United States Environmental Protection Agency
Office of Emergency and Remedial Response
EPA/ROD/R07-91/050
June 1991

EPA

Superfund Record of Decision:

Lehigh Portland Cement, IA

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R07-91/050	2.	3. Recipient's Accession No.

4. Title and Subtitle SUPERFUND RECORD OF DECISION Lehigh Portland Cement, IA First Remedial Action - Final	5. Report Date 06/28/91
	6.
7. Author(s)	8. Performing Organization Rept. No.
9. Performing Orgainization Name and Address	10. Project/Task/Work Unit No.
	11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. Type of Report & Period Covered 800/000
	14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Lehigh Portland Cement site is composed of two areas: the 150-acre Lehigh Portland Cement Company (LPCC) cement production facility, and the 410-acre Lime Creek Nature Center (LCNC), in Mason, Gordo County, Iowa. Land use in the area is rural, agricultural, and industrial. The site overlies an aquifer that serves as a source of water for 12 nearby wells; and municipal water is obtained from a deeper aquifer. Calmus Creek borders the site and discharges to the Winnebago River, located within a mile of the site. From 1911 to the present, the LPCC has manufactured cement products. As a result of operations, site features currently include four abandoned quarries at the LPCC area, which were worked until the 1950's and subsequently were filled in with water, and numerous tailings piles. The water bodies are known as Blue Waters Pond, Arch Pond, Cooling Waters Pond, and Area C Pond. During its history, the LPCC disposed of cement kiln dust (CKD) in several onsite piles and in Area C Pond. The LCNC area was used by LPCC to quarry materials until 1979, and subsequently was backfilled with CKD from the parent site and sold. Consequently, the LCNC quarries also have become ponds, including Quarry Pond. In 1981, hydrochemical tests of Blue Waters Pond on the LPCC area indicated high

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Lehigh Portland Cement, IA
First Remedial Action - Final
Contaminated Media: gw, sw
Key Contaminants: metals (arsenic, chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 52
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

alkalinity. Subsequent investigations indicated that the ponds on the LCNC area also have high pH levels, although water quality is better than at the LPCC area. Testing showed that CKD was the cause of high alkalinity, and that contamination of the aquifers has occurred. In addition, a flow control structure installed on the southeastern corner of Blue Waters Pond allowed highly alkaline water to discharge into Calmus Creek. Subsequently, overflow prevention measures at Blue Waters Pond were implemented by LPCC, but seepage to Calmus Creek continued. This Record of Decision (ROD) addresses the CKD, ground water, and surface water as a final remedy. Elevated pH of ground water and surface water also is of potential concern.

The selected remedial action for the LPCC area includes dewatering Blue Waters, Area C, and Arch Ponds, and treating pond water using acid neutralization, followed by ion exchange or reverse osmosis if needed, with onsite discharge; excavating and consolidating CKD from Blue Waters and Arch Ponds within Area C Pond, followed by constructing a clay cap over Area C Pond; constructing a cap over the existing area known as the CKD Reclamation Area; collecting shallow ground water via sumps and a seep collection system constructed in the base of Blue Waters and Area C Ponds, and treating the ground water in the onsite treatment system before onsite discharge; monitoring ground water, surface water, and treated discharge; and providing institutional controls including deed restrictions. The selected remedial action for the LCNC area includes constructing a dam across Quarry Pond and draining the western portion of the pond; excavating CKD within the western portion of Quarry Pond and consolidating the CKD within an exhausted quarry east of the pond; constructing a clay cap over the exhausted quarry; consolidating CKD from all other LCNC areas in the Badlands area, and constructing a clay cap over the consolidated material; allowing Quarry Pond to refill; and monitoring ground water and surface water. The estimated present worth cost for remedial action at the LPCC area is $3,400,000, and for the LCNC area is $1,600,000. No O&M costs were provided for the remedial action.

<u>PERFORMANCE STANDARDS OR GOALS</u>: Chemical-specific ground water clean-up goals for both the LPCC and LCNC areas are based on the more stringent of SDWA MCLs and State standards, and include arsenic 0.00003 mg/l (State), lead 0.015 mg/l (State), chromium 0.5 mg/l (MCL), and pH 6.5 to 8.5 (Secondary MCL).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

MEMORANDUM

SUBJECT: Record of Decision for the Lehigh Portland Cement Company Superfund Site, Mason City, Iowa

FROM: David A. Wagoner
Director, Waste Management Division

TO: Morris Kay
Regional Administrator

This Record of Decision presents the proposed remedy for the hydraulic containment and treatment of ground water and capping of cement kiln dust at the Lehigh site in Mason City, Iowa.

The major components of this remedy include dewatering of the quarries, consolidating the cement kiln dust, capping of the cement kiln dust, institutional controls, and continued monitoring to ensure the efficiency of the remedy.

This Record of Decision has been prepared by the Iowa Department of Natural Resources and coordinated with the Office of Regional Counsel, the Office of Public Affairs, the Congressional and Intergovernmental Liaison, and the Agency for Toxic Substances and Disease Registry.

On March 8, 1991, the remedy selection authority for the Lehigh site was delegated to you by Don R. Clay, Assistant Administrator. I recommend approval of the proposed remedy.

Attachment

Approval M Kay 6-28-91

Disapproval __________

RECORD OF DECISION

FOR

LEHIGH PORTLAND CEMENT COMPANY SITE

MASON CITY, IOWA

PREPARED BY:

IOWA DEPARTMENT OF NATURAL RESOURCES

June 25, 1991

RECORD OF DECISION

LEHIGH PORTLAND CEMENT COMPANY

MASON CITY, IOWA

Declaration

1.0 Site Name and Location
Lehigh Portland Cement Company, Mason City, Iowa

1.1 Statement of Basis and Purpose
This decision document presents the selected remedial action for the Lehigh Portland Cement Company Superfund site located in Mason City, Iowa. The remedial action was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the National Contingency Plan. This decision document explains the factual and legal basis for selecting the remedy for this site.

The Iowa Department of Natural Resources concurs with the selected remedy. The information supporting this remedial action decision is contained in the administrative record for this site.

1.2 Assessment of the Site
Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare or the environment. The essence of risk resulting from this site is environmental and the public health risk is not as great.

1.3 Description of the Remedy
The selected remedy consists of the following actions:

- Draining of Lehigh site ponds which contain high pH water, acid-neutralization, and discharge to Calmus Creek or the Winnebago River. Drainage of the site ponds will create a sump which should also collect shallow high pH groundwater in the site area.

- Construction of a drain system to collect runoff and groundwater inflow to the site ponds.

- Consolidation of cement kiln dust (CKD) deposits in Area C and other site ponds.

- Placement of an engineered clay cap over the consolidated dust as well as the cement kiln dust in the "CKD Reclamation Area" to minimize infiltration of water through the kiln dust.

- Installation of kiln dust dewatering wells, if necessary to facilitate kiln dust dewatering in the CKD Reclamation Area.

- Treatment of contaminated waters to meet Iowa NPDES discharge permit limits with discharge to Calmus Creek or the Winnebago River (Winnebago most likely).

- Assurances that the drainage system will be operated in perpetuity to maintain isolation of water from the waste kiln dust and collect and treat any contaminated water which is generated.

The selected response action constitutes final action for this site. The selected response action addresses the principal threats of cement kiln dust which acts as a source of contamination to the surface water and groundwater. The existing contaminated groundwater will be removed and treated thus preventing off-site migration. The waste kiln dust will be isolated from water to the extent practical to minimize production of contaminated water. Any contaminated water which is produced will be collected, treated, and discharged.

1.4 Declaration of Statutory Determination

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element. Because this remedy will result in the source of hazardous substances (kiln dust) remaining on-site, a review will be conducted to ensure the remedy continues to provide adequate protection of human health and the environment within 5 years after commencement of the remedial action.

6-28-91

MORRIS KAY, REGIONAL ADMINISTRATOR DATE
ENVIRONMENTAL PROTECTION AGENCY, REGION VII

CONCURRED ON

6/26/91

ALLAN STOKES, ADMINISTRATOR DATE
IOWA DNR, ENVIRONMENTAL PROTECTION DIVISION

Decision Summary

2.0 Site Name, Location, and Description

The Lehigh Portland Cement Company property is located at 700 25th Street on the north side of Mason City in Cerro Gordo County, Iowa (Refer to Figure 1). The site is situated in the northern half of Section 32, Township 97 North, Range 20 West and the eastern half of the northern half of Section 32, Township 97 North, Range 20 West. The area of investigation is bordered by 25th Street on the south, State Highway 65 on the east and northeast, the Chicago Rock Island and Pacific Railroad and Calmus Creek on the West. Rural and agricultural areas lie to the east and west of the site with Northwestern States Portland Cement Company to the south and American Crystal Sugar Company to the north. The Lime Creek Nature Center is approximately one mile northeast of the site. Calmus Creek flows to the Winnebago River which is less than a mile east of the site. The Winnebago River flows north of the Lehigh site, as well. The Winnebago River and Calmus Creek are used mainly for recreational purposes.

2.1 Site History and Enforcement Activities

The LPCC facility has manufactured cement since 1911 and is currently manufacturing a hydraulic cement. The Lehigh site covers approximately 150 acres and consists of a cement manufacturing plant and associated buildings and four abandoned limestone quarries and tailing piles (Figure 2). The abandoned quarries on the Lehigh property are: Blue Waters Pond, Arch Pond, and Area "C" Pond. Another pond, known as Cooling Waters Pond, is located west of the plant. This pond provides cooling water to the plant's rotary kiln and accepts warm water returned from the plant. The abandoned quarries are filled with water. Unreclaimed waste kiln dust has been disposed of in the northern quarry (Area "C" Pond). Several piles of waste cement kiln dust (CKD) surround the perimeter of this pond as well as protrude from the water. CKD is piled in other locations as well, and can be seen mixed with soil on the site. Some of the CKD piles have been graded and revegetated.

The process of manufacturing cement generates large quantities of waste kiln dust. Kiln dust is the waste produced from the process of heating the raw materials. During the manufacturing of portland cement raw materials such as limestone and clay are quarried then crushed, dried, and mixed in the correct proportions. This mixture is ground to a fine powder then burned in a sloping rotary kiln maintained at a temperature of about 2600-2800 F. to form a glassy "clinker". The "clinker" is crushed, a small amount of gypsum is added, and the mixture is reground to form cement.

Collection of the dust is difficult because it is entrained in large volumes of hot exhaust gases and it often contains unacceptable high concentrations of alkalies (sodium and potassium) which make it unsuitable for return to the cement-making process. At Lehigh, the unreclaimed CKD was placed in piles throughout the facility and a large quantity has been disposed of into the northern quarry (Area "C" Pond). Waste CKD is now landfilled in the clay quarry area.

The chemical composition of kiln dust is determined by the composition of the raw materials and the conditions the dust particles have encountered in the kiln. The major constituents of this hydraulic cement are calcium oxide (lime), aluminum, silica, and iron oxide. Magnesium oxide, sodium, potassium, and sulfates are also present. Trace quantities of chromium, lead, zinc, and other metals may be present depending on the source of raw materials used to manufacture the cement. Waste kiln dust contains fine particles of cement composed of these constituents and fossil fuel combustion products.

Waste kiln dust has highly corrosive properties and produces large quantities of hydroxides when combined with water. At the Lehigh site, the CKD has a pH value as high as 13.0 units. Corrosivity is characterized by a pH that is equal or greater than 12.5 units. Cement kiln dust has been designated a special study waste under the Resource Conservation and Recovery Act (RCRA). Human or animal contact with such highly corrosive material causes chemical-type burns of exposed tissue. High pH levels

