D6 and F6 results found at the eastern toe of the landfill around well 89-5.

2.4 Section I-I (before the steeper pitch to the lake)

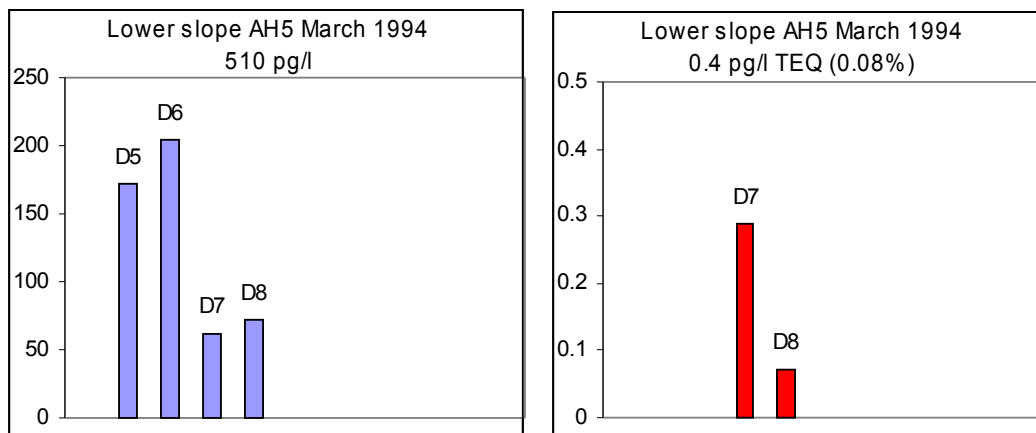
The first two wells on the west end of Section line I-I are 94-11 and 94-17.

Wells 94-11 and 17 are at the low point in the Section I-I contour line. I-I's contour line climbs as you move further east.

There is no available date for well 94-11.

Well 94-17 was sampled in June 1994. Only D8 (26 pg/l) was detected as expected below the western toe. It should be noted that 28 pg/l occurred in the blank. It is again unfortunate that there are no samples after 1994.

The next well to the east is AH5. AH5 is above well 94-17. In the available data, AH5 was only sampled once in March 1994 at Depth B. The depth is unknown. The results are in Figure A33.



**Figure A33– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans
Lower Slope Well AH5 March 1994**

AH5's Figure 33 results are odd. The high D5 predates the 1995 capping of the landfill and may originate with 1994 landfill activity. Well AH5 is on the western side of the landfill away from well 89-5's high D6 migrating down the slope. Potentially Section I-I's counter slope downhill to the east may be involved.

The lack of toxicity in D5 may be due to the rarity of the toxic form in the D5 family but the lack of toxicity in D6 is difficult to explain. Note the complete lack of detected furans.

The next two wells to the east are the adjacent 94-12 and 16 on the I-I section line.

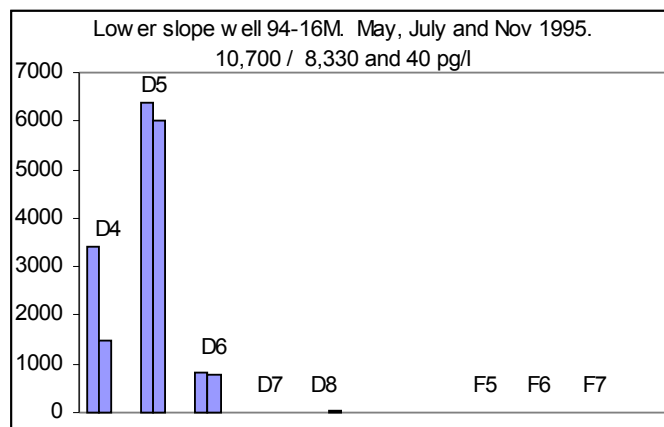
There is no available data for well 94-12.

In the available data well 94-16 was sampled 33 times. 94-16 has four sample depths.

Depth U at 10 metres was sampled 4 times. In June 1994, low D6, D7, D8 & F6 were detected (25 pg/l max). In May and July 1995, the results were dominated by a

sudden appearance of D5 dominance at 1900 and 4000 pg/l. In Nov 1995 no dioxans or furans were detected.

Depth M at 30 metres was sampled 4 times. In June 1994 only D5 was detected at low levels of 95 pg/l. The May, July and Nov 1995 results are displayed in Figure A34.



