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Long-Term Surveillance and Maintenance Plan Site A and Plot M Palos Forest Preserve, Cook County, Illinois

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U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

ANL	Argonne National Laboratory
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GWQS	Ground Water Quality Standards
IDPH	Illinois Department of Public Health
IEMA	Illinois Emergency Management Agency
LM	Office of Legacy Management
nCi/L	nanocuries/liter
pCi/L	picocuries per liter
USGS	U.S. Geological Survey

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1.0 Introduction

1.1 Purpose

This Long-Term Surveillance and Maintenance Plan explains how the U.S. Department of Energy (DOE) Office of Legacy Management (LM) will fulfill its responsibility for custody and long-term care of the Site A and Plot M radioactive waste disposal sites in the Palos Forest Preserve, Cook County, Illinois. The plan provides for actions necessary for the continued protection of human health and the environment, including inspections, monitoring, and stakeholder relations.

1.2 Legal and Regulatory Requirements

LM is responsible for the radioactive materials at Site A and Plot M under the authority of the Atomic Energy Act of 1954 (Title 42 *United States Code* §2011 [42 USC 2011] et seq.). The primary guidance governing surveillance of Site A and Plot M is DOE Order 458.1, *Radiation Protection of the Public and the Environment* (2011), which establishes a dose limit of 100 millirem per year. The U.S. Environmental Protection Agency (EPA) drinking water standards at Title 40 *Code of Federal Regulations* (CFR) Part 141 do not apply because the affected water supply (picnic water wells) does not meet the definition of a public water system (Golchert 1997). However, the Illinois EPA Class I Ground Water Quality Standards (GWQS; Title 35 *Illinois Administrative Code* subpart 620) for tritium and strontium-90 of 20,000 picocuries per liter (pCi/L; equivalent to 20 nanocuries per liter [nCi/L]) and 8 pCi/L, respectively, are useful contamination benchmarks. Neither tritium nor strontium-90 concentrations at the picnic water wells has exceeded these standards.

The Illinois Emergency Management Agency (IEMA) Division of Nuclear Safety acts as an interested but unaffiliated third party and is available for consultation on site issues to LM.

1.3 Role of the U.S. Department of Energy

DOE's Long-Term Surveillance and Maintenance Program, predecessor to LM, has had responsibility for Site A and Plot M since 1998. The LM program was created in December 2003 to conduct long-term management activities for DOE sites that no longer support DOE's ongoing missions, including Site A and Plot M.

LM is responsible for preparing, revising, and implementing this Long-Term Surveillance and Maintenance Plan. LM is also responsible for reporting the results of site inspections and monitoring, and for maintaining records pertaining to the site.

1.4 Role of Stakeholders

Stakeholders that have been involved with Site A and Plot M include the IEMA, EPA Region 5, the Illinois EPA, the U.S. Geological Survey (USGS), the Illinois Department of Public Health (IDPH), the Illinois Department of Nuclear Safety, the Forest Preserve District of Cook County, and the general public. Any changes made in the LM program requirements as specified in this document will be made in consultation with stakeholders.

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2.0 Site Background Information

2.1 Site Location and Description

Site A and Plot M are located within the Palos Division of the Forest Preserve District of Cook County, Illinois, approximately 20 miles southwest of downtown Chicago and about 3 miles east of the current site of Argonne National Laboratory (Figure 1). The federal government leased the sites from the owner, the Forest Preserve District of Cook County, from 1942 until 1956.

Approximately 9 million people reside within 50 miles of the site; the population within a 5-mile radius is about 150,000. The only portion of the Palos Forest Preserve in the immediate area of Site A and Plot M that is developed for public recreation is the Red Gate Woods picnic area, about 1,200 feet north of Plot M (Figure 1) (Golchert 1997). The area is not accessible by vehicle; however, several trails used for hiking, cross-country skiing, and horseback riding provide public access to Site A and Plot M (Biang et al. 1993). Directions to Site A/Plot M from the Argonne National Laboratory main gate on 9700 Cass Avenue are provided below.

Route and Mileage to Site A/Plot M from Main Gate at Argonne National Laboratory

Mileage	Route To Site A/Plot M
0.0	Argonne National Laboratory Main Gate (northeast side of facility, 9700 South Cass Avenue). Drive south on Cass until it dead ends at Bluff Avenue. Turn left onto Bluff Avenue.
2.0	Turn right on Highway 83, Kingery Avenue.
3.0	Cross bridge, then turn left on Highway 171, Archer Avenue.
	Route to Site A
4.0	Turn right at entrance road to Site A.
4.5	Pass through locked gate and follow gravel road about 0.5 mile to Site A.
	Route to Plot M
4.0	Turn right at Red Gate Woods picnic area parking lot (200 yards east of entrance road to Site A off of Archer Avenue.
	From Red Gate Woods parking lot, walk south from southeast corner of lot to find trail leading to Plot M, or drive up Site A road to top of hill and take first left, then turn left again after about 100 yards.

2.2 Topography, Geology, and Hydrology

The Site A and Plot M locations are within the 67,000-acre Palos Forest Preserve. Site A encompasses an area of 19 acres of forested, relatively flat terrain (IT 1996). Plot M, located approximately 1,600 feet north of Site A, encompasses an area of less than 1 acre (Figure 1).

Site A and Plot M sit on a recessional moraine upland that is dissected by two valleys, the Des Plaines River valley to the north and the Calumet Sag valley to the south. The upland is characterized by rolling terrain with poorly developed drainage. Streams are intermittent and drain internally or flow to one of the valleys. Because the soil in the upland is rather impermeable, swamps and lakes are common in the area (Biang et al. 1993). The area is underlain by glacial till or drift, dolomite, and other sedimentary rocks. The uppermost bedrock is Silurian dolomite that is about 200 feet thick. The overlying glacial till has a thickness that ranges from 165 feet at Site A to zero at the Des Plaines River and Calumet Sag Canal. The depth to bedrock at Plot M is 130 feet (Golchert 1997).

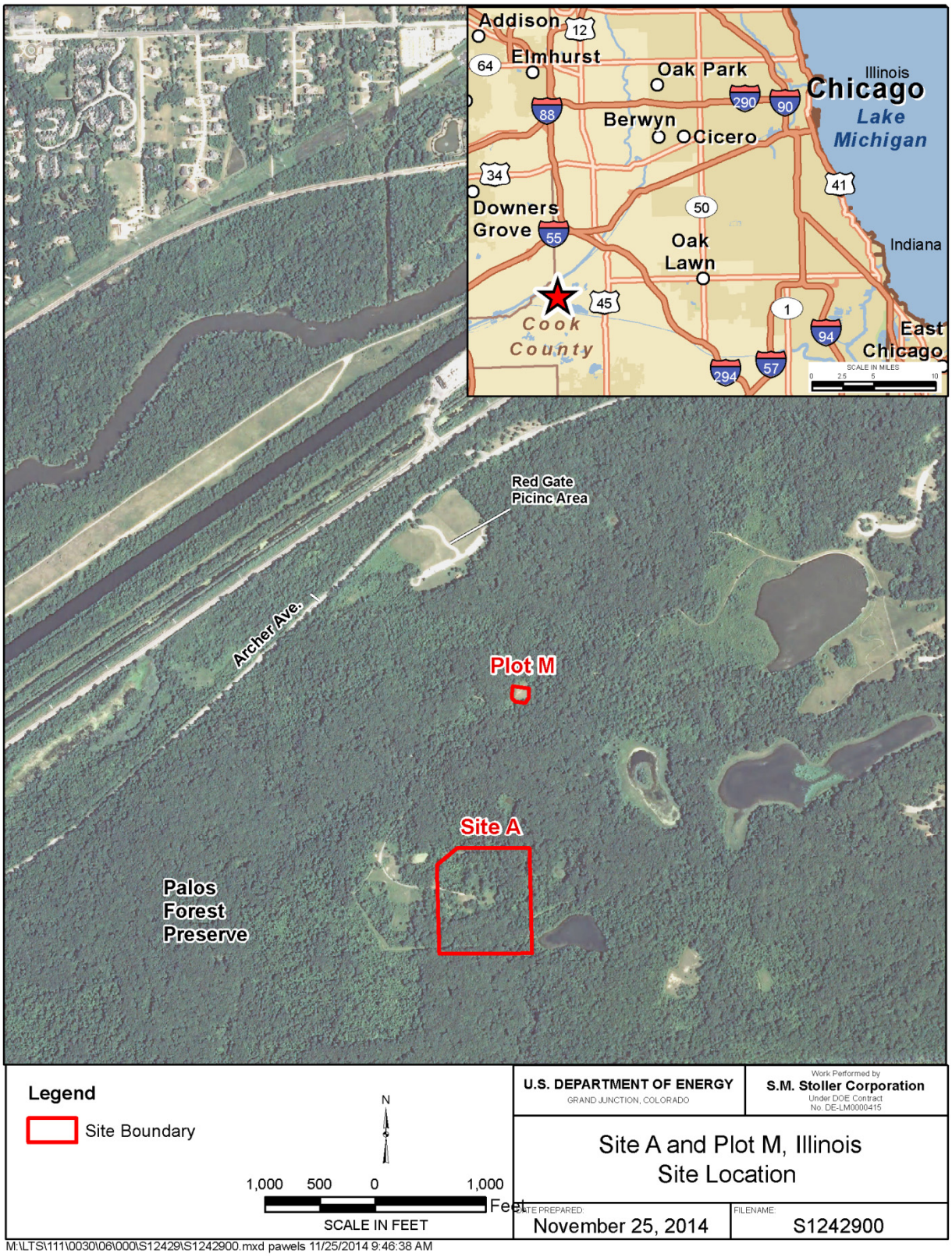

Figure 1. Site A and Plot M Vicinity Map

Surface water in the site area consists of ponds and intermittent streams. When there is sufficient water, the intermittent stream that drains Plot M flows from the highest point near Site A, past Plot M, then continues near the Red Gate Woods well and discharges into the Illinois and Michigan Canal (Golchert 1997).

Groundwater in the glacial till and dolomite forms two distinct flow systems. The shallow system consists of a fairly continuous perched water regime. The high clay content in the soils makes this possible. The flow in the glacial till is controlled principally by topography. The flow in the second system, the dolomite aquifer, which is recharged by groundwater from the glacial till, is controlled by two discharge areas, the Des Plaines River to the north and the Calumet Sag Canal to the south (Golchert 1997).

The dolomite bedrock forms an unconfined aquifer and is a major bedrock aquifer in this area. The dolomite aquifer was previously a source of drinking water (withdrawn using hand-pumped wells) in the adjacent Red Gate Woods picnic area of the forest preserve. Water is no longer available for public use because of high fecal coliform levels.

2.3 Climate and Vegetation

The climate is that of the upper Mississippi Valley, as moderated by Lake Michigan, and is characterized by cold winters and hot summers. Precipitation averages about 33 inches annually. The largest rainfalls occur between April and September. The average monthly temperature ranges from 21 °F in January to 73 °F in July (Golchert 1997).

The site lies within the Prairie Peninsula of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tallgrass prairie occurring in glaciated portions of Illinois, northwest Indiana, southern Wisconsin, and sections of other states. Much of the natural vegetation of this area has been modified by clearing and tillage. Forests in the region are somewhat limited to slopes of shallow, ill-defined ravines or low morainal ridges.

Gently rolling to flat intervening areas between ridges and ravines were predominantly occupied by prairie before their use for agriculture. The prevailing successional trend on these areas, in the absence of cultivation, is toward oak-hickory forest. Forests dominated by sugar maple, red oak, and basswood may occupy more pronounced slopes. Poorly drained areas, streamside communities, and flood plains may support forests dominated by silver maple, elm, and cottonwood (Golchert and Kolzow 2004).

2.4 Site History

The Site A and Plot M area is the former site of Argonne National Laboratory and its predecessor, the University of Chicago Metallurgical Laboratory, which was part of the World War II Manhattan Project, in the Palos Forest Preserve southwest of Chicago. The Laboratory used two locations in the Palos Forest Preserve; Site A, a 19-acre area that contained experimental laboratories and nuclear reactor research facilities; and Plot M, a 150-foot by 140-foot area used for the burial of radioactive waste (Golchert 1997). These locations are shown on Figure 2.

Site A was the operational facility for two of the nation's first nuclear reactors, referred to as Chicago Pile-2 and Chicago Pile-3 (CP-2 and CP-3, respectively DOE 1999). Besides the two reactors, an estimated 35 support buildings were also constructed at the site and included laboratory buildings, dormitories, a cafeteria, dog kennels, and a lead foundry, among others. No operations were conducted at Plot M. That site was used only for disposal of radioactive and other materials generated by Site A operations.

Operations at Site A began in 1943 and ceased in 1954. The first reactor to achieve a self-sustaining chain reaction, CP-1, was moved from the University of Chicago to Site A in 1943 and renamed CP-2. A second reactor, CP-3, was constructed on the site in 1943. Among the research programs carried out at Site A were reactor physics studies, fission product separations, tritium recovery from irradiated lithium, and studies of the metabolism of radionuclides in laboratory animals. In 1954, essentially all work was moved about 3 miles northwest to the current location of Argonne National Laboratory.

At the termination of the programs, the reactor fuel and heavy water, used for neutron moderation and reactor cooling, were removed and shipped to Oak Ridge National Laboratory. The biological shield for the CP-3 reactor, together with various pipes, valves, and building debris, was buried in place at Site A in 1956 (Golchert 1997). The CP-2 (formerly CP-1) reactor shield is also buried at Site A (Biang et al. 1993). By 1956, all buildings and equipment at Site A had been decontaminated and demolished (see Section 2.5.1 for details).

During operations, radioactive waste and radioactively contaminated laboratory articles generated from Site A research activities were buried in Plot M. Burial of radioactive waste at Plot M began in May 1944 (Biang et al. 1993); it is not clear how wastes were disposed of before that time, but it appears some may have been burned at locations at Site A (Biang et al. 1993). Disposal of wastes at Plot M was discontinued in 1949. Apparently both solid and liquid waste was buried from 1944 through 1946. Liquid wastes were disposed of in intact containers, which may have subsequently been breached (Biang et al. 1993). Through 1948, waste was buried in 6-foot-deep trenches and covered with soil to minimize radiation release; beginning in May 1948 burial took place in steel bins. The steel bins were removed in 1949 in a search for some missing uranium-235, which was subsequently found (Biang et al. 1993). Instead of being reburied, the bins were shipped offsite for disposal; the waste buried in trenches was allowed to remain in place. Records of items placed in Plot M are incomplete, but known items include animal carcasses, building debris, clothing, contaminated equipment, air filters, paper, and other radioactive and hazardous materials (Biang et al. 1993). Both the Site A and Plot M areas were decommissioned in 1956.

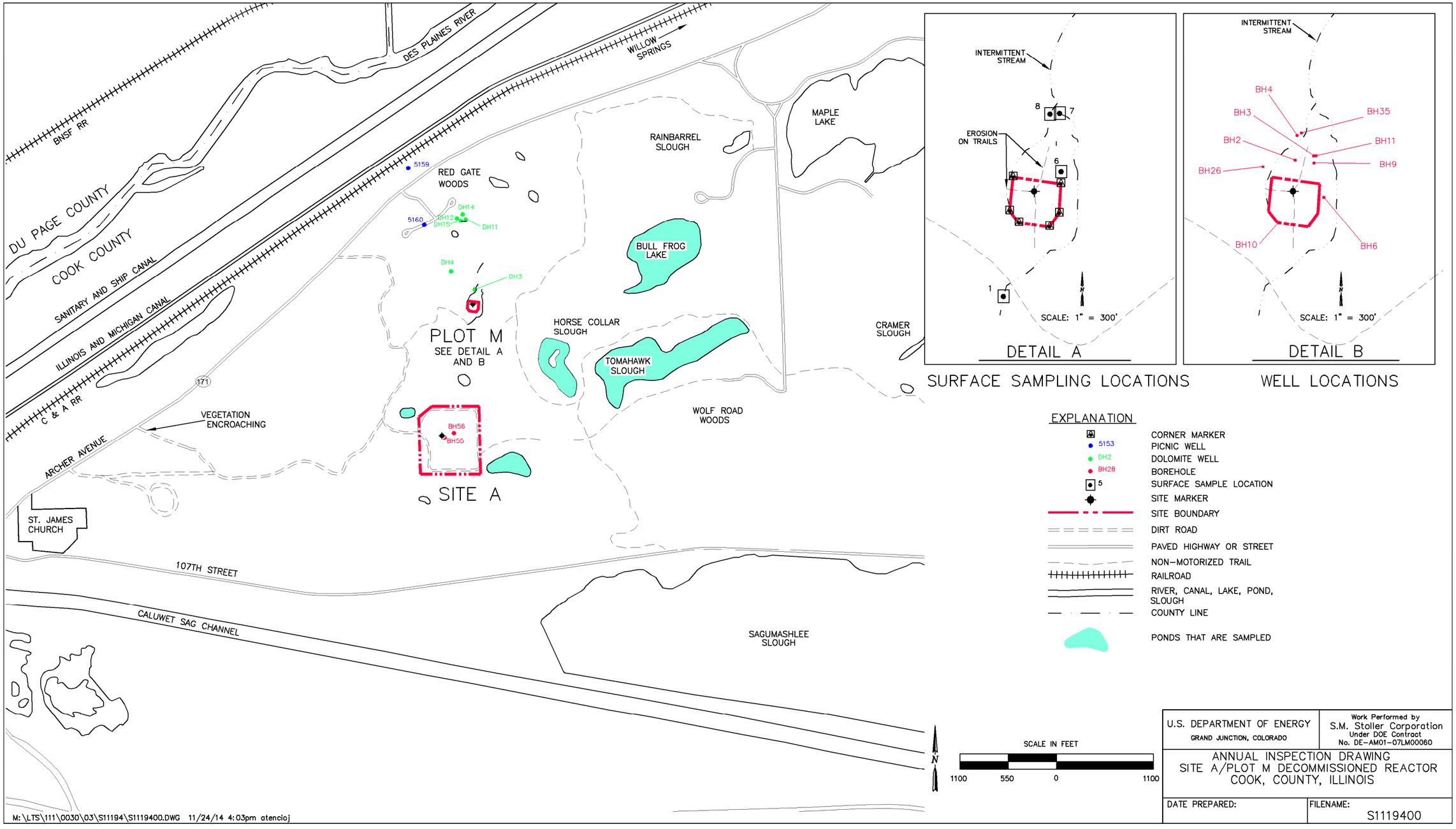

Figure 2. Annual Inspection Drawing

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In 1973, elevated levels of tritium were detected in two nearby hand-pumped picnic wells. The tritium was found to be migrating from the Plot M burial plot into the surrounding soil and groundwater. A subsequent investigation of soils, groundwater, sediment, and surface water in the vicinity of Plot M confirmed the presence of tritium in the subsurface. Tritium was also detected in surface water and sediment samples (Biang et. al. 1993). As a result, a groundwater, sediment, and surface water monitoring program was instituted at the sites and continues to the present. These studies focused primarily on determining the nature and extent of near-surface radioactive contamination. Studies conducted in the 1960s identified a small area (30 × 60 meters [98 × 197 feet) of surface soil northwest of Plot M that had somewhat elevated (compared to background) concentrations of uranium and plutonium (Sedlet and Golchert 1980), which was attributed to spillage during burial and removal operations. It is not clear if these soils were removed or if they were determined to pose no unacceptable risk and left in place.

