Public Health Assessment

Joslyn Manufacturing and Supply Company Site, West Area

City of Brooklyn Center, Hennepin County, Minnesota

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Prepared by:

The Minnesota Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes public health concerns at a hazardous waste site in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation:

- Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

- Soliciting community input: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us*.

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Summary

Minnesota Department of Health (MDH) staff were requested by Minnesota Pollution Control Agency (MPCA) Superfund Program staff to prepare this Public Health Assessment for the West Area of the Joslyn Manufacturing and Supply Company site in Brooklyn Center, Minnesota. The Joslyn site is a former wood treating operation.

Investigations conducted in the West Area from as far back as the 1940s have documented releases of contaminants from the former Joslyn wood treating operation and its predecessors. Surface soils, sediments, and surface water in some parts of the West Area are contaminated with pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAHs), and dioxins at levels that are well above current applicable state and federal human health and environmental screening criteria. The extent of this contamination has not been fully defined, and off-site contamination is possible. Potential impacts to Twin Lakes cannot be ruled out based on available information and the limitations of existing data.

Based on a review of available information in MPCA and MDH files, various site visits, and meetings with neighborhood groups, it appears that exposure to contaminated soil and sediments in the West Area may have occurred in the past. While the extent of possible exposure is difficult to evaluate, adverse health effects are unlikely. Cancer rates for the community around the site are within normal ranges. The construction of a fence around the majority of the West Area as an interim response measure should limit current and future exposures to contaminated soil and sediment. Some uncertainty exists over the extent of continued human exposure, the lack of definition of the full extent of soil contamination, and the lack of adequate surface water, sediment, and fish data for Twin Lakes.

Introduction

The Joslyn Manufacturing and Supply Company site, West Area (the site), is located in the City of Brooklyn Center, Minnesota, just northeast of the intersection of France Avenue and State Highway 100. The site is bounded on the west by Twin Lakes, on the north by railroad tracks, open space, and commercial/industrial properties with a residential neighborhood beyond, on the south by a residential neighborhood, and on the east by the development portion of the Joslyn site, France Avenue and Highway 100. The location of the site is shown in Figure 1.

Wood-preserving operations were conducted at the Joslyn site from the 1920's until 1980. Groundwater and soils at the site are contaminated with pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PAHs). Polychlorinated dibenzo-p-dioxins and furans, common contaminants of PCP, have also been detected in soils and groundwater at the Joslyn site. The entire site was listed on the National Priorities List (NPL) in 1983, but the majority of the Joslyn site (with the exception of the westernmost portion, known as the “West Area”) has been de-listed from the Permanent List of Priorities (PLP), the state Superfund list, following cleanup. The de-listed portion of the site is currently undergoing commercial redevelopment under the oversight of the MPCA Voluntary Investigation and Cleanup (VIC) Unit, while ongoing investigation of the West Area remains under the oversight of the MPCA Superfund Program. The West Area is located on private property owned by Joslyn.

MDH has conducted several evaluations of the Joslyn site, with the most recent being a Public Health Assessment dated February 7, 1994 (MDH 1994). A brief update to that document, in the form of a memorandum, was prepared in 1995. These documents did not specifically address the West Area. MDH staff were requested by MPCA Superfund Program staff to conduct a review of available information regarding the West Area of the site, and to develop conclusions and recommendations regarding potential public health concerns. Information reviewed included historical reports and environmental sampling data, information from community members, and data from the Minnesota Cancer Surveillance System (MCSS). This document will focus primarily on the West Area.

Background

Site Description and History

The Naugle Pole and Tie Company was the original owner and operator of the site. Wood treating began at the Joslyn site in the early 1920s, but little is known about these early operations. In the 1940s, the Consolidated Pole Treating Company purchased the property. The Joslyn Manufacturing and Supply Company (now Joslyn Corporation), a partial owner of the Consolidated Pole Treating Company, became sole owner of the facility in the early 1960s. Wood treating operations continued under Joslyn's ownership until site closure in September 1980.

Site operations consisted of treating wood products, primarily utility poles. Lesser quantities of posts, railroad ties, and other timbers were also treated. Thermal treating processes involved dipping wood products into tanks of heated preservative solution and consisted of “butt-dip treatment” (partial emersion of poles – used in the 1920s through 1965) and “thermal treatment” (full immersion of poles – used from about 1945 through 1980). In 1965, a pressure treatment system became the main treatment process. The preservatives used at this site for wood treatment included creosote, PCP, and soluble metal salts (copper-chromium arsenate, or CCA). Creosote was the only fluid used in the butt-dip treatment process, and PCP the only treatment fluid used in the thermal treatment process. All three of the preservatives were used at different times in the pressure treatment system, with PCP being the predominant fluid used.

Wastes from these treatment processes included dirt, “wood sugars,” wood debris, waste treating fluids, and water (Barr 2000). Sludge (consisting of dirt, grit, wood scraps, and residual wood treatment fluids) was periodically removed from the butt-dip and thermal treatment vessels and from storage tanks. This sludge was buried on site. Boiler blow-down water, which consists of water from boilers used to heat the treating fluids and power steam engines, was generated until approximately 1965 and contained lubricating oils from the steam engines. Until roughly the 1950s, boiler blowdown water was disposed on site in a pond known as Pond C, which was one of three ponds used for the disposal of wastewater. Pond C is located in the West Area, and was constructed between 1937 and 1945 according to aerial photos (Barr 2000). Pond C also received surface water runoff from the site. From the 1950s on, the boiler blowdown water was sent to Pond B, an infiltration pond not located in the West Area. The pressure treatment system produced wastewater that contained residual wood treating fluids, and a disposal pond (known as

Pond A) was constructed following the conversion to a pressure treatment system in 1965 to hold this wastewater. This wastewater was routed through a reclamation system, and preservatives and oil were skimmed from the water before it entered Pond A. Pond A was located east of the West Area.

A Remedial Investigation (RI) was completed at the Joslyn site in 1986. Based upon findings of the RI and a subsequent Feasibility Study, final groundwater and soil remedies were selected. The remedy included four major components: 1) a groundwater pump-out and oil recovery system; 2) removal and off-site disposal of heavily contaminated soils; 3) excavation and on-site land treatment of the remaining contaminated soil; and, 4) long-term monitoring of groundwater. The selection process and a description of the remedy were presented in a Record of Decision (ROD) for the site signed by MPCA in 1989.

Over the years, a series of investigations and cleanup activities have been conducted at the Joslyn site by the Joslyn Corporation under MPCA oversight, and have been described in previous MDH documents. They include excavation and off-site disposal of wood-treating sludge and highly contaminated soil, construction of a land-treatment unit (LTU) for the biological treatment (a process using soil bacteria to break down the contaminants) of the remaining less contaminated soils, installation of a groundwater pump-out, oil recovery, and monitoring systems in both the upper and lower aquifers, and continued monitoring of groundwater quality.

The Superfund Record of Decision (ROD) for the Joslyn site, executed in 1989, required that the remaining contaminated soil be excavated and biologically treated on site (MPCA 1989). Numerical soil treatment goals were set for PCP and PAHs. Excavation was to occur to the limits of no visual contamination or to the water table. Decisions about whether soils had been excavated to the limits of no visual contamination were made on the basis of a field screening procedure known as the oil sheen test, or “spoon” test. The procedure for conducting the spoon test consisted of obtaining approximately 25 grams of soil with a stainless steel spoon, and then directing a stream of water onto the soil until saturation was reached and water collected on the spoon. The amount of oil sheen on the water was then observed, and results recorded as follows: no sheen, or trace, moderate, or heavy sheen. Soils with a moderate or heavy sheen were excavated for biological treatment, while soils with no or slight (trace) oil sheen were considered to have met the cleanup goals.

Biological treatment of contaminated soil in the LTU was completed in 1998. With the completion of soil excavation and biological treatment, the Joslyn site consisted of a vacant property surrounded by a chain link fence, which did not include the West Area. The cleanup was consistent with the ROD and with the industrial/restricted commercial land use of the site. The ROD also required a groundwater pumpout and treatment and oil recovery system, which are operating successfully and will be ongoing for the foreseeable future. As described in the most recent annual monitoring report, the operation of the groundwater pumpout system has contained the plume of contaminated groundwater to approximately within the boundaries of the former Joslyn site (Barr 2001a). Pumped water is pretreated on-site to separate oil and discharged (under a permit from the Metropolitan Council) to the sanitary sewer system. The oil is disposed separately off-site.

Since 1998, activities at the Joslyn site (with the exception of the West Area) have centered on the redevelopment of the property for industrial and restricted commercial use. The redevelopment, when complete, will consist of several large commercial warehouse buildings with associated access roads, truck loading docks, parking lots, and landscaped areas. The city of Brooklyn Center also plans to extend Azalia Avenue across the site. Prior to the beginning of redevelopment activities, surface soil sampling was conducted across the entire Joslyn site to determine residual concentrations of PCP, PAHs, and dioxins in the uppermost, or accessible, soil layer. The results of this sampling were used to develop appropriate response action and construction contingency plans for the protection of workers, surrounding residents, and the ultimate users of the property. Residual soil contaminants are generally managed on-site by placing the soil under buildings or parking lots where the likelihood of future human exposure is minimal. Other areas will be covered with clean fill and vegetated. Institutional controls (in the form of deed restrictions on the future use of the property) are in place to help ensure that the contaminated soil is not made accessible for human contact. The development is consistent with the ROD and will provide additional protections that were not required by the ROD, but were identified by the MPCA during a mandated five-year review.

Geology/Hydrogeology

The Joslyn site is relatively flat and covered by sandy soil. Sandy fill was placed over much of the site during the early period of facility construction or operation. The site is underlain by an 80 to 140 foot thick sequence of unconsolidated (loosely arranged) sand, peat and sandy fill materials. The uppermost glacial deposit is a stratified fine- to medium-grained sand that ranges from 26 to 50 feet in thickness and is continuous under the site. This sand contains some beds of gravel and becomes progressively finer-grained with depth. The lower portions of the upper sand contains interbeddings of silt and silty clay. Beneath these materials is a layer of low-permeability silt, sand, and clay which ranges from 20 to 60 feet thick. This layer, referred to as the middle confining unit, covers the eastern two-thirds of the site. A buried bedrock valley under the western one-third of the site, including the West Area, is filled with sand and gravel. The valley cuts through the St. Peter and into the Prairie du Chien Group. The middle confining unit is absent in the buried valley.

The hydrogeology of the Joslyn site consists of an upper and lower aquifer. The upper aquifer is located within the unconsolidated materials and extends to depths of approximately 80 feet below grade. The lower aquifer, located below the middle confining unit, consists of the St. Peter Sandstone, the Prairie du Chien formation, and a sand and gravel unit that overlies these bedrock formations.

Groundwater in the upper aquifer moves from the west to east -- from Twin Lakes to the Mississippi River. The bedrock aquifers between the site and the Mississippi River are thought to be used only for industrial and residential, non-potable purposes. The St. Peter and Prairie du Chien-Jordan (deeper) aquifers also discharge to the Mississippi River. The Prairie du Chien-Jordan bedrock aquifers are important sources of drinking water for the Twin Cities metropolitan area. The municipal well nearest to the site draws from the Jordan and is about 1 mile to the northeast of the site.

Investigations in the West Area

The West Area was not directly used for wood treating operations, but rather for support activities. A railroad spur was located on the West Area, as was a small bunkhouse or barracks. The area now consists of a mixture of wooded uplands and defined wetlands, as shown in Figure 2. Contamination may have occurred in the West Area through a number of activities, including (Barr 2000):

- Sludge disposal or burial;
- Placement of contaminated fill;
- Use of Pond C for disposal of boiler blowdown wastewater; and,
- Overland flow of contaminated stormwater runoff.

The first soil samples collected in the West Area were from the former Pond C area in 1981. The soil samples were collected by Barr Engineering Company (Barr), an environmental consultant working on behalf of the Joslyn Corporation. Oil contamination was found at depths of 7 to 10 feet below ground level. No detailed chemical analyses of the soil samples were conducted, other than for the presence of arsenic and chromium; several aquatic toxicity tests were also conducted. The soil was determined to not meet the definition of a hazardous waste under Minnesota rules. In 1997, a soil boring (C-1A) was advanced near the location of one of the 1981 soil samples. Laboratory analysis of soil samples from the boring found PCP and PAH contamination extending to at least 8 feet below ground. The locations of historical soil samples, soil borings, and excavation areas are shown in Figure 3.

One soil boring (PB-1) was drilled to a depth of 141 feet in 1985 at the northern end of the West Area. A creosote odor was noted from a depth of 0 - 4.5 feet; below that level no evidence of contamination was noted. In 1989, 2,500 cubic yards of soil were excavated from this area. The soil was moderately contaminated (PCP concentration of 41 mg/kg, carcinogenic PAHs (cPAHs) concentration of 35 mg/kg), and was treated biologically in the LTU.

In 1997, additional soil borings were drilled in the area of Pond C to depths of up to 20 feet below ground. Analysis of soil samples from the borings showed low levels of PCP. Elevated levels of PAHs were found at depths between four and eight feet in one of the borings (PSS1). An oily sheen was also observed in this boring between four and 14 feet below the surface.

A series of hand-drilled borings was conducted around previous borings C-1A and PSS1 in 1997 to visually define the area of contamination in the surficial soils around these borings. No soil samples were collected for laboratory analysis from these borings. However, a composite soil sample from the identified contaminated area was collected and analyzed for PCP and PAHs. PCP was detected at a concentration of 1,300 milligrams per kilogram (mg/kg), and cPAHs were detected at a total concentration of 638 mg/kg. Five additional hand auger borings were then drilled, and soil samples collected and analyzed for PCP and PAHs to confirm the results of the previous visual borings. PCP ranged from 2.8 to 160 mg/kg and total cPAHs ranged from 62 to 886 mg/kg. This area (identified as the 1997 Excavation Area in Figure 2) was then excavated to a depth of 3 feet (at or below the level of the water table) and 650 cubic yards of soil were removed for treatment in the LTU. The area was then backfilled with clean soil from off site.

Soil samples collected from the base of the excavation showed contamination remains below the clean fill.

Three samples of soil/sediments (DSS1, DSS2, and DSS3) were collected from the former ice chute and adjacent wetland area in 1997 by Barr and analyzed for PCP and PAHs. The ice chute was a ditch that ran across part of the site, and was used for transporting blocks of ice cut from Twin Lakes. It was suspected that the ice chute could have served as a channel for contaminated water from the site to reach Twin Lakes. The ice chute is still visible today, but has been partially filled by vegetation. Low levels of total PAHs (1.91 mg/kg) were found in sample DSS1, which was located at the mouth of the former ice chute where it enters Twin Lakes. PCP was below the laboratory detection limit of 5.7 mg/kg. PCP and PAHs were not detected above the laboratory detection limits in DSS2 and DSS3, which were collected in the ice chute further in from Twin Lakes and from the former outlet of Pond C respectively.

In 1998, a broad sampling program was implemented by Earth Tech, Inc., a consultant for the developer of the Joslyn site, in an attempt to characterize the extent of remaining shallow soil contamination across the entire Joslyn site, including the West Area. For the West Area, this sampling was designed to provide a final data set prior to delisting of the site from the state Superfund list. For the purposes of this sampling, the West Area was divided into seven sub-areas based generally on geographic features (an eighth was later added). The sampling sub-areas are shown in Figure 4, and the sample locations are shown in Figure 3. From each sub-area, up to five surficial (0-18 inches in depth) soil samples were collected and combined (or composited) to form one sample designed to be representative of the entire sub-area. Samples from area WA-7, which contains an open water marsh, were collected from sediments at a depth of 3 feet below the water level. The composite samples were then analyzed for PCP and PAHs, and some samples were also analyzed for polychlorinated dioxins and furans.

The analytical results of this sampling are shown in Table 1. The results showed levels of PCP below the MPCA Soil Reference Value (SRV) for residential soil of 71 mg/kg, and below the recreational soil SRV of 67 mg/kg with the exception of one area (WA-3). Visual evidence of contamination was observed in sub-sample location 5-WA-3. Total benzo(a)pyrene equivalents (a measure of the relative toxicity of mixtures of cPAHs) exceeded the residential SRV in four of the areas. The reported PAH data did not include the full list of cPAHs now considered of concern to MDH; benzo(a)pyrene equivalents were calculated using relative potency factors recently communicated by MDH (MDH 2001). Conservatively, one-half the detection limit was used for those samples where levels of PAHs were below the detection limit; detection limits were quite high in some samples. The assumption of one-half the detection limit is commonly made when evaluating such data. Dioxins and furans exceeded SRVs in some samples. Recreational SRVs are numerically the same as residential SRVs for cPAHs and for dioxins and furans. The SRVs are human health-based values and represent the concentration of a contaminant in soil at or below which normal dermal contact, inhalation, and/or ingestion is unlikely to result in adverse human health effects. The SRVs are generic criteria, and exceedances of SRVs only indicate the potential that the contamination could pose an unacceptable long-term human health risk.

