ANL/EVS/AGEM/TR-05-05

Revised Plan: Recommended Investigation at Navarre, Kansas

prepared by
Environmental Science Division
Argonne National Laboratory

Argonne National Laboratory is managed by
The University of Chicago for the U. S. Department of Energy

United States Department of Agriculture
Work sponsored by Commodity Credit Corporation,
United States Department of Agriculture

About Argonne National Laboratory

Argonne is managed by The University of Chicago for the U.S. Department of Energy under contract W-31-109-Eng-38. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne and its pioneering science and technology programs, see www.anl.gov.

Availability of This Report

This report is available, at no cost, at http://www.osti.gov/bridge. It is also available on paper to U.S. Department of Energy and its contractors, for a processing fee, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone (865) 576-8401
fax (865) 576-5728
reports@adonis.osti.gov

ANL/EVS/AGEM/TR-05-05

Revised Plan: Recommended Investigation at Navarre, Kansas

by
Applied Geosciences and Environmental Management Section
Environmental Science Division, Argonne National Laboratory

January 2006

Contents

Figures

Tables

Notation

AGEM	Applied Geosciences and Environmental Management
AMSL	above mean sea level
BGL	below ground level
CCC	Commodity Credit Corporation
CPT	cone penetrometer
FSB	Flat Storage Building
ft	foot (feet)
h	hour(s)
HSA	hollow-stem auger
in.	inch(es)
KDHE	Kansas Department of Health and Environment
KGS	Kansas Geological Survey
NAIP	National Agricultural Imagery Program
PA	preliminary assessment
PVC	polyvinyl chloride
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOC	volatile organic compound

Revised Plan: Recommended Investigation at Navarre, Kansas

1 Background for the Present Recommendation

1.1 Earlier History

The Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA) operated a grain storage facility at Navarre, Kansas, from 1954 to approximately 1966, on property adjacent to the Navarre Co-op's operation. Over the years, the Co-op has expanded across the area formerly occupied by the CCC/USDA facility, and the property has been graded and developed extensively (Figure 1.1).

In 1991 the Kansas Department of Health and Environment (KDHE) conducted a preliminary assessment (PA) of groundwater contamination that had been detected in samples collected in 1990–1991 from drinking water wells in Navarre (KDHE 1992). Information in the PA indicates that the carbon tetrachloride and nitrate groundwater contamination resulted from activities conducted on the former CCC/USDA property and at the active Navarre Farmers Union Co-op. At that time, the Co-op was working with the KDHE to resolve the problem by assisting the KDHE in development of a plan to provide a new drinking water supply to the citizens of Navarre.

Argonne's site characterization studies for the CCC/USDA in the early 1990s delineated a plume of dissolved-phase carbon tetrachloride in groundwater samples collected from the upper aquifer across the town (Figure 1.2). Argonne also collected a limited number of groundwater samples from the lower aquifer at locations downgradient from the former CCC/USDA property. Carbon tetrachloride was detected in a groundwater sample collected from one lower-aquifer monitoring well, which was installed near a private well completed in both aquifers. This type of well completion could contribute to contaminant migration between the two aquifers. In addition to groundwater samples, Argonne analyzed subsurface soil samples collected at several locations on the former CCC/USDA property. Elevated carbon tetrachloride levels were detected in subsurface soil near the north end of the former CCC/USDA facility (Figure 1.3). Argonne was unable to gain access to the Co-op area north of the former CCC/USDA facility for further investigation of soil sources of carbon tetrachloride.

1.2 The Papadopulos Study in 2000

The Papadopulos study conducted for the U.S. Department of Justice in 2000 included a soil gas survey (Figure 1.4) and groundwater sampling (Figure 1.5) focusing on the upper aquifer in the area immediately north of the former CCC/USDA facility, in the vicinity of the Co-op's Flat Storage Building (FSB). The analytical results showed elevated levels of carbon tetrachloride at locations throughout the investigation target area (Papadopulos 2000).

1.3 The Co-op Investigation in 2005

In 2004 the North Central Kansas Cooperative signed a consent order to investigate and remediate the nitrate contamination, as well as to investigate the carbon tetrachloride contamination. As required in the consent order, the Co-op prepared two work plans: one for investigation of nitrate contamination and the other for investigation of carbon tetrachloride contamination in the upper aquifer. In January 2005 the KDHE approved both work plans. The investigations were conducted in May 2005. The final reports for these investigations have not been submitted to the KDHE.

The sample locations proposed in the Co-op work plan were limited in scope and sample depths. Furthermore, the proposed methodology for handling soil samples included storage of the samples in laboratory-approved containers, preservation on ice at 4°C, and adding methanol extractant in the laboratory. This is an accepted method. In contrast, the sample handling method used by Argonne includes preserving each soil sample on dry ice at -70°C. A comparison study conducted by Argonne showed that storing samples on dry ice is a more rigorous sample handling technique (Alvarado and Rose 2004). This preservation technique enhances the laboratory analysis of organic compounds that may be lost through volatilization under the method proposed in the Co-op work plan.

1.4 Existing Monitoring Wells

Table A.1 summarizes construction data for existing monitoring wells at the Navarre site.

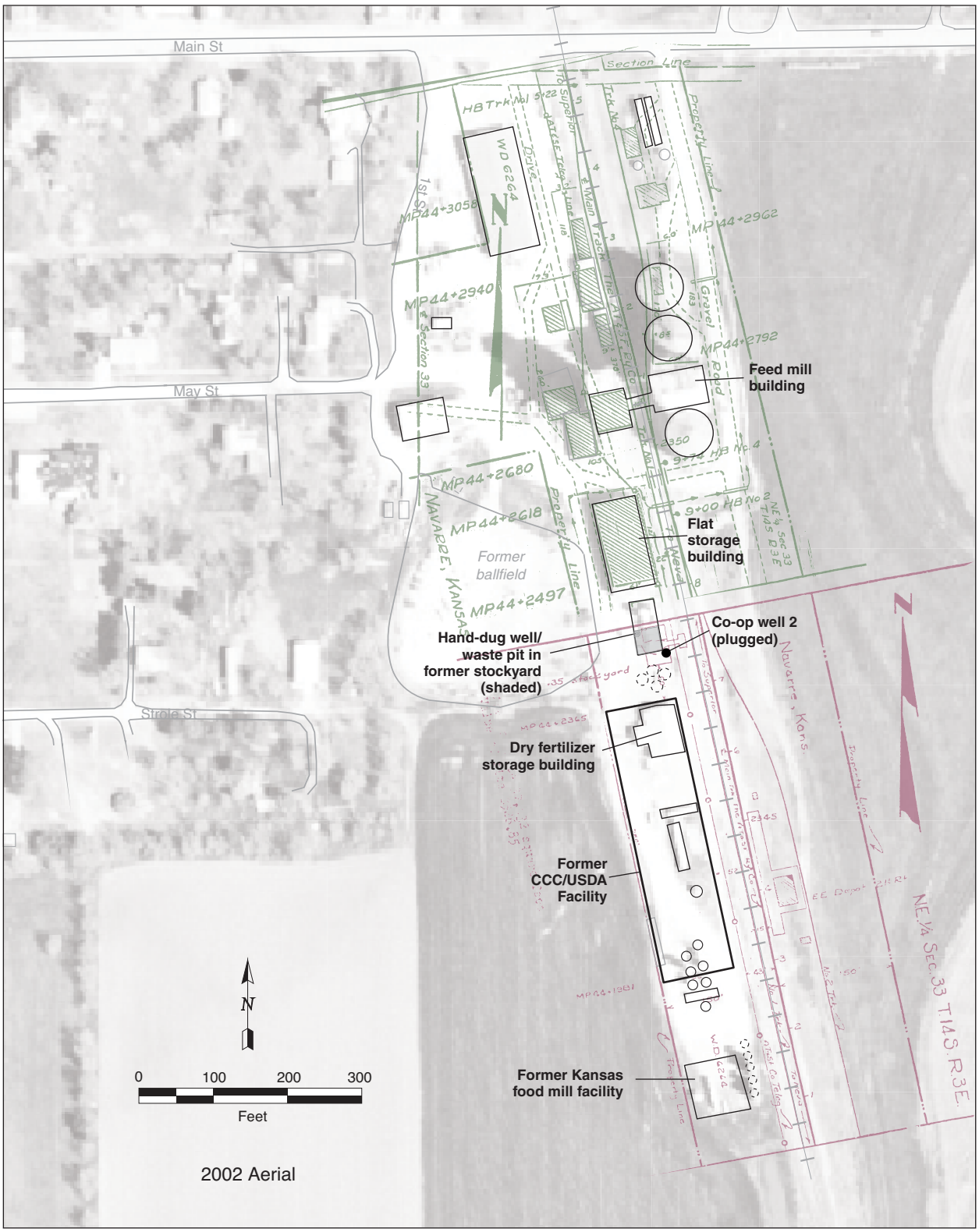

FIGURE 1.1 2002 aerial photo of Navarre overlain with historic lease data (1960, green; 1954, purple). Source of photograph: NAIP (2002).

