IEMA-OHS

ILLINOIS EMERGENCY MANAGEMENT AGENCY
AND OFFICE OF HOMELAND SECURITY

2022 Radiological Environmental Monitoring Report for Sheffield Low-Level Radioactive Waste Site

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Executive Summary

The Illinois Emergency Management Agency and Office of Homeland Security (IEMA-OHS) is mandated with protecting the citizens and environment of Illinois from the potentially harmful effects of radioactive materials. To that end, IEMA-OHS's Office of Nuclear Safety monitors the environs of several locations within Illinois for the presence of radionuclides. IEMA-OHS's radiological environmental monitoring program has three primary functions: 1) collection of diverse samples from carefully chosen locations on a routine basis; 2) analyzing samples for radionuclides; and 3) evaluation of test results on both an annual and historical basis. One of the locations monitored by IEMA-OHS is the Sheffield Low-Level Radioactive Waste (LLRW) disposal site near Sheffield, Illinois. The purpose of this report is to provide updated results of monitoring conducted at the Sheffield LLRW site during calendar year 2022.

The Sheffield LLRW site is located near the town of Sheffield, in Bureau County, Illinois. The site consists of a 20.4-acre disposal site and a 196-acre buffer zone. The LLRW site received radioactive waste between 1967 and 1978 when the disposal site reached capacity. Approximately 3.2 million cubic feet of waste was buried in 21 shallow earthen trenches.

The State of Illinois has conducted radiological environmental monitoring at the site since 1967. Since radioactive waste was disposed of in earthen trenches, monitoring of the groundwater on and around the site has been the primary focus of the monitoring program. Radioactive contamination was found in groundwater in the southeast quadrant of the disposal site in 1976. As a result, extensive geological and hydrological studies have been completed to gain a better understanding of the movement of contaminants away from the disposal trenches and to determine the best approach to monitor that movement.

It was discovered that two groundwater pathways flow away from the site. The primary pathway exists under the northern two-thirds of the disposal site, and the secondary under the southern one-third. Both pathways flow in a generally northeastern direction and eventually discharge into Trout Lake. IEMA-OHS's radiological monitoring efforts focus on the contamination levels along these two main pathways; however, careful monitoring is done in other areas both on-site and off to ensure that the contamination is contained within the disposal site and buffer zone.

The performance of the Sheffield LLRW site is measured by its ability to isolate the radioactive waste from the surrounding environment, thus minimizing the potential for public exposure. The radiological environmental monitoring program at the Sheffield LLRW site is designed to evaluate the site's performance by monitoring radionuclide movement, or lack thereof, away from the site.

Regulatory or "trigger" limits for specific radionuclides are defined in a settlement agreement between the State of Illinois and the original owner and operator of the site, US Ecology, known as the Sheffield Agreed Order (Agreed Order). Results from samples collected on-site are compared to these limits and to historical data in order to determine compliance with the agreement and to evaluate the site's performance. Off-site samples are compared to the more stringent United States Environmental Protection Agency (US EPA) and Illinois Environmental Protection Agency (IEPA) drinking water standards. Drinking water standards are regulated by the US EPA and IEPA. IEMA-OHS's purpose for sampling private wells and public water supplies is solely to screen for the presence of radionuclides.

As part of IEMA-OHS's Sheffield LLRW site radiological environmental monitoring program, samples are collected and analyzed for a variety of radionuclides. Sampling is conducted at both on-site and off-site locations and includes groundwater, surface water, and water from public water supplies, vegetation, sediment, and air samples. Additionally, monitoring for ambient gamma radiation is conducted around the site and buffer zone. Sample and monitoring results are compared to the appropriate regulatory limits, evaluated against historical data to monitor for changes at specific sampling locations, and used to evaluate the overall performance of the LLRW site.

With the exception of a total strontium result discovered in Well 516 which exceeded the established MDC, all results from IEMA-OHS's Radiological Environmental Monitoring Program at the Sheffield LLRW site were consistent with historical data and expected contamination levels. Results from the sampling and monitoring conducted in 2022 indicate that all contamination is contained within the boundaries of the disposal site and the buffer zone.

IEMA-OHS's Office of Nuclear Safety will continue to monitor the environs of, and evaluate its radiological environmental monitoring program for, the Sheffield LLRW site to ensure that the site is performing as expected and that the citizens and environment of Illinois are protected from the potentially harmful effects of radioactive materials buried at the site.

In 2022, all test results for samples collected as part of IEMA-OHS's environmental monitoring program for Sheffield LLRW site were below trigger limits set for in the Agreed Order.

Introduction

The Illinois Emergency Management Agency and Office of Homeland Security (IEMA-OHS) is charged with protecting the citizens of Illinois from the potentially harmful effects of radioactive materials. To that end, IEMA-OHS's Office of Nuclear Safety monitors the environment in Illinois for the presence of radionuclides. One of the locations monitored by IEMA-OHS is the area around the Sheffield Low-Level Radioactive Waste (LLRW) disposal site. Appendix A includes maps of the area and locations of IEMA-OHS sampling points around the Sheffield LLRW site as well as the background reference sampling location, Sangchris Lake State Park.

History of the Site

The Sheffield LLRW disposal site is located approximately three miles southwest of the town of Sheffield in Bureau County, Illinois. The town of Sheffield is about 120 miles west-southwest of Chicago, situated approximately midway between Peoria and Moline/Rock Island, just south of Interstate 80. The facility began disposing LLRW in 1967 and closed in 1978 upon reaching capacity. The LLRW disposal site includes 3.2 million cubic feet of LLRW buried in 21 shallow earthen trenches on 20.4 acres.

The State of Illinois began conducting an environmental monitoring program at the LLRW site in 1967. Between 1967 and 1980, the program was conducted by the Illinois Department of Public Health (IDPH). Since October 1980, IEMA-OHS; formerly the Illinois Department of Nuclear Safety (IDNS), has managed the monitoring program. Results of monitoring conducted between 1967 and 1988 were reported by IDNS in February 1991 (IDNS 1991), and the results of monitoring during 1989 and 1990 were reported in June 1992 (IDNS 1992). The June 1992 report also described features of the site, including meteorological and hydrological factors, which control the concentrations of radioactive contaminants in groundwater and surface water.

In 1976 radioactive contamination was observed in groundwater in the southeast quadrant of the original 20.4-acre disposal site. As a result, ongoing studies of the geology and hydrology of the site were expanded by both the Illinois State Geological Survey (ISGS) (Heigold and Larson 1984) and the United States Geological Survey (USGS) (Foster et al. 1984). These studies were designed to determine the best approach for monitoring the movement of the radioactive contamination in the groundwater.

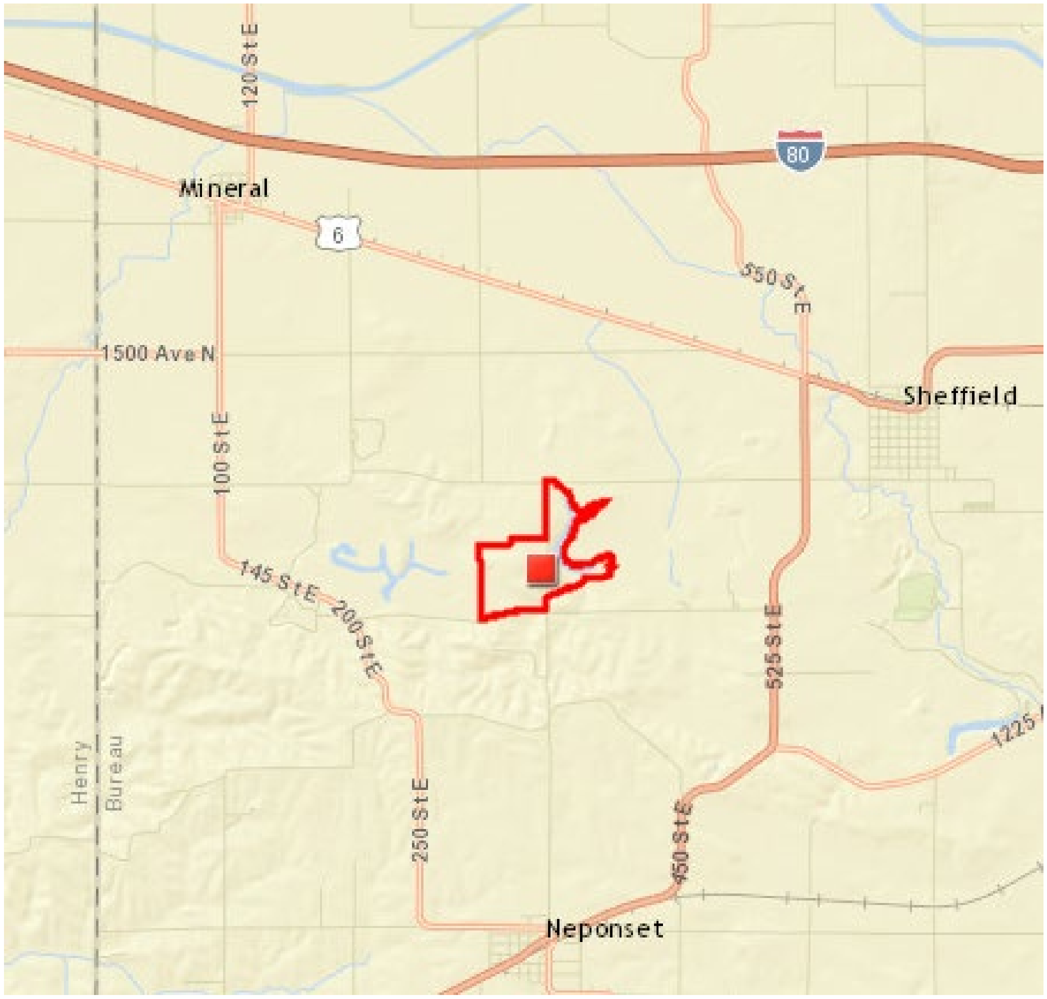
Since disposal of LLRW took place in earthen trenches, the major monitoring effort has been directed toward detecting radioactive contamination of groundwater. Samples are analyzed for a variety of radionuclides. These radionuclides may emit alpha particles, beta particles, and/or gamma rays. The type of radioactive emission determines the type of analysis required to detect a radionuclide.

The performance of a LLRW site is measured by its ability to isolate the radioactive waste from the surrounding environment. The environmental monitoring program at the Sheffield LLRW disposal site is designed to evaluate the site's performance as defined above by monitoring radionuclide movement, or lack thereof, away from the site and into pathways of possible human exposure.

Site Description

The Sheffield LLRW disposal site is located on rolling glaciated terrain in northcentral Illinois in Bureau County. The location of the site is shown in Figure 1. More detailed site maps and sampling locations are located in Appendix A.

Figure 1. Location of Sheffield Low-Level Radioactive Waste Disposal Site
(Disposal Site indicated by red square on the map. Buffer Zone is outlined in red.)



The area around the LLRW site is populated with fewer than 50 residences within a two-mile radius. Sheffield, with a population of 845 (2020 Census), is three miles to the northeast. The unincorporated town of Mineral, population 448 (2020 Census), is five miles to the northwest; the town of Neponset, population 680 (2020 Census), is three miles south of the site.

The 20.4-acre disposal site contains 21 disposal trenches, varying from 8 to 25 feet deep. A 196-acre buffer zone surrounds the site which includes a small lake called Trout Lake (previously known as Strip Mine Lake and Barbed Wire Lake) and a small stream to the south and southeast. The facility was licensed to accept radioactive waste in August 1967, began disposing waste in 1968, and closed in 1978 after the shallow land burial trenches were filled with LLRW.

A precise inventory of LLRW buried in each trench was not kept by the site operator but has been estimated in three separate studies (NUS 1979; Dragonette et al. 1979; MacKenzie et al. 1985). The estimated inventory of radionuclides is listed in Table 1.

Table 1. Maximum Values Estimated in the Sheffield Inventory
(Important Radionuclides with Half-Lives Greater than Five years)

Radionuclide	Curies	Half-Life (Years)
Tritium (H-3)	5,990	12.35
Carbon-14 (C-14)	450	5,730
Iodine-129 (I-129)	0.01	15,700,000
Strontium-90 (Sr-90)	3,690	28.1
Cesium-137 (Cs-137)	15,500	30
Cobalt-60 (Co-60)	20,000	5.27
Plutonium-238 (Pu-238)	7.5	87.74
Plutonium-239 (Pu-239); Plutonium-240 (Pu-240); Plutonium-241 (Pu-241)	4,870	24,065; 6,550; 14.4
Americium-241 (Am-241)	137.5	432

Two hazardous waste disposal areas are located to the north and northwest of the LLRW disposal site and are separated from it by at least 150 feet. These areas were used for the disposal of non-radioactive hazardous chemical waste. The first area accepted waste from 1968 to 1974 and the second area from 1974 to 1983.

The U.S. Environmental Protection Agency (US EPA) and the Illinois Environmental Protection Agency (IEPA) are the primary agencies responsible for regulation of the adjacent hazardous chemical waste sites. The site operator is working with US EPA and IEPA to remediate these sites and the surrounding area.

As part of this remediation effort, a single set of samples was collected during 1988 by SAIC, a US Ecology contractor, and analyzed for radionuclides as well as chemical contaminants. The results of this set of samples indicated extensive contamination of groundwater to the northeast of the LLRW site (SAIC 1988). Groundwater in this area contains tritium (hydrogen-3, or H-3, is a radioactive form of hydrogen that decays via beta emission) as well as a variety of chemical contaminants. Since tritium is chemically identical to non-radioactive hydrogen, it is readily assimilated into water (that is, one or both of the "Hs" in H_2O can be tritium, a form called "tritiated water"). This causes tritium to be very mobile in the natural environment. Tritium's half-life is 12.3 years, which means it will persist in the environment for about 100 years.

Hydrology of the Sheffield LLRW Disposal Site

The Sheffield LLRW site and its surrounding buffer zone are located on rolling glacial terrain. The shallow local aquifer is comprised of saturated glacial sediments and is isolated from the deep regional aquifer by a 450-foot sequence of Pennsylvanian shale bedrock. The piezometric surface of the glacial aquifer generally conforms to topographic drainage systems with gradients nominally trending west to east.

Northeast Pathway

The primary flow path for radiologically contaminated groundwater begins in a pebbly sand deposit that exists under the northern two-thirds of the disposal site. This relatively permeable unit (Toulon Member of the Glasford Formation) extends to the northeast where it constricts, filling a narrow outwash channel in the bedrock surface. This narrow channel, filled with deposits of saturated sand and gravel, extends from the northeast portion of the LLRW site to Trout Lake.

Because the northeast pathway is the principal route for contaminants leaving the LLRW site, considerable effort has gone toward understanding radionuclide movement in this area. The routine monitoring wells in this pathway are 563, 575, 577, and 600. The groundwater in these wells emanates from the continuous deposit of relatively permeable sand and gravel that underlies the northern two-thirds of LLRW site. This deposit of coarse-grained soils narrows and extends in a northeasterly direction terminating along the western shore of Trout Lake. The above-cited wells are used to sample contaminated groundwater as it moves through this narrow outwash channel from beneath the LLRW site.

Of the more than 100 groundwater monitoring wells throughout the entire buffer zone, the most highly contaminated are in the northeast pathway. These wells run along a line originating near the eastern edge of the LLRW site and extend about 900 feet in a northeasterly direction.

Southeast Pathway

A second groundwater pathway extends from under the approximate southern one-third of the LLRW site into the valley to the south and southeast. Unlike the northeast pathway, there is no continuous, spatially concentrated deposit of relatively permeable, coarse-grained soils in the southeast pathway. Because of this, groundwater flow velocities and volumes are relatively reduced, lessening the potential for movement of significant quantities of radiological contamination away from the disposal site. Consequently, areas of contamination are less extensive and contaminant concentrations are significantly less than those observed in the more permeable northeast pathway. Like in the northeast pathway, the vast majority of radiological contamination moving along this pathway ultimately discharges into Trout Lake.

The routine monitoring wells in this pathway are 512, 525, 566, 567, 574, 602, H, and TB. These wells are located in the buffer zone between the southeast corner of the LLRW site and the small stream (South Creek) located about 300 feet farther to the southeast. Wells 604, 606, and 607 slightly south of the southeast pathway are monitored to ensure that groundwater contamination from the site is not encroaching upon the buffer zone boundary.

Settlement Agreement

In 1979, site operator US Ecology attempted to abandon the LLRW site, unilaterally terminating its US Nuclear Regulatory Commission and IDPH licenses and state lease. This led to investigations which revealed that there were faulty trench caps. Both state and federal regulators objected to the unilateral terminations, arguing that the site operator must first safely close the site before terminating either of the licenses. This resulted in both federal and state litigation. The federal litigation was administratively argued before the Atomic Safety and Licensing Board, which eventually ruled against the operator on all counts.

The state's complaint was argued before the Bureau County Circuit Court. After ten years of negotiations, in May 1988, the State of Illinois and US Ecology came to an agreement and the litigation was resolved in the form of a settlement agreement known as the Sheffield Agreed Order (Agreed Order).

The Agreed Order specified what the site operator must do to safely close the site and assure its continuing safety into the future. Provisions and consequences of the agreement have had a significant impact on the scope of the monitoring program. The closure plan for the site has four basic parts:

- The operator agreed to install a new, low-permeability clay cap over all the waste trenches. The purpose of the cap is to significantly reduce the amount of radioactive material moving away from the site, reducing the potential for movement of radioactivity beyond the buffer zone.

- The operator agreed to purchase a buffer zone around the site. The 196-acre buffer zone is designed to contain, delay, and dilute any contaminants leaching from the waste. This helps to ensure that any discharges beyond the buffer zone are below the limits for release into unrestricted areas.

- Fences surrounding this zone were to be installed and maintained by the operator (See Figure A-1 in Appendix A).

- The operator agreed to monitor and maintain the site and buffer zone until 1998, as well as establish a long-term care fund to pay for IEMA-OHS (formerly IDNS) maintenance and monitoring beyond 1998.

If radionuclides are discovered outside the buffer zone in concentrations equal to or exceeding the limits for release to unrestricted areas (see Table 2), the operator must remedy the situation at its expense or pay the state an additional $1.9 million.

Table 2. Trigger Limits in Water for Selected Radionuclides

Trigger Limits in Water for Selected Radionuclides Per the Settlement Agreement of 1988		
Radionuclide	Half-Life	Limit in Water (picocuries per liter)
H-3	12.35	3,000,000
C-14	5,730	800,000
I-129	15,700,000	60
Sr-90	29.12	300
Cs-137	30	20,000
Co-60	5.27	50,000
Pu-238	87.74	5,000
Pu-239	24,065	5,000
Am-241	432	4,000

In 1989, a new cap consisting of 4.5 feet of highly compacted clay and 6 inches of vegetated topsoil was installed. The cap is designed to significantly reduce the amount of precipitation that can infiltrate the trenches and mobilize the waste. As part of the effort to install the cap, several onsite monitoring wells, sump risers, and piezometers adjacent to the waste trenches were sealed and are no longer accessible. The new cap and its immediately surrounding area are inspected regularly by IEMA-OHS and US Ecology personnel for proper vegetative cover and evidence of erosion or burrowing animals. As part of the settlement agreement, the operator has committed to immediate repairs to damaged areas.

In 2008, IEMA-OHS had the cap surveyed to estimate if subsidence is occurring over the trench area and to assess if precipitation will drain from the site or pond on the surface. The survey concluded subsidence, if any, was minimal and the cap is draining as expected.

A second cap survey was completed in 2017. The results of the 2017 survey concluded that there was some subsidence over Trench 18 that could affect drainage. Repair of the subsidence at Trench 18, found during the

2017 cap survey, was conducted in the fall of 2019. Repairs consisted of filling the affected area with topsoil and re-seeding with grass seed for top cover.

Additional minor subsidence on Trench 18 and Trench 14A was discovered in April 2021, with repairs completed the following month. The remainder of the cap shows little to no subsidence and appears to be draining as expected.

The Agreed Order defined terms that are only applicable to the Sheffield LLRW site, such as a "signaling event". A "signaling event" is defined as the occurrence within the Buffer Zone of any one of several events described in detail in the Agreed Order. In 1990, IDNS declared a "signaling event" because sampling and analyses detected that tritium had exited Trout Lake and the Buffer Zone Boundary. While the declaration of a signaling event does not indicate a threat to public health and safety, it serves as an official notice to the operator that events have occurred that may require attention and remedial action.

In accordance with the Agreed Order, US Ecology was required to meet specified financial conditions or post letters of credit. US Ecology did not meet the financial tests and did not post the required letters of credit in either 1996 or 1997. Due to US Ecology's breach of the Agreed Order, in November 1997 the state brought suit in Bureau County to require US Ecology to remain at the site and continue to provide site maintenance after May 1998. In April 1998, the Court ruled that US Ecology was in breach of the agreement and could not turn the site over to the state in May 1998. The court encouraged the parties to settle remaining issues. The parties entered into an addendum to the 1988 agreement called the 1999 First Supplement, which required US Ecology to remain at the site until it has satisfied the financial conditions of the agreement, modified some site monitoring requirements, and provided for transfer of private insurance for the site. Pursuant to the First Supplement, US Ecology satisfied all its financial conditions in June 2001, and at that time the state took ownership of the LLRW site. US Ecology remains responsible for certain remedial actions at the facility should any become necessary. US Ecology's liability for such an occurrence is limited to $1.9 million and expires in 2038. The state may take possession of the buffer zone at any time for a nominal fee but must take ownership when the Agreed Order expires.

Tritium Migration

With historical failure of the individual trench caps, subsidence, and water in the trenches, it could be expected that leachate migration might ensue. IDPH began monitoring the Sheffield site in 1967, and when the opportunity arose in the form of a study proposed by the ISGS to evaluate possible migration from the non-radioactive chemical waste site to the west, IDPH requested that the study ascertain whether chemical pollution from the "old" chemical site had entered state land and whether horizontal migration of radioactive waste occurred in the disposal trenches. In 1981, verifiable tritium was found offsite and off US Ecology property in Well 563, leading to the idea of the buffer zone. Tritium was migrating across the site in concentrations that were measurable but well below levels considered to be a threat to public health. As a result of the discovery of migrating tritium, geology and hydrology studies were performed by both the ISGS (Heigold and Larson, 1985) and the USGS (Foster et al., 1984).

IEMA-OHS Radiological Environmental Monitoring Program

The IEMA-OHS Radiological Environmental Monitoring Program for the Sheffield LLRW site is designed to evaluate the environment in general and site performance specifically by monitoring the movement, or lack of movement, of radionuclides, and subsequently determine any potential for public exposure. Program activities consist of sample collection and laboratory analysis, as well as review and analysis of the resulting data. Sample collection includes obtaining samples from both on-site locations (including the site and the buffer zone), and off-site locations (such as creeks or streams beyond the buffer zone and public water supplies in the area). On-site and off-site monitoring locations are shown in Appendix A.

Sample results are compared to applicable trigger or regulatory limits established in the Settlement Agreement, drinking water and groundwater standards, data collected from a background reference sampling location, as well as to historical data collected from the site. Drinking and groundwater standards are regulated by the US EPA and IEPA. IEMA-OHS's purpose for sampling private wells and public water supplies is solely to screen for the presence of radionuclides in drinking water. A summary of the sample collection, analysis, and results follows. Sample result tables are located in Appendix D and E.

Sampling and Monitoring Activities

On-Site Groundwater Sampling

Since the waste at the Sheffield LLRW site is buried in shallow earthen trenches, the major emphasis of the environmental monitoring program involves the sampling and analysis of groundwater. IEMA-OHS monitors groundwater through wells installed around the disposal cap and in the buffer zone.

