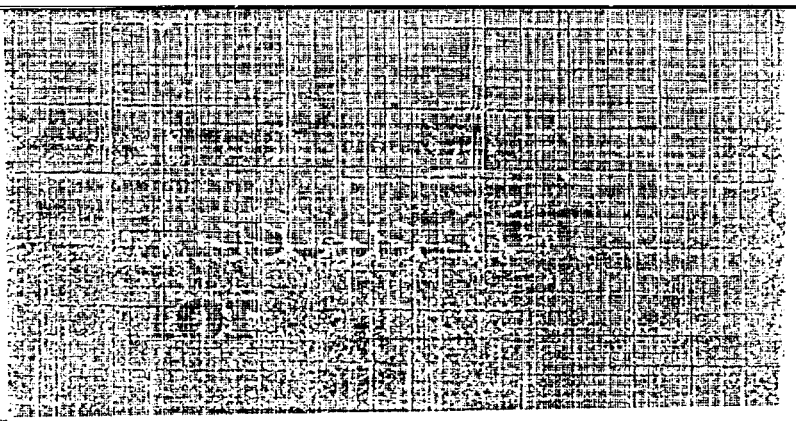

NEBRASKA ARMY ORDNANCE PLANT (FORMER)
MEAD, SAUNDERS COUNTY, NEBRASKA
CERCLIS NO. NE6211890011
APRIL 16, 1992

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

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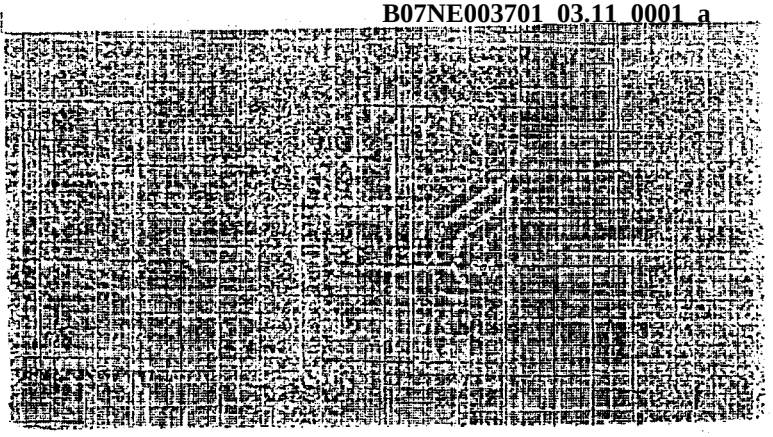

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PRELIMINARY PUBLIC HEALTH ASSESSMENT

NEBRASKA ARMY ORDNANCE PLANT (FORMER)

MEAD, SAUNDERS COUNTY, NEBRASKA

CERCLIS NO. NE6211890011

SUMMARY

The former Nebraska Ordnance Plant (NOP), a National Priorities List (NPL) site, is located in Saunders County, Nebraska. The plant assembled bombs from 1942 through 1945 and 1950 through 1956. Past waste disposal practices at NOP resulted in soil contamination with trinitrotoluene (TNT), cyclonite (RDX), and polychlorinated biphenyls (PCBs) and groundwater contamination with trichloroethylene (TCE), TNT, and RDX. In addition, the unused portions of the former manufacturing buildings contain steam pipes covered with frayed asbestos. From the available information, the Agency for Toxic Substances and Disease Registry concludes that the former Nebraska Ordnance Plant NPL site is a public health hazard because a risk to human health may exist from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Exposure to elevated levels of TCE and RDX has occurred in some on-site and off-site residents of the NOP site who used contaminated groundwater for drinking and bathing. This groundwater contamination could migrate into additional drinking water supplies in the future. Moreover, bioaccumulation of RDX in crops irrigated with contaminated water is another pathway of concern. Individuals could also have skin contact and ingestion exposures to RDX, TNT, and PCBs in on-site soils. The asbestos located in the unused manufacturing buildings is an additional public health hazard. Although there are indications that human exposure to on- and off-site contaminants occurred in the past, this site is not being considered for follow-up health activities at this time because no current exposure is occurring at levels of public health concern. However, if data become available suggesting that human exposure to hazardous substances at levels of public health concern is currently occurring, the Agency for Toxic Substances and Disease Registry will reevaluate this site for any indicated follow-up. ATSDR will continue coordination with the State of Nebraska Department of Health, the U.S. Environmental Protection Agency (EPA), and the Army Corps of Engineers to ensure provision of alternate water to the affected families. ATSDR will also continue to support protective actions taken by the proper authorities to mitigate the asbestos hazard.

BACKGROUND

A. Site Description and History

The former Nebraska Ordnance Plant (NOP) was a Department of Defense owned, contractor operated facility. NOP is located in Saunders County, Nebraska, near the city of Mead (See Appendix A, Figure I). The facility originally encompassed approximately 17,200 acres. NOP land is presently owned by the University of Nebraska (UN) (approximately 9,000 acres), the National Guard (approximately 2,100 acres), and other companies and individuals (approximately 6,100 acres). The UN property encompasses most of the land used to manufacture and store bombs (See Appendix A, Figure II). The other areas of bomb manufacture and storage are presently located on the National Guard property. The properties owned by other companies and individuals (approximately 6,100 acres) were not used extensively for bomb manufacturing.

NOP was originally constructed in 1941 to assemble bombs. Bombs were assembled from 1942 through 1945 and 1950 through 1956. The plant consisted of four bomb load lines, a bomb booster assembly area, a booster demolition area, waste explosive demolition areas (burning grounds), landfill, and support buildings. Most of the original buildings are still standing. The bombs were loaded with trinitrotoluene (TNT), Amatol (mixture of TNT and ammonium nitrate), Tritonal (80 percent TNT and 20 percent aluminum dust) and composition B (60 percent cyclonite (RDX) and 40 percent TNT). The only explosive produced on-site was ammonium nitrate. All the other explosives used at NOP were manufactured at other facilities and shipped to NOP.

Between 1946 and 1949, the NOP facility stored explosives. Fertilizer production was conducted at NOP from 1945 through 1950.

In 1959, the facility was declared excess to the Army needs. During the period 1962 to 1964, UN acquired approximately 9,000 acres for use as an agricultural research station. From 1959 through 1964 approximately 2,100 acres of the original NOP property was used by the U.S. Air Force for a missile site. This land is presently being used by the National Guard. The remaining portion of the former NOP was acquired by various individuals and private corporations.

The U.S. Army Toxic and Hazardous Materials Agency conducted the initial 1983 investigation of the extent of environmental contamination at the UN properties.[1] The UN property encompasses most of the land used to load bombs. The U.S. Army Corps of Engineers (Corps) is investigating the extent of environmental contamination at other portions of the former NOP (e.g., National Guard).

The Corps' investigation found off-site groundwater contamination in six residential wells in February 1989. The U.S. Environmental Protection Agency (EPA) began providing bottled water to one household in February 1989. Their two wells are contaminated above the safety standard established by EPA for drinking water (Safe Drinking Water Act Maximum Contaminant Level (MCL)

standards). In August 1989, the Corps assumed responsibility for the provision of bottled water to the household. The Corps has recently installed an activated carbon filtration system to treat the water before consumption at this location.

The EPA proposed to list NOP on the National Priorities List (NPL), "Superfund," on October 23, 1989 (Update 10). NOP was added to the NPL on August 30, 1990.

B. Site Visit

Mr. Sven E. Rodenbeck, Ms. Lynn G. Berlad, and Mr. Daniel M. Harper from the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a site visit on March 27-29, 1990. During the site visit, ATSDR staff met with representatives of the Nebraska Department of Health, the Nebraska Department of Environmental Control, the Lower Platte North Natural Resources District, the Lincoln Water System, the Lincoln-Lancaster County Health Department, UN, EPA, and the Corps. In addition, the ATSDR staff met with the family whose wells are contaminated with site-related substances above EPA MCL standards.

While at NOP, ATSDR staff scrutinized the areas of soil contamination (TNT, RDX, and polychlorinated biphenyls (PCBs)), the landfill, the burning areas, and the abandoned asbestos in the unused portions of the bomb manufacturing facilities. The areas of soil contamination are at discrete locations. The areas of TNT and RDX contamination are next to the load lines and are discernible by the lack of vegetation and pink soil color. The PCB soil contamination is at former electrical transformer locations.

UN renovated (e.g., removed asbestos) portions of the bomb manufacturing facilities for use by UN programs. The parts of the bomb manufacturing facilities not used by UN have not been maintained and are in poor state of repair (e.g., doors and roofs are missing or broken). The old steam pipes in the unused areas are covered with frayed asbestos. Some of the asbestos is exposed to the outside environment.

The solid waste generated while NOP was operational was disposed in an on-site landfill or burned. Both the landfill and burning area are located north of the Agronomy Research Facility (See Appendix A, Figure II). The Corps will investigate these areas for environmental contamination in the future.

C. Demographics, Land Use, and Natural Resource Use

The property presently owned by UN, the UN Field Laboratory, is devoted to agricultural research and demonstration studies. The families of four UN employees live at the UN Field Laboratory. These families have a total of ten children. All of the potable (drinking, bathing, and cleaning) water for these families is provided by the central water distribution system. The central water distribution system has been in operation since the construction of NOP. The wells for the water distribution system are being monitored for contamination. Two of the eleven wells have been removed from service (1988) because of potential contamination (wells number 6A and 7A).