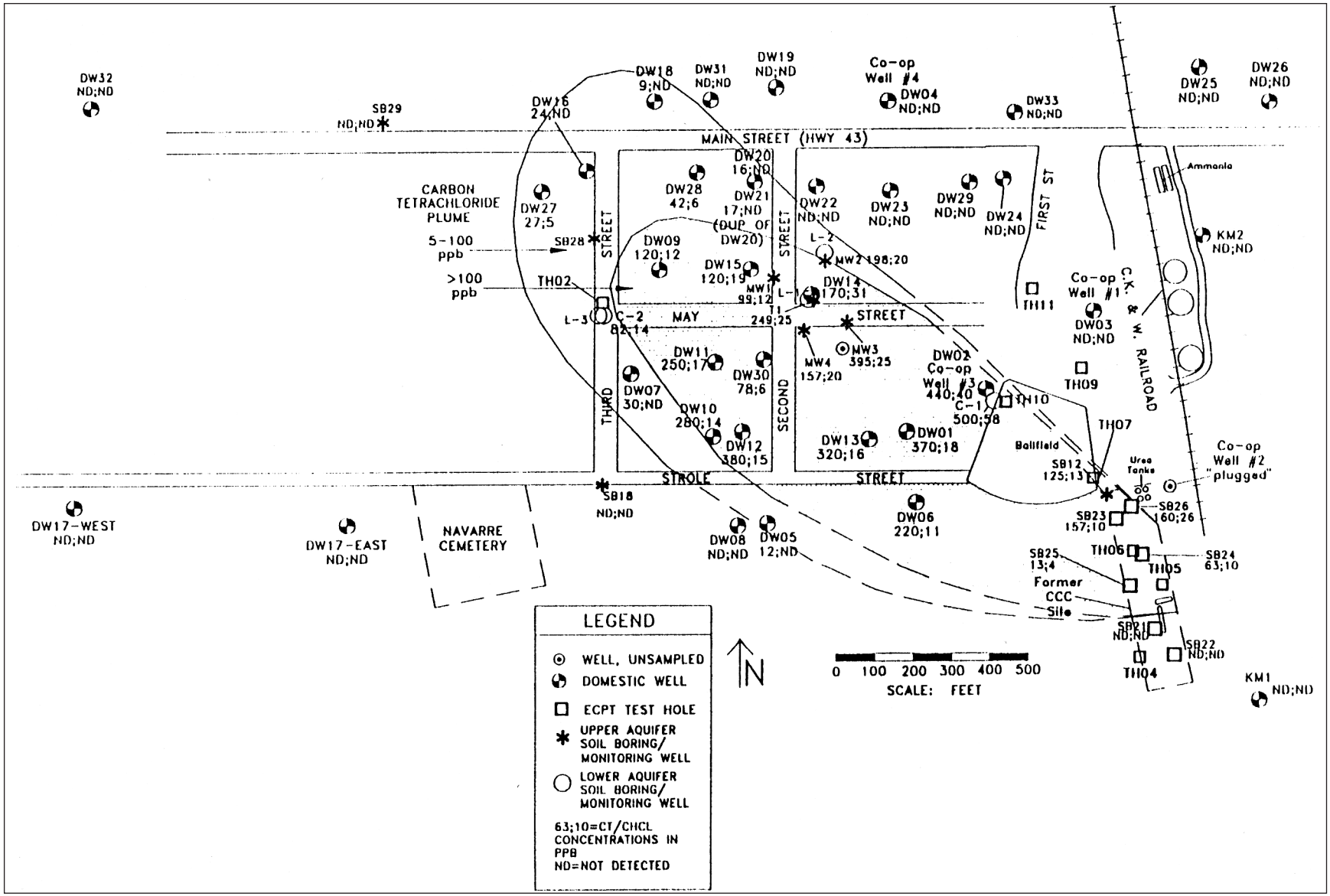

FIGURE 1.2 The spatial distribution of the carbon tetrachloride plume in groundwater at Navarre, based on August 1992 and April 1993 sampling results (Argonne 1995).

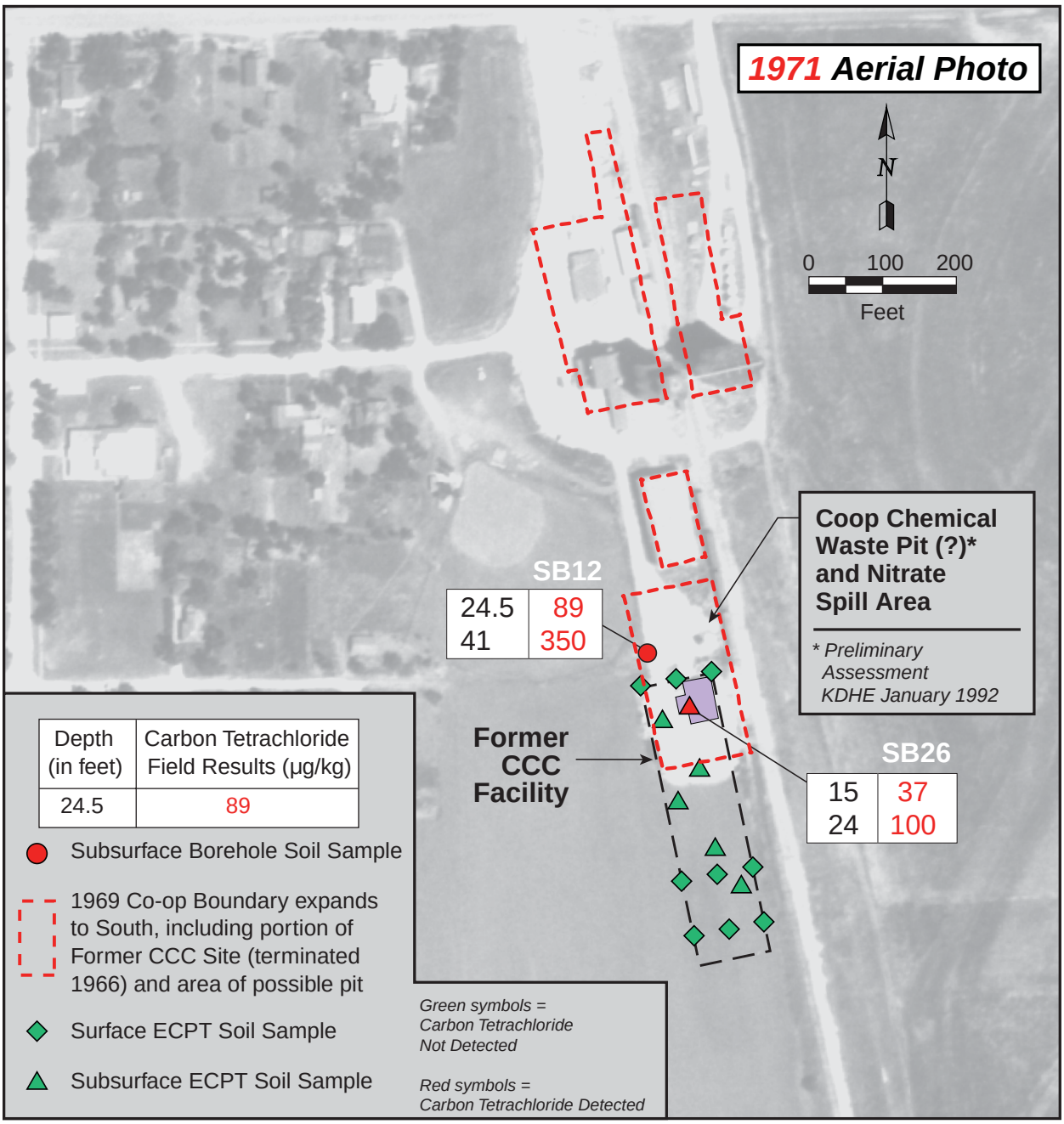

FIGURE 1.3 Soil sampling results from Argonne's 1993 investigation (Argonne 1995). Source of photograph: USDA (1971).

