

Permit Review 9

LAWRENCE COAL COMPANY, HARTLEY STRIP MINE (PERMIT # 30713008)

Site Summary

The Lawrence Coal Company, Inc. Hartley Strip mine operation is located in Monongahela Township, Greene County, Pennsylvania, in the Lower Monongahela Priority Watershed 19D. Over 300,000 tons of conventional PC fly and bottom ash from the Hatfield's Ferry Power Plant were placed on 30.3 acres of the site. The purpose of the operation is not clear from permit materials. It may have been simple "placement" to fill a pit on the site or as alkaline addition to remediate AMD problems. Information in the permit indicates the ash had been placed in the mine previous to this permitted operation but do not provide the locations for that placement.

Four monitoring wells were installed at the Hartley Strip ash placement area, two downgradient wells (MW-1 and MW1-A) and two upgradient wells (MW-2 and MW2-A). Operations started in 1988, and monitoring continued until 1998.

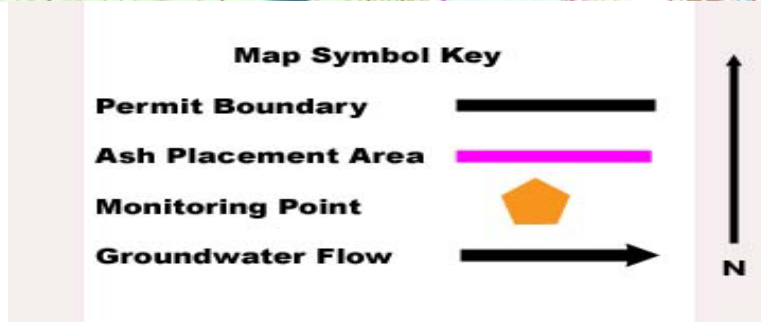
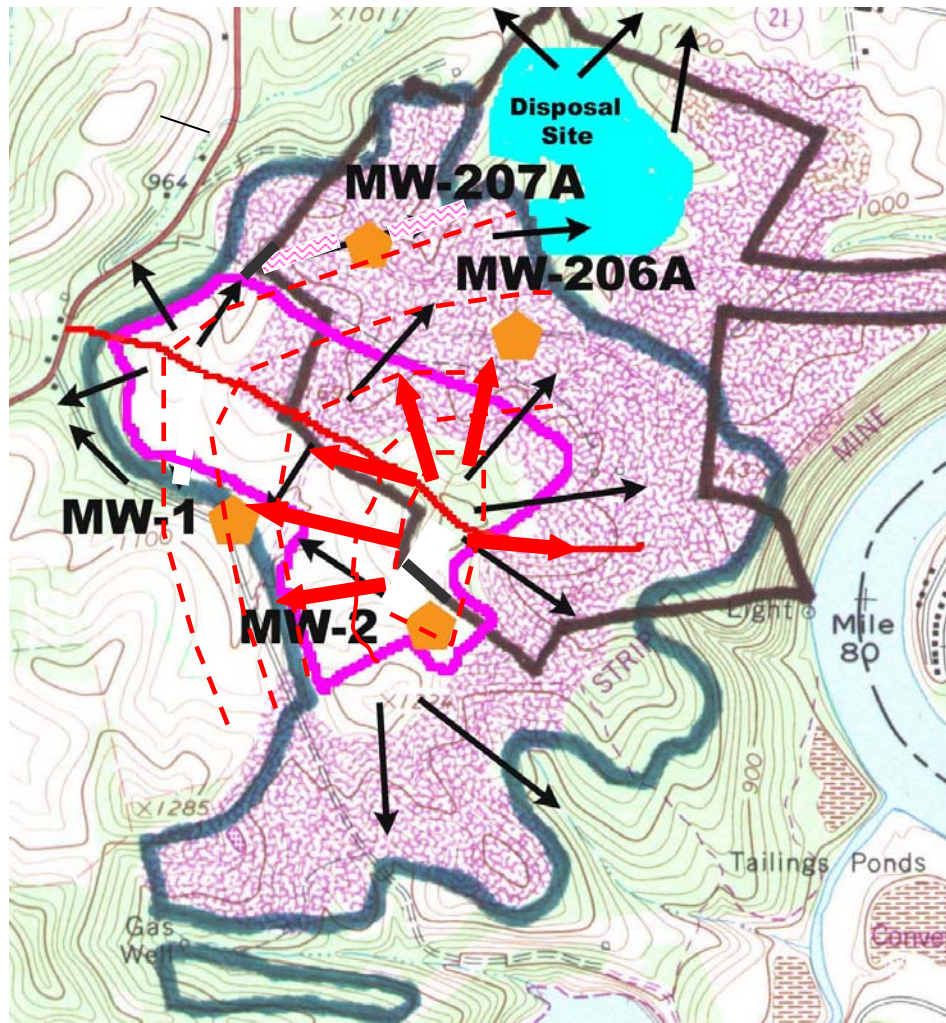
The northeastern half of the Hartley Site has become a coal ash landfill utilized for disposal of ash generated by the Hatfield's Ferry Power Plant. The mining operation has ceased but the landfill is still operating. Two monitoring wells installed as upgradient wells for the landfill, MW-206A and MW-207A (not operated under Surface Mine Permit 30713008) are probably affected by earlier ash placement from the Hartley Strip operation. These additional landfill wells provide insight into the impacts occurring from the Hartley Strip operation because of their location and the greater range of parameters measured at these wells under PADEP's residual solid waste program, including ash indicator parameters boron and molybdenum. The map below shows the original Hartley permit boundary in dark green, and the present Hatfield ash landfill disposal area shaded in light blue. The portion surrounded by the pink line was the ash placement area for the Hartley permit.

Geology

The two coal beds mined at the Hartley Strip operation were the Waynesburg Coal and the Waynesburg "A" Coal which is about 70 feet above the Waynesburg Coal. The Pittsburgh Coal is about 350 feet below the Waynesburg Coal. . The Pittsburgh seam was deep mined underneath this site, below the water level of the nearby Monongahela River although there is enough separation hydraulically that flow between the River and the deep mine is unlikely to affect shallow groundwater flow in the spoil and ash from the ridge at the Hartley site.

A structural syncline (the “trough” between two anticlines) runs across the center of the Hartley site. The structural attitude of the sedimentary beds is a dip (or inclination direction) towards the centerline (axis) of the syncline. This structure also probably does not significantly affect relevant surface and shallow groundwater flow directions.

Site Map: Hartley



**Lawrence Coal Company, Hartley Strip Operation (Permit # 30713008)
Scale: 1" = Approximately 1000'**

Topography

The regional topography is typical of the Pittsburgh Low Plateau section of Pennsylvania. The Hartley mine occupies the top of a hill (see map) with valleys trending down southeastward and northeastward towards the Monongahela River. A ridge, represented by the solid red line on the map above, that trends northwest/southeast divides the site into two roughly equal portions.

Groundwater

According to the permit, MW-1 and MW-2 are monitoring shallow groundwater in the spoil aquifer created from previous mining on the site. Permit information indicate that MW1-A and MW2-A are monitoring water at deeper depth. Monitoring reports for 1988 document an average static water elevation (elevation above seal level) in three measurements at MW-1 of 1049 feet and a average static water elevation in three measurements at MW-2 of 1078 feet. The dashed red lines on the map above are a conceptualized potentiometric surface depicting a radial flow pattern of shallow groundwater through the site based on these static water elevations and the flow directions described in the permit, depicted by the black arrows.

This map indicates groundwater is flowing through the disturbed portions of soil, rock and ash from MW-2, the upgradient well, to MW-1, the downgradient well. However as MW-2 is within the ash placement area and screened in the spoil aquifer, it might also measure impacts associated with ash contamination should ash be placed upgradient to the well. Unfortunately the authors of this review could not find information on specific ash placement configurations or the actual locations of ash deposits within the ash placement area.

Wells 206A and 207A for the Hatfield landfill are downgradient of flow moving north from the divide. Unlike the mine wells, the “A” in their label signifies their depth in the shallow spoil aquifer of the Hartley Mine, as opposed to being screened in the Uniontown Sandstone and Benwood Limestone underneath the mine and landfill as other landfill wells are. Hereafter this review will identify them simply as MW-206 and MW-207. On the north side of this ridge, groundwater flows mostly north and northeast from the Hartley ash placement area toward these two wells making them downgradient of the Hartley ash site but upgradient of the ash disposed in the Hatfield landfill. On the south side of this ridge, groundwater flows mostly to the southwest and the southeast into valleys bordering these portions of the site.

Components of shallow groundwater at the site also flow west and northwest into a valley and tributary draining to the northeast and then into the Monongahela River, via Little Whitely Creek. Little Whitely Creek is contaminated with high levels of boron, sulfate and molybdenum according to surface water monitoring data collected for the adjacent Hatfield coal ash landfill.

Groundwater monitoring data: Discussion

MW-1

Monitoring wells MW-1 and MW-2 were selected for analysis within this report. The monitoring reports for these wells do not indicate whether concentrations reported are for dissolved or total concentrations of analytes. The data collected for the Hatfield wells (discussed later) do differentiate, and in such instances, only dissolved values are assessed in the discussion of data from MW-206 and MW-207.

The first four graphs (figures 9.1 through 9.4) plot the concentrations of iron, manganese, sulfates, acidity, and trace elements for downgradient MW-1.

Initially, iron and manganese (figure 9.1) and sulfates (figure 9.2) were monitored only for a 1-year period in 1988. The next monitoring data for the major elements found in the permit are dated from mid 1995 onward, with a resulting 6-year data gap. No baseline data were found in the permit files. Review of the graphed data for iron and manganese suggest that there is a general upward trend in concentrations for iron but a less clear trend for manganese, with the highest value, 4.74 mg/L in September 1997, occurring in more recent monitoring but all other recent concentrations of manganese below levels reported in 1988. Sulfate concentrations generally appear to decrease over time, suggesting some remediation of AMD from reclamation activities and possibly from the placed ash. Acidity is increasing (figure 9.3) towards the end of the monitoring period even though it is only reaching levels one-tenth the peak in acidity that occurred in November 1988 (420 mg/L). Nonetheless the rise in acidity and peaks of iron and manganese from 1995 onward probably reflect mining operation disturbances.

Figures 9.3A and 9.3B are plots of lab pH and alkalinity, respectively at MW-1. Field pH data, which are generally considered to be more reflective of actual groundwater pH, were not recorded in the monitoring sheets within the permit files. The large data gap makes interpretation difficult. An extremely low lab pH of 2.9 units measured in November 1988 may have been an outlier, but is corroborated by a very high acidity and low alkalinity recorded in the November 1988 sampling. Notwithstanding the low November 1988 pH reading which produces a slightly upward trend line for pH, these data appear to reflect slightly declining alkalinity and increasing acidity over time at MW-1.