Routine Sampling

Samples are collected and analyzed quarterly from the following locations:

Well 150	*Well 511*	*Well 512*	*Well 513*	*Well 515*	*Well 516*	*Well 525*
Well 563	*Well 566*	*Well 567*	*Well 570*	*Well 574*	*Well 575*	*Well 577*
Well 600	*Well 602*	*Well 604*	*Well 606*	*Well 607*	*Well H*	*Well I*
Well J	*Well M*	*Well TB*				

On-Site Surface Water Sampling

The vast majority of groundwater in both major pathways from the disposal site discharges into Trout Lake. Concentrations of radionuclides found at the different surface water sampling locations depend on the concentration of water from the springs, the amount of runoff from surrounding areas, the volume of lake discharge to the Lawson Creek tributary, and the amount of ice on the lake. Samples are collected and analyzed quarterly from the following locations:

Trout Lake A	*Trout Lake C*	*Trout Lake D*	*South Creek*

Off-Site Surface Water Sampling

Off-site water samples are collected and analyzed to ensure that radionuclides originating from the Sheffield LLRW disposal site have not migrated into off-site surface water sources. Samples are collected quarterly from the following locations:

*Lawson Creek**	*Lorenson Farm Creek*

* Outflow from Trout Lake moves along an unnamed tributary of Lawson Creek into the creek itself. Lawson Creek monitoring results are important because they represent the only contaminated surface water flow path crossing the buffer zone boundary.

Public Water Supply and Private Well Sampling

Although public water supplies (PWS) and private wells are not impacted as a result of site conditions, nor are they expected to be, samples are collected and screened from these locations to reassure that there is no impact to local water supplies. Samples are collected quarterly from the following locations:

Public Water Supplies

Sheffield PWS *Mineral PWS* *Neponset PWS*

Private Wells

On-Site Lunchroom Tap *Pencock Hill*

Sediment Sampling

Sediment samples are collected from three sampling locations during the second and third quarters of the year. Sediment sampling is conducted to identify contaminants that have settled out of solution or suspension and, therefore, cannot be identified through water sampling, as well as to determine the extent of long-lived radionuclide accumulation within the aquatic environment. This accumulation reflects the long-term movement of radiological contaminants through the aquatic pathways.

Vegetation Sampling

Vegetation samples are collected from two sampling locations during the second and third quarters of the year and analyzed for radionuclides that may have been transported from the environment and incorporated into or on plant tissue.

Air Sampling

Air particulate samples are collected by a continuously running low-volume air sampler located near the cap. Particulate filter samples are exchanged and analyzed weekly.

Direct Radiation Monitoring

Unlike the environmental samples described above, dosimeters do not provide information on what radionuclides are found in the environment. Instead, dosimeters provide a direct measurement of the total dose produced by all sources of gamma radiation, including naturally occurring radionuclides and cosmic rays. A network of thirteen optically stimulated luminescent dosimeters (OSLs) is arrayed around the Sheffield LLRW site and are exchanged and analyzed quarterly.

Background Reference Sampling Locations

IEMA-OHS has established the environs of Sangchris Lake State Park, a cooling lake for a coal-fired power station near Kincaid, Illinois, as the background sampling location for water, sediment, and vegetation samples. Air monitoring stations in Springfield, Marion, and West Chicago, Illinois are used for background monitoring locations for air samples. To establish "background" radiation levels, samples are collected and analyzed utilizing the same procedures and methodologies used for the Sheffield LLRW site samples.

Results for background samples can be found in Appendix E.

Sampling and Monitoring Adjustments

No sampling and monitoring adjustments were made during the 2022 reporting year.

General Sampling and Monitoring Information

Every effort is made to collect all scheduled environmental samples; however, occasionally samples are unobtainable due to weather conditions, malfunctioning equipment, water levels, or obstructed access.

Laboratory Analysis

Sediment, vegetation, water, and air samples are analyzed by the IEMA-OHS Radiochemistry Laboratory located in Springfield, Illinois. The laboratory uses standard published radioanalytical procedures and participates in semi-annual proficiency testing programs through Environmental Resource Associates, an accredited proficiency testing provider, and the Department of Energy (DOE) Radiological and Environmental Science Laboratory's Mixed Analyte Performance Evaluation Program (MAPEP). OSLs are analyzed by IEMA-OHS's Radiological Field Services (RFS) staff using a Landauer – In Light System Auto Reader. A general description of each analysis performed is provided below.

Gross Alpha/Beta Analysis

Since the radionuclides in the disposal trenches emit either alpha or beta particles, water and air samples are analyzed for total alpha and beta radioactivity. This analysis provides a good method of screening samples for the presence of radioactive material.

- All air samples are analyzed for gross alpha/beta concentration. Samples are analyzed by gas proportional counting.

- Gross alpha/beta analysis is performed on water samples at least once per year from each routine sampling location. Samples are analyzed by liquid scintillation counting.

Tritium and C-14 Analysis

Tritium and C-14 emit low energy beta particles. Their beta energies are too low to be detected by ordinary analytical methodologies for evaluating gross beta activity. To measure the concentration of tritium and C-14, water samples are analyzed using liquid scintillation counting, a technique that is capable of measuring beta emissions at very low energies and very low concentrations.

- All routinely collected water samples are analyzed for tritium concentration.
- C-14 analysis is performed on water samples at least once per year from each routine sampling location.

Total Strontium Analysis

Strontium is easily masked by other radionuclides, including those which are naturally occurring. Therefore, samples being analyzed for total strontium undergo preliminary chemical separation so that the strontium may be isolated for analysis. Total strontium analysis is performed by isolating the strontium from the matrix using a chemical separation method and then counting the samples using a gas proportional counter.

Total strontium analysis is performed on water samples at least once per year from each routine sampling location.

Gamma Spectroscopy Analysis

Gamma emitting radionuclides Am-241, Co-60, and Cs-137 are analyzed using a high-purity germanium detector in a process called gamma spectroscopy, which allows the identification of individual radionuclides.

- Gamma spectroscopy analysis is performed on water samples at least once per year from each routine sampling location.

Gamma spectroscopy analysis is performed on all vegetation and sediment samples.

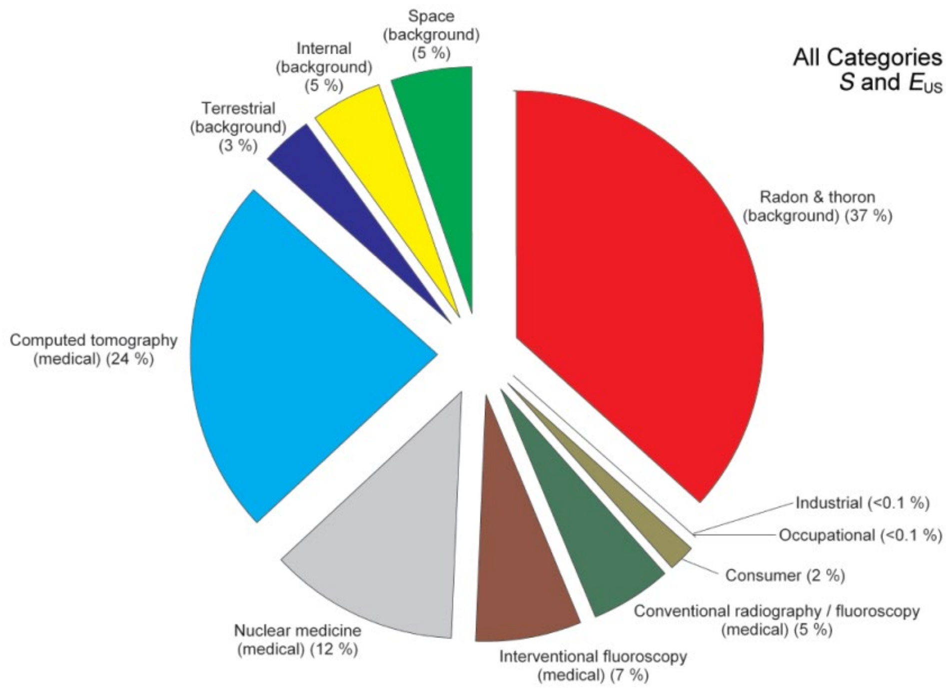
Note- Historically, environmental sediment samples contain Cesium-137 concentrations ranging between 0.1 – 0.2 picocurie per gram (pCi/g) as a result of atmospheric nuclear weapons testing. However, studies have shown that Cesium-137 concentrations of 1.0 pCi/g or higher are possible.

Optically Stimulated Luminescence Analysis

OSLs are analyzed by RFS staff using a Landauer – In Light System Auto Reader. Results found in Appendix D-Table D.17 are expressed as the average milliroentgen (mR) per quarter and are also calculated to the approximate mR per year that would have been accrued by an individual at that location for an entire year.

The ambient gamma results can be compared to the average annual radiation exposure to an individual of 620 mR/year from various sources (according to the 2009 National Council on Radiation Protection's (NCRP) Report 160). Approximately 8% (49.6 mR/year) of that exposure is from terrestrial and cosmic radiation (background radiation), Figure 2.

Figure 2. Sources of Radiation Exposure to Man



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Minimum Detectable Concentration (MDC)

All analytical methods have limitations: amounts that are just too small to be detected. Each measurement technique has its own minimum detectable concentration (MDC) which is the smallest quantity of radioactive material per unit volume that can be detected reliably. An MDC is a function of the limitations of the nuclear counting equipment, the volume/weight of sample used, chemical separation techniques, and ambient natural background radiation present in the laboratory. The MDC is an "a priori" measure of these limitations – an estimate of the lower limit of detection. It is defined as the smallest quantity that an analytical method has 95% likelihood of detecting. For example, if the MDC for IEMA-OHS's method for tritium analysis in water is 200 picocuries per liter (pCi/L), given a sample with a tritium concentration of 200 pCi/L, tritium would be detected approximately 95 times out of 100. Samples with concentrations less than 200 pCi/L could be detected, but with less certainty. Conversely, samples with concentrations higher than 200 pCi/L would be more likely to be detected, approaching 100% as concentrations increase.

Analysis Adjustments

- No analytical adjustments during the 2022 sampling year.

Radiological Environmental Sampling and Monitoring Results

On-Site Groundwater Sampling Results

Gross Alpha/Beta Results

Gross alpha/beta results for on-site groundwater samples are compared to historical data collected from the site. Analytical results are shown in Table D.1.

Results indicate that several sampling locations had gross alpha and/or gross beta concentrations above the established MDC. Results above MDC at these locations are consistent with historical data and are expected due to the sampling locations' proximity to the known contamination plume.

Tritium Results

Tritium results for on-site groundwater samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Tables D.3.

Routine sampling results indicate that wells sampled within the Northeast and Southeast pathways had tritium concentrations above the established MDCs. Concentrations above MDC are expected for these sampling locations due to the flow of water through the pathways away from the disposal site and are consistent with historical data. The general trend in routine sampling in tritium concentrations found on-site is decreasing.

Tritium results for all routine on-site groundwater sampling locations were consistent with historical data. All 2022 results were below the 3,000,000 pCi/L trigger limit set in the Agreed Order.

Appendix B provides a graphical depiction of tritium (H-3) results from routine on-site groundwater sampling locations. The graphs include historical results for those sites, which are included to display the overall trends of tritium concentration over time. Additionally, the graphs show the MDC and the highest recorded tritium concentration as a percentage of the samples respective trigger limit (3,000,000 pCi/L).

C-14 Results

C-14 results for on-site groundwater samples are compared to historical data, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Tables D.5.

Routine sampling results indicate the presence of C-14 in concentrations above the established MDC in several on-site wells within the known contamination plumes along the Northeast or Southeast groundwater pathways and on or near the disposal site cap. Concentrations of C-14 above the set MDC in these areas are known to exist and are consistent with historical data.

Well 511, located outside of the major contamination pathways but near the cap, has seen C-14 results above the set MDC since 2013. Although above the established MDC, the concentrations seen are significantly below the trigger limit set for C-14. IEMA-OHS will continue to monitor and track the C-14 concentration found at this specific location.

All 2022 results were below the 800,000 pCi/L trigger limit set in the Agreed Order.

Total Strontium Results

Total strontium results for on-site groundwater samples are compared to historical data, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.7.

A detectable concentration of total strontium was found in a sample collected from Well 516. Well 516 is located outside of the known contamination plumes and has not historically returned results above the established MDC for total strontium. The concentration found was below the US and IEPA limit of 8 pCi/L. IEMA-OHS will continue to monitor and track the total strontium concentration at this sampling location. Concentrations found in all other on-site groundwater sampling locations were below the established MDC.

Gamma Spectrometry Results

Gamma spectrometry results (Am-241, Co-60, and Cs-137) for on-site groundwater samples are compared to historical data, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.9.

Results indicate no concentrations above the established MDCs.

On-Site Surface Water Sampling Results

Gross Alpha/Beta Results

Gross alpha/beta results for on-site surface water samples are compared to historical data collected from the site and to sample data collected from the background reference location. Analytical results are shown in Table D.1.

Results indicate that all three Trout Lake sampling locations had gross beta concentrations above the set MDCs; occasional sample results with gross alpha and/or gross beta concentrations above the MDC are consistent with historical data. South Creek sampling results were below the MDC.

Tritium Results

Tritium results for on-site surface water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.3.

Results indicate tritium concentrations above the established MDC at all Trout Lake sampling locations. Concentrations above the MDC are expected at these sampling locations due to the flow of water through the groundwater pathways into Trout Lake and are consistent with historical data. South Creek sampling results were below the MDC. All on-site surface water results were below the 3,000,000 pCi/L trigger limit set in the Agreed Order.

Appendix B provides a graphical depiction of tritium results from on-site water sampling locations. The graphs display historical results for each sampling location and their overall trend in tritium concentration over time. Additionally, the graphs show the MDC and the highest recorded tritium concentration as a percentage of the samples respective trigger limit (3,000,000 pCi/L).

C-14 Results

C-14 results for on-site surface water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.5.

Results indicate no concentrations above the established MDCs.

Total Strontium Results

Total Strontium results for on-site surface water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.7.

Results indicate no concentrations above the established MDCs.

Gamma Spectroscopy Results

Gamma spectroscopy results (Am-241, Co-60, and Cs-137) for on-site surface water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.9.

Results indicate no concentrations above the established MDCs.

Off-Site Water Sampling Results

Gross Alpha/Beta Results

Gross alpha/beta results for off-site water samples are compared to historical data collected from the site and to sample data collected from the background reference location. Analytical results are shown in Table D.2.

Results above the MDC for gross alpha and/or gross beta were seen in samples collected from Mineral PWS, Neponset PWS, the Lunchroom Tap, and Pencock Hill. Mineral and Neponset public water systems are supplied through groundwater aquifers, the Lunchroom Tap and Pencock Hill through a private groundwater well. There are no treatment technologies for the removal of radium used at any of these locations. Therefore, it is likely that the increase in gross alpha/beta concentration is a result of naturally occurring radioactive materials in the water supply.

Tritium Results

Tritium results for off-site water samples are compared to historical data, data collected from the background reference location, the trigger limits established in the Agreed Order, as well as to drinking water and groundwater standards established by the US EPA and IEPA. The US EPA drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the IEPA groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013) both set the limit for tritium in groundwater at 20,000 pCi/L. Analytical results are shown in Table D.4.

Results indicate no concentrations above the established MDC.

Appendix C provides a graphical depiction of tritium (H-3) results from off-site water sampling locations. The graphs include historical results for those sites, which are included to display the overall trends of tritium concentration over time. Additionally, the graphs show the MDC and the highest recorded tritium concentration as a percentage of the samples respective regulatory limit (20,000 pCi/L).

C-14 Results

C-14 results for off-site water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.6.

Results indicate no concentrations above the established MDCs.

Total Strontium Results

Total Strontium results for off-site water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.8.

Results indicate no concentrations above the established MDCs.

Gamma Results

Gamma spectroscopy results (Am-241, Co-60, and Cs-137) for off-site water samples are compared to historical data, data collected from the background reference location, as well as to the trigger limits established in the Agreed Order. Analytical results are shown in Table D.10.

Results indicate no concentrations above the established MDCs.

Sediment Sampling Results

Sediment sample results are compared to historical data collected from the site and to sample data collected from the background reference location. Analytical results are shown in Tables D.11 and D.12.

A 2nd quarter sample from Trout Lake D was not collected due to poor conditions for sediment retrieval.

Cesium-137 concentrations greater than the established MDC were detected in both on-site and off-site sampling locations. Results seen are consistent with concentrations historically found from atmospheric nuclear weapons testing. All other gamma spectroscopy results for sediment samples were below the established MDC.

Vegetation Sampling Results

Vegetation sample results are compared to historical data collected from the site and to sample data collected from the background reference location. Analytical results are shown in Table D.13.

Results indicate no concentrations above the established MDCs.

Air Sampling Results

Air sampling results are compared to historical data collected from the site and to sample data collected from the background reference locations. Analytical results are shown in Table D.14.

Results are consistent with historical data and data collected from the background reference area.

Direct Radiation Results

OSL results are compared to historical data collected from the site and to sample data collected from the background reference location. Analytical results are shown in Table D.15.

Results are consistent with historical data and data collected from the background reference area.

Results Interpretation or Limit Adjustments

No changes or adjustments to result interpretations during the 2022 reporting year.

Summary

Due to the original design of the disposal site, the flow of groundwater away from the site, and the radionuclides disposed of; the presence of radiological contamination at the disposal site and within the buffer zone is known to exist and is expected.

In 2022, contaminants from the site were observed in groundwater collected on site, as well as within groundwater and surface water collected from the buffer zone. Detectable concentrations of tritium were observed at many on-site sampling locations, with wells located along the groundwater pathways containing the highest concentrations. C-14 concentrations above the MDC were detected in some on-site monitoring wells. Gross alpha and gross beta concentrations above the established MDC were seen intermittently in water samples but were consistent with historical data. A detectable concentration of total strontium was found in a sample collected from Well 516. Well 516 is located outside of the known contamination plumes and has not historically returned results above the established MDC for total strontium.

Gross alpha and gross beta concentrations above the established MDC were seen at some off-site locations. However, the elevated concentrations are likely due to naturally occurring radioactive materials in the groundwater supply since tritium, carbon-14, strontium, and gamma concentrations in off-site samples were all below the established MDCs. No contaminants attributable to the LLRW site were found within samples collected from off-site locations.

All 2022 water sample results were well below the trigger limits set forth in the Agreed Order and listed in Table 2 of this report.

Gamma results from vegetation sampling indicated no concentrations above the established MDCs. Cs-137 results above the established MDC were seen in both on-site and off-site sediment samples; however, the results seen were consistent with concentrations historically found from atmospheric nuclear weapons testing.

Results from air sampling were comparable to those seen at background air sampling locations in Springfield, Marion, and West Chicago, Illinois. Direct radiation measurements were comparable to historical levels found at the LLRW site.

With the exception of a total strontium result discovered in Well 516 which exceeded the established MDC, all results from IEMA-OHS's Radiological Environmental Monitoring Program at the Sheffield LLRW site were consistent with historical data and expected contamination levels. Results from the sampling and monitoring conducted in 2022 indicate that all contamination is contained within the boundaries of the Disposal Site and the Buffer Zone.

IEMA-OHS's Office of Nuclear Safety will continue to monitor the environs of, and evaluate its radiological environmental monitoring program for, the Sheffield LLRW site to ensure that the site is performing as expected and that the citizens and environment of Illinois are protected from the potentially harmful effects of radioactive materials buried at the site.

IEMA-OHS's Office of Nuclear Safety will continue to monitor the environs of, and evaluate its radiological environmental monitoring program for, the Sheffield LLRW site to ensure that the site is performing as expected and that the citizens and environment of Illinois are protected from the potentially harmful effects of radioactive materials buried at the site.