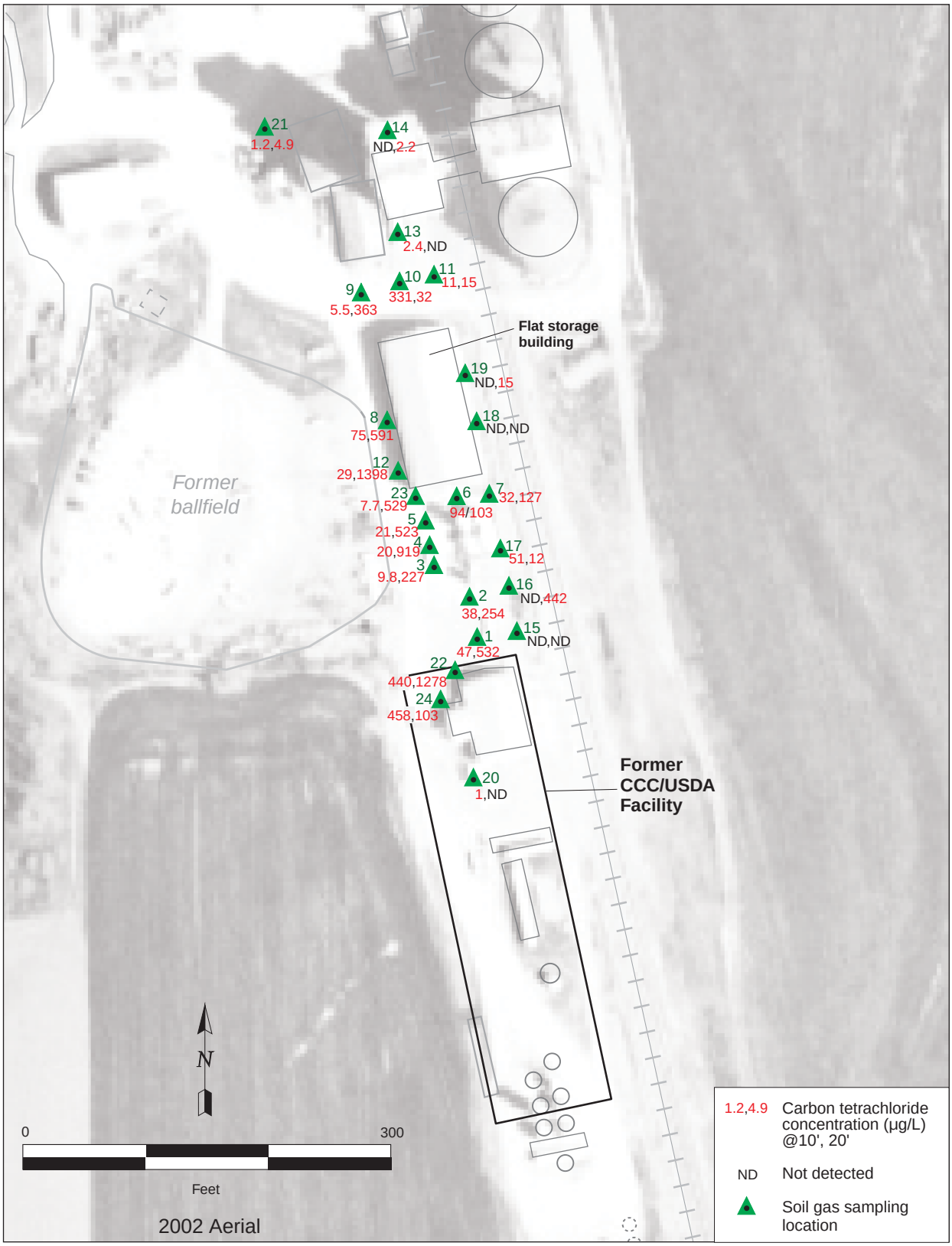

FIGURE 1.4 Results of Papadopulos soil gas sampling (shown on an Argonne base map), 2000. Source of photograph: NAIP (2002).

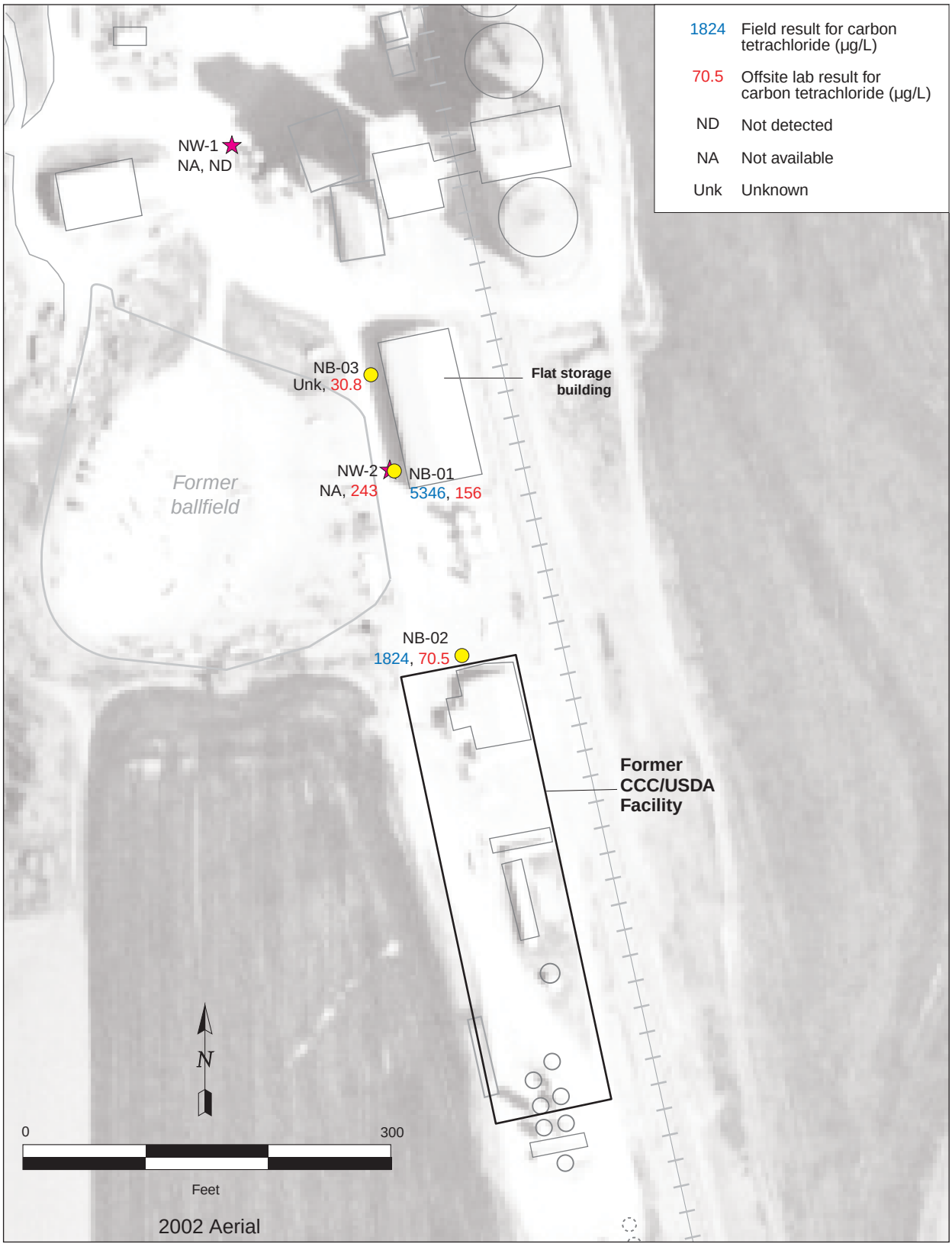

FIGURE 1.5 Field and laboratory results for carbon tetrachloride in groundwater reported in the 2000 Papadopulos study. Source of photograph: NAIP (2002).

2 Recommended Investigation

2.1 Areas of Concern to the CCC/USDA

The following areas of the former CCC/USDA and Co-op properties are of particular concern to the CCC/USDA (Figure 1.1 and Figure 2.1):

- **Former CCC/USDA property.** Historical investigations of the former CCC/USDA property indicated carbon tetrachloride contamination in soil and groundwater samples collected at various locations on the property. Additional investigation is warranted to generate current analytical data and to determine the full extent of contamination detected during previous investigations.