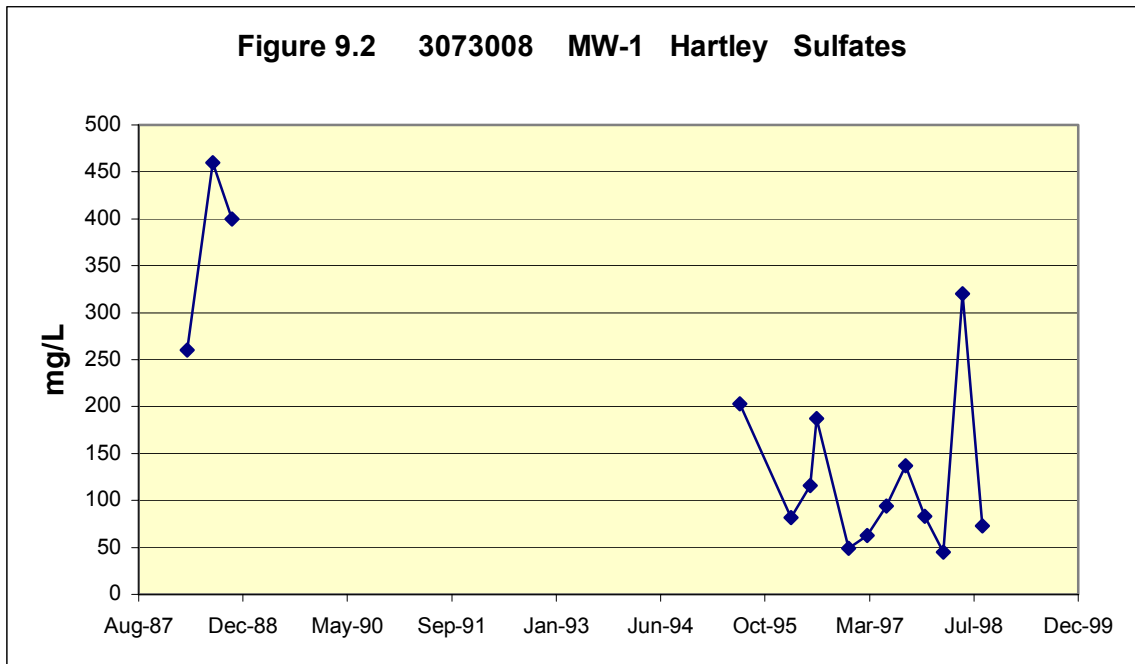
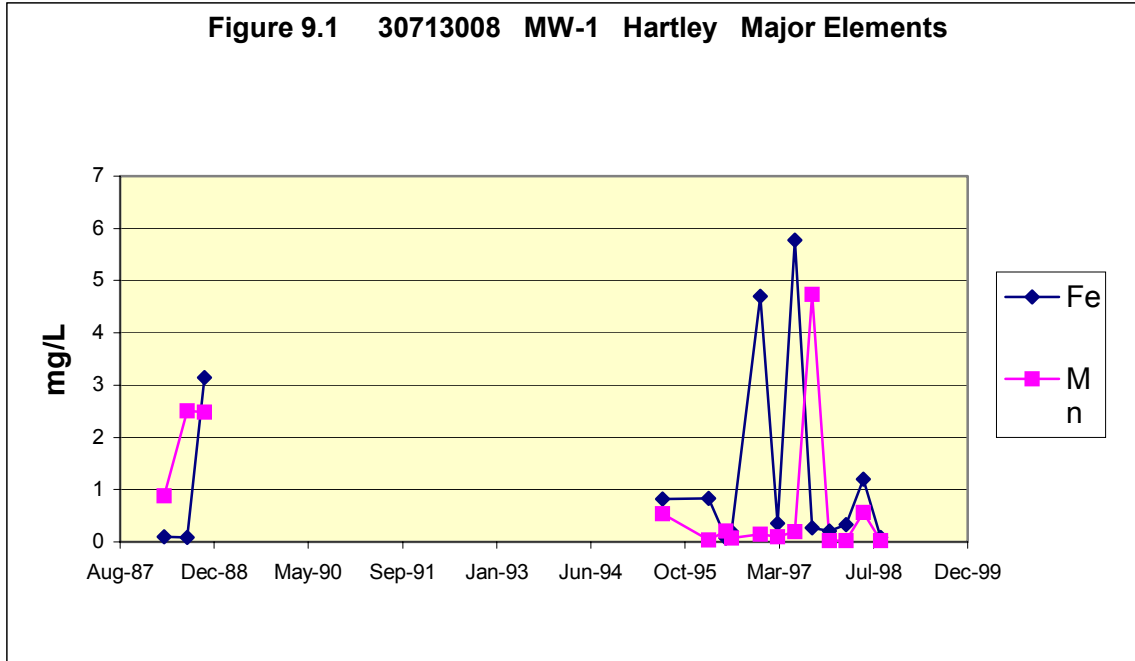
Trace element data (figure 9.4; antimony, cadmium, lead, and mercury) were collected over the life of the site, on a yearly basis, for MW-1. Data for 1994, 1995 and 1996 are missing however. In addition, the extremely variable detection limits make it very difficult to interpret the data, and on several occasions, the detection limits were well above the DWS. For example values reported as less than a detection limit for antimony in July 1992 and July 1993 samplings (<.10 mg/L) are more than 16 times higher than the DWS for antimony, and values reported as less than detection for cadmium in those samplings as well as in the April 1988 sampling (<0.010 mg/L) are below a limit twice its DWS. The value recorded as less than the detection limit for mercury in September 1998, 0.004 mg/L, is twice the DWS for mercury.

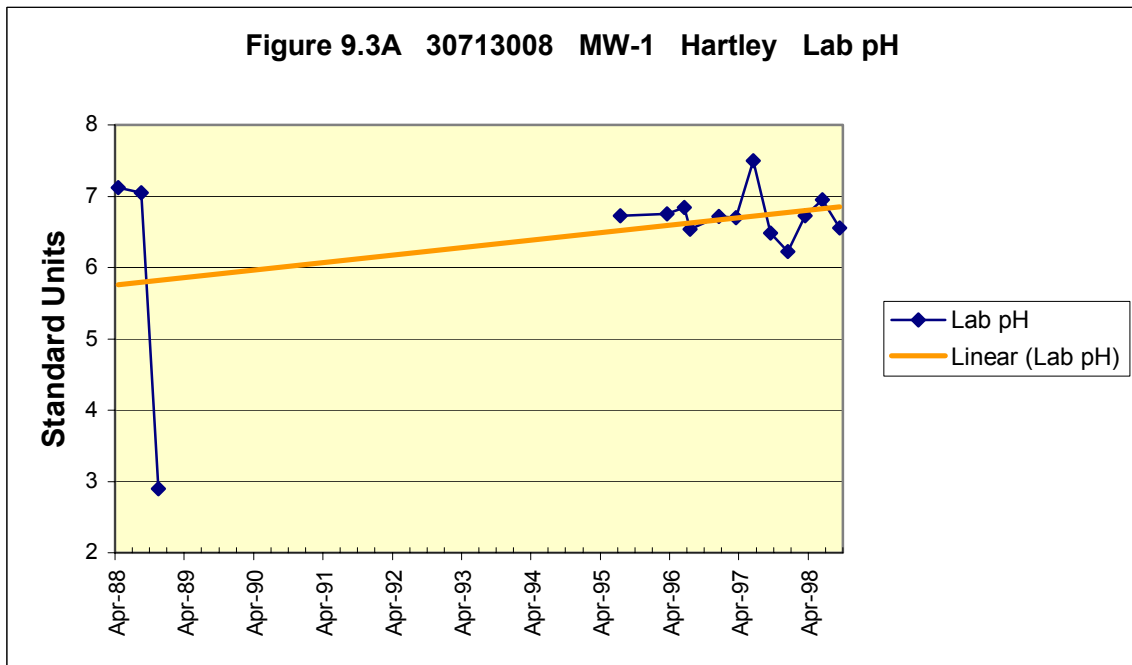
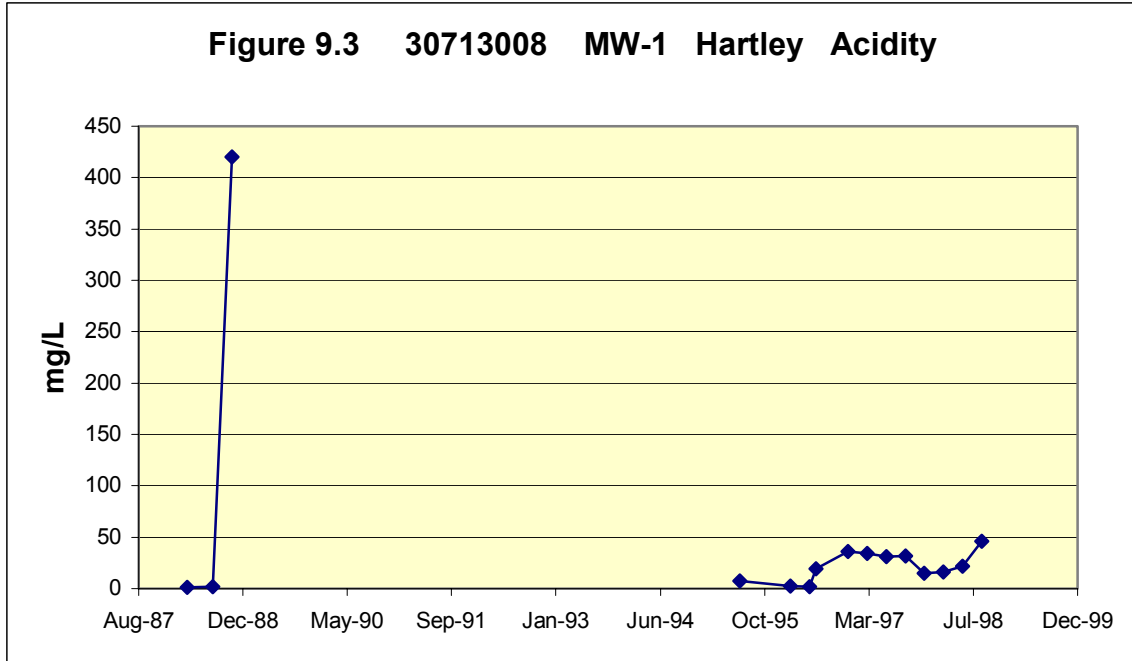
There were a number of actual concentrations measured for these trace elements at MW-1 however, and in several instances these concentrations exceeded the DWS. An actual concentration of antimony at 0.03 mg/L, exceeding the DWS (0.006 mg/L) by five times, was measured in August 1991. A cadmium concentration of 0.01 mg/L, twice the DWS, was measured in September 1998. Lead concentrations of 0.04 mg/L, 0.02 mg/L, and 0.06 mg/L were measured in April 1988, July 1992 and July 1993 respectively. The DWS (federal Action Level) for lead is 0.015 mg/L.

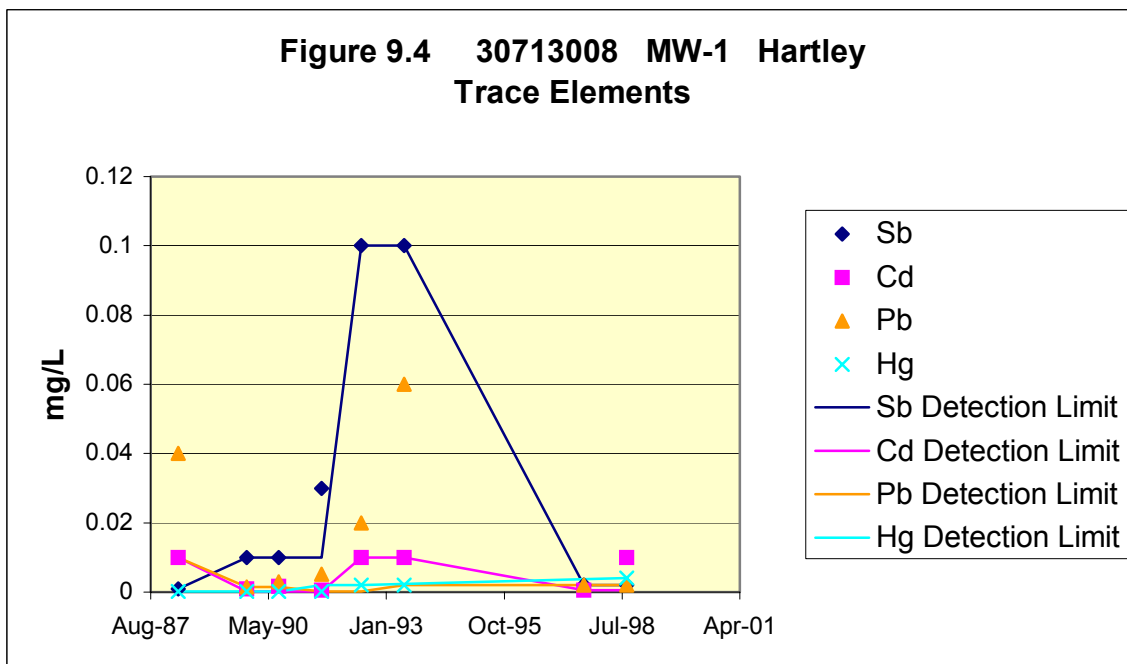
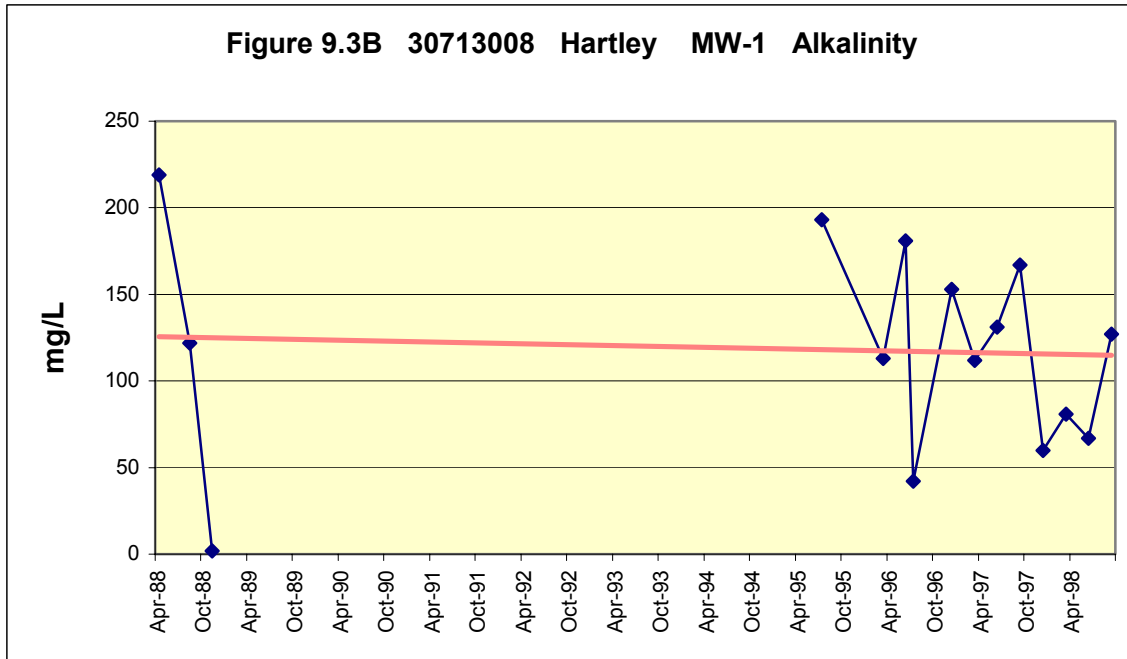
Molybdenum (ungraphed) was also measured in the last two samplings at MW-1 at 0.0040 mg/L in September 1997 and 0.19 mg/L in September 1998. The EPA Removal Action Level (clean up standard under Superfund, 42 U.S.C. 9601) for molybdenum is 0.010 mg/L. The EPA short term health children's health advisory for ingestion of this metal is 0.02 mg/L, longer term children's health advisory is 0.01 mg/L and longer term adult health advisory is 0.05 mg/L (Drinking Water Regulations and Health Advisories, US EPA, Office of Water, EPA 822-B-96-002, Oct. 1996). Thus the latter measurement clearly presents a level of concern.