**Figure A34– Total Weight of all Dioxins and Furans
Lower Slope Well 94-16 Depth M May, July & Nov 1995**

In Figure A34's 1995 results for well 94-16 at Depth M, D5 suddenly dominates in May, decreases slightly in July and disappears in November where low levels of D8 dominate. This continues to match the 1995 pattern seen at several places on the slope to the lake and continues to potentially be associated with the capping of the landfill. Depth U and L's 1995 results are similar.

Depth L at 40 metres was sampled 12 times. No Dioxans or Furans were detected in June 1994, Dec 1997, 2000, 2001, 2003, 2005 and 2006. The May, July and Nov 1995 results are similar to Figure A34 with D5 appearing in May at 360 pg/l, increasing to 860 pg/l in July and disappearing in November. Nov 95's result is dominated by D8 at 65 pg/l.

After 2000 the results generally diminish. This likely reflects the leachate removal concentrated at recovery wells 99-2, 4 & 5, particularly 99-5, during this period.

Depth B, bedrock at 50 metres was sampled 13 times. This is at lake level.

No dioxins or furans were detected in June 1994, Nov 1995, Dec 1997, 2000, 2001, 2002 and 2006. The May, July and Nov 1995 results are very different than those found at the higher depths with no appearance of high D5. The reason is unclear. The May and July results are dominated by low D8 at 11 and 8 pg/l, close to the detection level.

1999, 2003, 2004 and 2005 results are all dominated by low D8 levels from 5 to 70 pg/l. These are low to mid range results for bedrock but the dominant D8 is making its way down to bedrock and lake level.

Well 94-10 is above 94-16 on the slope.

94-10 has a single sample from April 1994. Its results are shown in Figure A35.

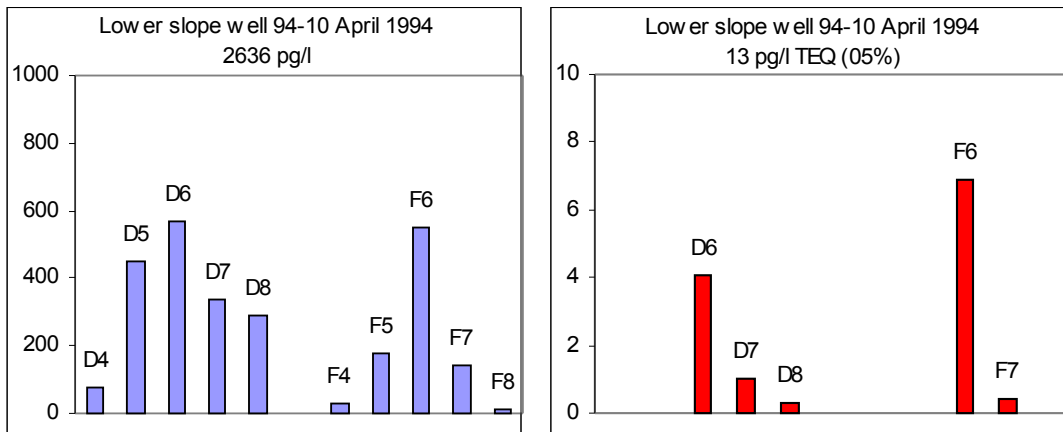


Figure A35– Total Weight of all Dioxins and Furans and TEQ of Toxic Dioxins and Furans Lower Slope Well 94-10 April 1994

Well 94-10 is 10 metres deep and below well AH3 where D6 & F6 are the consistent underlying pattern. The D6 and F6 pattern is originating with the eastern toe and the toxic area around 89-5.

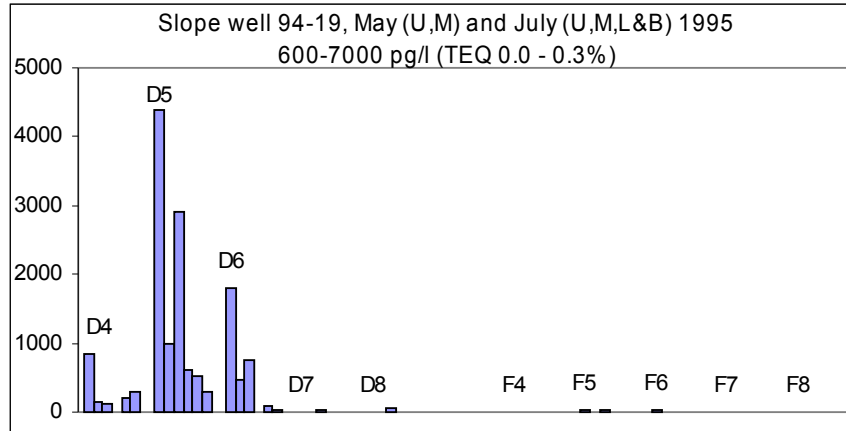
The next wells to the east are 94-19 and 94-15. 94-19 is on section line I-I and 94-15 is slightly above it. Both are on the high side of section I-I's upslope to the east. There is no available data for 94-15.