The only part of the UN Field Laboratory not serviced by the central water distribution system is the Agronomy Research Facility. Potable water is provided by a separate well. Approximately 70 year round employees work at the Agronomy Research Facility, while during the summer, approximately 150 individuals work at the facility.

The off-site population which could potentially be affected by the migration of contaminated groundwater resides towards the south and southeast of NOP (the direction of regional groundwater flow). According to information provided by the Lower Platte North Natural Resources District, approximately 140 residences are located south and southeast of NOP on the west side of the Platte River. (Letter, Larry Angle, State of Nebraska, Lower Platte North Natural Resources District, April 2, 1990.) All of these residences rely upon wells for potable water. It is estimated that 560 individuals (men, women, and children) live in this area.

Information from the 1980 Census indicates the population of Saunders County was 18,716 (99.5 % white, 0.4% Hispanic, and 0.08% Black). The percentage of the population under age 18 was around 30%, while individuals over the age of 65 were about 16%. The most common single ancestry cited was German.

Five individuals (two adults and three children) obtain potable water from the two off-site residential wells contaminated with TCE and RDX above EPA safety standards. This family has since been placed on an alternate water supply.

Most of the land surrounding NOP is used for agriculture (crops and livestock). Crop irrigation is conducted by a few of the farms.

In order to identify other possible facilities that could contribute to the groundwater and air contamination near NOP, ATSDR searched the 1987 and 1988 Toxic Chemical Release Inventory (TRI). TRI is developed by EPA from the chemical release (air, water, and soil) information provided by certain industries. The Toxic Chemical Release Inventory did not contain any information on toxic chemical releases in Saunders County, Nebraska.

The City of Lincoln (population of approximately 200,000) obtains all of its potable water from a well field eight miles southeast of NOP. The well field is located on the west side of the Platte River and is monitored for NOP-related contaminants. To date no NOP-related contaminants have been detected in the Lincoln city wells.

Hunting (deer, rabbit, and birds) and fishing is permitted on and around NOP. A man-made lake at the UN Field Laboratory is a wildlife refuge. Migratory birds can be found at the wildlife refuge during the spring and fall.

D. State and Local Health Data

The State of Nebraska Department of Health provided information from their Birth Defects and Cancer Registry for the populations living near NOP, in Saunders County, and within the state. (Letters, Charlene M. Dunbar, Health Data Coordinator, Division of Health Data Systems, Department of Health, May 25 and June 26, 1990.) The data provided included vital statistics (birth and

death) and the number of very low and low birth weights, birth defects, and cancer.

In addition, ATSDR reviewed 1950 to 1970 cancer mortality data on Saunders County and the State of Nebraska contained in the Riggans Cancer Mortality database. The database is maintained on the Centers for Disease Control computer mainframe.

COMMUNITY HEALTH CONCERNS

* One family with an off-site contaminated well would like to know if the duration of their exposures to TCE can be determined, and if medical tests exist to measure the significance of this past exposure.

* This same family would like to know the long-term effects from bathing in TCE-contaminated water, and if the risk for health effects is higher for children than adults.

* The community would also like to know if there are any health risks from watering crops and livestock with contaminated water.

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

A. On-Site Contamination

Table I lists the contaminants of health concern found at the UN Field Laboratory. Contaminants were selected by comparing the environmental sampling analytical results to health comparison values (e.g., EPA Drinking Water Health Advisories). The Corps has been evaluating the extent of contamination at the UN Field Laboratory.[1] In the future, the other NOP areas (e.g., National Guard) will be evaluated by the Corps.

The TNT and RDX soil contamination is located near the four load lines where waste material from the bomb loading operations were discarded onto the ground. The highest TNT contamination was found near load line 1. While the highest RDX contamination was found near load line 2. There is good correlation between orange-pink stained surface soils and elevated levels of TNT and RDX.[1] The distribution of TNT and RDX within the soil column (surface vs. subsurface) is not known at this time because the soil samples taken to date are composites from six foot soil intervals.

TABLE I
Table of Contaminants of Concern On-Site
Former Nebraska Ordnance Plant NPL Site
Mead, Nebraska

Contaminant	Media	In Parts per Billion Range of Contamination	Health Comparison
	Soil		
Trinitrotoluene (TNT)		<80-9,663,000	25,000[a]
Cyclonite (RDX)		<200-3,100,000	150,000[b]
Polychlorinated biphenyls (PCB)		<25,000-260,000	5,000[c]
	Groundwater		
Trichloroethylene (TCE)		<1-742	5*
Trinitrotoluene (TNT)		<0.2-1,018	2**
Cyclonite (RDX)		<0.2-1,190	2**

a = EMEG (Environmental Media Evaluation Guide) derived from EPA RfD.

b = EMEG derived from EPA drinking water lifetime health advisory.

c = EMEG.

* = Maximum Contaminant Level, (MCL)

** = EPA Drinking Water Health Advisory

Source: U.S. Army Corps of Engineers. Former Nebraska Ordnance Plant Mead, Nebraska, Confirmation Study (1989). Kansas City, Kansas: U.S. Army Corps of Engineers Kansas City District, 1989.

The former NOP electrical distribution system used transformers which contained PCBs. Some of the transformers leaked, which resulted in localized PCB soil contamination. UN removed and disposed of the PCB transformers and cleaned up the visible PCB soil contamination. The March 1988 Corps investigation found surface soil near load lines 1, 2, and 4 contaminated with PCBs ranging from 25,000 to 260,000 parts per billion (ppb).[1]

The Corps investigation has found on-site groundwater contaminated with TNT, RDX, and TCE. Two wells have been taken out of service because of potential contamination. In addition, the potable water well for the Agronomy Research Facility is contaminated with TCE, 92 ppb.[1] The two drinking water fountains at the Agronomy Research Facility are connected to separate activated carbon filtration systems. The effectiveness (removal of TCE) of these two systems has been confirmed by the Nebraska Department of Health. Laboratory water analysis of samples taken by the Nebraska Department of Health (April 4, 1990) indicate the TCE levels in the water from the water fountains are below levels

of public health concern. (Letter, Adi M. Pour, Ph.D., Toxicologist, State of Nebraska, Department of Health, May 31, 1990.)

In 1988, the highest RDX groundwater contamination was found by the Corps in a monitoring well located near load line 2.[1]

Another area of possible environmental contamination is the asbestos located in the unused bomb manufacturing buildings. UN does not use all of the former bomb manufacturing buildings; moreover, the unused areas are in a state of disrepair. During the March ATSDR site visit it was observed that the integrity of the asbestos has not been preserved over time. Asbestos insulation is presently hanging off the pipes and has fallen onto the ground. ATSDR was told by University employees that they have seen white clouds of material coming off of these pipes during the windy dry summer seasons. Access to these areas is not restricted. Fortunately the asbestos areas are not normally visited by University employees, but the potential for exposure remains. ATSDR has notified the appropriate EPA office about this hazard (Appendix B). ATSDR will continue to coordinate with EPA to ensure that protective actions are taken.

B. Off-Site Contamination

Off-site migration of contaminated groundwater has been confirmed by the Corps' investigations. Table II lists the contaminants of concern found off-site. Contaminants were selected by comparing the environmental sampling analytical results to health comparison values (e.g., EPA Drinking Water Health Advisories). The highest off-site groundwater contamination was found in two residential wells directly east of the UN Field Laboratory (TCE 89 ppb and RDX 7.2 ppb).[1] An activated carbon filtration system has been installed at this location. The system, if properly maintained, should effectively remove the contaminants to below levels of public health concern.

TABLE II
Table of Contaminants of Concern Off-Site
Former Nebraska Ordnance Plant NPL Site
Mead, Nebraska

Contaminant	Media	In Parts per Billion Range of Health Contamination	Comparison
	Groundwater		
Trichloroethylene (TCE)		<1-89	5*
Cyclonite (RDX)		<0.4-7.2	2**

* = Maximum Contaminant Level, (MCL)

** = EPA Drinking Water Health Advisory

Source: U.S. Army Corps of Engineers. Former Nebraska Ordnance Plant Mead, Nebraska, Confirmation Study (1989). Kansas City, Kansas: U.S. Army Corps of Engineers Kansas City District, 1989.

The Corps' is conducting quarterly monitoring of residential wells downgradient from NOP. The results of this monitoring indicate that two additional residential wells may have become contaminated above levels of health concern (one with TCE and other with RDX). The Corps' and the Nebraska Department of Health are presently evaluating these situations. If this contamination is confirmed, appropriate procedures should be employed to prevent human exposure to contamination above levels of health concern (e.g., provide an alternate water supply).

C. Quality Assurance and Quality Control

ATSDR was not provided with quality assurance and quality control (QA/QC) information concerning analytical environmental data for NOP. In preparing this public health assessment, ATSDR relies on the information provided in the referenced documents and assumes that adequate QA/QC measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this preliminary public health assessment is determined by the completeness and reliability of the referenced information.