These measurements suggest mobilization of trace elements although more measurements are needed before a meaningful analysis can be accomplished of the impacts of ash on trace elements in waters monitored by MW-1.

It should be noted nonetheless that antimony and molybdenum have been found to leach readily in the SPLP tests on many ashes placed in the minefills studied in this report although the Hartley permit was the only one researchers found in which water quality monitoring was undertaken for these two trace elements albeit with only two samplings at one monitoring well for molybdenum. Notwithstanding this fact, the Hartley permit failed to require any monitoring for arsenic, another trace element that has been found to leach from many ashes placed in the coal mines studied in this report.







MW-2

Major element data for upgradient MW-2 (figure 9.5, iron and manganese and figure 9.6, sulfates) was reported for 1988, with three samples, as was the case with MW-1. As MW-2 is an upgradient well, the concentrations of the major elements and sulfate are considerably less than that of downgradient MW-1. As was the case for MW-1, monitoring data for the six and a half years from 1989 until July 1995 were not found in

the permit files for MW-2, and subsequent written and in-person inquiries to the PADEP Greensburg Office were to no avail.

The data obtained shows different levels but a similar erratic behavior of these elements at the two wells; iron and manganese concentrations at MW-2 are usually less than one tenth their concentrations at MW-1. Both decrease at MW-1 (figure 9.1) in 1995; then iron rises in December 1996, followed by manganese in September 1997 both peaking at concentrations 5-15 times higher than their 1995 and 1996 levels. After another rise in June 1998, they drop in the last sample, in September 1998 to levels below the 1995-96 concentrations and within the DWS (0.30 mg/L for iron and 0.05 mg/L for manganese). However, the higher concentrations at MW 1 are many times over the DWS. At MW-2, (figure 9.5) all iron and manganese concentrations are under 1 mg/L. Both elements decrease in 1995 and 1996, then increase in 1997 to levels 5-10 times higher and then decrease in 1998 back to the 1995-96 levels which are under the DWS. The higher concentrations of iron are except for one instance, barely over the DWS at MW-2, while at least 5 higher concentrations of manganese range from nearly 4 to 10 times over the DWS. High and low levels of these constituents occur in all seasons, and don't appear to be driven by precipitation events or seasonal fluctuations.

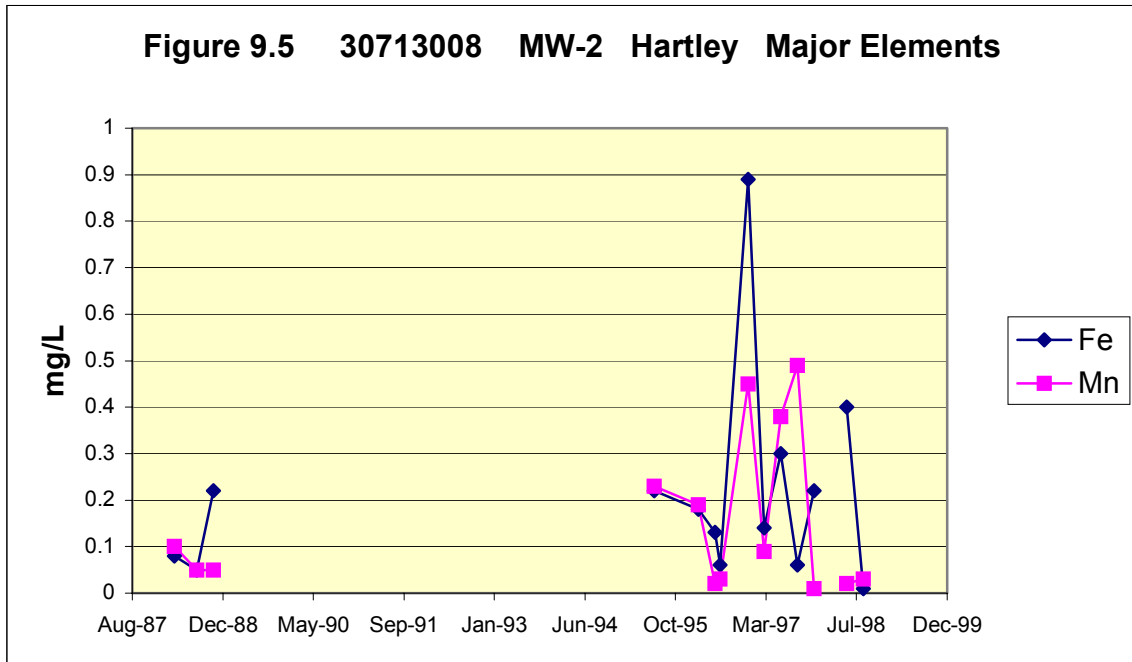
Average sulfate concentrations are around half of those at MW-1, except for one peak of 1180 mg/L on June 1998. However, this peak appears to be an outlier and is not consistent with the other data for this site. Overall, excluding this high value, it appears that sulfate concentrations have remained relatively stable over time at concentrations less than half the DWS (250 mg/L).

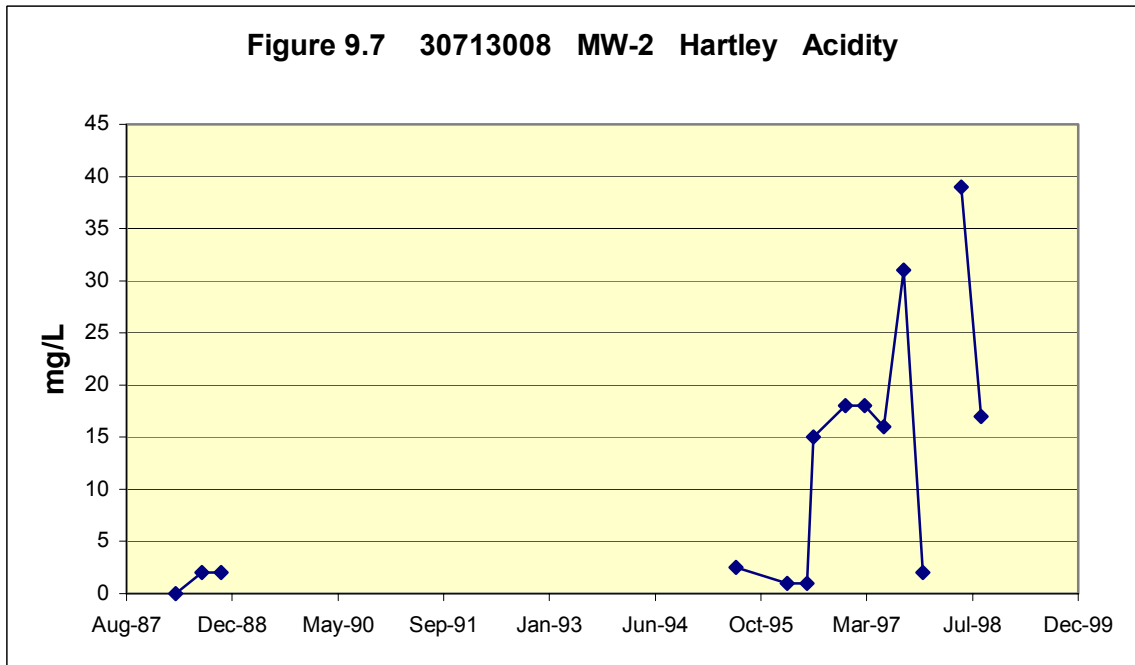
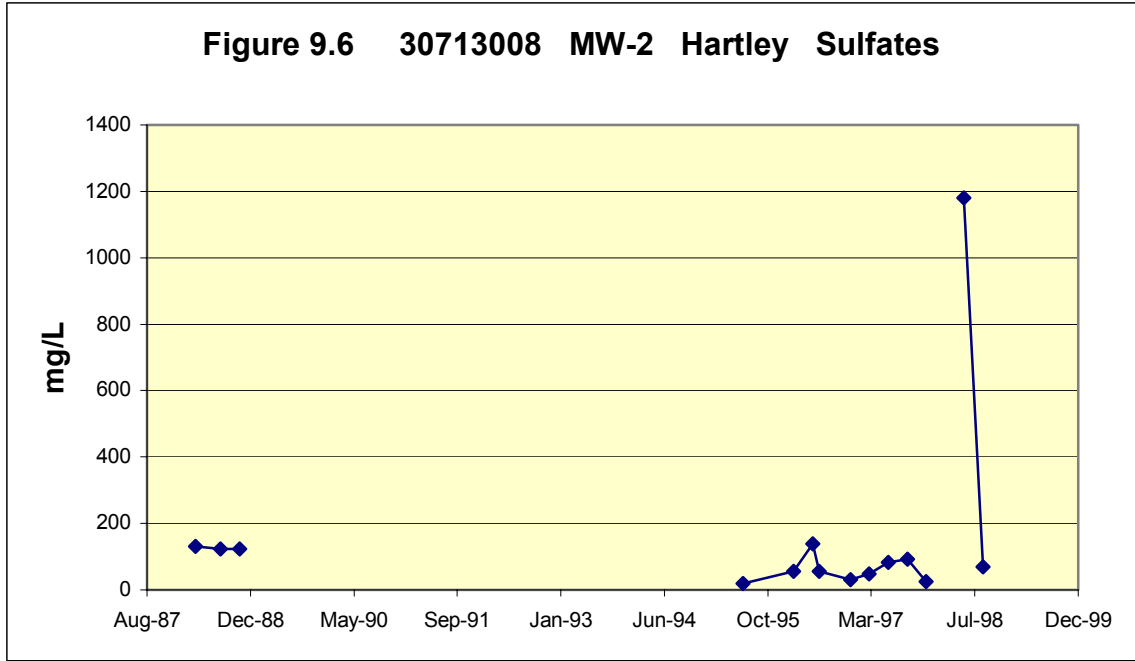
Acidity concentrations (figure 9.7) significantly increase from the 1988 levels of between 0 and 2 mg/L starting in the summer of 1996 to a maximum concentration of 39 mg/L in June 1998. Figures 9.7A and 9.7B are graphs of the lab pH and alkalinity over time. As with MW-1, field pH data was not included in the monitoring reports available to this report's authors. Consistent with other data for this site, the large data gap for MW-2 makes interpretation difficult. What is clear is that after 1995 the alkaline buffering capacity of the waters at MW-2 was being taxed; there is a declining average alkalinity with drops in actual values of 99-210 mg/L and a declining pH from values in the range of 7-7.5 units to values in the range of 6.5 to 7 units. This indicates the effects of mining were reaching this well, raising the question of its validity as an "upgradient" monitoring point.