Appendix A

Maps of IEMA-OHS Monitoring Locations

Figure A-1. Sheffield Site and Approximate Groundwater Pathways

Figure A-2. Sheffield On-Site Sampling Locations

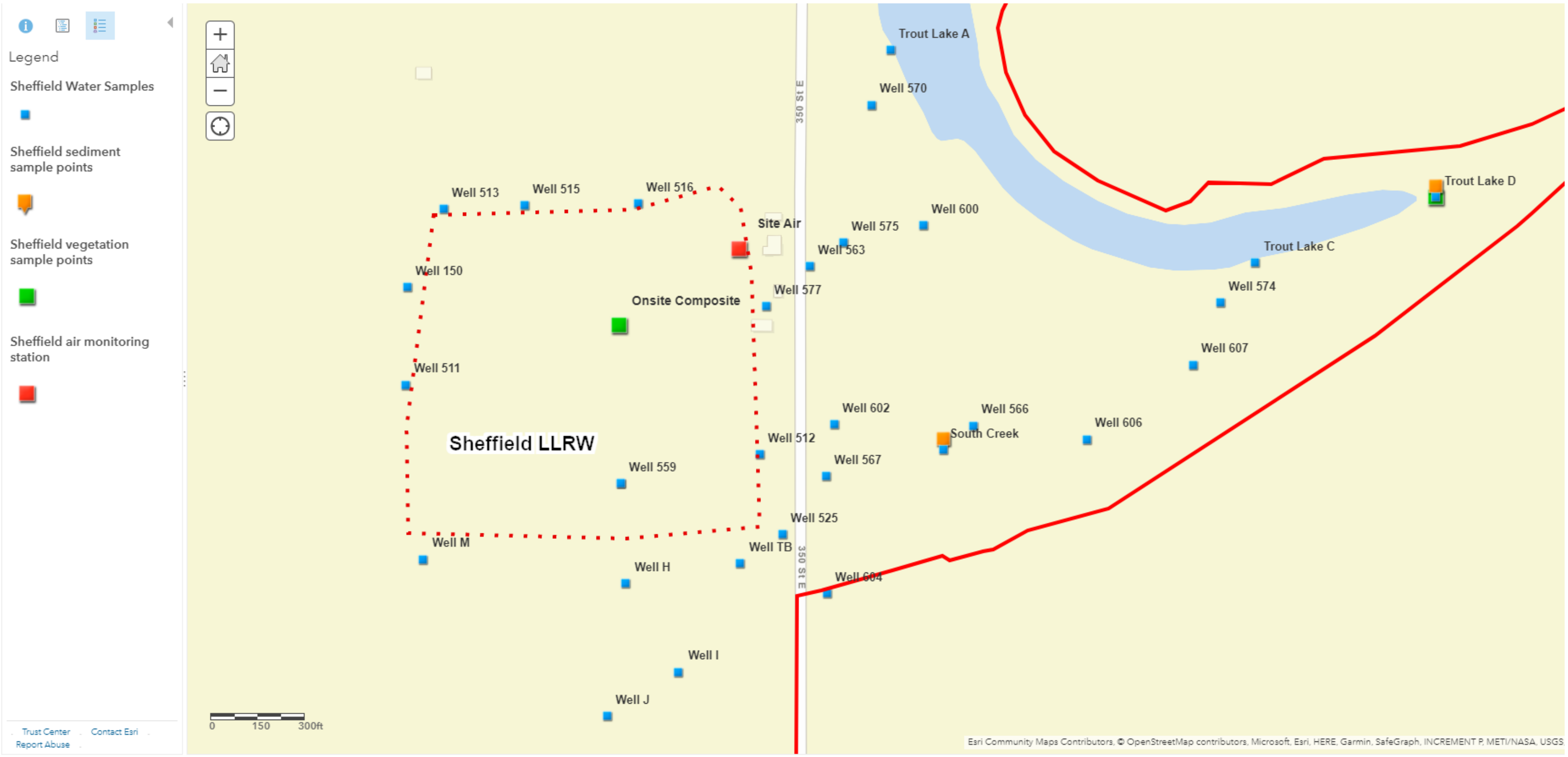


Figure A-3. Sheffield OSL Monitoring Locations

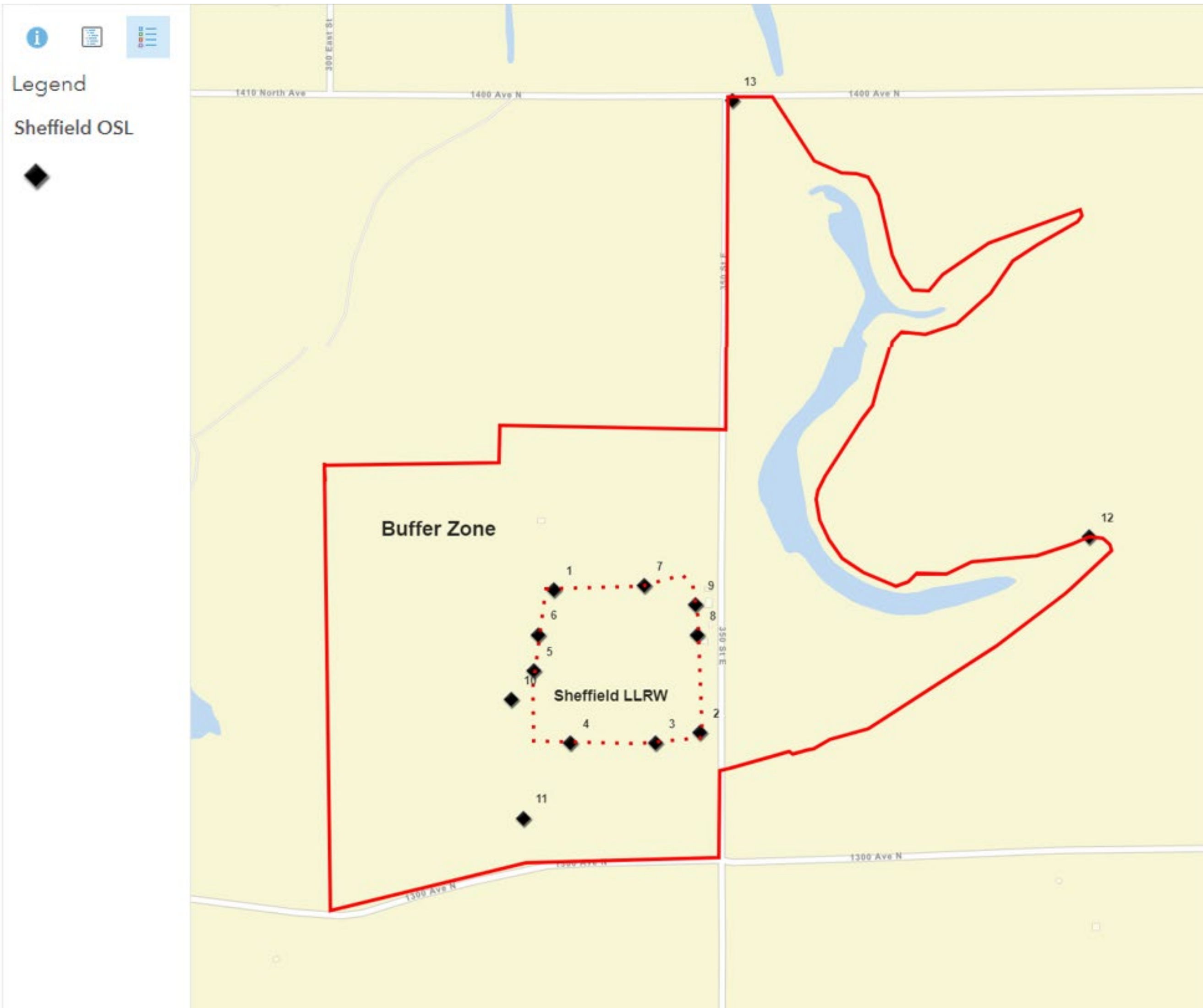


Figure A-4. Sheffield Off-Site Monitoring Locations

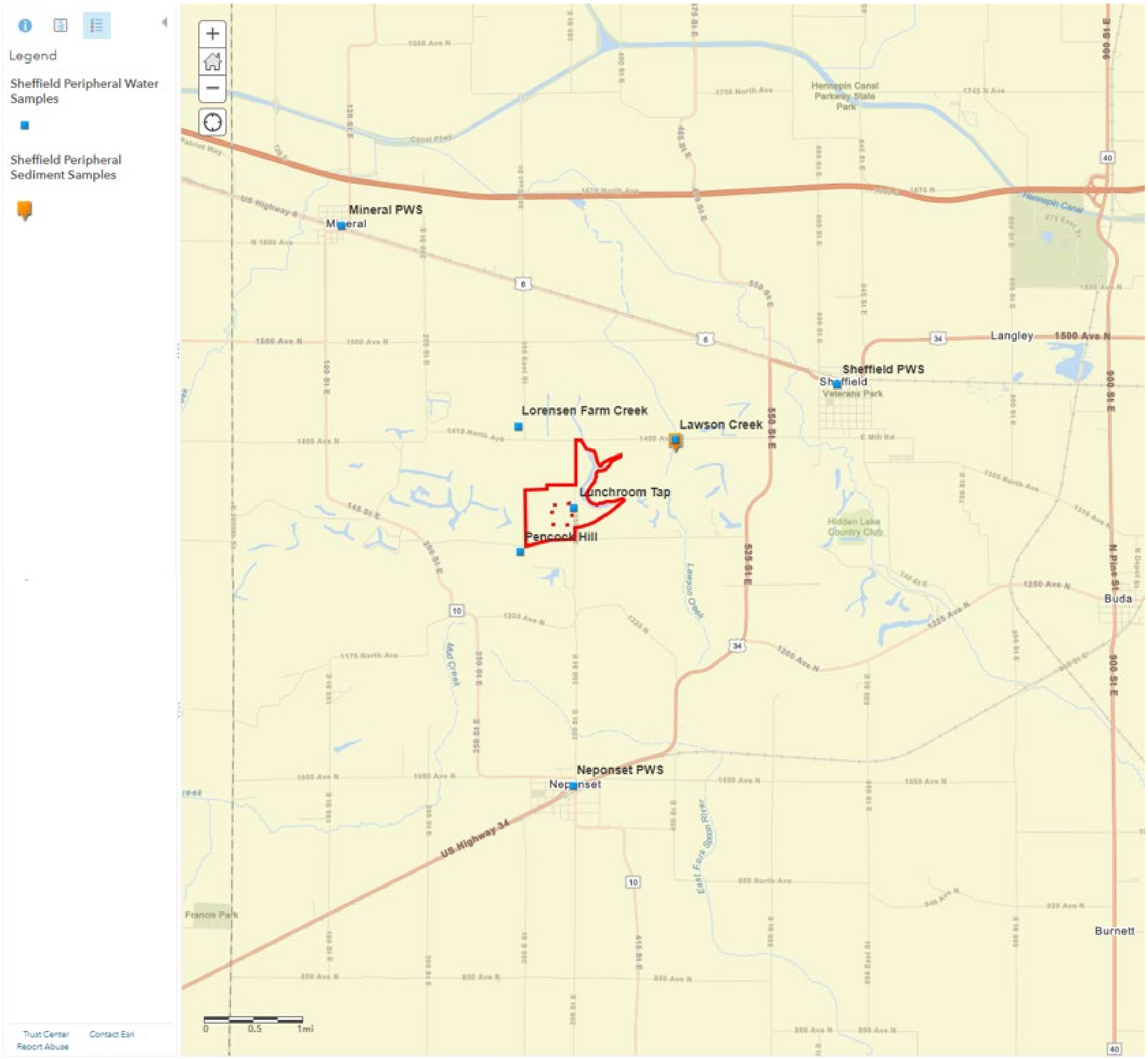
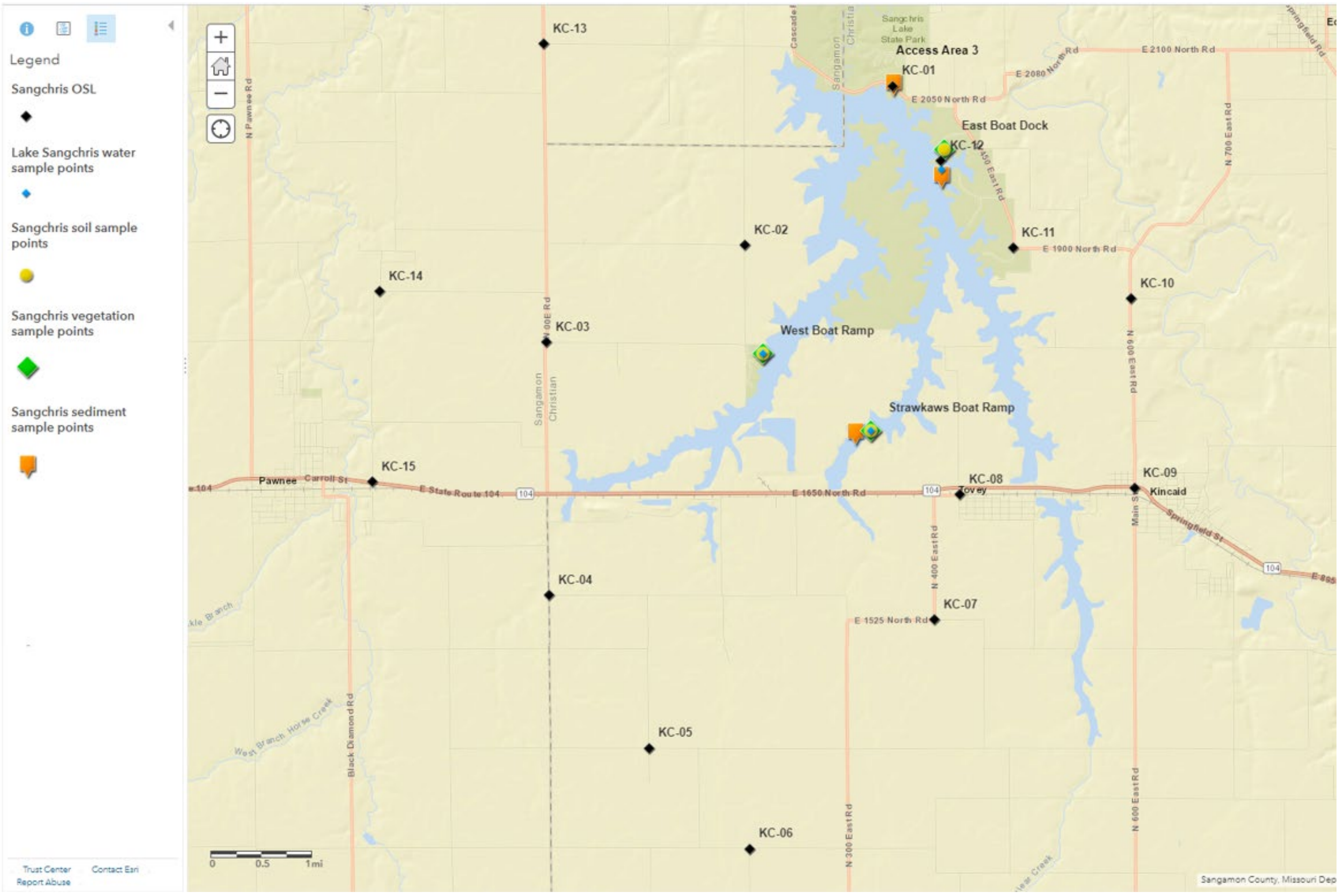


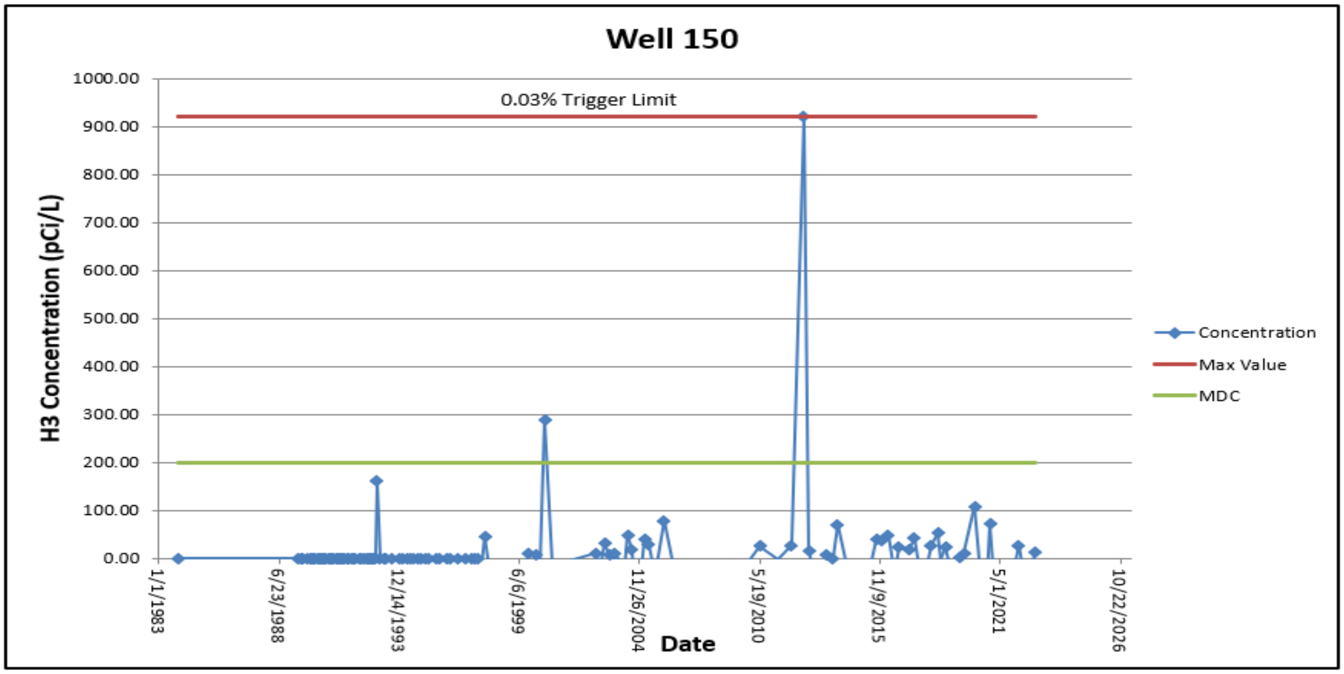
Figure A-5. Sangchris Lake State Park near Kincaid, Illinois

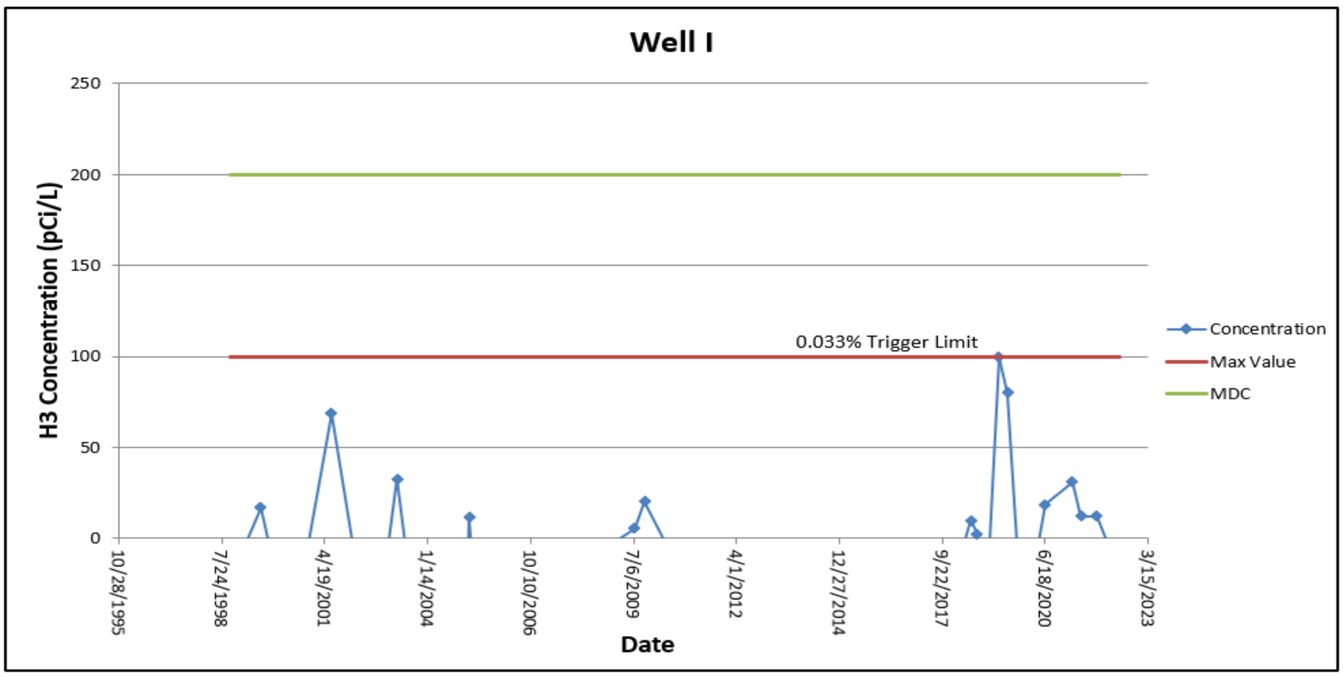


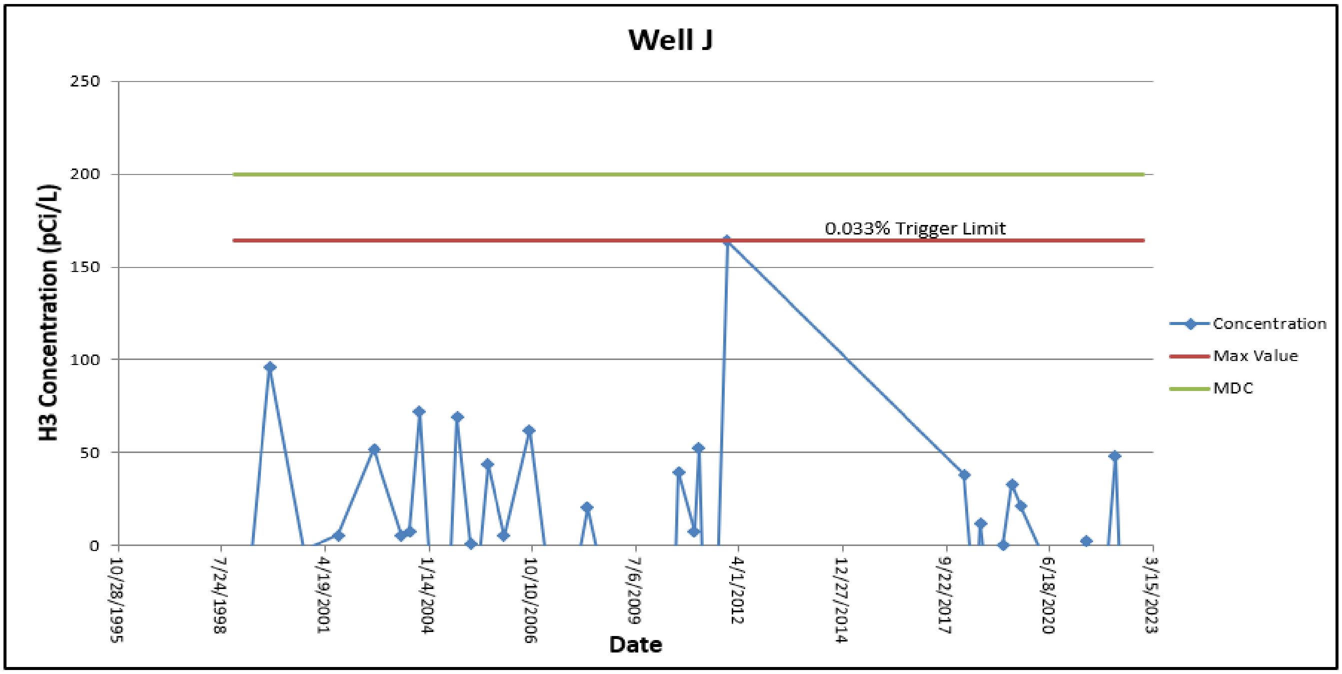
Appendix B

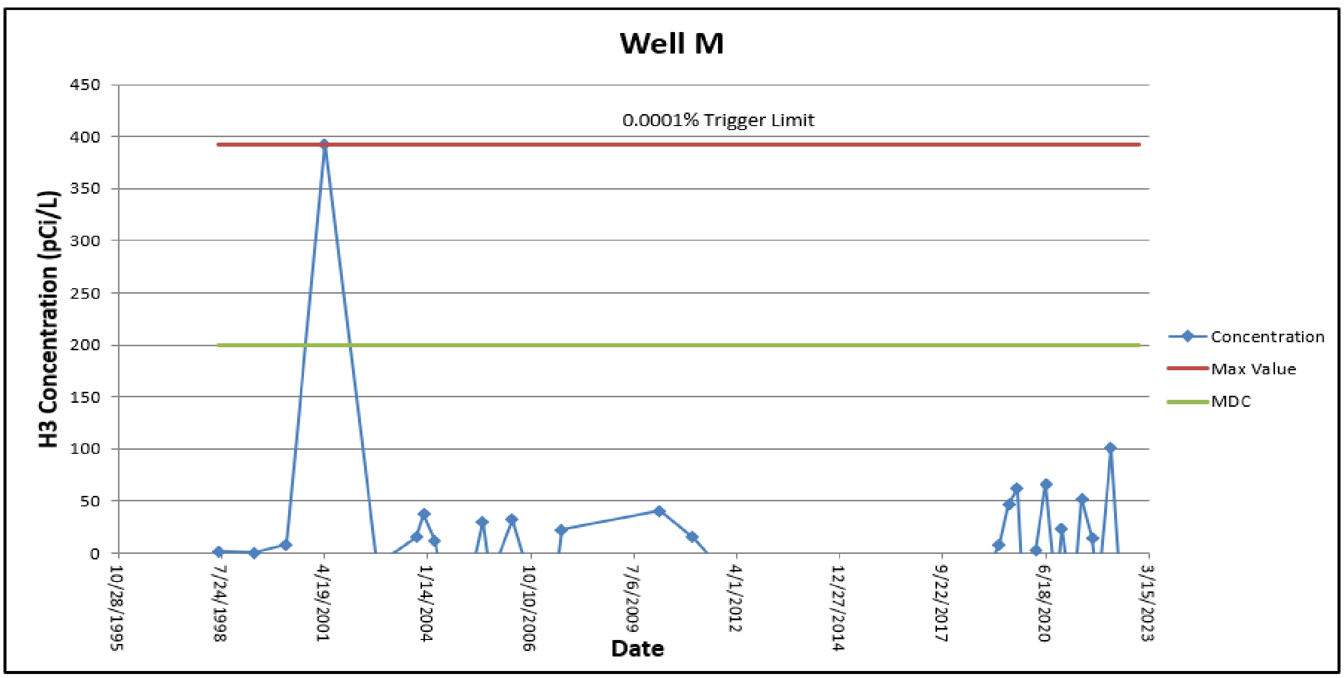
Trending Graphs for Tritium (H-3) in On-Site Water Samples