D. Physical and Other Hazards

As previously discussed above, several of the former bomb manufacturing buildings are in a state of disrepair. Physical injury (e.g., falls, cuts) could occur to individuals entering these buildings.

Before the NOP facilities were given to UN, explosive materials were removed from the buildings. The only remaining explosives (TNT and RDX) are found at the discrete locations as soil contamination and are not found in sufficient quantity to self detonate.

PATHWAYS ANALYSES

A. Environmental Pathways (Fate and Transport)

During the production of bombs at NOP, liquid waste material was discarded directly onto the ground. These liquid wastes contained TNT and RDX. Additional sources of TNT and RDX are the burning grounds and landfill at NOP. The Corps is presently investigating the burning grounds and landfill. Even though TNT and RDX tend to adsorb strongly to the clay loam soils found at NOP, these compounds can slowly migrate downward through the soil and enter the groundwater. The results of the Corps investigation found that TNT and RDX have migrated into the local groundwater.[1] Upon entering an aquifer system, RDX and TNT will migrate slowly in the direction of the groundwater flow, thus moving off-site to nearby residential wells.

TNT and RDX can under go biological and physical degradation. Possible degradation products are trinitrobenzenes and other nitroaromatics. TNT breakdown products have been detected at trace levels.

Like TNT and RDX, PCBs tend to adsorb very strongly to soils. Therefore, PCBs generally do not migrate readily into groundwater. Groundwater monitoring conducted by the Corps did not find groundwater contaminated with PCBs.

The source of the TCE groundwater contamination is not known at this time. However, TCE was used by the U.S. Air Force at the missile site north of the UN Field Laboratory. Unlike TNT, RDX, and PCBs, TCE does not adsorb to soils and will migrate rapidly through a soil. Once TCE has entered an aquifer system, it will migrate in the same direction as the groundwater.

Groundwater is the sole source of drinking water for the region surrounding NOP. There are four components to the hydrologic system underlying NOP. In descending order, three of the components are the Pleistocene sand and gravel (upper) aquifer, Omadi formation shale aquitard (dividing layer that retards groundwater movement between the upper and lower aquifer), and Omadi sandstone (lower) aquifer. When present, the shale partially confines the lower aquifer. However, the shale is not continuous through out the region, which permits the upper and lower aquifers to be in direct contact. The fourth component of the regional groundwater system is denoted by the upper and lower aquifers being in direct contact. The combined (Pleistocene-Omadi or fourth component) aquifer exists in the eastern and southern portions of the site. All of the aquifers in the region flow towards the south and southeast and discharge to local creeks (Silver, Wahoo, Johnson, and Clear) and the Platte River. Site related contaminants (RDX and TCE) have been found in the Pleistocene-Omadi aquifer; a total of three wells at the UN Field Laboratory and six off-site wells east of the UN Field Laboratory have been affected by

this contamination.[1] The total extent of contaminated groundwater is not known.

The City of Lincoln obtains its potable water from a well field eight miles southeast of NOP. This field is located on the western shores of the Platte River. Because the well field draws most (80 to 90%) of its water directly from the Platte River, it is unlikely contaminated groundwater from NOP will adversely affect the Lincoln City potable-water quality. The City of Lincoln monitors the wells for NOP-related contaminants.

TCE and TNT do not easily bioaccumulate (the process of concentrating compounds in living organisms) in plants or animals. PCBs, however, can be bioaccumulated by animals but not in plants. None of the PCB soil contamination areas are used for livestock production. It is therefore unlikely that the TCE, TNT, and PCB contamination from NOP could enter the food chain. By contrast, recent data for RDX suggest that this explosive has the ability to bioaccumulate in plants [2,3]. The family using the off-site contaminated wells may have watered crops with RDX-contaminated water. The levels of RDX taken up by their crops cannot be determined; however, continued irrigation with this water is not advised.

The asbestos located in the old bomb manufacturing buildings can be released into air if disturbed. When this occurs, asbestos fibers will be transported in the direction of the wind and eventually fall to the ground.

B. Human Exposure Pathways

The primary human exposure pathway of concern at NOP is the ingestion of groundwater contaminated with TNT, RDX, and TCE. RDX and TCE have migrated into the aquifer used for drinking water. Wells used by the UN Field Laboratory are contaminated. Two of the wells (number 6A and 7A) are no longer in service and the water from the third well (Agronomy Research Facility) is treated before it is consumed by humans. Of the six off-site residential wells found to be contaminated, two are contaminated at levels of public health concern. A carbon filtration system has been installed at the house that uses these two wells. Because the total extent of groundwater contamination is not known, it is not possible to determine when these two wells became contaminated.

The results of the Corps' quarterly residential well monitoring indicate that two additional residential wells may have become contaminated above levels of health concern (one with TCE and other with RDX). The Corps' and the Nebraska Department of Health are presently evaluating these situations. If this contamination is confirmed, appropriate procedures should be employed to prevent human exposure to contamination above levels of health concern (e.g., provide an alternate water supply). Additional wells could be contaminated in the future if the contaminated groundwater migration is not mitigated.

Additional human exposure pathways associated with contaminated groundwater include inhalation of volatilized TCE and dermal contact with RDX and TCE during bathing and other domestic activities. As indicated above, TCE and RDX is present in the potable water being used for domestic activities at the

Agronomy Research Facility and off-site residential wells. Because the total extent of groundwater contamination is not known, it is not possible to determine when these wells became contaminated.

Other possible human exposure pathways are dermal contact, inhalation, and ingestion of contaminants in soil (TNT, RDX, and PCBs). Because the contaminated sites are not frequently visited by either UN Field Laboratory employees or persons living near the area and are at discrete locations, such exposures are unlikely under existing conditions. However, access is unrestricted so the potential for these exposures is still a concern. Personnel involved in remedial activities could also be exposed to the contaminants, depending upon the type of remediation activity and the level of personal protection employed.

Humans are unlikely to be exposed to TCE or TNT through the food chain because these contaminants do not bioaccumulate. Food chain contamination from PCBs would not occur since PCB-contaminated soils are not used for crops or livestock production. The potential for human exposure to RDX through the food chain does exist via crops or home gardens irrigated with contaminated water. Continued irrigation with contaminated water is not advised.

Humans could be exposed to asbestos by inhalation. This type of exposure could occur whenever the asbestos steam pipe insulation is disturbed.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Implications

The contaminants associated with the NOP site are TCE, RDX, TNT, PCBs, and asbestos.

TCE

Users of the previously untreated water well at the UN Field Lab may have ingested TCE contamination at levels up to a maximum of 92 ppb. Off-site individuals in the household where private well contamination occurred may have ingested TCE at a maximum of 89 ppb. The EPA Maximum Contaminant Level (MCL) for TCE is 5 ppb. Both TCE levels related to NOP thus exceed the MCL. The MCL is a drinking water standard set to protect human health. It means that a person should not suffer any non-cancer adverse health effects drinking 2 liters of water per day contaminated with 5 ppb TCE, over an assumed 70-year lifetime.

Although the MCL has been exceeded, persons exposed to TCE both on- and off-site are not likely to develop non-cancer health effects from groundwater ingestion. Exposure duration was evidently much less than a human lifetime, and TCE levels were still too low to cause such effects after short exposure periods.

Contaminated water may transfer TCE to the human body not only through drinking, but also via inhalation. Since TCE volatilizes quickly, showering with contaminated water may present an additional health risk to people in their own homes. This risk was demonstrated in a study by Andelman, who examined well water contaminated with 40,000 ppb TCE that had been used in a running shower. TCE levels in bathroom air became elevated from 500 to 81,000 ppb in less than 30 minutes.[4] Lack of ventilation in a bathroom could further add to this inhalation exposure risk. A subsequent study reported that the degree of TCE volatilization could vary from an estimated 55% to 91%, depending primarily upon water temperature and shower duration.[5]

TCE contamination in the off-site private well is almost 500 times lower than the TCE level used in the experiment cited above. Moreover, showers typically last 5 to 10 minutes. Therefore, the TCE exposure time of the family with the contaminated well should be short and intermittent. Finally, there are no air monitoring data to confirm the concentration of TCE in the exposed family's bathroom air. Inhalation in this case may not have added significantly to the family's cumulative TCE exposure.

EPA considers TCE a probable human carcinogen since TCE causes cancer in rodents when inhaled and ingested. For example, lifetime oral exposures to TCE cause liver tumors in mice and kidney tumors in rats.[6] Lung and liver tumors develop in mice after lifetime inhalation exposures to TCE, while male rats develop testicular cancer.[6] However, results from human studies have not shown that TCE causes cancer in humans by these routes.[6]

There is some cancer risk to humans from inhalation and ingestion of TCE, with the chances increasing proportionately with increases in TCE concentration and exposure time. Individual factors (e.g., genetics, diet, smoking/alcohol/drug history) also contribute. The risk of developing cancer from TCE levels associated with NOP appears low, since persons both on- and off-site were exposed to relatively low doses of TCE (dilute TCE) for a short, discontinuous period.

Biomonitoring may be used to detect very recent exposures to TCE. These laboratory tests measure TCE or its breakdown products (metabolites) in blood, urine, and exhaled air. Although these tests are available, they are not useful to determine the duration of past exposures or to assess health effects.