In May 1990, the Illinois Department of Nuclear Safety, while conducting routine oversight monitoring at Site A, discovered a piece of uranium metal beneath leaves and underbrush on the forest floor (DOE 1999). Further inspection uncovered additional debris, and it was eventually concluded that this area was a forgotten sanitary landfill. As a result, a number of studies were undertaken to characterize Site A. Historical knowledge was used to identify different "investigation groupings" and "suspect areas," which were systematically sampled and analyzed for both radiological and chemical constituents. Geophysical surveys were conducted to investigate suspected burial areas, and subsurface anomalies were evaluated. The investigations determined that surface soils in several areas at Site A contained radiological contamination at levels above background. A number of physical hazards were also identified (e.g., pipes protruding from the ground, concrete rubble).

A risk assessment conducted in association with these characterization efforts indicated that residual contamination at Site A posed only minimal risk. However, in consultation with various stakeholder groups, DOE determined that it was in the best interest of the general public to conduct a voluntary cleanup action. The U.S. Army Corps of Engineers removed physical hazards in 1995. A limited removal action to address chemical and radioactive wastes was conducted in 1997. Subsequent verification surveys confirmed that radiological cleanup criteria had been met (see Appendix A), and control of Site A was returned to the Cook County Forest Preserve District (DOE 1997).

2.5 Stabilization/Isolation Technique

2.5.1 Decommissioning

Site A research activities ceased in May 1954 when the reactors were shut down. The CP-2 and CP-3 reactor shells were demolished and buried, and the support facilities and buildings were decontaminated and torn down (DOE 1997). Uncontaminated materials were removed from the site, and arrangements were made to return the site to the Forest Preserve District.

An excavation approximately 100 feet across and 40 feet deep was prepared between the two reactors. The reactors themselves were approximately 180 feet apart. The 800-ton, concrete-filled shell of the CP-3 reactor was buried by excavating around it on three sides and detonating strategically placed explosives in the earthen "pedestal" supporting it. The reactor shell rolled and came to rest upside down in the excavation (Biang et al. 1993). The concrete shield of CP-2 was demolished and pushed into the same excavation. The buildings that housed the reactors

were demolished and placed in the excavation. The excavation was then backfilled, leveled, and landscaped (Biang et al. 1993). The top of the CP-3 reactor shield is approximately 23 feet below ground surface; rubble and building debris fill the excavation both laterally and vertically to within a few feet of the surface (Bechtel 1995). A large, engraved stone marker briefly describes the history of the site and indicates the approximate burial location.

In 1956 Plot M was stabilized and isolated by backfilling after waste burial and encasing the sides and top of the burial zone with concrete. The disposal area was surrounded by concrete walls 8 feet deep and 1.5 feet thick. A 1-foot-thick concrete slab was placed over the top of the entire disposal area. The walls and slab are reinforced with wire mesh (Biang et al. 1993). The concrete was covered with 2 feet of soil and seeded with grass, and an inscribed granite marker was placed in the center of Plot M (Golchert 1997). The purpose of the concrete barrier was to prevent people from digging into the waste and to impede the flow of water through the buried radioactive materials (Biang et al. 1993).

2.5.2 Voluntary Removal Action

In 1995 the U.S. Army Corps of Engineers conducted a physical hazard removal action. Concrete rubble from foundations of the former support buildings, various pieces of pipe that were protruding from the soil surface, manholes, and other construction rubble were removed from Site A. In addition, holes resulting from subsidence of the former sewage system were backfilled. This action was completed in the fall of 1995 (DOE 1997).

A voluntary removal action of contaminated soil and debris was completed at Site A in 1997 (DOE 1997). This removal action consisted of excavation of approximately 360 cubic yards of contaminated soil and removal of an additional 140 cubic yards of debris, consisting primarily of graphite blocks. The soil and debris were mixed with Portland cement and shipped to the Hanford site near Richland, Washington, for disposal. Following completion of excavation, approximately 2000 cubic yards of clean clay were spread across the excavated areas to minimize groundwater percolation. Topsoil was brought in, placed over the clay, and reseeded to Forest Preserve District specifications. Additionally, three mounds of sludge from a chemical or water treatment facility (referred to as “milorganite”), previously brought to the area for use as fill and fertilizer, were leveled, covered with topsoil, and also reseeded to Forest Preserve District specifications.

The Record of Decision for Site A (DOE 1999) documents cleanup activities that were completed at Site A. The Record of Decision also includes the radiological verification report that was completed by the Illinois Department of Nuclear Safety. It is assumed that decommissioning activities at Plot M adequately addressed any concerns over surficial contamination.

2.6 Current Site Conditions

The surface at both Site A and Plot M is considered to be clean and suitable for recreational use (IDPH 2002a and 2002b). Hiking trails and bike paths are in use in the area. A picnic area is located adjacent to Plot M in the Red Gate Woods. The Cook County Forest Preserve District has control over surface use. DOE is responsible for the wastes buried at both Site A and Plot M. Consistent with the Forest Preserve’s goal of “preserving nature,” Forest Preserve regulations do not allow any digging. Consequently, it is assumed that this “land use restriction” remains in

effect at Site A and Plot M and that buried wastes will not become exposed through intentional human intrusion (DOE 1997). The concrete cap and vegetation on Plot M will prevent exposures of buried waste there through surface erosion. Vegetation at Site A will inhibit, though does not ensure prevention of, erosion that could expose buried wastes. However, the most radioactive wastes were placed at depth and covered with largely uncontaminated building rubble and debris, which in turn was covered with clean fill.

The primary constituents of concern in groundwater and surface water in the vicinity of Site A and Plot M are tritium (hydrogen-3) and strontium-90. Radiological characterization of Site A and Plot M showed that very low levels of tritium migrated from the burial ground at Plot M and were detected in two nearby hand-pumped picnic wells in the Red Gate Woods area approximately 1,500 feet to the north. (Pump handles have subsequently been removed to prevent exposure to fecal coliform contamination detected in the picnic wells. The fecal coliform contamination is not related to Site A or Plot M.) Tritium activity is still detected in the picnic wells, but average and maximum activities are significantly less than previous observations and well below the Illinois Class I groundwater quality standard of 20,000 pCi/L [equivalent to 20 nCi/L]. Tritium concentrations continue to exceed the Illinois standard in a number of monitoring wells at the sites and in a surface stream in the vicinity of Plot M. Low levels of strontium-90 have been detected in groundwater from several monitoring wells near Site A and Plot M since 1984. Strontium-90 (13.14 pCi/L) exceeded the Illinois GWQS of 8 pCi/L at one location in the glacial till at Site A in 2003.

Table 1 presents the analytical results of the groundwater and surface water monitoring program for Site A and Plot M for 2013 (updated from Golchert 2004). Results are presented only for those locations that will continue to be monitored in the future (see Section 3.3). These locations are shown on Figure 2.

USGS conducted a detailed investigation of the hydrogeologic and geochemical properties of the glacial drift to determine the extent of tritium in the drift material and the rate and direction of movement in bedrock groundwater (USGS 1984). These studies showed that anisotropic hydrogeologic properties of the drift significantly affected groundwater flow and contaminant migration. The size, shape, and configuration indicate that the plume is a single slug and that the site no longer releases tritium into the glacial drift. The leading edge of the plume probably left the burial site in the late 1940s or early 1950s and intersected the underlying bedrock surface before 1973. Several key factors that control both the activity level and the extent of migration of tritium in groundwater in the glacial drift at Plot M are (1) the limited amount of tritiated waste buried at Plot M, (2) the long period of time that has elapsed since the waste was buried relative to the radioactive half-life of tritium (approximately 12.3 years), and (3) the great thickness and low permeability of the glacial drift at the site. It is therefore expected that groundwater contaminant concentrations at the sites will continue to decrease over time.

2.7 Risk

Risks posed by the Site A and Plot M sites have been evaluated since monitoring and characterization activities were undertaken in the 1970s. The only currently complete exposure pathways are associated with exposures to contaminants that may be present at the surface of the sites. Groundwater is not currently being used at the site. Buried wastes at the two sites have adequate cover to prevent exposure. The Forest Preserve District controls land use and will impose restrictions on drilling or excavating in the area.

Limited removal actions were implemented at Site A in 1995 and 1997. The 1995 action removed potential physical hazards at the site. The 1997 action resulted in removal of soils with contaminants that exceeded background levels of some constituents. The need for these actions was not driven by risk; they were conducted as a best management practice. The Illinois Department of Nuclear Safety concurred that radiological cleanup criteria were met at Site A (see Appendix A).

Table 1. Summary of 2013 Analytical Results for Site A and Plot M Constituents of Concern

Area	Location	Tritium Range in nCi/L	Strontium-90 Range in pCi/L
Illinois GWQS		20	8
Groundwater from Monitoring Wells Screened in Glacial Drift			
Plot M	BH2	3.6–3,385	0.24–0.32
	BH3	278–1,050	−0.04 to 0.04
	BH4	360–719.1	−0.003 to 0.09
	BH6	27.7–1,543	0.48–1.67
	BH9[a]	188.6–1,462	2.85–6.70
	BH10[a]	0.2–329	0.06–0.49
	BH11s	27.8–234	−0.10 to 3.83
	BH26	0.002–455	0.03–1.16
	BH35	29.7–604	0.12–0.31
Site A	BH55	1.3–6.6	0.58–13.14
	BH56	1.6–4.0	1.26–3.80
Groundwater from Monitoring Wells Screened in Dolomite			
Plot M	DH3	0.69–1.7	na
	DH4	0.1–6.4	na
	DH11	0.57–2.2	na
	DH12	0.4–2.9	na
	DH14	0.7–2.3	na
	DH15	1.6–2.8	na
Groundwater from Picnic Wells Screened in Dolomite			
	5159	<0.10–3.6	na
	5160	0.06–2.24	na
Surface Water and Seep			
Plot M	1	<0.1–0.1	na
	6	<0.1–117.7	na
	7	0.1–62.6	na
	8	0.22–14.9	na
Regional	Ponds (5)[b]	−0.07–1.00	na

na = not analyzed; nCi/L = nanocuries per liter; pCi/L = picocuries per liter; GWQS = Ground water Quality Standard

[a] Slant hole drilled at 45°.

[b] The ponds are Horse Collar Slough, Bull Frog Lake, Tomahawk Slough, and two unnamed ponds northwest and southeast of Site A.

As discussed in Section 2.6, tritium and strontium-90 have been detected in well water in the vicinity of Site A and Plot M, although concentrations in the vast majority of samples have been well below the Illinois GWQS of 20,000 pCi/L (20 nCi/L) and 8 pCi/L, respectively (Title 35 *Illinois Administrative Code* subpart 620). At one time, picnic wells at the Red Gate Woods were used as a source of drinking water for visitors to the picnic grounds. These wells were removed from service due to contamination unrelated to Site A or Plot M. The only complete route of exposure to groundwater is where the water surfaces at a local seep and intermittent surface stream. Because potential exposures to contaminated groundwater and surface water are of low frequency and short duration, actual risks posed by site-related contamination are negligible. Potential risks continue to decrease as concentrations of constituents of concern in the groundwater system continue to decline. Results of the surveillance program continue to indicate that although radioactivity remains in the subsurface in the vicinity of Site A and Plot M and at the surface seep at Plot M, the potential for release of hazardous amounts of contamination into groundwater and surface water is low, and the observed levels of contamination do not endanger the health or safety of the public visiting the site, using the picnic area, or living in the vicinity. Potential radiation doses are well below the applicable standards.

IDPH conducted public health assessments of Site A and Plot M (IDPH 2002a and 2002b) and concluded that cleanup at Site A has been adequate to protect the public from any risks that the site may have posed in the past. IDPH also concluded that under current conditions, exposures at Plot M are not at levels that would be expected to cause adverse health effects, and therefore the site does not pose a public health hazard. Based on infrequent exposures that would be likely to occur at the sites today, and the fact that contaminated materials are buried at depth, the sites were determined to currently pose no unacceptable risks.

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3.0 Long-Term Surveillance and Maintenance

3.1 Stewardship Overview

LM will conduct stewardship activities at the Site A and Plot M sites to protect human health and the environment and to comply with applicable regulations. LM is responsible for the radiological and other hazardous substances that remain at Site A and Plot M. The Palos Division of the Forest Preserve District of Cook County is responsible for maintenance of the land surface. IEMA and IDPH will oversee LM stewardship activities at the site.

This plan implements long-term components of remedies selected for Site A and Plot M. LM will maintain protectiveness at the sites through a combination of continuing government ownership, conducting regular inspections, maintaining public awareness, and monitoring environmental media and institutional controls.

3.2 Inspections

3.2.1 Routine Inspections

Site inspections are guided by a checklist that addresses the performance of the inspection. The most recent completed checklist for the site is included in Appendix B. Figure 2 shows the inspection base map for the site. The map graphically depicts the locations of noted observations from the previous inspections and is used to record field notes, photograph locations, and other annotations of inspection findings. The field map becomes a part of the permanent site record. At the conclusion of a site inspection, inspectors will note revisions to the checklist in anticipation of the next site inspection. Revisions to the checklist may include inspection instructions addressing new observations, notes about maintenance conducted since the previous inspection, or progressive changes in site conditions.

The annual inspection will include an evaluation of both onsite and adjacent offsite erosion, if any occurs. Erosion involving headcutting in the direction of the disposal sites will receive special attention. The local topography and vegetation are expected to keep erosion at a minimum. However, changes in local conditions may warrant evaluation.

During annual inspections, inspectors will also assess the condition of site vegetation. Since vegetation is a primary deterrent to erosion, continued vegetation health is important.

During site inspections it may be useful to document some types of observations with photographs. Such observations may be evidence of vandalism, changed conditions, or maintenance needs. Inspectors will record photograph information on an approved photograph log, which becomes part of the LM site record maintained at the LM facility in Grand Junction, Colorado.

Typically, two inspectors will perform annual inspections. Inspectors will be experienced engineers or scientists who have the required knowledge, skills, and abilities to evaluate site conditions and recognize imminent or actual problems.

3.2.2 Follow-up Inspections

Follow-up inspections are unscheduled inspections that are conducted in response to threatening or unusual site conditions.

LM may conduct follow-up inspections if the following occurs:

- A condition is identified during the routine site inspection, or other site visit, that requires personnel with specific expertise to return to the site to evaluate the condition; or
- LM is notified by a citizen, employee, or federal, state, or local agency that conditions at the site are substantially changed.

Once a condition or concern is identified at the site, LM personnel will evaluate the information and decide whether to respond with a follow-up inspection.

Specific conditions that may necessitate a follow-up inspection include unauthorized intrusion, violation of institutional controls, vandalism, or the need to revisit the site to evaluate, define, or conduct maintenance tasks. Conditions that may require a more immediate follow-up inspection include extreme weather or seismic events and disclosure of human activity that threatens the integrity of waste containment. LM will evaluate risk when scheduling follow-up inspections. Urgency of the follow-up inspection will be in proportion to the seriousness of the condition.

If an incident or activity threatens or compromises institutional controls or poses a risk of exposure to or release of known contaminants, LM may, as appropriate, notify IEMA, begin the LM occurrence notification process, respond with an immediate follow-up inspection, and begin emergency measures to contain or prevent dispersion of constituents from the Site A or Plot M sites. At any time, LM may request the assistance of local authorities to confirm the seriousness of a condition at the site before scheduling a follow-up inspection or initiating other action.

The public may use the 24-hour number monitored at the LM office in Grand Junction, Colorado (970-248-6070) to request information about the site or to notify LM of site concerns.

Inspectors assigned to follow-up inspections will be selected on the same basis as for routine site inspections. Results of follow-up inspections will be included in the next annual inspection report. Separate reports will not be prepared unless LM determines it advisable to notify IEMA or other outside agency of a situation at the site that remains uncorrected. If follow-up inspections are required for more serious or emergency reasons, LM will submit a preliminary report of the inspection within 60 days of the inspection.

3.3 Groundwater and Surface Water Monitoring

Various parameters of the Site A and Plot M environment have been monitored to varying degrees since the site was decommissioned in 1956. In the past, groundwater, surface water, air, and stream sediments were systematically monitored. As part of the transfer of Site A and Plot M to LM, the monitoring program was evaluated (DOE 2003). The technical evaluation consisted of a qualitative review of Argonne National Laboratory (ANL) environmental monitoring results for the previous 10 years (e.g., Golchert 1997). The review of the program indicated that monitoring had demonstrated that the site conditions remained protective, as predicted, and

presented no unacceptable risk to human health and the environment. The technical evaluation was developed with a group consisting of the staff and contractors representing LM, ANL, DOE Chicago Operations Office, and IEMA.

In the context of long-term stewardship activities at other LM sites, the monitoring program was scaled back in 2004 without compromising DOE's ability to observe areas where potential problems or exposures could exist and to ensure ongoing protection of human health and the environment. Based on discussions and consensus of the group, the revised environmental monitoring program that was implemented at Site A and Plot M, effective in February 2004, consisted of 36 locations sampled on a quarterly basis, with 144 analyses for tritium and 60 analyses for strontium-90 (DOE 2004). Metals were no longer analyzed, since the technical evaluation group had determined that no metals were related to potential source materials. Justification for the sampling locations was based on technical and stakeholder concerns. The distribution of locations was selected to ensure that conditions would be known to remain protective.

Groundwater and surface water monitoring were evaluated in 2010 (DOE 2011) to determine if changes were needed to continue to meet two monitoring objectives: (1) ensure that existing contaminant concentrations continue to decrease as expected due to radioactive decay and other natural processes and (2) detect any potential future releases (though these are considered unlikely). Data collected through 2009 for the two remaining constituents of concern (tritium and strontium-90) indicated that with the exception of tritium at Plot M, concentrations of these radionuclides were low and trends were consistent. The low concentrations coupled with the consistent trends indicated that, with the exception of sampling for tritium at Plot M, the major monitoring objectives could be met through annual rather than quarterly sampling. However, sampling for tritium at Plot M remains on a quarterly schedule.