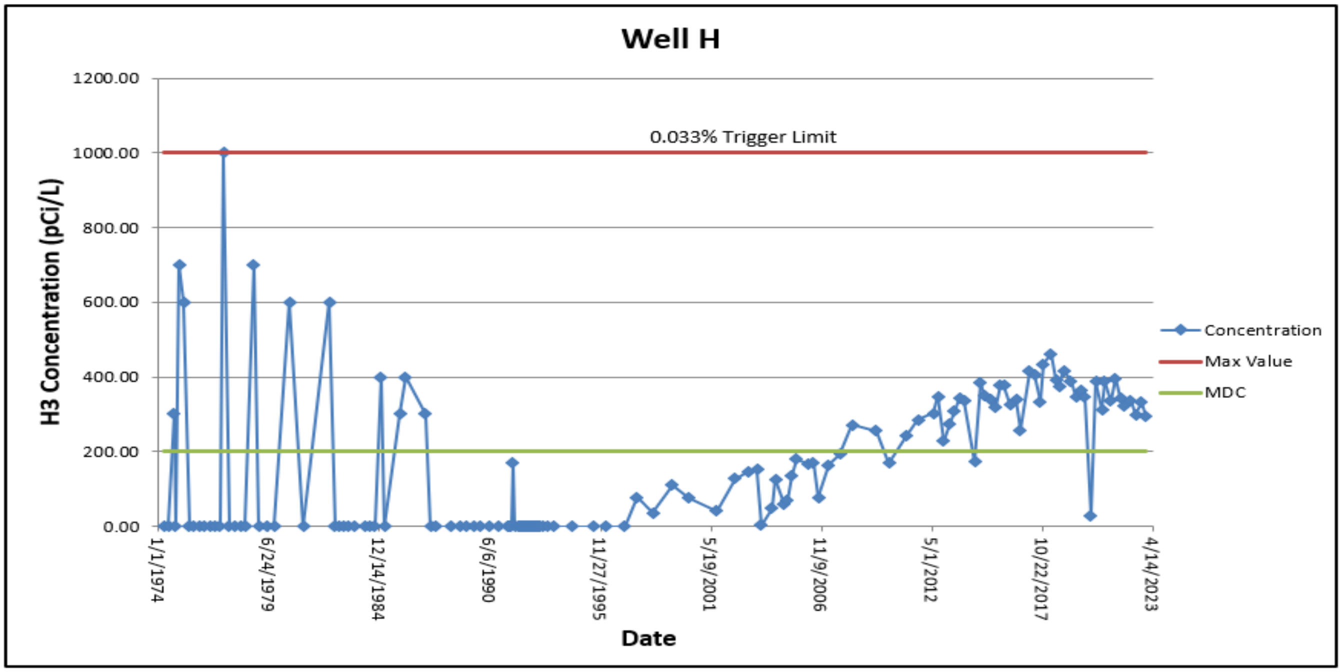
(Max value compared to Agree Order Trigger Limit of 3,000,000 pCi/L; MDC represented at 200 pCi/L to account for normal fluctuations)

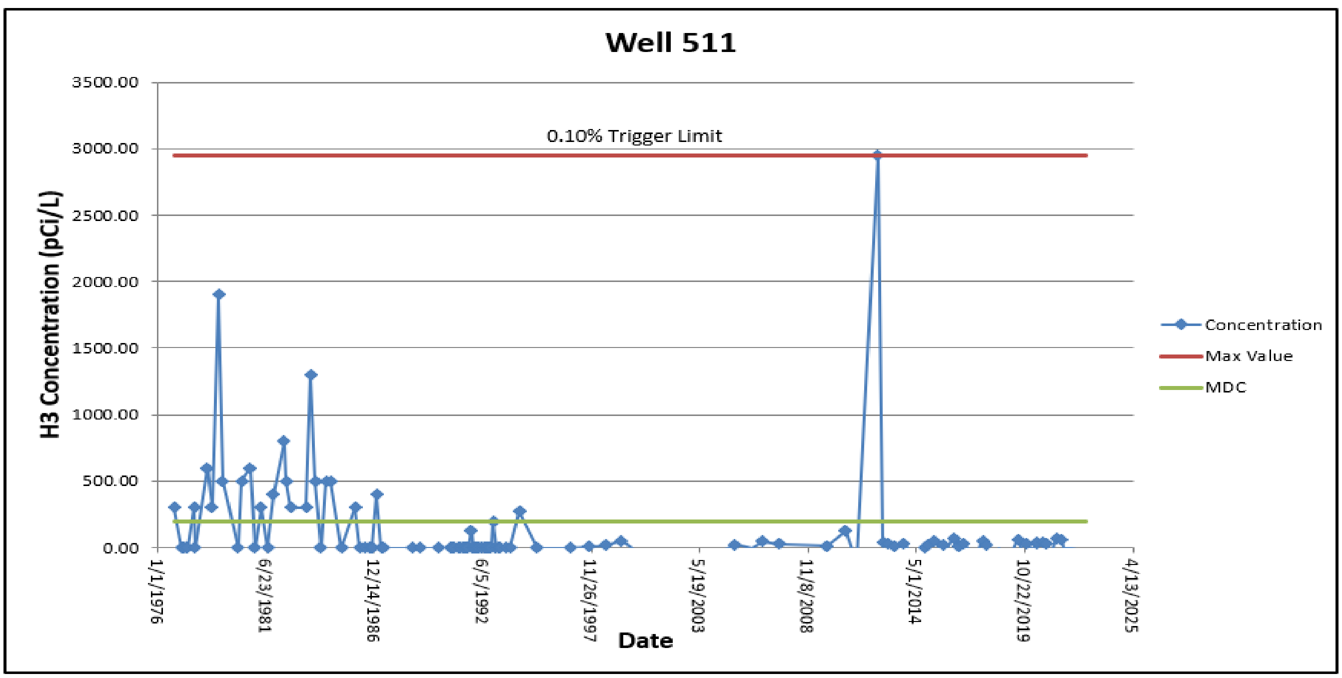


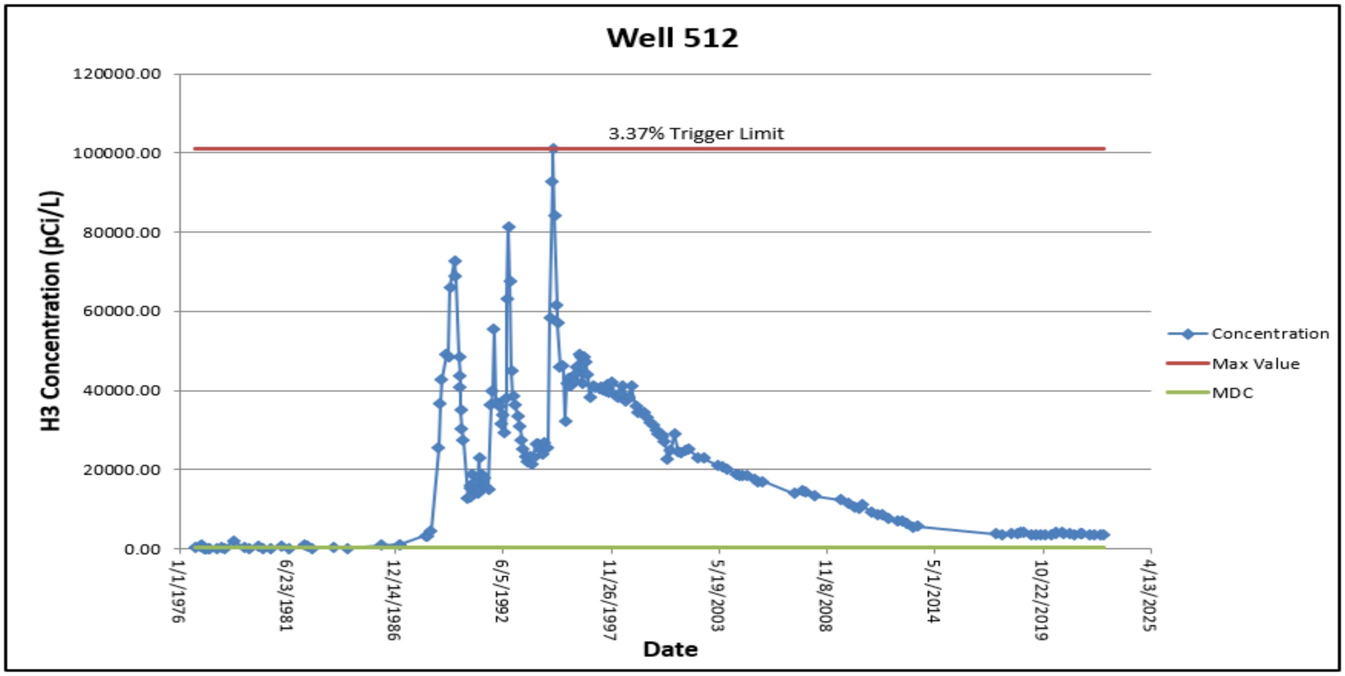



Well J
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.033% Trigger Limit
Concentration
Max Value
MDC
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
Date

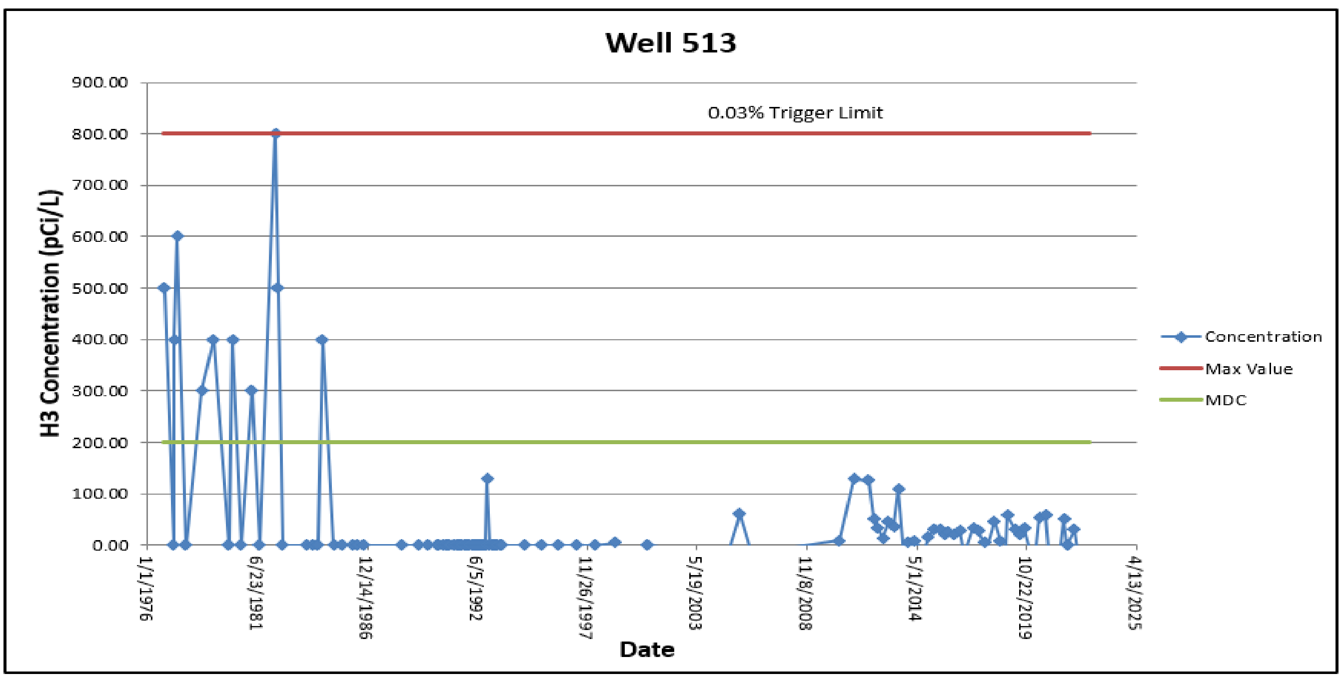

Well M
H3 Concentration (pCi/L)
450
400
350
300
250
200
150
100
50
0
0.0001% Trigger Limit
Concentration
Max Value
MDC
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
Date

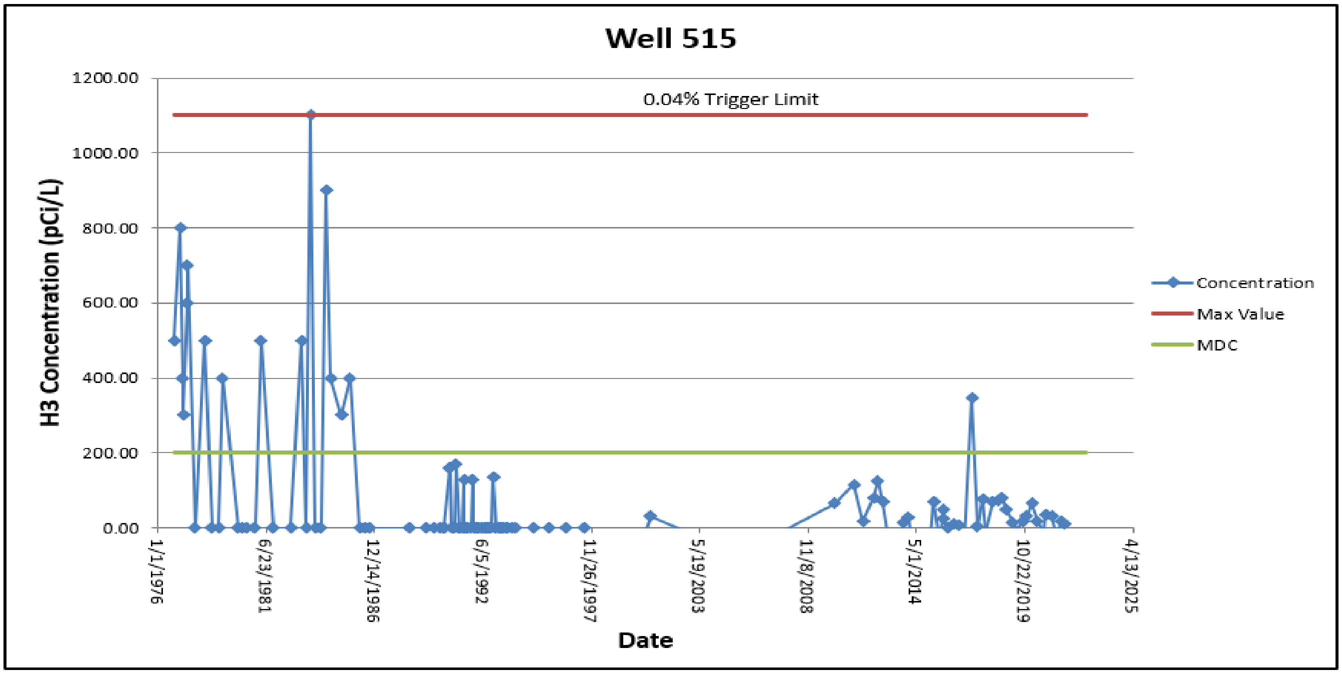

Well H
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
H3 Concentration (pCi/L)
0.033% Trigger Limit
1/1/1974
6/24/1979
12/14/1984
6/6/1990
11/27/1995
5/19/2001
11/9/2006
5/1/2012
10/22/2017
4/14/2023
Date
Concentration
Max Value
MDC

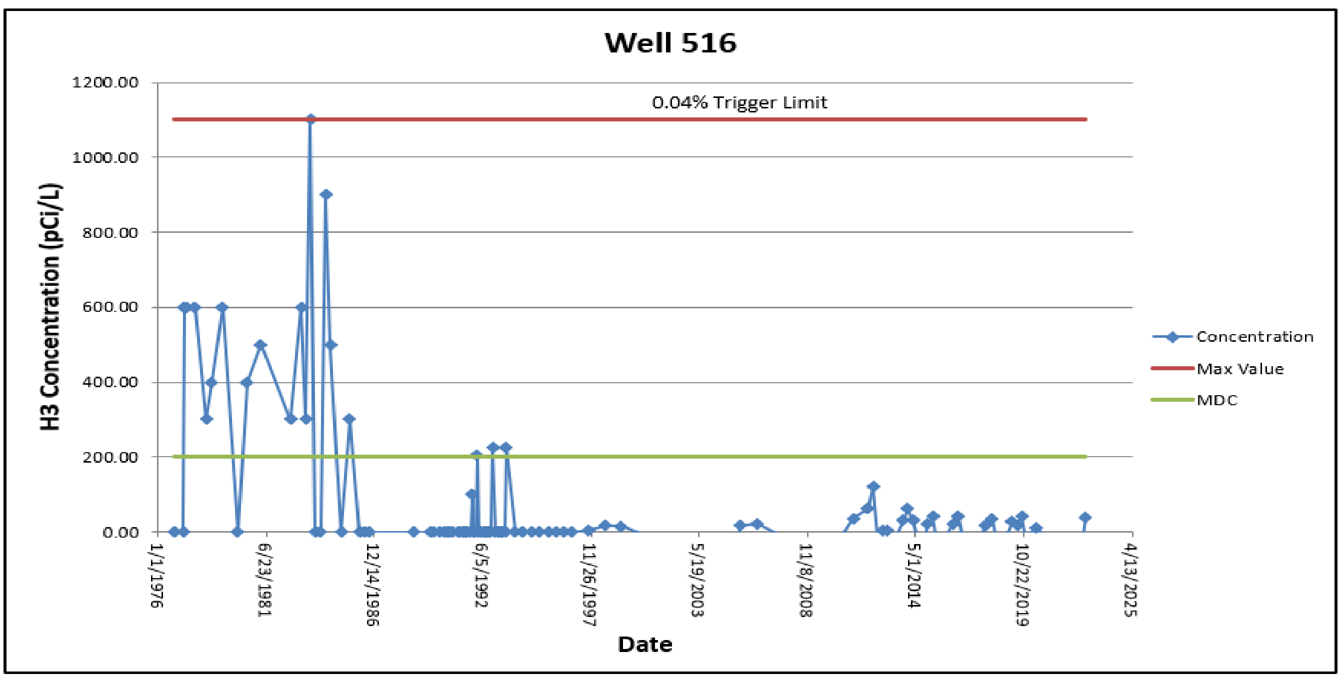

Well 511
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
H3 Concentration (pCi/L)
0.10% Trigger Limit
1/1/1976
6/23/1981
12/14/1986
6/5/1992
11/26/1997
5/19/2003
11/8/2008
5/1/2014
10/22/2019
4/13/2025
Date
Concentration
Max Value
MDC

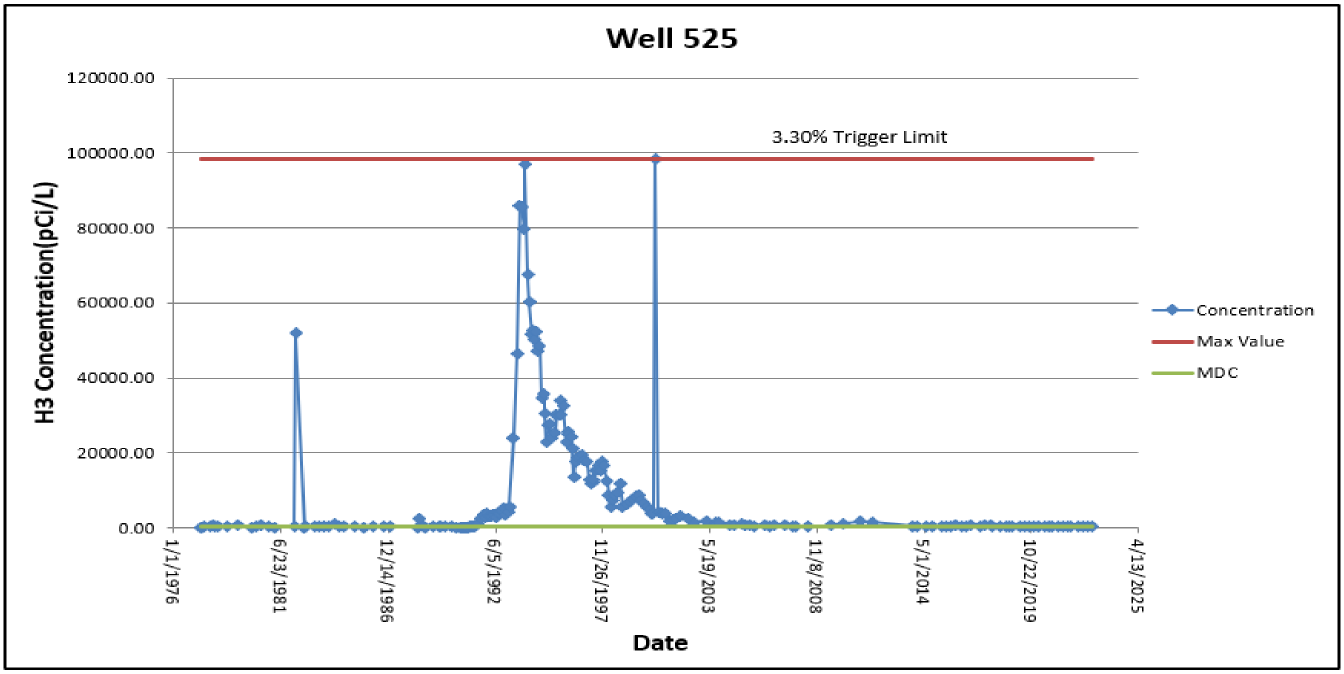


*MDC is represented at 200 pCi/L, not visible at this scale.