Currently, the public health impact of on-site TCE groundwater contamination has been mitigated by action from the U.S. Army in coordination with UN Field Lab staff and the Nebraska State Department of Health. Potential health effects from ingestion of off-site groundwater contamination are being prevented by an alternate water supply to the family with the contaminated well.

RDX

The family residing near NOP had been exposed to RDX from their private well at a maximum level of 7 ppb. When converted to the dose of contaminant ingested per day, this level exceeds the EPA's oral reference dose (RfD) of

0.003 milligram per kilogram per day (mg/kg/day). The RfD is an estimate of the daily exposure to the human population that is likely to be without an appreciable risk of causing long-term adverse health effects. Moreover, the RDX groundwater contamination levels associated with NOP exceed the 1988 EPA Health Advisory level of 2 ppb for lifetime risk from drinking RDX -contaminated water.

There are no human studies available that describe the health effects that may occur after drinking water ingestion of RDX at the levels cited above. It is unlikely that any severe effects would occur to the exposed population after only short-term use of water from either well.

Ingestion exposures to RDX in on-site soil may occur. A soil sample taken near a waste outflow point adjacent to the NOP load line buildings found RDX at a maximum level of 3,100,000 ppb. The RDX is localized in discrete areas; RDX soil contamination is not found uniformly across the entire site. Yet persons eating soil at this high RDX level would increase their risk of developing adverse health effects after chronic (one year or more) ingestion exposures. Children under the age of six, who typically eat as much as 200 mg/day from hand-to-mouth activities, represent an especially susceptible subgroup. It is not expected that chronic soil ingestion would occur by adults at NOP to the extent that health effects would result. Furthermore, children residing or visiting on-site would not be likely to eat soil around the outflow area for any extended period. There are no regulatory standards for RDX in soil.

In a 2-year chronic feeding study of rats at doses equal to or greater than 1.5 mg/kg/day, the major toxic effects recorded were hepatotoxicity (liver cell damage), anemia, lesions in the spleen, urinary, and genital areas, central nervous system involvement, and cataracts.[7] The toxicity in animal models is similar to what has been observed in humans orally exposed to RDX at equivalent dosages. Yet the human oral doses of RDX converted from a soil ingestion value of 3,100,000 ppb would be several hundred-fold lower than doses equivalent to those in the rat study. The development of similar health effects in humans at much lower dose levels is unlikely.

EPA considers RDX a possible human carcinogen for its risk of causing cancer by ingestion. A 2-year chronic feeding study in mice found liver cancer in females after dosages greater than or equal to 35 mg/kg/day.[7] There is no human epidemiologic data to corroborate this finding. For the levels of RDX found in the groundwater and soils related to NOP, the cancer risk to humans from ingestion would not be expected to be elevated.

Other ingestion exposures to RDX may have occurred off-site via bioaccumulation in crops irrigated with RDX-contaminated groundwater. Although the public health significance of this exposure pathway cannot be determined, persons are advised not to continue irrigating crops with such water.

TNT

Adults and children may be exposed to TNT from ingestion of on-site soils at maximum levels of 9,663,000 ppb. Although there are no regulatory standards for TNT in soil, conversion of this known TNT soil level to the dose of contaminant ingested per day yields a dose that exceed EPA's oral RfD of 0.0005 mg/kg/day. This indicates that harmful health effects may develop from long-term ingestion of soil contaminated with TNT at the level found on-site. As with RDX, however, the TNT contamination is localized in the waste outflow areas near the load line buildings. It is not expected that such soil ingestion would occur over an exposure duration sufficient to cause health effects.

Several intermediate and long-term TNT diet studies in rats, mice, and dogs found liver damage and anemia to be the primary toxic responses to TNT.[8] The estimated oral TNT doses from soil ingestion at NOP are within the dose range used in these studies. However, whether similar effects occur in humans from oral exposure is not known. Occupational exposure data from inhalation of TNT suggest that liver and blood effects actually do occur in humans. However, inhalation of pure TNT cannot be directly equated with exposure from eating soil mixed with TNT.

EPA considers TNT a possible human carcinogen for its risk of causing cancer via ingestion. TNT causes bladder cancer in rats after 2-year dietary exposures of 50 mg/kg/day. This oral dose is over fifty times higher than the estimated oral doses calculated for humans exposed on-site. Information regarding the carcinogenicity of ingesting TNT in humans was not found in the available literature.

There are several rare enzyme deficiencies which predispose persons to hemolytic disease (red blood cell destruction). Of these, glucose-6-phosphate dehydrogenase (G6PD) enzyme deficiency is the most common. Persons afflicted with G6PD deficiency have a 10% lower G6PD enzyme function in their red blood cells, predisposing them to the toxic effects of chemicals. This condition occurs at an approximate frequency of 11% in African-Americans, and may also be found at high frequency in dark-skinned Mediterranean populations. Children with G6PD deficiency may be considered to be the most susceptible populations to the effects of TNT exposures for their risk of developing methemogobinemia, a condition that impairs oxygen transport. Because the most common single ancestry in Saunders County is German, G6PD deficiency would not be expected to be common in this area.

PCBs

Persons on-site may ingest PCBs in soil at a maximum level of 260,000 ppb. No PCBs were detected in groundwater. When this measured soil PCB level is converted to an estimated oral dose, it exceeds the EPA 10-day health advisory levels for soil ingestion recommended for adults and children.[9]

Oral PCB exposures in rats result in liver effects, but at levels 1000 times higher than doses possible at NOP. Monkeys exposed to PCBs for 90 days during gestation deliver low birth weight babies, after receiving oral doses

comparable to NOP soil levels.[9] There is no data available for human health effects resulting from this level or route of exposure.

EPA regulates PCBs as probable human carcinogens since lifetime ingestion of PCBs at high doses causes liver cancer in rodents. However, only limited data exists for the development of cancer in humans exposed to PCBs by ingestion.

PCBs are chemicals which concentrate in fatty tissue. They have the ability to accumulate in breast milk, and may also cross the placenta. Pregnant women ingesting PCBs from the soil at NOP may run the risk of transferring contamination to their fetus. Yet the likelihood that adult females on-site would ingest enough soil for this to occur is low. Nursing infants must also be included in the susceptible population, but would only be at risk from PCBs if the mothers' exposures had been of sufficient severity and duration to allow the milk to be affected. Children under six years of age may eat on-site soil, but the effects on their health from such PCB exposures are unclear.

Thus, by both non-cancer and cancer criteria, ingestion of PCB-contaminated surface soil at the levels found at NOP is an unlikely but potential health threat to persons on-site.

ASBESTOS

Asbestos being released from steam pipe insulation exposed to the outdoor air may be inhaled by persons on-site. This release is occurring near the load line buildings. There are no air monitoring data available to measure the extent of this release.

There are very few studies which describe the effects of asbestos mineral fibers on humans after short-term inhalation exposures. By contrast, the risk for chronic exposure has been well studied. At a 20-year minimum exposure of 1,000,000 fibers per cubic meter air (fibers/m^3), susceptible people have developed permanent lung injury.[10] A minimum 20-year exposure of 3,400,000 fibers/m^3 has been fatal to persons with asbestosis (an accumulation of lung scar tissue).[11] A cubic meter is approximately equal to the amount of air people breathe in one hour. Other chronic effects include damage to the heart and immune system.[12,13]

Literature sources reveal that typical background levels of asbestos range from 3.0 fibers/m^3 in rural outdoor air to up to 2000 fibers/m^3 or more from factories and asbestos mines. Asbestos fibers do not degrade in air or soil.

Inhalation of asbestos fibers has been shown to increase the risk of developing lung cancers, mesotheliomas (cancers of the membrane surrounding the lung), and asbestosis. The period between asbestos exposure and disease development may vary from 10-30 years. The EPA considers asbestos a known human carcinogen for its risk of causing cancer in humans from inhalation.

Since the cancer potency of asbestos is related to the number of fibers in air, fiber type, and fiber length, these asbestos measurements are needed at

the site to determine the specific cancer risk from the asbestos release at the load line buildings.

Occupational studies have shown that cigarette smokers exposed to asbestos have a higher risk for developing lung cancer than non-smokers. The mechanism by which smoking and asbestos interact to increase lung cancer risk is not known.

Persons who regularly visit the unused bomb manufacturing buildings may therefore be exposed to asbestos at levels that could contribute significantly to their lifetime cumulative asbestos exposure.

B. Health Outcome Data Evaluation

A review of the 1986-1988 vital statistics data for Saunders County indicate that the number of births have been stable at approximately 250 per year. Data from 1984-88 show that the occurrence of very low (less than 1500 grams) and low (less than 2500 grams) birth weight babies are similar to state rates over the same time period (Rate per 1,000 live births--Saunders: 10.0 and 40.8, Nebraska: 8.9 and 54.4, respectively). In addition, the number of birth defects, infant deaths, and newborn deaths were not above what would be expected.

An examination of cancer incidence (number of new cases) rates for 1987-1988 indicates that for pancreatic and thyroid cancers, Saunders County rates were double the State of Nebraska rates (Age-adjusted figures per 100,000 population--Saunders: 17.5 and 7.9, Nebraska: 6.8 and 3.4, respectively). Current knowledge about what causes pancreatic and thyroid cancers is limited.