In 2014, DOE issued a supplemental assessment that identified eight groundwater monitoring wells that could be plugged and abandoned without jeopardizing site monitoring objectives (DOE 2014).

3.3.1 Revised Monitoring Program

The monitoring program, effective in 2015, is defined in Table 2 and shown in Figure 2. It consists of 28 sampling locations (19 wells, 4 seeps/streams, and 5 ponds). Samples will be analyzed for only the main constituents of concern, which are tritium and strontium-90. Monitoring wells at Plot M and surface water seeps and streams at Plot M are sampled quarterly. All other monitoring locations are sampled annually.

- ANL personnel will continue to conduct sampling, analysis, and reporting. The sampling crew will also make observations of the sites while performing the quarterly water sampling, which will be part of the overall surveillance for security and maintenance of the sites.
- Analytical data will be available to stakeholders. LM will maintain a database for reference and presentation to stakeholders. Reporting and distribution of information to stakeholders will be performed in the method standardized under the LM long-term surveillance and maintenance program. Information will be presented in annual reports and will be available on the LM website (http://energy.gov/lm/office-legacy-management).

Table 2. Summary of Environmental Monitoring Program for Site A and Plot M, Palos Forest Preserve[a]

Effective Calendar Year 2015			
Area	**Location**	**Frequency—Tritium**	**Frequency—Strontium**
Groundwater from Monitoring Wells Screened in Glacial Drift			
Plot M	BH2	Quarterly	Annual
	BH3	Quarterly	Annual
	BH4	Quarterly	Annual
	BH6	Quarterly	Annual
	BH9	Quarterly	Annual
	BH10	Quarterly	Annual
	BH11	Quarterly	Annual
	BH26	Quarterly	Annual
	BH35	Quarterly	Annual
Site A	BH55	Annual	Annual
	BH56	Annual	Annual
Groundwater from Monitoring Wells Screened in Dolomite			
Plot M	DH3	Annual	NSR
	DH4	Annual	NSR
	DH11	Annual	NSR
	DH12	Annual	NSR
	DH14	Annual	NSR
	DH15	Annual	NSR
Groundwater from Picnic Wells Screened in Dolomite			
	5159	Annual	NSR
	5160	Annual	NSR
Surface Water and Seeps			
Plot M	1	Quarterly	NSR
	6	Quarterly	NSR
	7	Quarterly	NSR
	8	Quarterly	NSR
Regional	Ponds (5)[b]	Annual	NSR

[a] Based on sampling recommendations made in 2011 (DOE 2011) and plugging and abandonment recommendations made in 2014 (DOE 2014).

[b] (1) Pond northwest of Site A; (2) Pond southeast of Site A; (3) Horse Collar Slough; (4) Tomahawk Slough; (5) Bull Frog Lake.

Notes:

NSR = No sample required

DOE (2011), Groundwater and Surface Water Monitoring Activities at Site A/Plot M, March 2011.

DOE (2014), Supplemental Assessment: Groundwater and Surface Water Monitoring Activities at Site A/Plot M.

LM will evaluate this monitoring program every 3 to 5 years. Changes should be implemented in the program, as deemed necessary, and with input from the stakeholders, to maintain the LM mission of protection of human health and the environment, and to reasonably reflect conditions at the sites and the level of potential risk.

3.4 Inspection and Monitoring Reports

Inspection and monitoring results will be recorded in an annual status report. A copy of the report will be distributed to interested stakeholders and posted on the LM website.

3.5 Maintenance, Repairs, Emergency Response, and Groundwater Corrective Action

3.5.1 Maintenance and Repairs

Maintenance refers to routine activities that may be necessary to prevent long-term site degradation or deterioration from a public perception standpoint. Anticipated tasks such as grass mowing fall into this category. The Palos Division of the Forest Preserve District of Cook County, as landowner, is responsible for routine maintenance of the site surface (e.g., erosion, groundskeeping, public safety issues).

Repairs are actions taken to restore a structure to design conditions. LM will conduct repairs for the structures DOE is responsible for (e.g., wells, markers and monuments, and the Plot M waste containment system).

3.5.2 Emergency Response

LM will respond to "unusual damage or disruption" that threatens or compromises site safety, security, or integrity. LM will contain or prevent dispersal of radioactive materials in the unlikely event of an actual breach of the site containment systems.

3.5.3 Groundwater Corrective Action

Currently, tritium and strontium-90 concentrations slightly exceed groundwater quality standards at some locations. Concentrations continue to decrease, and currently complete exposure pathways present no unacceptable risk. If abrupt reversals in trends or concentrations are observed, LM would first conduct confirmatory sampling. If confirmatory sampling verifies the exceedance, LM will initiate an evaluative monitoring program. Results of the evaluative monitoring program would be used to determine if corrective action is necessary.

If corrective action is necessary, LM will develop and implement a groundwater corrective action plan in consultation with IEMA.

3.6 Records

To support post-remediation maintenance of Site A/Plot M, LM maintains records at the LM office in Grand Junction, Colorado, and at the LM Business Center in Morgantown, West Virginia. These records contain critical information required to protect human health and the environment, manage land and assets, protect the legal interests of DOE and the public, and

mitigate community impacts resulting from the cleanup of legacy waste. Site historical records about the environmental remediation and stewardship are included in their site record holdings. All LM records will be managed in accordance with the following requirements:

- 44 USC §§2901–2911, "Records Management by the Archivist of the United States and by the Administrator of General Services." http://uscode.house.gov/
- 44 USC §§3101–3107, "Records Management by Federal Agencies." http://uscode.house.gov/
- 44 USC §§3301–3324, "Disposal of Records." http://uscode.house.gov/
- 36 CFR §§1220–1239, "Records Management." http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=%2Findex.tpl
- DOE Order 243.1B Chg 1, *Records Management Program*. https://www.directives.doe.gov/directives-documents/200-series/0243.1-BOrder-b-admchg1
- LM Records Management Program procedures.

3.7 Quality Assurance

All activities performed by LM related to the surveillance, monitoring, and maintenance of Site A/Plot M will be in compliance with the *Quality Assurance Manual* (LMS/POL/S04320). Services performed by ANL, Palos Forest Preserve District, and others not controlled by LM will perform work to their own quality standards, as approved by DOE.

3.8 Health and Safety

Work at Site A/Plot M is performed in accordance with safety regulations promulgated by DOE and the Occupational Health and Safety Administration, including the provisions in 10 CFR 851. Before work begins, the assigned workers and the supervisor responsible for the work activity develop a Job Safety Analysis, which is then approved by a Health and Safety representative following the five core functions of the Integrated Safety Management System. Site-specific information relating to known hazards and emergency information can be found in the *Comprehensive Emergency Management System*, LMS/POL/S04326.

All personnel assigned to a work activity or visiting the site are briefed to the approved Job Safety Analysis and are required to have the proper personal protective equipment and communication equipment available for their immediate use.

Maintenance subcontractors are required to follow this same process in accordance with the requirements of 10 CFR 851, which are found in their specific contract documents.

4.0 References

10 CFR 851. U.S. Department of Energy, "Worker Safety and Health Program," *Code of Federal Regulations*.

35 *Illinois Administrative Code* Subpart 620, "Groundwater."

36 CFR §§1220–1239. National Archives and Records Administration, "Records Management," *Code of Federal Regulations*.

44 USC §§2901–2911. "Records Management by the Archivist of the United States and by the Administrator of General Services," *United States Code*.

44 USC §§3101–3107. "Records Management by Federal Agencies," *United States Code*.

44 USC §§3301–3324, "Disposal of Records," *United States Code*.

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DOE (U.S. Department of Energy), 2014. *Supplemental Assessment, Groundwater and Surface Water Monitoring Activities at Site A / Plot M*, Office of Legacy Management, Grand Junction, Colorado.

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IDPH (Illinois Department of Public Health), 2002a. *Public Health Assessment, Palos Forest Preserve—Argonne Site A, Cook County, Illinois, 107th and Archer Avenue*, December 20.

IDPH (Illinois Department of Public Health), 2002b. *Public Health Assessment, Palos Forest Preserve—Argonne Plot M, Cook County, Illinois, 107th and Archer Avenue*, December 20.

IT, 1996. *Draft Final Work Plan, U. S. Department of Energy, Limited Source Removal, Site A, Palos Forest Preserve, Cook County, Illinois,* IT Corporation, September.

Sedlet, J., and Golchert, N.W., 1980. "Migration of Radionuclides Following Shallow Land Burial," in *International IRPA Congress Proceedings*, pp 99–102, March.

USGS (U.S. Geological Survey), 1984. *Low-Level Radioactive-Waste Burial at the Palos Forest Preserve, Illinois: Geology and Hydrology of the Glacial Drift, as Related to the Migration of Tritium*, U.S. Geological Survey Water-Supply Paper 2226.

Appendix A

Regulator Concurrence

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TEC.970512.0004

STATE OF ILLINOIS
DEPARTMENT OF NUCLEAR SAFETY
1035 OUTER PARK DRIVE
SPRINGFIELD, ILLINOIS 62704
217-785-9900
217-782-6133 (TDD)

Jim Edgar
Governor

Thomas W. Ortciger
Director

May 9, 1997

Ms. Sue Nielsen
Site A Project Manager
U. S. Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

Dear Ms. Nielsen:

The Illinois Department of Nuclear Safety (IDNS) has completed its report on remedial actions taken by the Department of Energy at Site A of the Palos Forest Preserve. This report describes IDNS's involvement in the cleanup of the park and documents the final radiation surveys conducted by IDNS. The report concludes that all agreed upon radiological cleanup criteria were met. Three copies are enclosed for your use.

I hope you find your report useful. If you have any questions, please call me at (217) 782-1322.

Sincerely,

Richard Allen

Rich Allen, Manager
Office of Environmental Safety

RA:tlk

Enclosures

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Appendix B

Site Summary and Inspection Checklist

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U.S. Department of Energy, Office of Legacy Management
Grand Junction, Colorado, Office

INSPECTION CHECKLIST
SITE A AND PLOT M SITE, PALOS FOREST PRESERVE, COOK COUNTY, IL

Status of Site Inspections

Date of This Revision: _____

Last Annual Inspection: _____
Inspectors _____

Next Annual Inspection (Planned): _____
Inspectors _____

Background

- Site A and Plot M are located within the Palos Forest Preserve District of Cook County, Illinois. The Forest Preserve owns the land and manages it as a park for recreational use. Maintenance is performed by the Forest District. Hiking and mountain bike trails cross both Site A and Plot M. The Red Gate picnic area has a reputation for vice and petty crime.
- The site is the original location of Argonne National Laboratory (previously the University of Chicago Metallurgical Laboratory), later moved to a new site a few miles northwest. Fermi's CP-1 reactor was reassembled here as CP-2.
- Site A is the burial site of a buried concrete-filled reactor shell (CP-3) and the concrete shield from CP-2. Plot M is a burial ground for wastes generated by early reactor operations and studies. Waste materials at Plot M have never been fully characterized, but site operations are said to have included metabolic studies and fission product separation activities. Tritium and strontium-90 have been detected in ground water beneath Site A.
- Monitoring shows that Plot M containment (an inverted concrete box) is generally effective; some tritium has been detected in shallow perched ground water, surface water adjacent to the Plot, and ground water in the dolomite aquifer. Strontium-90 and tritium has been detected in perched and bedrock monitor wells around Plot M.
- DOE-LM funds ANL to monitor ground and surface water. ANL maintains the monitor wells.
- In 2004, DOE-LM reduced the monitoring program to reflect observations and risk, and revised the LTS&MP.

No.	ITEM	ISSUE	ACTION
1	Access and Protocols	DOE does not have a formal real property agreement with the Cook County Forest Preserve District. ***ANL has gate keys***.	No action required to formalize a real property agreement. This situation has persisted since 1956 when ANL returned the site to the Forest Preserve.
		Partners and stakeholders include: • Lawrence Moos, ANL, • Brian Quirk, DOE/Chicago,, and • Gary McCandless, IL Emergency Mgmt Agency (Derron Robbins usually attends)	Contact partners and stakeholders and invite to attend the inspection.
2	Sampling locations	Monitoring network (revised in 2004). GPS coordinates exist for wells and surface sampling locations.	ANL visits the wells regularly and maintains them.
		<u>Perched water (glacial till)</u> Site A: 6 wells (BH–55, 56) Plot M: 9 wells (BH–2, 3, 4, 6, 9, 10, 11s, 26, 35)	Examine the condition of DOE monitor wells. Check to see that they are secure and clearly labeled.
		<u>Deeper ground water (dolomite)</u> Dolomite wells: 6 wells (DH–3, 4, 11, 12, 14 & 15) Picnic wells: 2 wells (5159 and 5160)	Examine the condition of DOE monitor wells. Check to see that they are secure and clearly labeled.
		<u>Surface Water</u> 9 locations (1, 6, 7, 8, and 5 ponds)	ANL visits the sampling locations regularly and maintains them.
3	Site A	Site A is wooded and unfenced. The hardwood forest is rapidly filling what open space remains.	Drive (or walk) perimeter road; observe changes, if any. Look for evidence that the integrity of the site is not threatened.
		Site A Historic Marker.	Evaluate the condition of the Site A Historic Marker.

No.	ITEM	ISSUE	ACTION
		Two Monitor Wells at Site A monitor the perched groundwater in the glacial till (BH–55, 56)	Examine the condition of DOE monitor wells. Check to see that they are secure and clearly labeled.
4	Plot M	Plot M is an open grass covered area. Two feet of soil and grass cover a 1 foot thick concrete cover.	Walk over the area, observe changes, if any. Look for evidence that the integrity of the site is not threatened.
		Nine Monitor Wells at Plot M monitor the perched groundwater in the glacial till (BH–2, 3, 4, 6, 9, 10, 11s, 26, 35)	Examine the condition of DOE monitor wells. Check to see that they are secure and clearly labeled.
		Six corner monuments set in concrete	Evaluate the condition of the 6 corner monuments set in concrete

		Plot M Historic Marker	Evaluate the condition of the historic marker. The historic marker was vandalized previously, look for additional damage.
		Erosion ruts across Plot M were repaired by ANL in 2010. It was noted in 2012 and 2013 that ruts are returning to the Plot M mound cover due to continued bicycle travel across the cover.	Assess current condition of area.
5	Access Road	The lower portion of the access road near Archer Avenue can become overgrown with vegetation. A large drop off is present on the access road leading to Site A at the point where the old road asphalt connects with the dirt road. The drop-off is present toward one side of the road, so the road was passible in 2013.	Check area and determine if vegetation control is being maintained. Check to see if road remains passable.

Appendix C

Groundwater and Surface Water Monitoring Activities at Site A/Plot M (March 2011) and Supplemental Assessment: Groundwater and Surface Water Monitoring Activities at Site A/Plot M (2014)

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LMS/SAM/S07581

Groundwater and Surface Water Monitoring Activities at Site A/Plot M

March 2011

U.S. DEPARTMENT OF ENERGY | Legacy Management

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LMS/SAM/S07581

Groundwater and Surface Water Monitoring Activities at Site A/Plot M

March 2011

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Contents

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Abbreviations

ANL	Argonne National Laboratory
COC	constituent of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GWQS	Ground Water Quality Standard
LM	Office of Legacy Management
LTSP	Long-Term Surveillance and Maintenance Plan
pCi/L	picocuries per liter

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Executive Summary

The Long-Term Surveillance Plan (LTSP) for Site A/Plot M requires that the groundwater and surface water monitoring activities at Site A/Plot M be assessed every three to five years. This assessment report satisfies that requirement. The purpose of the assessment is to determine if changes are needed in order to continue to meet monitoring objectives. The two major monitoring objectives at Site A/Plot M are to (1) ensure that existing contaminant concentrations continue to decrease as expected due to radioactive decay and other natural processes, and (2) detect any potential future releases.

Data collected through 2009 for the two remaining constituents of concern (COC) (tritium and strontium-90) indicate that, with the exception of tritium at Plot M, COC concentrations are low and trends are consistent. Low concentrations coupled with consistent trends indicate that, with the exception of sampling for tritium at Plot M, the major monitoring objectives defined in the LTSP for Site A/Plot M can be met through annual—rather than quarterly—sampling. Sampling for tritium at Plot M though (both groundwater in the glacial drift wells and surface water) should remain on a quarterly schedule. Stakeholder input should be obtained before any change to the monitoring program is implemented.

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1.0 Background

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) is responsible for the long-term custodial care of the Site A/Plot M radioactive waste disposal sites in the Palos Forest Preserve, Cook County, Illinois. These long-term responsibilities include groundwater and surface water monitoring, which are defined in the *Long-Term Surveillance and Maintenance Plan (LTSP) for Site A/Plot M, Illinois, Decommissioned Reactor* (DOE 2004).

The main constituents of concern (COC) in groundwater and surface water at Site A/Plot M are tritium and strontium-90. U.S. Environmental Protection Agency (EPA) drinking water standards found in Title 40 *Code of Federal Regulations* Part 141 do not apply to Site A/Plot M, because the affected water supply (picnic wells in the Palos Forest Preserve) does not meet the definition of a public water system. Illinois EPA Class I Ground Water Quality Standards (GWQS; Illinois Administrative Code Title 35, subpart 620) for tritium and strontium-90 of 20,000 picocuries per liter (pCi/L) and 8 pCi/L, respectively are useful contamination benchmarks. Tritium or strontium-90 concentrations at picnic wells in the Palos Forest Preserve have not exceeded these benchmarks.

Groundwater and surface water monitoring activities are conducted and reported annually by Argonne National Laboratory (ANL). The annual reports are made available to the public at the website http://www.lm.doe.gov/sitea_plotm/Sites.aspx.

The scope of the current groundwater and surface water monitoring program was implemented in February 2004. The scope is based on the outcome of a technical evaluation involving staff and contractors representing LM, ANL, DOE Chicago Operations Office, and the Illinois Emergency Management Agency (DOE 2004).

Groundwater and surface water monitoring requirements (locations, analytes, and frequencies) are defined in Table 1. Analyses are restricted to the main COCs, which are tritium and strontium-90. Sampling locations are shown in Figure 1. Monitoring results are used to assess the current status of past releases of tritium and strontium-90 from the site and to monitor elevated tritium concentrations previously detected in some of the picnic wells in the Red Gates Park section of the Palos Forest Preserve. Samples are collected quarterly. The LTSP defines the following two major monitoring objectives:

- Ensure that existing contaminant concentrations continue to decrease as expected due to radioactive decay and other natural processes, and
- Detect any potential future releases.