To further characterize the contamination observed in area WA-3, five additional soil samples were collected (6WA-3 through 10WA-3). Analysis of these samples showed PCP concentrations of between 20 and 130 mg/kg. PAH levels were below the SRVs; dioxins and furans were not analyzed for. Subsequently, hand augers borings and test pits were used to further define the area of visibly contaminated soil around 5-WA-3. In 1999, approximately 1,000 cubic yards of visibly contaminated soil was excavated from this area and disposed of off-site in an approved landfill (Barr 1999a). The results of the analyses of the composite soil samples from the base of the excavation show that contaminated soil remains beneath this area, at a depth of at least 3 feet below ground. This depth is below the water table, which is the depth at which the groundwater surface is found.

Surficial soil, sediment, and surface water samples were collected by Barr in 2000 to fill in gaps in the data collected by Earth Tech, Inc. in 1998 (Barr 2000, Barr 2001b). The goal of this sampling was to confirm and further supplement previous data for PCP, PAHs, and dioxins and furans that were available for each of the identified sub-areas in the West Area. A similar sampling approach was used, i.e. composite samples were collected from up to seven sub-sample locations in each area. The sample locations used by Earth Tech, Inc. were duplicated in some instances. The area containing the former Pond C (WA-6) was divided further into three smaller areas (WA-6S, WA-6MID, and WA-6N) to better characterize the variability of residual contamination in different parts of the former Pond C. Sediment samples were again collected from the open water portion of WA-7, and one surface water sample was also collected from this area. A sample (WA-7M) was collected from the marsh (cattail area) of WA-7. Sample locations are shown in Figure 5.

The soil, sediment, and water samples were analyzed for pH, organic carbon, PCP, PAHs, and dioxins and furans according to the data gaps that were identified. Two soil samples and the sediment sample were also subjected to a water leach test. Due to perceived “significant” differences in the data between individual sub-areas, the reserved samples from WA-6MID and WA-6S were later submitted to two separate labs for duplicate analyses for dioxins and furans. In general, the results of these duplicate analyses correlated well. The analytical results of the soil sampling are presented in Table 1, and the results of the sediment samples are presented in Table 2. Surface water results are presented in Table 3. The results of the water leach test can be found in Table 4.

The results of the analysis of the surficial soil samples collected in the West Area show that soils exceed the residential and recreational SRVs for PCP, PAHs, and/or dioxins and furans in five of the eight sub-areas (WA-1, WA-2, WA-3, WA-6, and WA-8). In these areas, PCP and cPAHs are present at levels only slightly in excess of their respective SRVs (with one exception – PCP in sample area WA-3). The highest concentrations of dioxins and furans, as expressed in 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalency factors (TEFs), exceeded the SRV by a factor of several hundred. The TEF concept is a way of expressing the toxicity of mixtures of dioxins and furans, and is described later in this document.

The results of the analysis of sediment samples collected in area WA-7 show that concentrations of dioxins and furans exceed available MPCA SRVs for residential soil, and concentrations of PAHs approached the SRV in one sample. No applicable sediment screening criteria have been

developed by the MPCA. Analysis of the surface water sample collected in area WA-7 showed low levels of PAHs and dioxins and furans; PCP was below the laboratory detection limit. Only one PAH (benzo(a)pyrene), and TCDD were present at a level in excess of MPCA surface water standards or criteria. The results of the soil water leach test showed that PAHs, and very low levels of dioxins and furans were leached from sediments from site soils.

Investigations of Twin Lakes

Oil in the wetlands abutting the West Area and Twin Lakes was reported as early as the mid-1940s, when representatives of the Minnesota Department of Conservation and MDH found oil from the site on the surface of Twin Lake (MDH 1944). The oil was believed to have reached the lake from a drain pipe which emptied into a system of ditches, ultimately reaching the lake through a channel formerly used as an ice chute. A ditch connecting Pond C to the ice chute is clearly visible on aerial photographs from 1945 (Barr 1996). Oil was also noted by MDH staff in the swamp that lies along the east shore of the lake. Analysis of water samples (it is not clear how many) collected by MDH from the outlet of the drainpipe and from the lake itself showed low levels of phenol and creosote (4.17 and 0.0107 parts per million phenols, respectively). The MDH report went on to discuss three factors involved in the problem of waste disposal from the site: 1) pollution of the lake with dissolved phenols, creosols, and possible other chemicals; 2) unsightly pollution of the lake surface by oil films which may develop from continual discharge of oily waste; and, 3) fire hazards (MDH 1944). Along with a recommendation for enclosing part of the marsh with an earthen dike and use of an oil filter, the report also recommended that phenol concentrations in the lake be monitored. An MDH investigation of Twin Lakes, conducted in response to a fish kill in April of 1950, did not find evidence of phenolic contamination from the site in water and bottom fauna samples collected from Twin Lakes, but again noted heavy oil contamination from the site in the swamps along the lake. The 1950 report noted that the company had reportedly stopped the use of the marsh adjacent to the lake for wastewater disposal, and concluded that the source of the fish kill could not be identified.

Because of concerns over the potential impact of the Joslyn site on Twin Lakes, in 1982 the U.S. Environmental Protection Agency (EPA) collected three surface water and three sediment samples from Twin Lakes and analyzed them for PCP, PAHs, metals, phenolic compounds, volatile organic compounds (VOCs), pesticides, and TCDD (EPA 1983). The samples were collected from the north end of middle Twin Lakes (near the railroad bridge), from the bank of the lake on the edge of the West Area, and from the outlet to lower Twin Lakes near the Highway 100 crossing. The results of analysis of surface water samples showed low levels of one PAH, pyrene, in the sample collected near the lake outlet. PAHs were also found in the sediment sample collected from this location, but were not detected in the two other samples. One pesticide compound, alpha-BHC (also known as alpha hexachlorocyclohexane) was found at low levels in the sediment sample collected at the north end of middle Twin Lakes. This pesticide is not believed to be related to the Joslyn site. Arsenic found in some of the surface water and sediment samples (from the inlet area, and near the site) was attributed by EPA to natural background sources. Arsenic containing compounds have reportedly also been used for weed control in Twin Lakes. Detection limits were high for some analytes, such as PCP (25 mg/kg) and TCDD (100 micrograms per kilogram (σg/kg)).

Surface water samples were collected from six locations on Twin Lakes in January and May of 1985 (Barr 1986). The sampling locations are shown in Figure 6. Two samples were collected from Upper Twin Lakes, two were collected adjacent to the West Area, one was collected adjacent to the swimming beach located in the park south of the site, and one from the outlet at the Highway 100 bridge. The samples were analyzed for PAHs, heterocyclics, and phenolic compounds. Results are presented in Table 5. Levels of PCP and other phenolics were not detected above laboratory detection limits (5 σg/L for both), while detectable levels of PAHs were found at all six sampling locations in both sampling events. Two PAHs (benzo(a)anthracene and benzo(a)pyrene) exceeded MPCA surface water screening criteria in two and four of the six locations respectively. The highest levels were found in Upper Twin Lake, in a location that was some distance from the site and was intended to serve as a background sample location. PAH levels were generally higher in the January 1985 samples than in the May 1985 samples.

In 1997, MPCA staff collected a series of five sediment core samples from Twin Lakes for visual inspection (MPCA 1997). The sediment samples were collected parallel to the shore of Twin Lakes, at various distances from shore. Sample locations were from approximately the end of the former rail spur to the channel leading to upper Twin Lakes. The samples ranged from six inches to two feet in length, and were examined visually for signs of oil contamination. No signs of oil contamination, or odors, were found in any of the five sediment samples. No chemical analyses of the sediment samples were conducted.

Site Visits

On July 6, 2000, and on several occasions since that date, Jim Kelly of MDH has conducted site visits to the Joslyn Site, West Area. The West Area is located along Twin Lakes, and was reportedly not used for wood treating operations by Joslyn except for possible drainage or discharge of process water, as described above. A railroad spur, bunkhouse, and ice chute were the only physical features observed on historical aerial photos. The area now consists of mostly wooded upland areas, wetlands, and the shoreline of Twin Lakes.

Prior to the installation of fences around the West Area, visible trails could be observed. The most heavily used trail began in a yard at the end of Twin Lake Avenue North, on the southern end of the West Area. This trail was obviously used fairly frequently judging by the lack of vegetation on it, and the presence of footprints (both human and canine), bike tire tracks, and crude “bridges” over low spots. There were also beer and soda cans as well as other litter scattered along the trail. The trail split at several locations, with one side-path leading to a small sandy area or beach on Twin Lakes. There were several empty cans at this location, as well as an old tire in the water that was surmised to have been used as a swing based on the presence of sections of rope on the tire and on a nearby tree. The remains of a campfire were also visible nearby. Wild raspberries were observed growing in this area as well. Another side-path led to the wetland on the north end of the West Area; it appeared that this path would not be traversable except in very dry or frozen conditions.

The main trail continued through the West Area along the base of the berm on the west side of the Wickes warehouse. A silt fence at the base of this berm was in poor condition. Along the path, near a small stormwater pond outlet from the Wickes building, is an area of exposed

objects including small pieces of burned tire, scrap metal, and small miscellaneous auto parts. Vegetation is sparse in this area. It is not clear how these wastes came to be here. The trail ultimately exited the West Area at the railroad tracks to the north. It may have continued on the other side of the railroad tracks. The railroad line appears to be quite active, with many trains passing by each day from a rail yard located east of the site.

It was obvious that people used the West Area for some recreational purposes, such as walking, biking, dog walking, "partying,"and perhaps wading or swimming. The shoreline of Twin Lakes (with the exception of the small sandy area) and the wetlands on the site were relatively difficult to access from the trails due to the amount of vegetation.

Subsequent site visits conducted during the winter of 2000-2001 showed that the West Area was being accessed from the lake by snowmobiles and perhaps ice fishermen. In the spring of 2001 a large portion of the West Area flooded due to the rapid snow melt and heavy spring rains. Much of the West Area is below the 100-year flood elevation, and runoff from the Joslyn site development appears to have at least been partially directed onto the West Area.

During the fall of 2000, a fence was placed along the north and south property lines of the West Area to restrict access. A third fence connecting the two previous fences was erected along the east border of the West Area in the spring of 2001. A fourth section of fence was completed along the west side in the fall of 2001. At this time, the West Area is completely fenced except for a small section through the wetlands along Twin Lakes where installation of a fence would be difficult. No trespassing signs stating that the West Area is private property have been posted by the site owner. The Joslyn Manufacturing Company has also reportedly hired a security guard to regularly police the property (Joslyn 2001). The fence restricts access to the site and should limit the types of activities observed on the West area that are described above to all but the most determined individual. As a further precaution, the MPCA has posted signs along the fence at various locations stating the following:

> **Warning** – contaminated soil, sediments and water. Walking or playing within the fenced area should be avoided. Contaminants may be released from soil or sediments if disturbed.

Demographics, Land Use, and Natural Resources

The site is located in a densely populated, mixed use area of Brooklyn Center. Single-family and multi-family residential properties are located in proximity to the site. A park, including a swimming beach, is located on Twin Lakes approximately ¼ mile south of the site. Twin Lakes, as an urban lake, is used for recreational activities such as wading, swimming, boating, water skiing, and fishing. According to 1990 census data (the most recent census data is not yet available) the population within a one-mile radius of the site was estimated to be 15,687 people (ATSDR 2001). Of this number, there were an estimated 1,512 children under the age of six.

A search of the MDH County Well Index identified 33 water wells within a one-mile radius of the site (MGS 1997). These wells are a mixture of private wells, public supply wells, and commercial/industrial wells. This does not include the numerous monitoring and groundwater pumpout wells located on the remainder of the Joslyn site. None of the wells appear to be in a

directly down-gradient location from the site, and are unlikely to have been affected by contaminants from the site.

General Regional Issues

There are numerous leaking underground storage tanks (LUST) sites, hazardous waste generators, and VIC Program sites located within a one-mile radius of the Joslyn site. None are located in an upgradient location in terms of groundwater flow, and none are known to have impacted the site. General regional issues, as with many urban areas, would include overall groundwater quality, surface water runoff, air pollution, etc. Surface water quality has been identified by area residents as a specific area of concern with regards to Twin Lakes.

Community Concerns

A local community group, the Brooklyn Center Community Association (BCCA), as well as individual citizens living near the site, have expressed concern over contamination remaining in the West Area and the possible impacts on public health, including a possible increase in the incidence of cancer in humans and animals near the site (human cancer rates in the area of the site are discussed below). Specific concerns cited by community members (and MDH's response) during a meeting held on May 15, 2001 with MDH and MPCA staff included:

- Prior to the fence being erected, the area was used quite regularly by many residents in the neighborhood for dog walking, hiking, biking, and as a shortcut to the beach area. Kids frequented the area, using it for play, and older kids or young adults used it for parties. It was also reported that vagrants had been living in the area, though not necessarily in the West Area itself.
    - MDH has received numerous reports over the years of past uses of the West Area as described by the residents.
- One resident noted that children were still using the West Area for play by simply going around the partial fence that was constructed in the fall of 2000.
    - This type of activity has been made more difficult, but not impossible, by the extension of the fence.
- Also described was the continued use of the West Area by boaters, who had easy access from the lake, and by snowmobilers and ice fishermen in the winter.
    - Again, the extension of the fence should limit the occurrence of trespassing. Winter activities would likely result in limited exposure due to frozen soil conditions.
- Concern was expressed about runoff from the rest of the Joslyn Site through the West Area and associated wetlands and into Twin Lakes. Holding ponds were described as ineffective, allowing water to pass through them.
    - MDH shares the concern over stormwater runoff.
- Odors have been reported in the West Area, and off of the site to the north. The odors were described as "creosote-like," or "rotten." They have been reported on the north side of the Wickes building, and along the railroad tracks.
    - The source of the odors is unknown. The still active Canadian Pacific Railway line is a possible source, as are wetlands.
- Fishing is popular in Twin Lakes, and is more concentrated near the park and Highway 100 bridge on Lower Twin. Ice fishing is also common in the winter. It is unclear, and

perhaps unlikely that the fishing could be considered "subsistence" fishing. Fishing piers were reportedly being considered by the cities of Brooklyn Center and Crystal that could increase fishing opportunities in the lake.

- MDH is aware that Twin Lakes is used for recreational fishing.

- A proposed extension of a road across the development site could increase the potential for people to be exposed to contaminants in the West Area.
  - This document is focused on the West Area. The possible effect of construction activities in the developed portion of the Joslyn site on potential exposure in the West Area cannot be predicted.

A draft version of this Public Health Assessment was made available for public comment from April 8 to June 7, 2002. A press release announcing the availability of the document was issued. A story about the site also appeared on a local television news program, and included an interview with MDH staff. Comments were received from several community members, as well as from the responsible party. These comments, along with MDH's response, are summarized in Appendix V.

Agency for Toxic Substances and Disease Registry (ATSDR) Involvement

MDH, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), evaluated the public health significance of contamination associated with the Joslyn, West Area site. More specifically, MDH and ATSDR cooperated to determine whether health effects are possible and to make recommendations to reduce or prevent possible health effects. ATSDR, located in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services. ATSDR is mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by Superfund Amendments and Reauthorization Act (SARA 1986), to conduct public health assessments at contaminated sites. In cooperation with ATSDR, the MDH has evaluated the public health significance of the entire Joslyn site in the past, issuing a Public Health Assessment on February 7, 1994. The 1994 Public Health Assessment concluded that the Joslyn site represented an indeterminate health risk, stating that "available data do not indicate that people are being or have been exposed to levels of site contaminants that would be expected to cause adverse health effects, but data or information are not available for all environmental media to which people could be exposed."

Health Outcome Data Review

MDH staff evaluated data compiled over the last 10 years from the Minnesota Cancer Surveillance System (MCSS) for the zip code 55429, which includes the cities of Crystal and Brooklyn Center. While this area is much larger that the immediate area around the former Joslyn site, it is the smallest area available for analysis in the MCSS. The number of cancer cases reported in this zip code over the last 10 years is within the normal expected range for both men and women. In addition, no individual cancer sites showed a statistically significant difference from the expected rates for the population of Minnesota.

Evaluation of Contamination and Exposure

Soils and Sediment Contamination in the West Area

Surface soils on the West Area are contaminated with PAHs, PCP, and dioxins at levels that exceed current MPCA Soil Reference Values (SRVs) for soil in residential and recreational areas, as well as current ATSDR soil screening criteria. Soil screening criteria are discussed in greater detail in Appendix III. Based on composite sample data, and as indicated in Tables 1 and 2, PAHs exceed the SRVs in subareas WA-1, WA-3, and WA-6, while PCP exceeded the SRVs in subareas WA-3 and a portion of WA-6 (WA-6MID). Concentrations of dioxins and furans (as expressed in TCDD TEFs) exceed the SRVs and the ATSDR and EPA residential soil screening criteria in soils (or sediment) in six of the eight subareas (WA-4 and WA-5, along the shore of Twin Lakes, were the exceptions). Four of the eight areas exceeded the EPA action criteria of 1 ppb for residential soils. There is relatively little information about levels of contaminants in the sub-soil; qualitative evidence (from past soil borings) suggests that contaminants are present at depth in some areas.