Pancreatic cancer incidence is approximately 27,000 per year in the United States.[14] Since most new cases have a low survival rate, incidence and death rates are similar for this type of cancer. Persons who develop pancreatic cancer are typically in lower socioeconomic groups with a median age of 69 years.

The 1986 estimated number of new cases of thyroid cancer in the United States is 10,600. Of these, 7,700 were women.[14] The majority of cases of this disease range in age between 25-65. Thyroid cancer has a 90% cure rate if appropriate surgery is performed soon after diagnosis; thus, mortality data do not reflect incidence rates for this disease. Ionizing radiation is the most common environmental agent known to cause thyroid cancer in humans.

Few definitive studies are available describing the human carcinogenic potential of NOP-related contaminants, especially RDX and TNT. Therefore, an association between NOP contaminants and their possible contribution to the elevated cancer levels cannot be made.

The incidence of other types of cancer in Saunders County was not above what would be expected for the area. Moreover, an examination of cancer incidence by zip code in geographic regions closest to NOP showed no clustering of a site-specific cancer. A review of Riggans Cancer Mortality database for

1950-1979 did not indicate a consistently elevated cancer mortality in this time period.

Based on the review of the toxicological information on the contaminants present and the health outcome data for the area, there does not appear to be any evidence to associate the contamination at NOP with any adverse health outcomes in the community at the present time.

C. **Response to Community Concerns** (Refer to Page 5)

* The duration of exposures to TCE in off-site residential wells cannot be determined with the information available. Blood and breath measurements may be made to detect TCE in persons recently exposed (within the past 5 days). However, there are no medical tests available that can help to estimate past exposure to this contaminant.

* Please see the previous section on TCE for a description of long-term (chronic) effects from inhalation exposures. It does not appear that children are more susceptible than adults to the effects of TCE exposures.

* Since TCE in water evaporates rapidly when exposed to open air, and since TCE is not readily absorbed by plants, it is unlikely that the viability of crops would be affected. In animals, effects on the kidney, liver, immune system, and developmental/reproductive systems begin to be seen at oral TCE doses over a thousand times higher than the level measured in one of the off-site residential wells (89 ppb). Livestock should therefore not be adversely affected by drinking this water. There is not enough information available to assess the risk to humans ingesting meat from these TCE-exposed animals.

  RDX does bioaccumulate in plants. Some studies suggest that the uptake may reach a level of ten times or greater than environmental levels. Actual measurements of RDX concentrations in crops grown near NOP and watered with contaminated water are not available. General data on mammalian toxicity is also limited. Therefore, the risks to human health from these biota pathways cannot be assessed.

CONCLUSIONS

On the basis of the available information, ATSDR concludes that the former Nebraska Ordnance Plant NPL site is a public health hazard because a risk to human health may exist from possible exposure to hazardous substances at concentrations that may result in adverse human health effects. Exposure to elevated levels of trichloroethylene (TCE) and cyclonite (RDX) has occurred in some on-site and off-site residents of the NOP site who use groundwater for drinking and bathing. This groundwater contamination could migrate into other nearby drinking water supplies in the future. Bioaccumulation of RDX in crops may have occurred from irrigation with contaminated groundwater. In addition, individuals, through skin contact and soil ingestion, could be exposed to RDX,

trinitrotoluene (TNT), and polychlorinated biphenyls (PCBs) soil contamination found on-site.

The asbestos located in the unused manufacturing buildings is also a public health hazard. ATSDR has alerted the U.S. Environmental Protection Agency Region VII of this public health hazard (see letter in Appendix B).

ATSDR concludes that additional soil and groundwater monitoring is needed to determine the total extent of contamination. Some of the areas which should be investigated are the landfill, burning area, and the bomb booster assembly area.

RECOMMENDATIONS

ATSDR recommends coordination with the appropriate authorities to carry out the following:

1. The total extent of groundwater contamination should be determined and appropriate procedures be employed to prevent future migration of the groundwater contamination into potable water supplies.

2. The total extent of soil contamination should be determined and appropriate procedures be employed to prevent future migration. Areas at NOP which should be investigated for soil contamination include the landfill, the burning area, and the bomb booster assembly area. Both surface (top three inches) and subsurface soils should be sampled.

3. Access to the areas of RDX, TNT, and PCB soil contamination should be restricted.

4. Appropriate procedures should be employed to prevent human exposure to the asbestos in the unused former bomb manufacturing buildings (e.g., monitoring, remediation, and access restrictions).

5. Appropriate procedures should be employed to prevent human exposure to the off-site groundwater contamination of public health concern (e.g., provide an alternate water supply).

6. Appropriate procedures should be employed to prevent human exposure to RDX via bioaccumulation in plants by ensuring that crops are not irrigated with contaminated groundwater.

7. Quarterly monitoring for site-related contaminants should be conducted at residential wells downgradient of the site.

8. Quarterly monitoring for site-related contaminants should be conducted at the Agronomy Research Facility to assure the water treatment systems are effective.

9. Ensure workers conducting remedial activities use adequate personal protective equipment which meets Occupational Safety and Health Administration standards and National Institute of Occupational Safety and Health recommendations.

10. The evaluation of additional relevant health outcome data and community health concerns is recommended when available, when indicated by public health needs, and as resources permit.

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, the former Nebraska Ordnance Plant NPL site, Saunders County, Nebraska, has been evaluated for appropriate follow-up with respect to health activities. Although there are indications that human exposure to on- and off-site contaminants occurred in the past, this site is not being considered for follow-up health activities at this time because no current exposure is occurring at levels of public health concern. However, if data become available suggesting that human exposure to hazardous substances at levels of public health concern is currently occurring, ATSDR will reevaluate this site for any indicated follow-up.

Public Health Action Plan

ATSDR will continue to coordinate with the State of Nebraska Department of Health, the EPA, and the Army Corps of Engineers to ensure provision of alternate water to the affected families, and to support protective actions to mitigate the asbestos hazard from the former manufacturing buildings.

PREPARERS OF REPORT

Environmental Reviewer:	Sven E. Rodenbeck, P.E. Environmental Engineer Consultant Remedial Programs Branch
Health Reviewer:	Lynn G. Berlad, M.Sc. Toxicologist Remedial Programs Branch
Regional Representative:	Daniel M. Harper Senior Public Health Advisor ATSDR Region VII

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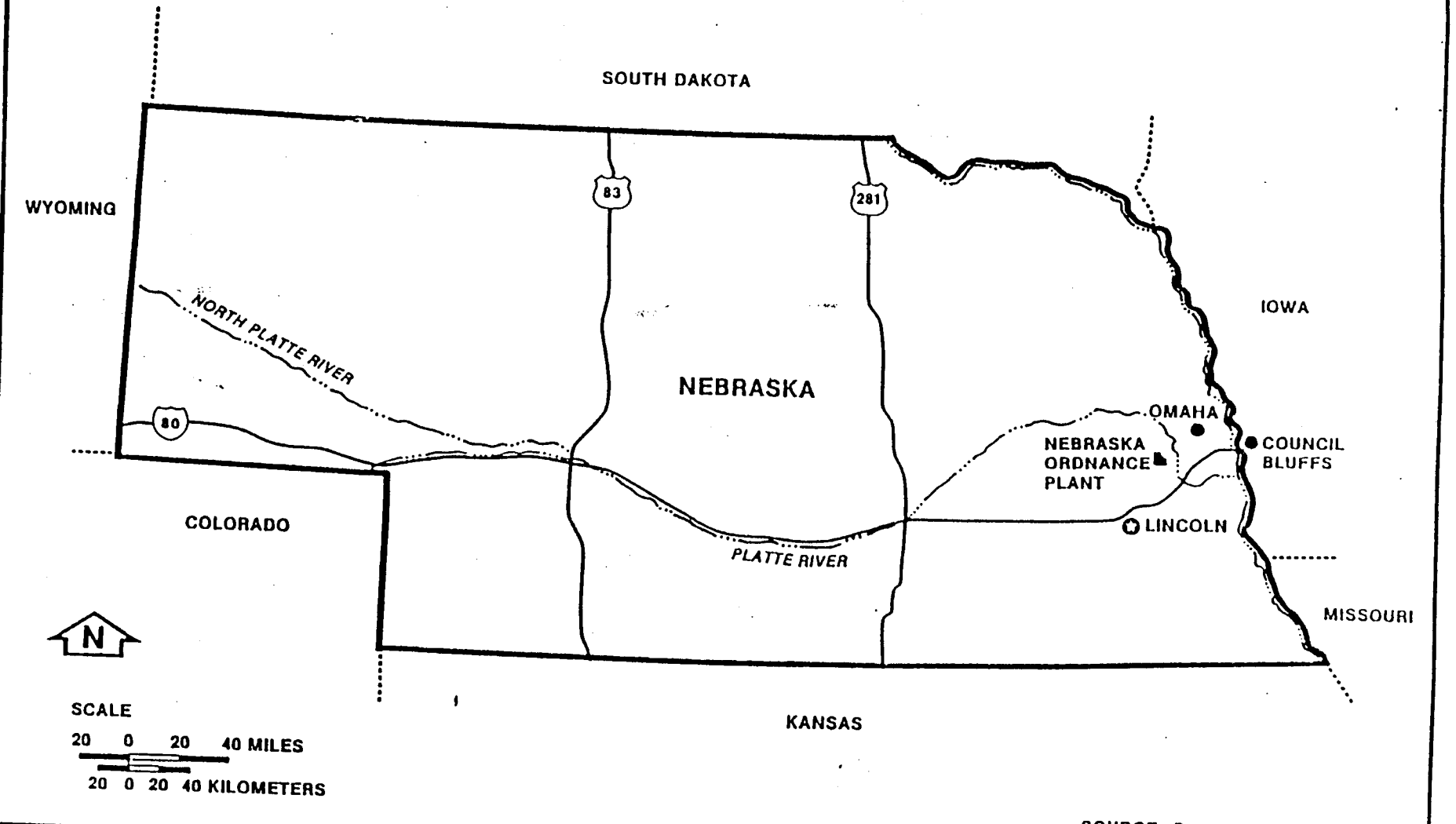
APPENDIX A