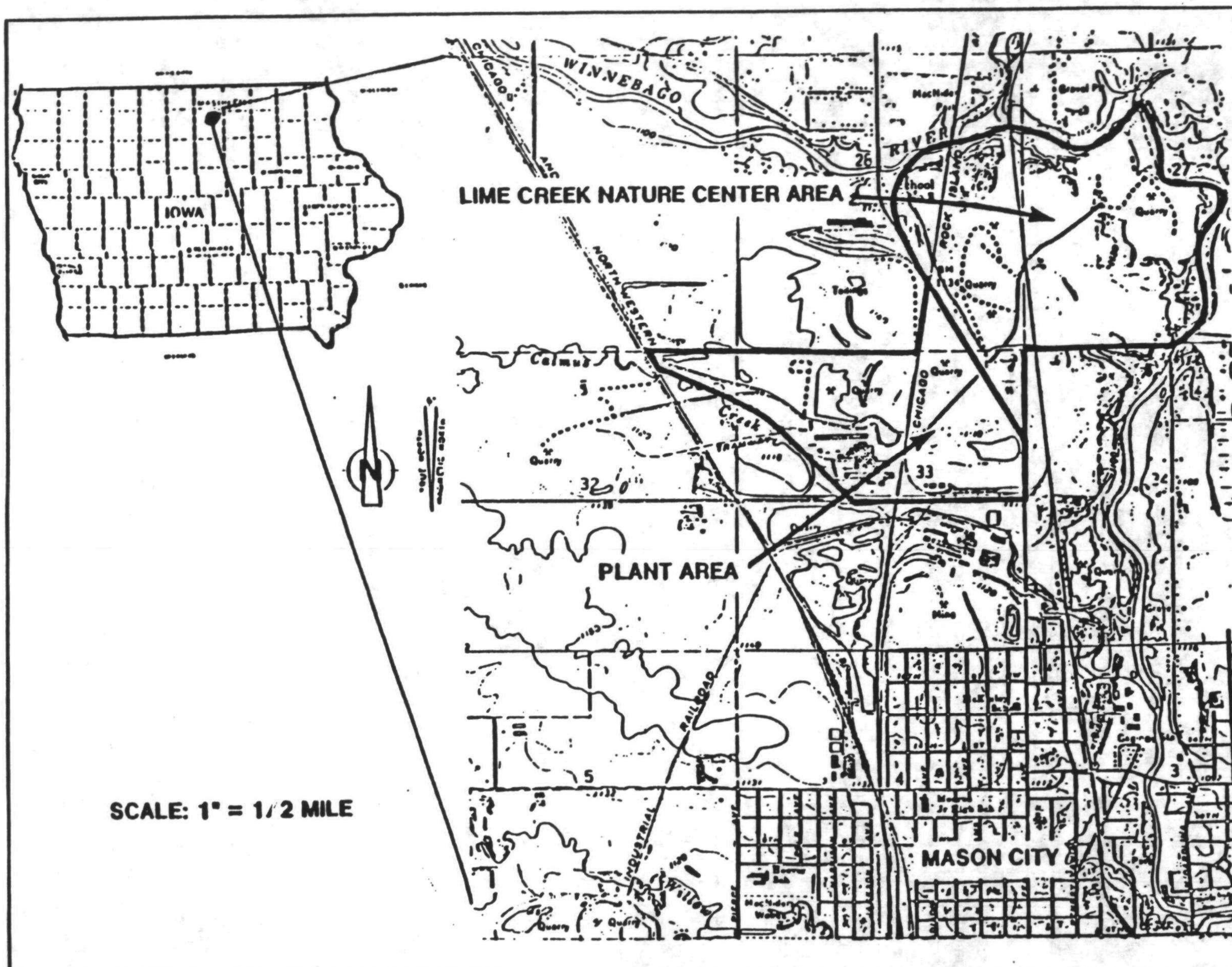

Figure 1: Site Location Map

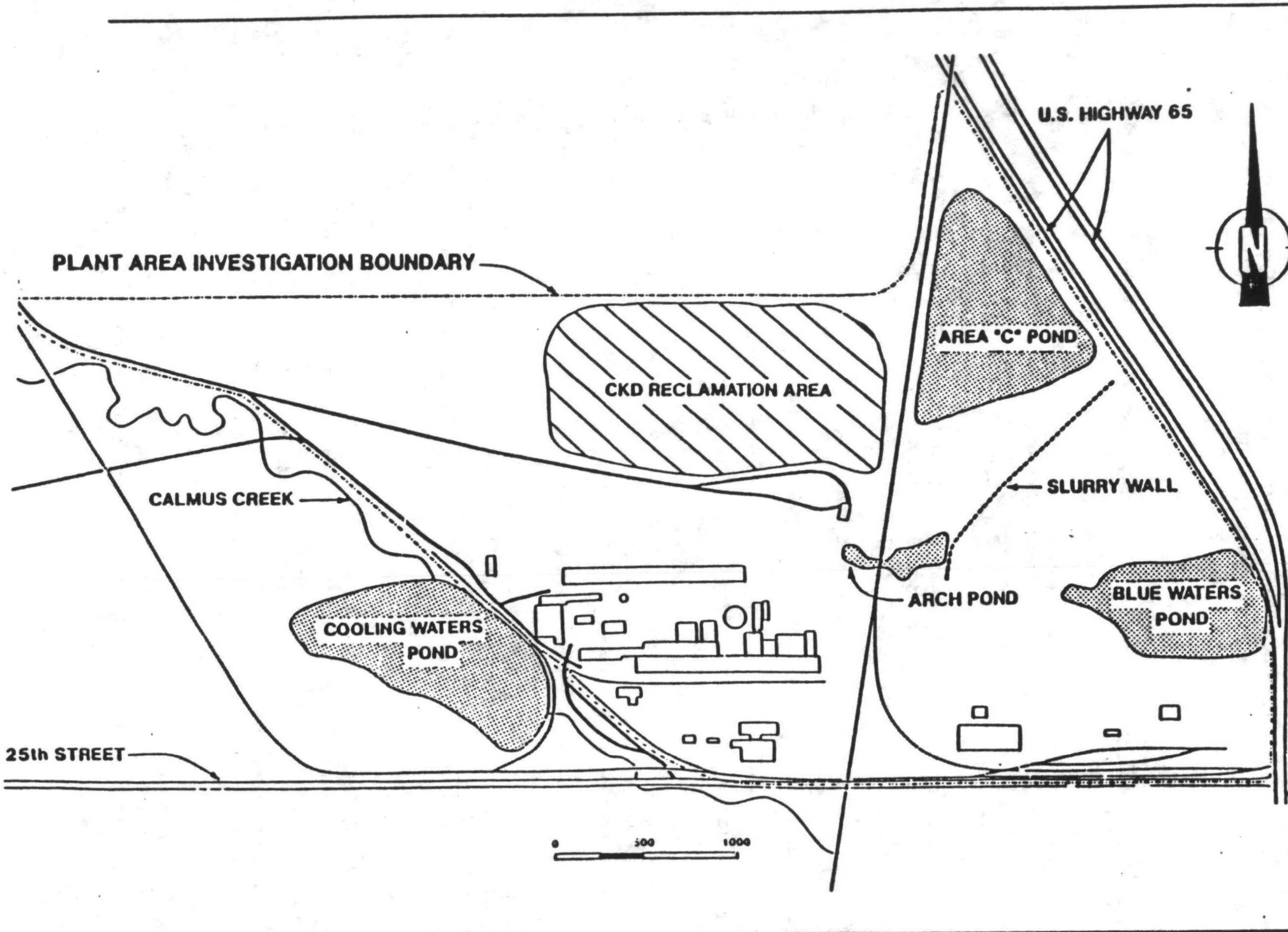

Figure 2 Site Features, Lehigh

in water also limit the survivability of aquatic organisms, including fish.
It has been estimated that a minimum of 136,000 tons of waste kiln dust has been disposed of on site since 1981. No records are available for the 70 years before 1981. Consequently, the actual amount of waste disposed of on site is probably much greater than 136,000 tons and has been estimated at over 1 million tons.

The Mason City area was an ideal area for cement manufacture due to the easily accessible raw materials needed, such as clay and limestone. Limestone was quarried from several areas on the site to depths where the bedrock became unsuitable for cement making. Over time, the quarries partially filled with water following the suspension of quarrying operations. As determined from chronologic photos (Site Investigation and Protocol, Layne GeoSciences), Blue Waters Pond existed by 1950, Arch Pond was an active quarry during the mid to late 1950's, and Area "C" was an active quarry during the late 1950's and beyond.

Prior to 1969, the cement manufacturing process reincorporated most of its waste kiln dust back into the finished product. Unusable dust was disposed of on-site. Cement industry changes in the late 1960's led to a significant increase in the quantity of waste kiln dust generated. By 1969, operators in the cement industry concluded that the high source of alkalis from the kiln dust caused degradation of the concrete due to the occurrence of aggregate blowouts. This condition was unacceptable to cement consumers. In response, Lehigh had to limit the amount of kiln dust in the product to achieve a less than 0.6% alkali content and large amounts of waste kiln dust had to be disposed.

Problems with the site were first identified in 1981 during a routine hydrochemical test of the Blue Waters Pond. The results of the test indicated that the pond water was highly alkaline. Lehigh had installed an overflow control structure at the southeastern corner of Blue Waters Pond. The control structure had been constructed because the Iowa Department of Transportation altered drainage patterns in the area which resulted in large volumes of water entering Blue Waters Pond. The flow control structure allowed water from the pond to be discharged directly to Calmus Creek to eliminate possible back-flooding of equipment critical to Lehigh's operation.

The result of testing in 1981 indicated pH values of approximately 10.6. State regulations only allow for the discharge of water with a pH value up to 9.0 into Class "B" warm water streams. Lehigh was instructed not to allow overflow until the alkalinity could be reduced.

At this time, Lehigh hired the consultant, Wallace, Holland, Kastler, Schmitz and Company (WHKS) of Mason City, Iowa to determine the source of high pH waters. Lehigh also performed their own chemical tests and determined that CKD and cement were the predominant sources of elevated pH.

WHKS obtained and analyzed 28 water samples from various surface water sources in order to determine the source of the elevated pH in Blue Waters Pond. The results of the WHKS report identified three potential sources, of which Arch Pond contributed the most significant quantities of high pH water to Blue Waters Pond. The high pH of Arch Pond was attributed predominantly to direct contact with CKD.

The WHKS report recommended options to reduce or contain high pH site waters. Lehigh chose to transfer the water from Blue Waters Pond to Area "C" Pond and retain the water behind two earthen dikes. These dikes have since failed due to high rainfall.

In 1984, the State of Iowa (Department of Natural Resources) conducted a Comprehensive Work/Quality Assurance project at Calmus Creek, which is located approximately 1,000 feet south and downgradient from the Blue Waters Pond. This investigation found that surface water contamination was directly related to the Lehigh facility. According to this report, a highly alkaline discharge of the

Blue Waters Pond into nearby Calmus Creek via the tile drain outlet southeast of the plant is believed to have contaminated Calmus Creek.

The Blue Waters Pond overflows during heavy rainfall (IDOT drains flow into Calmus Creek from the adjacent highway). The Arch Pond immediately west of the Blue Waters Pond would contribute an unknown quantity of runoff from the eastern half of the plant. The discharged water had a recorded pH of 11.4, total dissolved solids of 4,700 mg/l, including 2,000 mg/l potassium, and 829 mg/l sulfates. Chromium and other hazardous substances were not analyzed during this IDNR investigation.

The biological quality of Calmus Creek was found to have deteriorated from effluents from Lehigh and Northwestern States Portland Cement Company sites. Because of the deterioration of the chemical balance in Calmus Creek and the quarry ponds, the number and variety of fish and benthic organisms were found to be substantially reduced downstream of the tile drain outlet. (See Calmus Creek Water Quality Study, 1984, University Hygienic Laboratory). Calmus Creek also discharges into the Winnebago River, approximately 1,500 feet from the tile drain outlet. As a result of this study, Lehigh was required to eliminate the discharge into Calmus Creek.

To control overflow from Blue Waters Pond a control structure was placed in the southeast corner to control water elevation; dikes were constructed to separate Arch Pond, Area "C" Pond, and Blue Waters Pond; and an aboveground piping system was installed which pumps water from Blue Waters Pond into Area "C" Pond. Also, Lehigh proposed construction of a lined ditch to channel the surface runoff collected by the IDOT drain system from the adjacent highway (on Lehigh property) back into the IDOT tile drain located southeast of the Blue Waters Pond.

Lehigh's long-term goal was to eliminate Blue Waters Pond by backfilling and regrading the area. Lehigh retained a consulting firm in 1985 (R.E. Wright and Associates) to conduct a hydrogeological investigation of the site. The firm installed three on-site monitoring wells to characterize the chemistry of the groundwater and its flow parameters. Monitoring and sampling of these wells has shown that Arch Pond is hydrologically connected to Blue Waters Pond. The study found significant elevations in pH and in the levels of potassium, sodium, silicon, sulfates, total dissolved solids, and total organic carbon. Since this finding, compacted waste kiln dust is being disposed of into the West Quarry, which is clay-lined.

In 1987, the EPA hired a consulted, Ecology and Environment, Inc. to study the area. They visited the site in April, 1987. E & E noted in this investigation that the above-ground piping system was leaking in several locations between Area "C" Pond and Blue Waters Pond. Also, water had still been observed returning back to Blue Waters Pond via seepage in the two dikes used to contain Area "C" Pond and by groundwater flow through joints in the intervening bedrock.

A summary of the E & E Report includes the following comments: "Past investigations conducted internally by the Lehigh facility and the State of Iowa have shown that on-site contamination exists and contaminants are migrating to groundwater sources and Calmus Creek. The April 1987 field work conducted by E & E/FIT included kiln dust/sediment, surface water, and ground water sampling. This investigation has confirmed that the on-site quarry ponds and groundwater are contaminated locally and have the potential to migrate off-site."

The E & E investigation found waste kiln dust to have a pH of 13.0 units. The measured pH levels in water from the on-site quarry ponds and monitoring wells ranged from 7.19 to 12.04. Other constituents of the kiln dust included arsenic, chromium, lead, zinc, and sulfates. E & E noted that these kiln dust constituents are "toxic and persistent".
"Seepage has occurred from the quarry ponds and is contaminating the groundwater. The highest pH value detected in the on-site groundwater was 12.04 units. Sampling also indicated a contamination

threat to Calmus Creek and the Winnebago River, which is located within 1,500 feet of the site. However, contamination could occur during high intensity rainfall events, groundwater infiltration, and flooding. The potential exists for human and biological exposures to the hazards present at the Lehigh site."

In 1987, Lehigh hired R. E. Wright and Associates to present a plan for the elimination of the Blue Waters Pond discharge. In an excerpt taken from the R. E. Wright executive summary: "The project will involve reducing or eliminating the volume of water with high alkalinity levels which seeps into Blue Waters Pond from Arch Pond. This will be accomplished by constructing a slurry wall between Arch Pond and Blue Waters Pond, and grout curtain (in the future, only if required)."

The second objective of the project was to eliminate the runoff of storm water from I-65, which discharges into Blue Waters Pond, in order to prevent future overflows. This was to be accomplished by redirecting the storm water drainage from I-65 to discharge into the 25th Street storm sewer. The third task outlined was to dispose of existing high alkaline water in Blue Waters Pond by pumping water through an irrigation system into Area "C" Pond.

These steps were implemented by Lehigh. However, due to the persistence of high pH values on site and the results of the E & E study, Lehigh was evaluated in 1987 and 1988 for National Priorities Listing. Lehigh was proposed for the NPL in 1988. In August, 1990, Lehigh was made a Final NPL site.

In 1989, Lehigh hired Layne GeoSciences to perform the Remedial Investigation/Feasibility Study for the site. Nine monitoring wells were installed on the site, one a nested well. The nested well would allow for sampling the groundwater from two aquifers, or water-bearing units. As the investigation proceeded, two additional shallow monitoring wells were installed east of Highway 65, on Lehigh property (Figure 3). These wells were installed at the request of IDNR to determine pH as well as any other inorganic contaminant movement eastward onto the Lime Creek Nature Center.

On June 20, 1990, the first round of sampling was performed. Elevated pH values, total dissolved solids, and similar contaminants as prior studies were found in the groundwater and surface water. The pH values (field measurements) ranged from background to as high as 11.44 in MW-9. Total dissolved solids in this well were also the highest, at 7000. The pH values in the ponds on site were higher, up to 13.0 in Arch Pond, with TDS levels at 11000. It was apparent that Lehigh's previous work to eliminate the source of high pH and TDS was not working.

On July 19, 1990, the second round of sampling was performed. The results of this sampling round were comparable to the first round; pH values were still elevated, as were total dissolved solids, sulfates and in some monitoring wells, inorganic constituents. MW-9, for example, had a pH of 11.43 (field) and TDS of 9700. Arch Pond had a pH of 13.15, with TDS levels of 10000.

Further sampling was performed at the Lehigh site area in October, November, and December 1990. Similar results as the first two rounds of sampling were discovered. In addition to these results, the two monitoring wells installed east of Highway 65, MW-10, and MW-11 were showing little impact from pH or inorganics.