The highest concentrations of dioxins in surface soils were found in areas WA-6MID and WA-6S, in the area of the former Pond C. The highest dioxin concentrations are associated with high organic carbon concentrations in the soil, which in the case of area WA-6 may be from sediment deposits in the former Pond C. In terms of the specific dioxins and furans found, the hepta- and octa-chloro dioxins and furans predominate. This is usually the case with wood treating sites, where the more highly chlorinated dioxin and furan compounds are often found in high concentrations relative to the other compounds (Copeland et al 1993; Laine et al 1997). This may be due to these dioxins and furans being present in higher concentrations in the PCP originally used in the wood treatment process, or as a result of the relatively faster breakdown of the less chlorinated compounds in the environment.

The use of composite sampling is best suited when the goal is to determine if contamination is present or not, as was the case with the initial sampling conducted for delisting of the site from the state Superfund list. It is also useful for determining average exposure concentrations across an area. While composite sampling is consistent with EPA guidelines, the use of composite sampling methods in this case made it difficult to determine the actual extent and the maximum level of the contamination in surface soil in the impacted areas. Without analysis of the individual point samples, it cannot be determined if one or several of the sub-samples used to make up the composite are contributing the majority of the dioxins, or if the contamination is present at that level in all of the sub-samples. Based on the existing composite data, the southern extent of contamination has not been defined. It is important to define the extent of contamination and to determine if it extends off of the site closer or into residential areas where exposure could be more frequent through routes other than directly contacting contaminated soil. It has been estimated that as much as 32% of indoor dust could originate from outdoor soil through foot tracking or other transport mechanisms, thus providing a secondary exposure route (Calabrese and Stanek 1992). This also contributes to the fact that residential screening criteria are typically lower than industrial or recreational criteria.

The results of the soil-water leach tests (Table 4) show that very low levels of dioxins can be leached from the surface soil and sediment, either in dissolved phase or bound to fine particulates that may have passed through the filter used in the test. Dioxins that are bound to soil particles may also therefore be carried by surface water runoff. This indicates that contamination may be carried towards Twin Lakes during the spring thaw or periods of heavy rain. At least a portion of the stormwater runoff from the adjacent development appears to have been routed through the West Area. In addition, contamination may have been carried from the West Area to the south, into the adjacent residential area, through the past use (and overflow) of Pond C, or more recently due to flooding of the site. The 100-year floodplain elevation in the area is 855.5 feet above sea level. This elevation encompasses almost the entire West Area, and extends off of the site to the south. During at least one site visit, standing water was observed on the site (in the area of Pond C) and extending off the site to the south in one continuous pond. These factors indicate that soil sampling off of the West Area to the south in low elevation areas is warranted.

Sediments in the open water area (WA-7) are contaminated with dioxins at levels in excess of MPCA SRVs for residential soil (see Table 2). No applicable ecological-based sediment screening criteria are available for comparison at this time, although they may be developed on site-specific basis by the MPCA. This indicates that sediments may pose a potential threat to human health if people come into regular contact with the sediments, which is unlikely. The surface water samples collected in area WA-7 also showed detectable levels of PAHs and dioxins, with levels of the PAHs benzo(a)anthracene and benzo(a)pyrene and TCDD exceeding the MPCA's surface water criteria (Table 3). In both sediments and surface water, once again the hepta- and octa-chloro dioxins and furans predominate.

The MPCA is currently working with Joslyn to finalize a plan for additional sampling in the West Area to better define the extent and magnitude of the contamination. This sampling effort will include discreet samples of soil, sediment, and surface water at various locations and depths. Implementation of this sampling plan will help address some of the uncertainties with the existing data.

Twin Lakes

In the past, oil from the Joslyn wood treating operation discharged into Twin Lakes. Two investigations were conducted by MDH in the 1940s and 1950s as a result of complaints of oil on Twin Lakes and a reported fish kill. Phenolic compounds were detected in lake water samples collected by MDH in 1944. Figure 7, which is a map produced by the predecessor to the Minnesota Department of Natural Resources (DNR) in the 1950s, shows a ditch running from a pond (most likely Pond C) on the site to Twin Lakes. Thus, there is a possibility that wastewaters from Pond C may have directly reached the lake. In the years since, contamination may also have reached the lake through the former ice chute that connects area WA-7 and Twin Lakes, or through stormwater runoff from the site. Based on the results of the most recent site investigations, small amounts of contaminants are capable of being leached from surface soils. Contaminants bound to soil organic particles (which is where PAHs and dioxins would concentrate) could also have been carried by storm or floodwaters into the lake.

Twin Lakes have been part of past investigations. In 1982, three surface water and three sediment samples were collected by EPA. While PCP and PAHs were not detected in the water samples (with one exception), laboratory detection limits for the surface water samples were not reported. Laboratory detection limits for the sediment samples were well above the current relevant screening criteria for PCP and dioxins, so although they were not detected in the sediment samples, the presence of these contaminants above levels of concern cannot be ruled out based on these analyses alone.

Six surface water samples collected in 1985 showed PAHs were present in many of the samples, with some levels exceeding MPCA surface water criteria (see Table 5). PCP was not detected in any of the samples; analyses for dioxins were not conducted. The PAHs were detected in samples collected both near the site and further away from the site. It is certain that there are other sources of PAH contamination to the lake, such as surface runoff from highways and streets, the railroad tracks and bridge, and boat traffic. In their report on the surface water sampling, Barr indicated that the PAH contamination was likely the result of outboard motors, motor fuels, or lubricants based in part on the similarity of the data (Barr 1986). However, for five of the six samples, which were collected at the same locations in January and May of 1985, the PAH levels were higher for the January sample when the lake was presumably frozen than in the May sample, when boat traffic would be expected to be at or near its peak. PAHs, which would likely be adsorbed to particulate matter, would tend to settle out of the water column during the winter months. Volatilization could account for some of the concentration differences, especially for the non-carcinogenic PAHs. The unknown effect of the spring and fall turnover, other sources of PAHs, and large runoff events make overall interpretation of the PAH results difficult.

Routes of Exposure

There are several routes through which people may be exposed to contaminants from the site. The routes of exposure from contaminated soil at a former wood treatment facility that was similar to the Joslyn operation were discussed in a study conducted by Copeland et al (1993). The study primarily focused on dioxins and furans, as concentrations of PCP and PAHs were generally below levels of concern. The potential routes of exposure they evaluated that may be applicable to this site include:

- Ingestion of contaminated soil / sediments;
- Inhalation of airborne particulates; and
- Dermal (skin) exposure to contaminated soil / sediments.

This discussion will focus on ingestion of and dermal contact with contaminated soil or sediments, which are the most likely routes of human exposure at the site. Inhalation of airborne dusts is not believed to be a major exposure route for contaminants in the West Area due to the fact that the majority of the contamination is in low-lying soils or sediments that are vegetated and often wet (or frozen). In addition, studies of inhalation hazards posed by dioxin contaminated soils have shown that inhalation will rarely be a significant route of exposure based on cancer risks (Paustenbach et al 1991). The source of odors reported by some local residents is unclear, but could be related to the railroad tracks and bridge. Creosote is still used for the

treatment of wooden railroad ties and bridge timbers. Other potential routes of exposure may include consumption of contaminated fish from Twin Lakes, incidental ingestion of and dermal contact with contaminated surface water in Twin Lakes, and ingestion of mother's milk. Due to the lack of data, it is not possible to evaluate fish consumption, exposure to surface water, or the ingestion of dioxins in mothers milk at this time. As with any lake, MDH's general fish consumption advisory should be followed (see Appendix IV).

The ingestion of contaminated soil (which can include sediments) is usually viewed as the primary means of exposure to non-volatile contaminants in soil, including dioxins. Such ingestion is usually incidental, and occurs from hand-to-mouth contact as a result of such activities as gardening or work activities (in the case of adults) or outdoor play activities (in the case of children). An exception to this is pica behavior in children, in which the intentional ingestion of sometimes large amounts of soil is a defining characteristic.

The amount of contaminant due to incidental ingestion that is absorbed into the body and available to cause an adverse effect is affected by a number of factors, including (Copeland et al 1993):

- The chemical concentration in surface soil;
- The bioavailability of the contaminant in the soil;
- The half-life of the contaminant in soil;
- The soil ingestion rate; and,
- The frequency of soil ingestion.

The oral bioavailability of dioxins in soil may be dependent on the soil organic content, and for TCDD has been found to range from 0.5% to 50% in animals (Copeland et al 1993). The bioavailability of other dioxin compounds, such as the octa-CDDs may be less, perhaps 10% the absorption rate of TCDD. In a study of digestive absorption of dioxins and furans in humans (from food) using a mass-balance approach, the maximum absorption of TCDD was 63%; again the absorption of the more highly chlorinated congeners was reportedly much less (Schlummer et al 1998). The same study also found considerable variability in absorption rates among the test subjects, with age being a key factor. Absorption rates in older test subjects were much less than in younger subjects.

The frequency and amount of soil ingestion are the most difficult parameters to estimate. Anecdotal reports by local residents near the Joslyn site have indicated that adults and children could have entered the site as frequently as several times per week as a result of hiking, dog walking, and other activities. Most screening exposure scenarios utilize a residential setting, where exposure to soil could be expected to occur on a regular basis. In a survey study of soil contact behavior by adults in a similar climate to Minnesota, the adults surveyed reported contact (at the 95th-percentile) with soil at their residence through such activities as home repairs or digging a little more than one time per week (Garlock et al 1999). The median soil exposure rate was less, on the order of once per month for home repairs or digging. Exposure frequency from activities such as gardening, other yard work, and team sports appeared to be much more frequent, although the survey units for the two groups of activities made direct comparison difficult. Some adults may also have higher soil ingestion rates. People who have frequent

contact with soil, such as gardeners, also tend to ingest more soil. Behaviors that involve frequent hand to mouth contact, such as smoking, can also lead to higher soil ingestion rates.

The intake of contaminants and the potential effects of dermal (skin) exposure to contaminants in soil are influenced by several factors, including (Copeland et al 1993):

- The chemical concentration in surface soil;
- Skin surface area available for contact;
- Skin adherence properties of soil; and,
- Dermal bioavailability.

The area of skin available for contact with soil can vary. Typically, it is assumed that skin contact involves the hands and lower arms, but can include the legs, feet, or other body parts. In the soil contact study described above (Garlock et al 1999), median skin area potentially exposed during various outdoor activities during warm months was approximately one-third of the skin area of the body (32%) as reported by adults responding to the survey. The researchers assigned the estimated skin area exposed based on the respondents replies using values for various body parts that were similar, but not identical, to values used by EPA. The skin area potentially exposed does not necessarily equal the area of skin that actually comes into contact with soil.

When skin comes into contact with soil, only a small amount is usually left on the skin surface once the contact has ceased. Contaminants that remain on the skin may be absorbed through it, at a rate that is based on the properties of the contaminant. EPA summarized several studies of dermal soil loading in children and adults and cited values of between 0.5 and 1.5 milligrams of soil per square centimeter of skin (mg/cm^2) (EPA 1999). It should be noted that these values were derived mainly from studies using the hands, which typically have a higher soil adherence factor than other body parts. Theoretically, there is a point at which an increase in soil loading does not result in further absorption of a chemical due to the establishment of a uniform layer of soil on the skin - any additional soil is not in contact with the skin. In a study of pesticide absorption from soil using cadaver skin, this value was estimated to be between 1 and 5 mg/cm^2 (Duff and Kissel, 1996). The type of soil (clay, sand, etc) may influence the value.

The amount of a chemical contaminant that can be absorbed through the skin from soil is dependent on the condition of the skin, the amount of contaminated soil applied, the soil characteristics, and the physical properties of the chemical. Typical values cited in the literature for the dermal bioavailability of dioxin based on animal studies range from 0.1 to 2% (Copeland et al 1993). In a study using pharmacokinetic modeling instead of animal testing, higher absorption rates were predicted, typically between 14 and 26% (Kissel and McAvoy 1989). These results have not been validated through animal testing, however, and may represent a theoretical rather than a practical maximum. An important factor affecting absorption is the speed at which it is absorbed. Dioxins appear to be absorbed slowly through the skin, indicating that if the exposed area is adequately washed within a reasonably short time after exposure, much of the absorption can be prevented (Banks and Birnbaum 1991).

Properties of the Contaminants of Concern

Pentachlorophenol

Pentachlorophenol (PCP) has traditionally been one of the most widely used chemicals for the preservation of wood products. It was recognized and used as an insecticide, fungicide, herbicide, molluscicide, and algicide in a wide variety of applications (ATSDR 1994). The most common use for the treated wood was for utility poles; other uses have included fence posts, railroad ties, cross arms, and other common industrial wood products. Because of its widespread use, PCP is nearly ubiquitous in the environment, having been found across the United States in surface waters, sediments, rainwater, groundwater, soils, food, and living organisms, including humans. It has historically been estimated that volatilization from the surface of PCP-treated wood products releases as much as 760,000 pounds of PCP to the air per year in the U.S. (ATSDR 1994).
In the environment, PCP may adsorb to soils depending on the pH of the soil and its organic matter content. The amount of PCP adsorbed at a given pH increases with increasing organic content of the soil (ATSDR 1994). PCP is more mobile in soil under neutral or alkaline conditions, and adsorption is minimal at pH values above 6.8. PCP may also have the ability to bioaccumulate, or build up, in the tissues of animals (such as fish) exposed to it. It has not been shown to become concentrated in animal tissues as it moves up the foodchain, however. PCP is able to be broken down by microorganisms in the soil, and biodegradation is thought to be the major pathway of PCP degradation in the environment. Biodegradation was successfully used to treat contaminated soils from the site in the LTU area.

Short-term exposure to high concentrations of PCP is associated with adverse effects to the kidneys, blood, lungs, nervous system, immune system, and gastrointestinal tract (ATSDR 1994). It can also cause a potentially serious increase in body temperature as the body attempts to metabolize it. Dermal contact can irritate the skin, eyes, and mouth. These types of exposures and concentrations are usually only seen in the workplace. Long-term exposure to lower levels of PCP can cause damage to the liver, kidneys, blood, and nervous system. PCP is considered a probable human carcinogen. Some of the adverse effects associated with exposure to PCP may be caused by impurities present in commercially produced PCP, such as dioxins and furans.

Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are produced by the incomplete combustion of organic materials such as coal, oil, wood, tobacco, and even food products (ATSDR 1995). They are also found in such products as asphalt, coal tar, creosote, and roofing tar. As a result, they are very common in the environment from such processes as volcanic eruptions, forest fires, home wood burning, and vehicle exhaust. Over 100 PAHs have been identified, and they are usually found in the environment as mixtures. PAHs generally fall into two groups based on their potential health effects: those that are carcinogenic (cancer causing, known as cPAHs), and those that are not (non-carcinogenic PAHs, or nPAHs). The PAHs found on the site (a mixture of cPAHs and nPAHs) are likely present as a result of the use of creosote in wood treatment. Creosote itself is usually derived from coal tar, and is described as a thick, oily liquid that is amber or black in color, and contains hundreds or even thousands of different chemicals

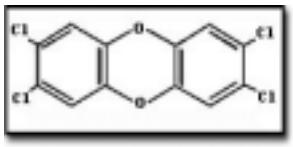
including PAHs and phenols (ATSDR 1996). It has been in use as a wood preservative and waterproofing agent for over 100 years.

PAHs tend to bind to soil particles, especially organic matter, and therefore tend to remain in soils and sediments. Because of their affinity for organic matter, PAHs can accumulate in aquatic and terrestrial organisms, but unlike PCP, can become concentrated as they move up the foodchain (ATSDR 1995). This effect is somewhat balanced by the ability of many organisms, such as fish, to metabolize PAHs. In soil, PAHs can be broken down by microorganisms. The rate and extent of biodegradation can be influenced by environmental factors, the composition of the soil, the type of microbes present, the presence of other toxic compounds, and the properties and concentrations of the mixture of PAHs present (ATSDR 1995).

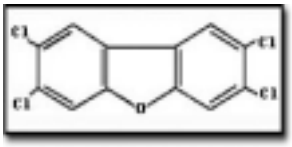
Individual cPAHs are classified as probable or possible human carcinogens by the International Agency for Research on Cancer (IARC) (ATSDR 1995). MDH uses information developed by the California Environmental Protection Agency to evaluate the carcinogenicity of cPAHs, and the list of cPAHs of concern has been expanded from prior lists typically reported by EPA (MDH 2001b). Exposure to high levels of PAHs in general has also been associated in animals with reproductive difficulties and adverse effects on the skin and immune system. Adverse effects on the liver and gastro-intestinal tract have also been noted.