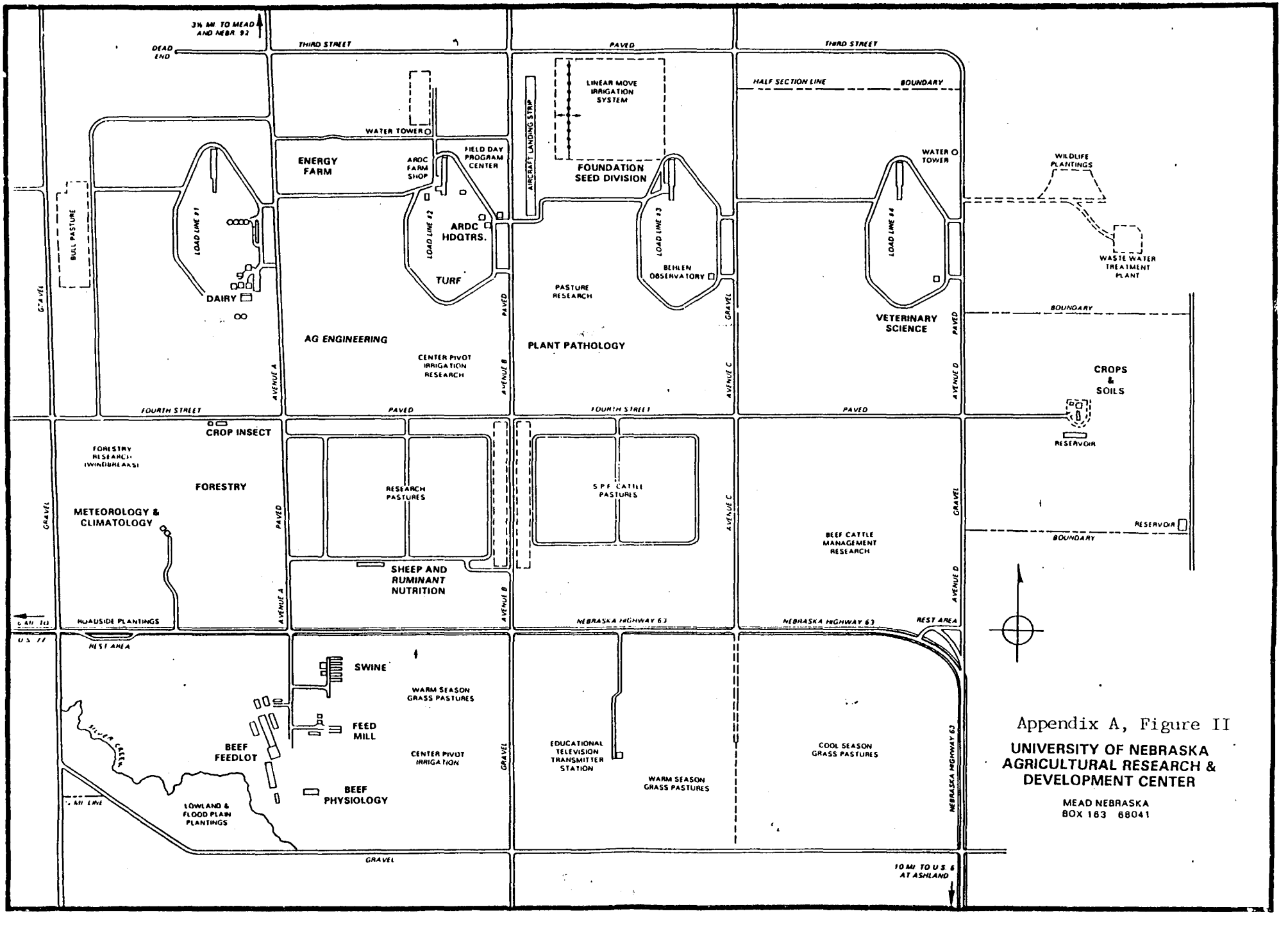
Figures I and II



SOURCE: Rand McNally & Co., 1981.

Appendix A, Figure I
SITE LOCATION —— NEBRASKA ORDNANCE PLANT

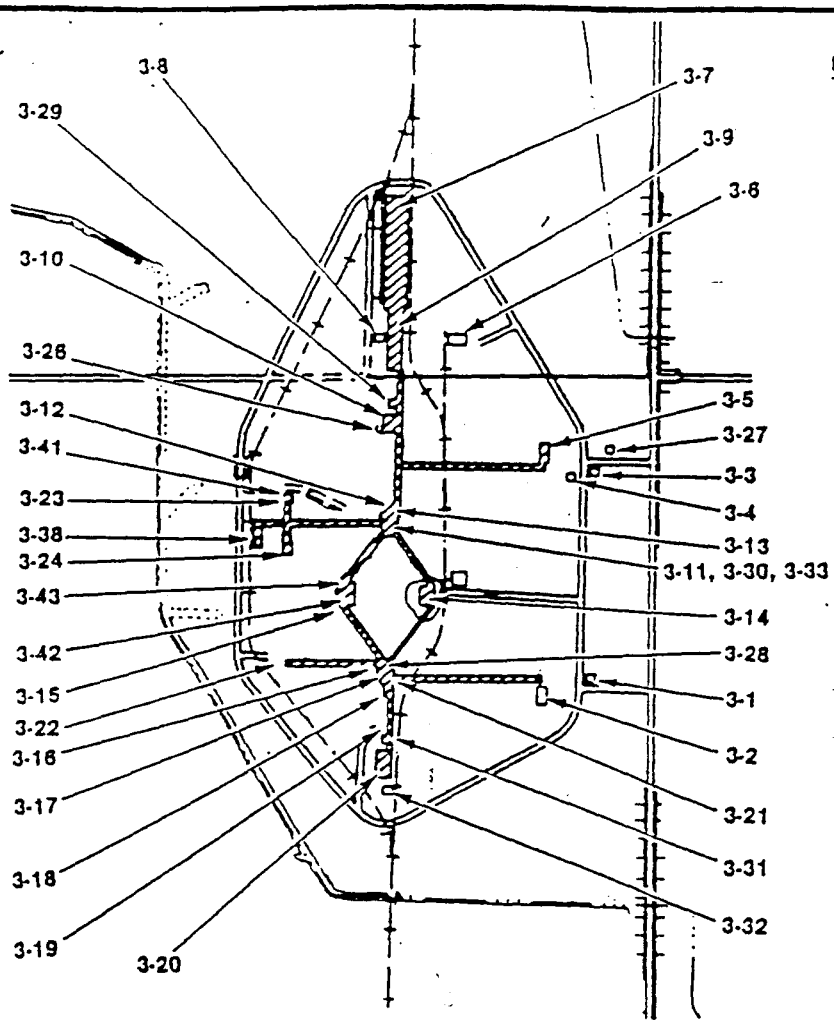
Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland



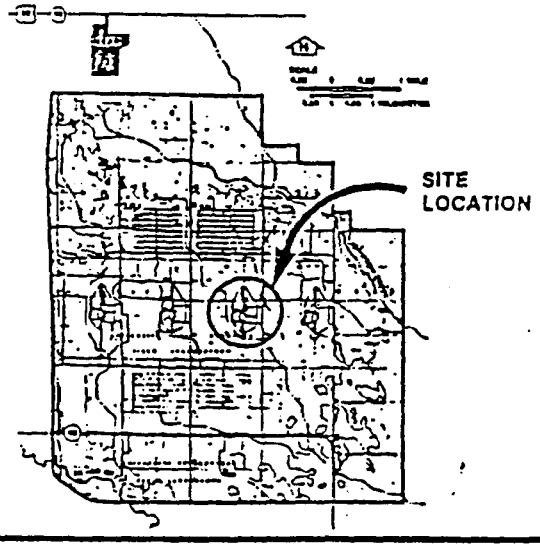
Appendix A, Figure II

UNIVERSITY OF NEBRASKA AGRICULTURAL RESEARCH & DEVELOPMENT CENTER

MEAD NEBRASKA
BOX 163 68041



BUILDING	DESCRIPTION
3-1	GATE HOUSE
3-2	CHANGE HOUSE
3-3	GATE HOUSE
3-4	LINE OFFICE
3-5	CHANGE HOUSE
3-6	BOILER HOUSE
3-7	INERT STORAGE
3-8	SERVICE BUILDING
3-9	RECEIVING AND PAINTING
3-10	SERVICE BUILDING
3-11	WASH PIT
3-12	SCREENING BUILDING
3-13	MELT POUR BUILDING
3-14	COOLING BUILDING
3-15	COOLING BUILDING
3-16	SERVICE BUILDING
3-17	FINAL POUR AND ASSEMBLY
3-18	SERVICE BUILDING
3-19	SERVICE BUILDING
3-20	SERVICE BUILDING
3-21	SERVICE BUILDING
3-22	SERVICE BUILDING
3-23	SERVICE BUILDING
3-24	SERVICE BUILDING
3-26	POUR BUILDING
3-27	SUBSTATION
3-28	WASH PIT
3-29	TOILET
3-30	TOILET
3-31	TOILET
3-32	SHIPPING BUILDING
3-33	WATER HEATER ROOM
3-38	TNT MAGAZINE
3-41	TOILET
3-42	WASH PIT
3-43	HEATER BUILDING



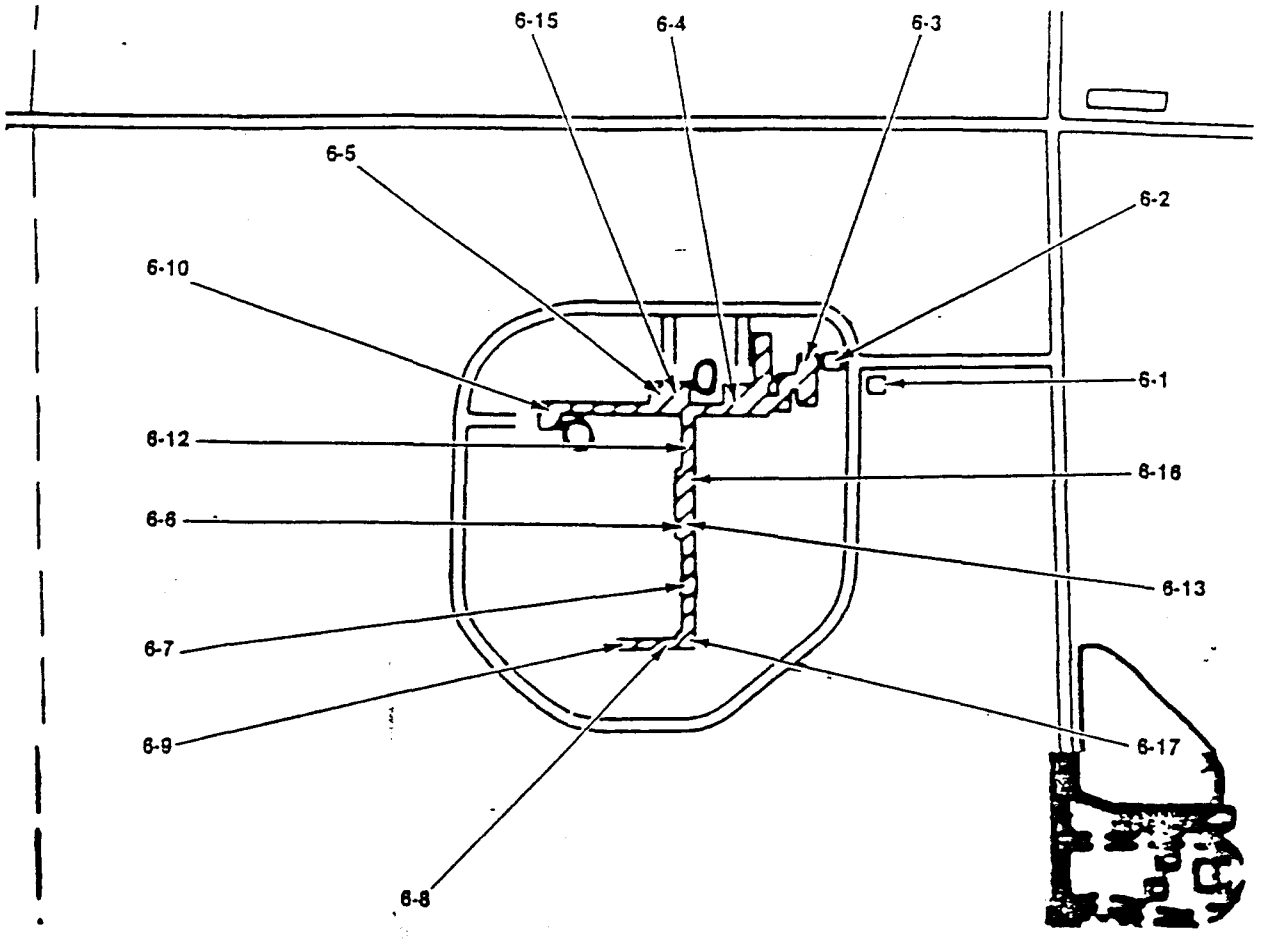
NOTE: LINE SET-UP AND BUILDING DESIGNATIONS ARE ESSENTIALLY SIMILAR FOR ALL FOUR BOMB LOADING LINES.

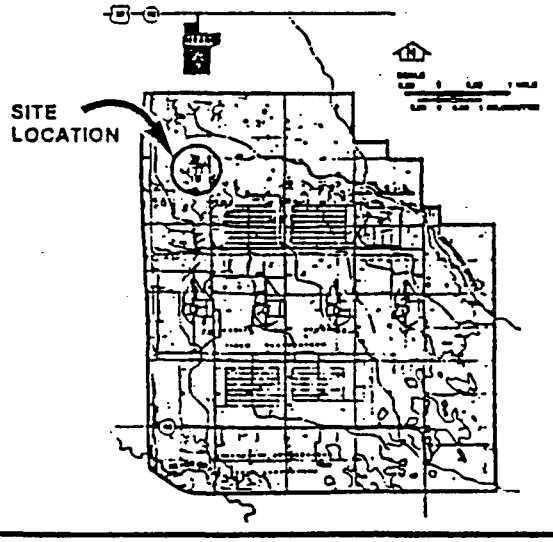
SOURCES: USGS, 1969a.
NOP, n.d.a., 1959.

