POSTER PRESENTATIONS

Assessment of Coal Combustion By-products and Water Quality Variations at Mine Sites
Carol R. Cardone and Ann G. Kim, U.S. Department of Energy, National Energy Technology Laboratory, Pittsburgh, Pennsylvania

Mine Remediation with Coal Combustion By-products
Ann G. Kim, U.S. Department of Energy, National Energy Technology Laboratory, Pittsburgh, Pennsylvania

The Release of Common Metals From Fly Ash During Leaching by Low pH Liquids
George Kazonich and Ann G. Kim, U.S. Department of Energy, National Energy Technology Laboratory, Pittsburgh, Pennsylvania

ASSESSMENT OF COAL COMBUSTION BY-PRODUCTS AND WATER QUALITY VARIATIONS AT MINE SITES

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Abstract

With over 100 million tons of coal combustion by-products (CCB) generated annually, the need to utilize fly ash is well established. The use of CCBs in surface mines can provide a beneficial and inexpensive alternative to landfill. If the CCB is alkaline, the placement of coal combustion by-products may prevent the formation of acid mine drainage (AMD) and improve water quality. Although, for most uses, fly ash is not considered a hazardous waste, environmental problems related to the release of heavy metals from CCBs are still a concern when it is exposed to acid mine drainage (AMD).

The Department of Energy has assembled a database from reports submitted by mining companies to the Pennsylvania Department of Environmental Protection (PADEP). In Pennsylvania, CCBs can be used for reclamation at surface mine sites if approved under their Module 25 permit. The Module 25 requires the submission of data on the physical properties and chemical composition of each ash placed at a facility and a monitoring plan for surface and groundwater. Data from the permit and from annual reports included major and trace element concentrations. The database included information from 37 sites with over 500 monitoring points and 75 CCB sources.

Statistical analysis of the water data included mean and median values of cation concentrations, pH, acidity, and alkalinity for up and down gradient samples. Because the distribution of values was not normal, this approach did not provide an accurate measure of changes due to CCB placement. Distributions of trace elements in water samples indicated that slightly increased levels of trace metal concentrations may have been related to levels of these elements in the CCB. However, down gradient concentrations of trace metals, such as arsenic, barium, cadmium, and zinc, were lower than RCRA or water quality standards. The pH and alkalinity of down gradient samples were generally higher than up gradient samples. The difference between up and down gradient values was determined at each site and evaluated over time. The data, analyzed to date, indicated no serious or consistent changes in water quality.

An analysis of the solid CCB composition showed that the major cations by weight were aluminum and iron with lesser amounts of calcium, magnesium, and manganese. The trace elements, antimony, barium, cadmium, cobalt, molybdenum, and silver, were detected in less than half of the CCB samples; while, arsenic, boron, chromium, copper, lead, mercury, nickel, selenium, and zinc were detected in more than half, but not all, of the samples. Considered as a random sample population, the mean, median, and standard deviation were determined. Differences between mean and median data indicated that the values, for the solid composition were not normally distributed. Four standard leachate tests were used to determine leachable concentrations : ASTM, EPTOX, SPLP, and TCLP. However, there was no consistent pattern to the results.

In general, CCB composition is variable; even samples from a single source sometimes exhibit compositional and leachate variability that can impact utilization. Based on this analysis, usage of CCB should be encouraged where such variability will not critically affect the application. Otherwise, the use should involve a single well characterized and consistent CCB or a quality control determination for the CCB must be incorporated in the process.

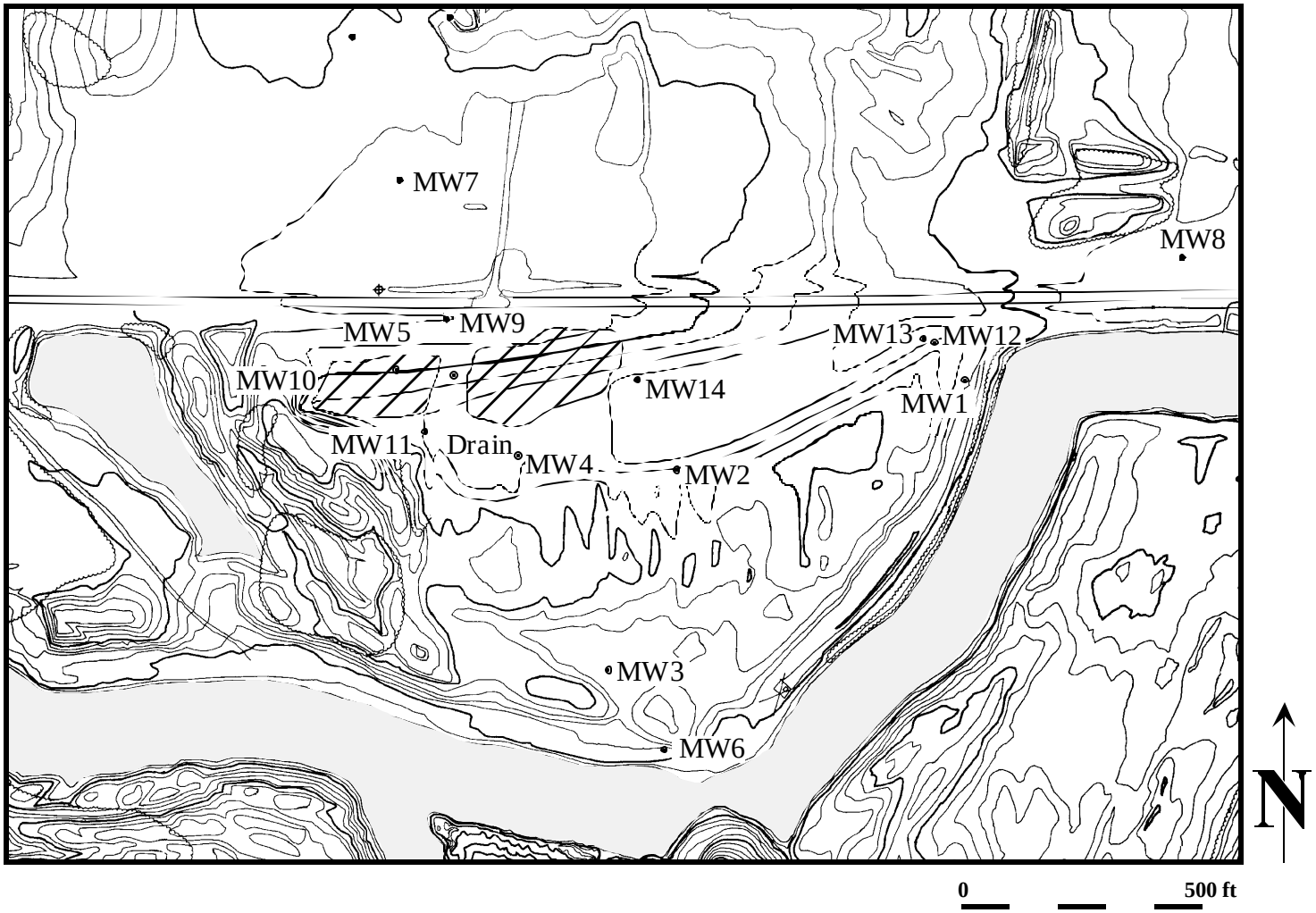

Figure 1. Forsythe-Energy site map showing the location of the monitoring wells. The shaded areas are lakes, the hatched area indicates the approximate area of the residue fill.

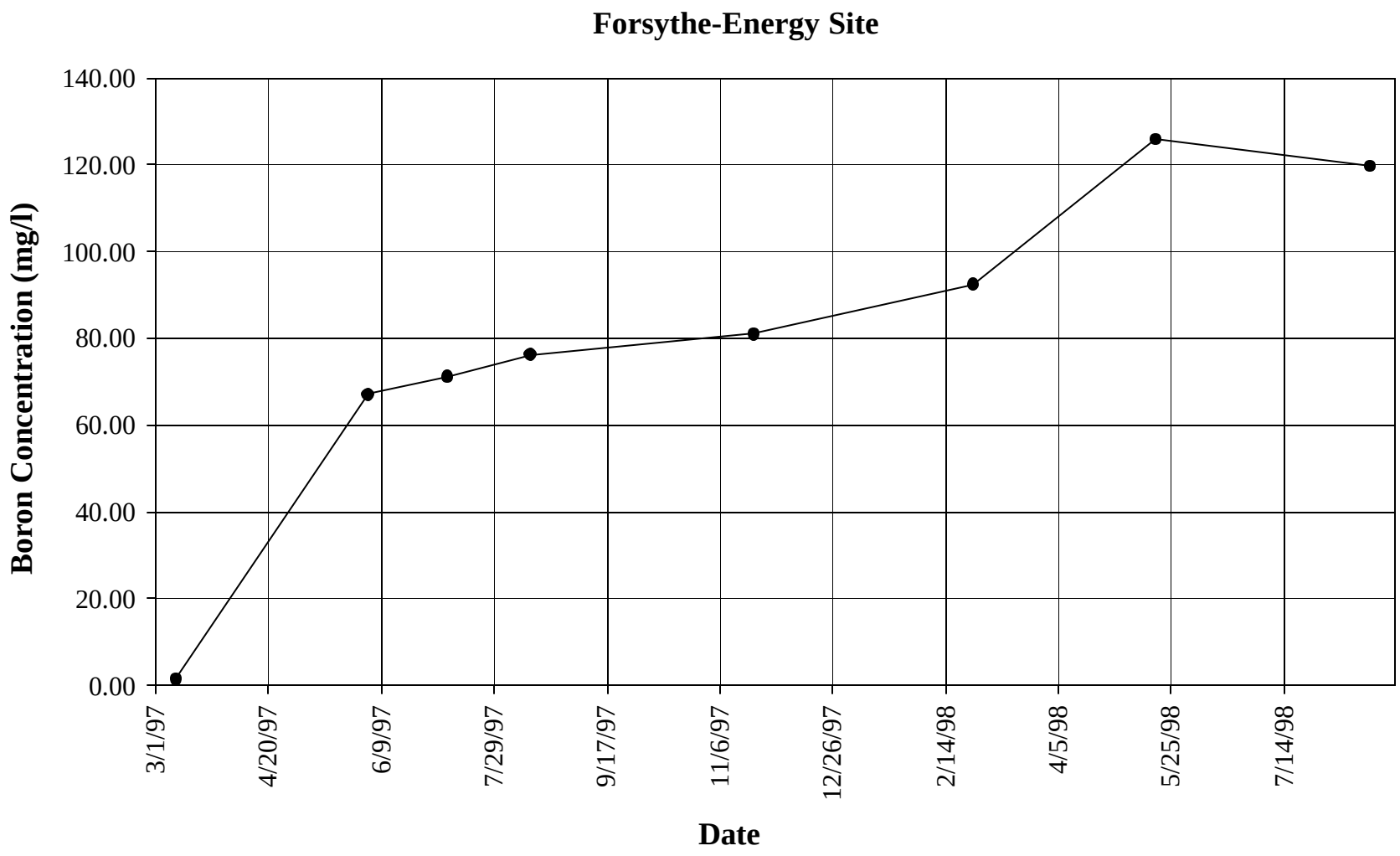

Figure 2. Boron concentration from the drain beneath the residues at the Forsythe-Energy site.