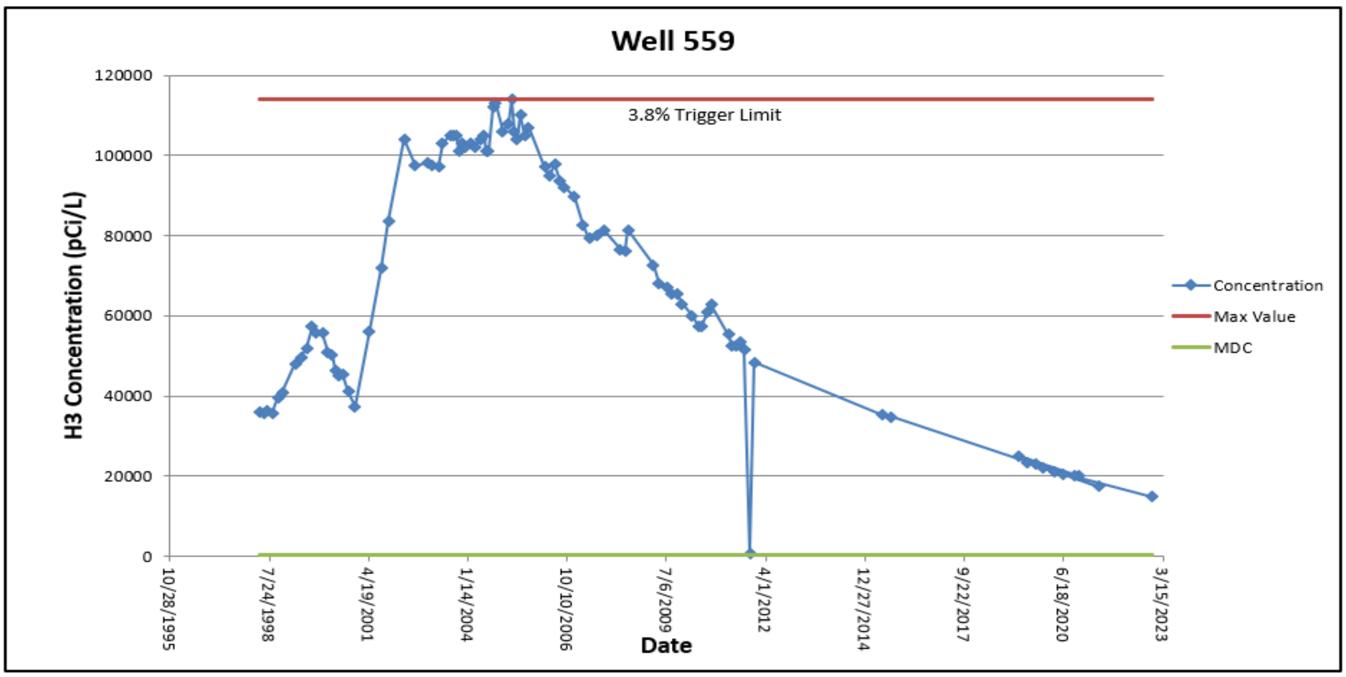


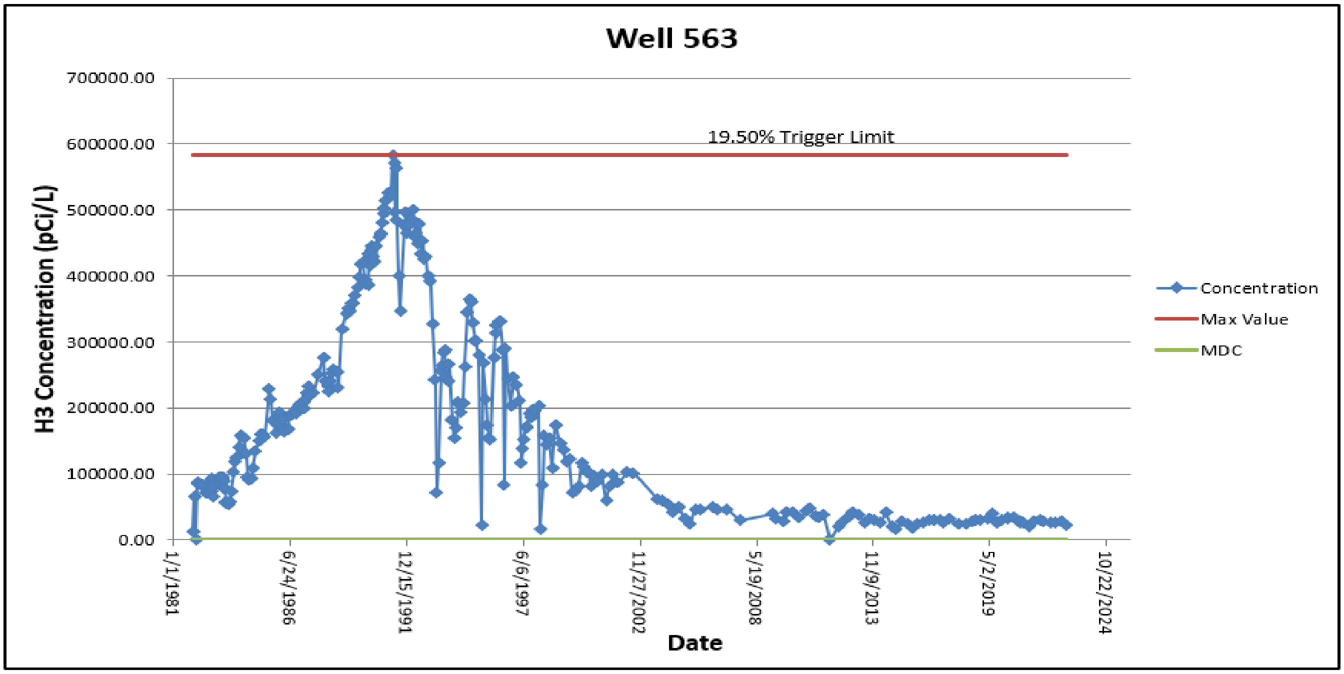

Well 515
0.04% Trigger Limit
H3 Concentration (pCi/L)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1/1/1976
6/23/1981
12/14/1986
6/5/1992
11/26/1997
5/19/2003
11/8/2008
5/1/2014
10/22/2019
4/13/2025
Date
Concentration
Max Value
MDC


Well 516
0.04% Trigger Limit
H3 Concentration (pCi/L)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1/1/1976
6/23/1981
12/14/1986
6/5/1992
11/26/1997
5/19/2003
11/8/2008
5/1/2014
10/22/2019
4/13/2025
Date
Concentration
Max Value
MDC

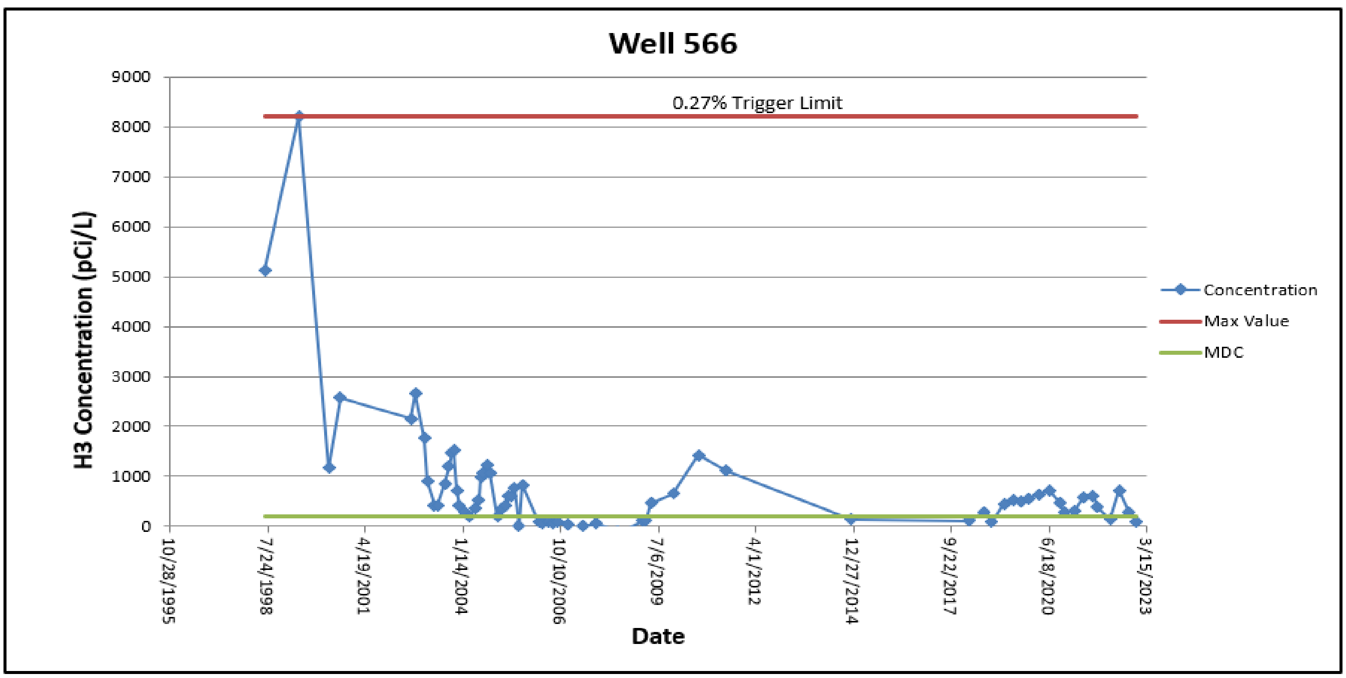


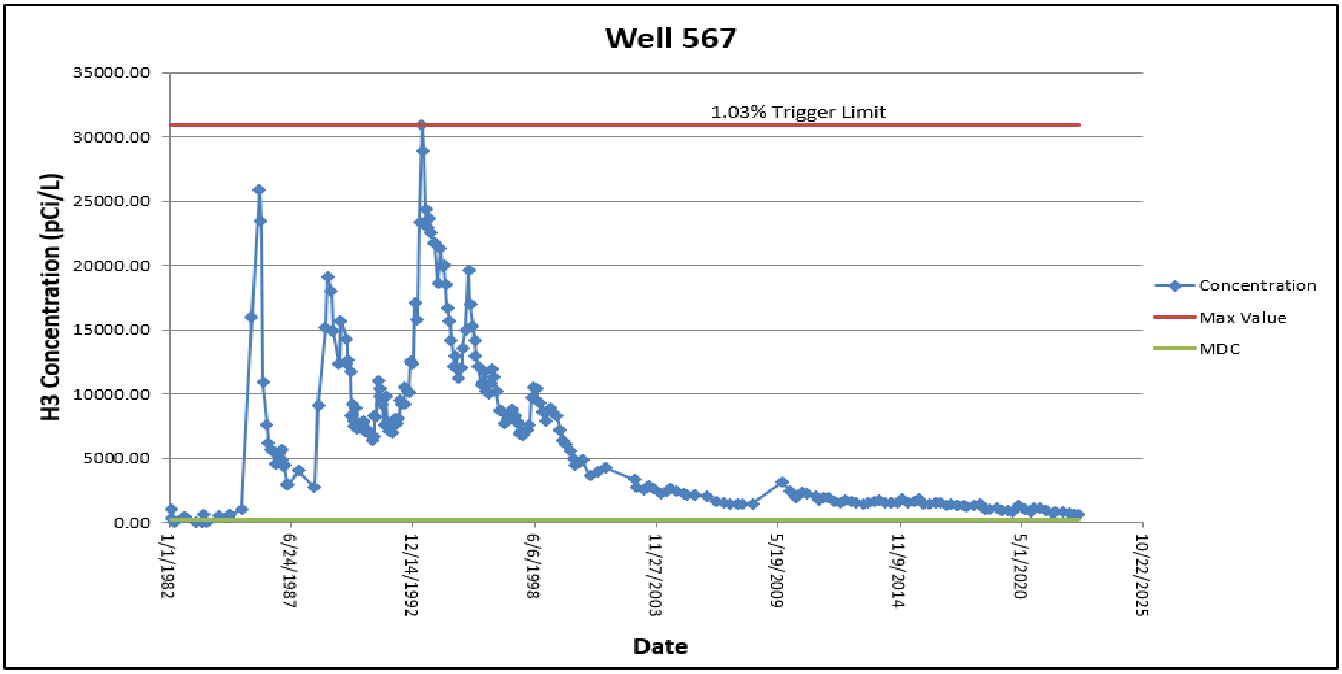
*MDC is represented at 200 pCi/L, not visible at this scale.



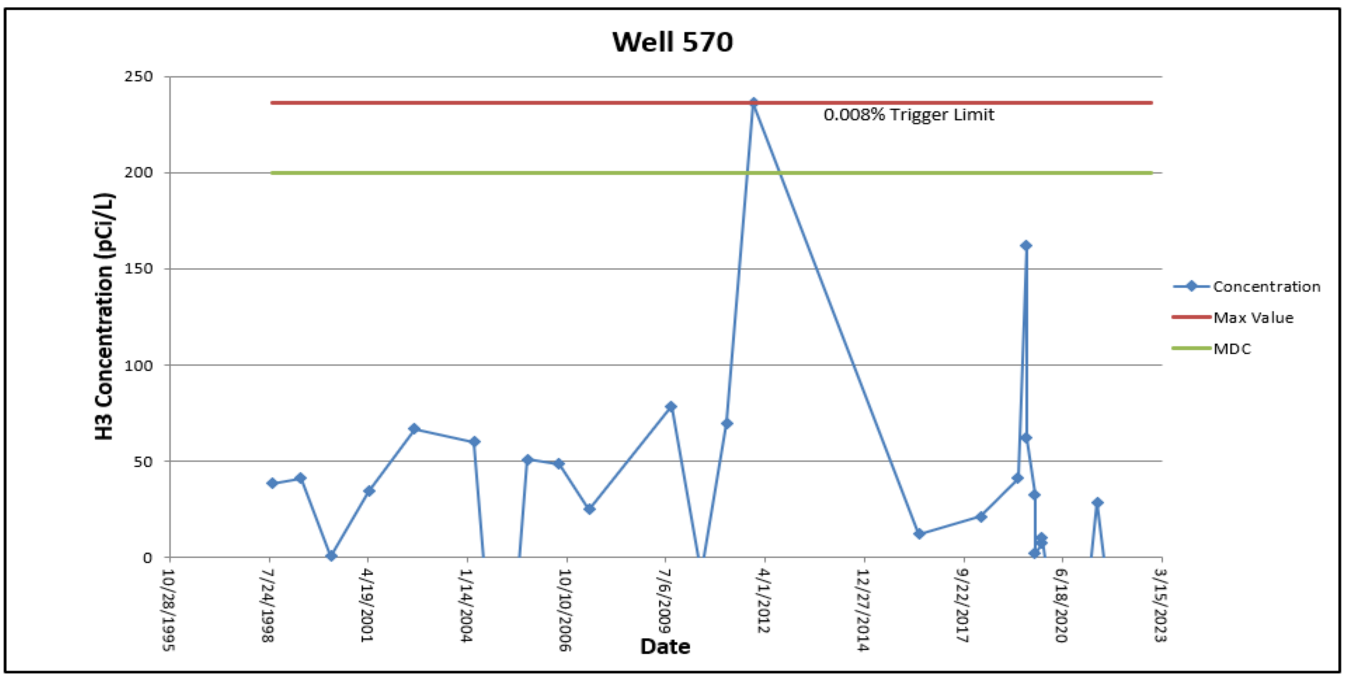


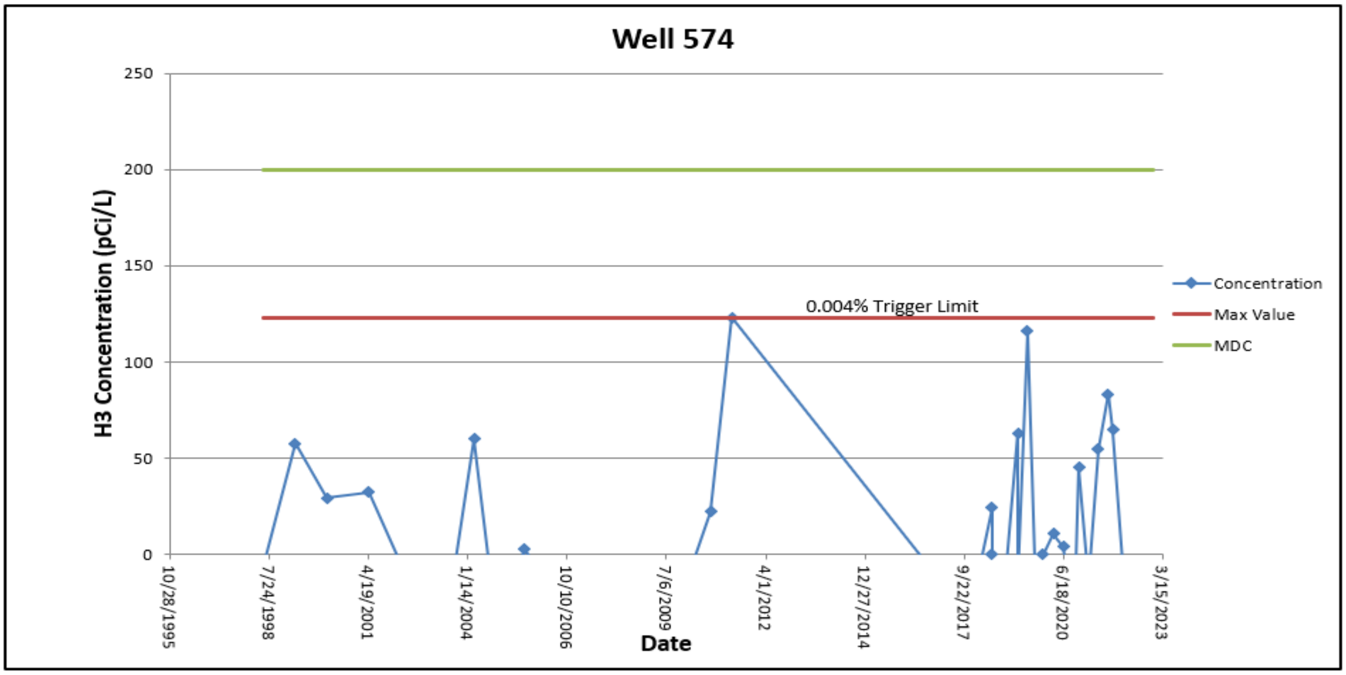
*MDC is represented at 200 pCi/L, not visible at this scale.

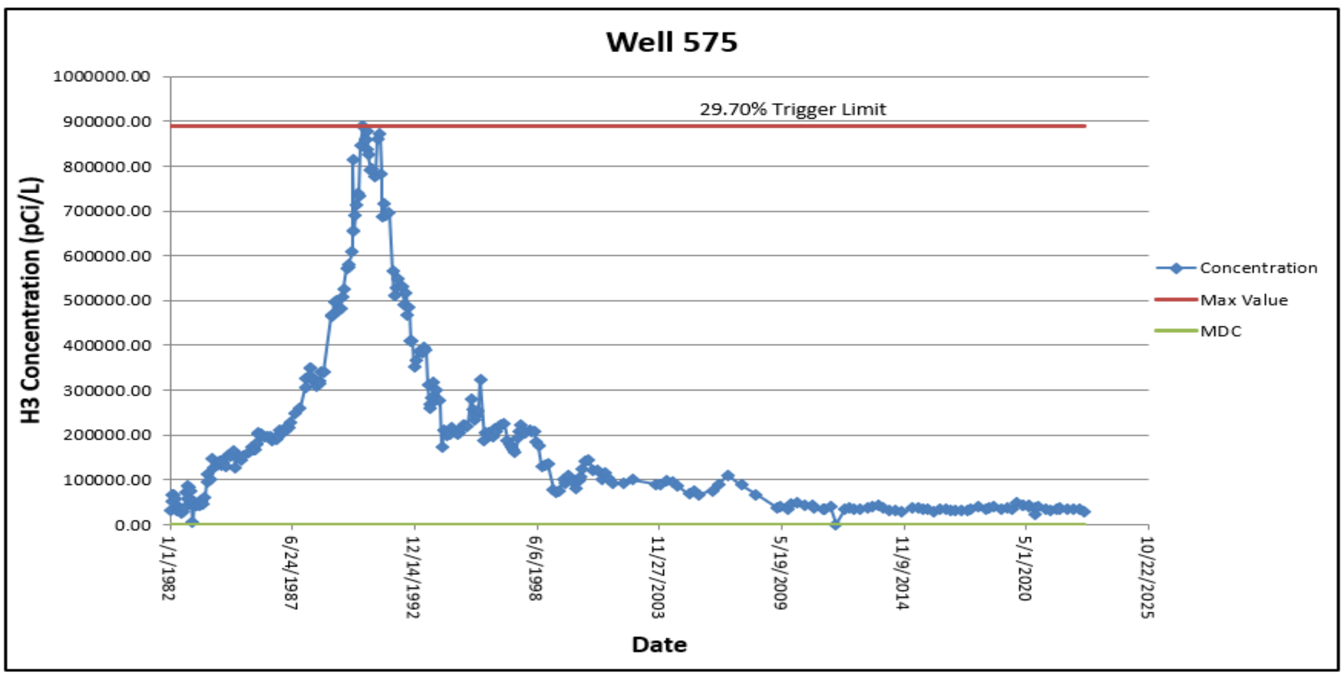




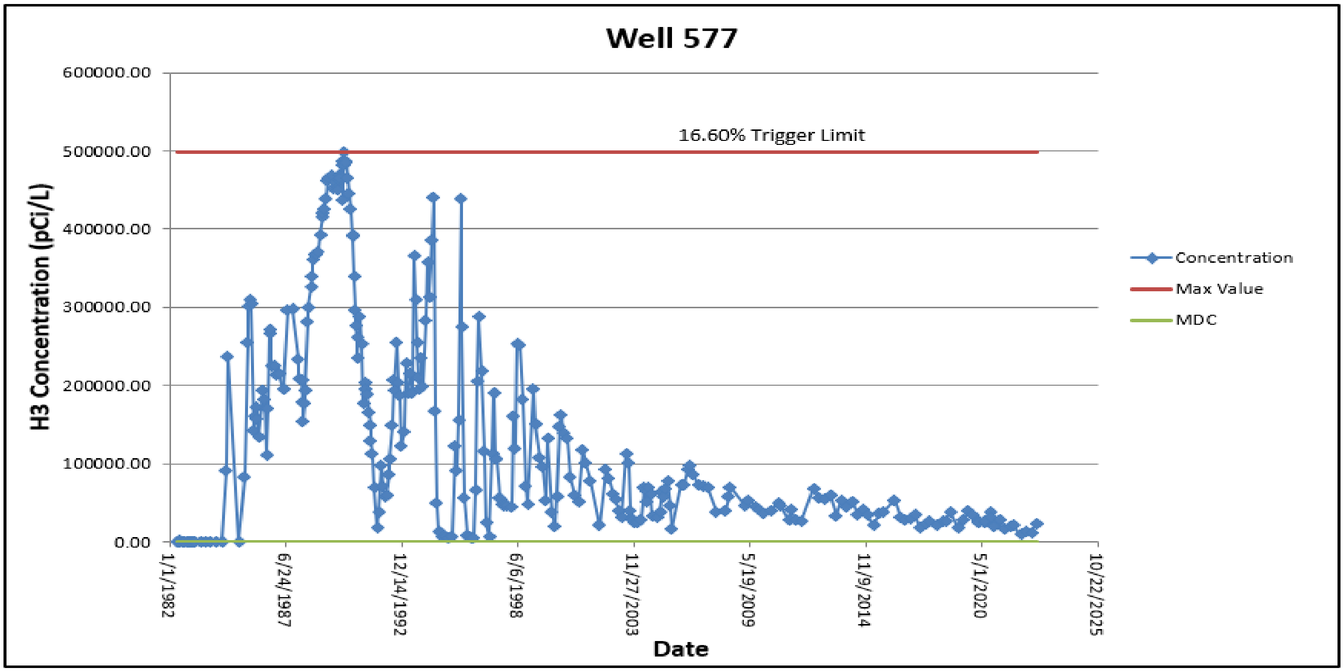
*MDC is represented at 200 pCi/L, not visible at this scale.