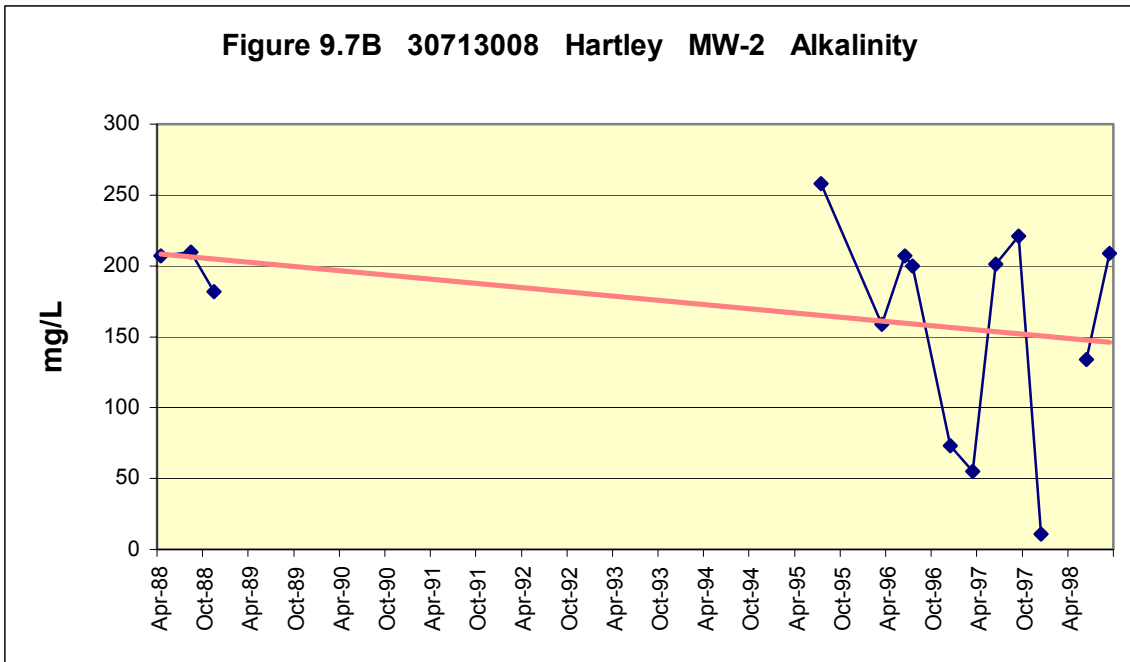
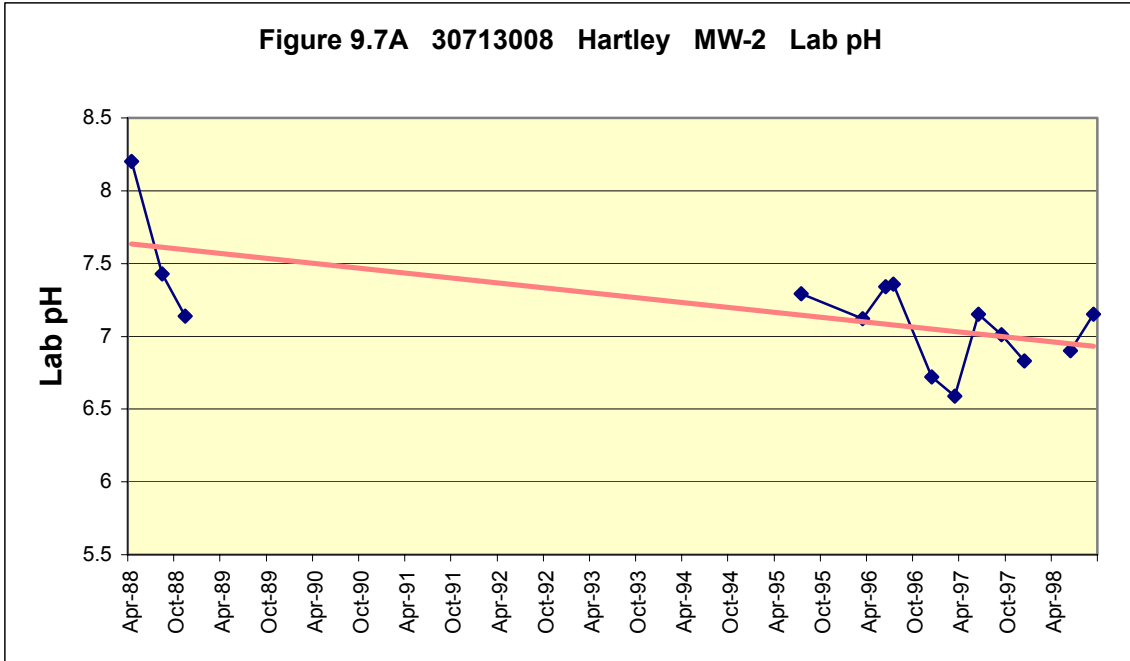
The trace element data for MW-2 (figure 9.8) are more complete than that of MW-1 with no data points missing except for any measurements in 1990. The plot pattern is similar to MW-1. The same high detection limits erode the usefulness of much of the data for antimony and cadmium. The antimony values for 1992, 1993, 1994 and 1996 were <0.1 mg/L, 16.7 times the DWS for antimony. And cadmium values for 1988, 1992, 1995 and 1996 were <0.01 mg/L, twice the DWS for cadmium. All mercury values were recorded at below detection limits, although from 1992 through 1996 that detection limit was <0.002 mg/L which is the DWS.

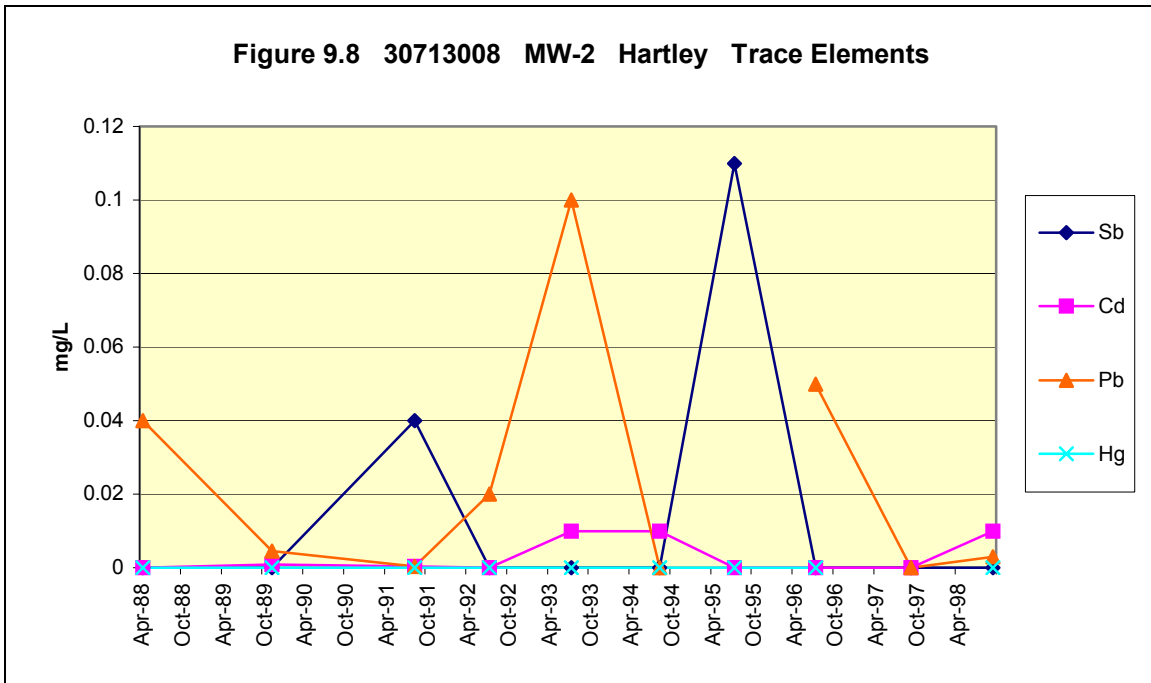
There were several actual concentrations exceeding the DWS at MW-2 and to somewhat greater degrees in a couple of instances than exceedances measured at MW-1. Antimony exceeded its DWS by 6.7 times in August 1991 at 0.04 mg/L. A measurement of 0.11 mg/L for antimony in July 1995 exceeded the DWS by 18.3 times. Unfortunately there is no measurement in 1995 at MW-1 with which to compare this value. Cadmium concentrations exceeded the DWS by 2 times in the July 1993, August 1994, and September 1998 measurements. And lead concentrations exceeded the DWS in four of the ten total measurements for trace elements at MW-2. The July 1993 lead measurement of 0.10 mg/L was the highest at 6.7 times the DWS.

There were no measurements for molybdenum at MW-2. Of some note however were actual concentrations for silver which ranged as high as 0.02 mg/L at MW-1 in July 1993 and 0.05 mg/L at MW-2 in July 1996. Although the federal secondary DWS for silver is 0.1 mg/L, the authors did not usually see silver detected at these levels in waters at the sites studied in this report.









Hatfield Coal Ash Landfill

The Hatfield coal ash landfill is adjacent to and partially overlaps the Hartley Strip ash placement site. The ash was transported from the nearby Hatfield’s Ferry Power Plant to this landfill for disposal purposes, with no intent to remediate AMD problems associated with mining activity. See the map above for the relationship between the Hatfield landfill and the Hartley site. The original Hartley site is outlined in dark green, and the more recent Hatfield ash disposal area is outlined in dark brown.

Data from two monitoring wells are discussed below: MW-206, and MW-207. While the exact timing, sequence, and location of ash placement in the Hartley mine is not clear, it should be noted that the data reflected in the figures for these wells presumably should reflect impacts from ash from the first measurements forward as ash placement presumably was well underway for as many as six years at Hartley before the first data discussed below was collected.

MW-206

Cross sections and elevation information in the Hatfield permit file indicate that MW-206 is upgradient of the ash disposed in the Hatfield landfill but downgradient of the ash in the northern half of the Hartley Strip site. Groundwater sampled at this well will be affected to some degree by ash at the Hartley operation.

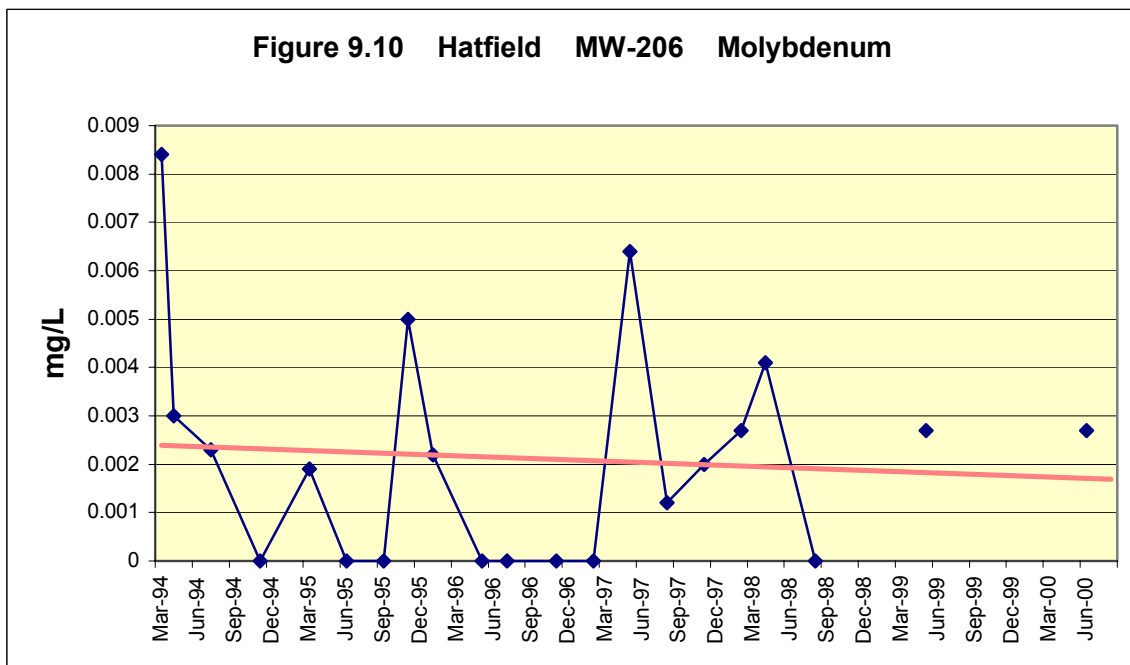
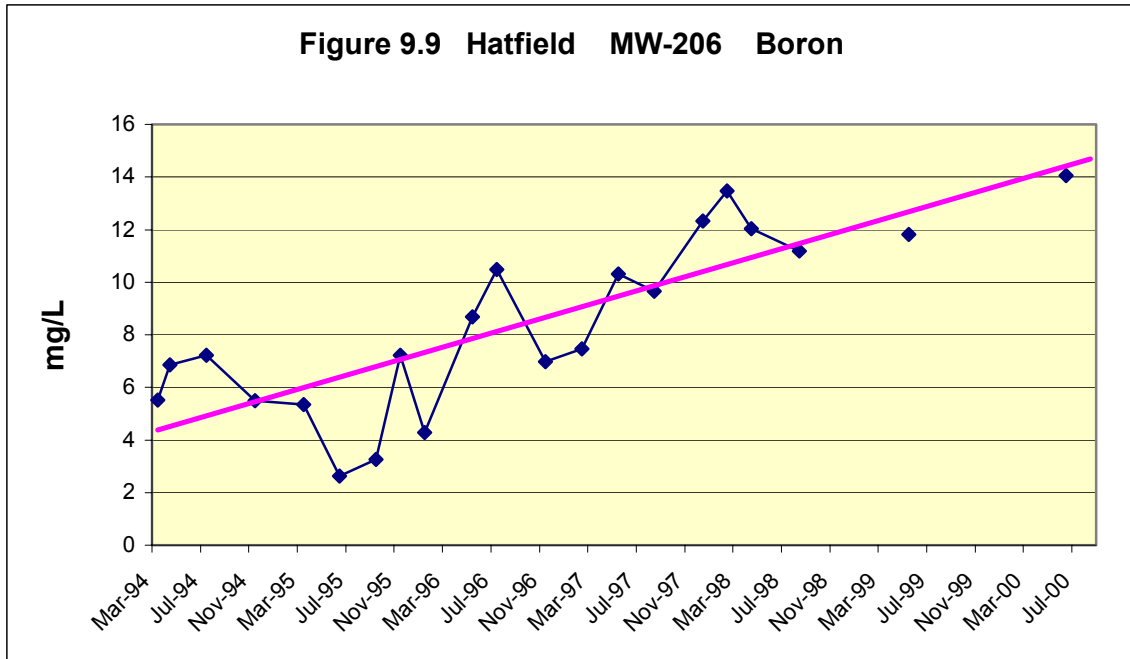
Two ash indicator element concentrations are graphed in figures 9.9 and 9.10, boron and molybdenum. Boron was not monitored at the Hartley wells and only two measurements of molybdenum were taken at MW-1. After a short decline in 1994 and 1995 from 7.225 mg/L to 2.616 mg/L, the boron concentrations rise steadily at MW-206