Well 94-19 is sampled 4 times at each of 4 depths in 1994 and 1995. In all 4 of the June 94 samples no dioxans or furans were detected. Again no samples were available after 1995.

The Upper depth, 94-19U, is 40 m. deep, about 5 meters above Powell Lake and the same levels as seen at 94-16M. Depth M is 45 metres, Depth L is 50 metres and bedrock (B) is at approximately 55 metres.

The May, July and Nov 1995 results display the same 1995 pattern seen at several other slope locations with high D5 suddenly appearing in May and July results and virtually disappearing by Nov 1995 when it's replaced by a low more normal D8 pattern.

The results for Depths U & M in May 95 and all 4 depths in July 95 can be seen in Figure A36.



**Figure A36– Total Weight of all Dioxins and Furans
Lower Slope Well 94-19 Depths U&M May and
Depths U, M , L & B July 1995**

The TEQ value for D5 is relatively high at 0.5. This toxicity is not reflected in the low TEQ results. In Nov 95 the dominant D8 results for the depths are U – 15, M – 15, and L – 20 pg/l total. No dioxans of furans were detected in the Nov 95 Depth B results.

Well 93-3 is above well 94-19.

In the available data it was sampled in April 1994 with no dioxins or furans found. In Jan 94 a very low level of F4 (29 pg/l) was detected with 19 pg/l in the toxic form. This well was later destroyed

Well 00-1 is above 93-3. It has no available data.

Well 94-18 is the last well to the east on Section line I-I. It has 4 depths U, M, L and B at similar levels to well 94-19.

In the available data it was sampled at all 4 depths in June 1994. No dioxins or furans were detected at the upper and bedrock samples. In the M and L samples low levels of only D8 were found at 11 and 15 pg/l.

2.5 Bottom of Slope at Lake (below the steeper pitch to the lake)

There are five springs at the lake, S1 to S5 from west to east. There is a well 98-5 at Spring S1. It has no available data.

All five samples, one for each spring in Jan1994 are omitted from discussion as only low F4 is detected and it was introduced from the blank.

S1 is the first western spring it is inset from the landfill western boundary. It is the most commonly sampled spring. In the available data it was sampled 32 times.

No dioxins or furans were detected in the Sept 1997, Dec 2000, Oct & Nov 2004, Aug & Dec 2005 and Dec 2006 samples.

The sample from 1993 is dominated by D8 and D6 & F6 at 47, 28 & 22 pg/l total respectively. It should be noted that for this sample 77 pg/l given as the detection level for D5 only compared to a more normal 5 pg/l.

Two S1 samples with low D8, in Dec 98 and Dec 99, are included. They are noted as NDR.

Spring 2 was sampled in 1992, 1993 and April 1994. In 1993's result no dioxins or furans detected. Its 1992 results are included in Figure A38 and the April 94 results in Figure A39.

Spring 3 was sampled in 1993 and April 1994 with no dioxins or furans detected.

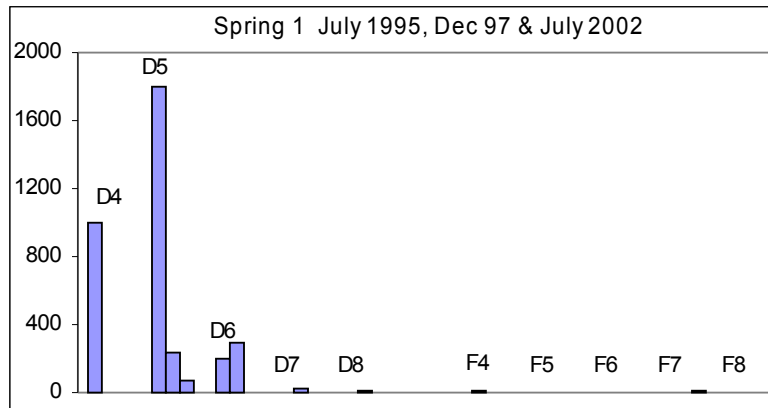
Spring 4 was sampled in 1992, 1993 and April 1994. In 1993 and April 1994 no dioxins or furans detected. Spring 4's 1992 results are in Figure A39.