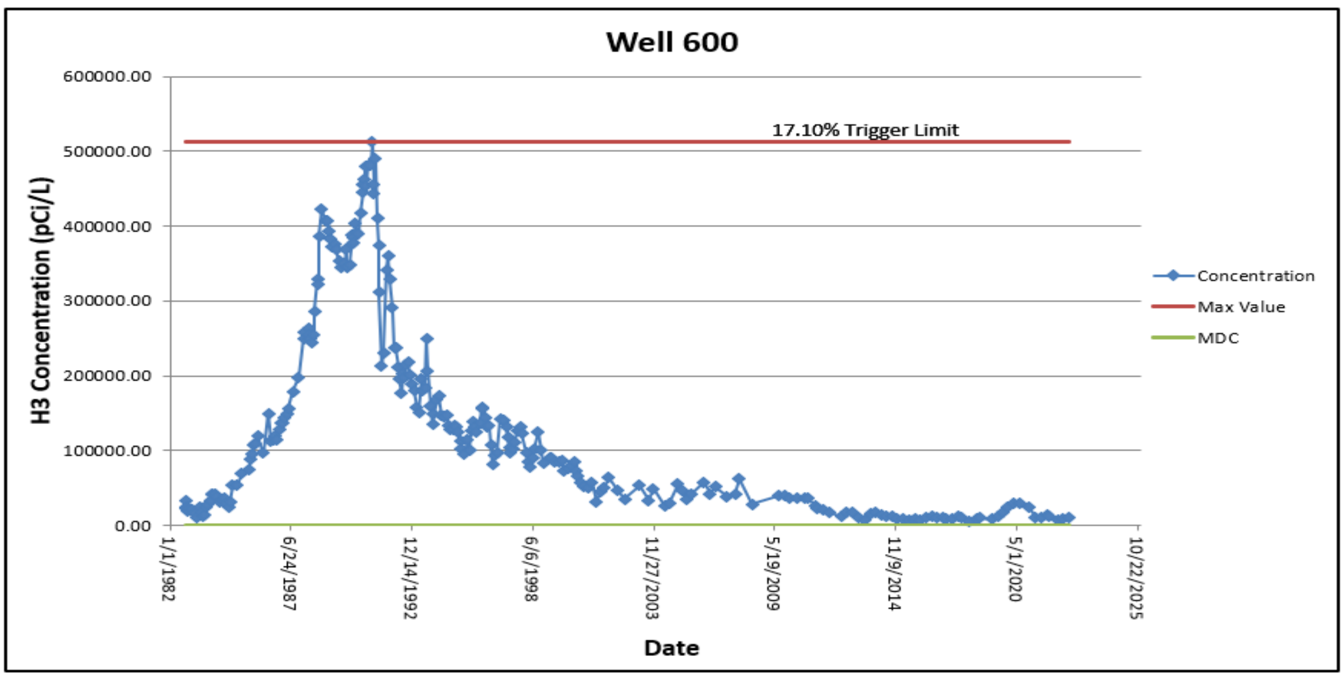




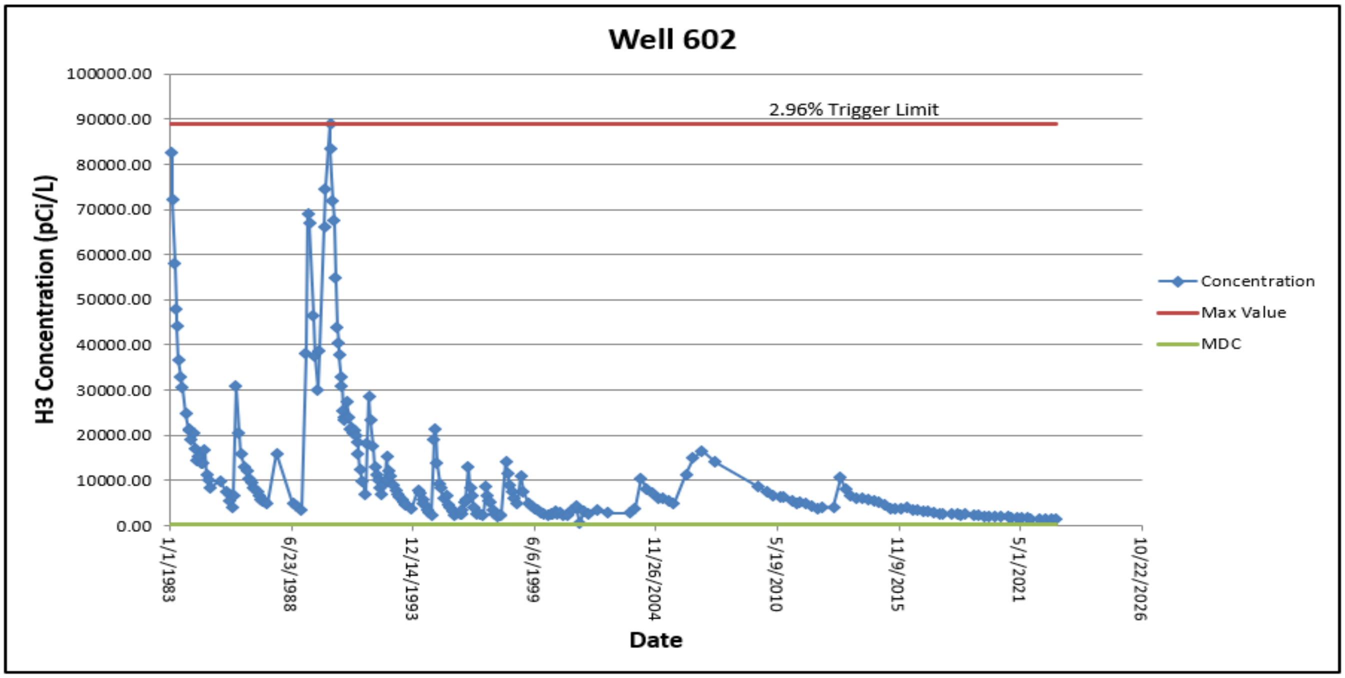
*MDC is represented at 200 pCi/L, not visible at this scale.



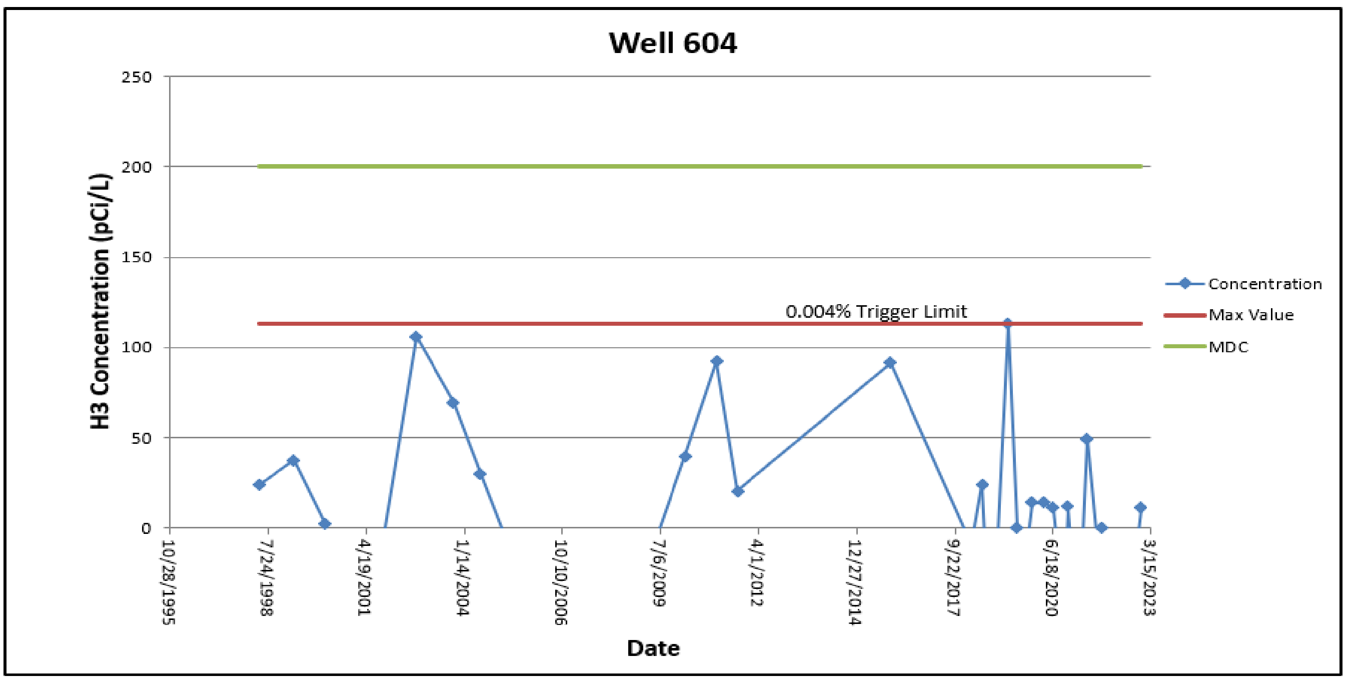
*MDC is represented at 200 pCi/L, not visible at this scale.

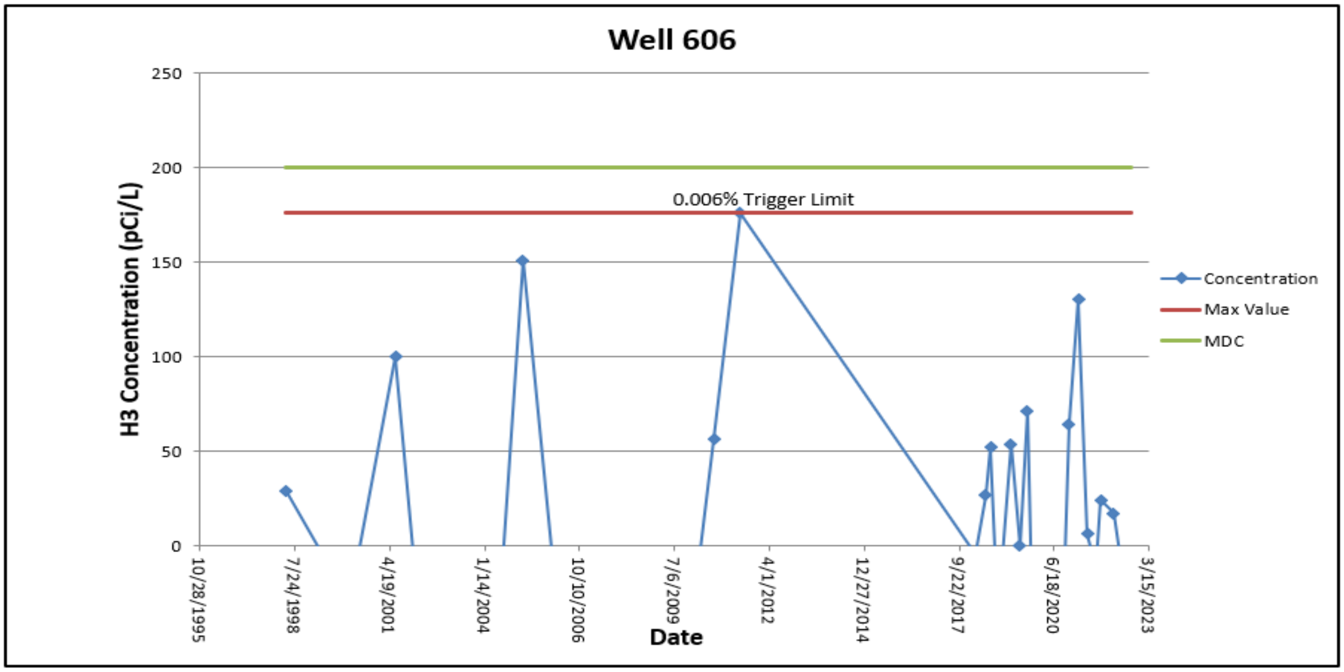


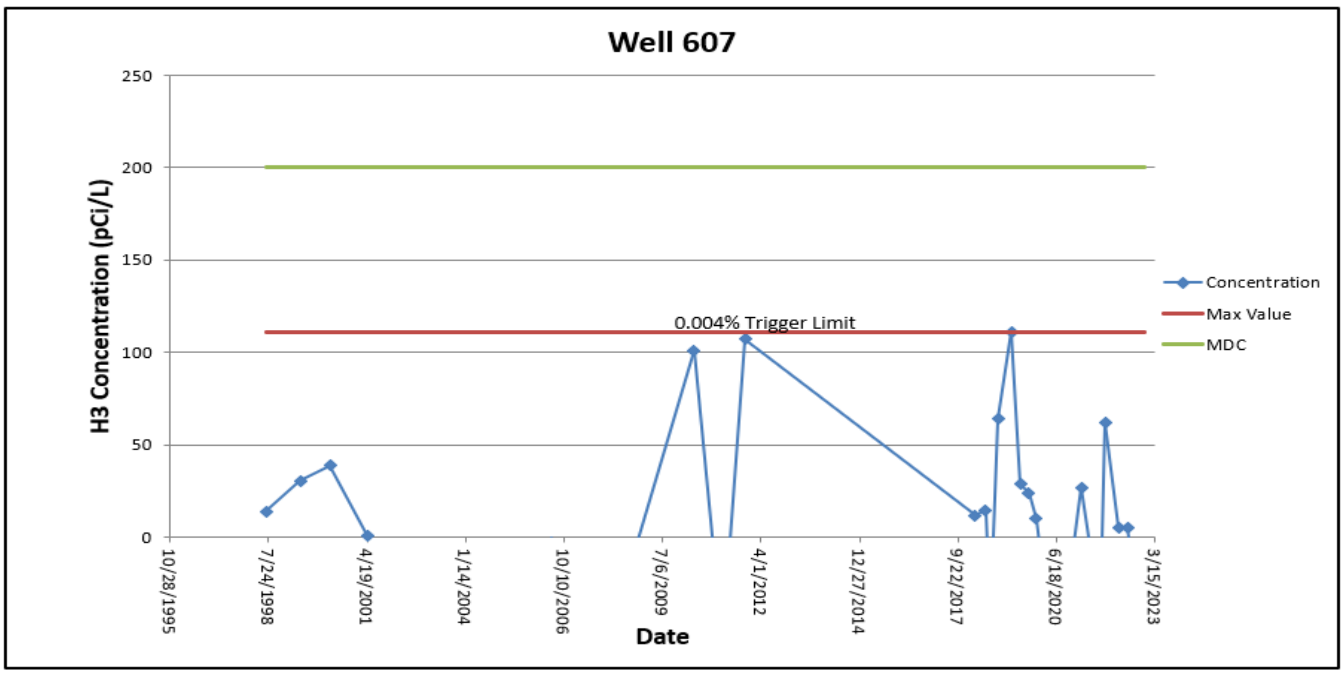
*MDC is represented at 200 pCi/L, not visible at this scale.

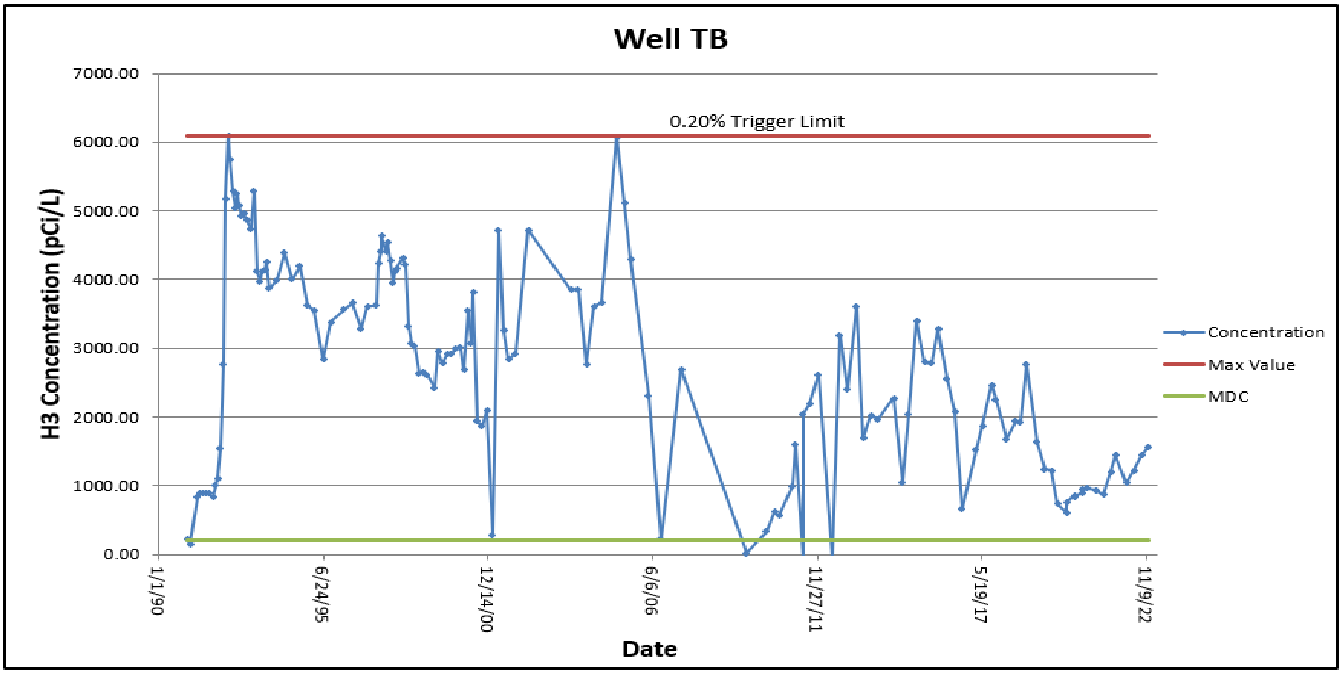


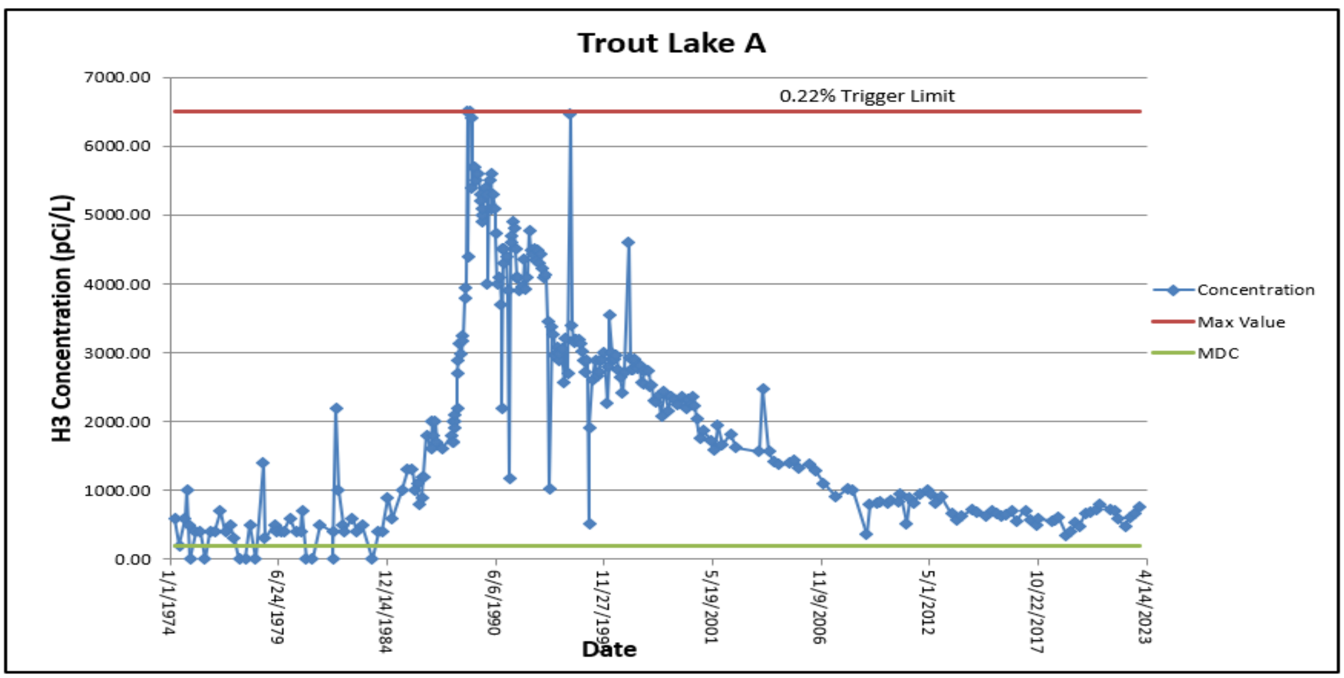
*MDC is represented at 200 pCi/L, not visible at this scale.

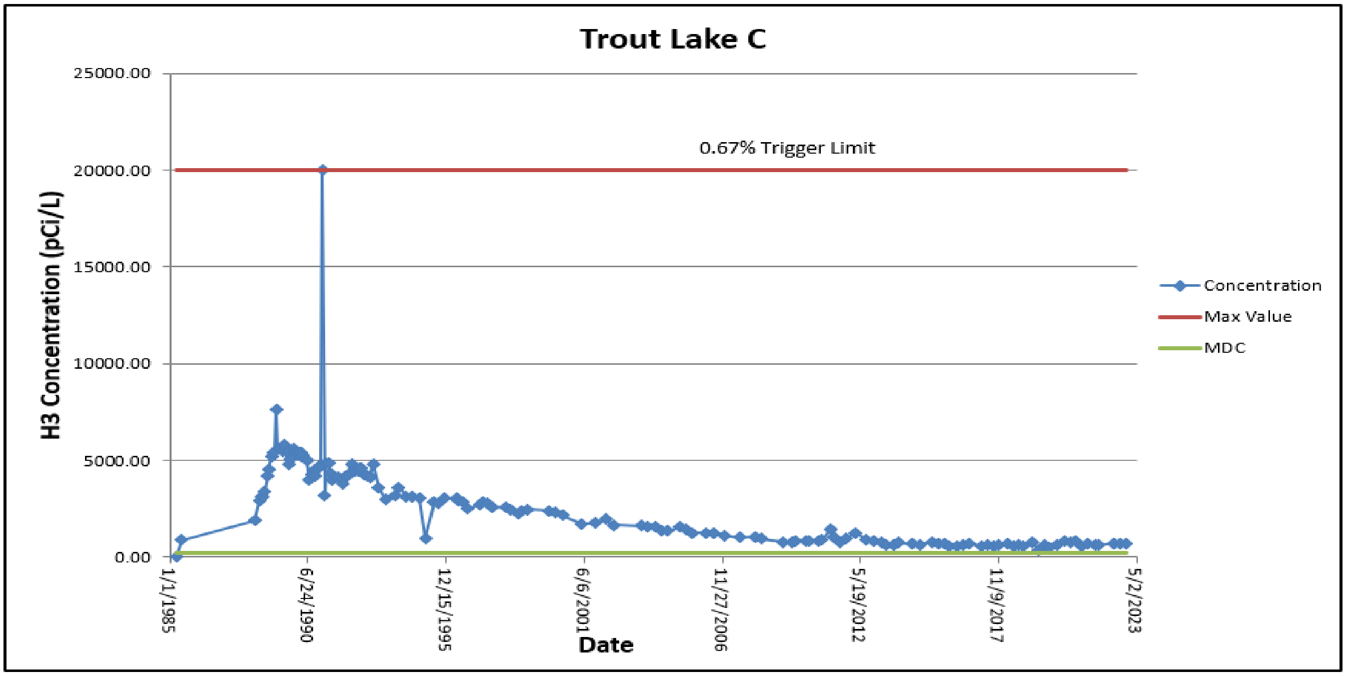



Well 606
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.006% Trigger Limit
Concentration
Max Value
MDC
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
Date

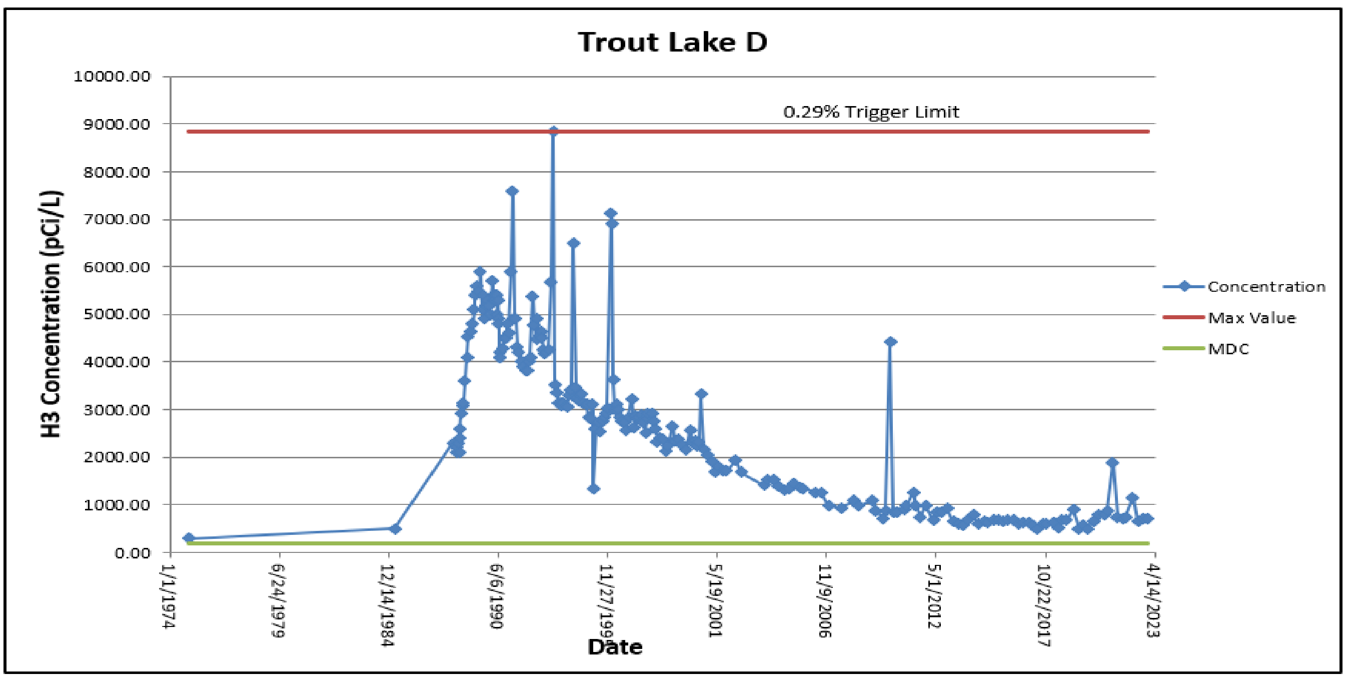

Well 607
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.004% Trigger Limit
Concentration
Max Value
MDC
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
Date

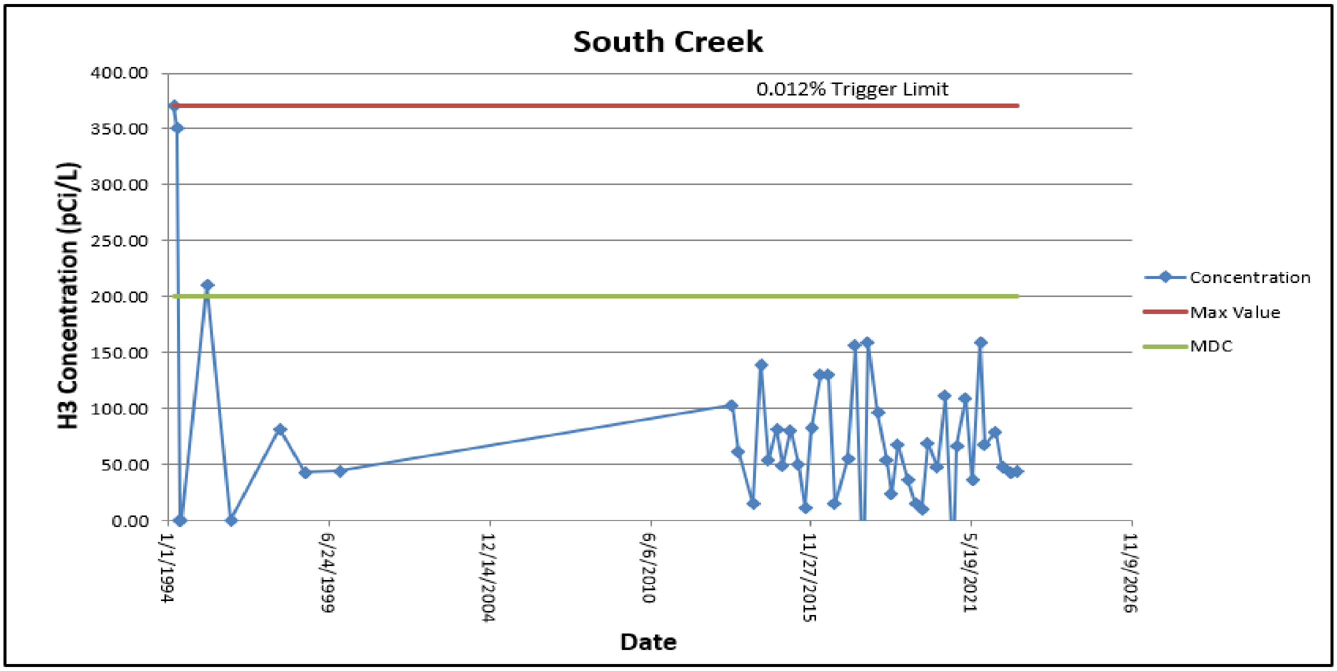

Well TB
0.20% Trigger Limit
H3 Concentration (pCi/L)
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
1/1/90
6/24/95
12/14/00
6/6/06
11/27/11
5/19/17
11/9/22
Date
Concentration
Max Value
MDC


Trout Lake A
0.22% Trigger Limit
H3 Concentration (pCi/L)
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
1/1/1974
6/24/1979
12/14/1984
6/6/1990
11/27/1995
5/19/2001
11/9/2006
5/1/2012
10/22/2017
4/14/2023
Date
Concentration
Max Value
MDC



*MDC is represented at 200 pCi/L, not visible at this scale.