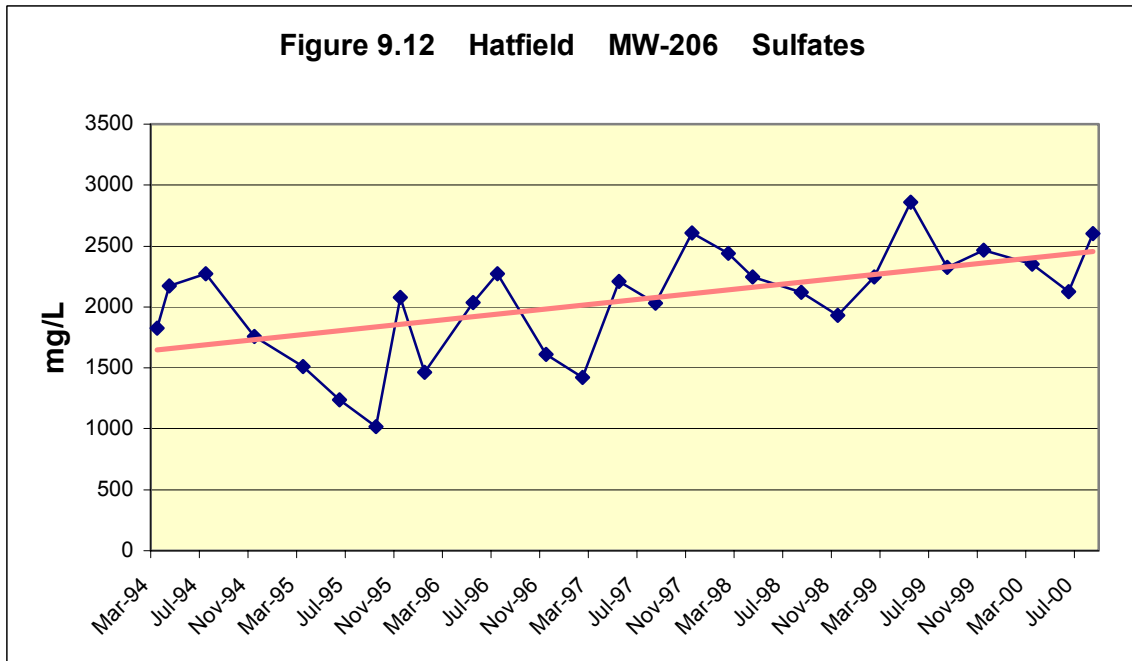
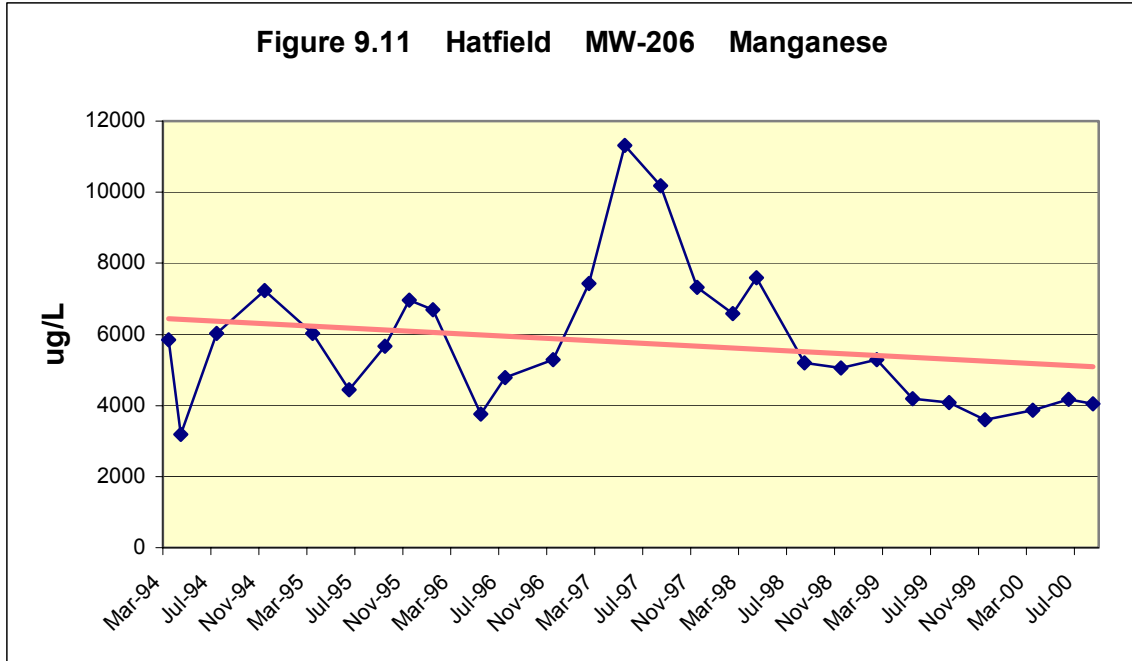
up to 13.466 mg/L in February 1998 and later, after some data gaps, to a high of 14.052 mg/L in June 2000. These concentrations are well beyond levels of concern for boron which has a Removal Action Level of 0.900 mg/L and health advisories ranging from 0.6 mg/L for an adult's lifetime exposure to 4 mg/L for the child's one day exposure to boron in drinking water (Drinking Water Regulations and Health Advisories, US EPA, Office of Water, EPA 822-B-96-002, Oct. 1996). Molybdenum concentrations at MW-206 are under 0.01 mg/L and their average level is slightly dropping over time (figure 9.10).

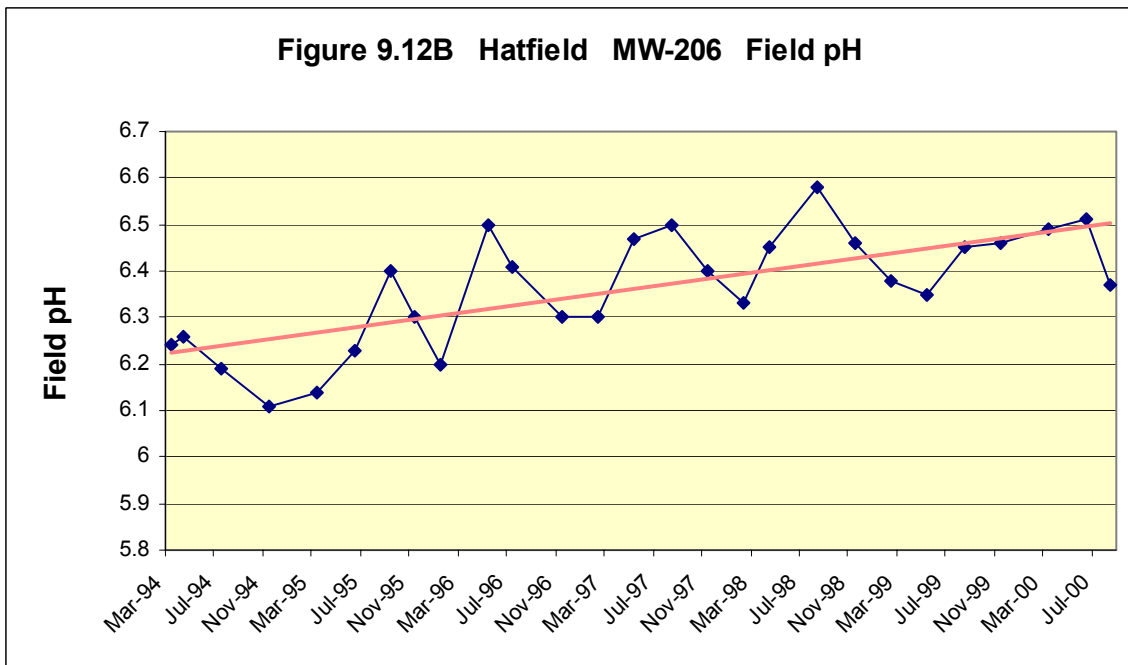
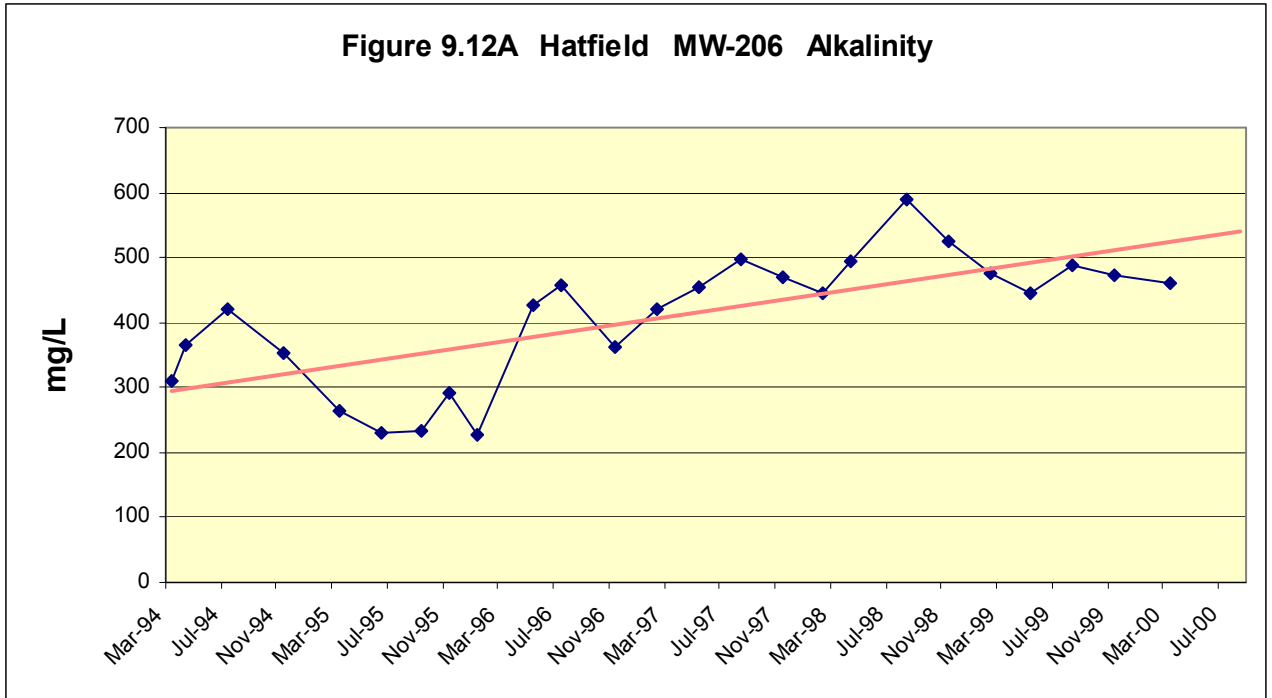
Manganese and sulfate trends are shown in figures 9.9 and 9.12, respectively. Manganese values at MW-206 are 1.5 to 2 times higher than at MW-1, and 15-20 times higher than at MW-2. However the graphs for manganese at all three of these monitoring points show sharp rises during the middle of 1997, indicating the Hartley wells and MW-206 could possibly be connected hydrologically. The sulfate concentrations at MW-206 are about 10 times the values from MW-1 and almost 20 times the values from MW-2. The sulfate trend at MW-206 starts from average levels already more than six times over the DWS in 1994 but clearly increases to average levels just under 2500 mg/L, ten times the DWS, compared with trends at MW-1 and MW-2 that are less clear.