Polychlorinated dibenzo-p-dioxins

Polychlorinated dibenzo-p-dioxins were the most elevated of the contaminants found at the site. They consist of a family of 75 different chemical compounds, commonly referred to as polychlorinated dioxins or just dioxins (ATSDR 1998). This family is further divided into eight groups, based on the number of chlorine atoms in the particular dioxin compound. There are a number of different dioxin compounds in each group (also known as congeners), based on the position of the chlorine atoms on the dioxin molecule. The names of individual dioxin compounds denote both the number and position of the chlorine (Cl) atoms. Furans are a similar family of compounds, differing from dioxins only by the lack of one of the two oxygen (O) atoms between the benzene (six-carbon atom, circle-shaped) ring structures. The chemical structures of two of the most studied (and toxic) compounds, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and 2,3,7,8-tetrachlorodibenzo-p-furan (TCDF) are shown below:



TCDD



TCDF

Dioxins and furans have never been manufactured, but are formed as a result of the incomplete combustion of fossil fuels, organic matter, and waste materials, during the bleaching of paper in pulp and paper mills, and as a by-product in the production of other chemicals such as PCP and the herbicide 2,4,5-T (ATSDR 1998). In the environment, dioxins and furans always occur as mixtures. Once in the environment, dioxins tend to bind to small particles or organic matter. They do not dissolve easily in water or air. As a result, they tend to settle out of the air or water

and end up in soils or sediments. In sediments, dioxins are taken up by microscopic plants or animals through feeding or direct contact. Dioxins can then pass through the foodchain and become concentrated in the tissues of larger animals, especially in the fatty tissue. The bioconcentration effect is more pronounced than in the case of PCP because dioxins are much more stable in the environment, and are much harder for most organisms to break down. Dioxins in soil can be transported to surface water bodies via runoff, and animals may be exposed to them through indirect ingestion or dermal contact. Plants do not efficiently take up dioxins through their roots, but may have dioxins on their surfaces as a result of particle deposition (ATSDR 1998). Animals that eat the plants may then ingest the dioxins.

On the surface of the soil, dioxins may be broken down by sunlight, a process known as photodegradation. The half-life of TCDD on soil may be on the order of 15 years at the soil surface (Paustenbach et al 1992). This process is only effective in the top few millimeters of soil where ultraviolet light can penetrate (EPA 2000). Burial in place (by the constant accumulation of airborne dust and dirt, erosion, and the buildup of organic matter) or erosion to surface water bodies are likely the main environmental fate of dioxins in soil. Once buried (i.e. in the sub-soil), TCDD has been shown to have a half-life of up to 100 years, and likely becomes tightly bound to soil organic matter (EPA 2000).

As a result of natural and man-made processes, dioxins are found nearly everywhere in the environment. Dioxins have been found in the fat tissue of humans across the U.S., even in those who have no known exposure to dioxins. This indicates that exposure is widespread, and is likely occurring through the food supply. Foods containing animal fat, such as meat, fish, and dairy products are the most common dietary sources. Dioxins may also be passed from mother to infant through breast milk, which is high in fat.

According to an EPA summary of available studies, background levels of dioxins in soils in rural areas in North America average 2.5 parts per trillion (ppt, or 0.0025 ppb) as expressed using TEFs, with a range of between 0.1 to 6 ppt (EPA 2000). In urban areas, the average cited by EPA is 9.4 ppt (0.0094 ppb), with a range of between 2 and 21 ppt. Background levels in sediments average 5.31 ppt (0.00531 ppb) with a range of from less than 1 ppt to 20 ppt.

Exposure to high levels of dioxins is associated with chloracne, a severe skin disease, as well as other skin disorders. Such skin diseases usually result from exposure to high concentrations for an extended time period, such as in the workplace or from an industrial accident. Studies in animals have shown that long-term exposure to lower levels of dioxins can affect the liver, and may cause reproductive or developmental effects. Dioxin exposure may also be associated with changes in the immune system (Stehr-Green et al 1987). The dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was recently listed as a “known human carcinogen” by the National Institutes of Health (NIH) based on studies in humans and animals (NIH 2001). EPA characterizes TCDD as “carcinogenic to humans,” and considers mixtures of dioxins to be highly potent “likely” carcinogens (EPA 2000). Exposure to TCDD is thought to be associated with an increased risk of all cancers, rather than a specific type of cancer. TCDD is believed to be a cancer promoter, rather than an initiator (Aylward et al 1996). Cancer initiators cause direct genetic damage that can also lead to mutations. The initial mechanism by which dioxins are thought to induce adverse health effects, including cancer promotion, is by binding with a cellular protein known

as the aryl hydrocarbon receptor (AhR). The chain of events that may lead to an adverse health effect following this action is poorly understood (EPA 2000). The AhR protein is part of a family of cellular proteins that play an important role in normal physiological function.

Not all dioxins and furans are as toxic as TCDD, but all are thought to cause adverse effects through the same mechanisms. Penta- and hexachloro-dioxins with chlorine atoms in the 2,3,7 and 8 positions appear to have similar toxicities, while other dioxins that do not have chlorine atoms in those positions are relatively less toxic (ASTDR 1998). To assess the toxicity of mixtures of dioxins and furans, a series of toxicity equivalency factors (TEFs) have been developed that compare the toxicity of other dioxins and furans to TCDD. The overall toxicity of a mixture can then be calculated in terms of total TCDD equivalents. The TEFs currently proposed for use by EPA were published by the World Health Organization (WHO) in 1998 (EPA 2000). The TEFs are based on existing toxicological data on individual dioxins and furans, or are estimated using a number of different methodologies. They are designed to be an interim approach pending additional research on specific dioxin and furan compounds. The current WHO TEFs are as follows (EPA 2000):

Dioxin/Furan TEFs, WHO 1998

Dioxin (D) Congener	TEF	Furan (F) Congener	TEF
2,3,7,8-TCDD	1.0	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1.0	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
1,2,3,4,6,7,8,9-OCDD	0.0001	2,3,4,6,7,8-HxCDF	0.1
		1,2,3,4,6,7,8-HpCDF	0.01
		1,2,3,4,7,8,9-HpCDF	0.01
		1,2,3,4,6,7,8,9-OCDF	0.0001

Current estimates of the mean daily exposure in the general U.S. population to dioxins and furans is one picogram per kilogram of body weight per day (1 pg/kg/day) of TCDD equivalents (EPA 2000). A picogram is one-trillionth of a gram (0.000000001 gram). Estimates of the 95th and 99th percentile intake rates are two times the mean and three times the mean, respectively. Intake rates may be as much as three times the mean for children. The vast majority of this exposure is through the diet. Certain sub-populations, such as those who eat a particularly fatty diet, subsistence fishermen, and nursing infants may have a higher daily intake. Studies have shown that levels of dioxins and furans measured in human body fat samples have declined from the early 1980s to the present as a result of the increased regulation of emission sources and the subsequent decrease in levels measured in the environment (EPA 2000).

Cancer Risk Assessment

The potency of a carcinogen is typically estimated using mathematical models. In general, cancer potency is estimated from the linear term in the equation used to describe the observed data. The resulting number is known as a cancer slope factor, and describes the cancer risk per

unit dose. For ingestion, it is expressed in terms of the risk per milligrams of contaminant ingested per kilogram of body weight per day (mg/kg/day).

In the evaluation of potential carcinogens, or cancer-causing chemicals, MDH uses a negligible excess lifetime cancer risk of 1 in 100,000, or 1×10^{-5}. This means that a person exposed to a concentration of a carcinogen equal to the lifetime risk level of 1×10^{-5} for a lifetime would have up to a 1 in 100,000 chance of developing cancer from this exposure. MDH regards an incremental risk from a single source as negligible at this level, and it is a very small risk compared to the overall existing lifetime cancer rate in Minnesota of approximately 40%.

The cancer slope factor, the MDH negligible lifetime excess cancer risk number, and standard default exposure parameters are used to generate environmental screening criteria such as HRLs, HRVs, and SRVs. Site-specific information may be used where appropriate to develop more refined criteria. The common use of conservative exposure assumptions means that the actual risk from exposure to levels of contaminants at the various screening levels lies somewhere between zero and 1 in 100,000.

A possible shortcoming in this approach is the typical use of a 70-year lifetime exposure model. Chemical exposures are often unequally distributed over a lifetime, and there are critical periods of susceptibility at varying times, especially during pregnancy and childhood. Children may be especially susceptible to during periods of rapid tissue growth and development, and have a longer time in which to develop adverse health effects. A significant portion of lifetime risk may therefore be accumulated in a relatively short time. Traditional risk assessment methods do not adequately address the issue of the proportion of cancer risk accrued during different time periods when exposures are for less than a lifetime. Children also typically receive higher doses per body weight than adults (as in the case of dioxin), and may be able to absorb higher doses of some contaminants than adults, increasing their dose relative to adults for a given level of environmental exposure.

Risk Assessment and Dioxin

While levels of PCP and PAHs do exceed MPCA screening criteria in several of the sub-areas, they are not expected to significantly contribute to the cancer risk compared to dioxins and furans. This section will focus therefore on the health risks from exposure to dioxins and furans in soil and sediment in the West Area.

There has been considerable scientific debate over the potential health risks posed by exposure to dioxins, furans, and dioxin-like compounds. This may be in part due to the wide variety in responses seen in some species of test animals exposed to dioxins. The difference in the amount of dioxin needed to produce death in fifty percent of test animals exposed (a dose referred to as the LD_{50}) differs by more than 1,000 times between some species of rodents (Aylward et al 1996). The recent listing of TCDD as a known human carcinogen by NIH was challenged in court prior to its release, and there has traditionally been debate as to the carcinogenicity of dioxins in humans. Some studies indicate that the cancer hazard to humans posed by exposure to background or environmental levels of dioxins in the diet are not significant (Aylward et al 1996). The U.S. EPA has undertaken considerable effort to conduct a reassessment of the human health risks from exposure to dioxin (EPA 2000). The EPA report concludes that dioxins are

highly potent animal carcinogens and likely human carcinogens, and recommends a cancer slope factor (a measure of the relative potency of a carcinogen) of 1×10^6 $(mg/kg\text{-}d)^{-1}$, a value approximately six times higher than the previous EPA cancer slope factor of 1.56×10^5 $(mg/kg\text{-}d)^{-1}$ (EPA 2000). EPA also concludes that non-cancer effects from exposure to dioxin may occur at levels within 10-100 times of average intake and body-burden levels in the U.S. population, based mainly on animal studies. EPA has not established a "reference dose" for assessing exposures for non-cancer risk, but recommends a "margin of exposure" approach where estimated intakes are compared to background exposure levels. A judgment decision must then be made as to whether the incremental exposure represents an unacceptable risk.

The EPA's conclusions regarding the health risks, including cancer risks, from dioxin exposure have been questioned by both EPA's Science Advisory Board (SAB) and industry groups (Pianin 2001). The SAB recently stated, however, that the EPA reassessment document likely represents the best possible review of the current literature, that key issued raised by the SAB have been addressed, and that any shortcomings are likely a result of gaps in the available data that limit EPA's ability to develop a more refined quantitative risk assessment (EPA 2001).

While it is unlikely that exposure has resulted in any adverse health effects in residents near the site, concentrations of dioxins (as expressed in TCDD TEQs) in surficial soil and sediments exceed the current ATSDR residential screening criterion of 50 ppt in six of the eight sub-areas in the West Area. It is important to note that the less toxic hepta- and octa- dioxin congeners predominate at the site, and levels of TCDD are thousands of times less than the concentrations of these congeners.

The ATSDR screening, evaluation, and action criteria (and MPCA SRVs) were developed using a cancer slope factor of 1.56×10^5 $(mg/kg\text{-}d)^{-1}$. If the EPA recommended cancer slope factor of 1×10^6 $(mg/kg\text{-}d)^{-1}$ was used to develop new criteria and SRVs, they would be approximately six times lower if the same methodology were used. While the current ATSDR criterion is designed for screening use only, MDH recommends the use of the ATSDR screening criterion as a site cleanup goal for dioxin contaminated soil in the West Area in this case. This recommendation is due to the West Areas location being immediately adjacent to residential areas, its use for a variety of recreational activities, and its potential contribution of dioxin contaminated soils and sediments to Twin Lakes. A value of 50 ppt or less of dioxins and furans in soil would fall within the midrange of criteria calculated using the proposed EPA cancer slope factor, and is therefore recommended by MDH as an appropriate cleanup goal and is consistent with Minnesota's policy of recommending remediation goals which are based on an excess lifetime cancer risk of 1x10-5 . This is a state goal, not an ATSDR goal. Further discussion of other screening and action levels for dioxin is presented in Appendix 4.

The presence of dioxins in the West Area remains a significant concern for MDH. Due to the potential toxicity of these compounds and the fact that people are already exposed to them through their diet, MDH feels that potential exposure to dioxins from man-made sources such as the West Area should be minimized as much as possible

Agency for Toxic Substance and Disease Registry (ATSDR) Child Health Initiative
ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances at waste disposal sites. They are more likely to be exposed because they play outdoors, ingest more soil, and often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Given the sites wooded nature and its location near a residential area and parks, it has served as an attraction for local youth over the years. While the apparent foot trails were generally not in areas of high contamination, it is possible that children have been exposed to contamination in surface soil or sediments in the West Area during activities such as playing or hiking if these activities occurred in contaminated areas. If lake sediments or surface water are contaminated, exposure also could have occurred to recreational users of Twin Lakes, or from the consumption of fish. The extent of these potential exposures is difficult to evaluate. The construction of a fence around the majority of West Area and the use of warning signs as an interim response measure should limit access and minimize future exposures.

Conclusions

Investigations conducted in the West Area from as far back as the 1940s have documented releases of contaminants such as oils from the former Joslyn wood treatment operation and its predecessors. Surface soils, sediments, and surface water in some parts of the West Area are contaminated with PCP, PAHs, and/or dioxins at levels that are well above current applicable state and federal human health and environmental screening criteria. The extent of this contamination has not been fully defined, and off-site contamination is possible. Potential impacts to Twin Lakes cannot be ruled out based on available information and the limitations of existing data.

Based on a review of available information in MPCA and MDH files, various site visits, and meetings with neighborhood groups, it appears that exposure to contaminated soil and sediments in the West Area may have occurred in the past. The extent of possible exposure is difficult to evaluate. The construction of a fence around the majority of the West Area as an interim response measure should limit potential exposures to contaminated soil and sediment, but is not a permanent remedy and does not address all potential routes of exposure. In the future, the site poses an indeterminate public health hazard due to the uncertainty over the extent of continued human exposure, the lack of definition of the full extent of soil contamination, and the lack of adequate surface water and sediment data for Twin Lakes. If sediments or surface water in Twin Lakes are contaminated, additional exposures from recreational uses or fish consumption could also occur. Fish are known to bioconcentrate contaminants such as dioxins.

Recommendations and Public Health Action Plan

1. People should respect the fence and keep out of the West Area. Signs have been posted on the fence around the West Area warning of the presence of contaminated soils and sediments.
2. The discharge of stormwater from the rest of the former Joslyn site or surrounding areas should be evaluated and modified if necessary to avoid the transport and discharge of dissolved and particulate-bound contaminants into wetlands and Twin Lakes.
3. Additional soil sampling (using discreet sampling methods) is needed to further characterize the horizontal and vertical extent of soil contamination in the West Area, especially the former Pond C area. This sampling should extend off the site to the south. The use of alternate sample analysis methods for dioxins and furans may be acceptable as long as similar analytical detection limits are maintained.
4. To address human exposure concerns and minimize potential impacts to Twin Lakes, all areas of contaminated soils should be removed or adequately covered so that concentrations of PCP and PAHs are below recreational SRVs, and dioxin concentrations in surficial soils are at or below 0.050 ppb or preferably, urban background concentrations. A value of 50 ppt or less of dioxins and furans in soil would fall within the midrange of criteria calculated using the proposed EPA cancer slope factor, and is therefore recommended by MDH as an appropriate cleanup goal and is consistent with Minnesota's policy of recommending remediation goals which are based on an excess lifetime cancer risk of 1x10-5 . This is a state goal, not an ATSDR goal.
5. Sediment samples should be collected in Twin Lakes near former waste discharge areas as well as in potential human exposure areas. The latter samples should focus on shallow sediments, while the former should include the collection of core samples to some depth to identify past impacts. A core sample in the sediment deposition area (normally the deepest part of the lake) should also be considered.
6. Representative samples of various fish species from Twin Lakes should be collected and analyzed for dioxins and furans to determine if concentrations of these contaminants in the fish population could pose an unacceptable health hazard. Samples from other urban lakes may be needed for comparison since dioxins are ubiquitous in the environment.
7. MDH’s existing Fish Consumption Advisory should be followed by persons who consume fish from Twin Lakes. A copy of this document is attached as Appendix IV.
8. The construction of fishing piers in Twin Lakes should be postponed until potential contamination in Twin Lakes can be properly assessed.
9. Groundwater monitoring, pumpout, and treatment and oil recovery downgradient from the West area should continue to ensure that any contaminated groundwater migrating from the West Area is contained and managed appropriately.
10. MDH’s Public Health Action Plan for the site will consist of:
    a. Providing copies of this report to the MPCA, the City of Brooklyn Center, Hennepin County, the site owner, and any other interested parties advising them of our conclusions and recommendations;
    b. The development of an information sheet outlining the contents of this document; and
    c. Continuing to work with the MPCA staff in reviewing any additional available workplans and data, and participating in any meetings or other public outreach activities.

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Glossary

Absorption: How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure: Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Additive Effect: A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

Adverse Health Effect: A change in body function or the structures of cells that can lead to disease or health problems.

Antagonistic Effect: A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

ATSDR: The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level: An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific-environment.

Cancer: A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control

Carcinogen: Any substance shown to cause tumors or cancer in experimental studies.

CERCLA: See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure: A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway: See **Exposure Pathway**.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): **CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. ATSDR was created by this act and is responsible for looking into the health issues related to hazardous waste sites.

Concern: A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Delayed Health Effect: A disease or injury that occurs as a result of exposures that have occurred far in the past.