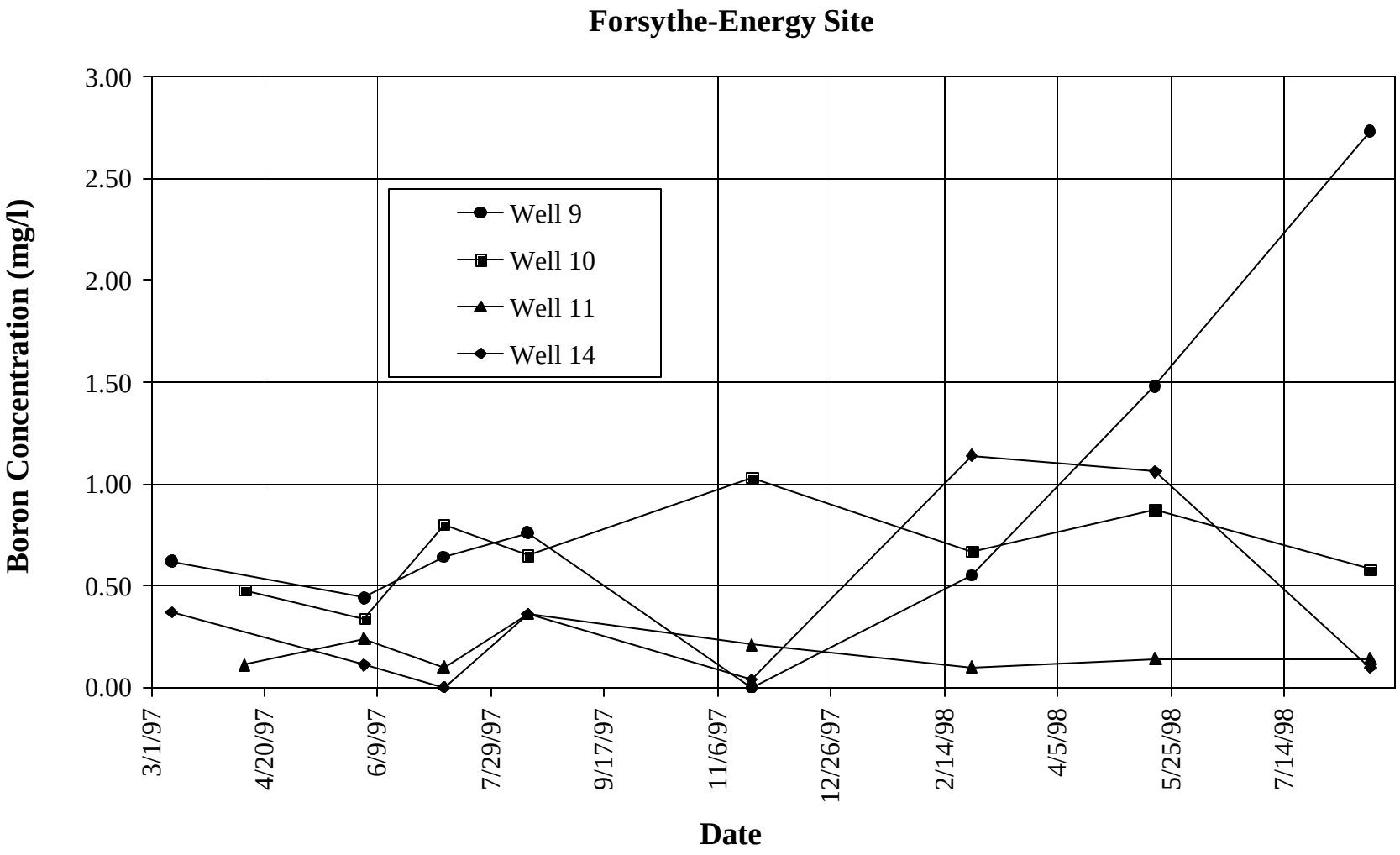

Figure 3. Boron concentration from groundwater samples collected at the Forsythe-Energy site. Well 9 shows elevated levels of boron in the last two sample events.

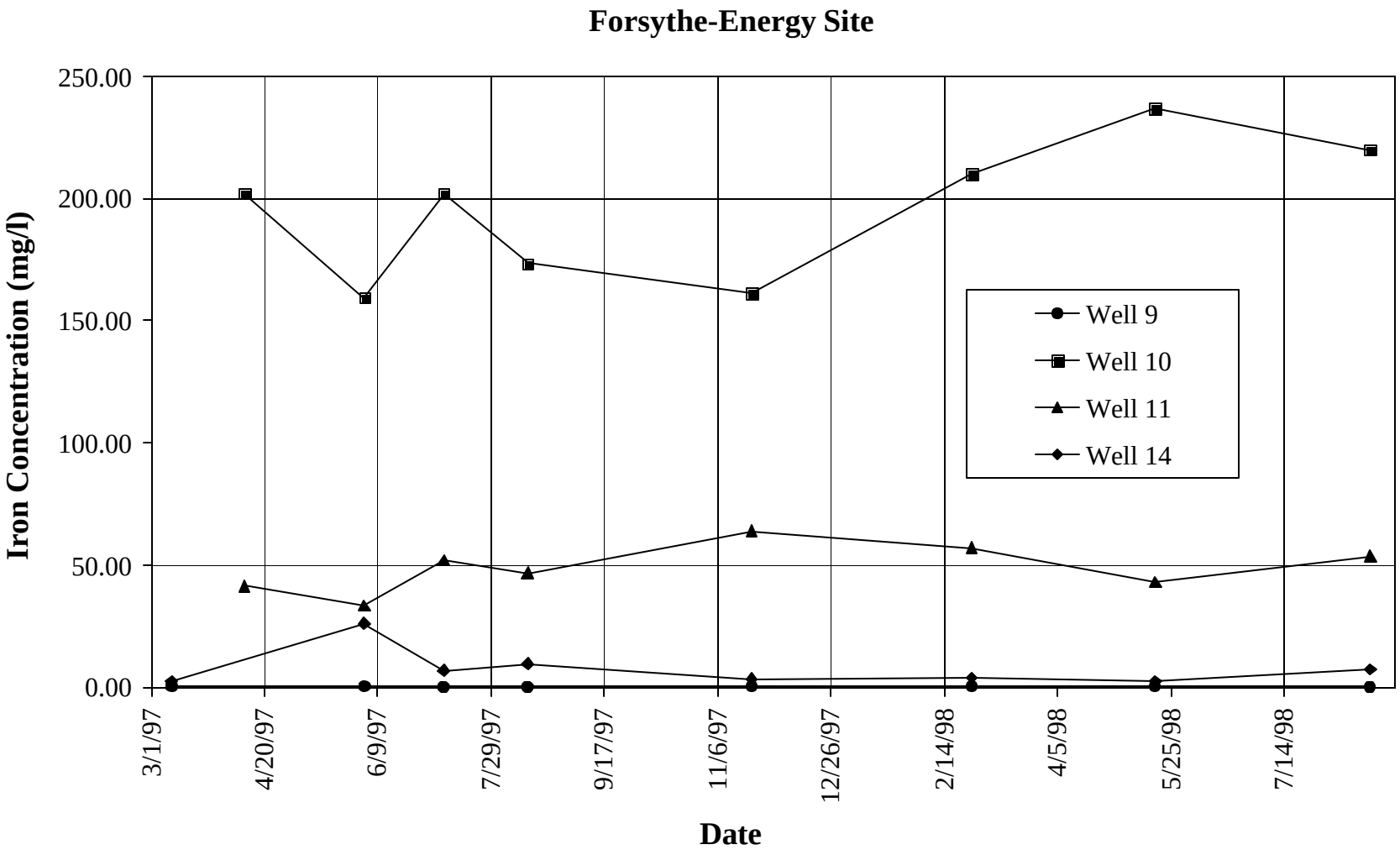

Figure 4. Iron concentration from groundwater samples collected at the Forsythe-Energy site. Note the higher iron levels in well 10, located upgradient of the fill.

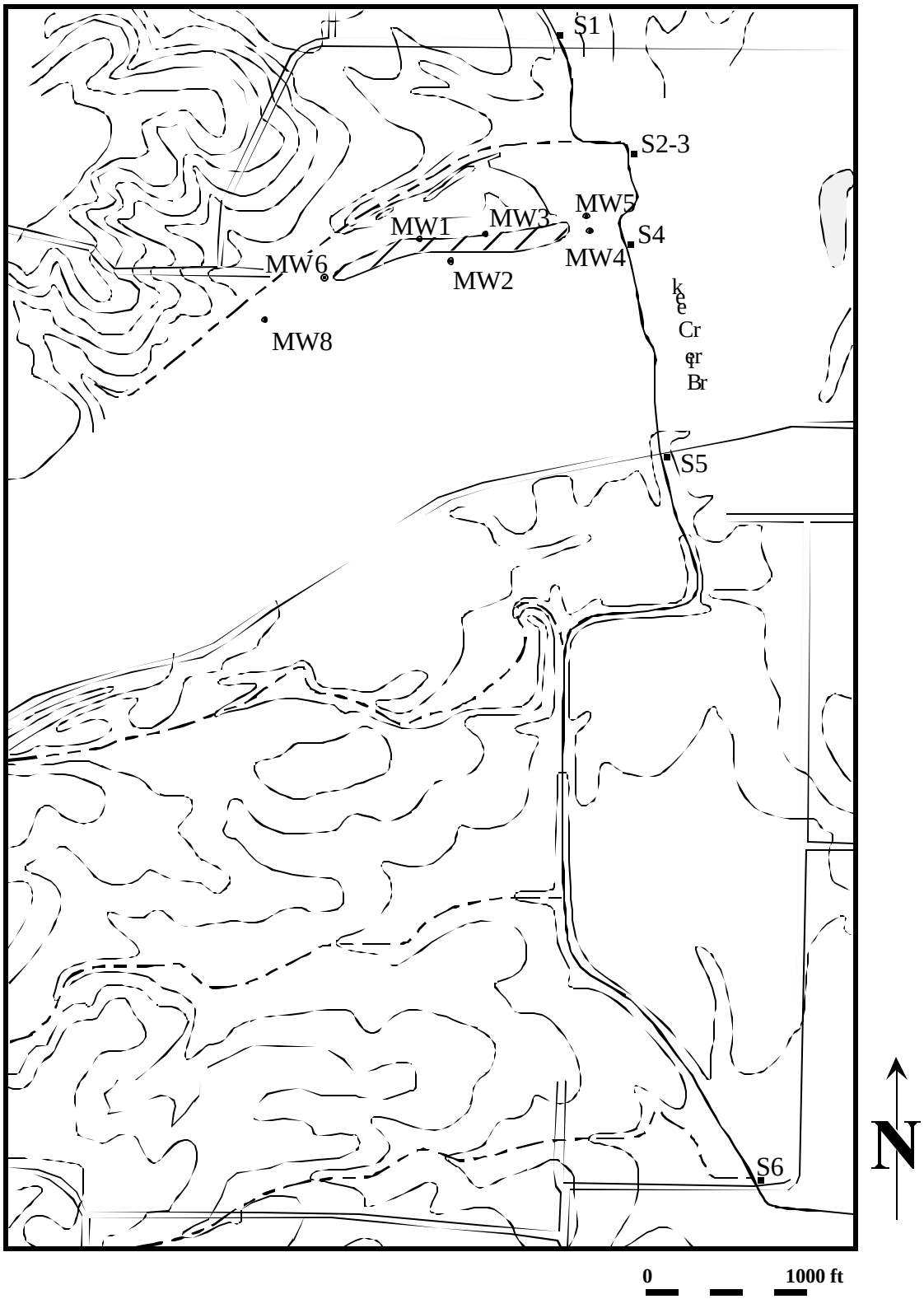

Figure 5. Thunderbird site map showing the location of the monitoring wells and the stream sample points. The hatched area indicates the location of the seven test plots.

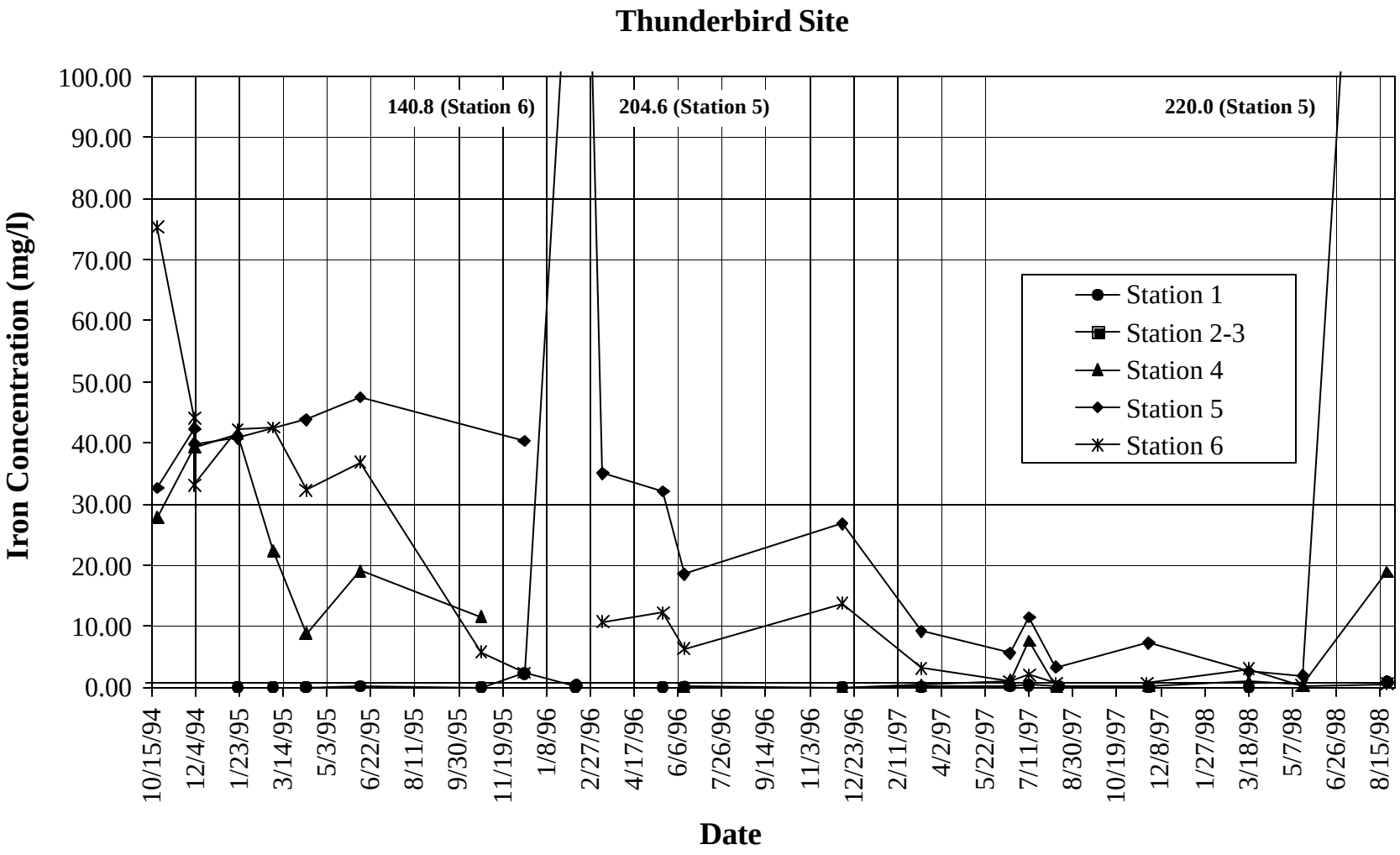

Figure 6. Iron concentration from surface water samples collected at the Thunderbird site. The values of spikes for stations 5 and 6 are indicated at the top of the graph.