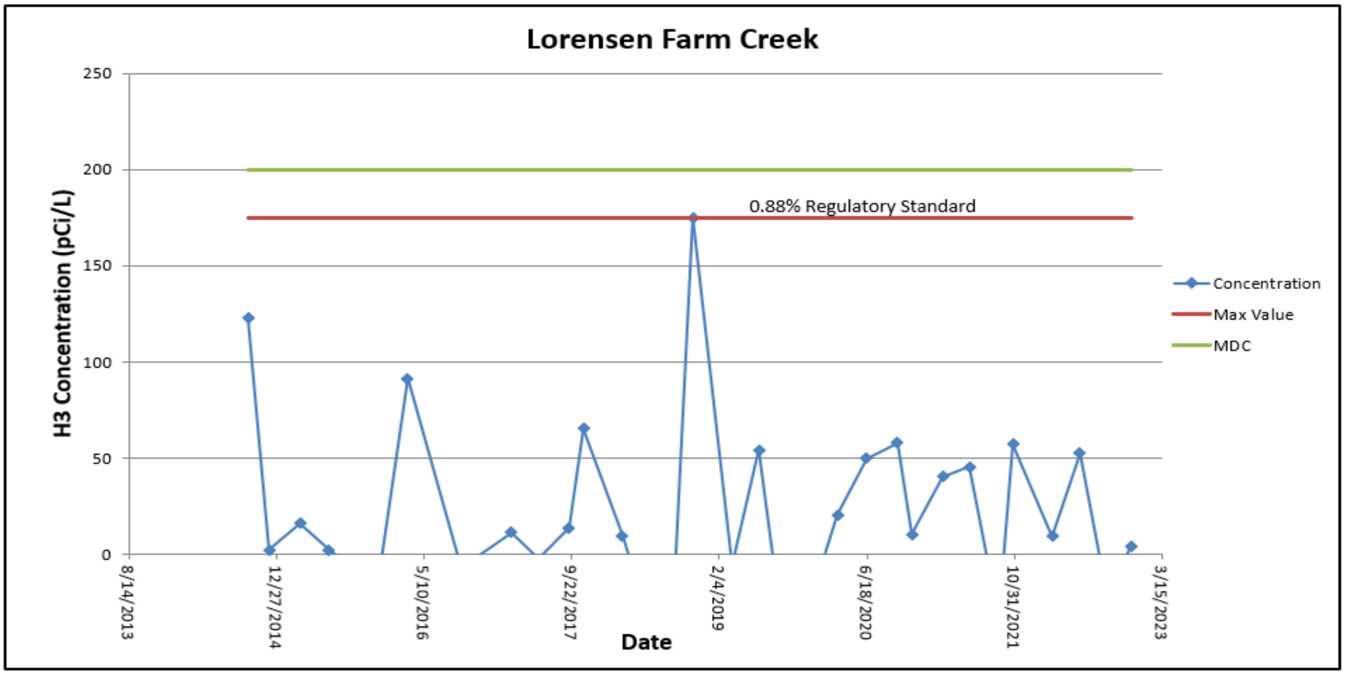


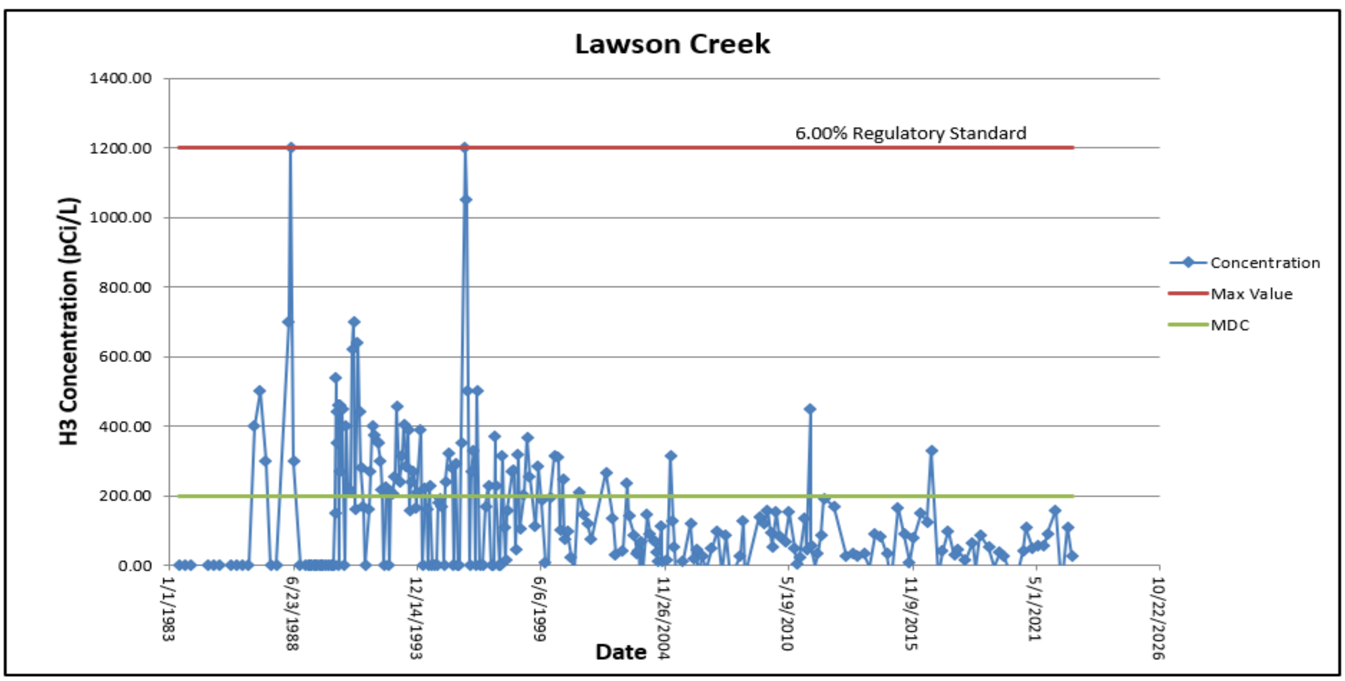

South Creek
0.012% Trigger Limit
H3 Concentration (pCi/L)
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1/1/1994
6/24/1999
12/14/2004
6/6/2010
11/27/2015
5/19/2021
11/9/2026
Date
Concentration
Max Value
MDC

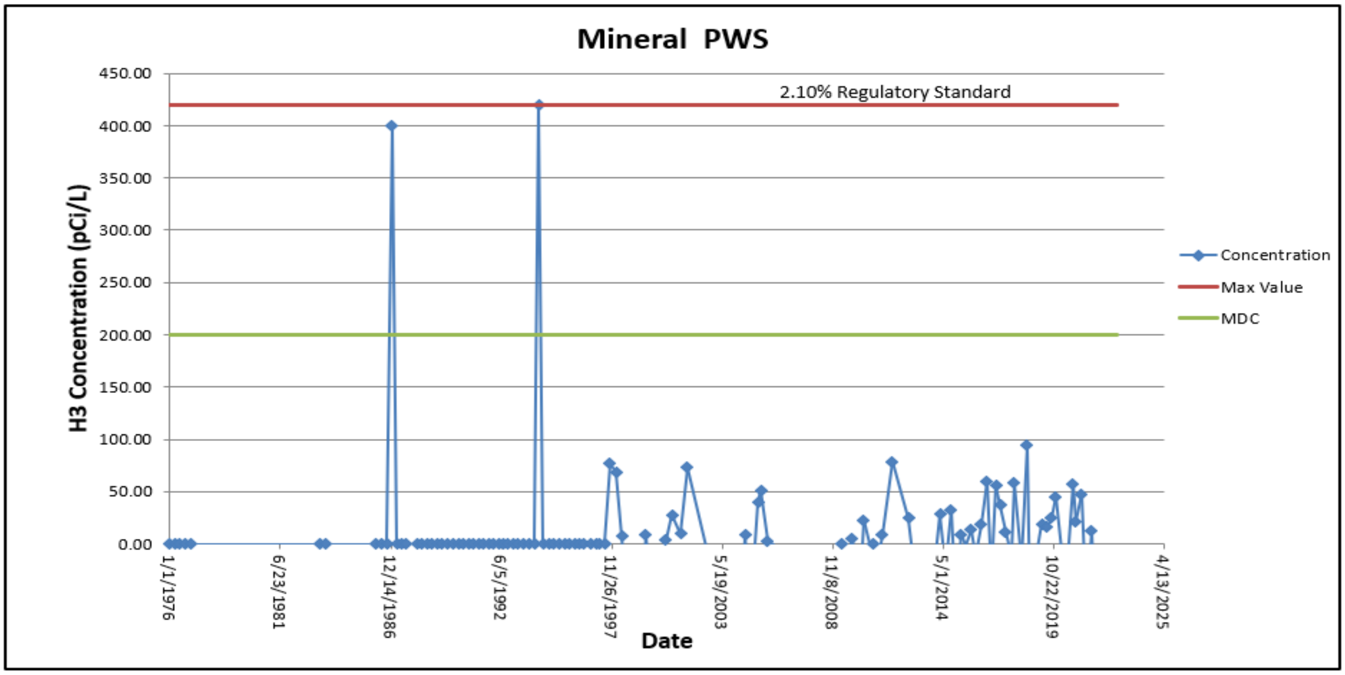
Appendix C

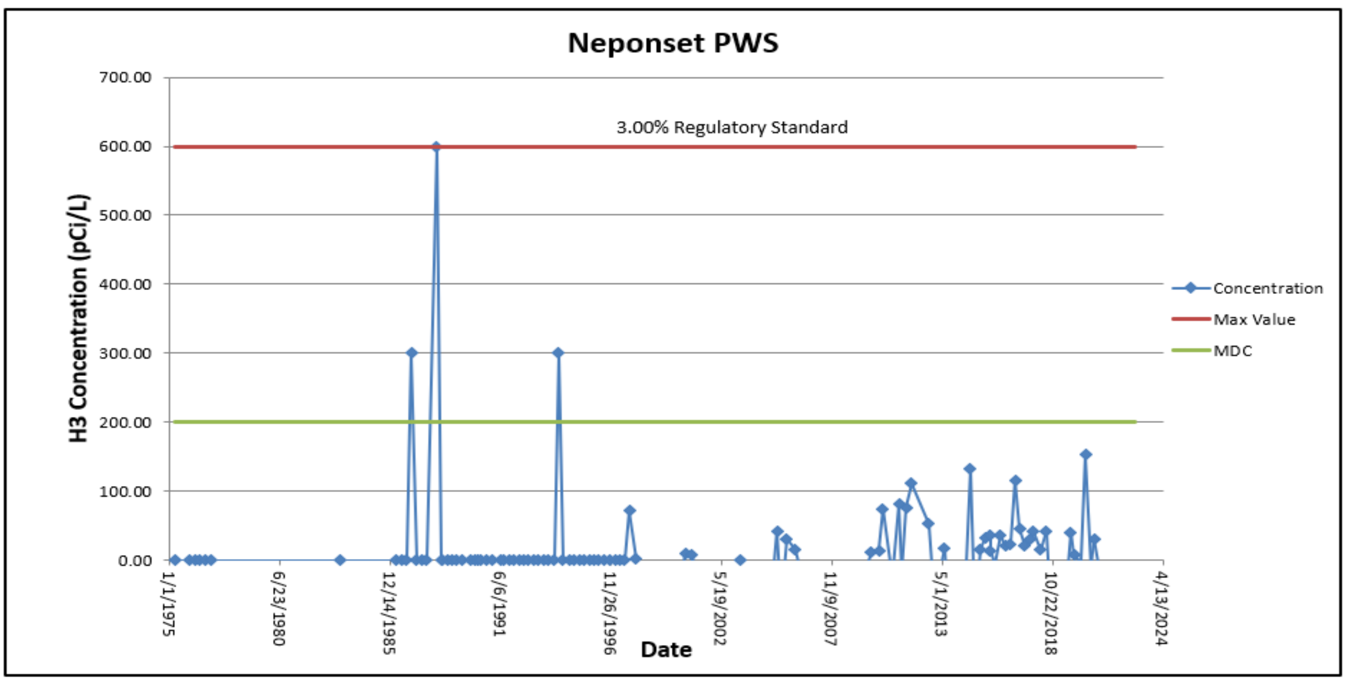
Trending Graphs for Tritium (H-3) in Off-Site Water Samples

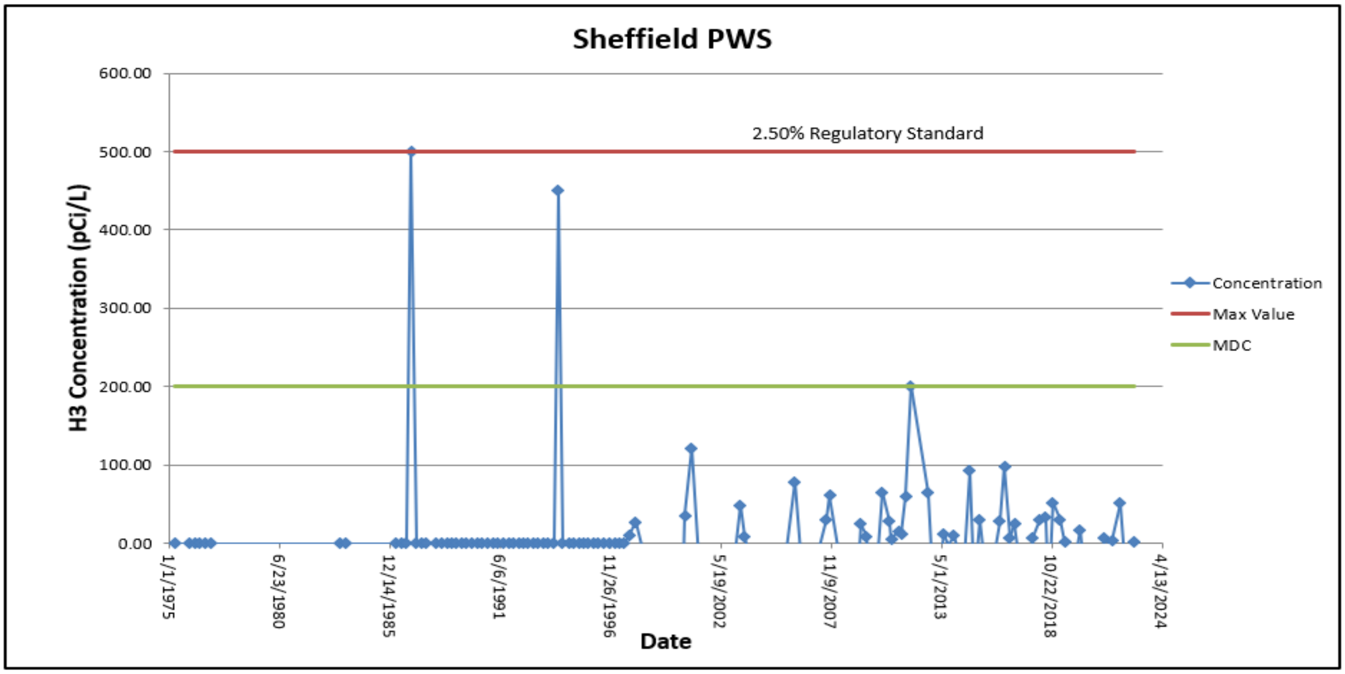
(Max value compared to IEPA and US EPA Class regulatory standard of 20,000 pCi/L; MDC represented at 200 pCi/L to account for normal fluctuations)

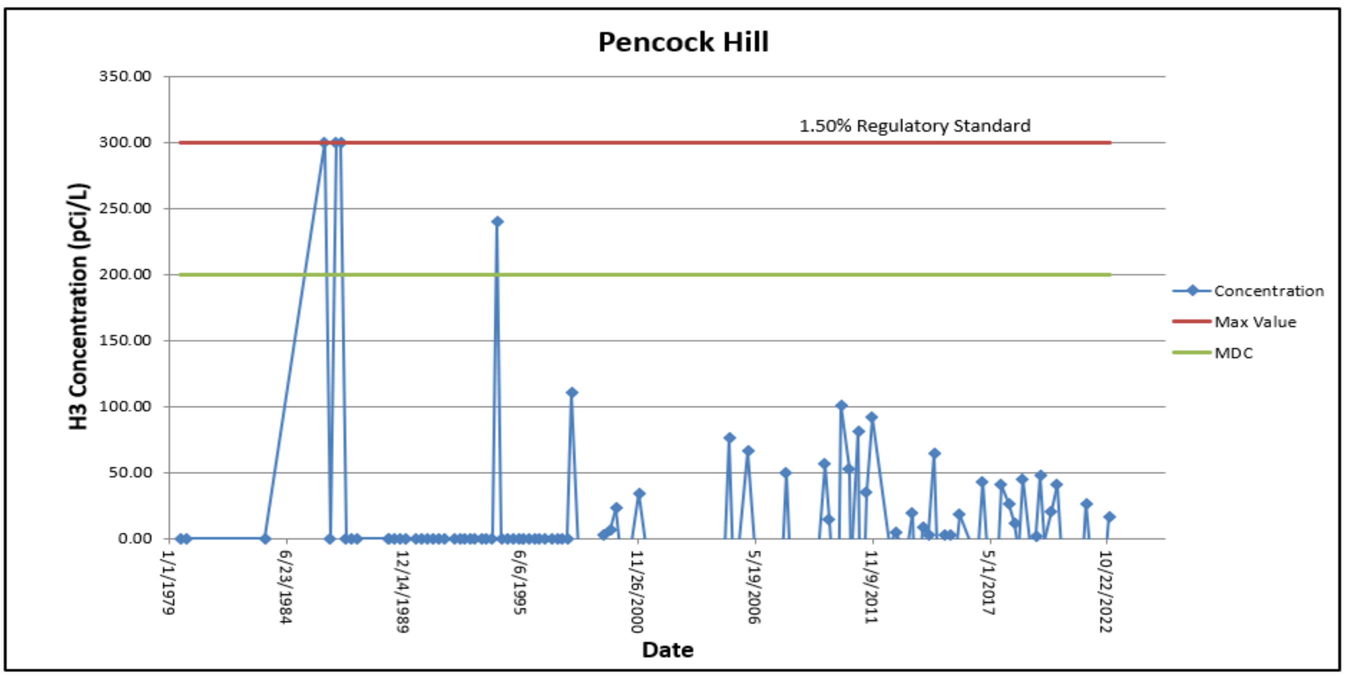


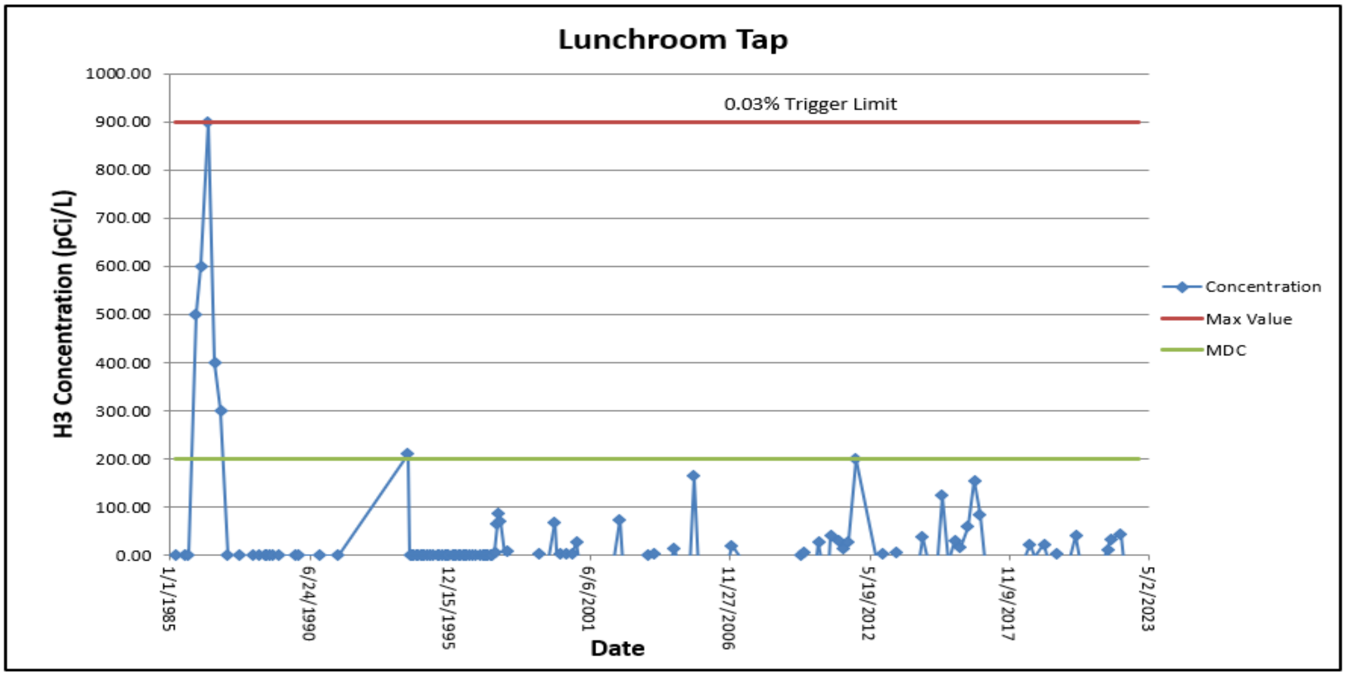



Mineral PWS
2.10% Regulatory Standard
H3 Concentration (pCi/L)
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1/1/1976
6/23/1981
12/14/1986
6/5/1992
11/26/1997
5/19/2003
11/8/2008
5/1/2014
10/22/2019
4/13/2025
Date
Concentration
Max Value
MDC