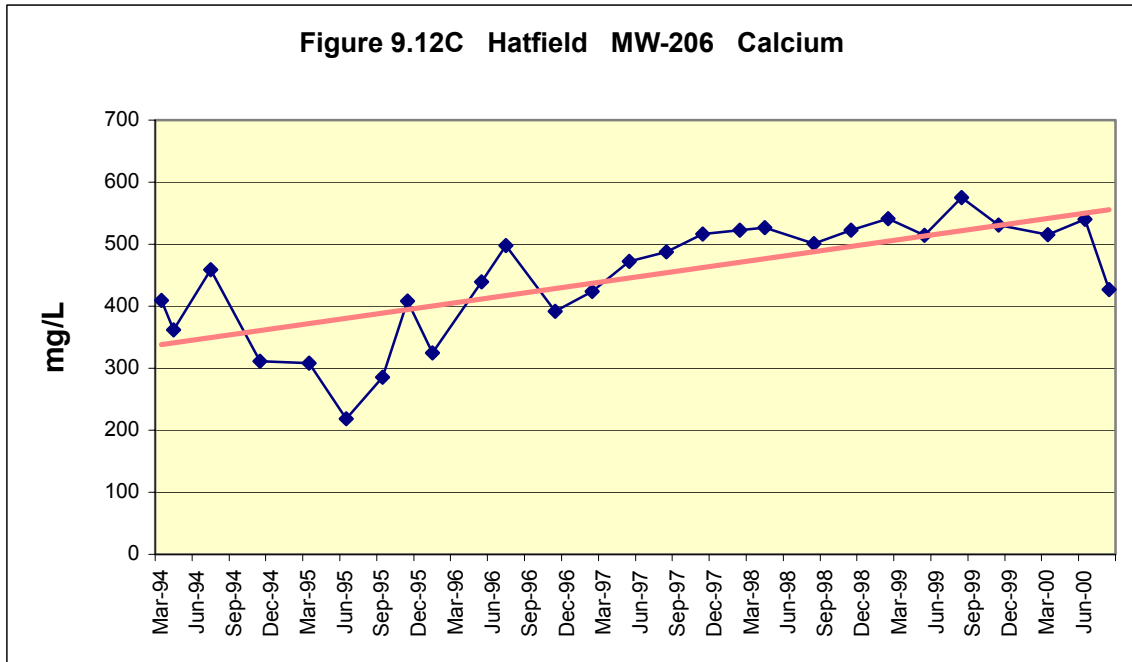
Figure 9.12A graphs alkalinity over time, showing a steady rise from an average of 300 mg/L to approximately 540 mg/L over the six years of monitoring data presented, that could be due to alkaline ash leachate reactions. The field pH (figure 9.12B) has a corresponding gradual rise from an average of 6.23 to 6.50 units, probably from alkaline ash leachate. There are no data for acidity in the database for Hatfield monitoring points in the Hatfield Landfill permit files available for this assessment. Calcium, potassium, and magnesium, all of which are ash indicator elements, have clearly rising trends at MW-206 (figures 9.12C, 9.12D, and 9.12E, respectively); over the six year monitoring period, average calcium rises from 340 mg/L to 560 mg/L, average magnesium more than doubles from 150 mg/L to 360 mg/L and average potassium also more than doubles from 10 to 21 mg/L. All of the evidence from these five graphs points to water quality effects from ash.

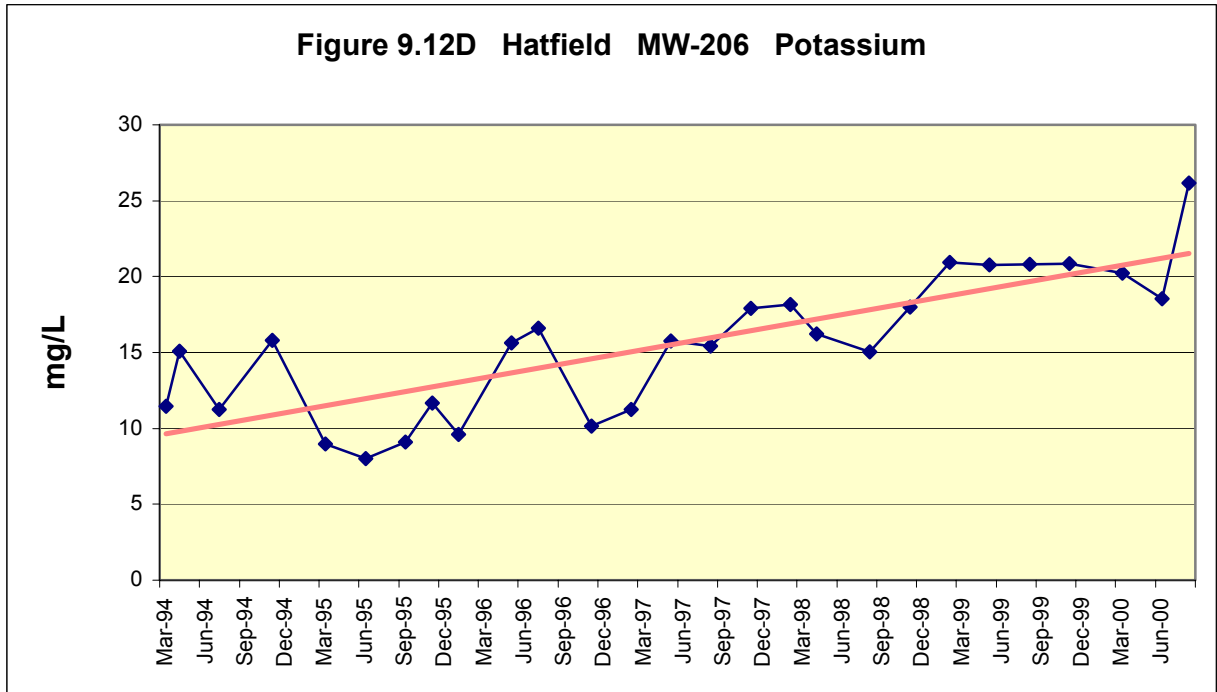
There is a small rise in chloride over the monitoring period at MW-206 (not graphed) punctuated with a spike in the November 25, 1996 sampling to 43.7 mg/l, 5-8 times over the other concentrations recorded at this point. This spike was measured from a sample taken on the same date that a sample from MW-207 was collected from which a spike in chloride to 37.99 mg/L was measured, also 5 times over the other concentrations for chloride at MW-207. This could have resulted from a sampling problem(s) or reveal a potential hydrologic linkage between these two points.