The LTSP requires that the groundwater and surface water monitoring effort at Site A/Plot M be assessed every three to five years. This assessment report satisfies that requirement and includes data collected through 2009. As shown on Table 1 and Figure 1, groundwater and surface water monitoring per the LTSP are conducted at:

- Site A: Monitoring wells at Site A and five ponds in the vicinity of Site A,
- Plot M: Monitoring wells at and north of Plot M and surface water at Plot M, and
- Red Gate Woods: Picnic wells.

Results of the monitoring assessment are presented in the following sections.

Table 1. Summary of Environmental Monitoring Program for Site A and Plot M, Palos Forest Preserve, Illinois

Area	Number	Frequency and Analytes	Location
Groundwater from Monitor Wells in Glacial Drift			
Plot M	BH2	4X H/S	Downgradient from Plot M
	BH3	4X H/S	Downgradient from Plot M
	BH4	4X H/S	Downgradient from Plot M
	BH6	4X H/S	Cross gradient from Plot M
	BH9	4X H/S	Slant hole beneath Plot M
	BH10	4X H/S	Slant hole beneath Plot M
	BH11	4X H/S	Downgradient from Plot M
	BH26	4X H/S	Downgradient from Plot M
	BH35	4X H/S	Farther downgradient from Plot M
Site A	BH41	4X H/S	Onsite --downgradient to west of Site A
	BH51	4X H/S	Onsite -- south of Site A
	BH52	4X H/S	Offsite -- east of Site A
	BH54	4X H/S	Onsite -- north of Site A
	BH55	4X H/S	Onsite -- middle of Site A
	BH56	4X H/S	Onsite -- middle of Site A
Groundwater from Monitor Wells in Dolomite			
Plot M	DH3	4X H	Downgradient from Plot M
	DH4	4X H	Farther downgradient from Plot M
	DH9	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH10	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH11	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH12	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH13	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH14	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH15	4X H	Downgradient from Plot M and adjacent to picnic wells
	DH17	4X H	Downgradient from Plot M and adjacent to picnic wells
Groundwater from Picnic Wells in Dolomite			
	5159	4X H	Recently used picnic well -- may be used for drinking in future
	5160	4X H	Recently used picnic well -- may be used for drinking in future
Surface Water and Seep			
Plot M	0001	4X H	Upstream from Plot M
	0006	4X H	Seep -- adjacent to Plot M
	0007	4X H	Downstream from Plot M
	0008	4X H	Downstream from Plot M
Regional	Ponds - 5	4X H	Adjacent ponds in vicinity of Site A

Key:
4X = frequency per year at location
H = hydrogen-3 (tritium)
S = strontium-90

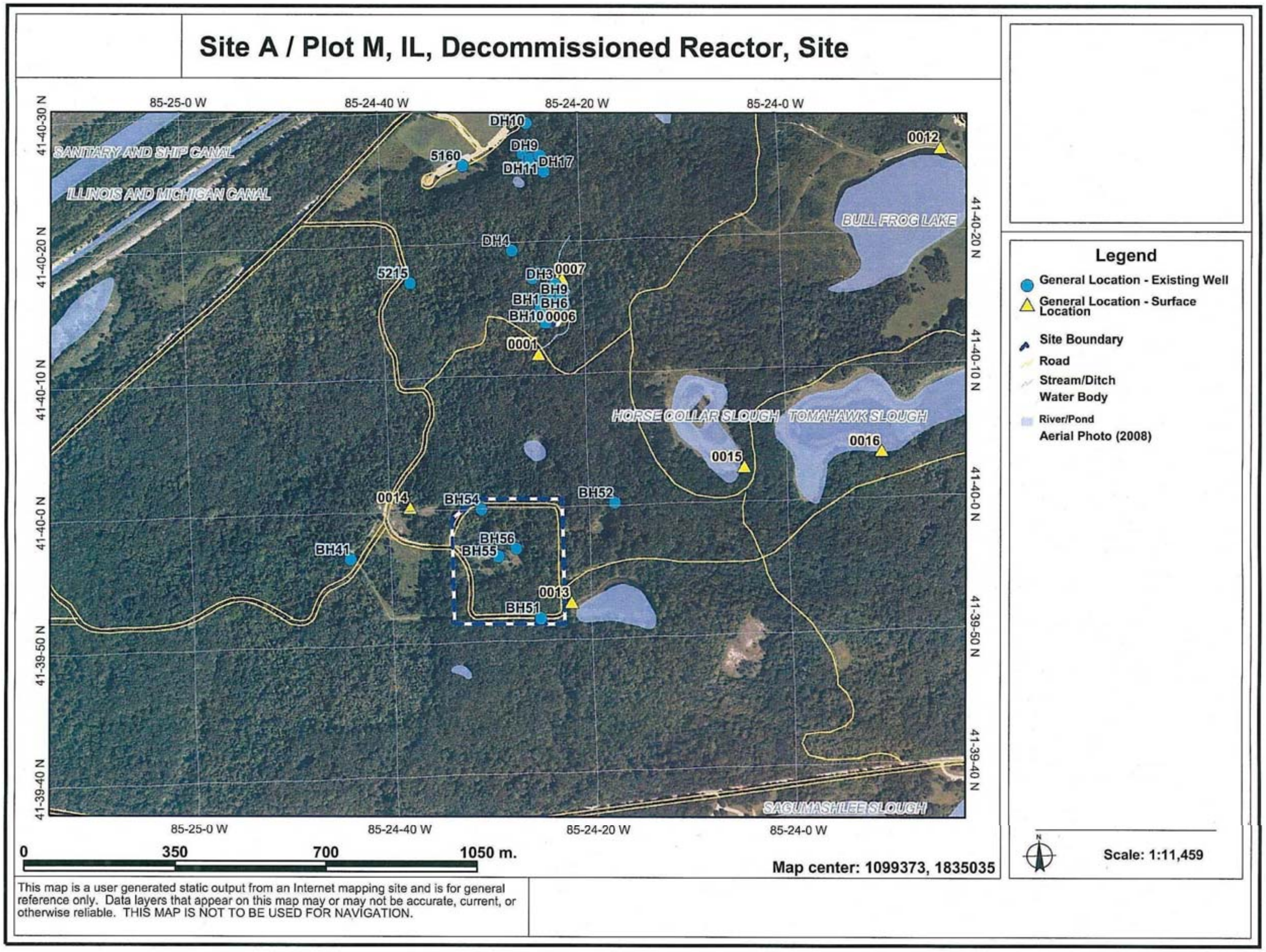

Figure 1. Sampling Locations

2.0 Site A Monitoring Results

Water quality monitoring is currently taking place at the following 11 locations (Table 1 and Figure 1) at and near Plot A:

- Six monitoring wells (BH-41, BH-51, BH-52, BH-54, BH-55, and BH-56) completed in the glacial drift are being sampled quarterly for tritium and semi-annually for strontium-90.
- Five ponds in the vicinity of Site A (Bullfrog Lake, the pond southeast of Site A, the pond northwest of Site A, Horsecollar Slough, and Tomahawk Slough) are being sampled quarterly for tritium.

2.1 Tritium Concentrations in Six Glacial Drift Wells at Site A

Figure 2 shows that from 1995 through 2009, tritium concentrations at all six monitoring wells at Site A have consistently been below the State of Illinois Class I GWQS value of 20,000 pCi/L. Two of the monitoring wells (BH-55 and BH-56) have tritium concentrations that are elevated relative to the other four wells. The relatively high tritium concentrations at these two wells are most likely from the buried CP-3 biological shield at Site A (ANL 2009). The tritium concentrations in both BH-55 and BH-56 have been decreasing since 1996. As reported by ANL, the tritium concentrations at Site A in 2009 were several orders of magnitude lower than what was measured at Plot M (ANL 2009).

The low tritium concentrations measured at Site A and the consistency of the concentration trends plotted for these wells indicate that an annual sampling effort should ensure that the two major monitoring objectives defined in the LTSP are met. Annual sampling should take place in the spring when water levels are seasonally high.

2.2 Strontium-90 Concentrations in Six Glacial Drift Wells at Site A

Figure 3 shows that from 1995 through 2009, only one well (BH-55) has exceeded the State of Illinois Class I GWQS value of 8 pCi/L for strontium-90. The last exceedance was in 2004. Stronitum-90 concentrations at all six monitoring wells have been below the State of Illinois GWQS since then and appear to be stable and/or decreasing.

The low strontium-90 concentrations measured in these wells at Site A and the consistency of the concentration trends since 2004 indicate that an annual sampling effort should ensure that the two major monitoring objectives defined in the LTSP are met. Annual sampling should take place in the spring when water levels are seasonally high.

2.3 Tritium Concentrations in Five Ponds in the Vicinity of Site A

Water samples are collected quarterly from five ponds in the vicinity of Site A to monitor for potential runoff. The locations (Bullfrog Lake, the pond southeast of Site A, the pond northwest of Site A, Horsecollar Slough, and Tomahawk Slough) are shown on Figure 1. The water samples are analyzed quarterly for tritium. Figure 4 shows the tritium concentrations measured at the five ponds from 1993 through 2009. With the exception of one result (899.2 pCi/L, November 15, 2004) the data have more or less fluctuated around the detection limit for the analysis (100 pCi/L).

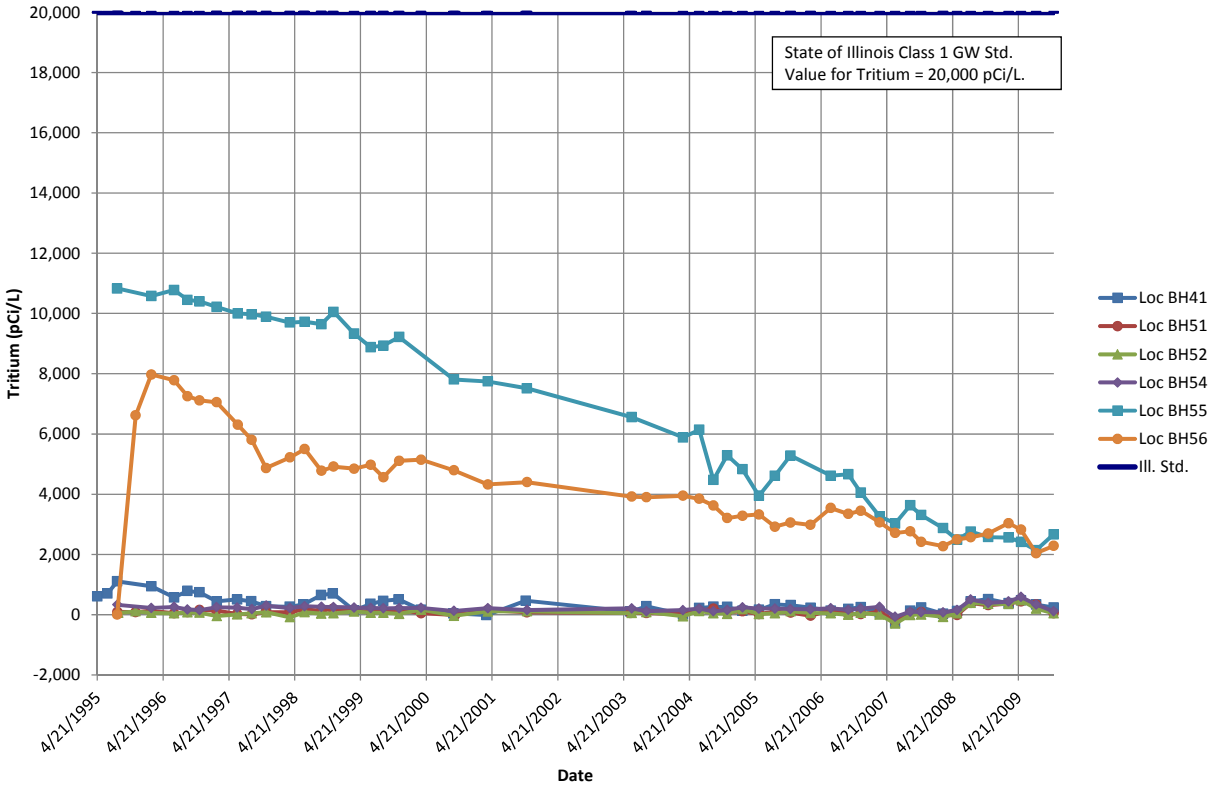

Figure 2. Tritium Concentrations in Six Glacial Drift Wells at Site A

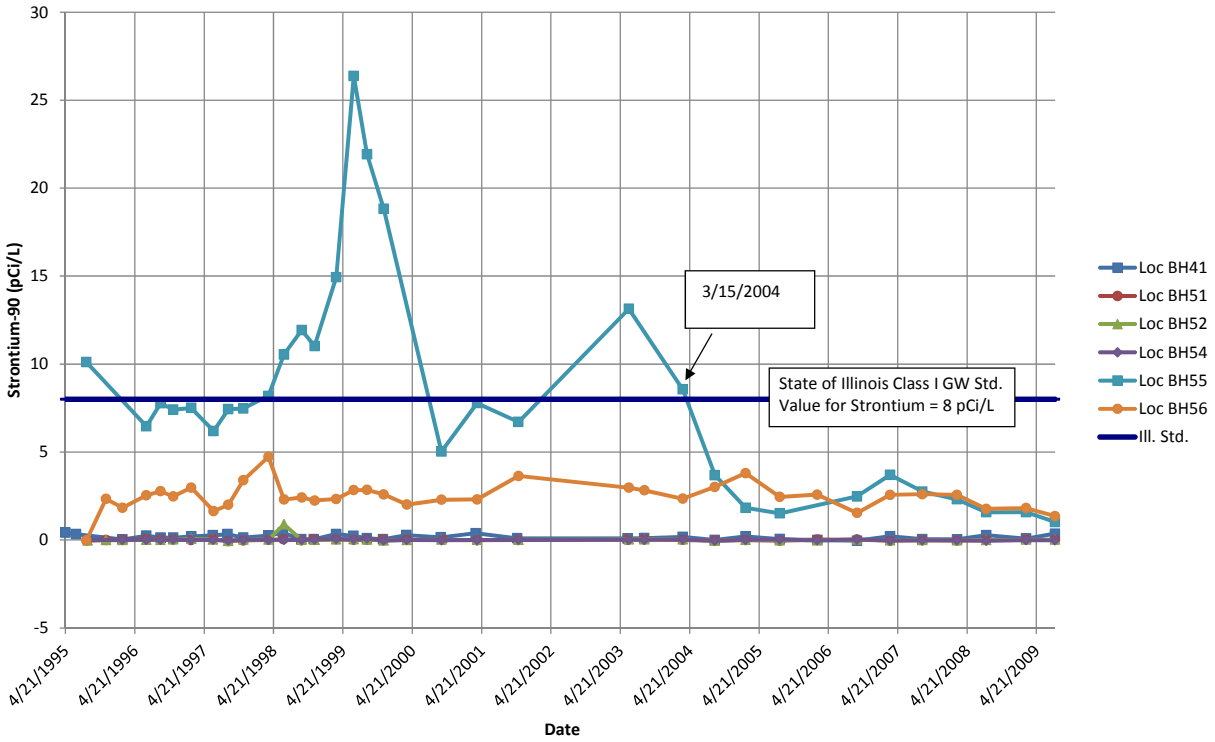

Figure 3. Strontium-90 Concentrations in Six Glacial Drift Wells at Site A

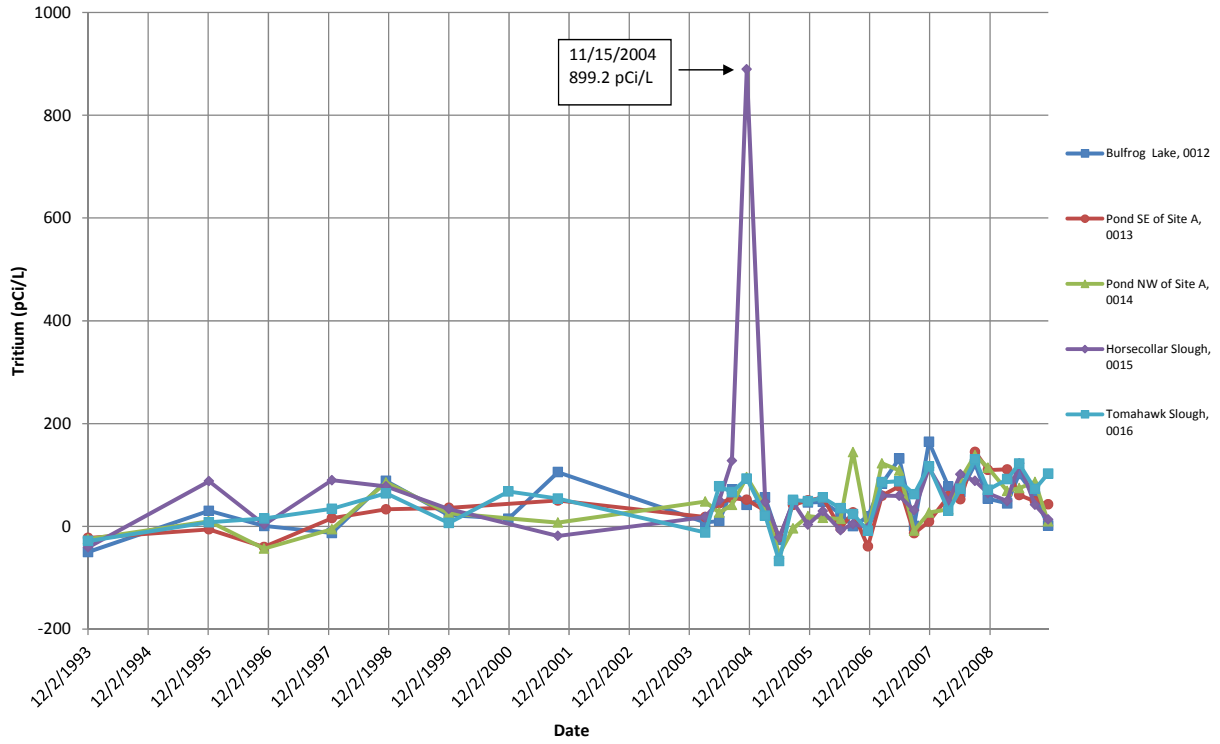

Figure 4. Tritium Concentrations in Five Ponds in the Vicinity of Site A

The consistency of the data trends and low concentration values measured indicate that an annual sampling effort should ensure that the two major monitoring objectives defined in the LTSP are met. Samples should be collected in the summer or fall when water levels might be at their seasonal lows; therefore, constituents in the water would be more concentrated.