In the fall of 1990, it was also determined that the Lime Creek Nature Center needed to be investigated for the same contaminants as the Lehigh site. Lehigh had formerly owned property at the Nature Center and a large quantity of cement kiln dust had been dumped in abandoned quarries on Nature Center property. The areas of greatest concern were a Quarry Pond area on the western edge of the Nature Center, and an area known as the "Badlands", which contained perhaps 40 acres of CKD.
In November 1990, at the request of IDNR, Lehigh agreed to a limited investigation of the Lime Creek Nature Center. This involved the installation of four monitoring wells, sampling the existing well on site,

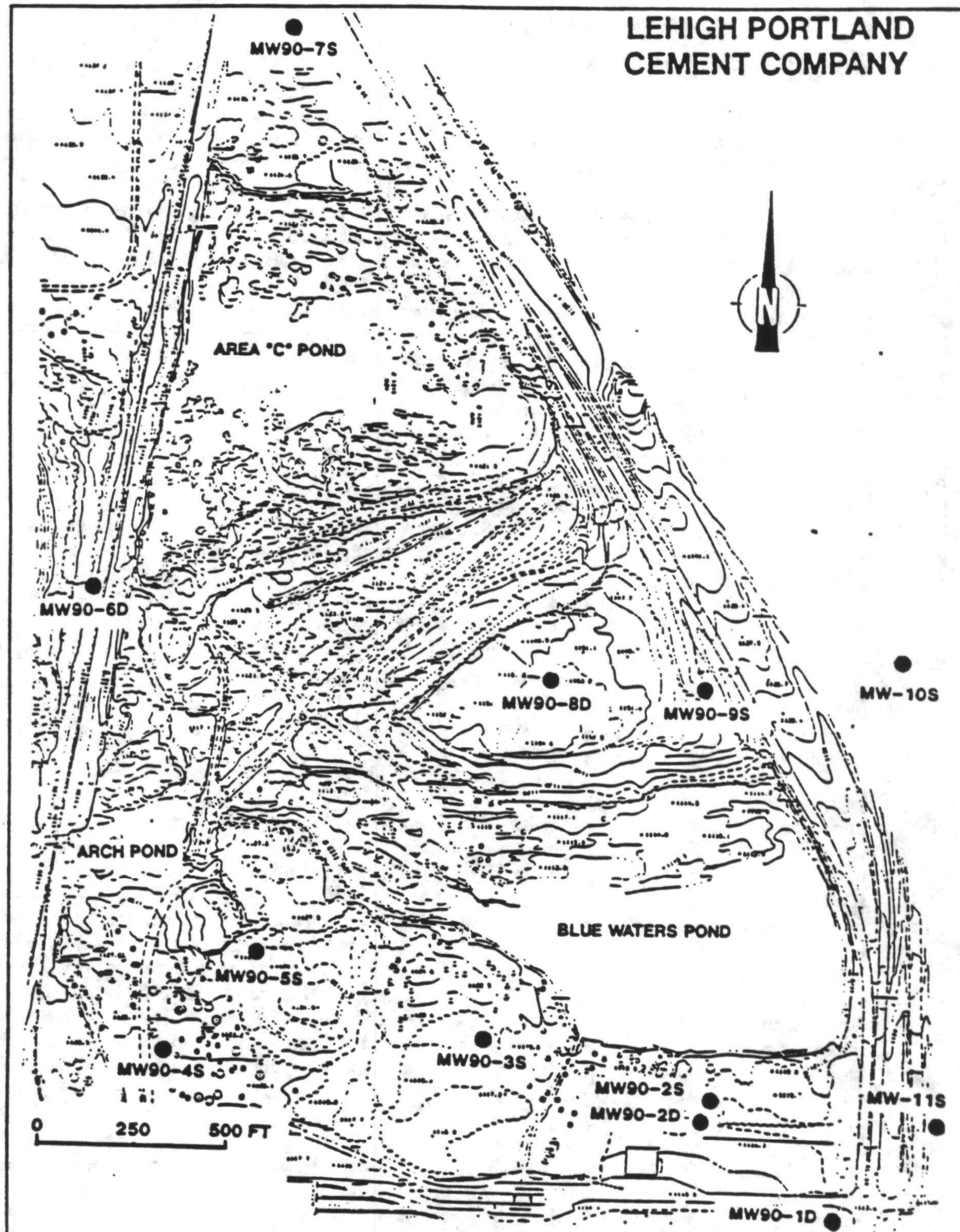

Figure 3: Monitoring Well Locations, Lehigh

POOR QUALITY
ORIGINAL

and sampling the cement kiln dust and surface water on site. The results of the Lime Creek Nature Center investigation are discussed later in this report.

2.2 Highlights of Community Participation

The Remedial Investigation and Feasibility Study Reports and the Proposed Plan for the Lehigh site were released to the public for comment May 20, 1991. These two documents were made available to the public in the administrative record maintained in an information repository at DNR Records Center, 5th Floor, Wallace Building, 900 East Grand, Des Moines, Iowa, and in the Mason City Public Library.

The notice of availability for these two documents was published on May 20, 1991 in the Mason City Globe-Gazette. A public comment period on these documents was held from May 20, 1991 through June 19, 1991. Also, a public meeting was held on June 5, 1991 at the Mason City Public Library. At this meeting, representatives from the DNR, EPA and LPCC discussed the site and the selected remedial alternative. Questions from the media were answered regarding the severity of the existing problem at LPCC and the potential for future hazards at the site. A response to comments received during this period is included in the Responsiveness Summary, which is part of this record. This decision document presents the selected remedial action for the LPCC site in Mason City, Iowa, chosen in accordance with CERCLA, as amended by SARA and, to the extent practical, the National Contingency Plan. The decision for this site is based on the Administrative Record.

2.3 Scope and Role of Response Actions Within Site Strategy

The selected response action addresses the principal threats of surface water, groundwater contamination and the source of water contamination. Based on past investigations of the site, as well as the Remedial Investigation, the source of contamination is the cement kiln dust disposed of in the CKD Reclamation Area and in Area "C" Pond. Of particular concern is its impact on the groundwater and on Calmus Creek. The kiln dust would be sufficiently isolated from water in the selected alternative to minimize production of contaminated water. Any contaminated groundwater which is produced, as well as existing contaminated groundwater and surface water, will be removed, treated and discharged, thus preventing off-site migration of contaminated water.

The response actions selected in this ROD address all principal threats posed by this site and are intended to constitute final remedial action for the site.

2.4 Summary of Site Characteristics

The major concern at LPCC is contaminated surface water and groundwater as a result of contact with waste cement kiln dust in the site ponds and the CKD Reclamation Area. The kiln dust is composed of a major cement constituent, calcium oxide (CaO), which reacts with water and releases hydroxide ions (OH^-) into solution. The hydroxide ion concentration directly controls the pH level of an aqueous solution. Local groundwater and surface water have been impacted by high pH levels, and by an increase in total dissolved solids content, as well as elevated concentrations of potassium, sulfate, sodium and other relatively nonhazardous parameters. Trace amounts of heavy metals have also been detected sporadically. Of the contaminants identified, arsenic, lead and chromium are suspected carcinogens. Levels of metals found in soil/sediment samples are not considered to be significantly different than background soils. The kiln dust at the Lehigh site is a RCRA special study waste, not a RCRA hazardous waste. Water at the LPCC site having a pH value exceeding 12.5 would exceed the RCRA criterion for corrosivity and be considered a RCRA hazardous waste.

Impacted groundwater has been found to exist at the site but does not appear to have significantly migrated to the bedrock underlying and adjacent to the site. The degree of impact has been shown to lessen with depth. No significant off-site groundwater contamination has been found. Figure 4 is a groundwater flow map showing typical flow conditions. Groundwater flow on site appears to be southeastward to either the Calmus Creek or the Winnebago River. Potential pathways of groundwater

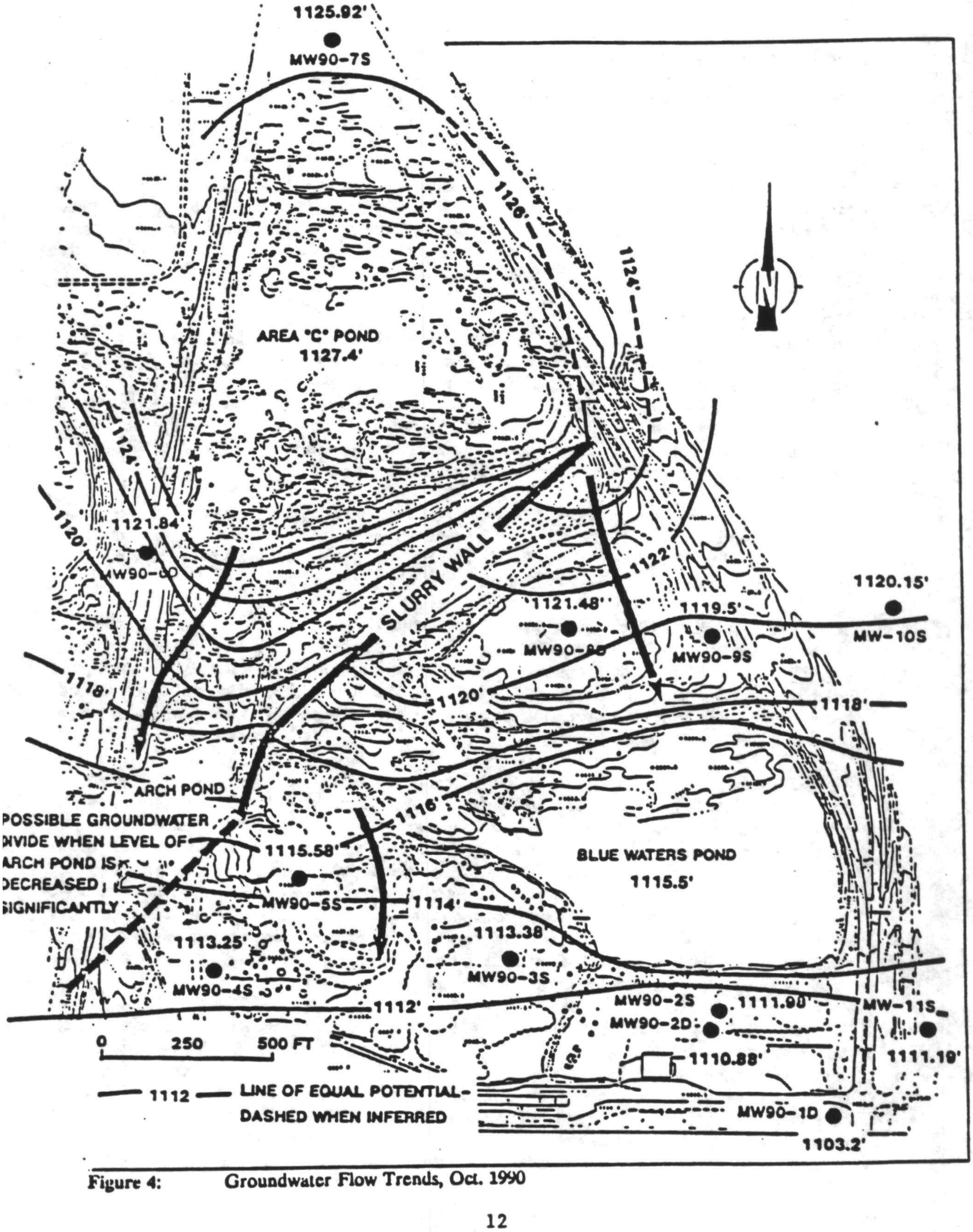

Figure 4: Groundwater Flow Trends, Oct. 1990

POOR QUALITY ORIGINAL

migration exist via the upper bedrock (Devonian aquifer).

The Devonian aquifer yields moderate amounts of water to wells. Devonian wells produce water primarily from the upper weathered portion of the rock and solution-enlarged fractures. Nearby wells which draw water from this aquifer include 11 private wells about a mile north of the site and 1 well in the Lime Creek Nature Center about a mile east of the site (See Figure 5 for domestic well locations, Figure 6 for Mason City municipal well locations). Wells with higher capacity in the area are completed in the Cambrian Jordan Sandstone at depths greater than 1200 feet, including the LPCC plant well and Mason City water supply wells. These deep wells are typically uncased though the Devonian aquifer, allowing Devonian water to enter the well, although this is most likely a small portion of the total well capacity.

2.5 Summary of Site Risks

The immediate concern on the Lehigh site is environmental with the public health risk not as great. The impact on Calmus Creek and nearby habitat was examined in a water quality study done in 1984 which indicated that point source discharges from both Lehigh and Northwestern States Portland Cement Company had a substantial negative impact on water quality and the integrity of the biological community. The instream pH value of 10.2 measured during this study exceeded Iowa Water Quality standards. There were also increased levels of ammonia nitrogen, turbidity, sulfate, sodium and potassium measured downstream of high pH discharges from Lehigh.

Sedimentation on the stream bottom from waste kiln dust and precipitation of calcium compounds greatly affected the biological community. The benthic population was almost non-existent in the affected reach. Fish populations were reduced with very little, if any, spawning activity occurring in the area. A similar study done by EPA in 1989 concurred with these results.

The situation in Calmus Creek has not changed substantially since 1989. In fact, recent rainfalls have caused more overflows of Blue Waters Pond into Calmus Creek. Lehigh is currently under order to stop this discharge and has been granted temporary permission to acid-neutralize Blue Waters pond water and discharge this treated water to Calmus Creek. Due to the high level of total dissolved solids in the treated water, however, Lehigh will need to discharge to the Winnebago River (with higher stream flow rates) in the long-term.

The U.S. Public Health Service Agency for Toxic Substances and Disease Registry (ATSDR) conducted a preliminary Health Assessment for the Lehigh site. ATSDR concluded that the site is of potential health concern because of the potential risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. The ATSDR report expressed a concern for potential human exposure to arsenic, chromium, lead, sodium, sulfate, and elevated pH via ingestion of groundwater from on-site and off-site private wells. Also human exposure to elevated pH may occur and may have occurred in the past via dermal contact, ocular contact, and incidental ingestion of on-site soil, sediment, surface water and groundwater; and via inhalation of reentrained dust. Human exposure pathway of concern includes the sodium and sulfate concentrations in the groundwater which may be detrimental to high risk populations.