- **Flat Storage Building, Built in 1957.** The highest contaminant levels found to date (Figures 1.4 and 1.5 in Papadopulos 2000) occurred south of the FSB and north of the former CCC/USDA facility. The investigation proposed by the Co-op in 2005 was limited to two soil sampling locations along the west and north sides of the FSB. Four soil samples were to be collected at various depths at each location. The sample locations indicated in the Co-op's 2005 work plan (Figure 12 in iSi 2004) were not in the immediate vicinity of the areas that had previously exhibited elevated levels of carbon tetrachloride contamination. In addition, groundwater samples were not to be collected. Further investigation near the FSB is warranted to generate current analytical data for soil and groundwater in areas that have historically exhibited carbon tetrachloride contamination, as well as to fill existing data gaps.

- **Waste Pit between the Flat Storage Building and the Location of the Plugged Co-op Well #2.** The Papadopulos study confirmed carbon tetrachloride contamination north of the former CCC/USDA facility, near the FSB (Figures 1.4 and 1.5 in Papadopulos 2000). In addition, Co-op well #2, which was located between the former CCC/USDA property and the FSB, exhibited an elevated level of carbon tetrachloride in a groundwater sample collected in 1991. The well was plugged that same year. The Co-op's 2005 proposed investigation included collection of soil samples at one location near the waste

pit but no groundwater samples. Further investigation in this area is warranted to generate current analytical data for soil and groundwater in locations that have historically exhibited carbon tetrachloride contamination, as well as to fill existing data gaps.

- **Feed Mill Building.** The current Co-op manager indicated that the feed mill building area was used to store carbon tetrachloride and to fumigate grain stored in rail cars. Only limited investigation has been conducted near the feed mill. Furthermore, the Co-op's 2005 investigation proposed only three locations for soil sampling in this area. No groundwater samples were proposed. Additional investigation in this area is warranted to generate current analytical data for soil and groundwater in locations where carbon tetrachloride is known to have been used and stored, as well as to fill existing data gaps.

- **Dry Fertilizer Storage Building.** This dry fertilizer storage building is along the north edge of the former CCC/USDA property. Historical investigations have indicated carbon tetrachloride contamination in soil and groundwater samples collected near the building. Only limited soil sampling of this area was proposed during the Co-op's 2005 investigation. Further investigation here is warranted to generate current analytical data, as well as to fill existing data gaps.

- **Lower Aquifer.** The lower aquifer is an area of concern, because only limited investigation has been conducted in this zone. Historical investigations have indicated carbon tetrachloride contamination in the lower aquifer at locations downgradient of the Co-op and former CCC/USDA properties. No investigation of this zone has occurred on either property. Further investigation is warranted to determine whether a source for the carbon tetrachloride exists on either property.

2.2 Phases of Investigation

The CCC/USDA recommends that the investigation at Navarre be accomplished in four phases. A summary of the proposed phases of investigation at Navarre is as follows:

- **Phase 1.** Determine groundwater contaminant levels and the groundwater flow direction in the entire study area through groundwater sampling and manual measurement of water levels in existing wells. Initiate long-term water level monitoring in a network of existing wells.

- **Phase 2.** Conduct subsurface soil and groundwater sampling to augment Argonne's earlier studies at the former CCC/USDA facility and confirm the results with today's more rigorous analytical methods. The objective is to identify potential soil source areas and pathways for contaminant migration to groundwater.

- **Phase 3.** Investigate the areas of specific concern to the CCC/USDA that are outside the former CCC/USDA facility and are currently on Co-op property. These are the FSB, a waste pit located between the FSB and the location of the plugged Co-op well #2, and the feed mill building.

- **Phase 4.** If a source of contamination is found at the former CCC/USDA facility, propose additional work (in consultation with the CCC/USDA and KDHE project managers) to determine the horizontal and vertical extent of contamination emanating from that source area.

2.2.1 Phase 1

Phase 1: *Determine groundwater contaminant levels and the groundwater flow direction in the entire study area through groundwater sampling and manual measurement of water levels in existing wells. Initiate long-term water level monitoring in a network of existing wells.*

Proposed monitoring well sampling locations are shown in Figure 2.2. Activities related to groundwater sampling and groundwater level monitoring in ***Phase 1*** of the investigation are as follows:

- Prior to any subsurface exploration of the former CCC/USDA facility, manual measurements of water levels will be recorded in all USDA monitoring wells, including MW1, MW2, MW3, MW4, T1, L-1, L-2, and L-3; Co-op wells Co-op #1 and Co-op #3; Papadopulos wells NW-1 and NW-2; and KDHE monitoring wells KDHE-1 and KDHE-2. The data collected will be used to establish the current local groundwater flow direction. A degree of uncertainty regarding the interval screened in several of the monitoring points needs resolution. Therefore, a critical objective of Phase 1 will be to determine the well depths and stratigraphic intervals in which these wells are screened. Currently available information indicates that wells L-1, L-2, and L-3 are completed in the lower aquifer. The Co-op wells may be completed in the lower aquifer; however, this is not verified at present. All other wells listed here are completed in the upper aquifer.

- The monitoring wells listed above will be sampled for analyses for volatile organic compounds (VOCs) after water level measurements are recorded. Prior to sample collection, the wells will be purged until the field parameters of pH, temperature, and conductivity are stable. If possible, a minimum of three well volumes of water will be purged from each well. Wells that are purged dry in this process will be sampled after adequate recharge has occurred, but no more than 24 h after the initial purging.

- Automatic water level recorders will be installed in a network of existing monitoring wells (to be identified in consultation with the CCC/USDA and KDHE project managers) for long-term water level monitoring. At a minimum, a one-year monitoring period is suggested to document seasonal changes in groundwater flow. After the initial monitoring period, the groundwater level data will be evaluated and compared with the analytical data at each installation to aid in determining whether additional monitoring or an extension of the existing monitoring network is warranted.

Upon completion of ***Phase 1***, the investigation will proceed to ***Phase 2*** on the property identified as the original CCC/USDA leasehold.

2.2.2 Phase 2

Phase 2: *Conduct subsurface soil and groundwater sampling to augment Argonne's earlier studies at the former CCC/USDA facility and confirm the results with today's more rigorous analytical methods. The objective is to identify potential soil source areas and pathways for contaminant migration to groundwater.*

The cone penetrometer (CPT) will be used initially to collect soil and groundwater samples from the upper aquifer — and the lower aquifer, if penetration is achieved. If subsurface conditions are such that the CPT cannot push to the deeper horizons, conventional drilling methods will be used to collect samples from the lower aquifer. If conventional drilling methods are required to investigate the lower aquifer, the number of locations investigated will be determined by the CCC/USDA and KDHE project managers on the basis of available data. The goal of investigating the lower aquifer is to determine whether carbon tetrachloride contamination is present. Sample locations in the lower aquifer will be determined after the upper aquifer has been investigated for possible source areas. The CCC/USDA and KDHE project managers will be consulted to determine the appropriate locations for investigating the lower aquifer. Samples will be collected according to procedures detailed in the Master Work Plan (Argonne 2002). Activities will be as follows:

- An initial borehole will be advanced at the former CCC/USDA facility. Electronic data collected from this initial borehole will define the detailed site lithology and determine the potential depth limitations of the CPT. After collection of electronic data, soil samples will be collected for lithologic analysis by continuous coring to the base of the upper aquifer at an offset hole approximately 1 ft from the original location. Penetration will stop at the point of refusal or the base of the upper aquifer. A series of locations will be tested in this way to establish a vertical profile of potential groundwater contamination in the upper aquifer. Vertical profiles of groundwater will be collected at 5-ft intervals to the top of the confining layer that separates the upper and lower aquifers.

- Upon completion of the initial borehole, electronic data and vertical profiles of soil and groundwater samples at up to 11 additional locations at the former CCC/USDA facility will be collected for chemical analyses and lithologic evaluation. Figure 2.2 shows the proposed locations. Vertical soil profiles will be collected from the proposed boreholes at 5-ft intervals to the top of the

upper aquifer. Vertical groundwater profiles will be collected from the proposed boreholes at 5-ft intervals from the top of the upper aquifer to the top of the confining layer that separates the two aquifers.

- Organic chemical analyses will be conducted on the soil and groundwater samples, and selected soil samples will be subjected to hydrogeologic testing and grain size analysis.

- As results are received in the field, adjustments will be made to sample locations, the number of samples, and sampling intervals in consultation with the CCC/USDA and KDHE project managers.