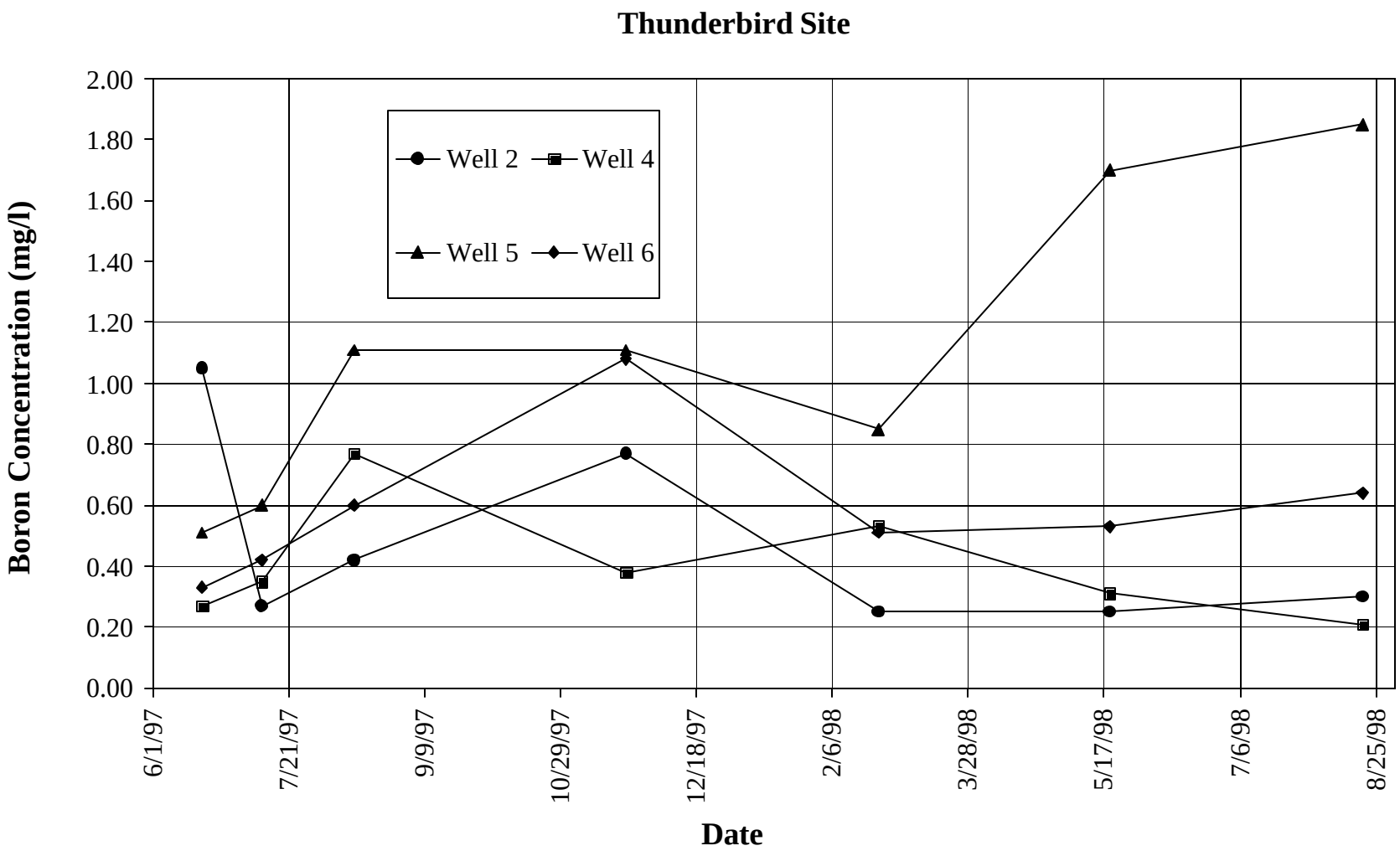

Figure 7. Boron concentration from groundwater samples collected at the Thunderbird site.

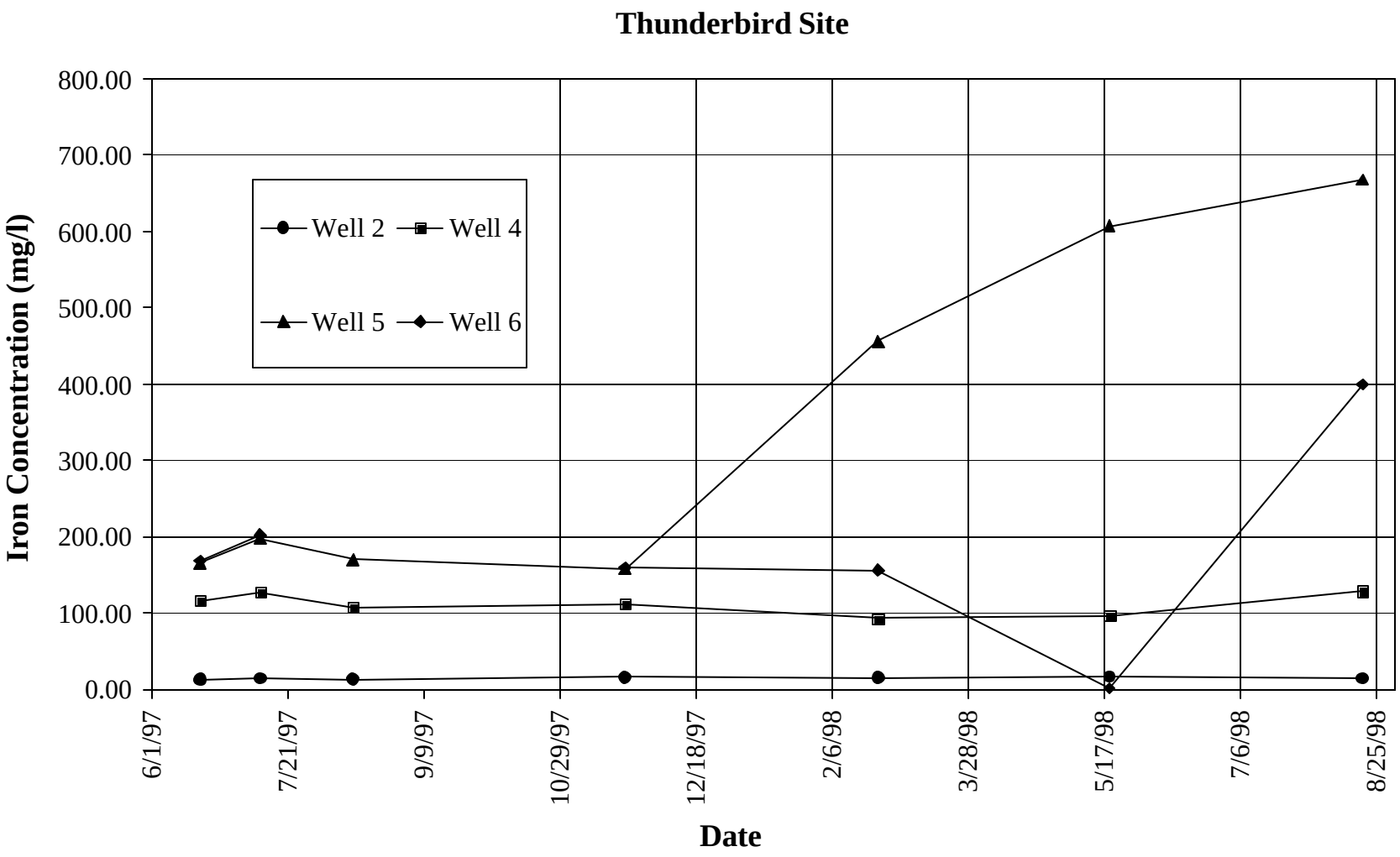

Figure 8. Iron concentration from groundwater samples collected at the Thunderbird site.

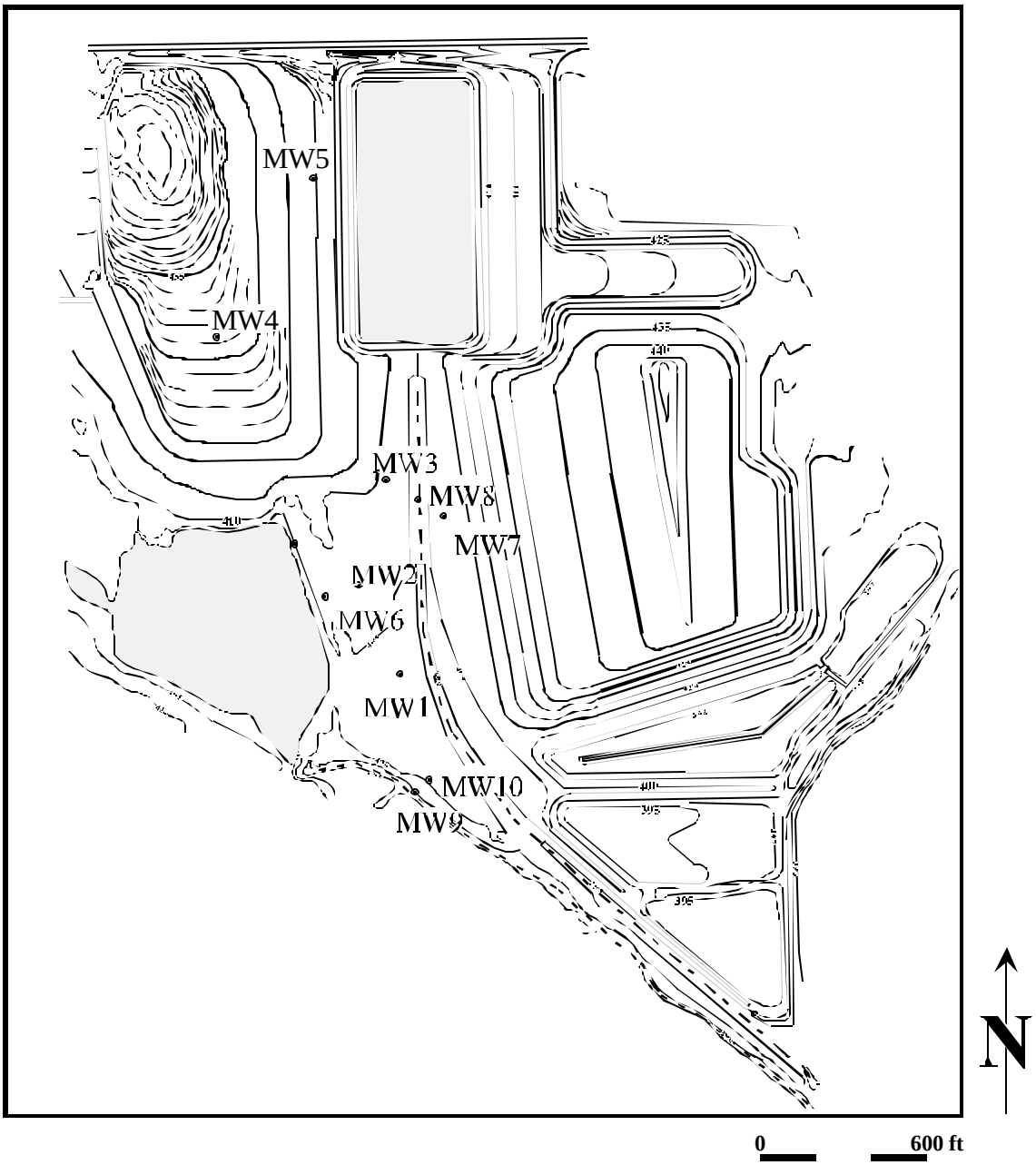

Figure 9. Harco site map showing the location of the monitoring wells.