A Baseline Risk Assessment was conducted as part of the remedial investigations and is included in the Administrative Record as a separate report. This Baseline Risk Assessment provided a basis to assist in the development of remedial alternatives. It assessed only the hazardous substances listed in Table I. The Baseline Risk Assessment did not consider pH, sodium, potassium, sulfate, or total dissolved solids which are the primary parameters impacting water quality at the site. These parameters are naturally occurring, often at relatively high concentrations; are not particularly toxic; and, as a result, do not fit into the risk assessment process. With this in mind, the Baseline Risk Assessment indicated that:

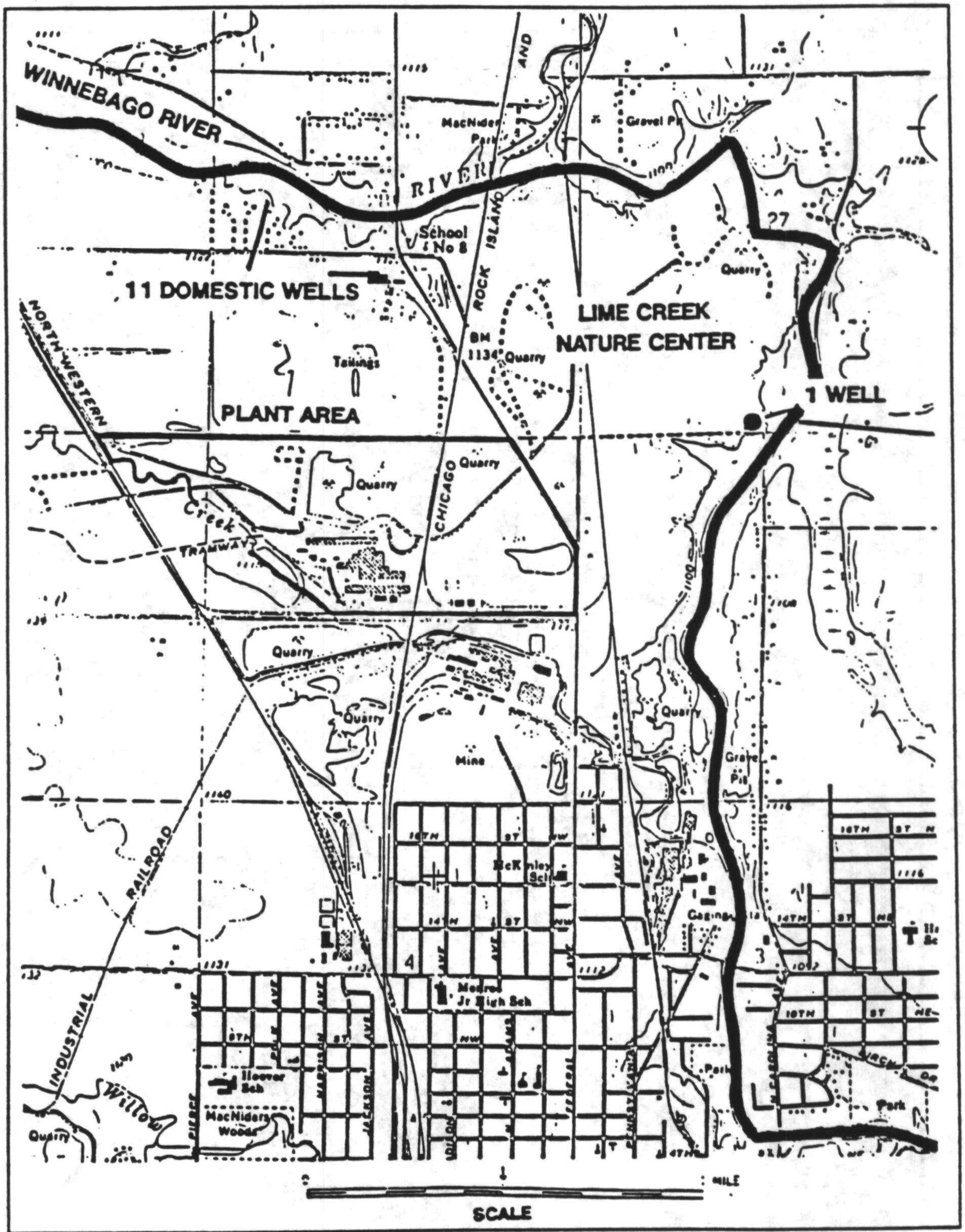

Figure 5: Location of Domestic Wells

POOR QUALITY
ORIGINAL

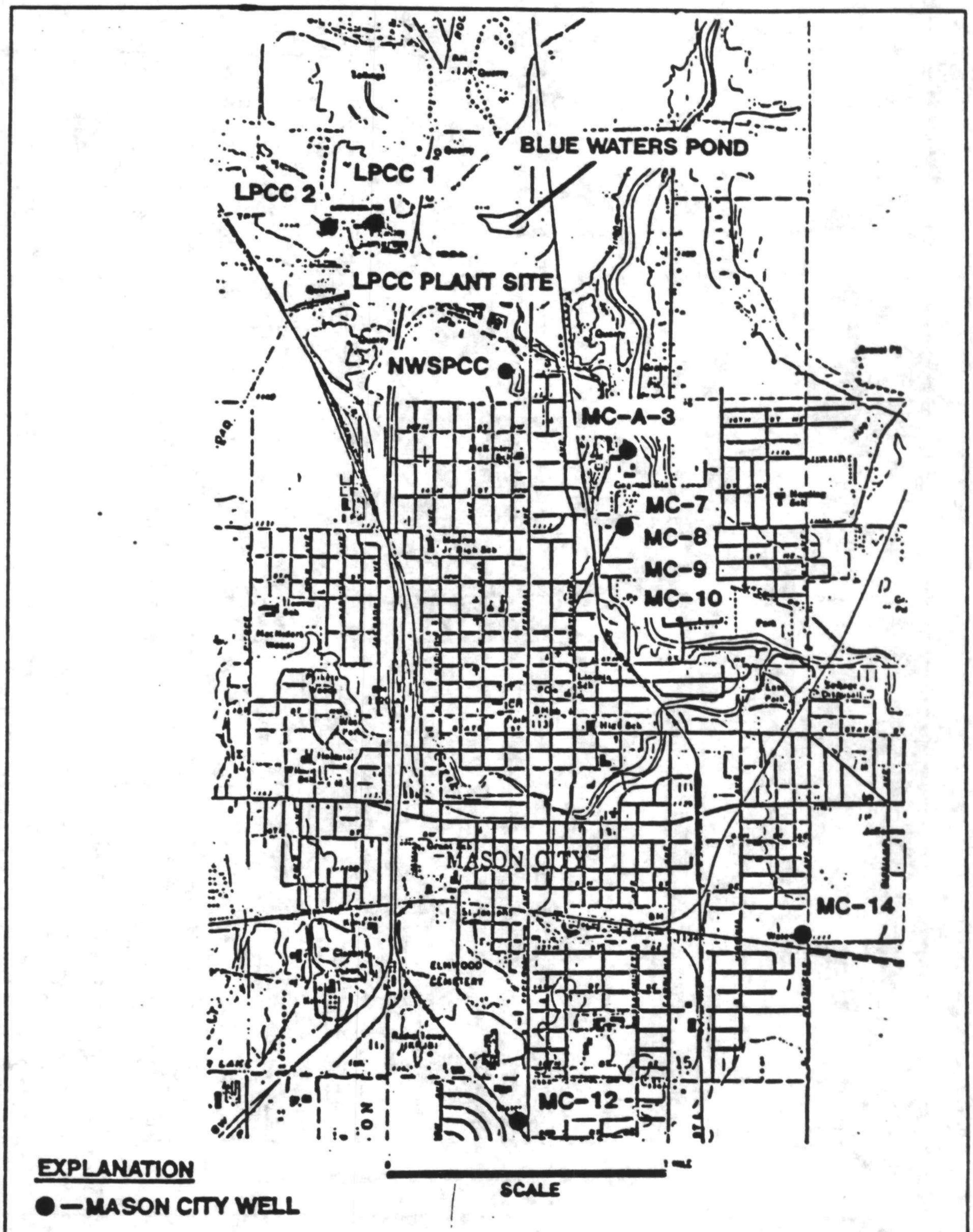

Figure 6: Municipal Well Locations

POOR QUALITY ORIGINAL

1) There are no complete exposure pathways identified for contaminants in the soil or air.

2) The surface water does not pose any adverse health exposure potential to the general public. Neutralizing and monitoring water quality on the Lehigh site ponds before releases should be continued.

3) The only potentially complete exposure pathway for the Lehigh site is through groundwater in the bedrock. There is no current or anticipated adverse exposure potential for the surrounding public and private wells in the near future.

4) The site ponds at Lehigh are not a present threat to the public health or welfare of the Mason City area.

Potential risks from drinking site groundwater were calculated in the Baseline Risk Assessment and are summarized in Table I. These hazards were based upon "potential" consumption of water with the Reasonable Maximum Exposure contaminant concentrations found in on-site monitoring wells. In reality there is no current consumption of this impacted water. The following paragraphs explain the information presented in Table I.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, that are not likely to be without an appreciable risk of adverse health effects. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given media to the contaminants's reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. HI values less than one are acceptable.

Slope factors (SFs), also called cancer potency factors (CPFs); have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. SFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Excess lifetime cancer risks are determined by multiplying the intake level with the Slope Factor. These risks are probabilities that are generally expressed in scientific notation (e.g., $1x10^{-6}$). An excess lifetime cancer risk of a $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site.

In summary, Table I shows that long-term consumption of the impacted site groundwater would pose a slightly elevated risk since the HI value is greater than one. Regardless, the selected remedy will prevent off-site migration of any impacted groundwater and consumption of contaminated water will not occur.

Table I- A shows a tabulation of the cancer risks associated with each chemical, and the total pathway cancer risk for ingestion of contaminated groundwater. Cancer risk has been calculated by multiplying the chronic daily intake by the Slope Factor for the chemical. Risk is expressed as an upper-bound estimate of the additional cancers which could result from lifetime exposure to the contaminant. For example, a 5×10^{-4} cancer risk means that 5 individuals in a population of 10^{-4} (10,000) could develop cancer as a result of lifetime exposure to a particular level of the chemical in question.

The bottom of Table I shows a summary of the risks discussed above. These risks were all calculated with present land use in mind, assuming future land use at Lehigh will not change. It was also assumed that there would be no anticipated future residential impact from contaminants at the Lehigh site.

The primary complete exposure pathway was through groundwater. Of all the groundwater sampling data, lead had the highest level, 0.52 mg/L, which caused its arithmetic mean and 95% confidence limit based on the mean to be higher than what is probably representative at the site. The highest cancer risk slope factor comes from arsenic. The slope factor for lead is much lower, and there is no carcinogenic slope factor for chromium, which is not considered an oral carcinogen. In an Appendix at the back of this report, the monitoring well and surface water sampling results can be found.

The total cancer risk exceeds the goal of cancer risk below 1×10^{-6} by a factor of roughly 1000. There are levels of uncertainty built into slope factors and into the calculations to account for a fairly large margin of safety. As mentioned earlier, even with the slightly increased cancer risk, the selected remedy will prevent off-site migration of any contaminated groundwater and its subsequent consumption.

The Baseline Risk Assessment did not specifically address the major parameters affecting water quality of the LPCC site. Figures 7 and 8 illustrate the concentrations of pH and total dissolved solids (TDS) found in groundwater throughout the LPCC site. Sodium concentrations have also been found in high levels. National secondary drinking water regulations set non-enforceable limits for contaminants in drinking water which may affect the aesthetic qualities or the public's acceptance of drinking water (e.g., taste and odor).

These secondary maximum contaminant levels (SMCLs) have been established for pH (6.5-8.5), sulfate (250 mg/l) and TDS (500 g/l). In addition, a guidance of 20 mg/l sodium exists for people on low-sodium diets. Significantly elevated levels, much in excess of the SMCLs, have been identified in the groundwater and surface water at the site. The elevated pH levels have been the primary concern associated with the LPCC site ponds. Levels of pH in excess of 12.5 have been found in site ponds (the level above which a liquid is considered a hazardous waste). Arch pond had pH levels in excess of 13. Site groundwater pH levels were slightly lower, although they have been as high as 11.0 - 12.0.

No significant off-site effect in groundwater has been found. The principal threat at Lehigh is cement kiln dust which acts as a source of contamination to the groundwater and surface water. However, significant long-term off-site impacts to groundwater are possible if no response action is taken. Also, continued adverse impacts to the Calmus Creek aquatic habitat and threats of direct contact to high pH water in the Lehigh site ponds will exist without response action.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD present an imminent and substantial endangerment to public health, welfare, or the environment.