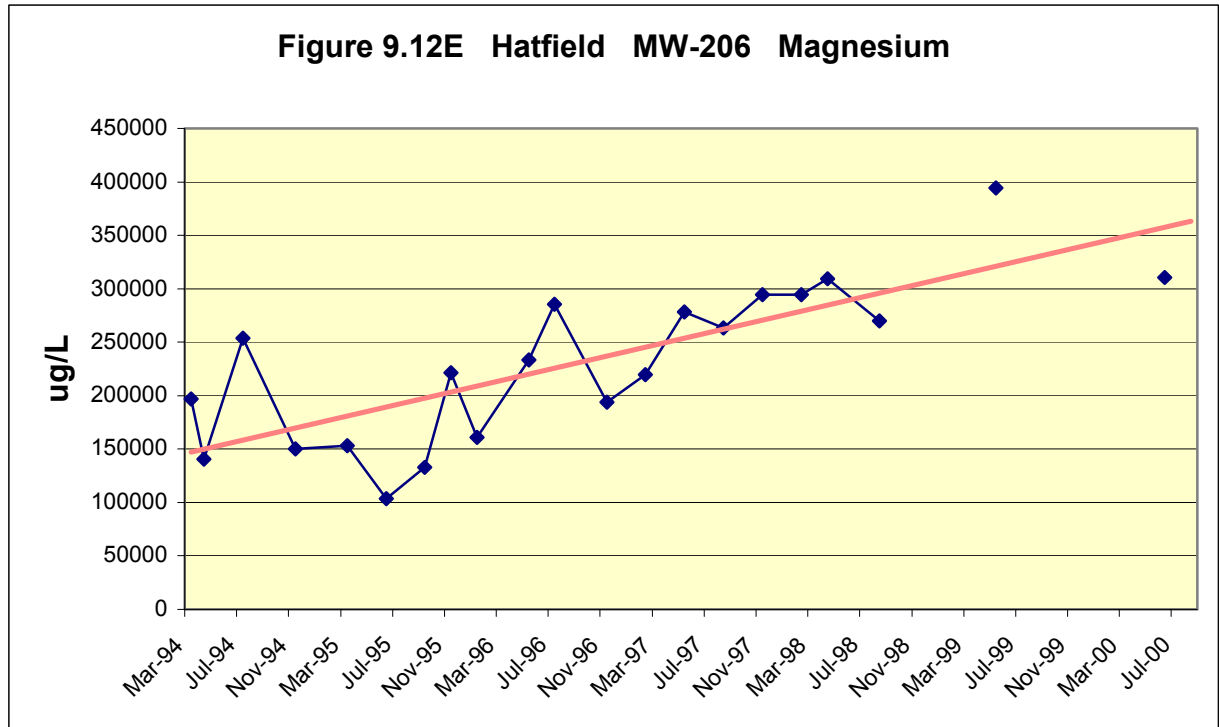












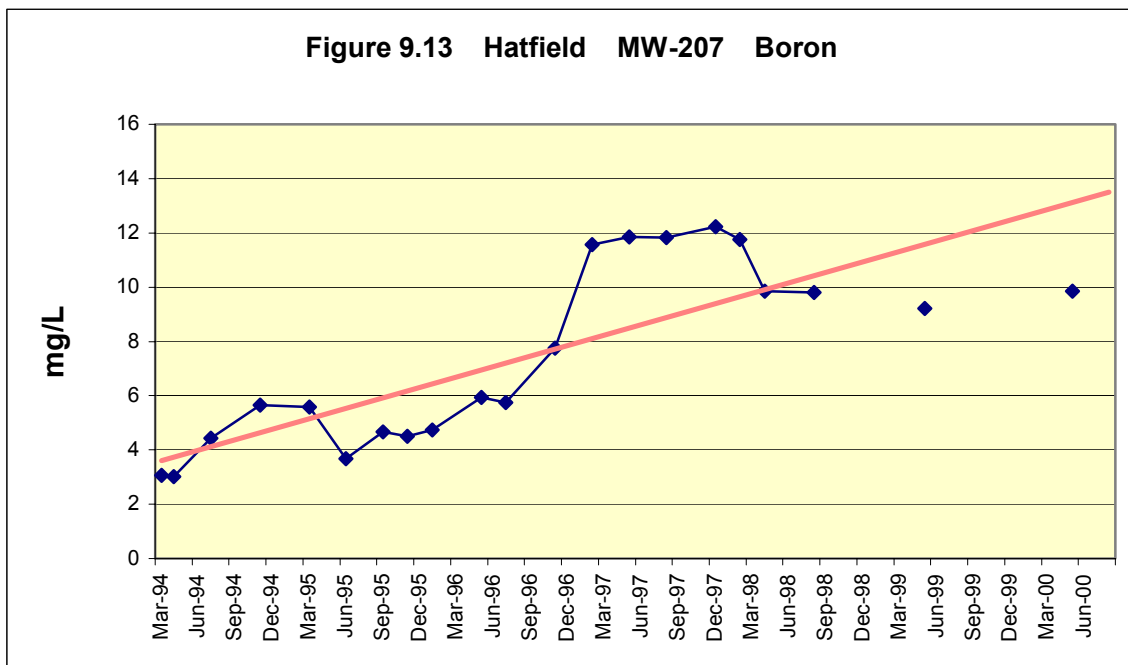
MW-207

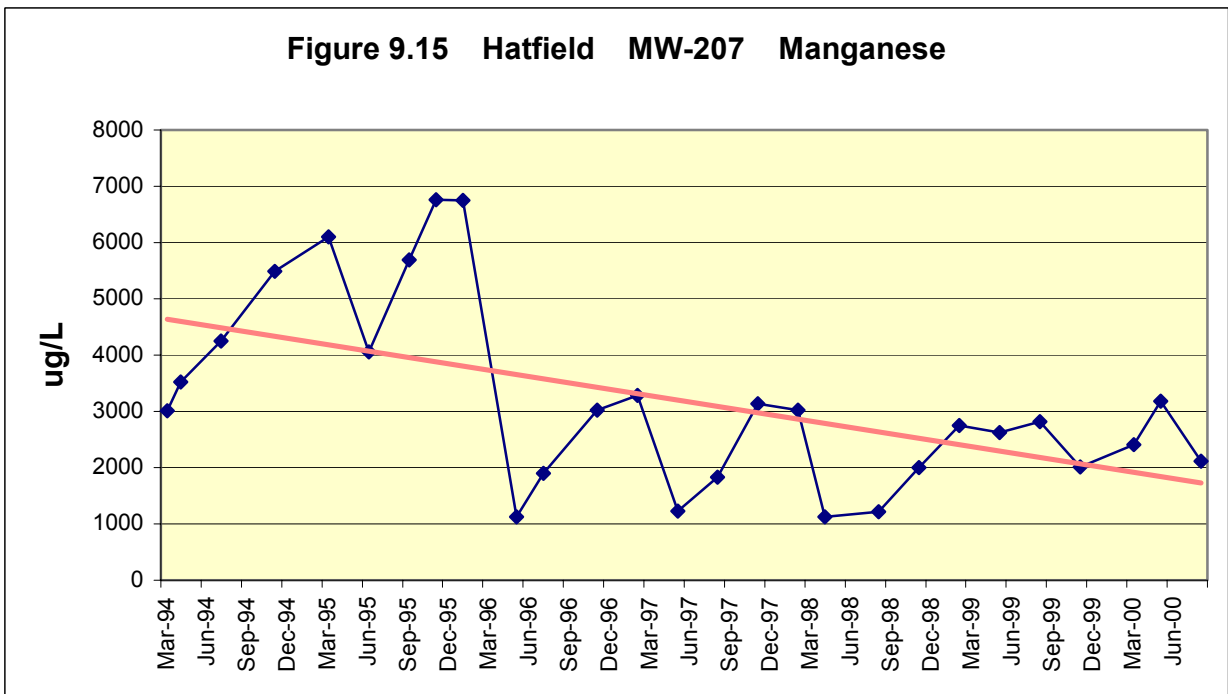
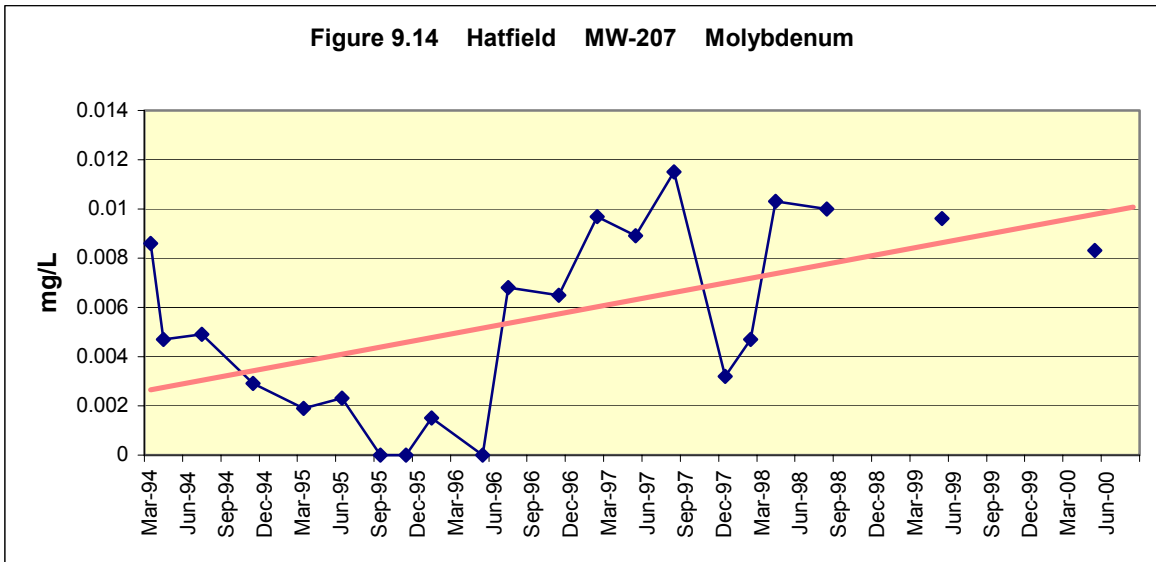
MW-207 is also identified as upgradient of the Hatfield ash disposal operation and downgradient of the Hartley strip ash. The trends for boron and molybdenum (figures 9.13 and 9.14) are both increasing with time. The rise in average boron concentrations at MW-207 is nearly identical to the rise at MW-206 from around 4 mg/L in 1994 to around 14 mg/L in 2000. However, molybdenum concentrations at MW-207 vary but with an average rising from 0.003 mg/L in 1994 to 0.010 mg/L in 2000. This latest average level is equivalent to the EPA’s Removal Action Level and longer term child health advisory for molybdenum and differs with the very gradual downward trend for average molybdenum levels at MW 206 from above 0.002 mg/L to below 0.002 mg/L although the concentrations are within the same order of magnitude.

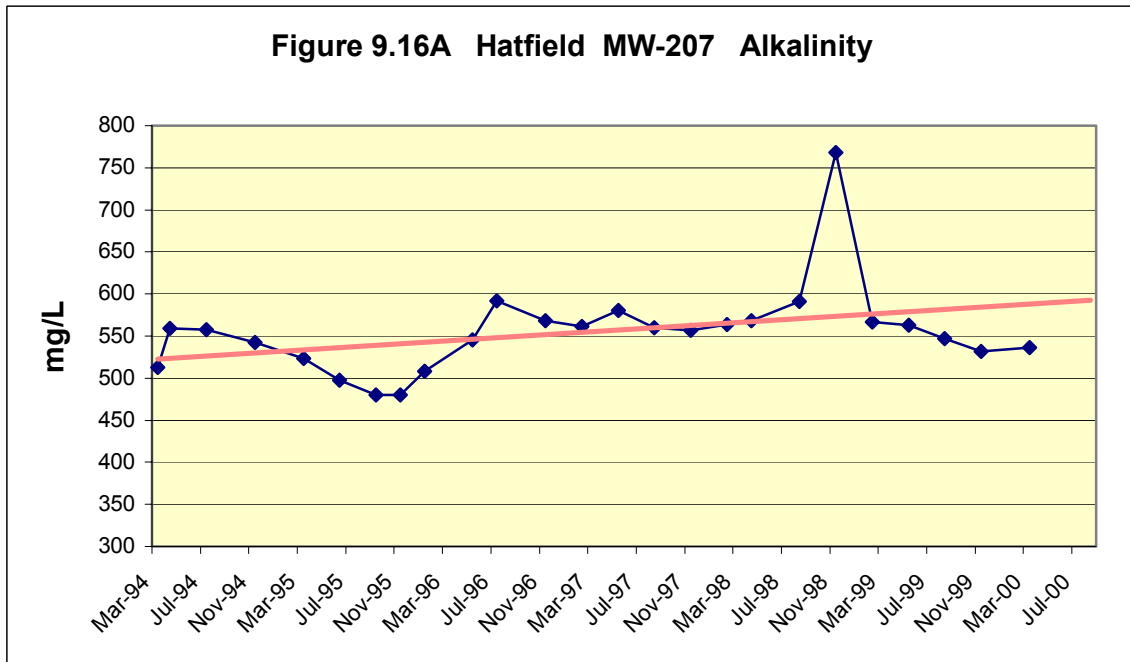
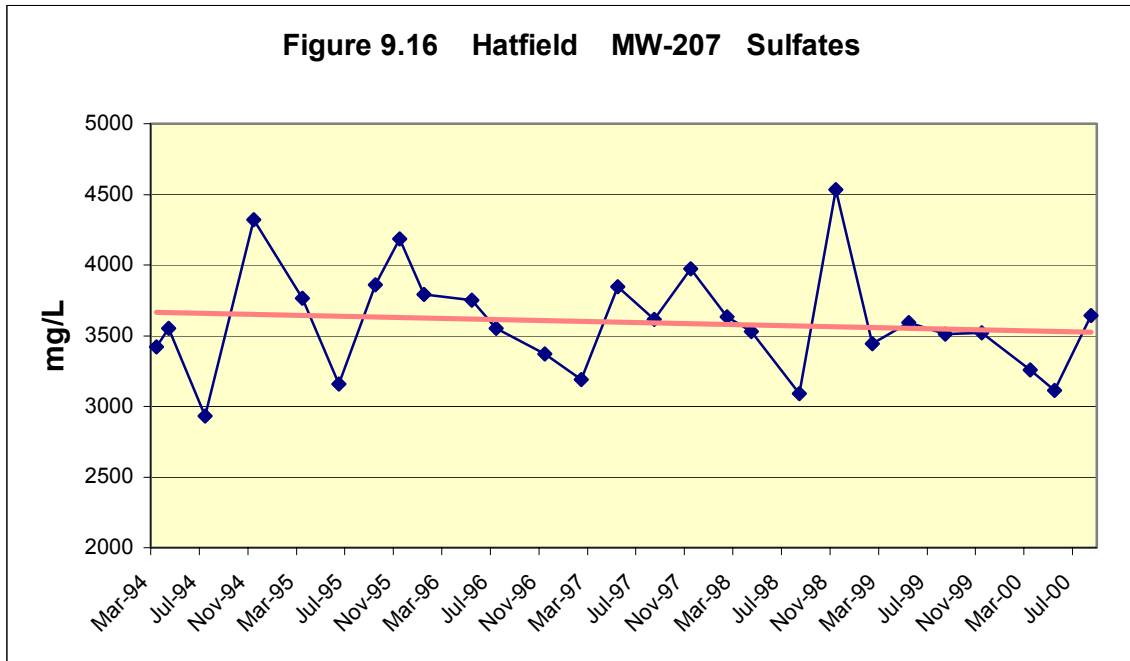
Manganese concentrations are falling over time at MW-207 (figures 9.15) from an average of approximately 4.7 mg/L to an average of 1.8 mg/L. They are less than half the concentrations at MW-206 but still noticeably higher than manganese levels at MW-1 and MW-2. There is no general rise in concentration in 1997 as seen in the graphs of data from MW-206 and the Hartley wells, suggesting MW-207 is hydrologically independent of MW-206 and the wells at Hartley.

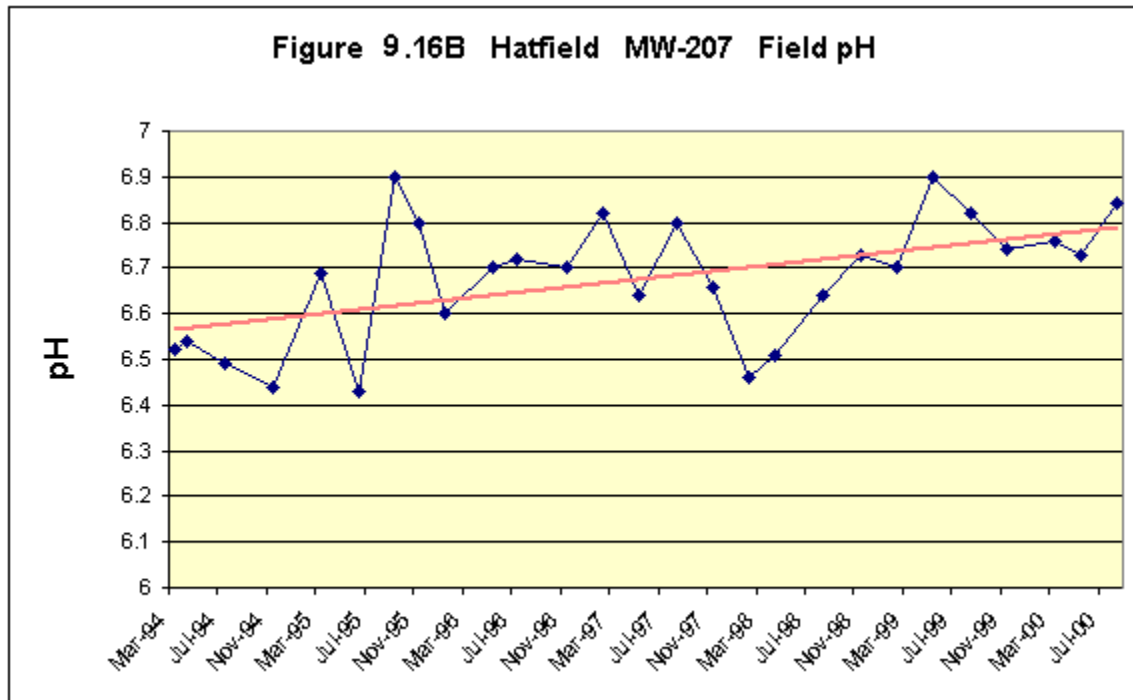
The average sulfate concentration at MW-207 (figure 9.16) is about 3600 mg/L, about 1500 mg/L higher than the average concentration at MW-206 (figure 9.12). However the MW 207 trend is not rising like the MW-206 trend.