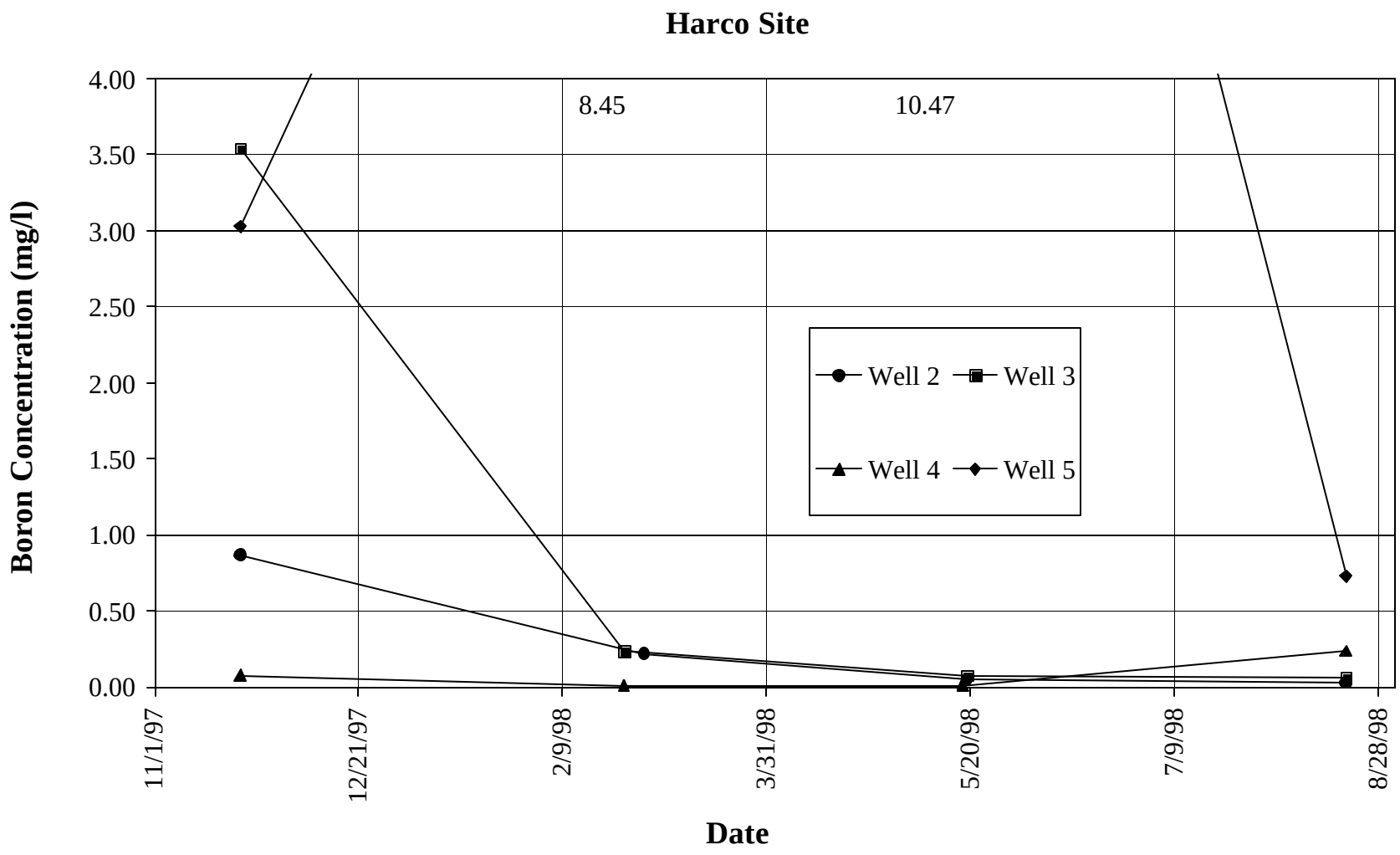

Figure 10. Boron concentration from groundwater samples collected at the Harco site.

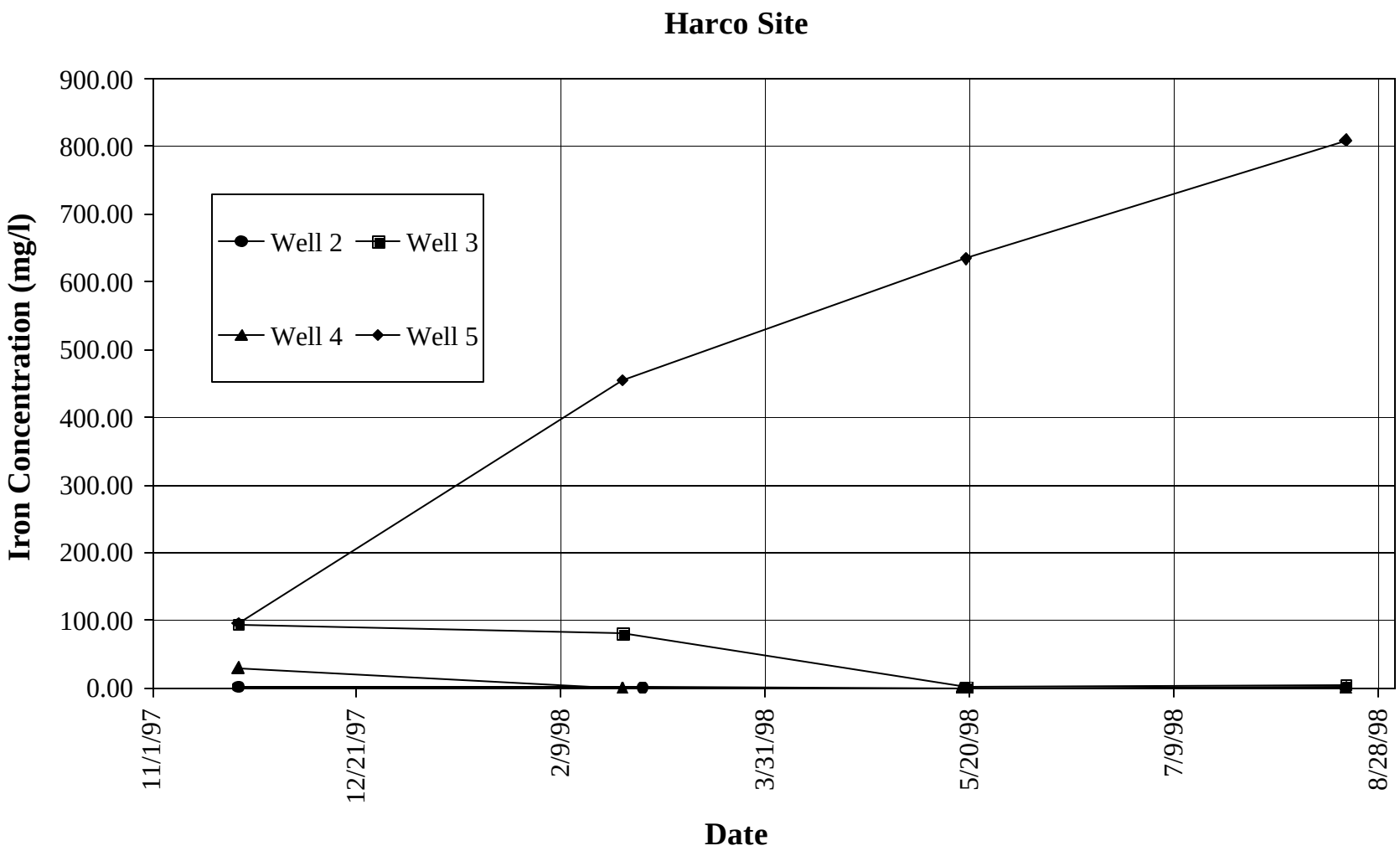

Figure 11. Iron concentration from groundwater samples collected at the Harco site.

MINE REMEDIATION WITH COAL COMBUSTION BY-PRODUCTS

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Abstract

In 1998, 1.1 billion tons of coal were mined in the United States. Eighty-four percent was used to produce electricity, and 108 million tons of coal combustion by-products (CCB), fly ash, bottom ash, boiler slag, and flue gas desulfurization materials, were also produced. A conventional pulverized coal boiler produces 158 pounds of CCB per ton of coal burned, and a fluidized bed combustion (FBC) boiler generates approximately 220 lb of by-product per ton of coal. Fly ash constitutes 60% of CCB, and about 30% of that produced annually from PC boilers is utilized in cement and concrete, structural fills, and waste stabilization. Less than 1% of CCB from conventional boilers is used in coal mine remediation. Almost 75% of FBC by-products are beneficially used; in 1995, 3.6 million tons were used in mine reclamation.

Under the Bevill Amendment to the Resource Conservation and Recovery Act (RCRA), the Environmental Protection Agency (EPA) was required to assess high volume low toxicity wastes. EPA issued a Report to Congress on wastes from the combustion of coal by electric utility power plants, and concluded in 1993 that regulation of such wastes under Subtitle C of RCRA was not warranted. In 1999, EPA, although it stated that there was insufficient information to assess potential risks of groundwater contamination, questioned the use of CCB in mine backfills. In its comments on EPA's report, the U.S. Department of Energy (DOE) summarized field data that supported this beneficial use.

The placement of alkaline fly ash in abandoned, reclaimed, or active surface coal mines is intended to reduce the amount of acid mine drainage (AMD) produced at such sites by neutralization, inhibition of acid forming bacteria, encapsulation of the pyrite, or water diversion. Preventive measures during reclamation or closure that inhibit the formation of AMD are intended to reduce the economic burden of perpetual treatment and limit the effect of mining on the environment.

Water quality changes have been monitored at three surface mine sites where fly ash grout was injected after reclamation to control AMD. The fly ash was produced at both PC and FBC plants. When compared before and after grouting, small increases in pH and decreases in acidity at discharge points were observed. When grouted and ungrouted areas were compared, the effect of the fly ash was shown to be localized in the areas of injection. Increases in trace element concentrations were comparable in grouted and ungrouted areas, suggesting that the coal or shale could be the source of these metals.

When FBC ash was injected, the concentrations of calcium and magnesium in water samples generally increased compared to background levels. The average concentration of trace elements (arsenic, cobalt, copper, nickel, and zinc) was slightly elevated in the injection areas, but in down dip and discharge water samples were comparable to background levels.

Over a four year period, average acidity in the injected area decreased by approximately 30% at sites where a mixture of class F fly ash and cement or the FBC grout was injected. Although coal mine remediation is a beneficial environmental use of FBC products, its effectiveness may be related to the amount of FBC by-products used and the method of emplacement.

THE RELEASE OF COMMON METALS FROM FLY ASH DURING LEACHING BY LOW PH LIQUIDS

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Abstract

More than 100 million tons of coal combustion by-products (CCB) are generated by U.S. power plants each year, and fly ash makes up 60% of that total. About 30% of fly ash is utilized (mostly for concrete and structural fill), requiring the disposal of approximately 40 million tons per year. Fly ash is primarily composed of relatively insoluble silicon, aluminum, and iron oxides; but it also contains a few percent of soluble metals and metal oxides. When exposed to natural fluids, the metals in fly ash could leach into the environment, polluting surface or groundwater.

The Department of Energy (DOE) is studying the leaching of metals from fly ash by liquids simulating natural fluids to assess the potential for environmental damage. The DOE leaching study places 1-kg CCB samples in 5-cm id by 1-meter columns. Seven lixiviants from pH 1 to pH 11 are used to simulate common environmental liquids such as acid rain, landfill runoff, and acid mine drainage. Each column is leached with approximately 230 mL/day of one lixiviant for 30 to 120 days. The leachates are analyzed for metals, sulfate, pH, alkalinity, and conductivity. Metals studied include aluminum, copper, iron, manganese, nickel, zinc, and the trace elements antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and selenium. Most of the metals leached from fly ash in an acidic environment. This resulted in a surge of metal values in the leachate as soon as the initial alkalinity in the fly ash was neutralized. The metal concentrations in the leachates dropped rapidly after this initial surge.

Tests have been completed on 36 fly ash samples. Metal recoveries varied greatly among fly ash samples, but some trends were observed. For example, zinc was the most soluble metal and it leached readily from most samples. Copper, however, leached well in some acidic conditions but little in others. Apparently copper occurs in different chemical compounds which produce differing extractions. Generally, the release of metals from CCB is low, less than 20% of the amount in the sample, and exposure to naturally occurring liquids does not release concentrations of environmental significance.

WHERE DO WE GO FROM HERE?

FORUM PARTICIPANT RECOMMENDATIONS

At the conclusion of the forum on April 12, 2000, the participants provided the following recommendations concerning issues or concerns deserving attention and efforts by the Coal Combustion By-Products Steering Committee.