- KDHE and Co-op representatives will have the opportunity to observe investigational field activities and to collect sample splits as appropriate.

- Long-term monitoring wells will be installed in all boreholes into the lower aquifer that must be drilled by using conventional methods. Well installation and completion will be in accordance with the procedures in Sections 2.3.2 and 2.3.3.

Upon completion of ***Phase 2,*** the investigation will be expanded to ***Phase 3***.

2.2.3 Phase 3

Phase 3: *Investigate the areas of specific concern to the CCC/USDA that are outside the former CCC/USDA facility and are currently on Co-op property. These are the FSB, a waste pit located between the FSB and the location of the plugged Co-op well #2, and the feed mill building.*

Vertical-profile soil and groundwater sampling will be conducted at each of the identified areas of concern. Specific activities will be as follows:

- Electronic data and soil samples will be collected at 5-ft intervals from ground surface to the top of the upper aquifer, and groundwater samples will be collected at 5-ft intervals from the top of the upper aquifer to the top of the confining layer that separates the upper and lower aquifers. Samples will be collected for organic chemical analyses and lithologic evaluation at

22 locations in the specific areas of concern. Figure 2.2 shows these proposed locations. Both soil and groundwater sampling will be attempted at every location near potential source areas, while locations more distant from these areas may be sampled only for groundwater. As the investigation proceeds and results are received in the field, alterations in the optimal locations for soil and groundwater samples may be needed. Alterations will be determined in consultation with CCC/USDA and KDHE project managers.

- Vertical-profile groundwater samples and some soil samples will be collected at up to 13 additional locations upgradient and downgradient from the areas of concern. Samples will be collected for organic chemical analyses and lithologic evaluation. This sampling will ensure that the full vertical and horizontal extent of contamination is determined. Figure 2.2 shows the proposed locations. Vertical soil profiles will be collected from selected boreholes at 5-ft intervals to the top of the upper aquifer. The locations chosen for this task will be determined after analytical results from samples collected in the areas of concern are evaluated and discussed with the CCC/USDA and the KDHE project managers. Vertical groundwater profiles will be collected from all proposed boreholes at 5-ft intervals from the top of the upper aquifer to the top of the confining layer that separates the two aquifers.

- Investigation of the lower aquifer at locations outside the former CCC/USDA property will proceed only if contamination is detected in the lower aquifer on the former CCC/USDA property. The goal of investigating the lower aquifer will be to determine the extent of contamination associated with carbon tetrachloride use on the former CCC/USDA property. If conventional drilling methods are needed to complete this task, the number of locations investigated will be determined by the CCC/USDA and KDHE project managers on the basis of available data. Sample locations in the lower aquifer will be determined after the upper aquifer has been investigated for possible source areas. The CCC/USDA and KDHE project managers will be consulted to determine the appropriate locations for investigating the lower aquifer.

- Long-term monitoring wells will be installed in all boreholes into the lower aquifer that must be drilled by using conventional methods. Well installation

and completion will be in accordance with the procedures in Sections 2.3.2 and 2.3.3.

Depending on the results from the initial phases, the investigation may expand to ***Phase 4***.

2.2.4 Phase 4

Phase 4: *If a source of contamination is found at the former CCC/USDA facility, propose additional work (in consultation with the CCC/USDA and KDHE project managers) to determine the horizontal and vertical extent of contamination emanating from that source area.*

If the groundwater analytical data collected in ***Phase 2*** and ***Phase 3*** indicate that contamination associated with a potential source area on the former CCC/USDA facility has migrated off that property, additional work will be proposed. This work will include the following tasks:

- Vertical-profile soil and groundwater sampling will be conducted with the CPT or conventional drilling equipment as necessary to further delineate the horizontal and vertical extent of contamination.

- Monitoring wells will be installed at select locations and depths (upper or lower aquifer or both) determined in consultation with the CCC/USDA and KDHE project managers, to the extent necessary to accomplish investigational goals. The lower aquifer will be investigated only if groundwater contamination is detected in samples collected from the lower aquifer on the former CCC/USDA property. Soil and groundwater sampling will be conducted during well installation.

- Organic chemical analyses will be conducted on soil and groundwater samples, and selected soil samples will be subjected to hydrogeologic testing and grain size analysis. The number of monitoring wells and their locations will be determined after analytical results from the initial phases are evaluated. The proposed locations will be mutually agreed upon by the CCC/USDA and the KDHE project managers.

- A plan for periodic sampling of a network of newly installed wells and existing monitoring wells will be prepared and submitted for KDHE approval.

During all phases of the recommended investigation, the CCC/USDA and KDHE project managers will be kept apprised of the results. Any modifications to the plans described here will be discussed and mutually agreed upon by the CCC/USDA and the KDHE.

2.3 Investigation Methods

The investigation at Navarre will be conducted in accordance with procedures in the *Master Work Plan* (Argonne 2002), which provides details concerning investigation procedures at former CCC/USDA facilities in Kansas and has been approved by the KDHE.

Acquiring the data needed to meet the goals of this investigation will require the collection of groundwater level measurements, soil samples, and groundwater samples. The samples collected will be analyzed for organic compounds, as well as for lithologic and hydrogeologic properties.

Several phases of work are proposed. Data collected during each phase will be evaluated to guide the subsequent phase. The CCC/USDA and KDHE project managers will be contacted during each phase and kept apprised of the results. Details concerning of each phase of work will be discussed and mutually agreed upon by the CCC/USDA and KDHE.

2.3.1 Soil and Groundwater Sampling

Initial attempts to collect soil and groundwater samples in the upper aquifer will be made with the CPT. If refusal is encountered in any hole, alternate drilling methods — either hollow-stem auger (HSA) or air rotary methods — will be implemented. The lower aquifer is expected to be explored by using the alternate drilling methods.

Soil samples collected with the CPT for vertical-profile chemical analyses will be taken at intervals of 5 ft or less, from the ground surface to the top of the upper aquifer saturated zone. Vertical profile groundwater samples collected from the upper aquifer with the CPT will be taken at 5-ft intervals to the confining layer. The CPT will also be used for electronic logging

from ground surface to the base of the upper aquifer or to refusal. The analytical and electronic data will provide information on the vertical and horizontal distribution of potential contaminants and will identify lithologic units.

Soil and groundwater sampling will also be conducted during all well drilling activities. When possible, soil samples will be collected by using a continuous core barrel. At a minimum, soil samples for chemical analyses will be collected every 5 ft to the top of the upper aquifer. Attempts will be made to core and sample the lower aquifer similarly. If continuous coring is not successful in the lower aquifer, samples for lithologic analysis can be collected from cuttings as they reach the surface, but the contaminant levels might not be representative of site conditions.

2.3.2 Well Installation

Procedures for monitoring well installation in the upper and lower aquifers are described below.

2.3.2.1 Monitoring Well Installation in the Upper Aquifer

After the collection and evaluation of initial soil and groundwater data from the upper aquifer, small-diameter monitoring wells may be installed at selected locations. Upper aquifer monitoring wells/piezometers installed by using the direct-push capabilities of the CPT will be advanced to the top of the confining layer that separates the upper and lower aquifers. In accordance with KDHE regulations, well installation methods will include use of the CPT to advance a 4.25-in.-diameter borehole to a depth of 20 ft below ground level (BGL). From 20 ft BGL to the base of the upper aquifer, a 3.25-in.-diameter hole will be pushed to the desired depth.

2.3.2.2 Monitoring Well Installation in the Lower Aquifer

If penetration with the CPT is feasible, the CPT will be used for well installation in the lower aquifer.

If penetration with the CPT is not feasible, lower aquifer monitoring wells will be installed by using a drill rig with HSA or air rotary methods or both. Drilling will proceed to the top of the confining layer that separates the lower and upper aquifers. The lower aquifer will be explored by using air rotary drilling methods. Drilling into the lower aquifer will require the setting of intermediate casing to seal the upper aquifer and prevent potential communication between the two aquifers.

To set intermediate casing, a borehole with a diameter of at least 10 in. will be drilled to the top of the confining layer that separates the upper and lower aquifers. The borehole through the upper aquifer will be drilled and cased with steel casing at least 6 in. in diameter, set from ground surface to a point slightly below the top of the confining layer. The annular space of the casing will be filled with bentonite or other KDHE-approved grout material, placed from the bottom to the top of the hole by using a tremie pipe. The grout will be allowed to cure adequately before drilling proceeds into the lower aquifer.