Spring 5 was sampled in April 1994 with no dioxins or furans detected.

The Spring results are varied. The variation is best summarized and includes:

- 3 sample results dominated by high levels of D5
- 9 sample results with D8 detected alone or dominant at low to mid range levels
- 14 sample results with low levels of individual dioxins and furans (<50 pg/l) generally dominated by D8 or D5 with one high D6 result.

The July 1995, Dec 1997 and July 2002 results with higher levels of D5 are shown in Figure A37.

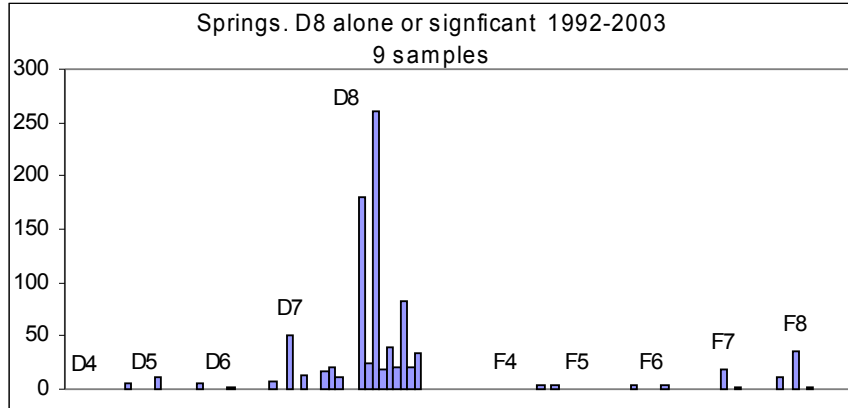


**Figure A37– Total Weight of all Dioxins and Furans
Spring 1 July 1995, Dec 1997 & July 2002**

Figure A37's very high July 1995 D5 result was seen at several slope locations and coincides with the capping of the landfill and the work around well 89-5 to incorporate some of its toxic surrounding soil in the cap.

The lesser but still high Dec 1997 and July 2002 results may reflect D5's migration down the slope.

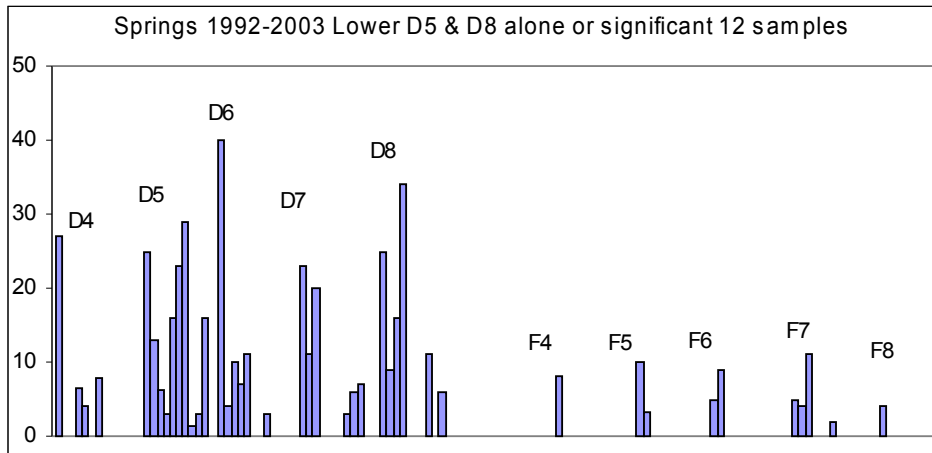
The 9 sample results with D8 detected alone or dominant at low to mid range levels are in Figure A38 below. The first two graphed samples are from Spring 2 in 1992 and April 1994 with all the subsequent samples from Spring 1.



**Figure A38– Total Weight of all Dioxins and Furans
Springs 1 & 2 1992 to 2003**

This is the most commonly expected result at the springs with the common D8 dominance in the landfill, at the western toe and on the slope to the lake.

The 14 sample results with low levels of individual dioxins and furans (<50 pg/l) generally dominated by D8 or D5 with one high D6 result are shown in Figure A39. The first two graphed samples are from Spring 4 in 1992 and Spring 2 in April 1994 with all the subsequent samples from Spring 1.



**Figure A39– Total Weight of all Dioxins and Furans
Springs 1 & 2 1992 to 2003**

Note the high D4 co-incident with the high D5 in the 1992 results from Spring 4. D4 was also detected alone in the Dec 2001 result from Spring 1.

In general, the dioxans and furans detected in the springs at the bottom of the slope are dominated by D5 and/or D8.