3.0 Plot M Monitoring Results

Water quality monitoring is currently taking place at the following 23 locations (Table 1 and Figure 1) at and near Plot M:

- Nine monitoring wells completed in the glacial drift (BH-2, BH-3, BH-4, BH-6, BH-9, BH-10, BH-11, BH-26, and BH-35) are being sampled quarterly for tritium and strontium-90.
- Ten monitoring wells completed in dolomite (DH-3, DH-4, DH-9, DH-10, DH-11, DH-12, DH-13, DH-14, DH-15, and DH-17) are being sampled quarterly for tritium.
- Four surface water locations (0001, 0006, 0007, and 0008) are being sampled quarterly for tritium.

3.1 Tritium Concentrations in Nine Glacial Drift Wells at Plot M

Figure 5 provides tritium concentration data from 1993 through 2009 for the nine glacial drift monitoring wells located at Plot M. The data from 1993 through 2009 indicate that tritium concentrations have consistently been elevated above the State of Illinois Class I GWQS value of 20,000 pCi/L. Table 2 provides tritium data collected from glacial drift wells at Plot M from 2004 through 2009. The last row of Table 2 provides the average tritium concentration for each of the nine wells. As shown in the table, tritium concentrations are elevated well above the 20,000 pCi/L.

Consistently elevated tritium concentrations in all nine glacial drift monitoring wells at Plot M indicate that quarterly monitoring should continue.

3.2 Strontium-90 Concentrations in Nine Glacial Drift Wells at Plot M

Figure 6 provides strontium-90 concentration data from 1993 through 2009 for the nine glacial drift monitoring wells located at Plot M. The data indicate that since June 1993, strontium-90 concentrations have been below the State of Illinois Class I GWQS value of 8 pCi/L. The highest strontium-90 concentration measured in 2009 was in well BH-9 (6.264 pCi/L). Mann-Kendall trends tests (95% confidence level) were run on the data set from monitoring well BH-9 using ChemStat Version 6.2. The Mann-Kendall trend test did not indicate either an up or down trend for strontium concentrations at this well.

Strontium-90 concentrations consistently below the State of Illinois Class I GWQS since 1994 indicate that an annual sampling effort for strontium-90 in these wells should ensure that the two major monitoring objectives defined in the LTSP are met. Annual sampling should take place in the spring when water levels are seasonally high.

3.3 Tritium Concentrations in Ten Dolomite Wells at and North of Plot M

Ten monitoring wells are cased into dolomite bedrock to monitor tritium at and between Plot M and the Red Gate Woods area. Figure 7 shows that from 1993 through 2009, tritium concentrations in the ten monitoring wells have consistently been below the State of Illinois Class I GWQS value of 20,000 pCi/L.

The low tritium concentrations coupled with the consistent concentration trends indicate that an annual sampling effort should ensure that the two major monitoring objectives described in the LTSP are met. Annual sampling should take place in the spring when water levels are seasonally high.

3.4 Tritium Concentrations from Four Surface Water Locations at Plot M

Quarterly surface water sampling for tritium is conducted at four locations (streams and seeps) located at Plot M. Figure 8 provides tritium concentration data measured from 1993 through 2009 from the four surface water locations. As shown in Figure 8, tritium concentrations in surface water around Plot M remain elevated and continue to fluctuate seasonally. A consistent concentration pattern among the sampling locations has been reported for this data (ANL 2009). The pattern shows that concentrations of tritium are usually below the detection limit upstream of Plot M, and concentrations increase in the seep water that leaches out Plot M. Lower concentrations are then measured farther downstream of Plot M.

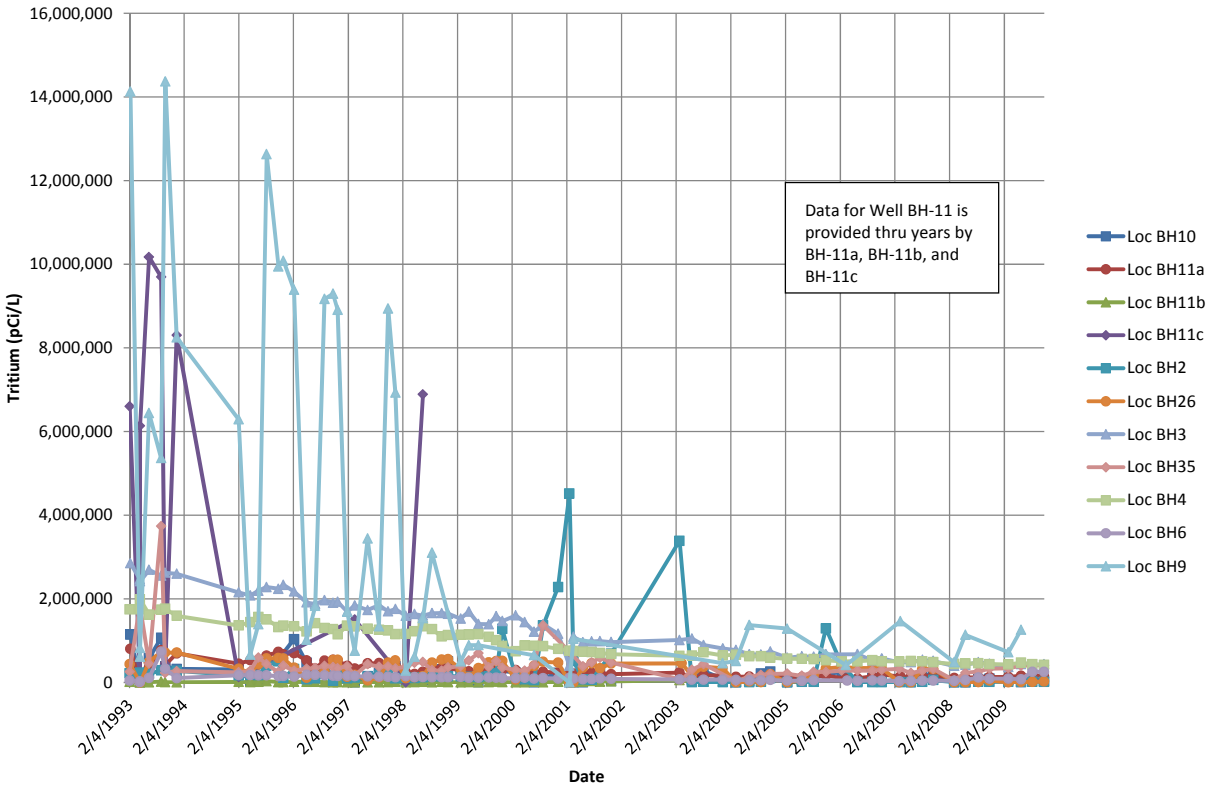

Figure 5. Tritium Concentrations in Nine Glacial Drift Wells at Plot M

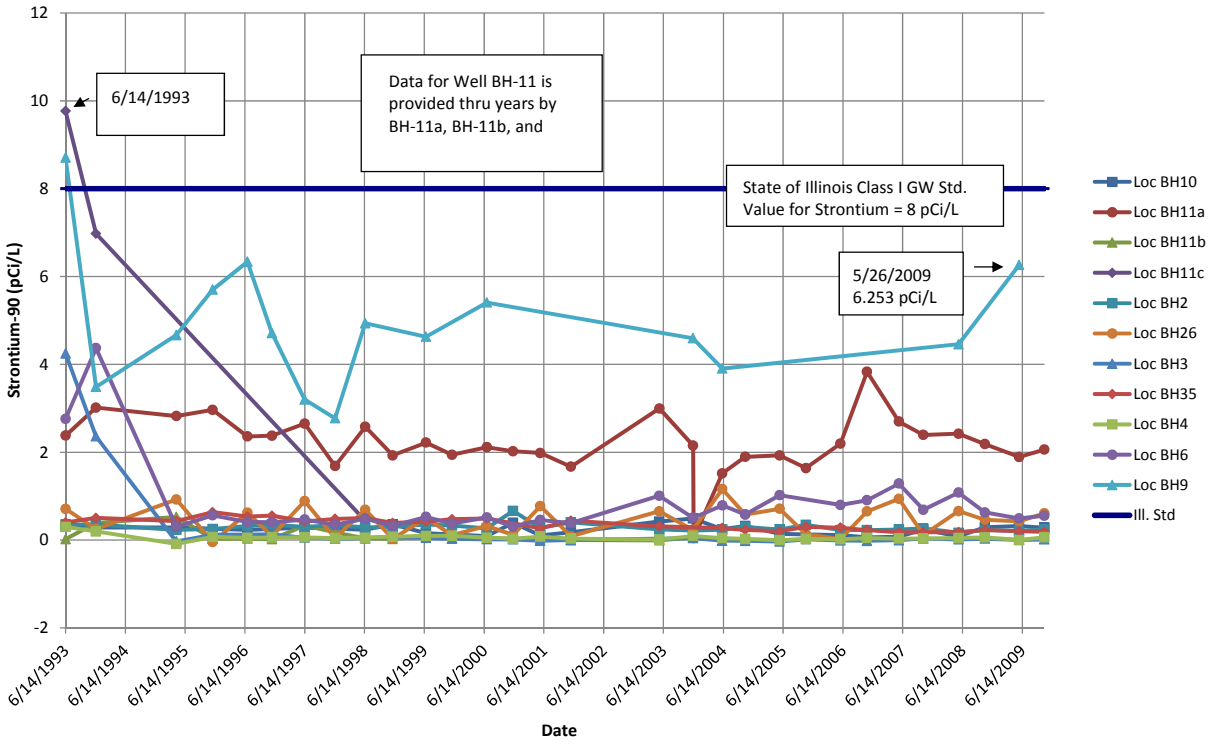

Figure 6. Strontium-90 Concentrations in Nine Glacial Drift Wells at Plot M

Table 2. Tritium Concentrations in Glacial Drift Wells at Plot M from 2004 through 2009

Sample Date	Loc BH-10 (pCi/L)	Loc BH-11a (pCi/L)	Loc BH-2 (pCi/L)	Loc BH-26 (pCi/L)	Loc BH-3 (pCi/L)	Loc BH-35 (pCi/L)	Loc BH-4 (pCi/L)	Loc BH-6 (pCi/L)	Loc BH-9 (pCi/L)
3/9/2004	455.9	132,700	5,184	63.14	774,000	29,660	661,100	60,120	511,200
6/7/2004	32,150	137,100	7,569	22,690	673,700	132,800	625,500		1,371,000
6/8/2004								48,920	
8/23/2004	211,300	143,700	9,387	4,905	666,000	179,300	623,700	49,950	
10/25/2004	256,800	147,700	102,500	197,000	738,000	201,100	590,400	59,220	
2/14/2005	232.20	116,800.00	8,433.00	2.05	591,800.00	208,800.00	564,800.00	41,670.00	1,285,000.00
5/23/2005	46,400.00	118,900.00	10,670.00	44,000.00	625,100.00	157,900.00	563,400.00	39,600.00	
8/10/2005		146,500.00	12,320.00	164,500.00	611,600.00	254,500.00	554,400.00	54,090.00	
10/31/2005		158,400.00	1,291,000.00	335,200.00	671,000.00		529,700.00		
11/1/2005						248,900.00			
2/13/2006	261,900.00		428,500.00	363,900.00		282,800.00	499,500.00		
3/14/2006		92,430.00							413,100.00
3/22/2006								45,050.00	
5/30/2006	21,010.00	97,020.00	3,598.00	342,900.00	675,500.00	282,600.00	504,500.00	35,340.00	
9/7/2006	104,300.00	142,700.00	5,418.00	344,200.00	523,800.00	278,800.00	527,400.00	48,240.00	
11/8/2006	24,130.00	187,300.00	6,201.00	337,400.00	572,900.00	300,000.00	504,500.00	42,620.00	
3/5/2007	66,330.00			3,170.00	482,400.00	322,000.00	498,600.00	27,710.00	
3/12/2007		139,700.00	6,066.00						1,462,000.00
5/21/2007	6,795.00								
5/22/2007		130,500.00	8,694.00	1,527.00	481,500.00	224,500.00	509,900.00	30,190.00	
8/6/2007	209,300.00	141,800.00	9,761.00	320,500.00		279,600.00	503,100.00	41,190.00	
8/7/2007					539,600.00				
10/18/2007	144,100.00	163,000.00	58,100.00	322,500.00	513,500.00	321,900.00	482,000.00	44,190.00	
3/6/2008	265.40	106,300.00	5,108.00	1,627.00	391,800.00	49,730.00	440,600.00	36,900.00	481,100.00
5/20/2008	939.60	111,200.00	6,485.00	324.00	419,000.00	226,700.00	451,400.00	60,390.00	1,136,000.00
8/15/2008	73,760.00	125,100.00	14,570.00	4,375.00	482,900.00	261,600.00	454,100.00	113,900.00	
10/28/2008	92,120.00	128,100.00	12,490.00	44,070.00	444,700.00	328,000.00	436,200.00	91,440.00	
3/3/2009	60,840.00	131,800.00	14,130.00	594.00	366,600.00	339,200.00	429,000.00	89,010.00	719,100.00
5/26/2009	7,857.00	159,800.00	12,670.00	9,360.00	433,900.00	400,600.00	469,800.00	75,240.00	1,256,000.00
8/10/2009	90,540.00	167,000.00	18,180.00	13,370.00	415,900.00	402,900.00	436,900.00	253,600.00	
10/27/2009	22,500.00	154,600.00	13,990.00	20,580.00	433,300.00	406,300.00	419,500.00	253,000.00	
Minimum	232.20	92,430.00	3,598.00	2.05	366,600.00	29,660.00	419,500.00	27,710.00	413,100.00
Maximum	261,900.00	187,300.00	1,291,000.00	363,900.00	774,000.00	406,300.00	661,100.00	253,600.00	1,462,000.00
Range	261,667.80	94,870.00	1,287,402.00	363,897.95	407,400.00	376,640.00	241,600.00	225,890.00	1,048,900.00
Average	**78,819.32**	**136,672.92**	**86,292.67**	**120,781.55**	**544,717.39**	**255,007.92**	**511,666.67**	**71,373.04**	**959,388.89**

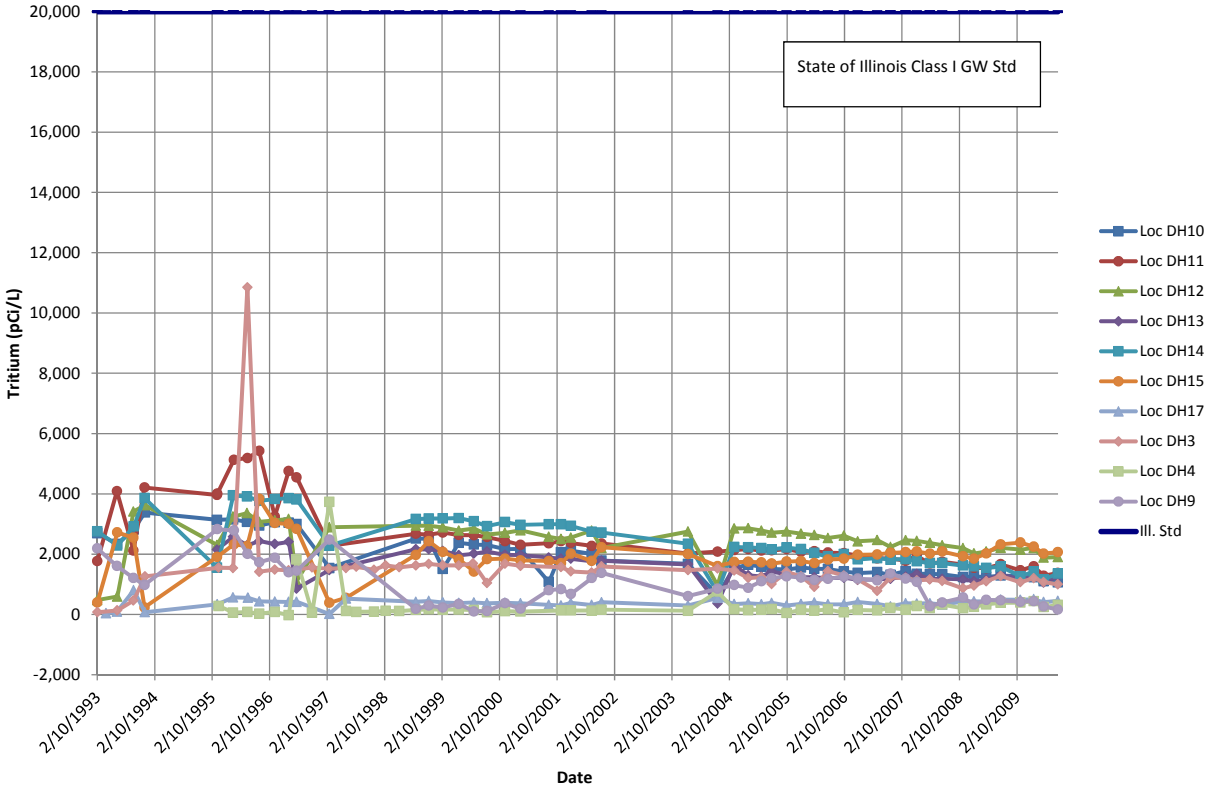

Figure 7. Tritium Concentrations in Ten Dolomite Wells at and North of Plot M

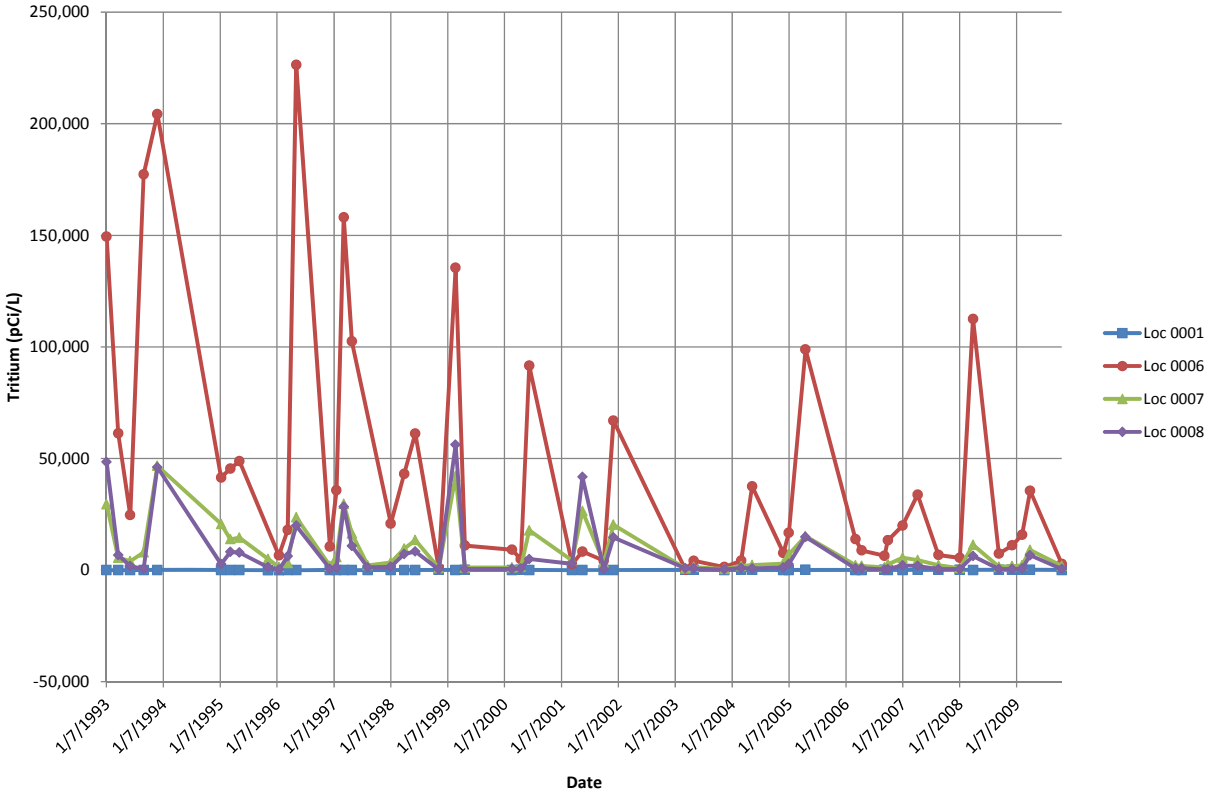

Figure 8. Tritium Concentrations from Four Surface Water Locations at Plot M

The elevated and fluctuating tritium concentrations indicate that continued quarterly monitoring of all four locations is needed in order to meet the two major monitoring objectives defined in the LTSP.