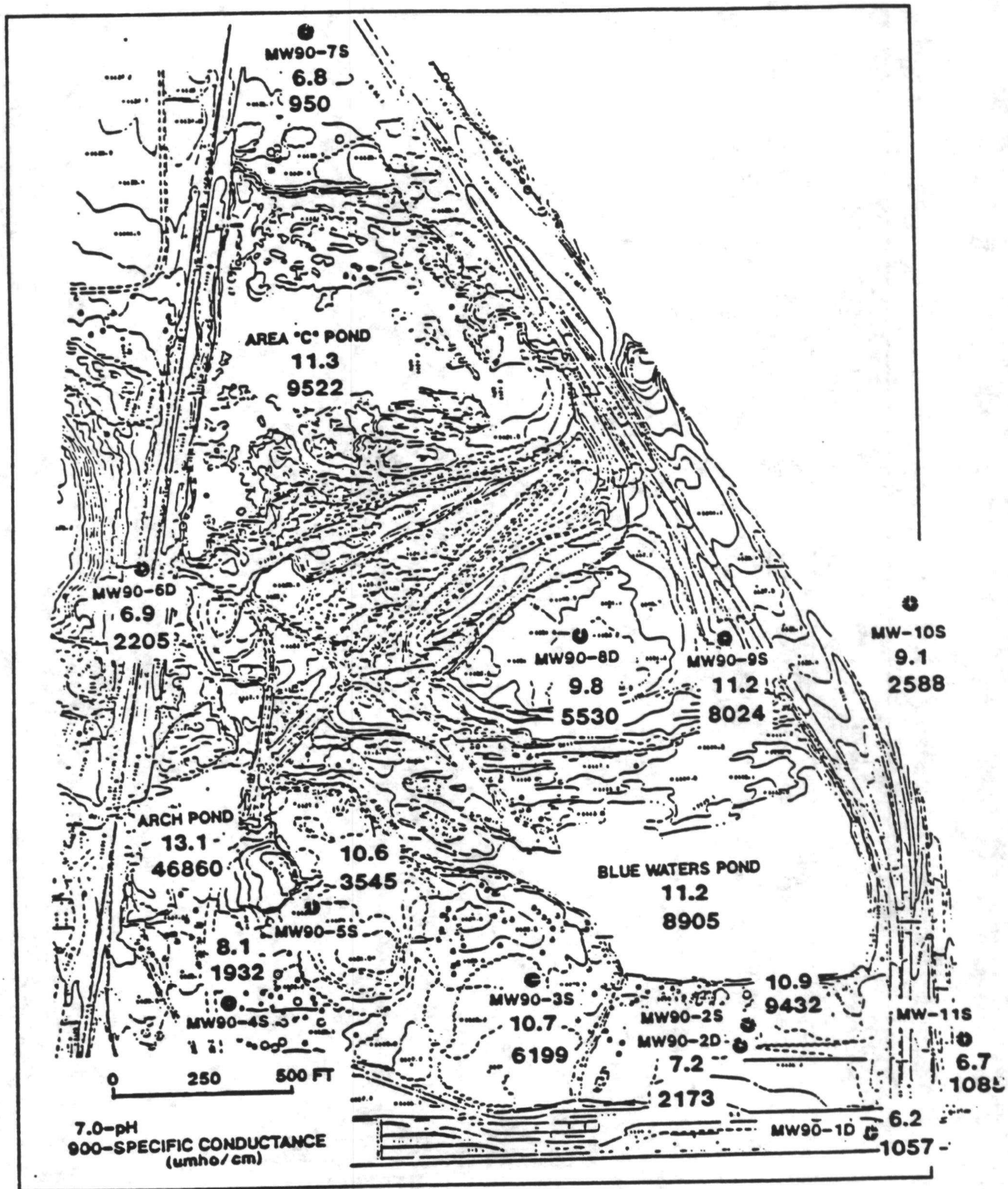

Figure 7: Groundwater pH, Oct. 1990

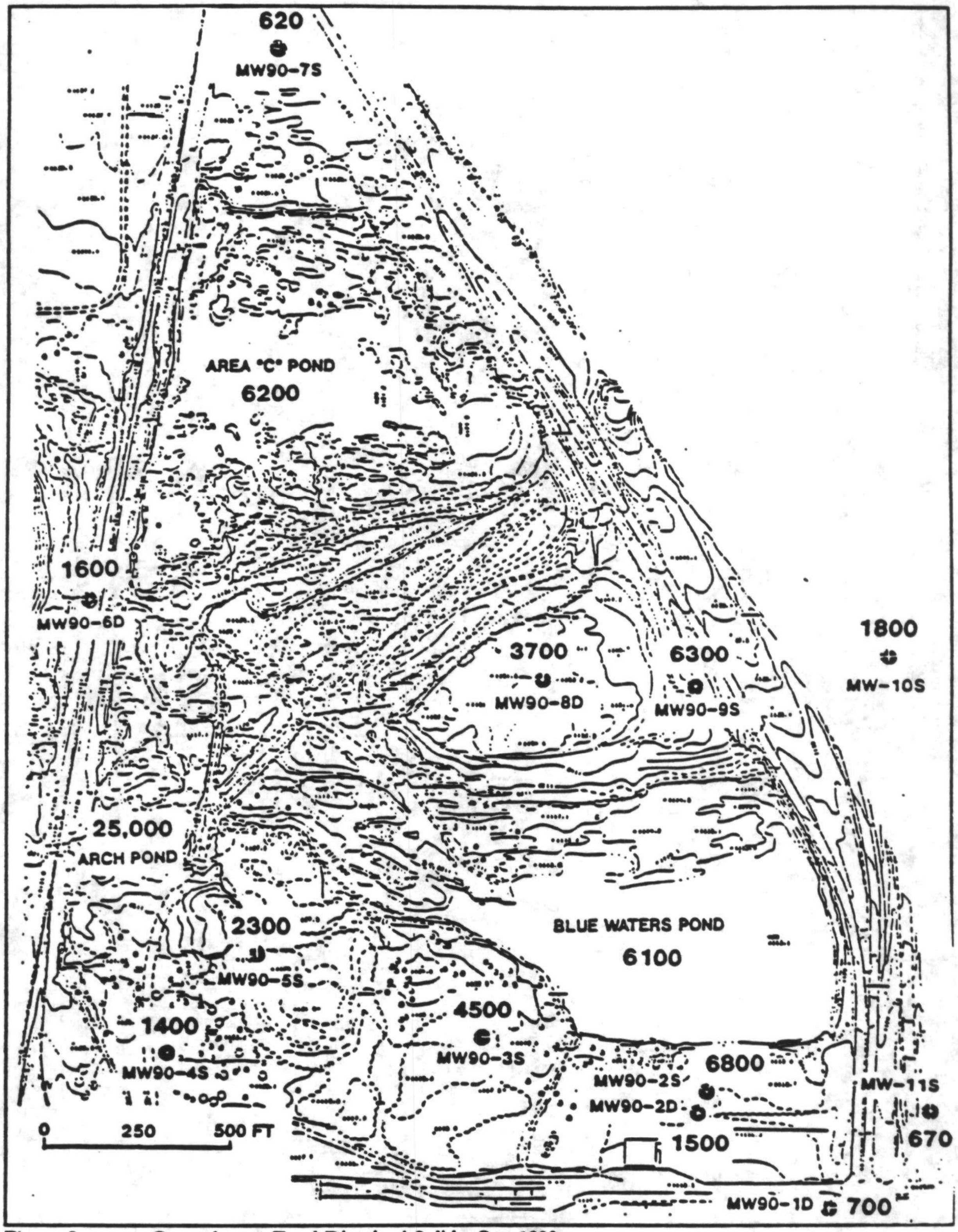

Figure 8: Groundwater Total Dissolved Solids, Oct. 1990

POOR QUALITY ORIGINAL

Table I

Chronic Hazard Index Calculations

Chemical	CDI	RfDc	CDI:RfDc
Arsenic	$6.94(10^{-4})$	$1.0(10^{-3})$	$6.94(10^{-1})$
Lead	$7.34(10^{-4})$	$1.4(10^{-3})$	$5.24(10^{-1})$
Chromium(total)	$3.02(10^{-4})$	$5.0(10^{-3})$	$6.04(10^{-2})$
			1.2784

The chronic hazard index (HI) representing the sum of CDI:RfDc ratio is 1.2784

CDI = Chronic Daily Intake

RfDc = Acceptable Intake for Chronic Response

Summary of Assessed Risks

Exposure Pathway	Cancer Risk	Chronic Hazard Index	Subchronic Hazard Index
Ingestion of Contaminated Groundwater	$1.28(10^{-3})$	1.2784	1.2523

Table I- A

Cancer Risk Estimates

Chemical	Chronic Daily Intake mg/kg-day	Slope Factor (mg/kg-day)-1	Chemical-Specific Risk
Exposure Pathway: Ingestion of contaminated groundwater			
Arsenic	$6.94(10^{-4})$	$1.8(10^{0})$	$1.25(10^{-3})$
Lead	$7.34(10^{-4})$	$4.0(10^{-2})$	$2.94(10^{-5})$
Chromium	$3.02(10^{-4})$	NA	NA
		Total Pathway Risk=	$1.28(10^{-3})$

Exposure Pathway: Inhalation of blowing dust, current conditions

There is no available data on % solids in the CKD material at the Lehigh site, thus no estimate can be made as to effects of blowing dust. It is presumed to be negligible under current conditions. Similar samples taken at Lime Creek reveal no high levels of metals in the dust and the dust at the Lehigh site is largely under water.

Exposure Pathway: Ingestion of contaminated dust, current conditions

There is no information regarding average "soil" concentrations in the Lehigh CKD. There were EP Toxicity tests performed on the CKD, however, the data from the EP Toxicity tests does not translate into an estimate of exposure due to ingested soils.

2.6 Description of Alternatives

The alternatives for soil and groundwater cleanup have been evaluated and listed below.

Remedial Action Alternative 1 - No Action

Remedial Action Alternative 2 - Drainage of quarries and water treatment.

Remedial Action Alternative 3 - CKD Isolation and Capping, including RAA-2 activities.

Remedial Action Alternative 4 - Waste Stabilization, including RAA-2 activities.

Remedial Action Alternative 5 - On-Site Engineered Landfill, including RAA-2 activities.

Alternative 1- No Action

The no action alternative includes allowing conditions at the site to remain as they exist today. Pond water would be pumped between ponds. Existing dikes and berms would attempt to contain high pH water in Blue Waters Pond. Evaluation of this Alternative is required by the National Contingency Plan (NCP) and also provides a baseline of comparison for the other alternatives. ARAR's would not be attained.

There would almost no cost associated with this alternative.

Alternative 2- Drainage of quarries and water treatment

This alternative involves the draining and treatment of water from the site ponds. The draining of the ponds is expected to create a groundwater sink which should extend under much of the plant area, therefore treating the shallow site groundwater. CKD leachate would continue to enter the groundwater system, through the CKD Reclamation Area and the site ponds, but would be captured and treated. This alternative includes obtaining an NPDES permit to discharge either to Calmus Creek or the Winnebago River, a drain system to collect groundwater which seeps into Arch Pond from the CKD Reclamation Area, and installation of three monitoring wells around the CKD Reclamation area to determine whether the base of the Area is saturated. Arch Pond (the sump area) will need to be pumped indefinitely, and water treatment as long as necessary.

The estimated present worth cost of this alternative is $1.5 million and would take one to two years to implement.

Alternative 3- CKD Isolation and Capping

This alternative would result in the remediation of the Plant area and would attain all applicable ARARs. This alternative would include all activities of Alternative 2.

In this alternative, additional activities would include: Consolidation of CKD in the drained Area "C" pond and the CKD sediment in Blue Waters and Arch pond. The consolidated CKD would then be covered with an engineered clay cap. Construction of a drain system to collect groundwater seepage from the CKD Reclamation area into Arch Pond. Consolidation of surficially deposited CKD in the Reclamation Area, regrading of this area, and construction of an engineered clay cap to limit infiltration of precipitation. A network of three monitoring wells would also be installed around the CKD Reclamation Area to determine whether the base of the CKD in the area is saturated. If so, appropriate steps will be taken to dewater the area. Finally, continued groundwater monitoring and continuous operation of the Arch pond sump and water treatment, if necessary.

The estimated present worth cost of Alternative 3 is $3.4 million and would take approximately three years to implement.

Alternative 4- Waste Stabilization

The successful implementation of this alternative would result in the remediation of the plant area and attain all ARARs and provide a permanent remedy. The remediation would be accomplished by rendering the CKD essentially inert through stabilization. This alternative would include all activities of Alternative 2. In addition, there would be laboratory kiln dust/fixative tests performed to establish the most effective combinations and concentrations. The waste kiln dust would be stabilized and solidified with a fixative agent introduced through kiln dust augering, or excavation and redeposition. A groundwater seepage collection gallery west of Arch Pond would be constructed to collect water from the CKD Reclamation Area, along with a network of three monitoring wells around the present CKD Reclamation Area to determine the effectiveness of the stabilization process. Continued groundwater monitoring and pumping of the dewatered ponds would also be part of this alternative.

The estimated present worth of Alternative 4 is $25.3 million and would take approximately three years to implement.

Alternative 5- Pond Drainage and On-Site Landfill Construction

This alternative would result in the total remediation of the site through the removal and treatment of CKD effected surface water and groundwater in conjunction with the construction of an engineered CKD storage facility. This landfill would be in compliance with state laws. Alternative 5 includes all activities of Alternative 2 plus: Engineering of a landfill capable of containing and isolating all the CKD present in the CKD Reclamation Area and Area "C" pond, as well as CKD sediment in Blue Waters and Arch Ponds. Following drainage, the CKD present in Area "C" pond and the CKD sediment in Arch and Blue Waters ponds would be removed and transferred to this on-site engineered landfill storage facility. Continued pumping of inflowing and surface water from the drained ponds, or following aquifer restoration, allowing them to fill with water. Continued groundwater monitoring.

The estimated present worth cost of this alternative is $19 million and would take approximately three years to implement.

2.7 Summary of Comparative Analysis of Alternatives

The treatment of impacted groundwater and surface water is a common remediation denominator to several of the alternatives. Although the actual quantity of water to be treated varies somewhat between individual alternatives, treatment processes and costs would be similar. The major differences in alternatives are the steps taken (if any) beyond drainage and water treatment.

A comparative analysis of each alternative against the following nine criteria has been made. These nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria must be satisfied for an alternative to be eligible for selection. The primary balancing criteria are used to weigh major tradeoffs among alternatives. Generally, the modifying criteria are taken into account after the public comment is received on the Proposed Plan. A glossary of the nine criteria follows.

Glossary of Evaluation Criteria

Threshold Criteria:

Overall Protection of Human Health and Environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) addresses whether or not a remedy will meet all of the ARARs of other Federal and State environmental statutes and/or provide grounds for invoking a waiver.

Primary Balancing Criteria:

Long-Term Effectiveness and Permanence refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

Reduction of Toxicity, Mobility, or Volume through Treatment is the anticipated performance of the treatment technologies that may be employed in a remedy.

Short-Term Effectiveness refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.

Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

Cost includes capital and operation and maintenance costs. Present worth costs are based upon capital costs plus the present sum necessary for operation and maintenance over a given period and a discount rate of 5% (before taxes and after inflation).

Modifying Criteria:

Support Agency Acceptance indicates whether the EPA concurs with the preferred alternative.

Community Acceptance will be addressed in the *Record of Decision* of the public comments received on the *Remedial Investigation/Feasibility Study* and the *Proposed Plan*.

<u>Overall Protection of human health and the environment</u>

The No Action alternative (Alternative 1) is not protective of human health and the environment because it does not address the present overflow problems of high pH and high TDS (total dissolved solids) water into Calmus Creek. It does not provide for any site remediation, and therefore could result in the deterioration of site and off-site environmental conditions. It does not address contamination in the surface or groundwater.

The Drainage of Quarries and Water Treatment Alternative (Alternative 2) does address current site surface water and shallow groundwater contamination. This alternative would also lower the water table in the vicinity of the site, decreasing the amount of CKD in contact with the groundwater system. However, this alternative is not protective of human health and the environment because it does not permanently address CKD on site, which is the source of contaminated seepage flowing into Arch Pond.