The lack of data at Springs S2 to S5 after 1995 limits any across slope pattern identification.

3. Powell Lake

In the available data, water from Powell Lake was sampled 30 times.

The lake is a remarkably large dilution source and the results are generally low as would be expected. Due to the high dilution only the more dominant landfill and slope dioxins or furans are detected.

There were no dioxins or furans detected in 16 samples from Aug 1997, Dec, June & Sept 1998, Dec & March 1999, March 2000, March & Dec 2001, Aug 2003, Aug, Oct & Nov 2004, Aug and Dec 05 and 2006.

D8 is higher in the blank in Aug. 2000 sample and is omitted. D5 occurs in the blank in June 2000 and the sample is retained.

In June 1997 only furans are detected. The TEQ is 9% of the total.

Six samples contain mainly or only D8, the generally dominant landfill result. They are from March 1998, June and Aug. 1999, Dec. 2000, Jan 2003 and Dec 2005.

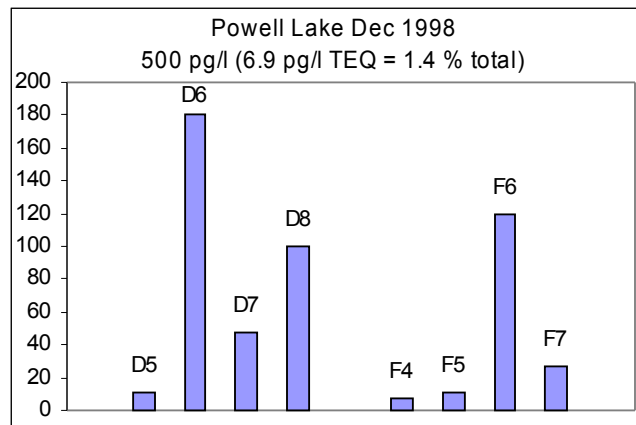
These samples range from a total D8 detected of 2.8 pg/l in Dec 2005 to 36 pg/l in June 1999 and average 19.6 pg/l total D8. When Dec 1998's 100 pg/l D8, discussed below, is included the detected D8 average climbs to 31.1 pg/l.

D5 or D4 are detected alone or dominant in six samples: June 2000, June and Sept 2001 (both just D4), Jan (D5 with D4) and Oct 2002 (D5) and in Aug 2006 (D5 with low D4). D5 appears in the blank in June 2000 - the sample is kept. D5 is commonly detected on the slope to the lake below the landfill, often at high levels and in combination with D4.

More strikingly, the results found at the springs are dominated by D5, often with accompanying D4 and by D8 as seen in the preceding Figures A37 to A39.

When combined with the landfill and slope results, it is remarkably simple to conclude that the dioxins detected in the lake are originating from the landfill.

Some evidence of D6 - F6 dominant results from the very toxic area around landfill well 89-5 would be expected. Considering the high dilution in the lake, the Dec 98 results appear to answer the expectation and are seen below in Figure A40.



**Figure A40– Total Weight of all Dioxins and Furans
Powell Lake Dec 1998**

Figure A36's high lake results are dominated by the D6 – F6 pattern found at the toxic area around well 89-5. Note that D8 is also high.

It must be noted that these results, at 500 pg/l, are 7.8 times higher than the next highest lake total dioxin and furan result of 64.1 pg/l in Jan 2002. However, they do occur in 1998 prior to the 1999 installation of recovery well 99-5. The 1995 leachate recovery wells' data indicates that they did not recover D6 – F6 dominated toxins originating from the well 89-5 area. See Figures A12 and A13.

Well 99-5 recovers some of the very toxic material originating from the well 89-5 area. December is quite often a high rainfall and groundwater flow month. Recovery well 99-5, below 89-5, shows a pattern of pulsing or slugging high levels of D6 – F6 as can be seen in the 2003 results in Figure A23. Well 89-5 itself also shows a pattern of pulsing or slugging high levels of D6 – F6 as can be seen in the March 2004 results in Figure A19.

It is therefore possible that a large slug of 89-5 area toxins made its way to the more quickly flowing water recovery area around the future well 99-5 area and to the lake in this period. It could then preferentially be carried by the river flow to the mill filter house where these lake samples were generally taken.

These results are similar to the very toxic results found at well 89-5 in Figure A16 and remarkably similar to the results found on the slope to the lake below well 89-5 at well 94-2 in Figure A21 and well AH6 in Figure A28.

This is another striking indication that the dioxins and furans detected in the lake are originating from the landfill.