4.0 Water Quality Monitoring Results for Drinking Water Wells at Red Gates Park

Red Gates Park is located north of Plot M (Figure 1). Water quality monitoring is currently taking place at two drinking water wells at Red Gates Park (#5159 and #5160). Both wells draw water from the dolomite formation and are sampled for tritium. Well #5160 has not been available to the public since 1999 due to high coliform levels.

Figure 9 shows that from 1993 through 2009 tritium concentrations at picnic wells #5159 and #5160 have consistently been well below the State of Illinois Class I GWQS value of 20,000 pCi/L. Tritium concentrations from these wells have historically shown a seasonal pattern of high concentrations in the winter and low concentrations in the summer. This seasonal pattern is no longer readily detectable given the low tritium concentrations being measured (ANL 2009). Since 2008, tritium concentrations at both wells have been consistently low and steady.

Consistently low and steady tritium concentrations in picnic wells #5159 and #5160 indicate that an annual sampling effort should ensure that the two major monitoring objectives presented in the LTSP are met. Sampling should take place in the spring when water levels are seasonally high.

5.0 Water Level Monitoring Results

Water levels are being monitored in the following three groups of monitoring wells:

- Wells completed in the Glacial Drift at Site A,
- Wells completed in the Glacial Drift at Plot M, and
- Wells completed in a dolomite formation at and north of Plot M.

Monitoring results are discussed below.

5.1 Water Levels in Glacial Drift Wells at Site A

Groundwater levels have remained relatively constant in the six glacial drift monitoring wells at Site A since 1995. Hydrographs for the six monitoring wells completed in the glacial drift beneath Site A are shown in Figure 10. Mann-Kendall trends tests (95% confidence level) were run using ChemStat Version 6.2 Software on the data sets from each well. The Mann-Kendall trend tests indicate no trends at four of the six wells (BH-41, BH-52, BH-54, and BH-56). The water level trend in BH-51 is down (Figure 11), and the water level trend in BH-55 is up (Figure 12). The trends in BH-51 and BH-55 are slight.

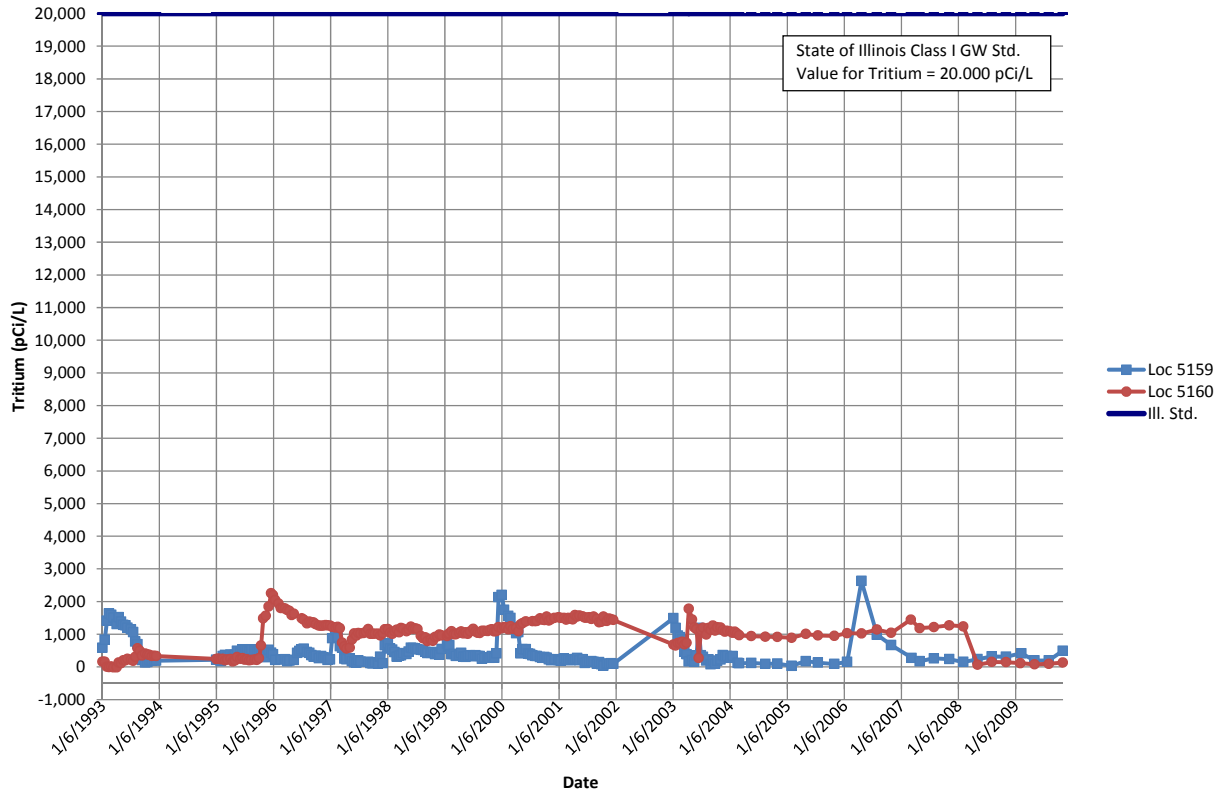

Figure 9. Tritium Concentrations in Picnic Wells at Red Gates Park

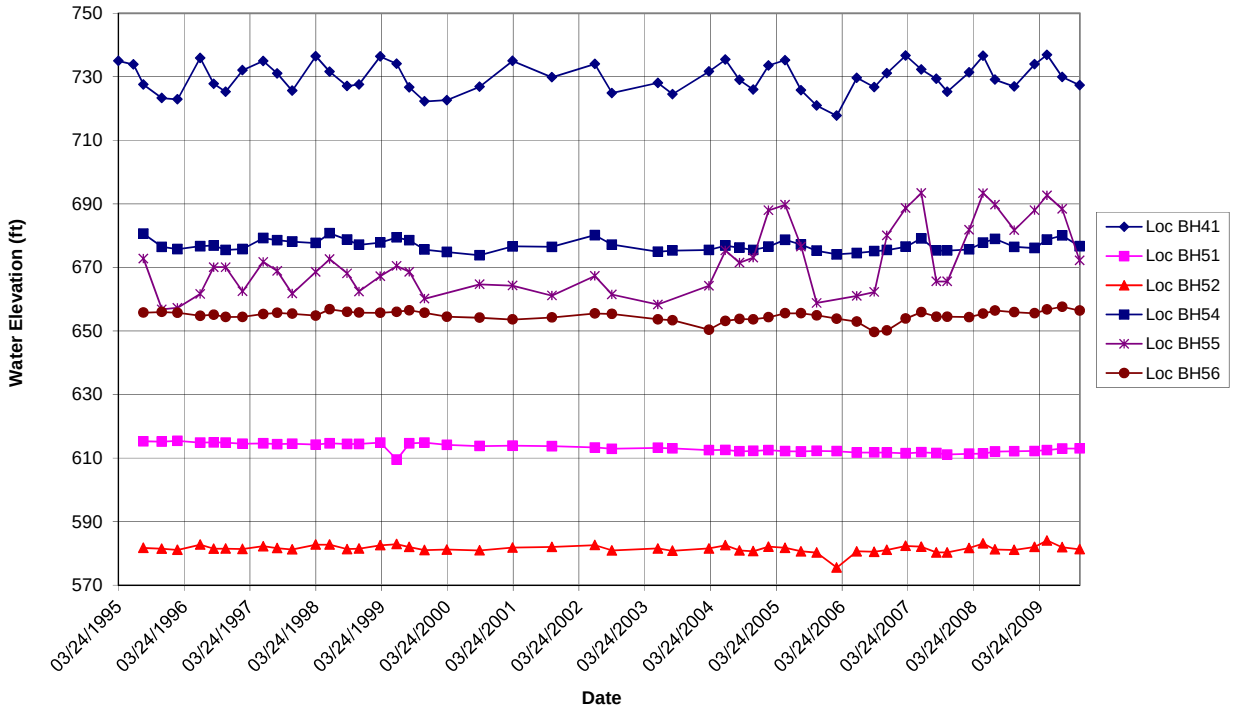

Figure 10. Hydrographs for the Six Glacial Drift Wells at Site A

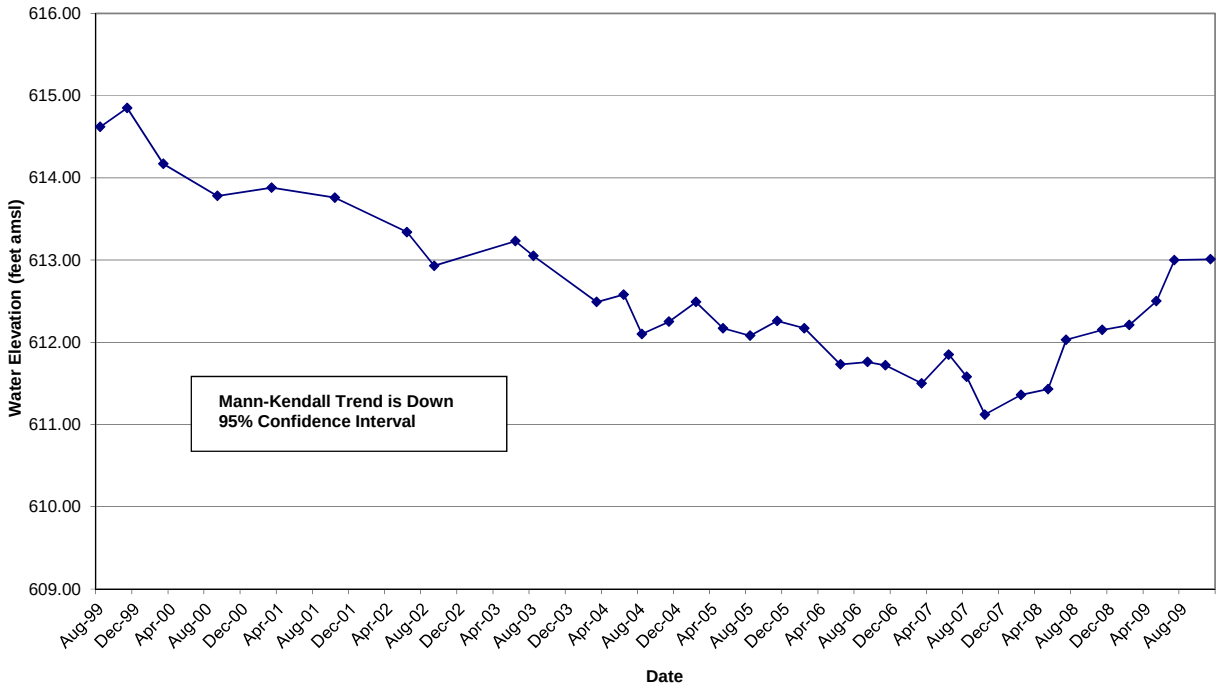

Figure 11. Hydrograph for Glacial Drift Well BH-51

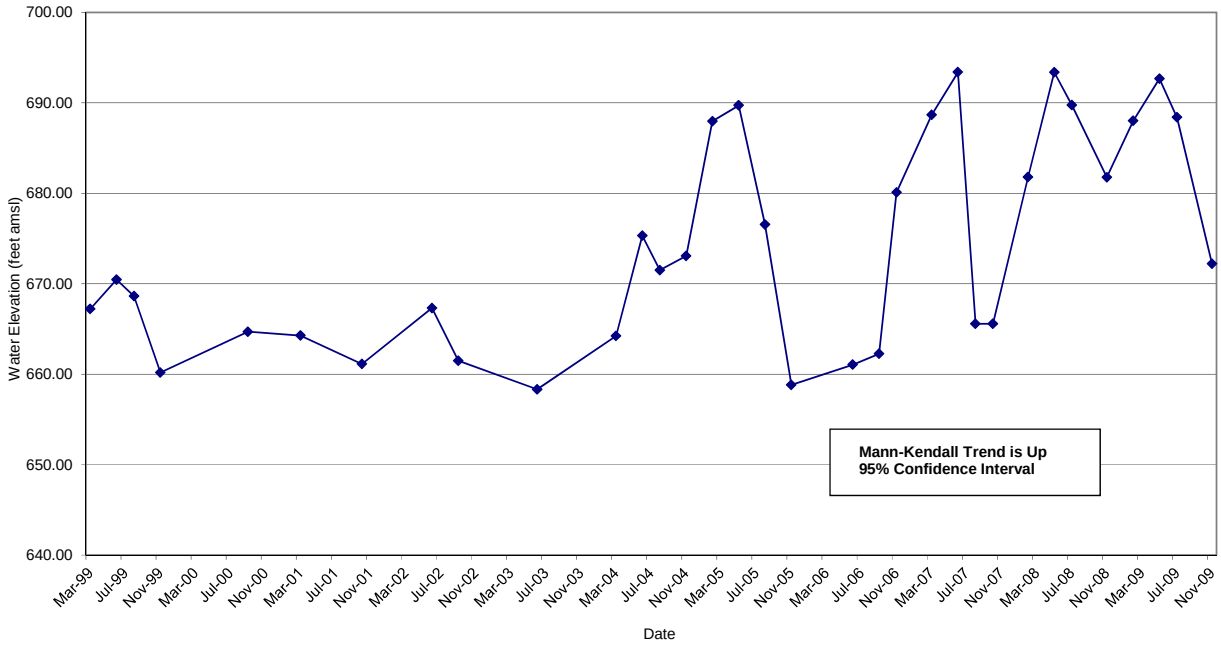

Figure 12. Hydrograph for Glacial Drift Well BH-55

5.2 Water Levels in Glacial Drift Wells at Plot M

Groundwater levels have remained relatively constant in the seven glacial drift monitoring wells at Plot M since 1994. Hydrographs for the seven monitoring wells completed in the glacial drift beneath Plot M are shown in Figure 13. Mann-Kendall trend tests (95% confidence level) were run using ChemStat Version 6.2 Software on the data sets from each well. The Mann-Kendall trend tests indicate no trends at four of the seven wells (BH-2, BH-3, BH-6, and BH-11). The water level trends at monitoring wells BH-4, BH-26, and BH-35 are down (Figures 14, 15, and 16, respectively). The down trends in BH-4, BH-26, and BH-35 are slight.

5.3 Water Levels in Dolomite Wells at and North of Plot M

Groundwater levels have remained relatively constant since 1994 in the ten monitoring wells completed in dolomite at and north of Plot M. Hydrographs for the ten monitoring wells are shown in Figure 17. Mann-Kendall trend tests (95% confidence level) were run using ChemStat Version 6.2 Software on the data sets from each well. The Mann-Kendall tests indicate that no water level trends are present in any wells.

6.0 Summary

An assessment of the groundwater and surface water monitoring data collected through 2009 at Site A/Plot M shows that:

- Quarterly monitoring for tritium should continue at all nine glacial drift monitoring wells and all four surface water locations at Plot M.
- The two major monitoring objectives defined in the LTSP for groundwater and surface water can be met through annual monitoring of the other sampling locations currently defined in the LTSP.
- Consistent groundwater levels support a less frequent monitoring schedule for COC constituents with steady concentrations that are below State of Illinois Class 1 GWQS.

7.0 References

ANL (Argonne National Laboratory), 2009, *Surveillance of Site A and Plot M Report for 2009*, Argonne National Laboratory, Argonne, Illinois.

DOE (U.S. Department of Energy), 2004, *Long-Term Surveillance and Maintenance Plan for Site A/Plot M, Illinois, Decommissioned Reactor*, Grand Junction, Colorado.