Dermal Contact: A chemical getting onto your skin. (see **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration: The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than that found in **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemcials of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Epidemiology: The study of the different factors that determine how often, in how many people, and in which people will disease occur.

Exposure: Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

HRL: **H**ealth **R**isk **L**imit. Groundwater quality criteria developed by MDH. Represents the concentration of a single contaminant, or a mixture of contaminants, that can safely be consumed daily in drinking water for a lifetime.

HRV: **H**ealth **R**isk **V**alue. Air toxics criteria developed by MDH. Represent concentrations of a contaminant in air that represent a lifetime health risk. Can also be multi-media based.

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

LTU: **L**and **T**reatment **U**nit. An area of the former Joslyn site, located just to the east of the West Area and used for the biological treatment of contaminated soils from the site.

MDH: **M**innesota **D**epartment of **H**ealth**.** Minnesota's public health agency**.**

MPCA: **M**innesota **P**ollution **C**ontrol **A**gency. Minnesota's environmental enforcement agency.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

PHA: **P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

PID: **P**hoto **I**onization **D**etector. A device for measuring the concentration of total organic vapors in air via ionization with ultra violet light.

Plume: A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). For examples:
the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, the location where fruits or vegetables are grown in contaminated soil, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRG: **P**reliminary **R**emediation **G**oal**.** US EPA soil cleanup criterion.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:
- Urgent Public Health Hazard
- Public Health Hazard
- Indeterminate Public Health Hazard
- No Apparent Public Health Hazard
- No Public Health Hazard

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
- breathing (also called inhalation),
- eating or drinking (also called ingestion), and
- or getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.

SARA: The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from chemical exposures at hazardous waste sites.

Sample Size: The number of people that are needed for a health study.

Sample: A small number of people chosen from a larger population (See **Population**).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

SLV: **S**oil **L**eaching **V**alue. Estimated concentration of a contaminant in soil that will not likely, through typical leaching processes, contaminate underlying ground water.

SRV: **S**oil **R**eference **V**alue. Estimated concentration of a contaminant in soil that will not likely pose a potential human health concern through exposure via ingestion, inhalation, and dermal contact.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Synergistic effect: A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.

TCDD: 2,3,7,8-Tetrachlorodibenzo-p-dioxin

TEF: **T**oxicity **E**quivalency **F**actor. Factors used to assess the toxicity of mixtures of dioxins and furans. They compare the toxicity of other dioxins and furans to TCDD.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

UST: **U**nderground **S**torage **T**ank. A large tank often used for the storage of gasoline, fuel oil, solvents or other liquids.

VOC: **V**olatile **O**rganic **C**ompound. Generally, an organic compound that easily volatilizes from soil or water.