1. Improve educational outreach efforts and products to the public.
2. Find a way to adequately investigate and document the actual circumstances behind each of the alleged EPA damage cases.
3. At any future technology transfer event, try to present more active mining case studies of CCB use and disposal that include relevant site specific permit information.
4. Continue the effort to provide speakers from all perspectives on the issues related to CCB use and disposal.
5. Continue to improve Internet access to CCB Information and provide information products on CD ROM format.
6. Consider making future forums more Region/State specific so that they can focus on more site specific problems and solutions.
7. Consider holding the next regional forum in the Western United States.
8. Investigate ways to make more citizen scholarships available.
9. Consider having more talks on construction methods and economics.
10. Investigate methods for promotion of better guidelines for handling and testing CCB materials.

SURVEY RESULTS
THE USE AND DISPOSAL OF COAL COMBUSTION BY-PRODUCTS AT COAL MINES: A TECHNICAL INTERACTIVE FORUM PARTICIPANT COMMENTS AND RECOMMENDATIONS

REGISTRATION

	# of Registrants	% of Registrants
TOTAL:	140	100

PARTICIPANTS THAT COMPLETED THE SURVEYS

TOTAL RECEIVED	49	100

LEVEL OF SATISFACTION WITH THE FORUM

VERY SATISFIED	22	45
SATISFIED	24	49
ADEQUATE	3	6
DISSATISFIED	0	0
VERY DISSATISFIED	0	0

COMPLIMENTS:

1. **Great Format with broad overview of topic. Fast Moving. I enjoyed the practical applications.**
2. **Congratulations. The forum was extremely useful. A good mix of State/University/Mining/Electric Utilities/and Environmental. I learned a lot and only wish I had done it sooner.**
3. **Impressive overall experience. My compliments on the selection of speakers. A well rounded forum.**
4. **Good coverage of topics.**
5. **All speakers were very professional and doing needed research.**
6. **Well planned overall. Good variety of speakers.**
7. **Very educational.**
8. **As a relative neophyte to the CCB issues, I found the presentations very helpful and informative.**
9. **All speakers generally good and the topics pertinent.**
10. **Good program. An overall success.**
11. **Excellent. Well balanced. Good adherence to the schedule, session leaders, and audio visual.**
12. **Very well conducted.**
13. **Good cross section of topics, excellent presentations. All presenters knew their topics extraordinarily well. Having both sides of the CCB disposal issue promoted a spirited discussion.**
14. **The forum overall was very good, timely, and informative. Keep up the good work.**
15. **Very good and informative forum. Good job keeping on schedule.**
16. **The forum was great, the right length, good speakers, and a focused setting.**

PARTICIPANT AFFILIATION	# of Registrants	% of Registrants
STATE	27	19
CONSULTANT	27	19
COAL INDUSTRY	21	15
POWER INDUSTRY	16	11
UNIVERSITY	14	10
OSM	14	10
US DOE	12	9
CITIZEN	5	4
OTHER FEDERAL	3	2
EPA	1	1

REGIONAL REPRESENTATION	#	%
APPALACHIAN	89	64
MID-CONTINENT	34	24
WEST	17	12

PARTICIPANTS FROM THE FOLLOWING 20 STATES

Arizona	Illinois	Mississippi	Tennessee
California	Indiana	North Dakota	Texas
Colorado	Kentucky	New Mexico	Virginia
Washington D.C.	Louisiana	Ohio	West Virginia
Georgia	Maryland	Pennsylvania	Wyoming

PARTICIPANT RATING ON USEFULNESS OF TALKS
1=EXCELLENT; 2=GOOD; 3=FAIR; 4=POOR

SESSION 1 CCB BASICS

PRESENTER	AVERAGE RATING	RATING RANGE
Debra Pfleughoeft-Hassett	**1.8**	**1-3**
Kolker	**1.9**	**1-4**
Chugh	**2.1**	**1-4**
David Hassett	**1.5**	**1-3**
Tyson	**1.9**	**1-4**

SESSION 2 REGULATORY PERSPECTIVES

PRESENTER	AVERAGE RATING	RATING RANGE
Wittner	**2.4**	**1-4**
Ehret	**2.2**	**1-4**
Groseclose	**1.8**	**1-4**
Stant	**2.8**	**1-4**
Holbrook	**2.2**	**1-4**
Archer	**2.4**	**1-4**

SESSION 3 BENEFICIAL USE AT THE MINE SITE

PRESENTER	AVERAGE RATING	RATING RANGE
Prichard	**1.7**	**1-4**
Rathbone	**1.6**	**1-3**
Black	**1.7**	**1-3**
Dick	**1.6**	**1-3**
Chugh	**1.8**	**1-3**
Stuart	**1.8**	**1-4**

SESSION 4 HYDROLOGIC LONG TERM MONITORING

PRESENTER	AVERAGE RATING	RATING RANGE
Ziemkiewicz	**1.7**	**1-3**
Groenewold	**1.9**	**1-4**
Butalia	**1.6**	**1-4**
Haefner	**1.9**	**1-4**
Esling	**1.8**	**1-3**

SUGGESTIONS FOR IMPROVEMENT

CITIZEN INVOLVEMENT

- Need a more balanced input from environmental groups. Environmental speaker not credible. The

perspective of a credible environmental group would have been useful in evaluating concerns with heavy metals.

- Future forums should address more citizen concerns as to exposure risks.
- There needs to be more public outreach to citizens. Both scientists and government can benefit by public education and communication that can dispel existing public misinformation.
- Need to use good science to evaluate citizen data to determine its value in a credible way.
- Invite environmental experts like Dr. Cherry and Dr. Currie who write negative reports to bring their questions to the forum.
- Invite more citizens affected by CCW disposal and application at mine sites and scientists who present a different view to present a more balanced view point.

REGIONAL CONCERNS

- Would like to see a future forum focus on the western States.
- Need more specifics on the detailed processes of States like Pennsylvania, West Virginia, Maryland, and Ohio.

CASE STUDIES

- Would like to see more case studies of CCB buffering and mine refuse sites.
- Need more case studies of disposal on the mine site.

ECONOMICS

- Need to see more economic details and reviews of economic viability.
- Need more emphasis and data on the economic viability of projects.

GENERAL

- EPA should have participated more.
- Need to consider future forums that would focus more on the needs of the scientific community.
- Explore beneficial re-use options.
- Need to have this type of forum on a more frequent basis.
- A good historical review of CCB utilization and impacts would have been very informative.

APPENDIX

APPENDIX 1: RECORDED DISCUSSIONS

Edited by
Kimery C. Vories
USDI Office of Surface Mining
Alton, Illinois

The following are the edited discussions that took place at the end of each speaker presentation and at the end of each topic session. The actual comments have been edited to translate the verbal discussion into a format that more effectively and efficiently communicates the information exchange into a written format. The organization of the discussion follows the same progression as that which took place at the forum. A topical outline has been developed to aid in accessing the information brought out in the discussions.

The topic of each question is shown in alphabetical order in **bold.** The individual speaker questions are listed in outline format under the appropriate topic session and presentation title. Questions during the twenty minute interactive discussion are listed at the end of the session in the following format.

SESSION # AND TOPIC AREA

1. Presentation Title
   - **Subject of Question or Comment**

SESSION INTERACTIVE DISCUSSION
Subject of Question or Comment

OUTLINE OF DISCUSSION TOPICS

SESSION 1: COAL COMBUSTION BY-PRODUCTS: THE BASICS

1. Production of Coal Combustion By-Products: Processes, Volumes, and Variability
   - **Ash variability due to power plant operations**
   - **Ash variability within a given coal seam**
2. Composition of Coal Combustion By-Products
   - **Arsenic enhancement in ash**
3. Physical Properties and Engineering Performance of Coal Combustion By-Products
4. Environmental Performance and Regulatory Status of Coal Combustion By-Products
   - **North Dakota Damage Site**
   - **Validity of the TCLP test for determining environmental impact of CCBs**
5. Coal Combustion Products: A Material Flow Model
   - **Change in concrete strength due to increasing fly ash in mixture**

SESSION 1 INTERACTIVE DISCUSSION
Comparability of cement kiln dust to CCBs
Mercury in ash
Reaction of CCB contractors to EPA rule making
Trace element partitioning

SESSION 2: REGULATORY PERSPECTIVES

1. U.S. Environmental Protection Agency/Fossil Fuel Combustion: A Hazardous Waste Determination
   - **Clarification of uncertainty and unevenness**
   - **Effect of improving waste management**
   - **Mining damage cases**
   - **Nature of the damage cases**
2. A Discussion of the Development and Evolution of Indiana's Process for Regulating the Disposal of Coal Combustion Materials at Surface Coal Mines
   - **Background water monitoring in Indiana**

- **Effect of EPA rule making on disposal of CCBs in Indiana**
- **Use of CCBs for abatement of acid mine drainage at abandoned sites**

3. Utility Industry Perspective of Mine Placement of Coal Combustion By-Products
   - **Legality of EPA rule making without adequate public notice**
4. A Citizen Regulatory Perspective of Disposal of Coal Combustion Wastes at the Mine Site
   - **Indiana ash dump aquifers**
   - **Indiana disposal site - coal processing waste or CCBs?**
   - **Oklahoma CCB problem disposal sites?**
   - **Pennsylvania public meetings on ash disposal**
5. The Office of Surface Mining's Perspective of Coal Combustion Waste Disposal on Native American Land
   - **OSM baseline hydrology requirements**
   - **OSM bond requirements for protection of groundwater resources**
   - **OSM relationship to RCRA**
6. Comparison of Legal Approaches to Coal Combustion By-Product Reuse: A Changing Area of the law

SESSION 2 INTERACTIVE DISCUSSION

Different state definitions of beneficial use
Disposal requirements for construction products containing CCBs
Elimination of state beneficial uses not defined by EPA
EPA staff vs management differences
Fluidized bed combustion ash should be exempt from Subtitle C determination
Hazardous waste characterization of CCBs
Misrepresentation of Pennsylvania program for handling CCBs
Potential for different standards to be applied to the same CCBs
Spoil chemical characterization
States that HEC thinks are doing a good job regulating CCBs

SESSION 3: BENEFICIAL USES AT THE MINE SITE

1. Development and Demonstration of Coal Combustion By-Product Based Structural Products for Mine Use
   - **Cost comparison with wood**
   - **Comparison with normal construction products**
   - **How are these products cut?**
   - **Product density**
   - **Product ingredients**
2. Backfilling of Highwalls for Improved Coal Recovery
   - **Delivery problems**
   - **Required strength**
3. Grout Injection into an Underground Coal Mine to Control Acid Mine Drainage and Subsidence
   - **Benefits of grouting**
   - **Explain the fluctuating concentrations of metals during grouting**
   - **Extent of mine slumping**
   - **Flow distance of the grout**
   - **Length of time that water monitoring is necessary**
   - **Long-term pH levels**
4. Beneficial Uses of Clean Coal Combustion By-Products: Soil Amendment and Coal Refuse Treatment Examples and Case Studies
   - **Application of sulfide based lime to coal refuse**
   - **Benefits of CCB addition to plant growth**
   - **Concerns about boron**
   - **Exchange capacity of composting material**

- **How is CCB compost applied**
- **Plant material chemical analysis on trace elements**
- **Regulatory requirements for use of CCBs in agriculture in Ohio**
- **Type of compost material**

5. Underground Placement of Coal Processing Waste and Coal Combustion By-Products Based Paste Backfill for Enhanced Mining
6. Remining with Coal Combustion By-Products at the Broken Aro Demonstration Site
   - **Recent water quality data**

SESSION 3 INTERACTIVE DISCUSSION

Boron levels toxic to plants
Expansion of CCBs in underground applications
Impact of EPA rule making on CCB research
Industry reaction to CCB substitutes for conventional products
Potential benefits of clarification of acceptable uses for CCBs
Purpose of lining mine floor with CCBs

SESSION 4: HYDROLOGIC LONG-TERM MONITORING

1. Water Quality Effects of Beneficial Coal Combustion By-Product Use at Coal Mines
   - **Extend of fracturing**
   - **Water quality parameters**
2. The Effects of Fly Ash and Flue Gas Desulfurization Wastes on Groundwater Quality in a Reclaimed Strip Mine Disposal Site
   - **EPA applicability of TCLP test**
   - **EPA statement of application of TCLP to CCBs**
3. Performance Assessment of a Flue Gas Desulfurization Material at a Lined Pond Facility
   - **Disintegration due to freeze-thaw**
   - **Impact of moisture content on permeability**
4. Water Quality at an Abandoned Mine Land Site Treated with Coal Combustion By-Products
5. Hydrologic Monitoring at Three Mine Sites Reclaimed with Mixtures of Spoil and Coal Combustion Residues in Illinois
   - **Effectiveness of down gradient wells**

SESSION 4 INTERACTIVE DISCUSSION

Boron attenuation studies
Regulatory prohibition below the groundwater table
Texas solid waste regulations

DISCUSSION BY SESSION

SESSION 1: COAL COMBUSTION BY-PRODUCTS: THE BASICS

1. Production of Coal Combustion By-Products: Processes, Volumes, and Variability Debra Pflughoeft-Hassett, Energy and Environment Research Center, University of North Dakota, Grand Forks, North Dakota

Question: **(Ash variability due to power plant operations)** We found that different power plant operations have effected the chemistry of some coal combustion materials. Would you comment on your experience with changes to the power plant operations?