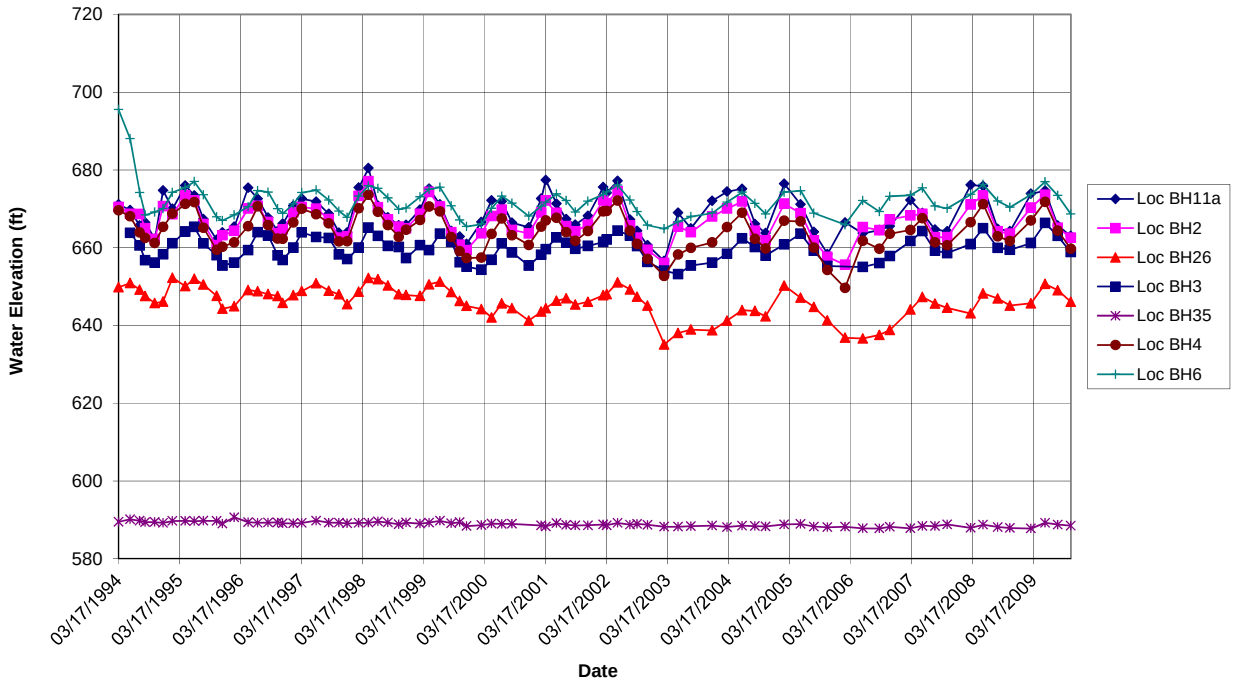

Figure 13. Hydrographs for the Seven Glacial Drift Wells at Plot M (Slant Wells BH-10 and BH-11 not included)

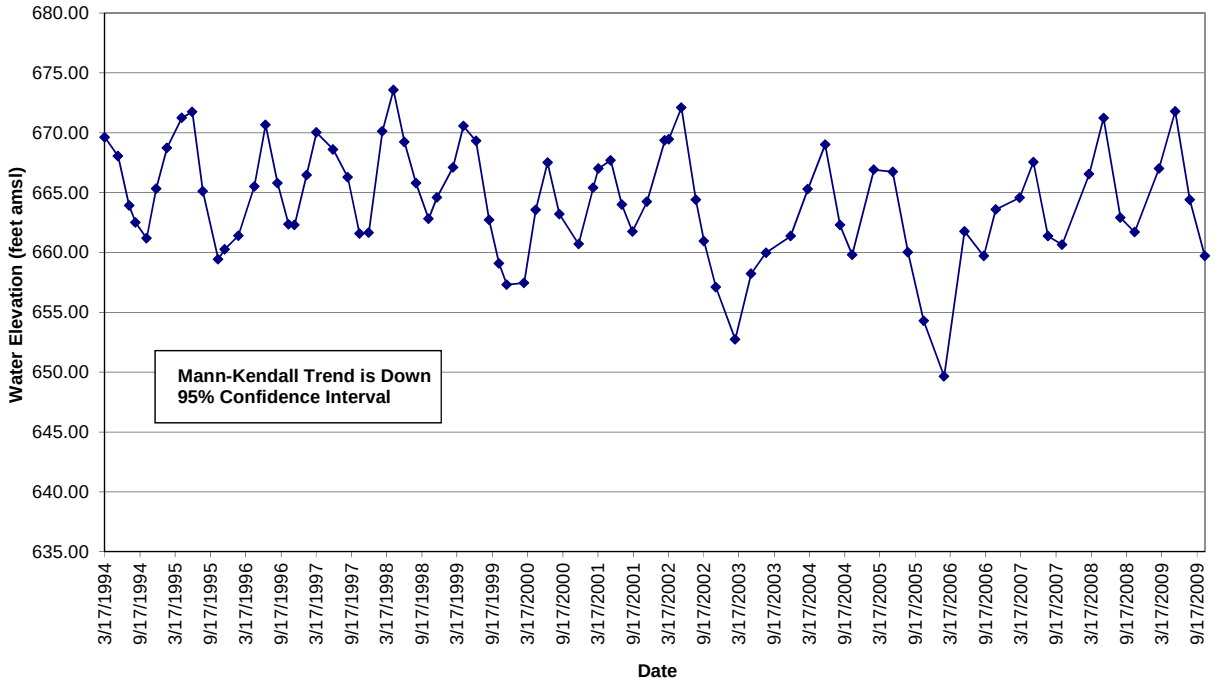

Figure 14. Hydrograph for Glacial Drift Well BH-4

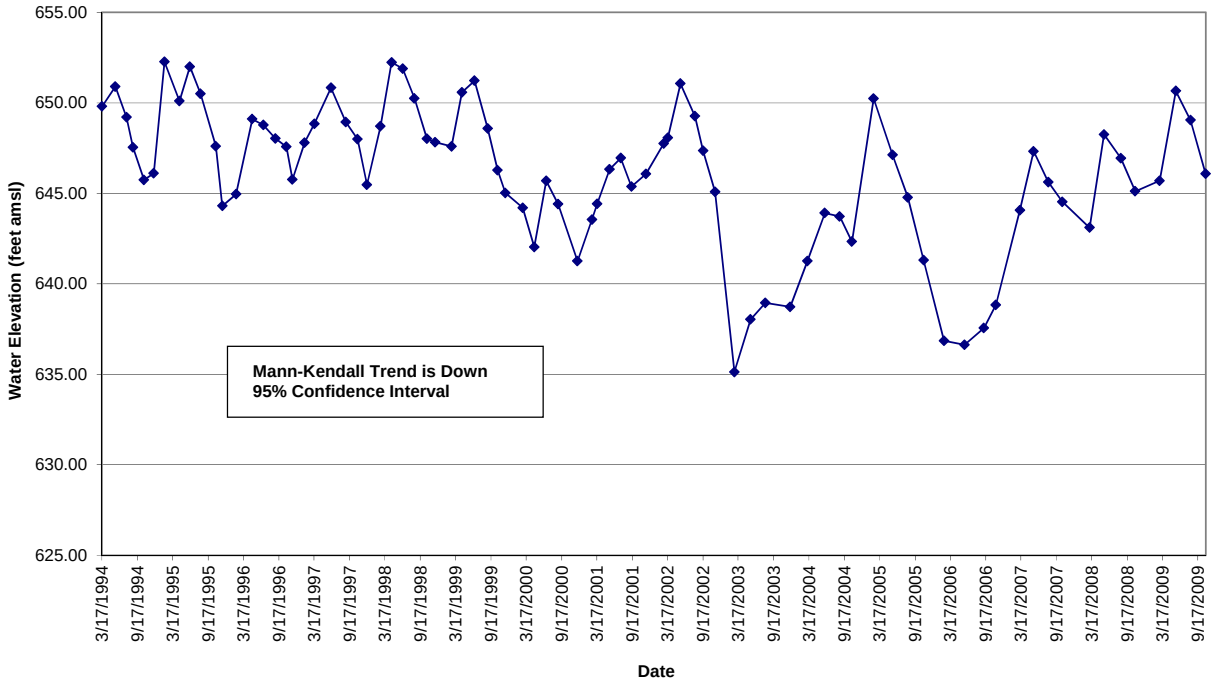

Figure 15. Hydrograph for Glacial Drift Well BH-26

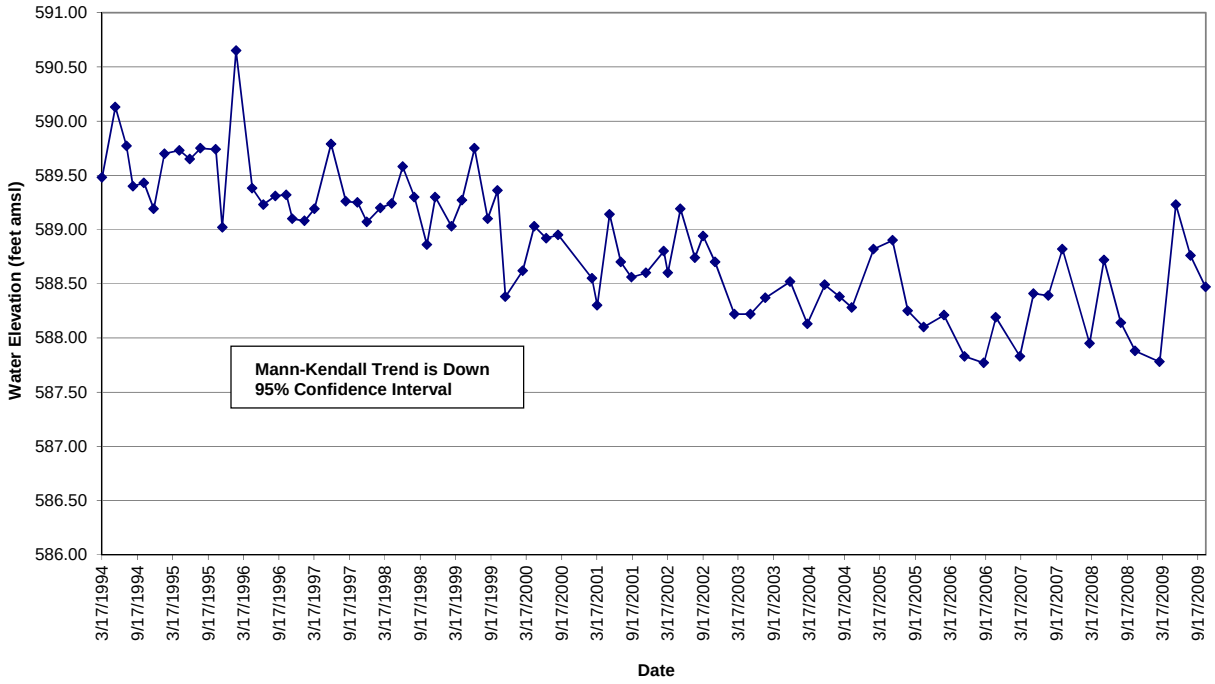

Figure 16. Hydrograph for Glacial Drift Well BH-35

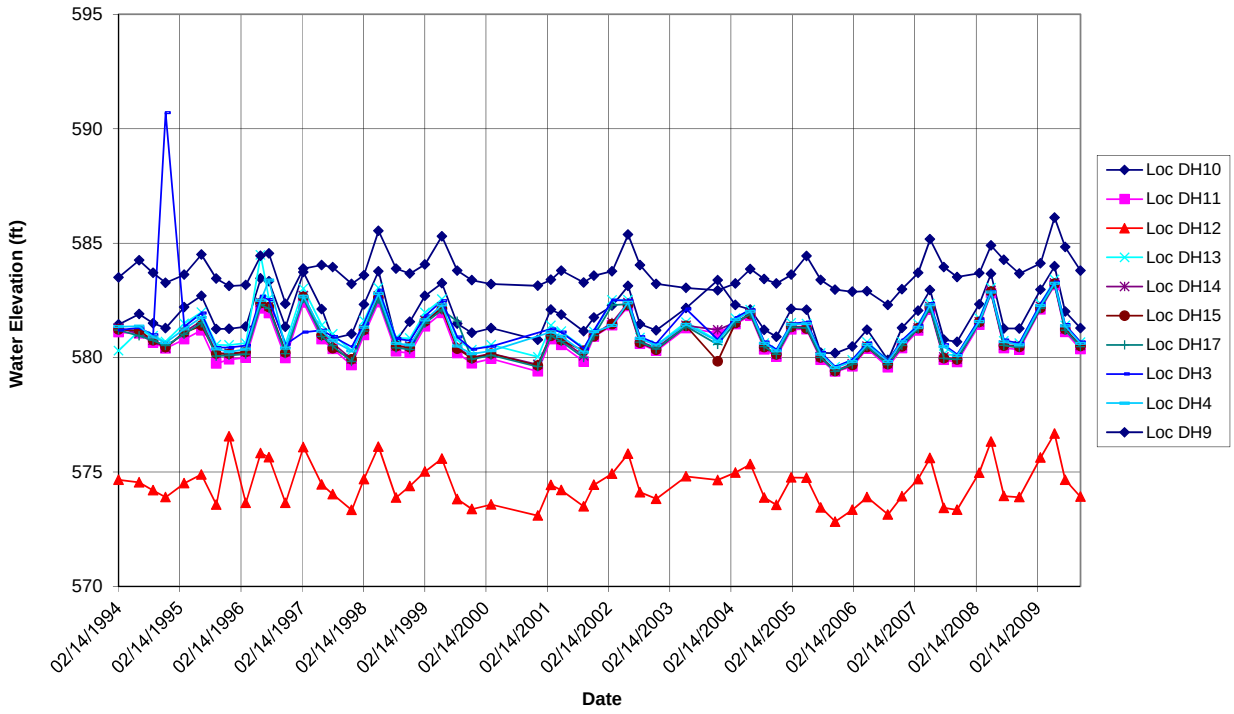

Figure 17. Hydrographs for Dolomite Wells at and North of Plot M

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Executive Summary:

This supplemental assessment was conducted for the purpose of evaluating the groundwater monitoring program at Site A/Plot M to determine if there are existing wells that could be plugged and abandoned without compromising the objectives of the monitoring program defined in the Site LTSP.

The assessment identifies eight groundwater monitoring wells that could be plugged and abandoned at Site A / Plot M based on water monitoring data presented in the *Groundwater Monitoring Assessment for Site A / Plot M* (DOE 2011).without jeopardizing the LTSP objectives.

Background:

Monitoring at Site A / Plot M has been ongoing for 32 years (1980 to 2012). It has been 9 years since the last monitoring program change was implemented in 2004. The current LTSP for Site A / Plot M directs quarterly and semiannual sampling for tritium and strontium-90 at 27 wells and 9 surface locations to achieve two major monitoring objectives:

1. Ensure that existing contaminant concentrations continue to decrease as expected due to radioactive decay and other natural processes, and
2. Detect any potential future releases.

Data collected from 2004 thru 2009 for the two remaining constituents of concern (tritium and strontium-90) resulted in the recommendation to reduce the sampling frequency of several locations to annual (DOE 2011).

This supplemental assessment looks at sampling locations, and concludes that data collected from 2004 thru 2009 also indicate that eight of the 27 monitoring wells currently being sampled could be removed from the program without compromising the two monitoring objectives listed above.

The wells identified for plugging and abandonment are located at Site A and near Red Gate Woods, specifically,

- Site A: Monitoring wells BH-41, BH-54, BH-52, and BH-51.
- Red Gate Woods: Monitoring wells D-10, D09, D17, and D13.

It should be noted that consistently elevated tritium concentrations in the glacial drift wells at Plot M indicate that no wells should be plugged and abandoned at this time at Plot M. Specifics concerning Site A and Red Gate Woods are provided below.

Site A

Six wells are currently sampled quarterly for tritium and strontium-90 at Site A. It was recently recommended that the sampling frequency of all 6 wells be reduced to annual. The recommendation is based on low tritium and strontium-90 concentrations and the consistency of the concentrations trends since 2004 (DOE 2011).

The six wells at Site A are completed in the glacial till or drift, which is a fine grained (silty-clay) with discontinuous lenses of coarse material (sandy silt and gravel) that may contain perched water (DOE 2004). The six wells range in depth from 26 feet bgs to 165 feet bgs (Attached Figure 3.3). The wide range in depths is consistent with the heterogeneous nature of the till.

Monitoring wells BH-55 and BH-56 are the two wells closest to the buried reactors, and as shown in Figure 2 and 3 of the 2011 GW assessment (attached) Monitoring Wells BH55 and BH56 have higher tritium and strontium concentrations and larger historical ranges for both constituents than the other four wells do. Since these two wells are nearest to potential sources, they are best positioned to detect any future releases.

It is therefore proposed that Monitoring Wells BH41, BH54, BH52, and BH51 be plugged and abandoned and that monitoring wells BH55 and BH56 remain and be sampled annually for tritium and strontium-90. If 10 additional years of sampling shows that the groundwater does not pose a threat to human health and the environment based on Illinois EPA Class 1 Groundwater Quality Standards, then these remaining two wells at Site A should also be plugged and abandoned.

Red Gate Woods

Ten monitoring wells completed in the dolomite aquifer are currently being monitored for tritium quarterly. As shown in attached Figure 3.4, eight of these wells are located next to Red Gate Woods. The depths of the dolomite wells are fairly consistent, 78 feet bgs to 120 feet bgs. Concentration versus time plots for these wells are attached. The plots indicate that concentrations are decreasing and trending in a consistent similar pattern. Given the close proximity of these 8 wells to each other, and that they all target the same aquifer, it is proposed that the four wells with the lowest tritium concentrations and historical range be plugged and abandoned (DH-10, DH-09, DH-17, and DH-13) and that the four wells with the highest tritium concentrations and historical range be sampled annually (DH-11, DH-12, DH-14, and DH-15).

References Cited:

DOE 2004, Environmental Monitoring Program at Site A and Plot M, Palos Forest Preserve, Cook county, Illinois, GJO-2004-558-TAC, United States Department of Energy Office of Legacy Management (DOE-LM), Grand Junction, Colorado, February 2004.

DOE 2011, Groundwater and Surface Water Monitoring Activities at Site A / Plot M, LMS/SAM/S07581, United States Department of Energy Office of Legacy Management (DOE-LM), Grand Junction, Colorado, March 2011.