Below the intermediate casing, drilling will continue to a depth that ensures adequate penetration of the lower aquifer. Drilling and well completion will be conducted with these methods in accordance with KDHE regulations and will follow the procedures detailed in the *Master Work Plan* (Argonne 2002).

2.3.3 Well Completion

All *upper aquifer* monitoring wells/piezometers installed with direct-push technology will be cased with 1-in.-diameter, Schedule 40 polyvinyl chloride (PVC) with a 0.010-in. slotted screen.

Drilled monitoring wells in the *lower aquifer* will be cased with 2-in.-diameter, Schedule 40 PVC with 0.010-in. slotted screen. Casing centralizers will be used when necessary, and screen lengths and depths will be dictated by the aquifer thickness and analytical data from groundwater samples collected during the initial sampling. The exact screen depth intervals will be determined in consultation with the CCC/USDA and KDHE project managers.

Appropriate quantities of sand and grout will be used to complete each well properly. A tremie pipe will be used to ensure that materials are placed properly in all annular spaces. Wells will be completed flush to the ground where necessary. All other wells will be completed above

grade. Well completions will conform to KDHE regulations and will be conducted in accordance with procedures detailed in the *Master Work Plan* (Argonne 2002).

2.3.4 Sample Handling and Analysis

Soil and groundwater samples will be collected in laboratory-approved containers and shipped overnight to the Applied Geosciences and Environmental Management (AGEM) Laboratory at Argonne. Before shipment, soil samples will be preserved on dry ice, and groundwater samples will be preserved on ice. The soil samples will be analyzed for carbon tetrachloride and chloroform by using a gas chromatograph-mass spectrometer system, according to U.S. Environmental Protection Agency Methods 5030B and 8260B (http://www.epa.gov/epahome/index/). Groundwater samples will be analyzed at the AGEM Laboratory for VOCs, including carbon tetrachloride, chloroform, and methylene chloride. Confirmation samples will be shipped to a certified reference laboratory for verification analyses, as appropriate. In addition, selected groundwater samples will be analyzed for cations and anions and for evidence of natural attenuation. Hydrogeologic testing will be conducted on selected soil samples. Proposed tests include porosity, organic carbon content, dry bulk density, and grain size.

2.3.5 Reporting Requirements

Argonne will develop a comprehensive report upon the completion of field activities and after the data have been received and evaluated. The report will include documentation and discussions of all field activities and analytical data.

2.3.6 Access Issues

Access to the Co-op and railroad properties will be required to complete this investigation. The CCC/USDA will request access from the property owners; however, previous attempts to gain access to conduct investigations on these properties have met with limited success. If access if denied, the CCC/USDA will request assistance from the KDHE project manager.

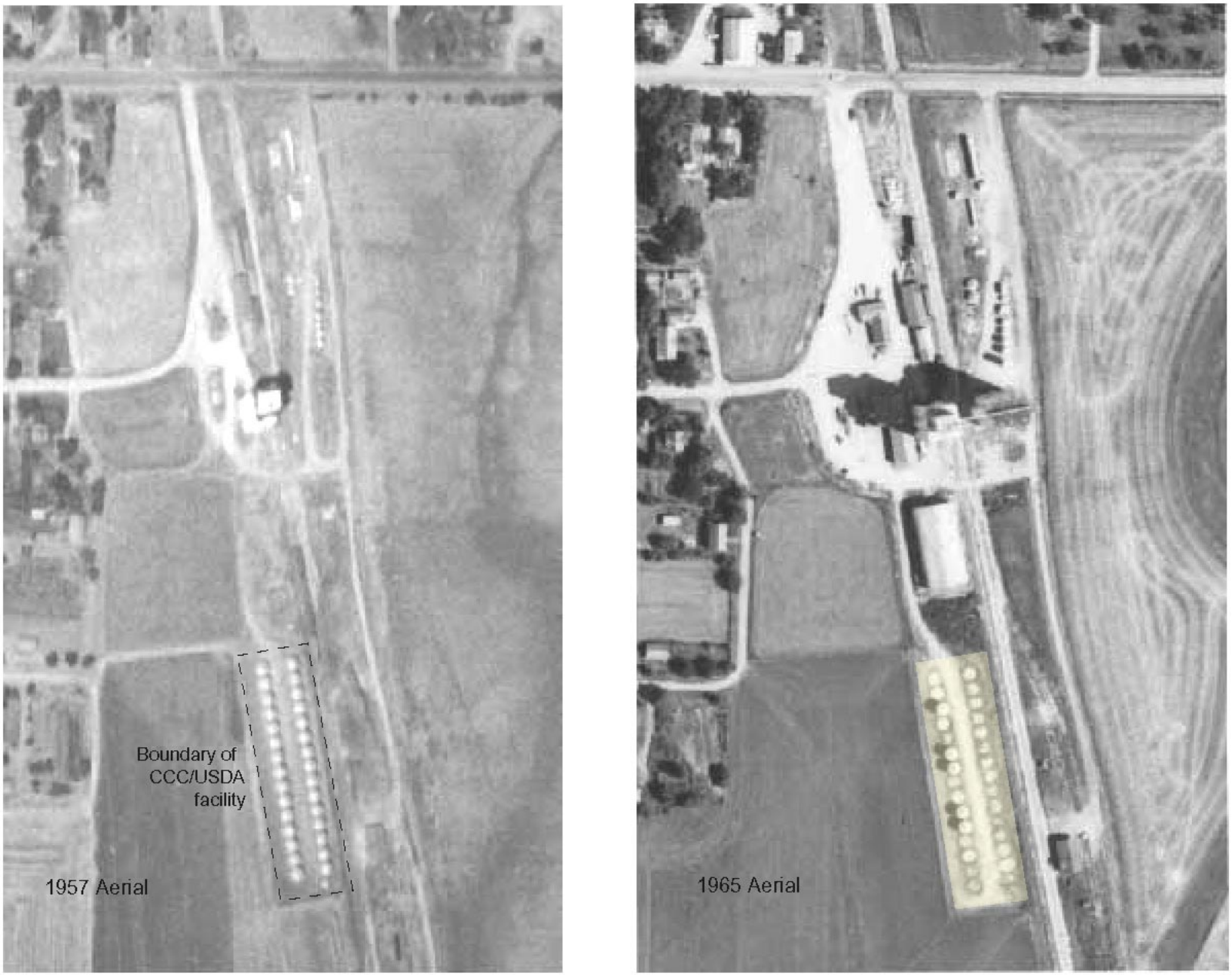

FIGURE 2.1a Navarre, 1957 and 1965. Sources of photographs: USDA (1957, 1965).