The CKD Isolation-Capping (Alternative 3), Waste Stabilization (Alternative 4), and CKD Isolation in an On-site Landfill (Alternative 5) are protective of human health and the environment because they will drain the contaminated surface (and some groundwater) as well as treat the CKD and prevent it from interacting with water on the site, at least in a way that would cause further leaching of high pH water onto the site. With the CKD Isolation and On-Site Landfill Alternatives, it will be necessary that a long-term monitoring program exist to prevent against future threats to human health or the environment.

Compliance with ARARs
The No Action alternative (Alternative 1) would not comply with ARARs for the discharge to Calmus Creek or for surface water and groundwater contamination. The Drainage of Quarries and Water Treatment alternative (Alternative 2) would address surface water and groundwater ARARs for existing site conditions, but may not address ARARs for future contamination caused by leachate from the CKD Reclamation area.

The CKD Capping-Isolation alternative (Alternative 3), Waste Stabilization alternative (Alternative 4), and On-Site Landfill alternative (Alternative 5) all would comply with ARARs by stopping the untreated discharges to Calmus Creek and to groundwater, and by addressing contaminated groundwater through drainage of the site ponds. The Waste Stabilization alternative (Alternative 4) would permanently address ARARs for future contamination.

Long-term effectiveness and permanence
The No Action alternative (Alternative 1) and the Drainage of Quarries alternative (Alternative 2) lack long-term effectiveness and cannot be considered as permanent cleanup actions.

The CKD Capping-Isolation (Alternative 3) and On-Site Landfill (Alternative 5) alternatives have effectiveness and permanence but require assurances for continued pumping and groundwater monitoring to maintain long-term compliance with this criterion. The Waste Stabilization alternative (Alternative 4) would not require long-term pumping but would provide for monitoring at the Plant site, as well as permanently treat the waste.

Reduction of toxicity, mobility, and volume through treatment
The No Action alternative (Alternative 1) would not reduce the toxicity, mobility, or volume of the contaminated materials. All other alternatives include treatment of water prior to discharge. The Drainage of Quarries and Water Treatment alternative (Alternative 2) would reduce the volume of the contaminated water, but would not reduce the toxicity or mobility of contaminants that would still seep from the CKD Reclamation area into Arch pond. The groundwater would still be impacted over time due to this seepage.

The Waste Stabilization (Alternative 4), CKD Isolation-Capping (Alternative 3), and On-Site Landfill (Alternative 5) alternatives all reduce the volume of groundwater and mobility of contaminants to similar levels. All three of these alternatives accomplish this by treatment of existing contamination and drainage to prevent further contamination. The groundwater contamination would also be greatly diminished and future discharges to Calmus Creek eliminated. Of all the alternatives, Waste Stabilization (Alternative 4) would best accomplish the goal of reduction of mobility.

Short-term effectiveness
The No Action alternative (Alternative 1) lacks short-term effectiveness. The Quarry Drainage (Alternative 2) alternative is partially effective in the short-term, since it stops the discharge to Calmus Creek and to bedrock groundwater. It would have limited effectiveness on seeps from the CKD Reclamation Area, but should eliminate many of these in the short-term.

The CKD Isolation-Capping (Alternative 3) would be more effective in the short-term as well, as it takes less time to implement than either Waste Stabilization (Alternative 4) or creating an On-Site Landfill (Alternative 5). The effect of Alternatives 3 through 5 on short-term groundwater remediation should be substantial, but long-term groundwater remediation by Alternatives 3 through 5 would need to be monitored. Alternatives 3 through 5 include drainage and water treatment. Airborne dust generated by Alternative 5 would be a problem in the short-term.

Implementability
The No Action alternative (Alternative 1) presents no implementation difficulties. The Quarry Drainage (Alternative 2) alternative presents the next easiest alternative to implement, and uses easily obtained technologies and equipment. The CKD Isolation-Capping (Alternative 3) would require a more difficult level

of implementation, but would have proven technology and available equipment.

The Waste Stabilization alternative (Alternative 4) requires that a usable fixative be identified and that it be auguered and mixed into a kiln dust deposit that may be over 10 feet deep (Area "C" pond). Implementation will be technically difficult and will require at least two years.

Engineering an On-Site Landfill (Alternative 5) would not entail the incorporation of any new or untested technologies, such as Waste Stabilization. However, the potential for failure of a landfill exists, no matter how carefully engineered. Permits would need to be obtained, and airborne dust must be controlled to transfer the CKD to one consolidated area. This alternative is probably the least easy to implement.

Cost
The costs of the alternatives are presented in the Description of Alternatives section of this document.

Support Agency Acceptance
This criterion addresses the concern and degree of support that the U.S. EPA has expressed regarding the remedial action alternatives. The Iowa Department of Natural Resources (DNR) has reviewed the documents pertaining to the site, including this document. The DNR has given its concurrence on the selected remedial action.

Community Acceptance
At the end of the public comment period (June 19, 1991), there were no comments objecting to the preferred remedial alternative. This includes comments during the public hearing held June 5, 1991 as well as written comments received from May 20, 1991 to June 19, 1991.

2.8 The Selected Remedy

The selected remedy is Alternative 3, CKD Isolation and Capping, Quarry Drainage, and Water Treatment. This remedy entails several steps. The initial step is draining of Blue Waters, Area "C" and Arch Ponds, which would require 1 to 2 years if a 300 to 500 gpm pumping and treatment rate could be maintained. The pumped water would then be treated using the acid neutralization process and discharged to either Calmus Creek or the Winnebago River. Depending on the stream concentration limits for TDS, set by Iowa NPDES officials, further water treatment may be required (particularly if Calmus Creek is selected as the body of water for discharge) to lower TDS limits in acid-treated water. Further treatment would be by ion exchange or reverse osmosis.

Following drainage of the ponds, drainageways would be constructed in the base of Blue Waters and Area "C" Ponds. These drainageways would be connected to a sump which would be excavated in the ponds following sediment dredging. It is expected that shallow groundwater will also be remediated during this drainage, due to local shallow groundwater gradients reversing toward the quarries. As a result of this, impacted shallow groundwater will be drained from the sump and prevented from being able to move off-site.

Next, an engineered clay cap would be placed over the CKD Reclamation Area. Construction specifics of this cap will be determined during the design phase following proctor and permeability testing of the local clay soils. The cap would be graded so that runoff would be directed to the sump to allow blending of surface water with the impacted water prior to treatment. The cap will be constructed to satisfy state landfill requirements and reduce long-term pumping costs from infiltration of water.

CKD in Area "C" Pond and the CKD sediment in Blue Waters and Arch Ponds would be consolidated into the drained Area "C" Pond and covered with an engineered clay cap. This cap of the two CKD areas would require approximately 80,000 cubic yards of clay-rich soil. The cap will be finished with a sand drainage layer and seeded topsoil layer to facilitate runoff and protect the clay.

A groundwater seep collection system to the west of Arch Pond will also be implemented during the initial stages of remediation. This is designed to intercept seepage from the CKD Reclamation Area.

Finally, three monitoring wells will be installed around the CKD Reclamation Area in order to assess the effects of pond drainage and the effectiveness of the clay cap. If the base of the Reclamation Area is found to be saturated, dewatering wells will be installed in or below the CKD deposit. The saturated thickness is not expected to be greater than five feet. The actual determination of the most efficient method to maintain the dewatered state of the CKD will be determined during the remedial design phase.

The overall effect of Alternative 3 should be the isolation of the contaminant source (CKD) from interaction with surface and groundwater, and the removal and treatment of impacted water presently in site ponds and shallow groundwater. Institutional controls, such as deed restrictions, will also be required on any future land sale.

The treated discharge to either Calmus Creek or the Winnebago River will be monitored to ensure compliance with the Iowa NPDES permit. A contingency plan will be required to ensure continued operation, including financial assurances.

The remedy was selected from among three alternatives that would provide for protection of human health and the environment, comply with ARARs, reduce the toxicity, mobility, and volume of the waste through treatment, and have both long-term and short-term effectiveness. The No Action alternative (Alternative 1) and the Quarry Drainage alternative (Alternative 2) would not meet all the above criteria, and so were not selected. Of the remaining three alternatives, the CKD Isolation-Capping alternative (Alternative 3) could be implemented with greater assurance of effectiveness, and at a substantially lower cost.

THE LIME CREEK NATURE CENTER

The Lehigh Portland Cement Company site also includes the Lime Creek Nature Center (LCNC). This area, although separate from the above discussed plant area, also has deposits of CKD which are in contact with water. LCNC was investigated as part of the Lehigh RI/FS investigation. This section will briefly discuss the Lime Creek sub-site, and evaluate the Remedial Alternative selected for the sub-site.

SITE BACKGROUND

The Lime Creek Nature Center (LCNC) is a 410 acre facility controlled by the County of Cerro Gordo and operated as an area for outdoor recreation. It was opened to the public in May, 1984. The Center was jointly donated by Lehigh and Northwestern States as a public recreation and nature center. Cerro Gordo County employs several full-time employees at the center and operates a visitor center with a library and numerous nature exhibits. The Nature Center is located immediately north of Mason City, and is bounded by the Winnebago River to the north and east, U.S. Highway 65 to the west, and private owners to the south (Figure 9). The Lehigh plant site is across Highway 65 west of the Nature Center.

Portions of the current LCNC were formerly owned by Lehigh Portland Cement Company (LPCC). LPCC transferred the property to Cerro Gordo county in 1979. During its ownership, LPCC mined limestone from the site and replaced CKD within the exhausted quarries. CKD is identifiable at three locations at the site. The CKD sites include two exhausted quarries located on the western side of LCNC (near the Quarry Lake) and one area of surficial deposit along the eastern boundary of the site, referred to as the "Badlands" (Figure 10).

As with the Lehigh site, the primary concerns in the LCNC area include elevated pH and TDS levels. Based on the assumed thicknesses and lateral dimensions, there are approximately 30,000 cubic yards of CKD at Quarry pond, approximately 400,000 cubic yards in the Badlands area, and 9,000 cubic yards in the exhausted quarry. Elevated pH levels were detected in Quarry pond (9.5) and monitoring well 14 (10.4). The water quality in Quarry pond has deteriorated slightly, but the water quality in this pond was better than the water quality in the Lehigh ponds. Arsenic was detected in two of the monitoring wells on one occasion, at 0.01 and 0.07 mg/L (well 12, well 13) and lead was above drinking water standards once, in well 14 at 0.06 mg/L. Well locations are shown in Figure 11.

The CKD samples that were collected showed high values for extractable and final pH (11-12.7) There were no metals parameters which tested above EP toxicity limits. This high pH was not found in the LCNC water well, which is probably downgradient of the CKD deposits. This well is a deep well (actual depth is unknown) and its water quality and pH are normal.

In summary, the specific contamination concerns at the Lime Creek site include:

1. The large volume of low toxicity CKD at the site.

2. The presence of elevated groundwater pH readings beneath the Badlands area.

3. The presence of elevated pH and TDS levels in Quarry Pond.

The ARARs applicable to the Plant area are applicable to Lime Creek.