APPENDIX I: FIGURES

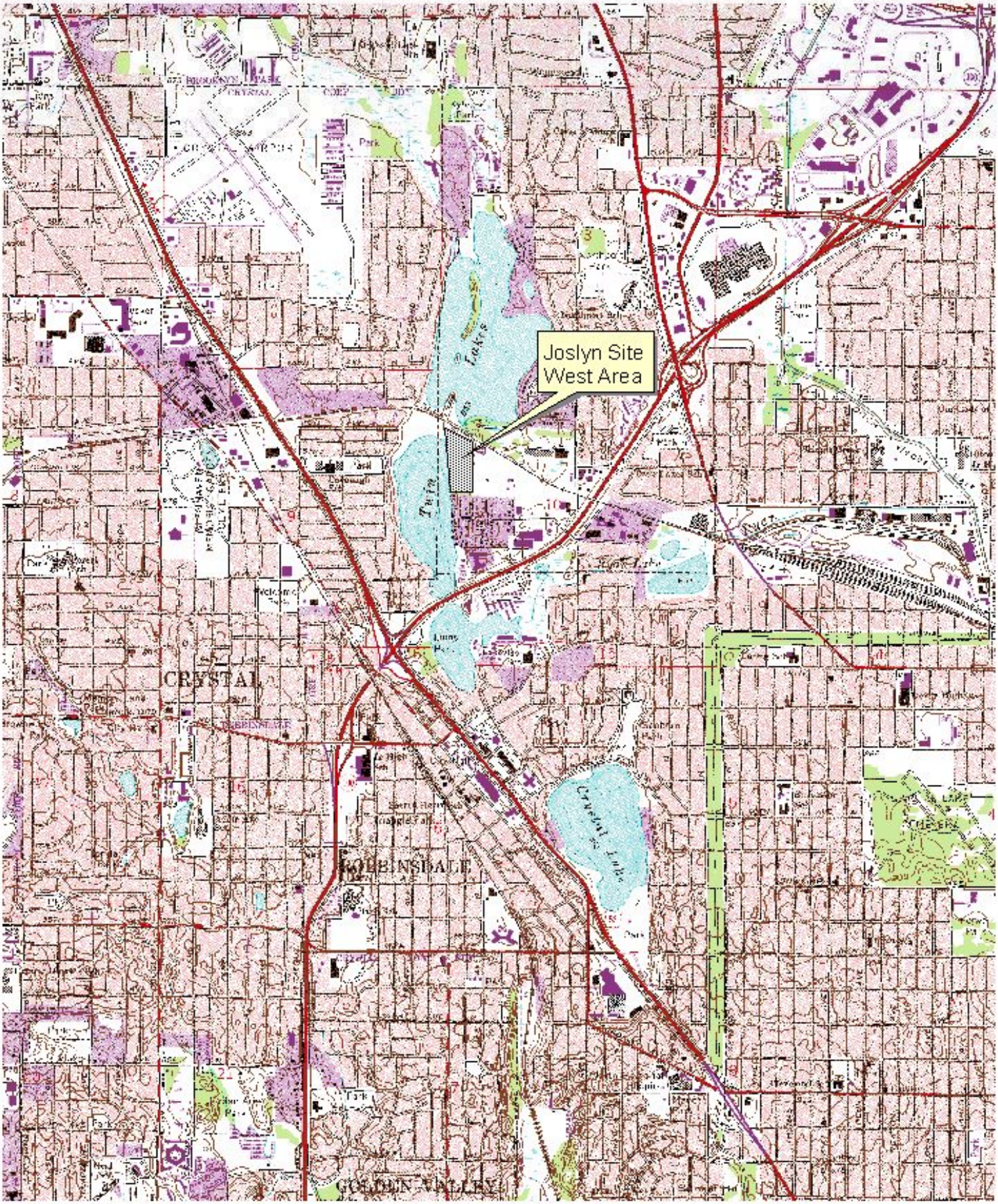


Figure 1: Joslyn Site, West Area Location

N

0 0.5 1 1.5 2 Miles

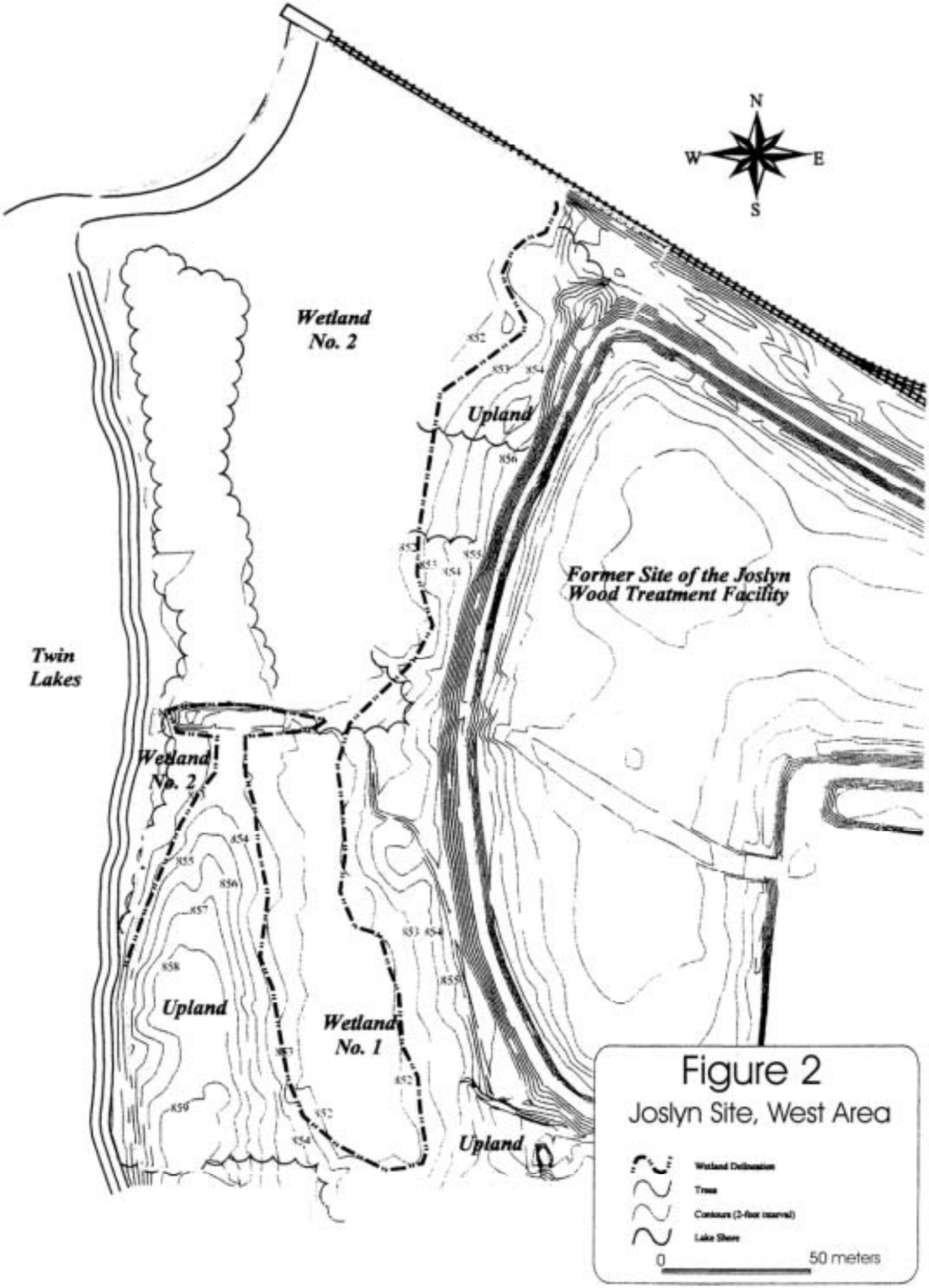


Figure 2
Joslyn Site, West Area

Source: Barr 2000

Figure 3: Historical Sample Locations

Source: Barr 2000

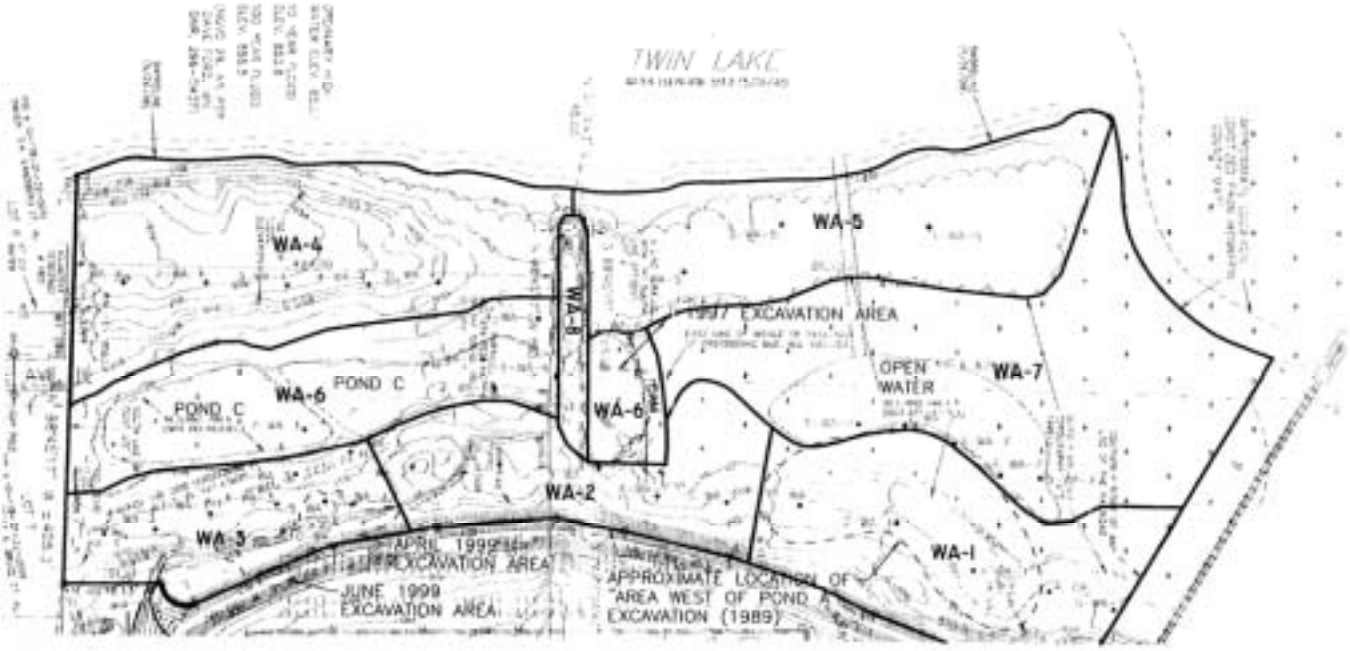


Figure 4: Sample Subareas

0 100
SCALE IN FEET

Source: Barr 2000

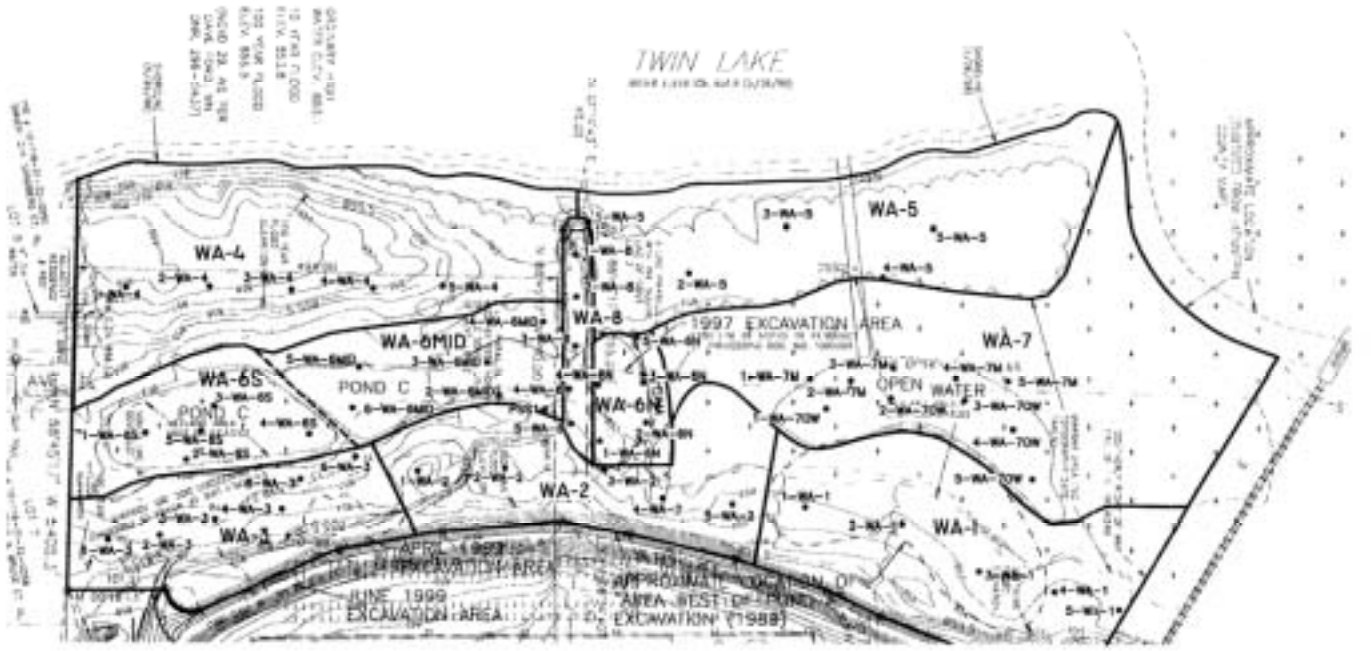


Figure 5: 2000 Sample Locations

Source: Barr 2001

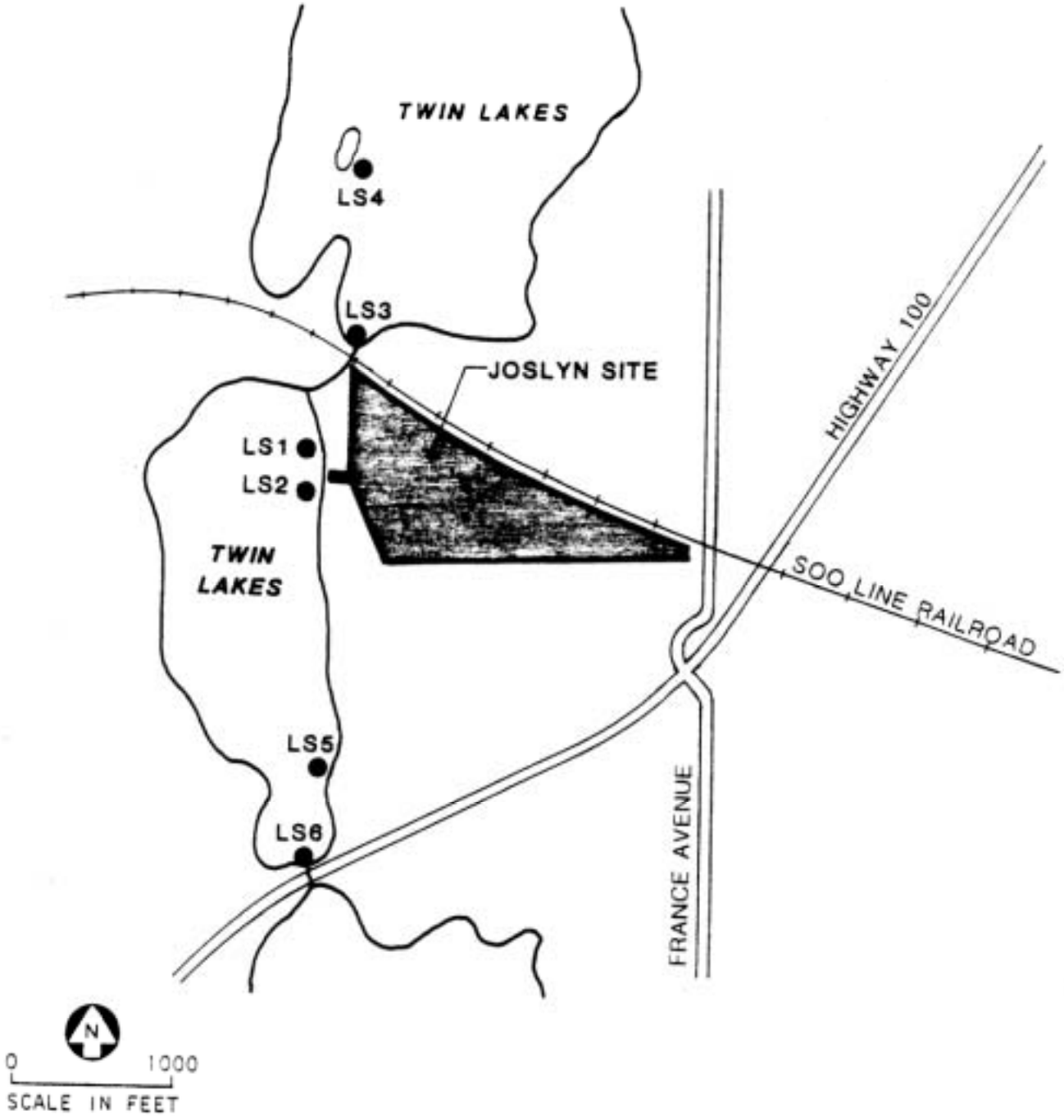


Figure 6: Twin Lakes Sample Locations

Source: Barr 1986

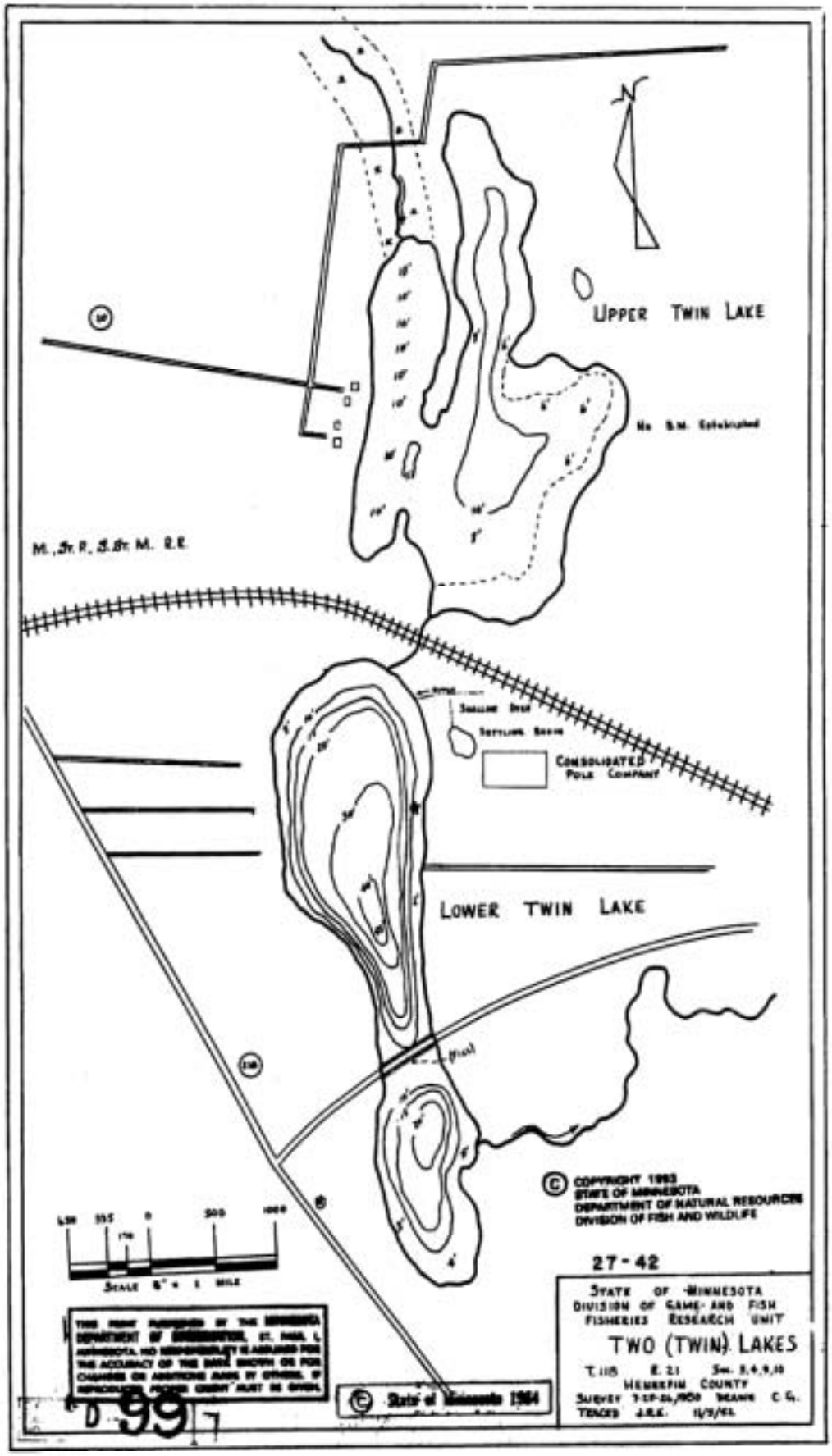


Figure 7: DNR Lake Map

c. 1950

APPENDIX II: TABLES

Table 1
Surficial Soil Analytical Results
Jordyn Site West Area

Analyte	RisKP Potency Factor (MDH)	TCDD Toxic Equivalency Factor (WHO 98)	MPCA Residential SRV	Loc. Code Lab	WA-1 Dec-98 Legend	WA-2 Dec-98 Legend	WA-3 Dec-98 Legend	WA-3 Oct-00 CAS	SWA-3 Feb-99 Legend	7WA-2 Feb-99 Legend	8-WA-3 Feb-99 Legend	WA-4 Dec-98 Legend	WA-5 Dec-98 Legend	WA-6 Feb-00 Legend	WA-6MD Oct-00 ALTA	WA-6MD Oct-00 STL	WA-6MD Oct-00 CAS	WA-6N Oct-00 CAS	WA-6G Oct-00 ALTA	WA-6G Oct-00 STL	WA-6G Oct-00 CAS	WA-7 Feb-99 Legend	WA-8 Oct-00 CAS	WA-9 Oct-00 CAS (Dup)
cPAHs, mg/kg																								
Benzo(a)anthracene	0.1				1.6	<0.33	0.44	0.14	<1.8	<5.1	<0.66	<0.33	<0.33	<0.4			1.4	0.22			0.17	<0.66	0.36	0.29
Chrysene	0.01				2.5	0.34	1	0.33	<1.8	<5.1	<0.66	0.41	<0.33	0.1 j			2.7	0.31			0.49	<0.66	0.54	0.43
Benzo(b)fluoranthene	0.1				7.2	0.8	2.4	0.48	<1.8	<5.1	<0.66	0.78	<0.33	<0.4			5.1	0.6			0.94	<0.66	0.8	0.45
Benzo(k)fluoranthene	0.1				2.1	0.34	0.76	0.24	1.8	5.4	1.3	<0.33	<0.33	4			2.7	0.24			0.43	0.81	0.41	0.32
Benzo(a)pyrene	1				2.8	0.36	<0.33	0.17	<1.8	<5.1	<0.66	0.42	<0.33	<0.4			2.3	0.24			0.58	<0.66	0.37	0.29
Indeno(1,2,3-cd)pyrene	0.1				0.88	<0.33	<0.33	0.24	<1.8	<5.1	<0.66	<0.33	<0.33	<0.4			11	1.1			0.71	<0.66	0.57	0.42
Dibenz(a,h)anthracene	0.38				<0.33	<0.33	<0.33	0.054	<1.8	<5.1	<0.66	<0.33	<0.33	<0.4			0.77	0.064			0.16	<0.66	0.091	0.068
RisKP Equivalents			2		[illegible]	0.58	0.81	0.31	1.68	4.8	0.94	0.41	0.29	[illegible]			4.77	0.49			0.85	0.82	0.6	0.46
PAHs, mg/kg																								
Acenaphthene			1,200		<0.33	<0.33	<0.33	<0.305	2.6	<5.1	<0.66	<0.33	<0.33	<0.4			0.063	0.048			<0.25	<0.66	0.01	0.007
Anthracene			7,800		0.98	<0.33	1.3	0.11	<1.8	<5.1	<0.66	<0.33	<0.33	<0.4			2.1	0.44			0.38	<0.66	0.68	0.11
Fluoranthene			1,000		4.1	<0.33	<0.33	2.5	<1.8	<5.1	<0.66	<0.33	<0.33	3.4 j			3.8	0.33			0.09	<0.66	0.64	0.46
Fluorene			1,140		<0.33	<0.33	<0.33	<0.005	<1.8	<5.1	<0.66	<0.33	<0.33	<0.4			0.065	0.003			<0.25	<0.66	0.008	0.007
Naphthalene			18		<0.33	<0.33	<0.33	0.072	1.7 j	<5.1	1.1	<0.33	<0.33	3.5 j			0.2	<0.005			0.061	0.7	0.025	0.006
Pyrene			600		5.1	0.41	5.1	0.33	<1.8	<5.1	<0.66	<0.33	<0.33	2.1 j			3.6	0.46			0.49	<0.66	0.62	0.42
Pentachlorophenol			71		4.2	2.2	[illegible]	39	50	30	20	<0.33	<0.33	40			[illegible]	3.72			[illegible]	1.1	0.83	0.71
Dioxins, ng/kg																								
2,3,7,8-TCDD		1			7.6	6.5		0.61				<0.1	0.58 emj		1,130	2,000	1,200	7.18	26	430	466		1.41	2.76
1,2,3,7,8-dioxin (penta)		1			63.4	31.7		256				0.44 emj	4.2 j		20,000	29,000	14,130	61.6	3,860	8,900 e	5,760		15.3	22.1
1,2,3,4,7,8-Dioxin (hexa)		0.1			177	218		561				1.8 j	12.1		144,000	192,000	75,000	233	27,900	35,000	35,700		381	72.1
1,2,3,6,7,8-dioxin (hexa)		0.1			81,250	1,800		15,500				5	40.1		188,000 e	212,000	106,000	627	95,300	110,000	112,000		490	82.6
1,2,3,7,8,9-dioxin (hexa)		0.1			909	478		1,600				3.9 j	35.3		95,000	140,000	60,400	328	35,900	28,000	31,900		91.8	95.5
1,2,3,4,6,7,8-dioxin (hepta)		0.01			32,500 e	13,600 e		291,000				125	1,212		6,340,000 e	4,400,000 ej	400,000	16,400	2,800,000 e	2,300,000 e	1,870,000		11,100	13,400
Dioxin (total)		0.0001			387,830 e	237,280 e		489,000				988	11,330 e		52,000,000 e	7,900,000	2,030,000	117,000	23,000,000 e	4,900,000 ej	1,800,000		125,000	130,000
Furans, ng/kg																								
2,3,7,8-TCDF		0.1			42.5	24.3		5.31				0.82	1.1 emj		1,340	1,300 e	1,120	4.75	124	135	114		13	13
1,2,3,7,8-dibenzofuran (penta)		0.05			154	103		56.2				0.76 j	3.9 j		8,600	10,000	6,600	18.8	891	1,900	722		63	71
2,3,4,7,8-dibenzofuran (penta)		0.5			183	125		140				0.72 j	5.1		17,000	8,800	12,500	60.8	2,700	1,300	1,840		123	150
1,2,3,4,7,8-dibenzofuran (hexa)		0.1			1,770	793		3,000				3.1	23		62,000	79,000	54,300	238	30,000	27,000 e	30,400		408	384
1,2,3,6,7,8-dibenzofuran (hexa)		0.1			341	214		1,770				1.33	13		17,000	22,000	14,200	124	8,400	8,900 e	10,600		146	186
2,3,4,6,7,8-dibenzofuran (hexa)		0.1			314	307		1,440				2.0 emj	16.2		34,000	12,000	17,700	123	13,700	6,200	13,900		1,410	206
1,2,3,7,8,9-dibenzofuran (hexa)		0.1			58.8	44.4 pr		288				<0.36	2.1 pm		33,000	3,600	21,000	113	5,210	500	3,700		30	197
1,2,3,4,6,7,8-dibenzofuran (hepta)		0.01			5,640 e	8,500 e		101,000				40.1	307		1,310,000 e	1,150,000 ej	101,000	4,230	1,240,000 e	1,200,000 ej	958,000		4,200	4,740
1,2,3,4,7,8,9-dibenzofuran (hepta)		0.01			1,110	686		7,300				2.2 j	24.1		79,700	91,000 j	12,700	286	85,100	99,300 j	62,500		437	460
Dibenzofuran (octa)		0.0001			41,880 e	38,420 e		510,000				111	961		4,840,000 e	3,400,000 ej	394,000	17,700	7,900,000 e	3,200,000 ej	800,000		12,200	12,900
TCDD Equivalents			200		[illegible]	[illegible]		[illegible]				4.44	40.99		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
Carbon, total organic, %					4.97*	1.31*		2.8							28		24.8	2.51	25.7		21.4		1.22	1.38

Notes:
mg/kg = milligrams per kilogram
ng/kg = nanograms per kilogram
[illegible] = Exceedance of SRV

j = Reported value is less than stated lab quantitation limits and is considered and estimated value
e = Estimated value, exceeded the instrument calibration range
p = Small peak in chromatogram below method detection limit
pr = Poorly resolved peak
em = Estimated maximum concentration (below PQL)

Legend = Legend Technical Services, Inc.
CAS = Columbia Analytical Services
ALTA = Alta Analytical Laboratory, Inc.
STL = Severn Trent Services
* Analysis done by CAS

Source: Barr 2001b

Table 2
Sediment Sample Analytical Results
Joslyn Site West Area

Analyte	B(a)P Potency Factor (MDH)	TCDD Toxic Equivalency Factor (WHO 98)	MPCA Residential SRV	*Loc.:* *Date:*	WA-7M Oct-00	WA-7OW Nov-00
cPAHs, mg/kg						
Benzo(a)anthracene	0.1				0.11	1.9
Chrysene	0.01				0.19	2.8
Benzo(b)fluoranthene	0.1				0.24	1.5
Benzo(k)fluoranthene	0.1				0.17	1.3
Benzo(a)pyrene	1				0.14	1
Indeno(1,2,3-cd)pyrene	0.1				0.17	0.69
Dibenz(a,h)anthracene	0.36				0.025	0.17
B(a)P Equivalents			2		0.22	1.63
PAHs, mg/kg						
Acenaphthene			1,200		0.006	0.061
Anthracene			7,880		0.098	1.1
Fluoranthene			1,080		0.27	6.3
Fluorene			1,140		0.01	0.17
Napthalene			10		0.01	0.071
Pyrene			890		0.22	5.5
Pentachlorophenol			71		1.9	2.3
Dioxins, ng/kg						
2,3,7,8-TCDD		1			21.2	5.29
1,2,3,7,8-dioxin (penta)		1			240	43.8
1,2,3,4,7,8-Dioxin (hexa)		0.1			902	180
1,2,3,6,7,8-dioxin (hexa)		0.1			4,480	1,360
1,2,3,7,8,9-dioxin (hexa)		0.1			2,100	406
1,2,3,4,6,7,8-dioxin (hepta)		0.01			127,000	30,000
Dioxin (octa)		0.0001			1,530,000	210,000
Furans, ng/kg						
2,3,7,8-TCDF		0.1			81	40
1,2,3,7,8-dibenzofuran (penta)		0.05			360	136
2,3,4,7,8-dibenzofuran (penta)		0.5			752	349
1,2,3,4,7,8-dibenzofuran (hexa)		0.1			2,590	1,010
1,2,3,6,7,8-dibenzofuran (hexa)		0.1			1,050	315
2,3,4,6,7,8-dibenzofuran (hexa)		0.1			1,350	449
1,2,3,7,8,9-dibenzofuran (hexa)		0.1			1,090	392
1,2,3,4,6,7,8-dibenzofuran (hepta)		0.01			34,400	10,800
1,2,3,4,7,8,9-dibenzofuran (hepta)		0.01			2,390	1,040
Dibenzofuran (octa)		0.0001			22,700	34,800
TCDD Equivalents			200		3,813	1,088
Carbon, total organic, %					36.7	4.28