Appendix A, Figure III

BOMB LOADING LINE —— NEBRASKA ORDNANCE PLANT

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland



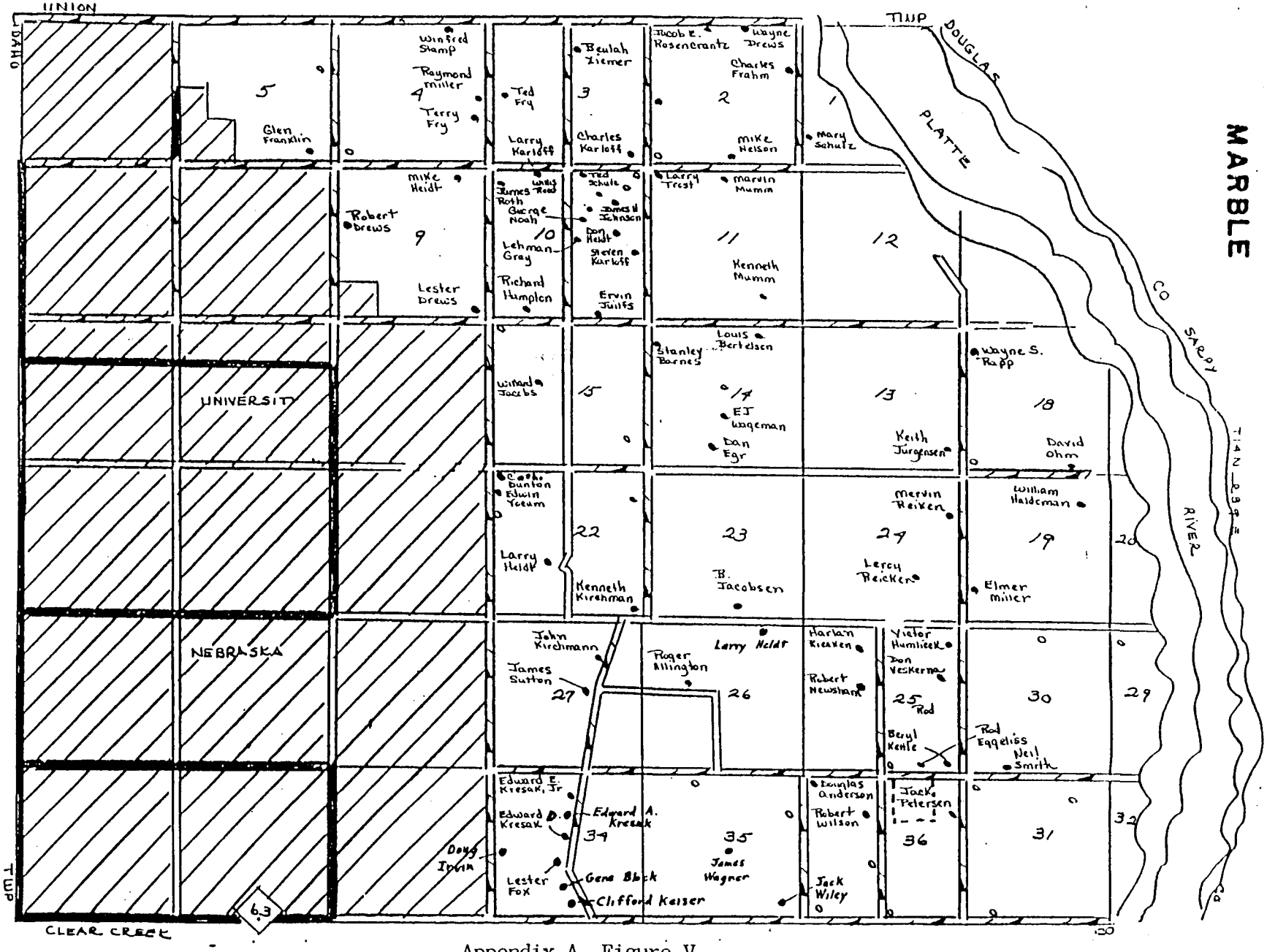


BUILDING	DESCRIPTION
6-1	GATE HOUSE
6-2	LINE OFFICE
6-3	BOILER HOUSE
6-4	INERT STORAGE
6-5	BOOSTER ASSEMBLY
6-6	TETRYL PELLETING
6-7	TETRYL REST HOUSE
6-8	SCREENING AND BLENDING
6-9	MAGAZINE
6-10	MAGAZINE
6-12	TOILET
6-13	TOILET
6-15	VACUUM CLEANER BUILDING
6-16	VACUUM CLEANER BUILDING
6-17	VACUUM CLEANER BUILDING

SOURCES: USGS, 1969a.
NOP, n.d.a., 1959.

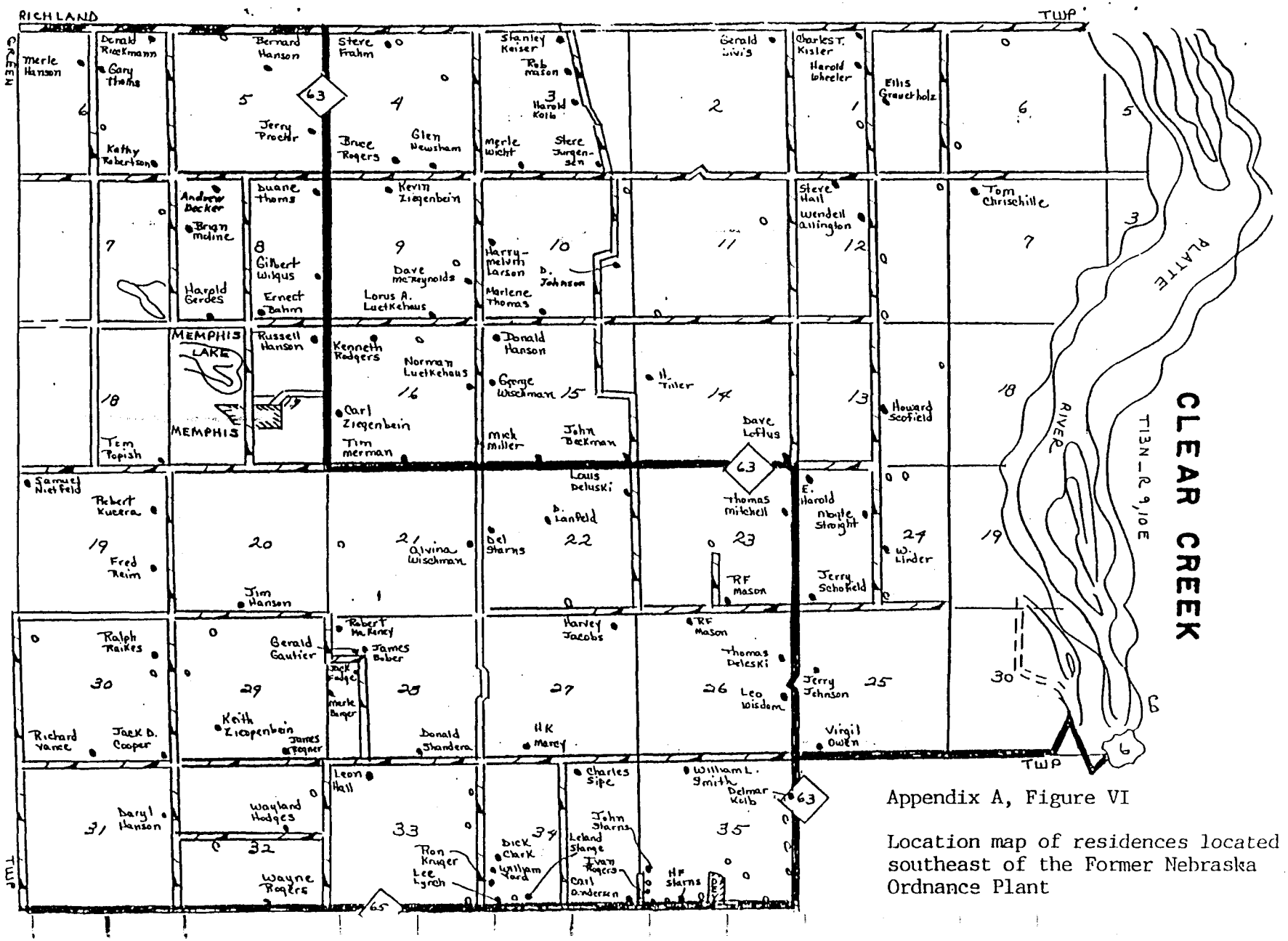
Appendix A, Figure IV
BOOSTER ASSEMBLY AREA——
NEBRASKA ORDNANCE PLANT

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland



Appendix A, Figure V

Location map of residences located east of the Former Nebraska Ordnance Plant



Appendix A, Figure VI

Location map of residences located southeast of the Former Nebraska Ordnance Plant

Atlanta GA 30333
May 29, 1990

Greg McCabe
Waste Management Branch
Region VII
U.S. Environmental Protection Agency
726 Minnesota Ave.
Kansas City, Kansas 66101

Dear Mr. McCabe:

The Agency for Toxic Substances and Disease Registry (ATSDR) appreciates your assistance during our site visit at the Former Nebraska Ordnance Plant National Priorities List (NPL) Site. The information collected during the site visit will assist ATSDR in developing the Health Assessment for this NPL Site.

One area of concern noted during the site visit is the possible emission of asbestos fibers to the ambient air. During the site visit, University of Nebraska employees gave us a tour of the old ordnance manufacturing facilities. The University does not use all of the former manufacturing buildings; moreover, the unused areas are in a state of disrepair. Steam pipe asbestos is located in these unused areas, typically where the doors and roofs are either missing or broken. The integrity of the asbestos has not been preserved. Asbestos insulation is hanging off the pipes and has fallen onto the ground. University employees reported seeing white clouds of material coming off of these pipes during the windy dry summer seasons. Access to these areas is not restricted. Fortunately the asbestos areas are not normally visited by University employees. However, the release of asbestos fibers into the environment should not be permitted because the potential for adverse human health outcomes does exist.

We understand that the steam pipe asbestos is not part of the NPL Site. However, we bring this issue to your attention so it may be referred to the appropriate U.S. Environmental Protection Agency Region VII unit. Should there be any questions concerning this issue, please contact me. I can be reached through this office or by telephone at FTS 236-0605.

Sincerely yours,

Sven E. Rodenbeck

Sven E. Rodenbeck, P.E.
Environmental Engineer Consultant

cc:
C. Harold Emmett, ATSDR
Lynn Berlad, ATSDR
Dan Harper, ATSDR/Region VII
Adi M. Pour, Nebraska Department of Health

APPENDIX C

Response to Public Comments

SUMMARY OF PUBLIC COMMENTS

The Nebraska Ordnance Plant (former) Preliminary Public Health Assessment was available for public review and comment from May 1 - 30, 1991. The Public Comment Period was announced in five local newspapers. Two repositories (the Mead Village Office and University of Nebraska Research Development Center) were established to permit public review. In addition, copies of the Public Health Assessment were automatically sent to eight individuals who were thought to be interested in reviewing the findings. Only one individual submitted comments. The comments and the corresponding response are summarized below.

Comment
The first off-site sampling was conducted by the Corps' in February 1989 not December 1988.

Response
The Public Health Assessment was corrected.

Comment
The Corps' installed a carbon filtration system at the one home which utilizes the two wells contaminated with both RDX and TCE.

Response
The Public Health Assessment was revised to reflect this recent development.

Comment
Technically, the aquifers in the Todd Valley also discharge to the Silver, Wahoo, Johnson, and Clear Creeks and then to the Platte River.

Response
The Public Health Assessment was revised to clarify this issue.

Comment
The most current residential well monitoring data were submitted. The data indicates that two additional residential wells may be contaminated above levels of public health concern.

Response
The monitoring data was reviewed. The Public Health Assessment was revised to reflect these recent results.