Answer: Power plants that are being modified for low nitrous oxide combustion systems, SCR systems, and SNCR systems to reduce nitrogen emissions need to be looked at on a case by case basis. In general, to understand the

variability of ash you need to know the source of the ash. Some power plants continually use the same source of coal while others may us several sources that are continually changing.

*Question: (***Ash variability within a given coal seam***):* You have been discussing the variability between the different types of coal combustion materials and you mentioned that ash from a similar type of coal will not be too variable. If you have the same type of coal burned in the same power plant unit, what type of variability would you expect in the ash products?

Answer: I would expect a very limited variability. We have data from some mine mouth power plants that go back for about 20 years, and we have seen very little variability in that data. You will see some changes in ash quality as the mine moves across the coal seam over time. We have seen some variability in the potassium concentrations and in some of the trace elements. Even within a particular coal basin we have seen very little variability in the ash materials. This needs to be checked, however. You can not just assume that it will not change.

2. Composition of Coal Combustion By-Products Allen Kolker, U.S. Geological Survey Coal Division, Reston, Virginia

Question: **(Arsenic enhancement in ash)** Could you clarify your statement concerning arsenic enhancement in feed coal and ash?

Answer: We found that close to 100 percent of the arsenic is retained in the combination of fly ash and bottom ash, but it was preferentially concentrated in fly ash.

3. Physical Properties and Engineering Performance of Coal Combustion By-Products Yoginder P. Chugh and Debasis Deb, Department of Mining Engineering, Southern Illinois University, Carbondale, Illinois

4. Environmental Performance and Regulatory Status of Coal Combustion By-Products David Hassett, Energy and Environment Research Center, University of North Dakota, Grand Forks, North Dakota

Question: **(North Dakota Damage Site)** In the current EPA rulemaking process, EPA has noted that in North Dakota there is an exceedance for selenium and arsenic in down gradient monitoring wells. Do you know anything about this?

Answer: I will have to stand by my earlier statement, that according to the North Dakota Public Health Department, who are not friends or advocates of the mining industry, there are no problematic sites in North Dakota.

Answer: We think that EPA is referring to a historical disposal situation. At this site when disposal was initiated, everyone including the Regional EPA and the State, determined that no liners were needed for the site. Later it was found that there were some discharges with high concentrations of certain elements. The State and utility then agreed that it would be better to install a liner and the disposal facility was taken out of service. It was ultimately determined that both a clay liner and synthetic liner were necessary on this site and the utility has followed this practice on all of its disposal areas. Since the water quality is continually improving at this site, North Dakota does not consider this to be a problematic site.

Question: **(Validity of the TCLP test for determining environmental impact of CCBs)**You made a statement about the TCLP test for determining leachate concentrations. You said you would not recommend the TCLP test for CCBs because it can't be backed up by science. Could you explain this statement since this is the test recommended by EPA for testing CCB leachate characteristics?

Answer: The use of TCLP in the leaching of ash to determine its environmental impact is invalid and this is why. If I am going to do a test in the laboratory, then I should be able to say that the test is going to have some sort of relevance to what also will happen in the environment. The TCLP test was designed for use in sanitary landfill

codisposal conditions. This is not the case with disposal of ash because the water that comes into contact with the ash is not generally acid because the ash is not exposed to rotting garbage. The second thing that is wrong with the TCLP is that it is an 18 hour test. I can tell you with certainty that ash will change its character radically in the first 360 days so that an 18 hour test will be invalid in terms of measuring this change.

5. Coal Combustion Products: A Material Flow Model Samuel S. Tyson, American Coal Ash Association, Alexandria, Virginia

Question: **(Change in concrete strength due to increasing fly ash in mixture)**What would happen to the strength of concrete if it were composed of 50 percent fly ash?

Answer: With a class F ash you would have a lower early strength gain. You would go from a 28 day strength result to a 90 day strength result. The question is whether on not the market can live with that change.

SESSION 1 INTERACTIVE DISCUSSION

Question: **(Comparability of cement kiln dust to CCBs)** Has the EPA rulemaking concerning cement kiln dust (which is similar to what is being proposed for CCBs) hurt its acceptance as a recycled product? It is my understanding that the cement kiln dust requirements provide minimal safety standards for this material. What is wrong with providing similar minimal safety standards for CCBs?

Answer: First, it is my understanding that EPA, under Subtitle D of RCRA, does have the ability to intervene in a situation where certain kinds of unacceptable, environmentally dangerous threats to health practices are employed. Concerning the impact on recycling of cement kiln dust following EPA regulation of the material under the "soft C" approach, there was a short-term (6 months to a year) reduction in use that disappeared after that time. The market for cement kiln dust, however, is a very different market than the market for CCBs. Cement kiln dust is primarily marketed to remediation contractors who have an in-depth knowledge of Subtitle C management practices that deal with Subtitle C on a daily basis. The basic customer base for CCBs, however, is made up of average construction companies. If you place yourself in the position of these companies, who are looking at only a small monetary difference in price between CCBs and non-hazardous construction materials, they will turn away from a material that may require a hazardous waste cleanup. ACAA sees that the current regulation of CCBs by the states under Subtitle D (solid waste) is working, so why try to fix something that isn't broken?

Question: **(Mercury in ash)** What quantities of mercury are you finding in ash?

Answer: We really don't have an answer for mercury in ash. We are just beginning to do some tests to determine the rate of loss of mercury from ash over time. I am concerned that if we start putting more mercury in ash that it will be a problem in the future.

Question: **(Reaction of CCB contractors to EPA rule making)** Have you heard from ash product consumers regarding the EPA proposal to list CCBs under Subtitle C (hazardous waste) of RCRA?

Answer: Not only have we heard from our marketers, ACAA has a documented case from a marketer in Nebraska, where the State has approved ash based products for floors for feedlots, who had been working with a contractor for months in using ash as a second pond liner for feedlot waste. Recently, the State wrote the contractor that because of the current EPA discussion of Subtitle C regulation of CCBs they would immediately suspend indefinitely the progress on this project. This points out, that at the State level, the system was working to encourage the use of these materials. It only took the rumor that EPA was thinking about a Subtitle C regulation to kill the process.

Question: **(Trace element partitioning)** Please explain trace element partitioning.

Answer: From an environmental standpoint, the more volatile trace elements like selenium, cadmium, and lead tend

to go up the stack gases and associate more with the lightweight fly ash and not the bottom ash. Although not always the case, there is generally a partitioning of the trace elements with the finer fractions of ash like the fly ash.

SESSION 2: REGULATORY PERSPECTIVES

1. U.S. Environmental Protection Agency/Fossil Fuel Combustion: A Hazardous Waste Determination
Andrew Wittner, U.S. Environmental Protection Agency, Washington, D.C.

Question: **(Clarification of uncertainty and unevenness)** Please clarify your references to the uncertainty and the unevenness of the damage cases.

Answer: The unevenness is the different levels of protection provided by the different states. The uncertainty is the level of damage that may be occurring in terms of the interpretation of the evidence. Whether or not the damage is evidence of a precursor that may be an indicator of more damage in the future.

Question: **(Effect of improving waste management)** It is my understanding that most of the damage cases come from the 1970s. Since many of these cases are the result of practices that no longer occur, does EPA take into account the diminishing impact of these cases? How does EPA evaluate the effect of better management practices being currently employed?

Answer: I think there is no doubt that the states are becoming more knowledgeable about handling these situations. I think that management practices are getting more protective. The question, however, is whether or not this trend will continue, and is the increase in protection sufficient?

Question: **(Mining damage cases)** Of the damage sites that EPA has recorded, how many involve mining?

Answer: Most of the damage cases do not involve mining to my knowledge.

Question: **(Nature of the damage cases)** Have the damage cases been shown to be exclusively the product of coal combustion wastes?

Answer: There is no question that the damage cases are subject to interpretation and there are compounding effects. With respect to mine filling there is the question of whether the results are a result of mine filling or the presence of wastes. More importantly, whether enough time has passed, assuming we are monitoring properly, that the results we are seeing are just the precursor of what we may see at a later time. At this time, EPA does not have the data necessary to adequately model the groundwater mine filling situation.

2. A Discussion of the Development and Evolution of Indiana's Process for Regulating the Disposal of Coal Combustion Materials at Surface Coal Mines Paul Ehret, Indiana Department of Natural Resources, Bureau of Mine Reclamation, Indianapolis, Indiana

Question: **(Effect of EPA rule making on disposal of CCBs in Indiana)** If EPA comes out with a determination for CCBs that is similar to that for cement kiln dust concerning disposal of the materials below the water table, how would that impact the program for disposal of CCBs at mine sites?

Answer: The Indiana program is based on placing CCBs below the water table. The rationale is that in general the upland areas of southwestern Indiana are not groundwater rich. Groundwater is a limited resource in this area of the State with the exception of bottomland areas and alluvial valleys. The amount of groundwater is limited and after mining the groundwater is highly mineralized. It makes no sense to us in this situation to try to separate the spoil water from the CCB water. The problem with placement of CCBs above the groundwater is that this may result in a conflict with the approximate original contour requirements of the Surface Mining Act which would preclude the disposal of CCBs at surface coal mines.

Question: **(Background water monitoring in Indiana)** How extensive is your background monitoring of groundwater quality in Indiana?

Answer: We have a pretty good handle on the pre-mining groundwater data. The problem is that the pre-mining water quality is not a good indicator what the post-mining groundwater quality will be. This has nothing to do with CCBs. There is tremendous variability in post-reclamation water quality from wells that may only be 50 feet apart. Because of this problem with post-reclamation groundwater, we do not consider it to be a resource.

Comment: **(Use of CCBs for abatement of acid mine drainage at abandoned sites)** In Maryland, we have four CCB damage cases that have been grandfathered. But speaking of grandfathered problems, we have 450 abandoned coal mines in Maryland that have unquestionably created environmental damage. As a result, Maryland has 450 miles of streams that are devoid of aquatic life. My problem is that the risk analysis described by EPA considers eliminating the use of CCBs as a method for mitigation of the acid mine drainage at the 450 abandoned mine sites because of four CCB damage cases resulting from grandfathered CCB disposal areas. This does not seem to be either good science or good public policy to me.

Response: In abandoned mine situations you change the subject dramatically. Acid mine drainage (AMD) problems can be severe. My problem with the proposed EPA rule making is that it appears to preclude the use of CCBs for mitigation or abatement of AMD. Given the known problem we have with mitigation of AMD at abandoned mine sites, the EPA proposal seems to through the baby out with the bath water.

3. Utility Industry Perspective of Mine Placement of Coal Combustion By-Products Steven Groseclose, Piper, Marbury, Rudnick, and Wolfe LLP, Washington, D.C.

Question: **(Legality of EPA rule making without adequate public notice)** What is the legal perspective on EPA sending a report to Congress that indicates the evidence does not support regulation of CCBs under Subtitle C (hazardous waste) in March of 1999 and then at the 11th hour without any public notice in the Federal Register, completely reversing itself based on data from only four additional sites that even EPA has not had time to adequately investigate?

Answer: Certainly it is highly irregular and is not the way it is supposed to be done. We will have to wait and see how the final determination comes out before I would consider the legal aspects.

4. A Citizen Regulatory Perspective of Disposal of Coal Combustion Wastes at the Mine Site Jeff Stant, Hoosier Environmental Council speaking for Tom FitzGerald, Kentucky Resources Council, Inc., Frankfort, Kentucky

Question: **(Indiana ash dump aquifers)** What were you referring to when you said that Indiana was reconstituting aquifers as ash dumps?

Answer: What I mean is that there are final box cuts in Indiana where they dispose of fly ash from the elevation of the lowest coal seam mined to within 4 feet of the final surface. These areas are up to 1,000 yards long and 200 yards wide horizontally. They call this a monofill. Instead of any spoil material being put back, what you have is a block of solid ash the size of a ship under the ground in the water table. Within this monofill site, I would call this an ash aquifer. The Indiana Universal site has very high levels of boron (60 -70 ppm), many times over the standards used in the State of Wisconsin and many times over the U.S. Department of Agriculture's crop irrigation standard.

Question: **(Indiana disposal site, coal processing waste or CCBs?)** You showed us pictures of CCB disposal at Pride Creek in Indiana. The material being disposed of in the picture was not CCBs but coal processing waste.

Answer: We had it tested and the analysis showed that it was coal ash.

Response: I tell you what Jeff, you send a person and the State of Indiana will send a person to this site and we will collect a sample and split it. We can then both test the same sample and see what the result is. The site you showed in your picture is approved for both fly ash disposal and for coal processing waste. The pit you showed in your picture is only approved for coal processing waste primarily from their underground mine and that is what we were looking at in your picture.

Question: **(Oklahoma CCB problem disposal sites?)**I am from the Oklahoma Department of Mines. You mentioned several states that had groundwater pollution due to disposal of CCBs and Oklahoma was one of them. I am not aware of that. Could you tell me the particulars to which you are referring?