Notes:
mg/kg = milligrams per kilogram
ng/kg = nanograms per kilogram
= Exceedance of MPCA sediment Screening criteria

Source: Barr 2001b

Table 3
Surface Water Sample Analytical Results
Joslyn Site West Area

Analyte	B(a)P Potency Factor (MDH)	TCDD Toxic Equivalency Factor (WHO 98)	MPCA Surface Water Standards / Criteria	WA-7OW Nov-00
cPAHs, ug/L				
Benzo(a)anthracene	0.1		0.027	0.005
Chrysene	0.01			0.009
Benzo(b)fluoranthene	0.1			0.007
Benzo(k)fluoranthene	0.1			0.004
Benzo(a)pyrene	1		0.0005	0.003
Indeno(1,2,3-cd)pyrene	0.1			0.005
Dibenz(a,h)anthracene	0.36			<.003
B(a)P Equivalents				0.0057
PAHs, ug/L				
Acenaphthene			20	0.02
Anthracene			0.035	0.017
Fluoranthene			1.9	0.019 b
Fluorene			3.9	0.02
Napthalene			81	0.027 b
Pyrene				0.015 b
Pentachlorophenol			5.5	<0.5
Dioxins, ng/L				
2,3,7,8-TCDD		1	0.0000038	<.00191
1,2,3,7,8-dioxin (penta)		1		<.00675
1,2,3,4,7,8-Dioxin (hexa)		0.1		<.00562
1,2,3,6,7,8-dioxin (hexa)		0.1		.0128 j
1,2,3,7,8,9-dioxin (hexa)		0.1		<.00541
1,2,3,4,6,7,8-dioxin (hepta)		0.01		0.2800
Dioxin (octa)		0.0001		3.4500
Furans, ng/L				
2,3,7,8-TCDF		0.1		<.00417
1,2,3,7,8-dibenzofuran (penta)		0.05		<.00317
2,3,4,7,8-dibenzofuran (penta)		0.5		<.00298
1,2,3,4,7,8-dibenzofuran (hexa)		0.1		0.0136 j
1,2,3,6,7,8-dibenzofuran (hexa)		0.1		0.00989 j
2,3,4,6,7,8-dibenzofuran (hexa)		0.1		<0.00501
1,2,3,7,8,9-dibenzofuran (hexa)		0.1		<0.00735
1,2,3,4,6,7,8-dibenzofuran (hepta)		0.01		0.1250
1,2,3,4,7,8,9-dibenzofuran (hepta)		0.01		<0.00688
Dibenzofuran (octa)		0.0001		0.3340
TCDD Equivalents				0.0080
Carbon, total organic, %				11.9

Notes:
ug/L = milligrams per liter
ng/L = nanograms per liter
= Exceedance of MPCA surfcae water standard or criteria
b = Potential false positive based on blank data validation procedure
j = Reported value is less than stated lab quantitation limits and is considered and estimated value

Source: Barr 2001b

Table 4

Soil-Water Leach Sample Analytical Results
Joslyn Site West Area

Analyte	B(a)P Potency Factor (MDH)	TCDD Toxic Equivalency Factor (WHO 98)	MPCA Surface Water Standards / Criteria	*Loc.:* *Date:*	WA-7OW Nov-00	WA-6MID Oct-00	WA-6S Oct-00
cPAHs, ug/L							
Benzo(a)anthracene	0.1		0.027		0.018		
Chrysene	0.01				0.033		
Benzo(b)fluoranthene	0.1				0.01		
Benzo(k)fluoranthene	0.1				0.006		
Benzo(a)pyrene	1		0.0005		0.005		
Indeno(1,2,3-cd)pyrene	0.1				0.005		
Dibenz(a,h)anthracene	0.36				<0.003		
B(a)P Equivalents					0.0098		
PAHs, ug/L							
Acenaphthene			20		0.57		
Anthracene			0.035		0.22		
Fluoranthene			1.9		0.41		
Fluorene			3.9		0.42		
Napthalene			81		50		
Pyrene					0.26		
Pentachlorophenol			5.5		<.50		
Dioxins, ng/L							
2,3,7,8-TCDD		1	0.0000038		<0.000875	0.0103	<0.00366
1,2,3,7,8-dioxin (penta)		1			<0.00115	0.132	0.048
1,2,3,4,7,8-Dioxin (hexa)		0.1			<0.00159	0.687	0.243
1,2,3,6,7,8-dioxin (hexa)		0.1			<0.00172	1.71	1.26
1,2,3,7,8,9-dioxin (hexa)		0.1			<0.00155	0.857	0.432
1,2,3,4,6,7,8-dioxin (hepta)		0.01			<0.0055	53.7 e	39.6 e
Dioxin (octa)		0.0001			0.0302	519 e	313 e
Furans, ng/L							
2,3,7,8-TCDF		0.1			<0.00118	0.0217	<.00445
1,2,3,7,8-dibenzofuran (penta)		0.05			<0.00126	0.144	0.018
2,3,4,7,8-dibenzofuran (penta)		0.5			<0.00121	0.26	0.03
1,2,3,4,7,8-dibenzofuran (hexa)		0.1			<0.000690	1.1	0.412
1,2,3,6,7,8-dibenzofuran (hexa)		0.1			<0.000686	0.674	1.65
2,3,4,6,7,8-dibenzofuran (hexa)		0.1			<0.000784	0.467	0.189
1,2,3,7,8,9-dibenzofuran (hexa)		0.1			<0.00114	0.426	0.0575
1,2,3,4,6,7,8-dibenzofuran (hepta)		0.01			<0.00101	17.9	23.9 e
1,2,3,4,7,8,9-dibenzofuran (hepta)		0.01			<0.00156	1.24	0.843
Dibenzofuran (octa)		0.0001			<0.00659	78.6 e	95.3 e
TCDD Equivalents					0.000003	1.66	1.17
Carbon, total organic, %					1.8		

Notes:

ug/L = milligrams per liter

ng/L = nanograms per liter

= Exceedance of MPCA surfcae water standard or criteria

e = Estimated value, exceeded the instrument calibration range

Source: Barr 2001b

Table 5
Surface Water Sample Analytical Results
Twin Lakes

Analyte	B(a)P Potency Factor (MDH)	MPCA Surface Water Standards / Criteria	LS1 1/25/1985	LS1 5/30/1985	LS2 1/25/1985	LS2 5/30/1985	LS3 1/25/1985	LS3 5/30/1985	LS4 1/25/1985	LS4 5/30/1985	LS5 1/25/1985	LS5 5/30/1985	LS6 1/25/1985	LS6 5/30/1985
List 1 PAHs, ug/L														
Benzo(a)anthracene	0.1	0.027	0.067	<0.001	<0.0020	0.005	<0.0020	<0.0010	0.21	0.0021	0.0051	<0.0010	0.0034	<0.0010
Chrysene	0.01		0.064 c	<0.001 c	0.0024 c	0.0057 c	0.0020 c	<0.0010 c	0.29 c	0.0026 c	0.0064 c	<0.0010 c	0.0077 c	<0.0010 c
Benzo(b)fluoranthene	0.1		<0.005 c	<0.001 c	<0.0020 c	0.015 c	<0.0020 c	<0.0010 c	0.72 c	<0.0010 c	<0.0020 c	0.0022 c	0.022 c	<0.0010 c
Benzo(a)pyrene	1	0.0005	0.038	<0.001	<0.0020	0.0058	<0.0020	<0.0010	0.18	0.0014	<0.0020	<0.0010	0.0034	<0.0010
Indeno(1,2,3-cd)pyrene	0.1		0.048	<0.0017	<0.0034	0.007	<0.0034	<0.0017	0.21	0.0027	<0.0034	<0.0017	0.0058	<0.0017
Dibenz(a,h)anthracene	0.36		<0.007	<0.0014	<0.0028	<0.0014	<0.0028	<0.0014	0.031	<0.0014	<0.0028	<0.0014	<0.0028	<0.0014
Benzo(g,h,i)perylene			0.043	<0.001	<0.0020	0.0091	<0.0020	<0.0010	0.2	0.0029	<0.0020	<0.0010	0.0049	<0.0010
Quinoline			0.0099	<0.001	0.0061	<0.0010	0.029	0.015	0.035	0.0027	0.015	0.002	0.006	<0.0010
Sum, List 1			0.26	nd	0.0085	0.048	0.031	0.015	1.9	0.014	0.026	0.0042	0.053	nd
B(a)P Equivalents			0.051	nd	nd	0.009	nd	nd	0.31	0.013	0.001	nd	0.007	nd
List 2 PAHs, ug/L														
Acenaphthene		20	0.0059	<0.0013	<0.0026	<0.0013	<0.0026	<0.0013	0.021	<0.0013	<0.0026	<0.0013	<0.0026	<0.0013
Acenaphthylene			<0.005	<0.001	<0.0020	<0.0010	<0.0020	<0.0010	0.0087	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010
Acridine			<0.009	<0.0018	<0.0036	<0.0018	<0.0036	<0.0018	0.025	<0.0018	<0.0036	<0.0018	<0.0036	<0.0018
Anthracene		0.035	0.0053	<0.001	<0.0020	<0.0010	<0.0020	<0.0010	0.042	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010
Benzo(k)fluoranthene			<0.005	<0.001 c	<0.0020 c	c	<0.0020 c	<0.0010 c	c	<0.0010 c	<0.0020 c	c	c	<0.0010 c
2,3-Benzofuran			dlnd	0.0057	dlnd	0.0085	0.0023	0.0052	dlnd	0.0051	dlnd	0.0041	0.0036	0.0042
Benzo(e)pyrene			0.18	<0.001	<0.0020	0.0055	<0.0020	<0.0010	0.25	0.0014	<0.0020	0.0014	0.0049	<0.0010
Benzo(b)thiophene			<0.005	<0.001	<0.0020	<0.0010	<0.0020	0.018	<0.010	<0.0010	<0.0020	<0.0010	0.0023	<0.0010
Biphenyl			<0.005	0.0018	<0.0020	<0.0010	<0.0020	0.0056	<0.010	0.017	0.003	<0.0010	<0.0020	<0.0010
Carbazole			0.0087	<0.0011	<0.0022	<0.0011	0.0062	<0.0011	0.047	<0.0011	0.0042	<0.0011	0.004	<0.0011
Dibenzothiophene			dlnd	dlnd	dlnd	dlnd	dlnd	dlnd	0.027	dlnd	dlnd	dlnd	dlnd	dlnd
Dibenzofuran			0.015	<0.002	<0.0040	<0.0020	<0.0040	<0.0020	<0.020	<0.0020	<0.0040	<0.0020	<0.0040	<0.0020
2,3-Dihydroindene			<0.007	0.0026 s	<0.0020	0.012	0.0043	0.0094 s	<0.014	0.0029 s	0.0029	0.0031 s	0.0053	0.0022 s
Fluoranthene		1.9	0.12	0.0019	0.005	0.022	0.0096	0.008	0.67	0.011	0.024	0.0047	0.025	0.0015
Fluorene		3.9	0.012	<0.0014	<0.0028	<0.0014	<0.0028	<0.0014	0.015	<0.0014	<0.0028	<0.0014	<0.0028	<0.0014
Indene			<0.005	0.0022 s	<0.0020	0.0052	<0.0020	<0.0010	<0.010	0.0016 s	<0.0020	<0.0010	<0.0020	0.0013 s
Indole			<0.014	<0.0029	<0.0058	<0.0029	<0.0058	<0.0029	<0.029	<0.0029	<0.0058	<0.0029	<0.0058	<0.0029
Isoquinoline			0.01	dlnd	0.0024	dlnd	dlnd	0.012	0.028	dlnd	0.014	dlnd	0.0093	0.0022
1-Methylnapthalene			0.017	0.0016	0.012	<0.0012	0.01	0.0027	0.035	<0.0012	0.0085	<0.0012	0.0048	<0.0012
2-Methylnapthalene			0.019	0.0028 s	0.0065	0.0023 s	0.01	0.0032 s	0.018	0.0020 s	0.011	<0.0020	0.0064	0.0022 s
Napthalene		81	0.019	0.012 s	0.012	0.0020 s	0.016	0.0096 s	0.027	0.010 s	0.012	0.0092 s	0.013	0.0093 s
Perylene			0.007	<0.0010	<0.0020	0.0011	<0.0020	<0.0010	0.031	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010
Phenanthrene		2.1	0.073	<0.0010	0.0061	0.0052	0.01	<0.0010	0.3	0.0013	0.016	0.0018	0.019	<0.0010
Pyrene			0.12	0.0034	0.0042	0.021	0.011	0.0064	0.69	0.0093	0.021	0.0064	0.023	0.0025
Triphenylene			c	<0.001 c	c	c	c	<0.0010 c	c	c	c	<0.0010 c	c	<0.0010 c
Sum, List 2			0.62	0.0034	0.051	0.1	0.061	0.08	3.2	0.062	0.12	0.031	0.15	0.027
Phenolics, ug/L														
4-chloro-3-methylphenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2-Chlorophenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
O-Cresol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
M-Cresol			<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c
P-Cresol			<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c	<5 c
2,4-Dichlorophenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2,4-Dimethylphenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2,4-Dinitrophenol			<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
2-methyl-1,4,6-dinitrophenol			<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
2-Nitrophenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
4-Nitrophenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Pentachlorophenol (PCP)		5.5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5 p
Phenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2,4,6-Trichlorophenol			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Notes:

Source: Barr 1986

= Exceedance of MPCA surface water standard or criteria
p = Small peak in chromatogram below method detection limit
c = Coeluting compound (concentrations reported with the List 1 compound). Coeluting compounds are Chrysene/Triphylene and Benzo(b)fluoranthene/Benzo(k)fluoranthene.
s = Statistical analysis indicates a potential false positive value.
dlnd = Not detected. Detection limit not determined.
nd = Not detected.

Appendix III - Screening Criteria for Dioxins, PCP, and PAHs

ATSDR has adopted an interim policy for evaluating dioxin contamination in residential soils on or near waste sites (ATSDR 1997). The policy sets an initial screening level for dioxin (as expressed using TEFs) of 50 parts per trillion (ppt, equivalent to 0.05 ppb) in surface soil. If sample results exceed this value but are less than 1 ppb, further evaluation may be needed based on site-specific factors. ATSDR has developed the following decision framework for the evaluation of dioxins in surface soil in residential settings:

Screening Level	Evaluation Level	Action Level
Ω50 ppt (0.05 ppb) TEFs	>0.05 ppb but <1 ppb TEF	∅1 ppb TEF
∉# Based on a minimal risk level of 1 picogram per kilogram per day (pg/kg/day; pub. by ATSDR in 1989)	Evaluation of site-specific factors, such as: ∉# Bioavailability ∉# Ingestion rates ∉# Pathway analysis ∉# Soil cover ∉# Climate ∉# Other contaminants ∉# Community concerns ∉# Demographics ∉# Background exposures	Potential public health actions considered, such as: ∉# Surveillance ∉# Research ∉# Health studies ∉# Community education ∉# Exposure investigations

If dioxin levels in surface soil in residential areas exceed 1.0 ppb, a more active approach may be called for. This may involve educating residents on how to reduce or avoid exposure, and conducting more extensive research on past exposure and possible health impacts. Other actions to prevent or limit exposure could also be recommended, including response actions or cleanup. While the exposure scenario contemplated above is a residential one that may not be directly applicable to other scenarios, the ATSDR guidance may be a useful reference.

The EPA has set a preliminary remediation goal (PRG) of one part per billion (ppb, equivalent to one microgram per kilogram (σg/kg) of soil) of dioxin or TEFs in surface soil involving a residential exposure scenario (EPA 1998). Using EPA standard default exposure factors for reasonable maximum exposure scenarios, this exposure level corresponds to an excess lifetime cancer risk of 2.5×10^{-4}, which is approaching the upper limit of EPA's acceptable risk range for Superfund site cleanups of 10^{-4} to 10^{-6} (EPA 1998). For commercial or industrial settings, a range of values between 5 ppb to 20 ppb is recommended.

The MPCA has developed a residential SRV for dioxin (as expressed using the dioxin TEF approach) of 200 ppt (0.2 ppb). This is based on a relatively standard, conservative exposure scenario, with an exposure duration period of 33 years. The SRV based on a recreational land use scenario is identical. The SRVs for PCP are 71 mg/kg and 67 mg/kg for residential and recreational exposures, respectively. The SRVs for PAHs vary, with cPAHs usually expressed in total benzo(a)pyrene equivalents. As previously stated, SRVs represent the concentration of a

contaminant in soil at or below which normal dermal contact, inhalation, and/or ingestion is unlikely to result in an adverse human health effect. The SRVs are generic criteria, and the exceedance of an SRV only indicates the potential that the contamination could pose an unacceptable long-term human health risk. The MPCA has also established a site-specific surface water criterion for the site of 0.0038 picograms of TCDD per liter (MPCA 2001). This criterion is protective of both wildlife and human health.