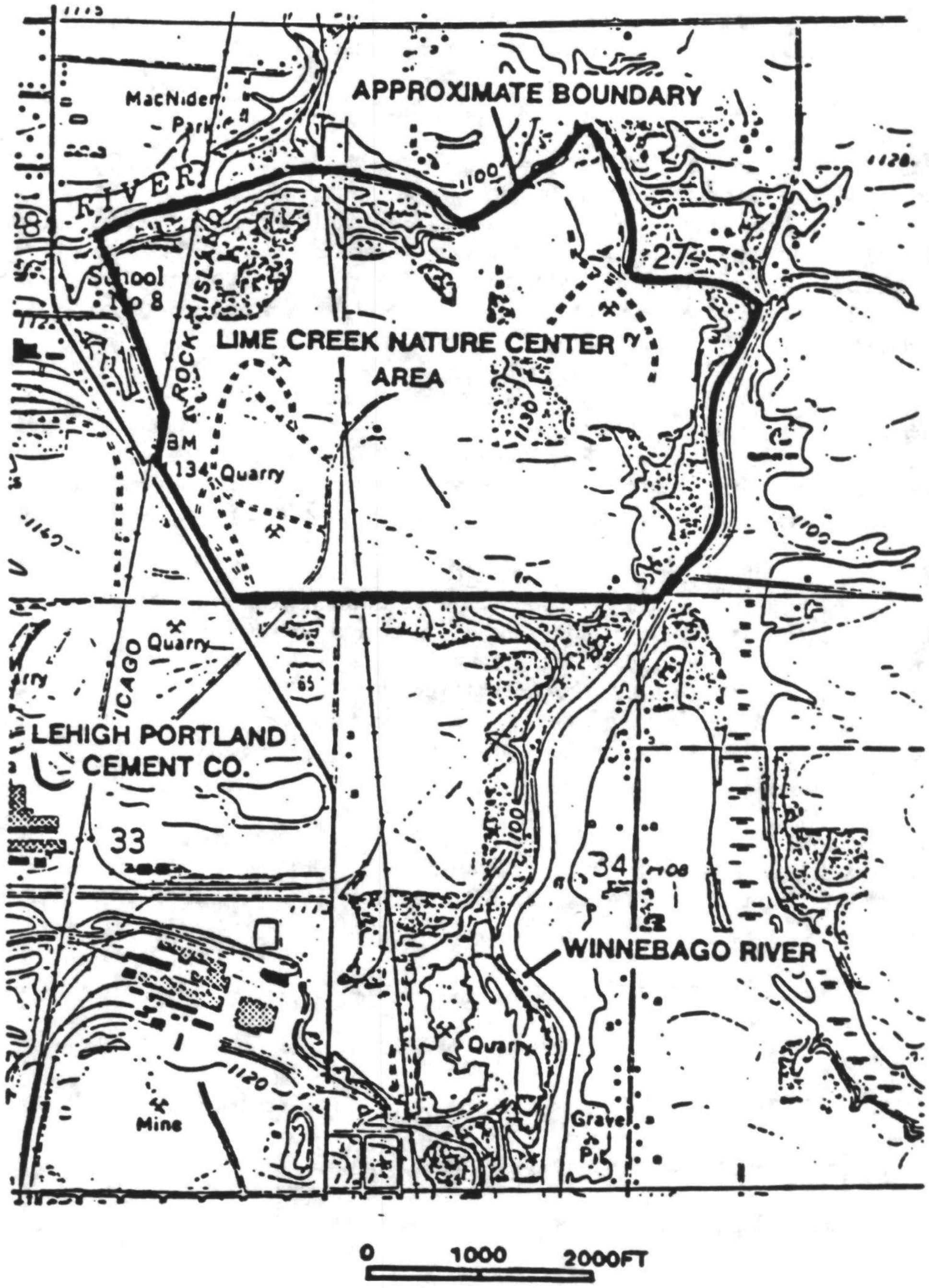

Figure 9: Location of Lime Creek Nature Center

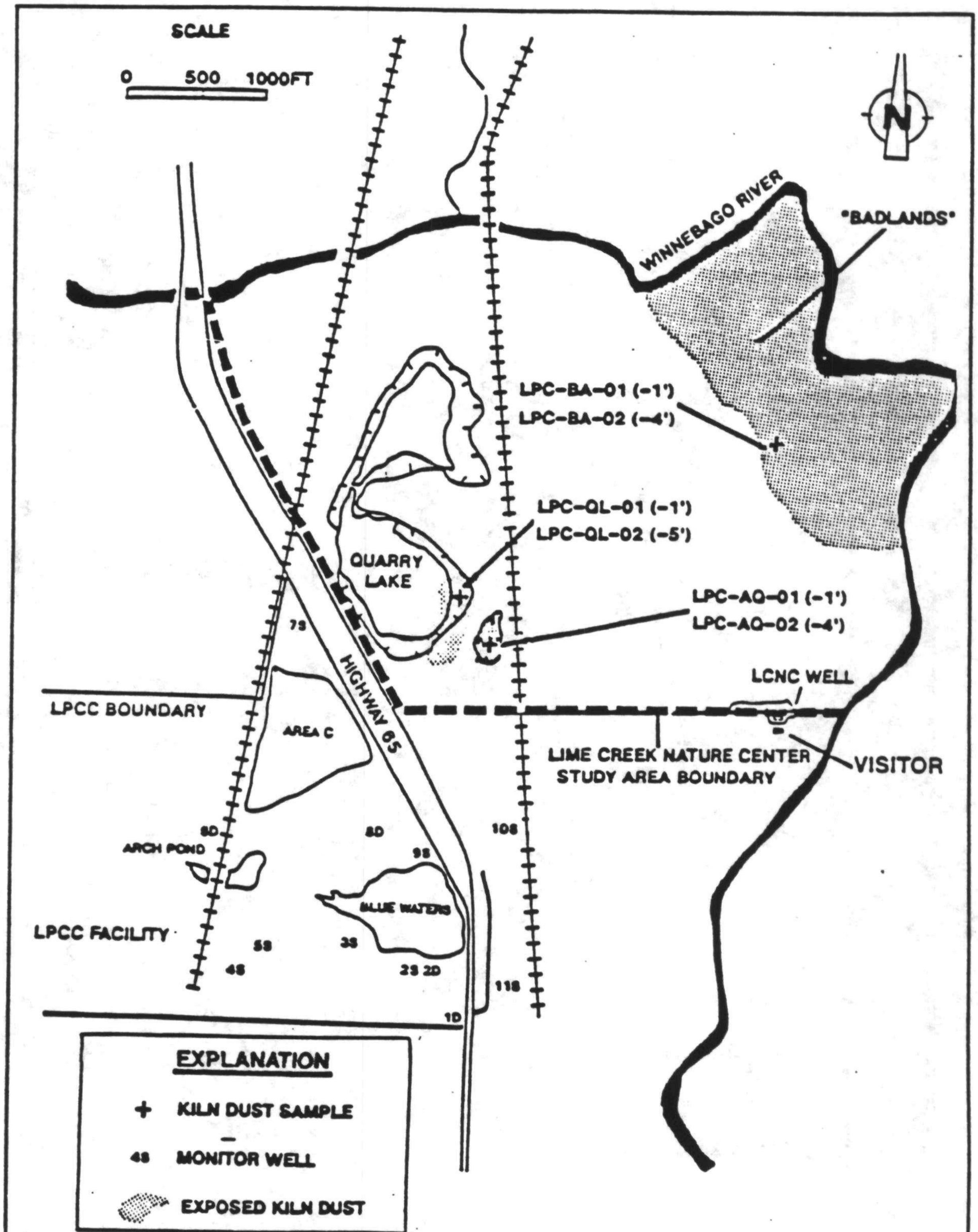

Figure 10: CKD Deposits and Investigation Area

POOR QUALITY ORIGINAL

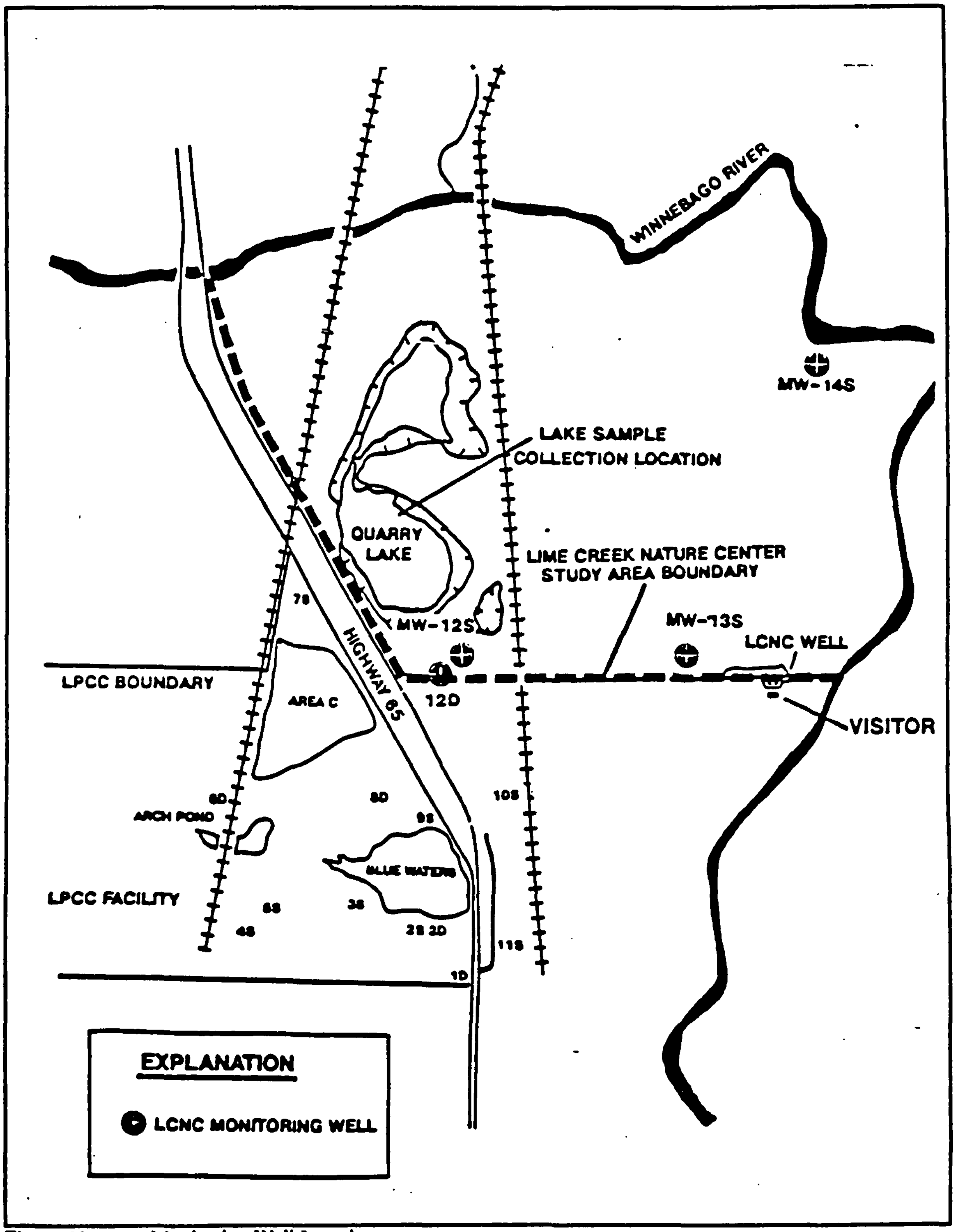

Figure 11: Monitoring Well Locations

POOR QUALITY
ORIGINAL

SUMMARY OF THE PREFERRED ALTERNATIVE

Lehigh presented similar remedial alternatives for LCNC, with the exception of an off-site landfill for LCNC and an on-site landfill for LPCC. The Lime Creek alternatives included No Action, Consolidation and Isolation of the CKD Deposits, Waste Stabilization, and Disposal in an Engineered Off-Site Landfill. For the same reasons discussed in the analysis for the Lehigh site, all were ruled out except for Waste Consolidation and Isolation.

This alternative calls for the consolidation and capping of the area CKD deposits. By inhibiting the interaction of water with the CKD deposits, the quality of the area surface water and groundwater will improve through natural dilution. Because the level of pH found at LCNC is not nearly as high as at the Lehigh site, and because the interaction of water with CKD is the greatest concern at the site; this remedy was chosen.

The preferred alternative includes:

1. Install a dam between the two portions of Quarry Pond and drain the western pond.
   NPDES discharge permit
   No treatment necessary because of pond water quality
   Install temporary pumping and discharge system

2. Excavate the CKD present within and around Quarry pond and transfer to the exhausted quarry east of Quarry pond.

3. Grade the CKD deposits in the exhausted quarry and install an engineered clay cap.

4. Consolidate the CKD in the Badlands area and cover with an engineered clay cap.

5. Allow the drained portion of Quarry pond to refill.

6. Continue groundwater and surface water monitoring.

The implementation of this alternative would result in an effective site remediation. It would accomplish this by isolating CKD on site from both the groundwater and surface water systems. Isolation would be accomplished by consolidation and coverage with an engineered clay cap. Capping will significantly retard the amount of water infiltration through the CKD, and because both the exhausted quarry east of Quarry pond and the western portion of the Badlands are both situated well above the water table, the introduction of high pH, high TDS leachate into shallow groundwater will essentially be stopped.

With significant reduction in leachate, the natural buffering systems and dilution rates will probably lower pH and TDS concentrations to background levels. Continued monitoring will assess the effectiveness of the caps.

Overall protection of Human Health and the Environment and Compliance with ARARs
Through CKD isolation and gradual dilution, the area groundwater quality should eventually improve to background or near background levels. In addition, Quarry pond will be remediated following the removal of CKD currently in contact with the water body. Because LCNC is a public assess area, the capping of the CKD deposits in the area will remove it from public contact. An NPDES permit will be needed prior to pumping of Quarry pond. The water pumped from Quarry pond would not require treatment for discharge to the Winnebago River. With dilution, it is expected that contaminant levels of the groundwater will eventually diminish to levels below drinking water standards.

Long-term Effectiveness and Permanence
The isolation of the CKD from direct contact with the water systems at LCNC will result in an effective and permanent remediation. The effectiveness of the remediation will be assessed through ongoing monitoring.

Reduction of Toxicity, Mobility, and Volume
By isolating the CKD from interaction with surface and groundwater, the mobility of contaminants which may migrate to the groundwater system will be greatly reduced. The implementation of the alternative will have no effect on the volume of CKD, although after consolidation, its surface area will be greatly reduced.

Short-term Effectiveness
The immediate beneficial short-term effect associated with this alternative will be the safeguarding of the public through CKD capping. Once initiated, the pond drainage and CKD capping process is expected to require approximately 1.5 years to complete. Once capped, the area groundwater quality will gradually improve although it is difficult to estimate how rapidly this will be achieved.

Implementability
The earth moving and pumping technologies are readily available in the Mason City area and are not complex.

Estimated Costs
The estimated costs associated with the implementation of the preferred alternative would be approximately $947,000 to $1,609,000 depending on the volumes of CKD encountered in the Quarry pond deposit and capping requirements. The estimated present worth cost of this alternative is approximately $1.6 million.

This remedy was selected from other alternatives (similar to the ones presented for the Lehigh site) because it would provide protection of human health and environment, comply with ARARs, reduce the mobility and volume of the contaminant and have both long-term and short-term effectiveness. The preferred alternative also has a greater assurance of effectiveness, without risk of adverse off-site impacts associated with the removal of kiln dust to another location, and could be accomplished at a substantially lower cost. Figure 12 shows the selected remedial alternative for the Lime Creek Nature Center.

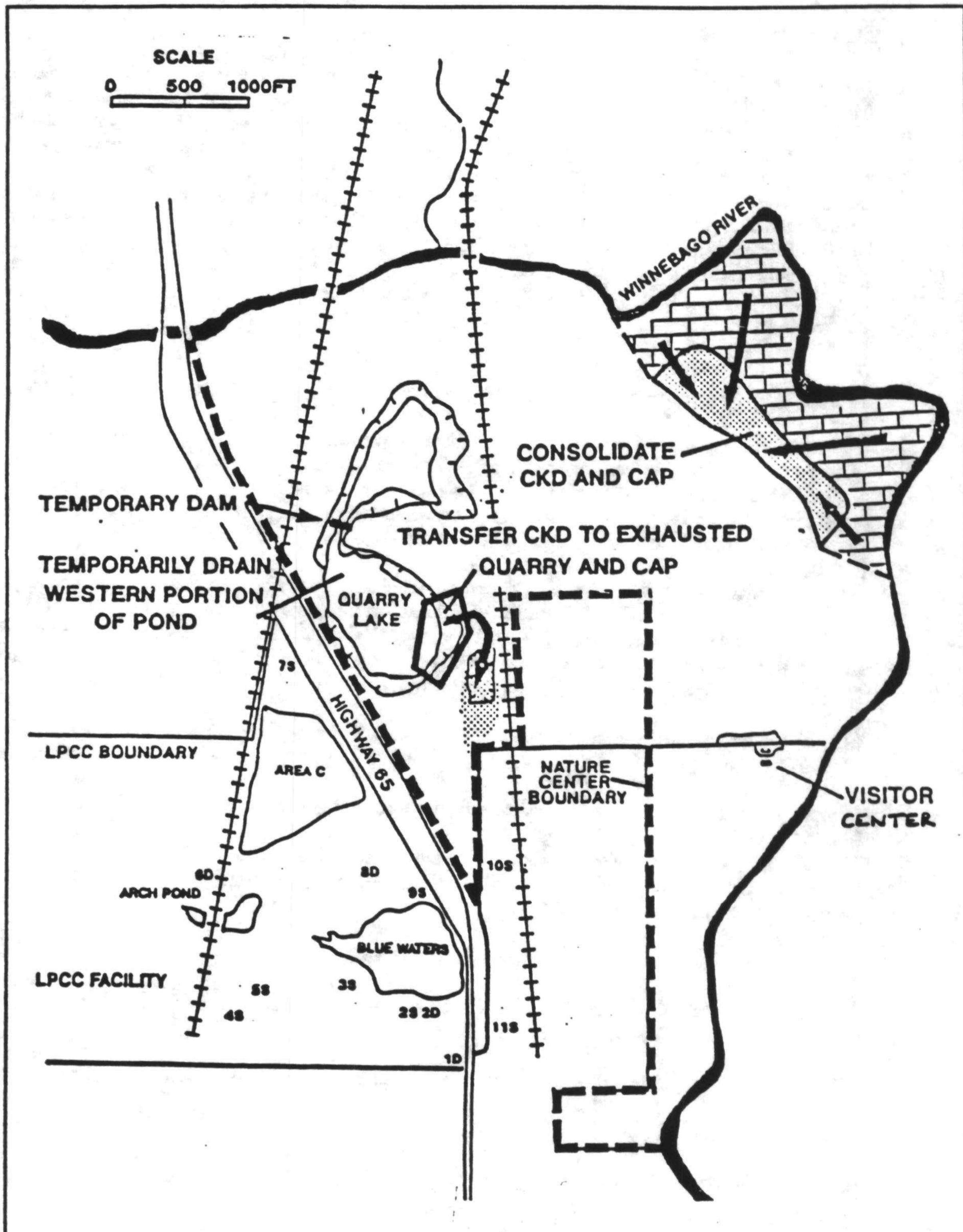

Figure 12: Selected Remedial Alternative

2.9 Statutory Determinations

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, section 121 of CERCLA established several other statutory requirements and preferences. These specify that, when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate (ARARs) environmental standards established under Federal and State environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy protects human health and the environment by removing and treating impacted waters and minimizing further impacts on water from the kiln dust by minimizing kiln dust contact with water. This should result in groundwater contaminant levels below health-based standards and surface water meeting state water quality standards. This will be accomplished through capping the waste kiln dust, pond drainage, and shallow groundwater dewatering.