Answer: Although it was several months ago, we were dealing with four sites and the State person we were talking to, who told us about the sites, later told us that the sites did not exist. It was our interpretation that he had been instructed by management to not talk to us because it would be admitting that the State was not doing its job.

Question: **(Pennsylvania public meetings on ash disposal)** I take issue with you concerning what you said about the Pennsylvania project that I am intimately involved with. This issue I take is that you said we had exceeded 250,000 tons and the State did nothing about it. The regulation reads that if you exceed 250,000 tons you need to

submit a request for approval. This is what we have done and we have had three public meetings concerning this request. We are meeting with the public on this issue because it is good business.

Answer: I stand corrected.

5. <u>The Office of Surface Mining's Perspective of Coal Combustion Waste Disposal on Native American Land</u>
Rick Holbrook, Office of Surface Mining, Denver, Colorado

Question: **(OSM baseline hydrology requirements)** On the permit application, you mentioned that the permit should describe protection of the hydrologic balance and hydrologic resources. In Indiana, we are claiming that if you are going to turn mines into large disposal sites for CCBs you need to do a better job characterizing the groundwater rates, direction of flow, and quality, and the vertical connection between aquifers. Are you saying that OSM requires this for each aquifer? In Indiana the State says that this can be assessed from existing technical guides and permitting information from nearby mines without obtaining site specific baseline information.

Answer: Although I think you need to work with the State Regulatory Authority on this I think you should be able to ask what is the technical basis for their review findings.

Question: **(OSM bond requirements for protection of groundwater resources)** You said that during bond release the regulatory authority needs to take into account the amount of bond necessary to protect the water resources. If the State says they don't value the post-mining groundwater resource then there is no money in the bond for groundwater resource protection.

Answer: If you have no groundwater resource, then you have nothing to protect.

Question: **(OSM relationship to RCRA)**What would be the advantage to OSM of operating its program under RCRA authorization?

Answer: OSM now operates under a RCRA plan to the degree that the Solid Waste regulations have to be abided by and are self implementing. OSM is obligated to insure that the permittee under a Federal program is in compliance with the EPA Solid Waste regulations. If there would be a Subtitle C (hazardous waste) determination for CCBs, then there will be another regulatory authority that we would need to coordinate with.

6. <u>Comparison of Legal Approaches to Coal Combustion By-Product Reuse: A Changing Area of the law</u> Tina

Archer, Howard and Howard Attorneys, Peoria, Illinois

SESSION 2 INTERACTIVE DISCUSSION

Question: **(Different State definitions of beneficial use)** If EPA does require additional regulation of CCBs and beneficial use is exempted, and yet many states do not have the same definition of what constitutes beneficial use, how will that effect the EPA rule making?

Answer: If EPA rule making does exempt beneficial use, then EPA will define what it means by beneficial use and states could be more stringent but not less.

Question: **(Disposal requirements for construction products containing CCBs)** Under the proposed EPA rule making for CCBs, if you are using Sheetrock in construction that has CCB gypsum in it, later when a building containing this Sheetrock is torn down where would this waste be disposed? Would construction material with CCBs be disposed of differently than construction materials without CCBs?

Answer: It would be taken to a Subtitle D (solid waste) landfill. If, however, you did not take it to an appropriate solid waste disposal area, then it would be regulated as a hazardous waste.

Response 1: I would not go down to the lumber yard and buy Sheetrock or concrete with CCBs in it if there was a chance it would have to be disposed of differently than Sheetrock or concrete without CCBs.

Response 2: People buy batteries today with lead in them, and we have programs for recycling the lead that has been brought about by RCRA in order to control the hazardous components of batteries.

Question: **(Elimination of State beneficial uses not defined by EPA)** If beneficial use is defined by EPA, and the states have listed uses not included in the EPA definition, will those uses be eliminated at the State level?

Answer: That is my understanding.

Question: **(EPA staff vs management differences)** Was there a technical or professional group of staff within EPA solid waste that recommended that EPA continue the exemption of CCBs from Subtitle C that was overruled by EPA management?

Answer: That is my understanding. There are a number of letters written by congressmen and senators to that effect.

Comment: **(Fluidized bed combustion ash should be exempt from Subtitle C determination)** Concerning the March 1999 EPA Report to Congress, there were five different categories of coal combustion wastes being considered. There were the large volume wastes comingled with the low volume wastes, the large volume wastes, the fluidized bed combustion (FBC) waste, the low volume wastes, and then the oil and natural gas wastes. The recently proposed EPA determination does not distinguish between the large volume wastes and the FBC wastes. We have beneficially used FBC ash in Pennsylvania for some time. We have a number of FBC power plants that use coal refuse as a fuel source. There is no other way to reclaim these coal refuse sites short of capping the areas with some type of concrete. These FBC power plants take the FBC ash back to the coal refuse site to finish the reclamation of the area. We have had some tremendous successes with reclaiming these sites. The groundwater has been monitored closely and there is not one site reclaimed with FBC that is even close to being considered a damage case. At one site I used FBC ash as a grout at a mine site where it is in contact with groundwater that has a pH of 2.3 from acid mine drainage from surrounding mines. Groundwater contamination was well documented prior to remediation with FBC ash with high levels of several RCRA metals. After grouting with FBC ash these concentrations were reduced by 65 - 95 percent. These reduced levels have remained the same for the last 8 years. I have yet to see a single case of FBC damage. If EPA looked at the FBC data, I think they would determine that FBC ash should remain exempt. The industry has told us that if a single FBC power plant has to start land filling the FBC ash then all of the

FBC power plants in Pennsylvania will shut down. In Pennsylvania we have on our inventory 854 abandoned coal refuse piles covering about 8,500 acres across the State. The 8.5 billion gallons of water per year coming off these unreclaimed sites would all be proven damage cases because of the AMD with very high levels of trace metals and a pH as low as 1.9.

Question: **(Hazardous waste characterization of CCBs)** Have CCBs been adequately tested to determine whether or not they would be characterized as hazardous materials?

Answer: Industry and academia have conducted extensive characterization studies on CCBs and determined that between 1 and 2 percent of the CCBs would be characterized as hazardous. But EPA would not consider that to be a sufficient test. No one would assert that these materials routinely test as hazardous for one of the RCRA metals. The problem is that in some cases leachate from CCB disposal sites have been found to pollute the environment and create damages.

Comment: **(Misrepresentation of Pennsylvania program for handling CCBs)** Having worked for the State of Pennsylvania for almost three decades, I would like to point out that the Pennsylvania program for handling CCBs has been seriously misrepresented here today. Pennsylvania has learned a lot concerning handling CCBs over the last 20 plus years. At this point in time, the program does involve testing the CCB materials often and early, it does not allow CCBs to be disposed of below the water table, and there is a complete list of conditions that control how it can be used.

Question: **(Potential for different standards to be applied to the same CCBs)**If EPA does regulate CCBs on mine sites under Subtitle C (hazardous waste), what happens to the very same CCBs when they are being used as fill on highway construction or flowable fill for utilities or make school soccer fields. Why would the same material

be required to have a liner and have groundwater monitoring on a mine application but not on these other applications?

Answer: In Illinois, there are some CCBs that can be beneficially used in applications that you have mentioned. There also are some CCBs that need a special handling plan. This is how we handle CCBs in Illinois. There are situations in Illinois where the scenario you suggested does occur, and ash that is suitable for a beneficial use is instead disposed of because there is just not enough demand for its use.

Question: **(Spoil chemical characterization)**Have spoil materials been characterized in the same sense that CCBs have been characterized chemically?

Answer: The answer is yes. If you what to know the detailed mineralogy please contact Dr. Chugh at SIUC.

Question: **(States that HEC thinks are doing a good job regulating CCBs)** I have been employed to explore both new and proven sound methods of using CCBs in coal mine subsidence issues. My goal is to take in positive information from speakers at this conference. Based on the Hoosier Environmental Council research of CCB sites you indicated that states are doing a good job utilizing CCBs in mine subsidence.

Answer: The Hoosier Environmental Council looked at State programs, their permits, and testing in an effort to regulate the use of CCBs in the environment. We think that both the Department of Natural Resources and the electric utilities in Wisconsin are very aggressive in dealing with problems related to CCBs. In Wisconsin the people do not fight disposal of CCBs because they feel that they are being protected. I think that Illinois has been trying to do a good job with its groundwater protection act and its effort to monitor surface impoundments and to put adequate water monitoring at its CCW disposal sites and mine sites. We also were very impressed by the Kentucky law and the Ohio Surface Mine disposal permits. We were impressed by the amount of water monitoring being done at the Turris Mine in Illinois where they had 26 monitoring wells around a 180 acre lagoon. There were a couple of other sites where there was a small disposal area were extensive water monitoring was being conducted. I have been impressed with the amount of research that is being done in West Virginia on leaching tests with sulfuric acid and

the research on ash characterization in Wisconsin. Ohio has a provision that requires a one year column leaching test where if the resulting leachate does not exceed drinking water standards then the ash can be disposed of below the water table. Although there are examples of states trying to be protective in this area, there are other states where this is not the case, and we need a minimum federal floor that all of the states have to abide by.

SESSION 3: BENEFICIAL USES AT THE MINE SITE

1. Development and Demonstration of Coal Combustion By-Product Based Structural Products for Mine Use
Y. P. Chugh, Mining Engineering Department, Southern Illinois University, Carbondale, Illinois

Question: **(Comparison with normal construction products)** How would these products compare to construction products not found on the mine site?

Answer: Our CCB blocks are not nearly as hard or strong as a conventional concrete block. They also tend to bleed the fly ash which could be a concern in a home environment.

Question: **(Cost comparison with wood)** What is the cost comparison of your CCB product with comparable wood products?

Answer: Our CCB blocks are made to be economically comparable to the Omega blocks. I do not know the actual price but our CCB blocks are less expensive and the performance is substantially higher. Our CCB blocks have a compresive strength around 200 pounds per square inch (psi) compared to the Omega block at around 40 psi.

Question: **(How are these products cut?)** Wood products can be shaped with a saw, how do you cut these products?

Answer: They can be cut with a bow saw just like wood.

Question: **(Product density)** How does the density of wood compare with the density of your CCB product?

Answer: The average density of an oak hardwood support member you would see in a mine is 80 to 90 pounds per cubic foot (pcf). The CCB crib ties were cast at 85 pcf. This gives a product that is almost identical to wood products currently in use.

Question: **(Product ingredients)** One slide showed that your product was about 80 percent fluidized bed combustion ash. What are the other ingredients in these products?

Answer: The crib elements are F ash with liming agents, commercial concrete foam to lower the density, and a reinforcing polymer.

2. Backfilling of Highwalls for Improved Coal Recovery Robert Rathbone, Center for Applied Energy Research, University of Kentucky, Lexington, Kentucky

Question: **(Delivery problems)** It seemed like the problem with the cement trucks was that they could not deliver quickly enough. Would more trucks and a different wash down area promote quicker delivery?

Answer: We used more trucks the second time but this just seemed to compound the problem. Since they were rented trucks, the drivers felt that they really needed to get them clean and the cleaning time really killed us. I liked the idea I heard here at the forum about using on site pug mills that you mixed yourself from a stockpile.

Question: **(Required strength)** Looking at your strength values, did you really need 1,500 psi?

Answer: No. What was actually calculated was about 50 psi. But we just decided to make it 500 psi. I think in general the higher the strength the better and we did not have to do anything other than add water to get the flow that we needed. But we didn't need it that high.

3. Grout Injection into an Underground Coal Mine to Control Acid Mine Drainage and Subsidence D. Courtney Black, National Mine Land Reclamation Center, West Virginia University, Morgantown, West Virginia

Question: **(Benefits of grouting)** Where is the true benefit of grouting these AMD mine pools, is it the treatment of acid mine drainage with alkaline material in the grout or is it sealing the underground works so that the incoming water does not come in contact with the acid forming materials in the mine?

Answer: We do not want the grout to dissolve because of neutralization of the mine water. We want to plug the hole so that water does not come in contact with acid forming materials in the mine.

Question: **(Explain the fluctuating concentrations of metals during grouting)** Comparing concentrations before, during, and after grouting, it seemed the concentration of several chemicals went down and then came back up but not as much as before grouting. How do you explain that?

Answer: The arsenic number I reported was before cell one was completed. We were getting a lot of acid mine drainage. Once we sealed that off, the pH of the discharge water started going up above 8.0. Because of leakage from the mine pool, the pH went up significantly during grouting. A lot of things happened during grouting because of the high pH levels of the grout. I am more concerned with what is happening after grouting.

Question: **(Extent of mine slumping)** Were you able to determine if you had much slumping in the mine before you started grouting?

Answer: We did do a survey with the OSM down hole camera and found a significant amount of slumping around cell #2.

Question: **(Flow distance of the grout)** Were you able to determine how far the grout would flow?