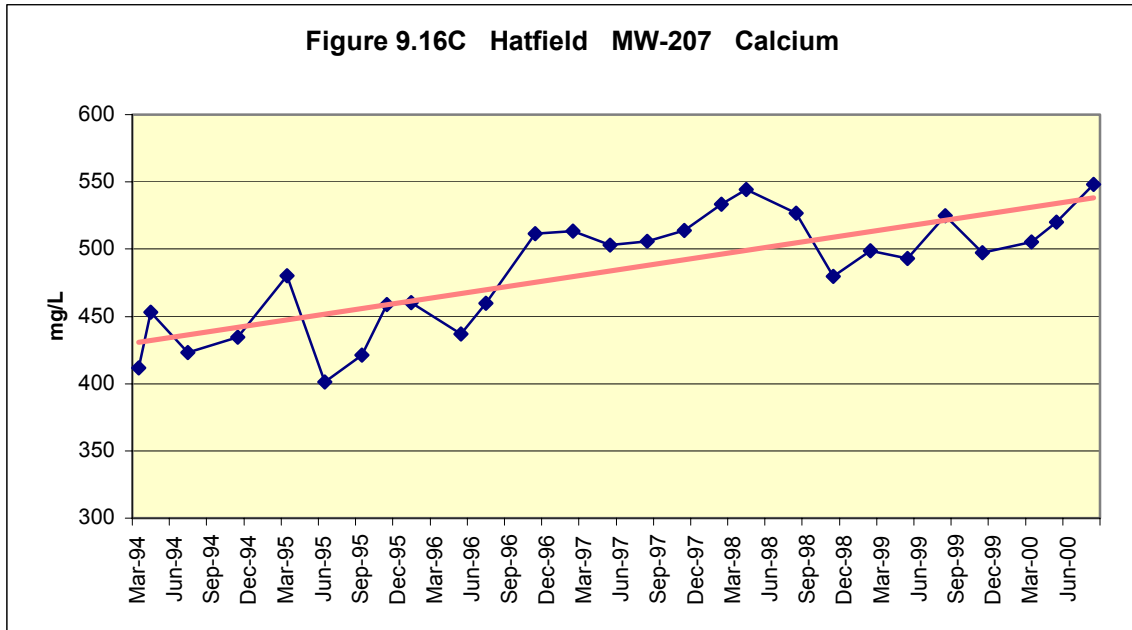
Alkalinity and field pH are both rising at MW-207 (figures 9.16A and 9.16B). Their trends are similar to those at MW-206 except that pH values at MW-207 are around one fourth of a unit higher than at MW-206 while the rise in average alkalinity at MW-206 is more steep than at MW-207 (240 mg/L increase at MW-206 vs 70 mg/L increase at MW-207). The trends for concentrations of calcium, potassium, and magnesium (figures 9.16C, 9.16D, 9.16E respectively) are all rising at MW-207 and in the same general ranges as at MW-206, although there are some differences of note. At MW-206, calcium concentrations on average are about 200 mg/L higher than magnesium concentrations, while at MW-207 magnesium concentrations on average range from 95 to 140 mg/L higher than calcium concentrations. Nonetheless the steady rises of these known ash indicator parameters provide strong evidence that Hartley ash is a source for the groundwater degradation observed at the upgradient Hatfield monitoring points.

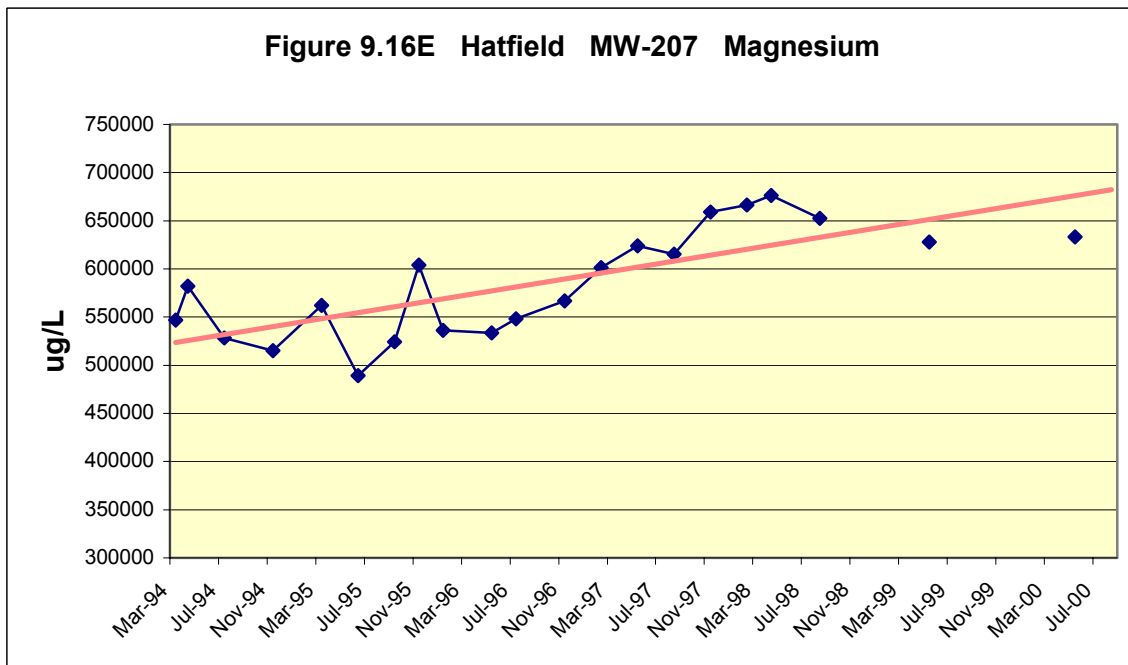
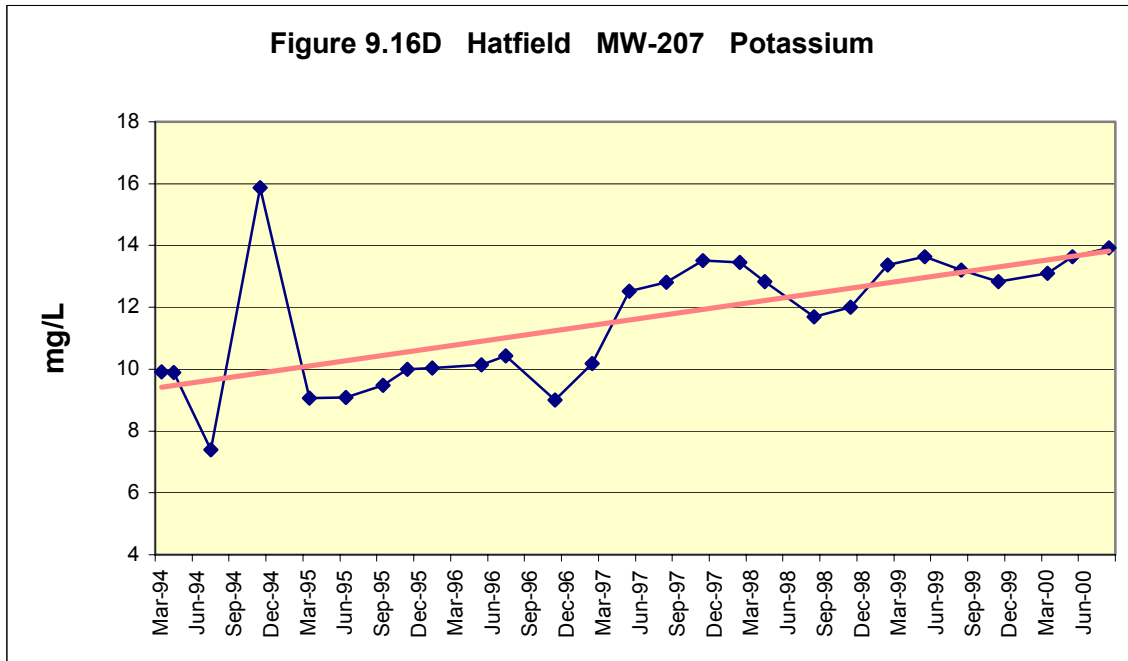












Conclusion

Missing information and data gaps make analysis of this site difficult. There is no baseline data, a six -year data gap exists for most elements in the middle of the mining and ash placement operation, and apparently there was no monitoring of the Hartley Strip

wells after ash placement ended although specific dates of when ash placement and monitoring ceased were not found in the Hartley permit file.

At downgradient MW-1, trace element concentrations were measured only eight times during an 11-year time period. Upgradient MW-2 had 11 concentration measurements for trace elements over this 11-year period. Variable detection limits make it very difficult to interpret the data however. In a number of occasions, the detection limits were well above the DWS. Nonetheless actual concentrations of dissolved cadmium and lead were measured at two to six times above the DWS at both of these wells. Antimony was measured at a concentration of 0.03 mg/L, six times the DWS in the downgradient MW-1 and at concentrations of 0.04 mg/L and 0.11 mg/L, more than 18 times the DWS in the upgradient MW-2. Antimony regularly leaches in the tests on coal ashes deposited in the mines studied in this report although only at this site could the report's authors find water quality monitoring data for antimony. The authors also found two measurements of molybdenum at MW-1, with the latest one in September 1998 being 0.190 mg/L. This is 19 times the EPA Superfund Removal Action Level and several 4-8 times most health advisory levels for molybdenum. High levels of antimony, molybdenum and other trace metals revealed by this data suggest a mobilization from the ash. While a number of the high levels were measured at MW-2 labeled as an upgradient well, its location inside the area authorized for ash placement as well as other data indicating AMD and alkalinity impacts on this well warrant further examination of whether this well was actually "upgradient" of ash placed at this site. Nonetheless the amount of information collected was not enough to effectively characterize the impacts of ash on trace elements at this site.

However, there are relationships between the Hartley Strip ash placement operation and the upgradient monitoring wells at the Hatfield coal ash landfill that provide clues to the impact of the ash placement at Hartley. The patterns for concentrations of constituents such as manganese suggest that MW-206 may have a hydrological connection to MW-1 and MW-2. A more in-depth study of these relationships would be possible if boron and molybdenum were regularly analyzed for in the Hartley operation monitoring wells.

Nonetheless, rising levels of boron, a classic indicator parameter for coal ash, in both MW-206 and MW-207 indicate that ash in the Hartley strip operation is degrading downgradient groundwater with concentrations 3-15 times EPA health advisory levels for ingestion of boron in drinking water. Allegheny Energy, the operator of the Hatfield landfill and generator of the ash placed in the Hartley strip, stated in an August 20, 1997 revision to an application to modify the permit for the landfill that the elevated boron in these upgradient wells was "due to the fact that fly ash has been codisposed with mine spoil in the upgradient area, in addition to the permitted disposal area." This observation of degradation of water quality from the Hartley ash is corroborated by the rising field pH and concentrations of alkalinity, calcium, magnesium, and potassium, additional indicators of ash leachate, at both of these monitoring points which are upgradient of the ash placed in the Hatfield landfill.

Based on this data as well as additional data revealing very high levels of boron, sulfate and molybdenum in Little Whitely Creek which is fed by the tributary draining north and east from the Hartley ash site, there is a need to reinstate a monitoring program for the ash in the Hartley Strip. Such a monitoring program must be an enhanced program with sufficient parameters, monitoring points and frequency of sampling to ensure that CCW-contaminated drainages from this mine are located and remediated.