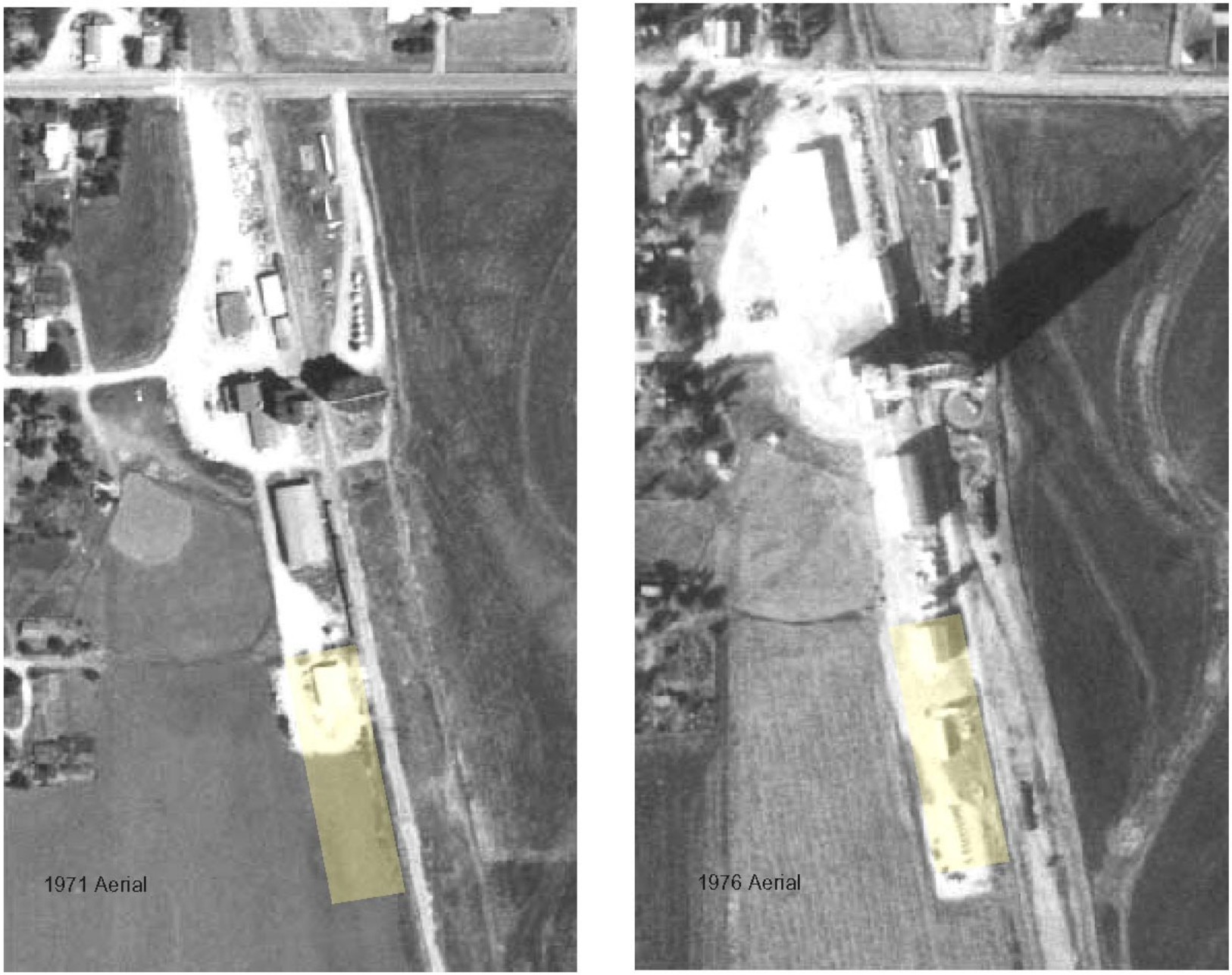

FIGURE 2.1b Navarre, 1971 and 1976. Sources of photographs: USDA (1971, 1976).

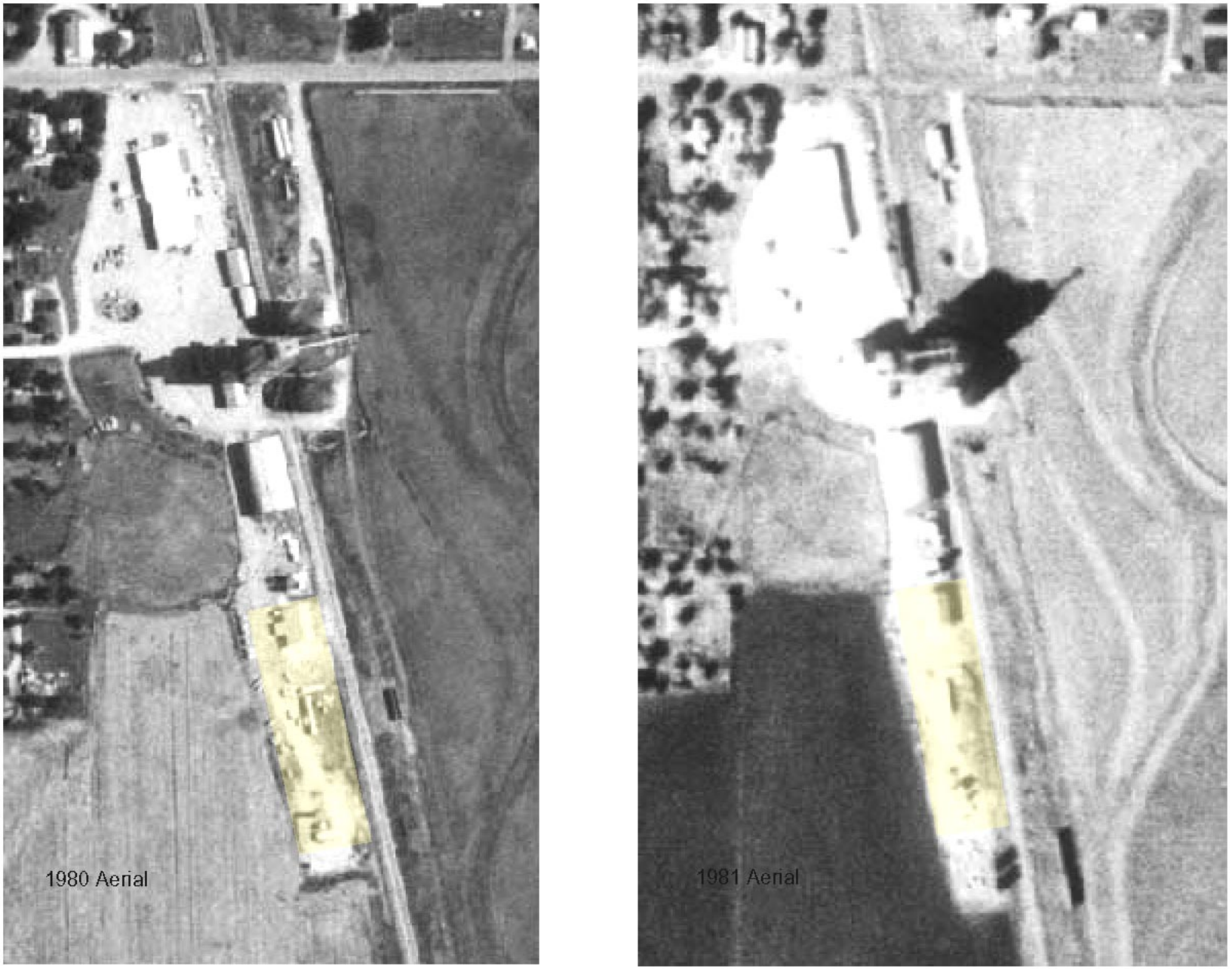

FIGURE 2.1c Navarre, 1980 and 1981. Sources of photographs: USDA (1980, 1981).

FIGURE 2.1d Navarre, 1985 and 1991. Sources of photographs: USDA (1985) and USGS (1991).

FIGURE 2.1e Investigation area at Navarre, 2002. Source of photograph: NAIP (2002).