Answer: If there was no mine drainage occuring, we could fill 800 feet of cell with about three holes. In actual practice we needed about 17 holes to fill that 800 feet of cell. We filled one cell that had a high point with one hole.

Question: **(Length of water monitoring necessary)** How long will you need to monitor around the grout to determine if the seal will break down?

Answer: We plan to monitor this site on a quarterly basis indefinitely in order to determine the long-term effects because the cost at this site is fairly low.

Response: At another site where the grout has been exposed to AMD at a pH of 2.1 we have been monitoring for seven years and have not seen any breakdown of the grout.

Question: **(Long-term pH levels)** Have you determined the long-term impact on the pH of the mine pool?

Answer: We determined that the water coming into the mine pool had a pH of 5 to 6. It was being discharged from the mine pool at about pH 2.7. The water after grouting only needs settling not treatment for low pH.

4. Beneficial Uses of Clean Coal Combustion By-Products: Soil Amendment and Coal Refuse Treatment Examples and Case Studies Warren Dick, School of Natural Resources, The Ohio State University, Wooster, Ohio

Question: **(Application of sulfide based lime to coal refuse)** How do you apply a sulfide based lime to coarse coal refuse material?

Answer: At one site we are working on, we are applying it in layers with a dozer. The distribution of material is not uniform but adequate for our purposes.

Question: **(Benefits of CCB addition to plant growth)** Do you apply the FGD as an alternate to convential soil amendments or is this a supplement to those?

Answer: We would apply FGD primarily as lime substitute. Farmers in the eastern United States require lime additions to adjust the soil pH. So instead of the farmer buying commercial lime, we would recommend the application of FGD in the place of lime. The advantage is that it not only increases the soil pH just like lime but it also supplies essential trace nutrients that the farmer would not apply otherwise. Very few farmers apply trace nutrients as part of their fertilizer application even when they are deficient.

Question: **(Concerns about boron)** Please explain your concerns about boron.

Answer: I have several examples of where reclamation was done on mine sites about 15 years ago where the revegetation failed initially due to high boron levels. After enough time had passed for the boron to leach from the soils, the areas were reseeded successfully. Boron has a very fine line between optimum concentration for plant growth and too much. Boron is an absolute nutrient requirement that is needed by the plants for growth but there is a fine line between sufficient and too much.

Question: **(Exchange capacity of composting material)** Do you have to account for the exchange capacity of material such as your compost that may absorb cations and lock them up?

Answer: No we don't because if you have 70 percent of the by-product in the compost, you have so much excess calcium or other exchangeable bases that you don't have to worry about this.

Question: **(How is CCB compost applied?)** Concerning your reference to FBC compost, how is that applied?

Answer: If you use FBC by itself it is very dry. When you spread this material it is very difficult to apply because it would blow too much. By mixing the FBC with the compost as 70 percent FBC and 30 percent compost by

weight and about 50 percent each by volume within conventional compost mixing machinery, you end up with a granular type of material that spreads very well with a comercial lime spreader.

Question: **(Plant material chemical analysis on trace elements)** Have you collected data to determine which specific trace elements we are getting a benefit from applying these CCB materials?

Answer: We have not done this yet due to the expense and complications of numerous variables.

Question: **(Regulatory requirements for use of CCBs in agriculture in Ohio)** What type of regulatory approvals are required in Ohio for this type of agricultural application?

Answer: We really do not know for sure. There has been an ongoing interaction with the Ohio EPA concerning how much regulation is necessary, but this is still an issue that we struggle with.

Question: **(Type of compost material)** What type of compost were you using?

Answer: Our compost was a yard waste compost consisting of grass clippings and leaves.

5. <u>Underground Placement of Coal Processing Waste and Coal Combustion By-Products Based Paste Backfill for Enhanced Mining Economics</u> Y.P. Chugh, Department of Mining and Mineral Resources

Engineering, Southern Illinois University, Carbondale, Illinois

6. Remining with Coal Combustion By-Products at the Broken Aro Demonstration Site Ben J. Stuart, Department of Civil Engineering, Ohio University, Athens, Ohio

Question: **(Recent water quality data)** Have you had any results for this year?

Answer: We had our last results from February of 2000. We only had data from about half of the sites because of the very low flow rates. Water quality was continuing to improve but we did not calculate loads.

SESSION 3 INTERACTIVE DISCUSSION

Question: **(Boron levels toxic to plants)** Concerning boron toxicity, at what level does boron negatively affect the growth of plants?

Answer: If you have very sensitive plants, one part per million(ppm) of boron can cause problems if you were growing plants in a nutrient solution. Normally, if you are getting 10 to 15 ppm of boron then you will need to delay the establishment of vegetation until leaching brings the level down to 3 to 4 ppm.

Question: **(Expansion of CCBs in underground applications)** Have you noticed any threat from expansion of these materials in mine applicatons?

Answer: We have seen some expansion of materials in underground applications but it was not enough to cause any problems. This has only been in unconfined situtations.

Question: **(Impact of EPA rule making on CCB research)** Concerning EPA's draft proposal to regulate CCBs as hazardous waste and not allow mine filling as an exempt practice, what would be the impact to CCB research?

Answer: I have two more CCB project proposals in Ohio, and I was told by the Ohio Department of Natural Resources that they were hesitant to continue with these projects because of the EPA rule making even though they like the projects and would like to do more of them.

Question: **(Industry reaction to CCB substitutes for conventional products)** What kind of reactions are you getting from industry for the CCB products that are substitutes for more traditional materials like wood?

Answer: The people from the mine site have been very enthusiastic. The only actual product that is in production is the ventilation blocks.

Question: **(Potential benefits of clarification of acceptable uses for CCBs)** If the EPA determination provides a clear exemption of AML projects and other projects that utilize CCBs beneficially to groundwater and surface water system or to soils, couldn't such a determination benefit CCB research and encourage greater application of this research in the marketplace?

Answer: Certainly, it would benefit everyone if the boundaries for the use of CCB materials were clear because up to now they have been constantly shifting. Assuming we could get to this point, it would be good for marketing CCB products. One of the ways I like to look at CCBs is they are usually a mixture of fly ash, where we have just tons of information over the years. The by-product of the scrubbing of the flue gas is gypsum and gypsum has been used in agriculture for thousands of years. The unreacted sorbent which is calcium carbonate or lime also has been used in agriculture for thousands of years. What makes CCBs so special when you mix all of these ingredients together? This shows that much of the marketing of these materials is dependent upon education.

Answer: At any of our abandoned mine site projects, we are looking at tens of thousands of kilograms per day of

acid and sulfur being dumped into streams. When you talk about beneficial use of these materials reducing the acid loads to these streams, the leachability of these materials is way below the levels of trace elements already impacting these areas due to acid mine drainage for the last several decades. There is a tremendous benefit to using these materials to remediate the effects of acid mine drainage.

Answer: I am a reseacher for the Department of Energy. When I try to obtain soils that have been contaminated with hazardous waste in order to conduct research, I have to go through so much paper work in order to acquire the material and work with them on site that this is a good indication to me of the negative impact that will result to CCBs being regulated under Subtitle C of RCRA.

Question: **(Purpose of lining mine floor with CCBs)** Someone mentioned the use of FBC on mine floors. What is the point of this type of use?

Answer: When pyritic material is located right below and above the coal seam, we lay the FBC material next to the exposed coal seam and on the pit floor in order to prevent the contact of water with either the exposed coal seam or the pyritic material on the pit floor. These materials compact very well and are great for use as sealants but do not produce long-term alkalinity.

SESSION 4: HYDROLOGIC LONG-TERM MONITORING

1. Water Quality Effects of Beneficial Coal Combustion By-Product Use at Coal Mines Paul F. Ziemkiewicz and D.C. Black, National Mine Land Reclamation Center, West Virginia University, Morgantown, West Virginia

Question: **(Extent of fracturing)** I was suprised you had such low permeabilities with FBC material. Don't you get a lot of fracturing?

Answer: If you mix FBC with water and put it in a bucket outside, it will be concrete for about a year and then it will be mush. If you put it in an underground mine, where it is not exposed to freeze-thaw with relatively constant moisture conditions it tends to set up and stay set up for a very long period of time. Most of the fractures you saw in the pictures were less than one half inch deep and were a function of drying on the surface.

Question: **(Water quality parameters)** How many water quality paramenters do you test for?

Answer: We normally test for about 18 metals plus the typical AMD suspects of iron , aluminum, and manganese. Sometimes we do not analyze for boron because West Virginia doesn't really care about boron, but Pennsylvania does.

2. The Effects of Fly Ash and Flue Gas Desulfurization Wastes on Groundwater Quality in a Reclamed Strip Mine Disposal Site F. W. Beaver, University of North Dakota, Department of Geology and Geological Engineering, David J. Hassett and G.J. Groenewold, Energy and Environment Research Center, Grand Forks, North Dakota, and O.E. Manz, Alvarado, Minnesota

Question: **(EPA applicability of TCLP test)** What did you mean by your statement that EPA has readily admitted that the use of the TCLP leachate test procedure is not the way the go?

Answer: At a meeting on leaching and leaching protocols held by EPA, it was discussed that it could not be used for CCBs because of its reactivity to the formation of secondary hydrated phases, and acedic acid is not produced in the environment. I would not like to take distilled ionized water and apply a leaching test to environmental settings that have acid mine drainage. Being in academia, when we saw that TCLP didn't seem to make sense, we invented a method that did. There are other tests that are as good as the TCLP.

Question: **(EPA statement of application of TCLP to CCBs)** Did the Office of Solid Waste in EPA actually say that

they did believe the TCLP test should not be applied to CCBs?

Answer: Representatives of EPA said this, but I don't know which office they were from. I was really suprised to hear all of this frank open discussion about the misapplication of the TCLP test.

Response: TCLP was developed for the situtation where a waste would enter a municipal landfill. It was developed to estimate the potential leachate that would be generated if the waste in that municipal landfill was aproximately 5 percent or less. The problem is when you apply the TCLP to a monofill situtation.

3. Performance Assessment of a Flue Gas Desulfurization Material at a Lined Pond Facility Tarunjit Butalia and William Wolfe, The Ohio State University, Columbus, Ohio

Question: **(Disentigration due to freeze-thaw)** Have you noticed any disentigration of the material that is exposed to the air due to freeze-thaw?

Answer: Absolutely. What we found was that the surface half inch of the material was fractured but it was hard below that. At most pond sites you would cover the material with a few inches of soil.

Question: **(Impact of moisture content on permeability)** Would the permeability be impacted by moisture content in the field?

Answer: It would be impacted if you were limited to 28 days for curing, but if you have 60, 90, or 180 days for curing then it is not impacted.

4. Water Quality at an Abandoned Mine Land Site Treated with Coal Combustion By-Products Ralph J. Haefner, U.S. Geological Survey, Water Resources Division, Columbus, Ohio

5. Hydrologic Monitoring at Three Mine Sites Reclaimed with Mixtures of Spoil and Coal Combustion Residues in Illinois Stephen P. Esling, Department of Geology, and Bradley C. Paul, Department of Mining Engineering, Southern Illinois University, Carbondale, Illinois

Question: **(Effectiveness of down gradient wells)** Did the all of the proposed down gradient wells actually turn out to be down gradient?

Answer: There is no question that well 14 is down gradient. There is now some question whether or not well 9 or 11 are down gradient. The only well that showed any elevated levels of boron was well 9 not 14. Originally the plan was to fill the entire pit but then they ran out of ash and the deficiency was filled with spoil. This resulted in some of the wells being too far away from the site to serve as down gradient wells. This is why we installed well 14 to insure we had a down gradient well which is very close to the fill material. I am hoping that we can continue monitoring of this site long-term.

SESSION 4 INTERACTIVE DISCUSSION

Question: **(Boron attenuation studies)** Does anyone know about studies being done concerning the attenuation of boron?

Answer: There are very few attenuation mechanisms for boron. The only attenuation that we know of that has any strength is alkaline attenuation. If you are talking about boron attenuation in a very alkaline environment, we know you can get initial mobility followed by very high uptake and stabilization.

Question: **(Regulatory prohibition below the groundwater table)** I am concerned that regulations that would prohibit the disposal of CCBs below the water table would in effect prohibit monofils at the mine site and also potentially prohibit the use of CCBs in underground mines because they are also below the water table. Please comment.

Answer: I am concerned about over simplifications in this area. Site specific conditions have so much to do with what may or may not be proper. I am a big advocate of testing to determine what is necessary for the specific site.

Answer: In Pennsylvania, with FBC ash we strongly suspect they do not cause problems below the water table. In fact, we have several demonstration projects where ash has been placed either in contact with or below the water table. These projects are well monitored, and we have not seen any problems with any of the leachate with respect to placement below the water table.

Comment: **(Texas solid waste regulations)** In regards to a statement made earlier, it was said that the State of Texas has no solid waste regulations in the case where an operator owns the land. That is not correct. There are solid waste regulations in Texas covering permitting, monitoring requirements, liners, and caps regardless of who owns the land.

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