MDH has developed a multi-media Health Risk Value (HRV) of 0.07 pg/kg/day for TCDD for incremental exposures from a specific source (MDH 2001a). While the HRVs were primarily developed for use in evaluating contaminants in air, the multi-media HRVs are designed to be protective of human health based on daily, long term inhalation, ingestion, or dermal contact with contaminants whose primary entry into the environment is from air emissions. Bioconcentration is a primary driver for the development of multi-media HRVs. The TCDD HRV is derived from chronic animal studies.

All of the above screening levels were developed prior to the completion of EPA's most recent draft dioxin reassessment, which proposes increasing the cancer potency slope factor by approximately six-fold. Use of this proposed cancer potency slope factor to develop new screening criteria could result in correspondingly lower screening levels or site cleanup goals.

APPENDIX IV: MDH FISH CONSUMPTION ADVISORY

Eat fish often?

MINNESOTA MDH DEPARTMENT OF HEALTH

A Minnesota Guide to Eating Fish

You already know that Minnesota is the *Land of 10,000 Lakes* and some excellent fishing.
But how much do you know about the fish that you eat?

Fish are an excellent food — they're a great source of protein, vitamins and minerals, and are low in saturated fat. Studies have shown that eating fish may help prevent heart disease in adults. **And most fish are healthy to eat.**

However, *any fish* (store-bought or sport-caught) could contain contaminants such as mercury or PCBs that could harm human health — especially the development of children and fetuses.

What should you do?

There's no need to stop eating fish. **But if you wish to reduce your exposure to contaminants, you need to make wise choices about the *kinds of fish* you eat and *how often* you eat fish.** Begin by checking the Safe Eating Guidelines in this brochure to see if you and your family need to make changes. By following these healthy guidelines, you can reduce your exposure to the contaminants in fish, help reduce your health risks, and still get the benefits of eating fish.

Safe Eating Guidelines: *General Population*

For adults who eat fish all year long*

Kind of fish	How often can you eat it?
Fish caught in Minnesota:	
Panfish (sunfish, crappie), perch, bullheads	unlimited amount
All sizes of other species	1 meal a week
Commercial fish:	
Limit the following species: shark, swordfish, tile fish, king mackeral	1 meal a month

* In general, adults who eat fish just during vacation or one season can eat fish twice as often as recommended in these guidelines.

Tips for Reducing Contaminants

You can't see, smell or taste the mercury or PCBs in fish. That's why it's important to know which fish are safer than others to eat. Larger fish, older fish and fatty fish have higher amounts of contaminants. Fish that feed on other fish — such as walleyes, northern pike and bass — have the highest amounts of mercury in their meat.

Remember the following tips when eating fish:

1. Eat smaller fish.
2. Eat more panfish (sunfish, crappies) and fewer predator fish (walleyes, northern pike, lake trout).
3. Trim skin and fat, especially belly fat. Also, eat fewer fatty fish such as carp, catfish and lake trout. PCBs build up in fish fat. For instructions on cleaning and cooking fish properly, see the question and answer section inside this brochure.

Safe Eating Guidelines: *Special Populations*

For pregnant women, women who may become pregnant and children under age 15*

Kind of fish	How often can you eat it?
Fish caught in Minnesota:	
Panfish (sunfish, crappie), perch, bullheads	1 meal a week
Walleyes shorter than 20 inches, northern pike shorter than 30 inches, all sizes of other species	1 meal a month
Walleyes longer than 20 inches, northern pike longer than 30 inches, muskellunge	**Do not eat.**
Commercial fish:	
• Shark, swordfish, tile fish, king mackeral	**Do not eat.**
• Other commercial species, including canned tuna	See MDH's brochure, *"An Expectant Mother's Guide to Eating Minnesota Fish,"* for guidelines.

Special Note:

Please see the precautions included on the following pages for exceptions to these guidelines. These exceptions are for eating fish from certain Minnesota waters known to have higher levels of contaminants. ➜

* There is no change in these guidelines for eating fish just during vacation or one season.

Questions & Answers About Fish Contaminants

Q. What are the contaminants found in fish and where do they come from?

A. In Minnesota, **mercury** is the contaminant in fish that causes the most concern. Mercury can come from natural and man-made sources. Mercury in the air settles into lakes and rivers. It can then build up in fish.

There are also other contaminants in fish, including **PCBs.** PCBs are man-made substances that were banned in 1976. Levels have declined, but PCBs are still found in the environment.

Q. How can mercury and PCBs in fish harm me?

A. In adults, mercury can damage your kidney and nervous system. It may cause tingling, prickling or numbness in hands and feet or changes in vision. Exposure to PCBs may cause cancer.

Q. How can they harm children and babies?

A. Young children, developing fetuses and breast-fed babies are at most risk, because small amounts of mercury can damage a brain that is just starting to form or grow. Too much mercury may affect a child's behavior and lead to learning problems later in life. Babies who are exposed to PCBs during pregnancy may have lower birth weight, reduced head size and delayed physical development.

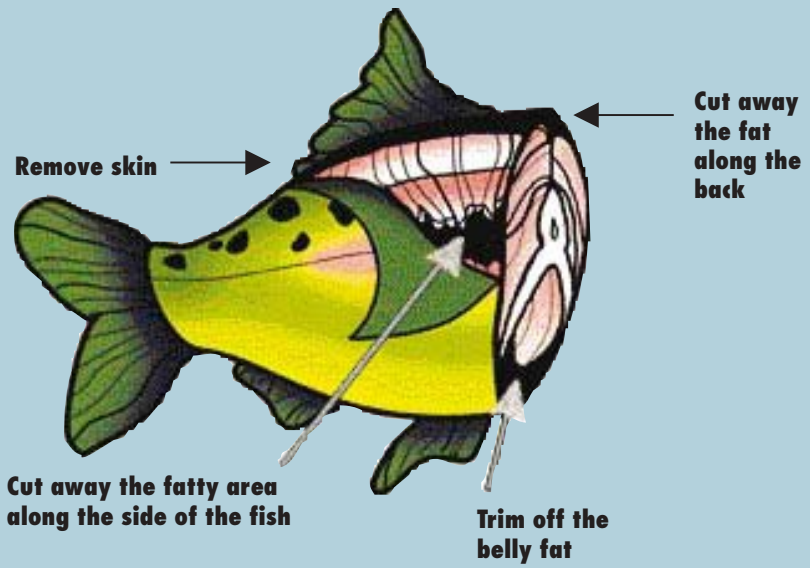
If you are pregnant, planning to be pregnant, breastfeeding or have young children, you and your children need to be more careful about the kinds of fish you eat and how often you eat fish. Contact the Minnesota Department of Health (MDH) at the phone numbers or Web site listed on the back of this brochure for a copy of the brochure, "*An Expectant Mother's Guide to Eating Minnesota Fish*."

Q. What can be done to reduce the amount of contaminants in fish?

A. Minnesota is one of the leading states in studying mercury contamination and developing programs to keep mercury out of the environment. For more information about preventing and reducing pollution, visit the Minnesota Pollution Control Agency's Web site at www.pca.mn.us (search for mercury or PCBs), or call the agency at 651/296-6300 or 1-800-657-3864.

Q. How can I clean and cook fish properly to deal with contaminants?

A. Mercury cannot be removed through cooking or cleaning — it gets into the flesh of the fish. However, you can reduce the amount of other contaminants like PCBs by removing fat when you clean and cook fish.



Extra Precautions for Eating Fish from Specific Lakes and Rivers in Minnesota

What makes the lakes and rivers listed in the table on the following page different?

The lakes and rivers listed in the table have been tested and found to contain fish with higher than average levels of mercury or PCBs.
It may seem surprising, but fish from lakes in the northeastern portion of Minnesota generally have higher levels of mercury. Although many of these lakes are relatively pristine, airborne contaminants still fall on them. Unfortunately, the sensitive natural water chemistry in these lakes efficiently turns non-harmful forms of mercury into a potentially harmful form. As a result, fish in these lakes accumulate more mercury. PCBs are found mainly in Lake Superior and major rivers such as the Mississippi River.

Should I be concerned about eating fish from these waters?

Higher levels of mercury do *not* mean it isn't safe for most adults to eat fish from these waters. In fact, **for most adults, there is no difference in the Safe Eating Guidelines for fish from these lakes and rivers.** However, **pregnant women, women planning to be pregnant and children under age 15** are more sensitive to contaminants, and need to take the precautions below in addition to following the Special Population Safe Eating Guidelines.

Important! Follow the precautions below if:

- **You are pregnant or are planning to be pregnant and you eat fish from the waters listed in the table at right, OR**
- **You have children under age 15 who eat fish from these waters.**

1 **Precaution #1:** The lakes and rivers listed contain **one or more of the following fish species that should not be eaten more than once a month:** panfish, perch, bullheads.

2 **Precaution #2:** The lakes and rivers listed contain **one or more of the following fish species that should not be eaten:** bass, buffalo, carp, catfish, lake trout, northern pike, sauger, siscowet lake trout, walleyes, white bass.

Each lake or river listed has a " 1 " or a " 2 " next to it corresponding to the above precautions. For more information and specific advice for each lake or river, please contact the Minnesota Department of Health or the Department of Natural Resources (see the back of this brochure).

County	Lake Name	DOW ID*	Precaution #
	Superior		2
Aitkin	Moulton	10212	2
	Round	10070	1
Beltrami	Stump	40130	1
Benton	Little Rock	50013	1
Big Stone	Artichoke	60002	1
Carlton	Cross	90062	2
Carver	Steiger	100045	1 2
Cass	Lizzard	110270	1
Chisago	Fish	130068	1
Cook	Aspen	160204	1
	Clara	160365	1
	Devilfish	160029	2
	Gull	160632	2
	Little Cascade	160347	1
	Papoose	180206	1
	Red Rock	160793	2
	Rose	160230	2
	Swamper	160128	1
	Tait	160384	1
	Toohey	160645	1
	Trout	160049	1
	Upper Cone	160412	2
	Vista	160224	1
	Wampus	160196	1
	Winchell	160354	2
Dakota	Orchard	190031	1 2
Douglas	Agnes	210053	1
	Andrew	210085	1
	Victoria	210054	1
Hennepin	Bryant	270067	1
	Bush	270047	1
	Parkers	270107	2
	Round	270071	2
	Staring	270078	1
	Weaver	270117	1
Hubbard	Eleventh Crow Wing	290036	1
Itasca	Aspen	310690	1
	Blandin	310533	1
	Snowball	310108	2
	Trout	310216	2
Kanabec	Lewis	330032	1
Kandiyohi	Long	340192	1
Lake	Beaver Hut	380737	1
	Cross River Lake	380002	1
	East	380020	1
	Fall	380811	1
	Grass	380635	1
	Greenwood	380656	1
	Jack	380441	1
	Silver Island	380219	1
	Windy	380068	2
Lincoln	Benton	410043	1
Meeker	Dunns	470082	1
	Minnie Belle	470119	1

County	Lake Name	DOW ID*	Precaution #
Otter Tail	Dayton Hollow Res.	560824	1
	Otter Tail	560242	1
	Pelican	560786	2
Pine	Bass	580128	1
Pope	Grove	610023	1
Ramsey	Josephine	620057	1
	Sucker	620028	1
Redwood	Redwood	640058	1
St. Louis	Ban	690742	1
	Coe	690562	2
	Crane	690616	1 2
	Crellin	690459	1
	Dark	690790	2
	Day	690906	1 2
	Dovre	690604	1 2
	Ed Shave	690199	1
	Ek (Leif)	690843	2
	Embarrass	690496	1
	Esquagama	690565	2
	Gun	690487	2
	Hustler	690343	2
	Island Lake Res.	690372	1
	Johnson	690117	1
	Little Sand	690732	1
	Little Trout	690682	2
	Little Vermillion	690608	1 2
	Locator	690936	2
	Long	690765	1
	Loon	690470	2
	Moose	690806	1
	Namakan	690693	1 2
	Nels	690080	1
	North Twin	690419	1
	Otto	690144	1
	Picket	690079	1 2
	Pike River Flowage	690580	1 2
	Rainy	690694	1 2
	Sand Point	690617	1
	Seven Beaver	690002	1
	Shannon	690925	2
	Silver	690662	1
	Spring	690761	1 2
	Stuart	690205	1
	Tee	690083	1
	Tooth	690756	2
	Virginia	690663	1
	White Iron	690004	1
	Whiteface Res.	690375	1
	Wolf	690143	1
	Wynne/Sabin	690434	1 2
Swift	Oliver	760146	1
Washington	Big Marine	820052	1
	Carver	820166	1

Rivers:

Big Fork	2
Le Sueur	2
Minnesota	2
Mississippi	1 2
Rainy	1 2
Red	2
St. Croix	2
St. Louis	1 2
Vermilion	1

* The DOW ID is the identification number for the lake as assigned by the Department of Natural Resources' Division of Waters. We have included these numbers to help distinguish between lakes with the same names.

For more information

Call or visit us on the Web:

Minnesota Department of Health
www.health.state.mn.us
651/215-0950
1-800-657-3908
TDD: 651/215-0707

Minnesota Department of Natural Resources
www.dnr.state.mn.us
651/296-6157
1-800-MINNDNR
TTY: 651/296-5484 or 1-800-657-3929

Notes:

- The guidelines in this brochure are based on mercury and PCB levels measured in fish throughout Minnesota and levels of mercury found in commercial fish. Not all lakes and rivers in Minnesota have been tested for contaminants in fish.
- To obtain specific advice for waters that have been tested, please visit the Minnesota Department of Health or Department of Natural Resources Web sites above. You may also call the numbers above and ask to be mailed a DNR Lake Survey Report.

Minnesota Department of Health
121 East Seventh Place, Suite 220
P.O. Box 64975
St. Paul, MN 55164-0975

To request this document in another format, such as large print, Braille or cassette tape, call 651/215-0700; TDD 651/215-0707 or toll-free through the MN Relay Service, 1-800-627-3529 — ask for 651/215-0700.

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Appendix V - Public Comments Summary and Response

A draft version of this document was made available for public comment from April 8 to June 7, 2002. Comments were received from five individuals, two local government representatives, the MPCA, and an environmental consultant on behalf of the responsible party for the site. The comments and MDH's response are summarized below:

Comment: Several comments were directed towards the fence and signage at the site, expressing concern that people could still access the site by climbing over or going around the fence.

MDH Response: MDH shares this concern, and is recommending that soil and sediment contamination be removed or covered so that potential exposure to contaminants is minimized.

Comment: Several comments were directed towards the development portion of the former Joslyn site, as opposed to the West Area. Specific comments were in regards to a proposed road across the development, utilities, and stormwater runoff from the developed portion of the site into the West Area and adjacent private property.

MDH Response: The Public Health Assessment is specific to the West Area of the Joslyn site, not the development portion to the east. The only issue with regards to the development portion of the site addressed in the Public Health Assessment is stormwater management. MDH recommends that the discharge of stormwater from the development portion of the site be studied and modified if necessary to minimize potential transport of contaminants to Twin Lakes. MDH is also recommending that soil samples be collected to the south of the West Area to determine if it has been impacted as a result of stormwater runoff.

Comment: Several comments were directed towards water quality in Twin Lakes, and the potential for fish to be contaminated.

MDH Response: There is little recent data available as to water quality in Twin Lakes. However, the contaminants of concern (PCP, PAHs, and dioxins) tend to preferentially bind to organic matter and sediments as opposed to staying in the water column. MDH is therefore recommending that sediment and fish tissue samples be collected and analyzed rather than surface water to determine if Twin Lakes has been impacted by contaminants from the site.

Comment: One comment was received regarding the potential for past exposures from drinking water from private wells near the site and from dust that may have blown off the site when it was operating and being cleaned up.

MDH Response: These issues were discussed in previous MDH documents on the site, and as there is no new information available to better assess these potential exposures there is no reason to address them in this document.

Comment: One comment was submitted regarding the health statistics review, namely applicability of data from the Minnesota Cancer Surveillance System (MCSS) for the entire zip code 55429 to potential exposures from the site.

MDH Response: MDH states in the document that while this area is much larger than the area immediately surrounding the site, it is the smallest area available for review in the MCSS.

Comment: Several comments related to clarifications, misspellings, or incorrectly labeled figures were received.

MDH Response: MDH has made corrections to the document where possible.

Comment: A comment from the MPCA was received indicating that the MPCA sediment screening criteria in the draft document and data tables were incorrect.

MDH Response: The references to sediment screening criteria were removed and the data tables corrected.

Comment: Several pages of comments were received from the environmental consultant on behalf of the responsible party for the Joslyn site. The comments had to do with clarifying certain facts with regards to specific borings, samples, or cleanup actions taken at the site, clarifications to certain statements made by MDH, addressing community concerns stated in the document, and certain recommendations made by MDH.

MDH Response: MDH made certain factual corrections to the document where warranted, and attempted to address other comments that reflected the differing viewpoint of the responsible party.