Existing impacted shallow groundwater will be extracted and treated by the sump used to drain the site ponds. This will prevent off-site migration of impacted groundwater thus eliminating potential human exposure via drinking water wells. All water discharged to Calmus Creek or the Winnebago River from the site will be treated as necessary to meet Iowa water quality standards which are established to protect aquatic life and secondary human contact (e.g. wading).

Capping of the kiln dust will reduce production of leachate due to infiltration of precipitation.

Compliance with Applicable or Relevant and Appropriate Requirements

The following ARARs apply to the selected remedy. It should be noted that levels of metals detected in groundwater are generally low and in all likelihood will not be a determining factor. The primary water quality parameter of concern is pH.

NPDES limits, which will need to be obtained from Iowa DNR

Iowa Water Quality Standards, Chapter 61, Class B instream standards (which apply to either the Winnebago River or Calmus Creek):

pH	6.5 to 9.0 (the maximum change in pH shall not be greater than 0.5 pH units)
TDS	750 mg/l

Iowa Groundwater Action Levels, Chapter 133:

Arsenic	0.00003 mg/L
Lead	0.015 mg/l
Chromium(total)	0.1 mg/l

Maximum Contaminant Levels, Federal Safe Drinking Water Act (SDWA):	
Arsenic	0.05 mg/l
Lead	0.05 mg/l
Chromium(total)	0.05 mg/l
pH	6.5 to 8.5 (Secondary Maximum Contaminant Level)

State landfill requirements will also apply, Chapters 100-121.

The selected remedy should be able to attain these ARARs.

Cost-effectiveness

The selected remedy is cost-effective because it is the least expensive action alternative and yet provides a high degree of overall protection. The other alternatives which were less costly did not provide long-term remediation or compliance with ARARs. It was also uncertain whether the Waste Stabilization alternative, which would be much more costly ($25.3 million dollars), could be effectively implemented. The On-Site Landfill alternative was also more costly ($19 million dollars) and involved the transfer of contaminants, which could result in other problems as well as require more maintenance. The selected remedy will meet all ARARs and provide a long-term solution to the problem at a substantially lower cost. Thus there are no significant advantages to the more expensive alternatives.

Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable (MEP):

The Iowa DNR and EPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be practically utilized in a cost-effective manner for the final response actions at the LPCC site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the State and EPA have determined that this selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; cost; consideration of the statutory preference for treatment as a principal element; and State and community acceptance.

Preference for Treatment as a Principal Element

Cement kiln dust is not a hazardous substance in itself. It is through interaction with water that high pH conditions are created. The selected remedy does not treat the kiln dust, but it does isolate the kiln dust from water to minimize further production of high pH water. Existing impacted water will be treated prior to discharge. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

2.10 Documentation of Significant Changes

The Proposed Plan for the Lehigh site was released for public comment May 20, 1991. The Proposed Plan identified Remedial Action Alternative 3, Waste Isolation and Capping, as the preferred alternative. The Iowa DNR reviewed all comments received during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was identified in the Proposed Plan, were necessary.

APPENDIX

Groundwater and Surface Water Sampling Results

Well History Information, NET and UHL Results

MW 2-S*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	UHL 7/20/90	NET 10/9/90	UHL 10/9/90	NET 11/29/90
pH	9.7	10.2	10.3	10.84	10.6		10.5
TDS	3000		6300		6800		6800
Sulfate	490		1400		1500		1400
Arsenic	0.014	0.03		0.04	0.090	0.02	0.019
Lead	0.005	0.12		<0.01	0.006	0.01	<0.010
Chromium,total	<0.005	<0.02		<0.02	<0.005	0.02	<0.010
Calcium	96	99	88	14	2.2	430	5.9
Potassium	1200	1500	1900	2700	3700	2900	3100
Sodium	230	210	260	260	300	320	280
Iron, total	5.90	10		0.56	0.72	23	0.58

*All values, except for pH, are in mg/L

Well History Information, NET and UHL Results

MW 2-D*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	UHL 7/20/90	NET 10/9/90	NET 11/29/90
pH	7.6		7.7		8.0	7.6
TDS	1400		1500		1500	1600
Sulfate	510		550		610	560
Arsenic	0.003	<0.01		<0.01	<0.005	<0.010
Lead	0.001	<0.001		<0.01	<0.005	<0.010
Chromium, total	<0.005	<0.02		<0.02	<0.005	<0.010
Calcium	110	55	96	120	70	88
Potassium	370	300	330	350	490	470
Sodium	100	87	110	90	120	110
Iron, total	0.29	0.22		0.36	<0.10	0.10

*All values, except for pH, are in mg/L

Well History Information, NET Results

MW 3-S*

Indicator Chemical	NET 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/29/90
pH	9.8	10.3/11.18	10.5	10.8
TDS	2100	6300	4500	6000
Sulfate	320	970	800	1200
Arsenic	0.025		0.100	0.030
Lead	0.001		<0.005	<0.010
Chromium, total	0.006		<0.005	<0.010
Calcium	230	120	1.9	1.2
Potassium	500	2000	2200	2900
Sodium	60	180	220	240
Iron, total	7.12		0.57	<0.10

*** All values, except for pH, are in mg/L**

Well History Information, NET Results

MW 4-S*

Indicator Chemical	NET 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/28/90
pH	7.7	7.7/7.93	8.1	7.6
TDS	1100	1300	1400	1300
Sulfate	380	470	510	510
Arsenic	0.001		<0.005	<0.010
Lead	0.001		<0.005	<0.010
Chromium, total	0.042		<0.005	<0.010
Calcium	1300	190	41	77
Potassium	210	280	510	400
Sodium	64	84	91	100
Iron, total	24.7	1.8	0.83	0.38

* All values, except for pH, are in mg/L

Well History Information, NET and UHL Results

MW 5-S*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	UHL 7/20/90	NET 10/9/90	NET 11/29/90
pH	10.4	10.65	10.2	10.67	10.2	10.6
TDS	3200		2300		2300	4100
Sulfate	580		540		580	860
Arsenic	0.028	0.07		0.04	0.080	0.0290
Lead	0.001	0.52		<0.01	<0.005	<0.010
Chromium, total	0.009	0.04		<0.02	<0.005	<0.010
Calcium	1100	2400	520	1600	14	23
Potassium	900	1000	1200	980	1000	1700
Sodium	130	140	120	120	130	220
Iron, total	19.1	72	12	28	1.4	2.2

* All values, except for pH, are in mg/L

Well History Information, NET Results

MW 6-D*

Indicator Chemical	NET 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/28/90
pH	7.6	7.2	7.9	7.6
TDS	1400	700	1600	1600
Sulfate	570	140	860	780
Arsenic	0.002		<0.005	<0.010
Lead	0.003		<0.005	<0.010
Chromium, total	0.04		<0.005	<0.010
Calcium	1700	340	100	100
Potassium	180	470	340	400
Sodium	51	110	95	86
Iron, total	55.8	9.8	0.99	0.23

* **All values, except for pH, are in mg/L**

Well History Information, NET Results

MW 7-S*

Indicator Chemical	NET 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/28/90
pH	7.2/6.80	7.2/7.45	7.3	7.0
TDS	760	700	620	800
Sulfate	130	140	130	200
Arsenic	0.004		<0.005	<0.010
Lead	0.001		<0.005	<0.010
Chromium, total	0.038	0.035	<0.005	<0.010
Calcium	160	180	120	170
Potassium	23	26	15	18
Sodium	16	22	20	23
Iron, total	37.5	51	4.6	0.23

* All values, except for pH, are in mg/L

Well History Information, NET and UHL Results

MW 8-D*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/29/90
pH	9.5	9.85	9.6/10.15	9.7/9.75	9.5
TDS	4200		5500	3700	4100
Sulfate	1000		1100	1200	1100
Arsenic	0.012	0.04		0.040	<0.010
Lead	0.001	0.21		<0.005	<0.010
Chromium, total	0.020	0.02		<0.005	<0.010
Calcium	250	150	110	5.6	6.4
Potassium	1200	1600	1700	1700	1600
Sodium	190	140	200	210	210
Iron, total	15.0	26		0.76	0.50

* All values, except for pH, are in mg/L

Well History Information, NET and UHL Results

MW 9-S*

Indicator Chemical	NET 6/20/90	NET 7/20/90	UHL 7/20/90	NET 10/9/90	UHL 10/9/90	NET 11/29/90
pH	10.8	10.8	11.43	11.2		11.0
TDS	7000	9700		6300		6800
Sulfate	1300	1500		1400		1400
Arsenic	0.038		0.05	0.070	0.02	0.021
Lead	0.010		<0.01	0.033	<0.01	<0.010
Chromium, total	<0.005		<0.02	<0.005	<0.02	<0.010
Calcium	63	46	79	0.54	30	1.7
Potassium	2200	2600	3000	3200	3000	3000
Sodium	240	270	280	280	260	140
Iron, total	2.58		3.2	<0.15	1.3	0.12

* All values, except for pH, are in mg/L

Surface Water Sampling History, NET and UHL Results

Blue Waters Pond*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	UHL 7/20/90	NET 10/9/90	UHL 10/9/90	NET 11/28/90
pH	10.8	11.54	10.7	12.08	10.6	11.2	11.0
TDS	7300		7600		6100		6500
Sulfate	1300		1200		1400		1300
Arsenic	0.039	0.06		0.03	0.100	<0.01	0.031
Lead	0.004	<0.001		<0.01	0.006	<0.01	<0.010
Chromium,total	<0.005	<0.02		<0.02	<0.005	<0.02	<0.010
Calcium	0.61	1.0	3.3	7.8	0.58	44	1.8
Potassium	2800	3000	2300	2200	2900	650	2700
Sodium	260	280	230	210	250	83	270
Iron, total	0.11	0.34		0.77	0.64	2.3	0.16

* **All values, except for pH, are in mg/L**

Surface Water Sampling History, NET and UHL Results

Area "C" Pond*

Indicator Chemical	NET 6/20/90	UHL 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/28/90
pH	11.2	11.73	10.8/12.05	11.0/11.4	11.0
TDS	7200		8900	6200	6800
Sulfate	1300		1400	1400	1400
Arsenic	0.040	0.06		0.120	0.033
Lead	0.006	<0.001		0.006	<0.010
Chromium, total	<0.005	<0.02		<0.005	<0.010
Calcium	1.1	1.0	0.38	0.70	2.1
Potassium	2300	2900	2600	2900	2800
Sodium	280	270	260	250	140
Iron, total	0.219	0.04		0.12	0.15

* All values, except for pH, are in mg/L

Surface Water Sampling History, NET Results

Arch Pond*

Indicator Chemical	NET 6/20/90	NET 7/20/90	NET 10/9/90	NET 11/28/90
pH	12.3/13.0	12.3/13.15	12.0/13.1	11.3/11.38
TDS	11000	10000	25000	6500
Sulfate	2000	1800	4700	1500
Arsenic	0.040	0.050	0.200	0.023
Lead	0.002	0.029	<0.005	<0.010
Chromium, total	<0.005	<0.10	0.006	<0.010
Calcium	1.5	12.0	0.07	8.6
Potassium	3800	54.0	11000	2800
Sodium	270	400	830	280
Iron, total	0.23	0.32	0.12	0.11

* All values, except for pH, are in mg/L

Well History Information, NET and UHL Results

MW 10-S*

Indicator Chemical	NET 10/9/90	UHL 10/9/90	NET 11/29/90	UHL 12/11/90
pH	9.0	9.1	9.0	8.53
TDS	1800		1700	
Sulfate	530		440	
Arsenic	0.040	<0.01	<0.010	<0.01
Lead	*0.018*	<0.01	<0.010	<0.01
Chromium, total	<0.005	<0.02	<0.010	<0.02
Calcium	15	44	16	39
Potassium	900	650	600	640
Sodium	110	83	88	74
Iron, total	0.46	2.3	0.54	1.5

***All values, except for pH, are in mg/L**

Well History Information, NET and UHL Results

MW 11-S*

Indicator Chemical	NET 10/9/90	UHL 10/9/90	NET 11/29/90	UHL 12/11/90
pH	7.4	6.7	7.3	6.88
TDS	670		730	
Sulfate	180		160	
Arsenic	<0.005	<0.01	<0.010	<0.01
Lead	0.012	<0.01	<0.010	<0.01
Chromium, total	<0.005	<0.02	<0.010	<0.02
Calcium	130	330	130	330
Potassium	4.7	4.2	3.9	4.9
Sodium	45	34	33	28
Iron, total	0.19	4.6	<0.10	4.3

*All values, except for pH, are in mg/L