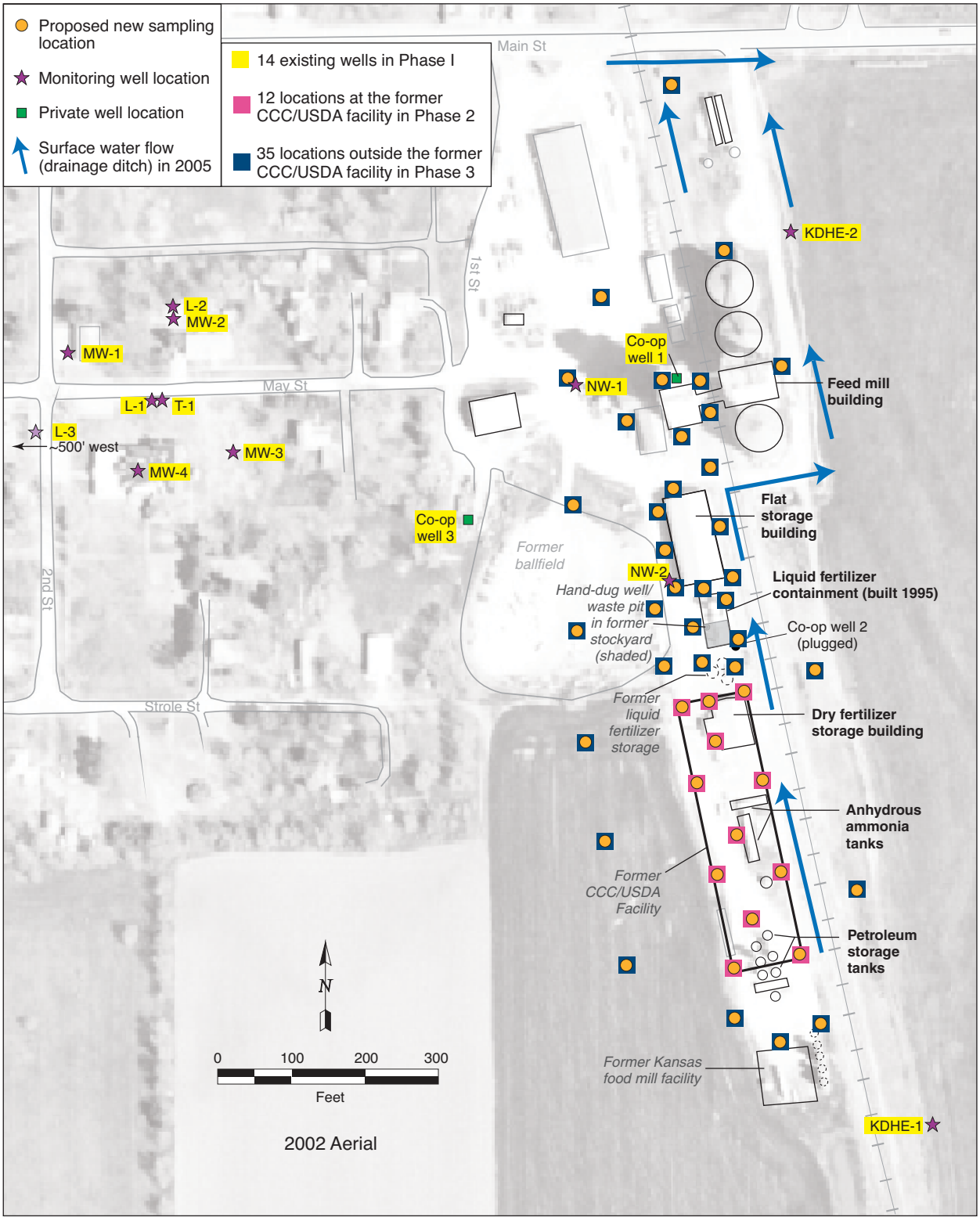

FIGURE 2.2 Proposed CCC/USDA–Argonne sampling locations at Navarre. Source of photograph: NAIP (2002).

3 References

Alvarado, J.S., and C. Rose, 2004, "Static Headspace Analysis of Volatile Organic Compounds in Soil and Vegetation Samples for Site Characterization," *Talanta* 62:17–23.

Argonne, 1993, *Final Report: Expedited Site Characterization, Navarre, Kansas*, prepared for the Commodity Credit Corporation, U.S. Department of Agriculture, by Argonne National Laboratory, Argonne, Illinois, December.

Argonne, 1995, *Final Feasibility Study for Remedial Action at Navarre, Kansas*, prepared for the Commodity Credit Corporation, U.S. Department of Agriculture, by Argonne National Laboratory, Argonne, Illinois, February.

Argonne, 2002, *Final Master Work Plan: Environmental Investigations at Former CCC/USDA Facilities in Kansas, 2002 Revision*, ANL/ER/TR-02/004, prepared for the Commodity Credit Corporation, U.S. Department of Agriculture, by Argonne National Laboratory, Argonne, Illinois, December.

iSi, 2004, *Carbon Tetrachloride Comprehensive Investigation Work Plan (Revision 1) for the North Central Kansas Cooperative, Navarre Branch, Navarre, Kansas*, Integrated Solutions, Inc., Wichita, Kansas, August 31.

KDHE, 1992, *Preliminary Assessment: Navarre Groundwater Site, Navarre, Kansas*, Bureau of Environmental Remediation, Kansas Department of Health and Environment, Topeka, Kansas, January.

NAIP, 2002, aerial photograph of Navarre, Kansas, National Agricultural Imagery Program, U.S. Department of Agriculture, http://www.apfo.usda.gov/NAIP.html.

Papadopulos, 2000, (draft) *Geoprobe® Assessment Report, Coop Facility, Navarre, Kansas*, Terracon Project No. 01007102, prepared by Terracon, Lexena, Kansas, for S.S. Papadopulos and Associates, Bethesda, Maryland, and for the U.S. Department of Justice, November 17; transmitted to Argonne National Laboratory December 4, 2000.

USDA, 1957, aerial photograph AYH-2T-127, U.S. Department of Agriculture, July 13.

USDA, 1965, aerial photograph AYH-4FF-101, U.S. Department of Agriculture, August 12.

USDA, 1971, aerial photograph AYH-3MM-147, U.S. Department of Agriculture, June 28.

USDA, 1976, aerial photograph 20041 176 11L, U.S. Department of Agriculture, October 31.

USDA, 1980, aerial photograph 20041 180 71A, U.S. Department of Agriculture, June 14.

USDA, 1981, aerial photograph HAP81 171 183L, U.S. Department of Agriculture, September 27.

USDA, 1985, aerial photograph NHAP2 21 46L, U.S. Department of Agriculture, May 25.

USGS, 1991, aerial photograph of Navarre, Kansas, U.S. Geological Survey, October 1.

Appendix A:

Construction Details for Monitoring Wells at Navarre, Kansas

TABLE A.1 Construction details for monitoring wells at Navarre, Kansas, as reported in investigation reports and as recorded in the state water well construction database.[a]

			Details from Construction Diagrams and Text in Reports					Details from WWC-5 Registration Database			
Well	Installation Date	Driller	Well Depth (ft BGL)	Screen Length[b] (ft)	Screen Interval (ft BGL)	Filter Interval (ft BGL)	Casing Diameter (in.)	KGS[c] Registration No.	Well Depth (ft BGL)	Screen Interval (ft BGL)	Filter Interval (ft BGL)
Wells Installed during KDHE Preliminary Assessment (reported in KDHE 1992)[d]											
KDHE-1	6/13/1991	NR[e]	–	20	–	–	2	11591	45	25–45	21–45
KDHE-2	6/12/1991	NR	–	20	–	–	2	11592	55	35–55	25–55
Wells Installed during Argonne Phase II Investigation (reported in Argonne 1993)[f]											
T-1	3/30/1993	Layne-Western	65	20	40–60	37–65	6	316460	Same[g]	Same	Same
MW1	4/2/1993	Layne-Western	59	15	43–58	40–59	2	316456	Same	Same	Same
MW2	4/3/1993	Layne-Western	60	15	42.8–57.8	38.5–60	2	316457	57.8	Same	Same
MW3	4/2/1993	Layne-Western	60	15	44–59	41–60	2	316458	59.8	Same	Same
MW4	4/3/1993	Layne-Western	60	15	45–60	41–60	2	316459	Same	Same	Same
Wells Installed during Argonne Feasibility Study (reported in Argonne 1995)[h]											
L-1	3/4/1994	Layne-Western	95	20	75–95	72–95	4	11595	Same	Same	Same
L-2	3/4/1994	Layne-Western	90	10	80–90	73–90	2	11594	Same	70–90	67–90
L-3	3/4/1994	Layne-Western	90	10	80–90	77.5–90	2	11593	Same	70–90	67–90
Wells Installed during Papadopulos Investigation (reported in Papadopulos 2000)[i]											
NW-1	10/25/2000	Terracon	53	10	40–50	39–50	2	318194	35	25–35	22–35
NW-2	10/27/2000	Terracon	48	10	35.5–45.5	34.5–45.5	2	318063	53	40–53	41–53
NW-3	10/26/2000	Terracon	51	10	38–48	36–48	2	318064	48	40–50	38–50
NW-4	10/28/2000	Terracon	50	10	33.5–43.5	33–43.5	2	318065	NR	NR	NR

[a] Co-op well 1 and Co-op well 3 were not found in the WWC-5 registration database. Construction details are unknown.

[b] Screen lengths for all wells are from Table 3 in Papadopulos (2000).

[c] KGS, Kansas Geological Survey.

[d] Well installation and sampling were reported by the KDHE (1992), but the depth and the screen and filter intervals were not documented. The registered well depth and screen intervals are assumed to be correct. Casing diameters were registered as 2 in.

[e] NR, not reported.

[f] Well construction diagrams for these shallow aquifer wells in Argonne (1993) are consistent with the WWC-5 database, with two minor exceptions related to well depths.

[g] Same as data in the investigation report.

[h] Construction diagrams for these three lower aquifer wells are in Appendix A of Argonne (1995). The original field log for well construction is on file. The report (Argonne 1995) says that L-1 has a 20-ft screen, while L-2 and L-3 both have 10-ft screens. Registration details for L-2 and L-3 do not correspond to the well construction diagrams, and which registration form belongs to which well is uncertain. Well ownership was not registered correctly. Owner transfer forms from the Co-op to the CCC/USDA are on file but might not have been transmitted or processed.

[i] Well construction details are reported in Table 1 of Papadopulos (2000), and construction diagrams are in Appendix 1 of that report. Registered intervals do not correspond to the well construction diagrams (consistent with Table 1 and the field log) that are attachments to the registration forms. The WWC-5 form for NW-4 does not list the intervals.