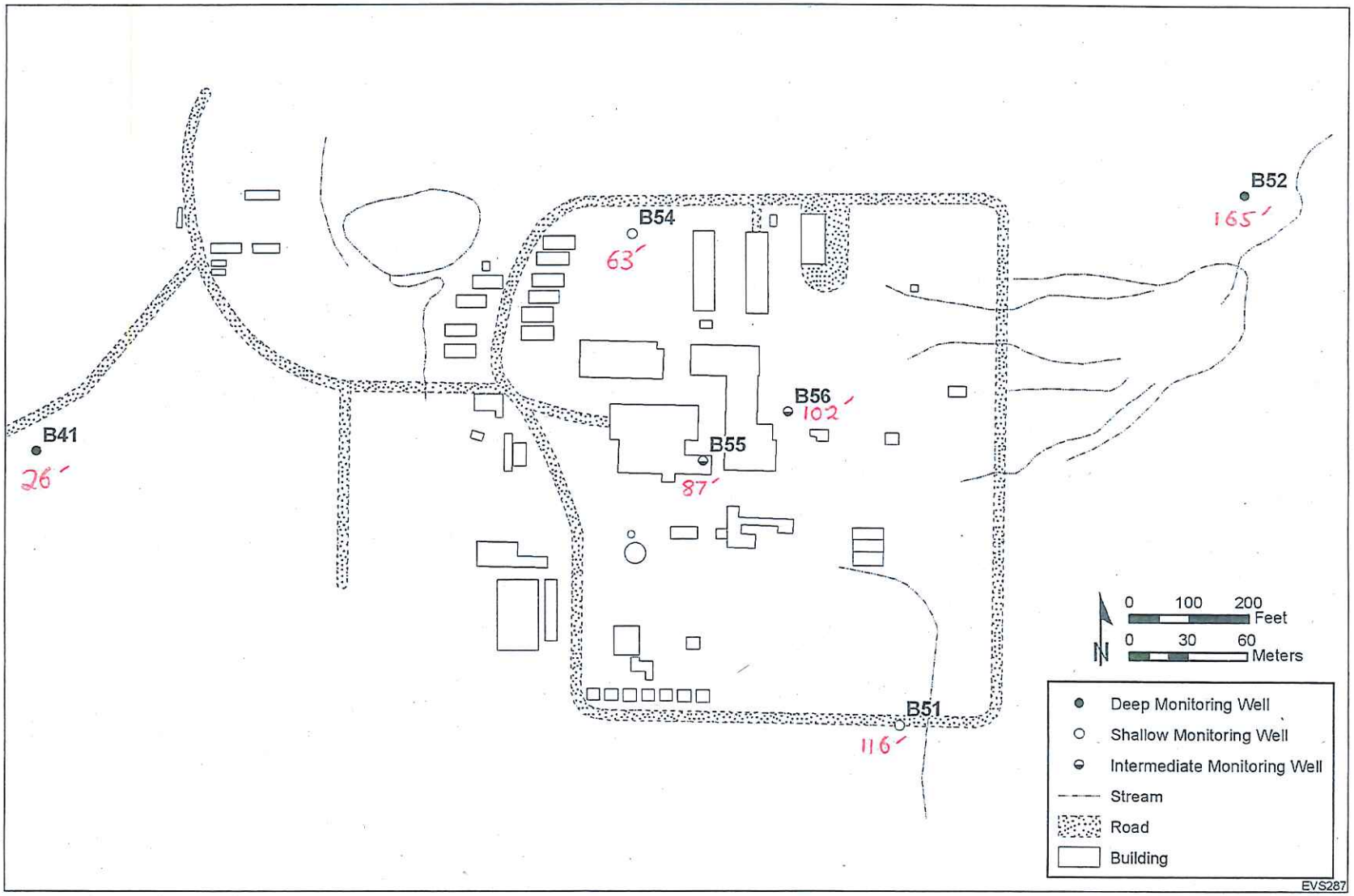

Figure 3.3 Monitoring Wells at Site A

Figure 2
Tritium Concentrations in Six Glacial Drift Wells at Site A

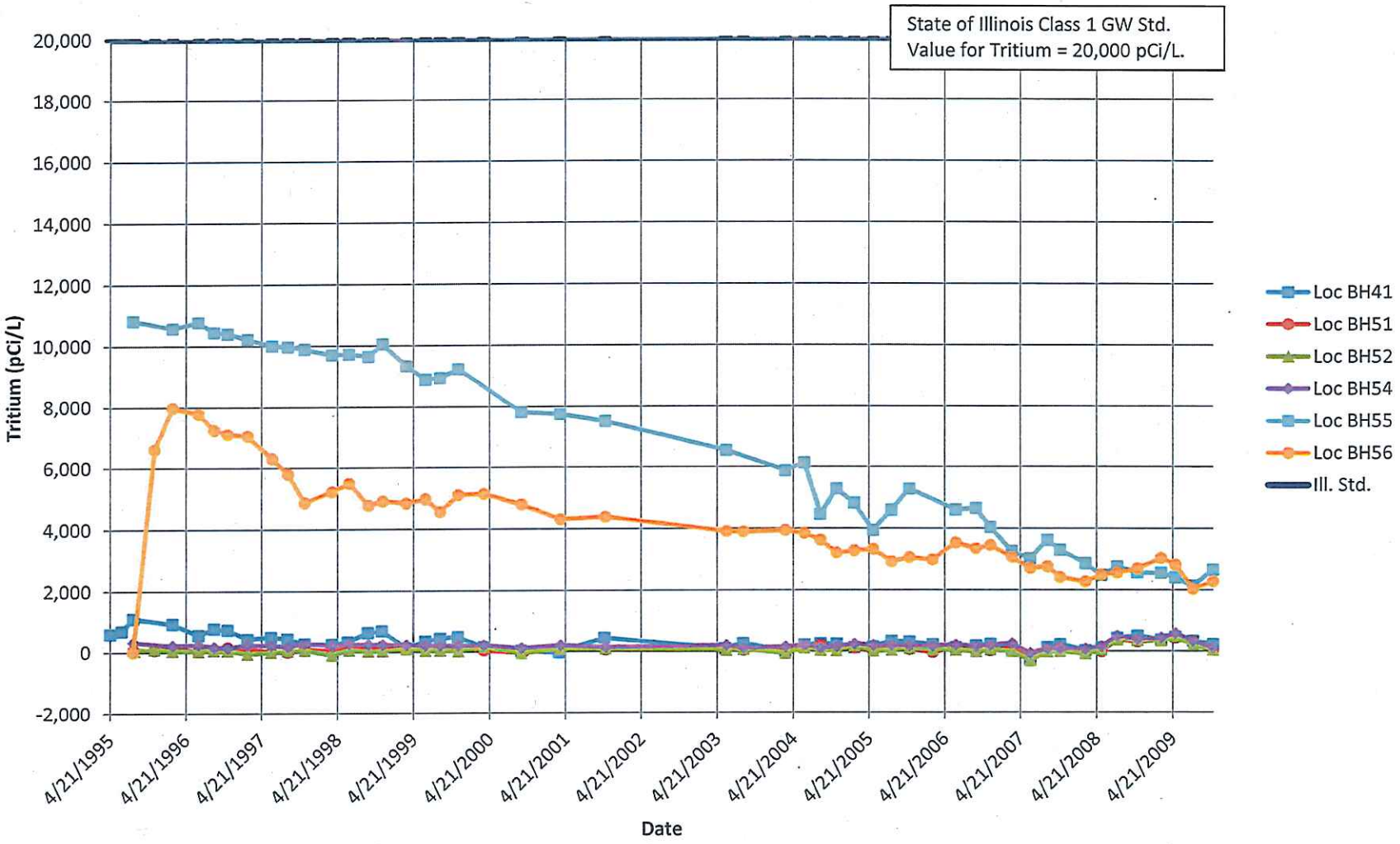

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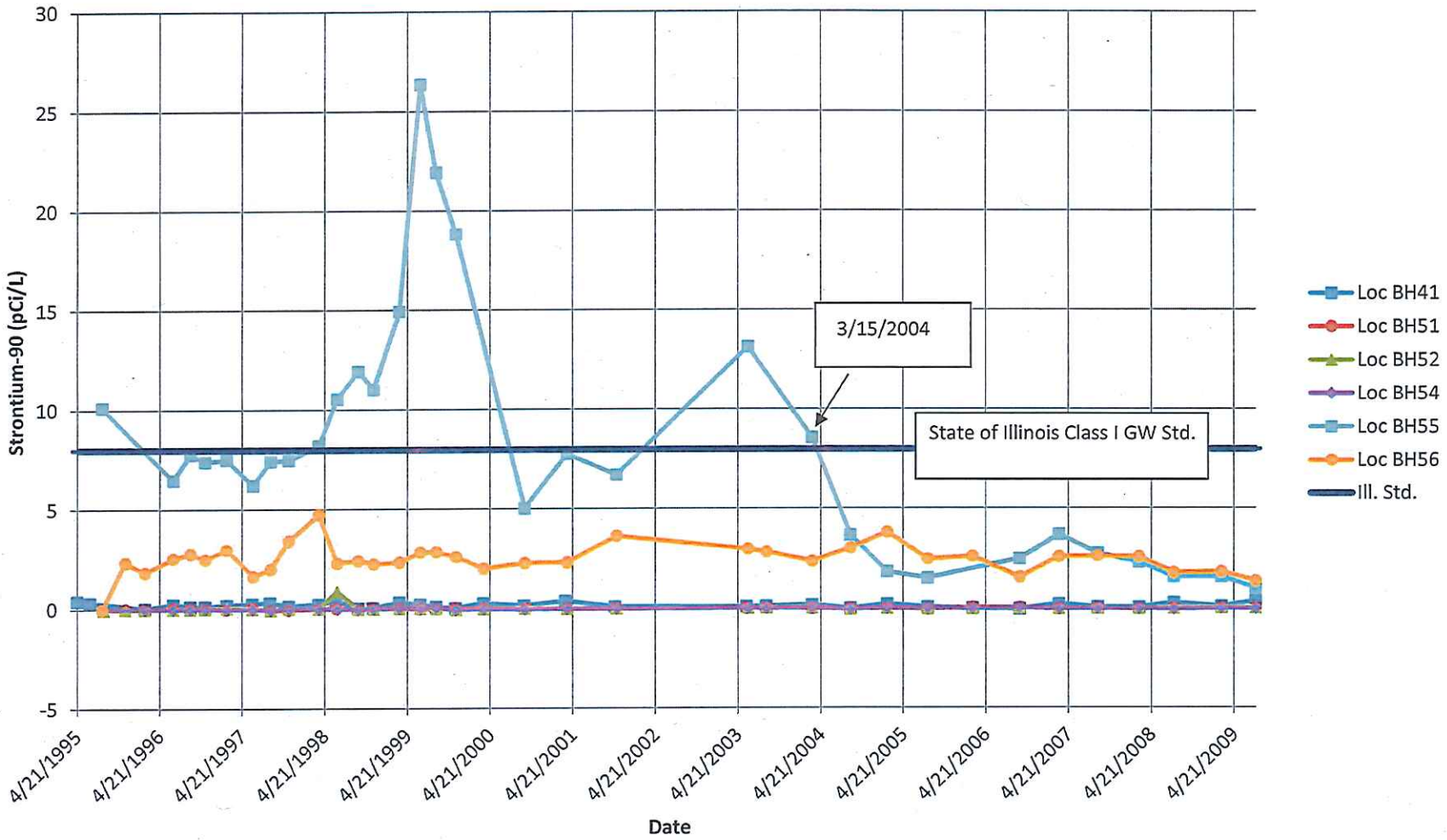
Figure 3
Strontium-90 Concentrations in Six Glacial Drift Wells at Site A



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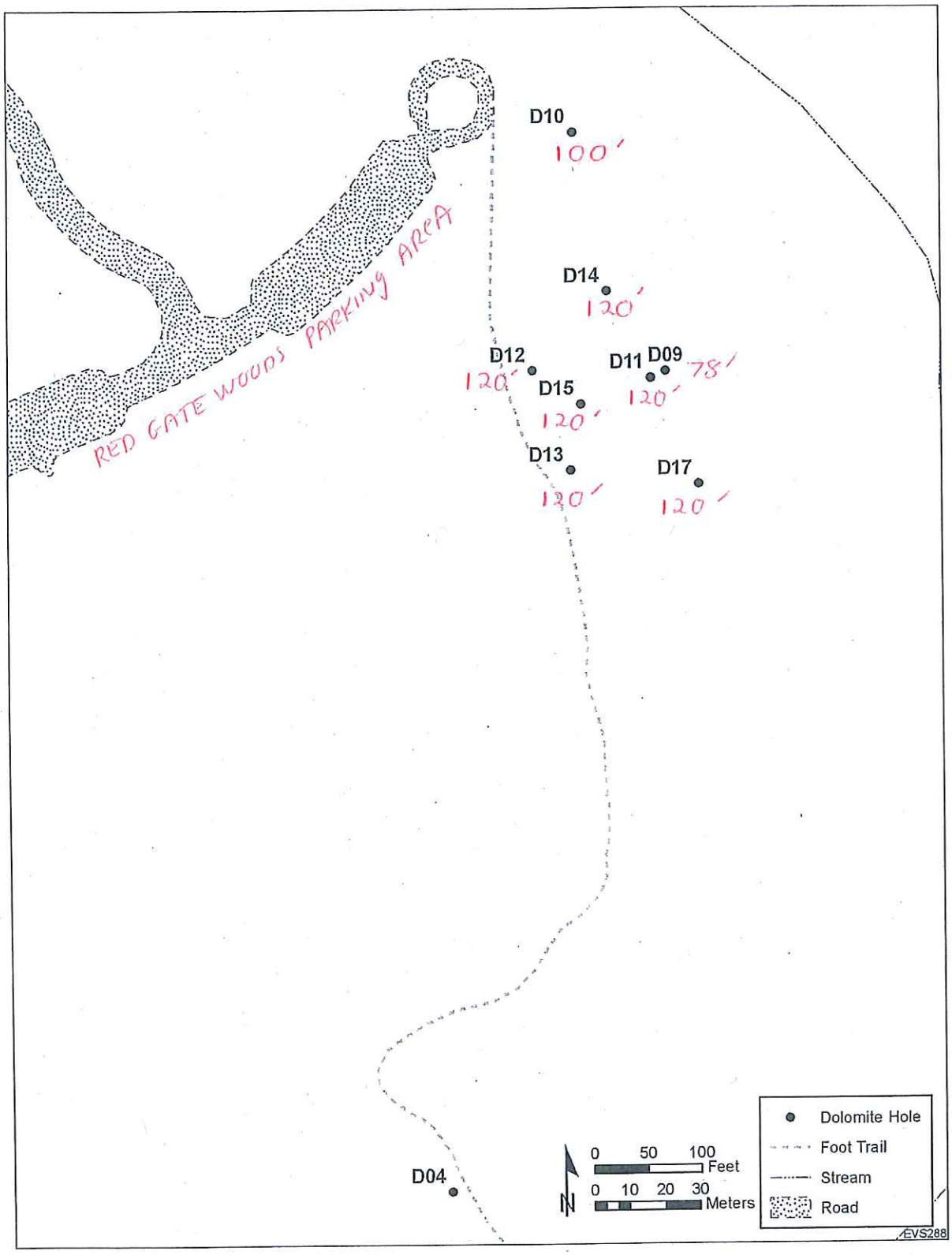
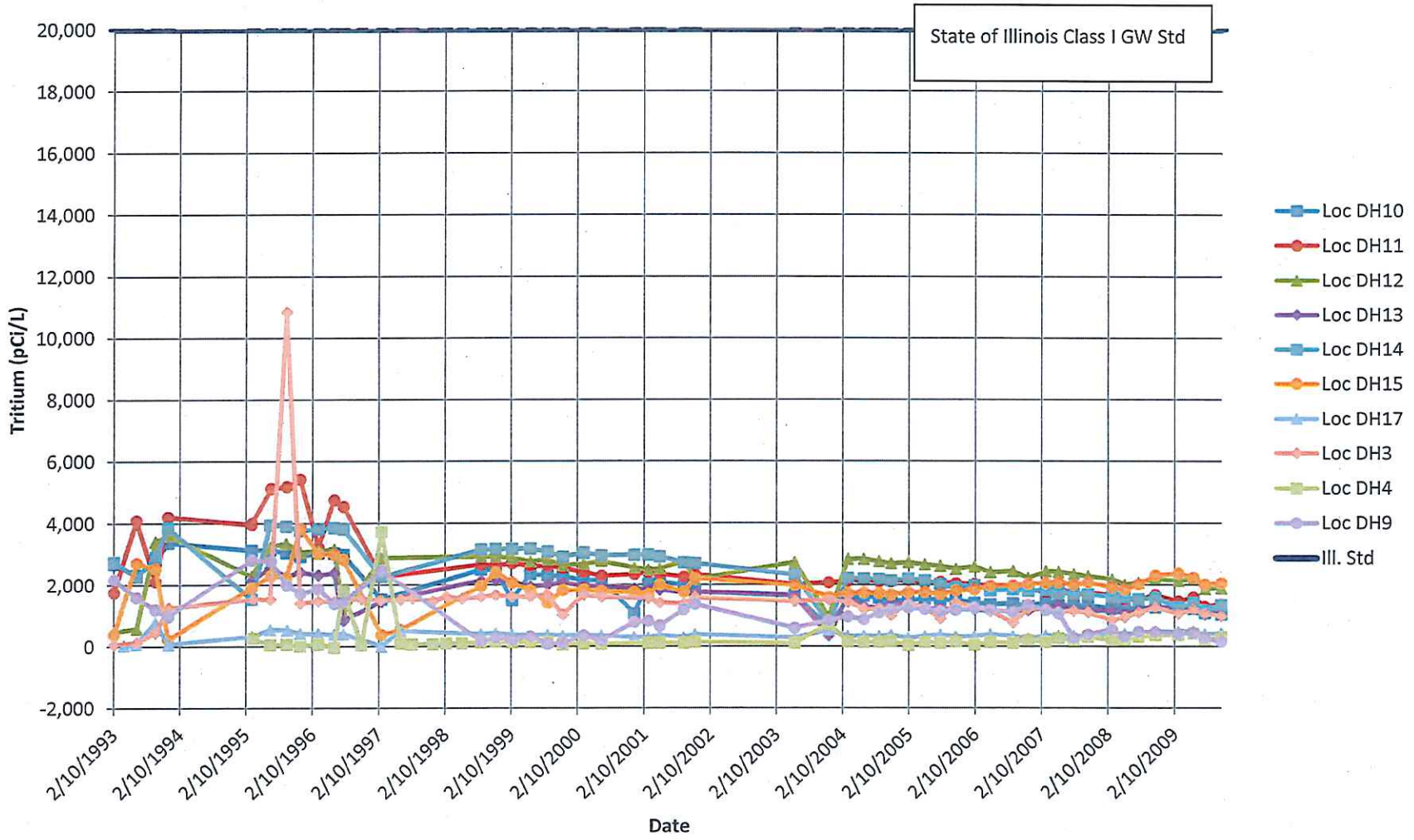


Figure 3.4 Locations of Dolomite Holes North of Plot M

Figure 7
Tritium Concentrations in Ten Dolomite Wells at, and north of Plot M



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