Neponset PWS
3.00% Regulatory Standard
H3 Concentration (pCi/L)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1/1/1975
6/23/1980
12/14/1985
6/6/1991
11/26/1996
5/19/2002
11/9/2007
5/1/2013
10/22/2018
4/13/2024
Date
Concentration
Max Value
MDC


Sheffield PWS
600.00
500.00
400.00
300.00
200.00
100.00
0.00
H3 Concentration (pCi/L)
2.50% Regulatory Standard
Concentration
Max Value
MDC
1/1/1975
6/23/1980
12/14/1985
6/6/1991
11/26/1996
5/19/2002
11/9/2007
5/1/2013
10/22/2018
4/13/2024
Date


Pencock Hill
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
H3 Concentration (pCi/L)
1.50% Regulatory Standard
Concentration
Max Value
MDC
1/1/1979
6/23/1984
12/14/1989
6/6/1995
11/26/2000
5/19/2006
11/9/2011
5/1/2017
10/22/2022
Date


Lunchroom Tap
0.03% Trigger Limit
H3 Concentration (pCi/L)
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1/1/1985
6/24/1990
12/15/1995
6/6/2001
11/27/2006
5/19/2012
11/9/2017
5/2/2023
Date
Concentration
Max Value
MDC

Appendix D
Sheffield Sample Results

Table D.1 Gross Alpha/Beta Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
South Creek				
3/9/2022	<MDC	3.9	<MDC	4.3
Trout Lake A				
11/30/2022	<MDC	3.9	6.3	4.3
Trout Lake C				
9/14/2022	<MDC	3.9	9.2	4.3
Trout Lake D				
6/9/2022	<MDC	3.9	9.8	4.3
Well 150				
9/14/2022	<MDC	3.9	<MDC	4.3
Well 511				
11/30/2022	<MDC	3.9	<MDC	4.3
Well 512				
11/30/2022	<MDC	3.9	4.7	4.3
Well 513				
6/9/2022	<MDC	3.9	<MDC	4.3
Well 515				
3/9/2022	<MDC	3.9	<MDC	4.3

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Well 516				
11/30/2022	<MDC	3.9	<MDC	4.3
Well 525				
9/14/2022	<MDC	3.9	<MDC	4.3
Well 563				
6/9/2022	<MDC	3.9	6.4	4.3
Well 566				
11/30/2022	<MDC	3.9	<MDC	4.3
Well 567				
11/30/2022	<MDC	3.9	5.5	4.3
Well 570				
3/9/2022	<MDC	3.9	<MDC	4.3
Well 574				
9/14/2022	<MDC	3.9	<MDC	4.3
Well 575				
9/14/2022	<MDC	3.9	<MDC	4.3
Well 577				
3/9/2022	<MDC	3.9	<MDC	4.3

Table D.1 (continued) Gross Alpha/Beta Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Well 602				
6/9/2022	<MDC	3.9	5.4	4.3
Well 604				
9/14/2022	<MDC	3.9	<MDC	4.3
Well 606				
3/9/2022	<MDC	3.9	<MDC	4.3
Well 607				
11/30/2022	<MDC	3.9	<MDC	4.3
Well H				
6/9/2022	<MDC	3.9	<MDC	4.3
Well I				
3/9/2022	<MDC	3.9	<MDC	4.3
Well J				
3/9/2022	<MDC	3.9	<MDC	4.3
Well M				
9/14/2022	<MDC	3.9	<MDC	4.3
Well TB				
3/9/2022	<MDC	3.9	<MDC	4.3

Table D.2 Gross Alpha/Beta Results for Off-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Lawson Creek				
11/30/2022	<MDC	3.9	<MDC	4.3
Lorensen Farm Creek				
6/9/2022	<MDC	3.9	<MDC	4.3
Lunchroom Tap				
3/9/2022	<MDC	3.9	4.7	4.3
Mineral PWS				
6/9/2022	5.9	3.9	7.0	4.3
9/14/2022	<MDC	3.9	5.8	4.3
11/30/2022	<MDC	3.9	10.4	4.3
Neponset PWS				
9/14/2022	3.9	3.9	10.6	4.3
Pencock Hill PWS				
9/14/2022	<MDC	3.9	7.7	4.3
Sheffield PWS				
3/9/2022	<MDC	3.9	<MDC	4.3

Table D.3 Tritium (H-3) Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	H-3	
Date	Result	MDC
South Creek		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Trout Lake A		
3/9/2022	479	173
6/9/2022	608	173
9/14/2022	661	173
11/30/2022	769	173
Trout Lake C		
6/9/2022	721	173
9/14/2022	698	173
11/30/2022	705	173
Trout Lake D		
3/9/2022	1150	173
6/9/2022	657	173
9/14/2022	710	173
11/30/2022	716	173
Well 150		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 511		
3/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 512		
3/9/2022	3640	173
6/9/2022	3410	173
9/14/2022	3470	173
11/30/2022	3410	173

Location	H-3	
Date	Result	MDC
Well 513		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 515		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 516		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 525		
3/9/2022	311	173
6/9/2022	225	173
9/14/2022	222	173
11/30/2022	350	173
Well 563		
3/9/2022	27200	173
6/9/2022	25600	173
9/14/2022	27700	173
11/30/2022	22100	173
Well 566		
3/9/2022	<MDC	173
6/9/2022	724	173
9/14/2022	273	173
11/30/2022	<MDC	173
Well 567		
3/9/2022	809	173
6/9/2022	689	173
9/14/2022	596	173
11/30/2022	656	173

Table D.3 (Continued)Tritium (H-3) Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location Date	H-3 Result	H-3 MDC
Well 570		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 574		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well 575		
3/9/2022	34600	173
6/9/2022	35100	173
9/14/2022	33700	173
11/30/2022	28000	173
Well 577		
3/9/2022	9540	173
6/9/2022	13500	173
9/14/2022	12100	173
11/30/2022	23700	173
Well 600		
3/9/2022	7620	173
6/9/2022	8870	173
9/14/2022	10400	173
Well 602		
3/9/2022	1570	173
6/9/2022	1460	173
9/14/2022	1550	173
11/30/2022	1470	173
Well 604		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173

Location Date	H-3 Result	H-3 MDC
Well 606		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
Well 607		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well H		
3/9/2022	337	173
6/9/2022	299	173
9/14/2022	331	173
11/30/2022	294	173
Well I		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
Well J		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
11/30/2022	<MDC	173
Well M		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Well TB		
3/9/2022	1040	173
6/9/2022	1220	173
9/14/2022	1440	173
11/30/2022	1570	173

Table D.4 Tritium (H-3) Results for Off-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	H-3	
Date	Result	MDC
Lawson Creek		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Lorensen Farm Creek		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Lunchroom Tap		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Mineral PWS		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173

Location	H-3	
Date	Result	MDC
Neponset PWS		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Pencock Hill PWS		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Sheffield PWS		
3/9/2022	<MDC	173
6/9/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173

Table D.5 C-14 Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	C-14	
Date	Result	MDC
South Creek		
3/9/2022	<MDC	8.1
Trout Lake A		
11/30/2022	<MDC	8.1
Trout Lake C		
9/14/2022	<MDC	8.1
Trout Lake D		
6/9/2022	<MDC	8.1
Well 150		
9/14/2022	<MDC	8.1
Well 511		
11/30/2022	39.6	8.1
Well 512		
11/30/2022	46.6	8.1
Well 513		
6/9/2022	<MDC	8.1
Well 515		
3/9/2022	<MDC	8.1
Well 516		
11/30/2022	<MDC	8.1
Well 525		
9/14/2022	33.5	8.1
Well 563		
6/9/2022	563.3	8.1
Well 566		
11/30/2022	<MDC	8.1

Location	C-14	
Date	Result	MDC
Well 567		
11/30/2022	31.6	8.1
Well 570		
3/9/2022	<MDC	8.1
Well 574		
9/14/2022	<MDC	8.1
Well 575		
9/14/2022	151.5	8.1
Well 577		
3/9/2022	78.1	8.1
Well 602		
6/9/2022	<MDC	8.1
Well 604		
9/14/2022	<MDC	8.1
Well 606		
3/9/2022	<MDC	8.1
9/14/2022	<MDC	8.1
Well 607		
11/30/2022	<MDC	8.1
Well H		
6/9/2022	<MDC	8.1
Well I		
3/9/2022	<MDC	8.1
Well M		
9/14/2022	<MDC	8.1
Well TB		
3/9/2022	137.5	8.1

Table D.6 C-14 Results for Off-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	C-14	
Date	Result	MDC
Lawson Creek		
10/27/2021	<MDC	8.1
Lorensen Farm Creek		
6/2/2021	<MDC	8.1
Lunchroom Tap		
3/3/2021	<MDC	8.1
Mineral PWS		
6/2/2021	<MDC	8.1
Neponset PWS		
9/8/2021	<MDC	8.1
Pencock Hill PWS		
9/8/2021	<MDC	8.1
Sheffield PWS		
3/3/2021	<MDC	8.1

Table D.7 Total Strontium Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Date	Strontium Result	Strontium MDC
South Creek	3/9/2022	<MDC	1.7
Trout Lake A	11/30/2022	<MDC	1.7
Trout Lake C	9/14/2022	<MDC	1.7
Trout Lake D	6/9/2022	<MDC	1.7
Well 150	9/14/2022	<MDC	1.7
Well 511	11/30/2022	<MDC	1.7
Well 512	11/30/2022	<MDC	1.7
Well 513	6/9/2022	<MDC	1.7
Well 515	3/9/2022	<MDC	1.7
Well 516	11/30/2022	3.8	1.7
Well 525	9/14/2022	<MDC	1.7
Well 563	6/9/2022	<MDC	1.7
Well 566	11/30/2022	<MDC	1.7
Well 567	11/30/2022	<MDC	1.7
Well 570	3/9/2022	<MDC	1.7
Well 574	9/14/2022	<MDC	1.7
Well 575	9/14/2022	<MDC	1.7
Well 577	3/9/2022	<MDC	1.7
Well 602	6/9/2022	<MDC	1.7
Well 604	9/14/2022	<MDC	1.7
Well 606	3/9/2022	<MDC	1.7
Well 607	11/30/2022	<MDC	1.7
Well H	6/9/2022	<MDC	1.7
Well I	3/9/2022	<MDC	1.7
Well J	3/9/2022	<MDC	1.7
Well M	9/14/2022	<MDC	1.7
Well TB	3/9/2022	<MDC	1.7

Table D.8 Total Strontium Results for Off-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Strontium	
Date	Result	MDC
Lawson Creek		
11/30/2022	<MDC	1.5
Lorensen Farm Creek		
6/9/2022	<MDC	1.5
Lunchroom Tap		
3/9/2022	<MDC	1.5
Mineral PWS		
6/9/2022	<MDC	1.5
Neponset PWS		
9/14/2022	<MDC	1.5
Pencock Hill PWS		
9/14/2022	<MDC	1.5
Sheffield PWS		
3/9/2022	<MDC	1.5

Table D.9 Additional Radionuclide Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
South Creek						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Trout Lake A						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Trout Lake C						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Trout Lake D						
6/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 150						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 511						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 512						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 513						
6/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 515						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 516						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 525						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 563						
6/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 566						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 567						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4

Table D.9 (Continued) Additional Radionuclide Results for On-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
Well 570						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 574						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 575						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 577						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 602						
6/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 604						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 606						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well 607						
11/30/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well H						
6/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well I						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well J						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well M						
9/14/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4
Well TB						
3/9/2022	<MDC	45.0	<MDC	3.5	<MDC	3.4

Table D.10 Additional Radionuclide Results for Off-Site Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
Lawson Creek						
11/30/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Lorensen Farm Creek						
6/9/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Lunchroom Tap						
3/9/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Mineral PWS						
6/9/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Neponset PWS						
9/14/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Pencock Hill PWS						
9/14/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3
Sheffield PWS						
3/9/2022	<MDC	42.0	<MDC	3.6	<MDC	3.3

Table D.11 Sheffield On-Site Sediment Sampling Results
Results are in picocuries per gram (pCi/g)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
South Creek						
6/9/2022	<MDC	0.11	<MDC	0.01	0.02	0.01
9/14/2022	<MDC	0.11	<MDC	0.01	0.01	0.01
Trout Lake D						
6/9/2022	<MDC	0.11	<MDC	0.01	<MDC	0.01
9/14/2022	<MDC	0.11	<MDC	0.01	0.01	0.01

Table D.12 Sheffield Off-Site Sediment Sampling Results
Results are in picocuries per gram (pCi/g)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
Lawson Creek						
6/9/2022	<MDC	0.01	<MDC	0.01	0.04	0.01
9/14/2022	<MDC	0.01	<MDC	0.01	0.02	0.01

Table D.13 On-Site Vegetation Sampling Results
Results are in picocuries per gram (pCi/g)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
Onsite Composite						
6/9/2022	<MDC	0.18	<MDC	0.05	<MDC	0.03
9/14/2022	<MDC	0.18	<MDC	0.05	<MDC	0.03
Trout Lake D						
6/9/2022	<MDC	0.18	<MDC	0.05	<MDC	0.03
9/14/2022	<MDC	0.18	<MDC	0.05	<MDC	0.03

Table D.14 Air Monitoring Gross Alpha/Beta Results for Sheffield Site
Results are in femtocuries per cubic meter (fCi/m³)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Site Air				
1/4/2022	5.5	1.5	42.6	4.4
1/10/2022	5.1	1.5	39.3	4.4
1/17/2022	3.0	1.5	34.3	4.4
1/24/2022	4.6	1.5	27.2	4.4
1/31/2022	4.0	1.5	23.3	4.4
2/7/2022	6.6	1.5	39.8	4.4
2/14/2022	3.8	1.5	22.6	4.4
2/21/2022	5.3	1.5	25.8	4.4
2/28/2022	4.1	1.5	22.0	4.4
3/7/2022	2.7	1.5	32.7	4.4
3/14/2022	2.3	1.5	18.1	4.4
3/21/2022	3.4	1.5	25.9	4.4
3/28/2022	1.5	1.5	13.8	4.4
4/4/2022	1.6	1.5	10.7	4.4
4/11/2022	2.1	1.5	6.8	4.4
4/18/2022	2.0	1.5	9.0	4.4
4/25/2022	2.9	1.5	9.4	4.4
5/2/2022	2.7	1.5	10.1	4.4
5/9/2022	2.0	1.5	7.3	4.4
5/16/2022	4.8	1.5	21.9	4.4
5/23/2022	2.4	1.5	11.0	4.4
5/31/2022	2.0	1.5	12.3	4.4
6/6/2022	2.3	1.5	15.0	4.4
6/13/2022	4.2	1.5	14.0	4.4
6/20/2022	4.8	1.5	15.5	4.4
6/27/2022	4.8	1.5	16.8	4.4

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Site Air				
7/5/2022	2.7	1.5	16.5	4.4
7/11/2022	2.4	1.5	14.6	4.4
7/18/2022	2.7	1.5	19.1	4.4
7/25/2022	3.8	1.5	20.0	4.4
8/1/2022	2.4	1.5	14.8	4.4
8/8/2022	2.2	1.5	18.0	4.4
8/15/2022	1.8	1.5	15.5	4.4
8/22/2022	5.3	1.5	21.0	4.4
8/29/2022	5.2	1.5	25.6	4.4
9/6/2022	4.9	1.5	18.4	4.4
9/12/2022	5.2	1.5	20.4	4.4
9/19/2022	6.2	1.5	27.1	4.4
9/26/2022	4.6	1.5	19.5	4.4
10/3/2022	2.4	1.5	13.8	4.4
10/10/2022	6.1	1.5	16.8	4.4
10/17/2022	7.5	1.5	23.3	4.4
10/24/2022	7.5	1.5	19.9	4.4
10/31/2022	4.4	1.5	21.3	4.4
11/7/2022	9.5	1.5	36.2	4.4
11/14/2022	2.0	1.5	16.7	4.4
11/21/2022	1.7	1.5	18.3	4.4
11/28/2022	2.5	1.5	46.8	4.4
12/5/2022	<MDC	1.5	23.3	4.4
12/12/2022	11.1	1.5	45.7	4.4
12/19/2022	6.0	1.5	20.5	4.4
12/28/2022	5.4	1.5	23.9	4.4

Table D.15 Summary of Ambient Gamma Results

Location	Quarter 1 mR/quarter	Quarter 2 mR/quarter	Quarter 3 mR/quarter	Quarter 4 mR/quarter	Annual exposure mR/year
SHER-01	8.9	11.7	8.8	9.9	39.2
SHER-02	10.5	11.6	8.7	9.0	39.9
SHER-03		11.2	9.7	8.4	39.1
SHER-04	10.3	12.7	10.6	9.7	43.3
SHER-05	10.7	13.9	9.9	9.0	43.4
SHER-06	10.2	12.4	13.3	10.6	46.5
SHER-07	11.3	10.6	8.4	9.7	40.0
SHER-08	7.2	11.4	9.7	8.4	36.8
SHER-09	7.3	10.3	3.8	7.1	28.5
SHER-10	11.2	12.7	12.8	10.9	47.5
SHER-11	9.4	12.8	9.4	8.2	39.8
SHER-12	11.2	13.3	8.2	11.9	44.6
SHER-13	9.3	10.5	8.0	9.8	37.6

Blanks in the table indicate that dosimeters were missing at the end of the quarter.
Annual Exposure column based on averages of all available data.
Quarter length is estimated to be 91.25 days.

Appendix E
Background Location Sample Results

Table E.1 Gross Alpha/Beta Results for All Water Samples
Results are in picocuries per Liter (pCi/L)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
East Boat Dock				
3/8/2022	<MDC	3.9	<MDC	4.3
5/27/2022	<MDC	3.9	<MDC	4.3
9/14/2022	<MDC	3.9	<MDC	4.3
11/30/2022	<MDC	3.9	<MDC	4.3
Strawkaws Boat Ramp				
3/8/2022	<MDC	3.9	<MDC	4.3
5/27/2022	<MDC	3.9	<MDC	4.3
9/14/2022	<MDC	3.9	<MDC	4.3
11/30/2022	<MDC	3.9	<MDC	4.3
West Boat Ramp				
3/8/2022	<MDC	3.9	<MDC	4.3
5/27/2022	<MDC	3.9	<MDC	4.3
9/14/2022	<MDC	3.9	<MDC	4.3
11/30/2022	<MDC	3.9	<MDC	4.3

Table E.2 Tritium (H-3) Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location / Date	H-3 Result	H-3 MDC
East Boat Dock		
3/8/2022	<MDC	173
5/27/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
Strawkaws Boat Ramp		
3/8/2022	<MDC	173
5/27/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173
West Boat Ramp		
3/8/2022	<MDC	173
5/27/2022	<MDC	173
9/14/2022	<MDC	173
11/30/2022	<MDC	173

Table E.3 C-14 Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location / Date	C-14 Result	C-14 MDC
East Boat Dock		
5/27/2022	<MDC	8.1
Strawkaws Boat Ramp		
3/8/2022	<MDC	8.1
11/30/2022	<MDC	8.1
West Boat Ramp		
9/14/2022	<MDC	8.1

Table E.4 Total Strontium Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	Strontium	
Date	Result	MDC
East Boat Dock		
5/27/2022	<MDC	0.7
Strawkaws Boat Ramp		
3/8/2022	<MDC	0.7
11/30/2022	<MDC	0.7
West Boat Ramp		
9/14/2022	<MDC	0.7

Table E.5 Additional Radionuclides Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
East Boat Dock						
3/8/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
5/27/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
9/14/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
11/30/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
Strawkaws Boat Ramp						
3/8/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
5/27/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
9/14/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
11/30/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
West Boat Ramp						
3/8/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
5/27/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
9/14/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4
11/30/2022	<MDC	42.0	<MDC	3.6	<MDC	3.4

Table E.6 Gamma Results for Sediment Samples from Background Location
Results are in picocuries per liter (pCi/g)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
Strawkaws Boat Ramp						
5/27/2022	<MDC	0.22	<MDC	0.03	<MDC	0.03
9/14/2022	<MDC	0.22	<MDC	0.03	<MDC	0.03
West Boat Ramp						
5/27/2022	<MDC	0.22	<MDC	0.03	<MDC	0.03
9/8/2021	<MDC	0.22	<MDC	0.03	<MDC	0.03

Table E.7 Gamma Results for Vegetation Samples from Background Location
Results are in picocuries per liter (pCi/g)

Location	Am-241		Co-60		Cs-137	
Date	Result	MDC	Result	MDC	Result	MDC
East Boat Dock						
5/27/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05
9/14/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05
Strawkaws Boat Ramp						
5/27/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05
9/14/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05
West Boat Ramp						
5/27/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05
9/14/2022	<MDC	0.27	<MDC	0.06	<MDC	0.05

Table E.8 Air Monitoring Gross Alpha/Beta Results for Background Location (Springfield)
Results are in femtocuries per cubic meter (fCi/m³)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Knotts Street Air Sampler				
1/4/2022	6.1	1.6	54.3	4.7
1/11/2022	4.2	1.6	37.1	4.7
1/18/2022	3.4	1.6	38.2	4.7
1/25/2022	1.6	1.6	26.7	4.7
2/1/2022	4.7	1.6	38.1	4.7
2/8/2022	4.9	1.6	42.8	4.7
2/15/2022	2.4	1.6	16.6	4.7
2/22/2022	2.5	1.6	26.2	4.7
3/2/2022	3.5	1.6	27.2	4.7
3/9/2022	3.0	1.6	21.9	4.7
3/15/2022	2.1	1.6	14.9	4.7
3/22/2022	2.5	1.6	20.5	4.7
3/29/2022	<MDC	1.6	8.1	4.7
4/5/2022	2.3	1.6	10.7	4.7
4/12/2022	1.9	1.6	5.7	4.7
4/19/2022	2.4	1.6	7.0	4.7
4/26/2022	1.9	1.6	11.7	4.7
5/4/2022	2.9	1.6	14.3	4.7
5/11/2022	3.0	1.6	13.7	4.7
5/17/2022	2.9	1.6	21.6	4.7
5/25/2022	<MDC	1.6	10.4	4.7
6/1/2022	2.0	1.6	15.2	4.7
6/8/2022	<MDC	1.6	17.6	4.7
6/14/2022	3.1	1.6	20.0	4.7
6/21/2022	<MDC	1.6	11.5	4.7
6/29/2022	3.5	1.6	16.9	4.7

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Knotts Street Air Sampler				
7/5/2022	2.0	1.6	11.8	4.7
7/13/2022	2.1	1.6	15.3	4.7
7/26/2022	<MDC	1.6	5.6	4.7
8/2/2022	2.0	1.6	16.3	4.7
8/9/2022	<MDC	1.6	9.5	4.7
8/18/2022	2.7	1.6	18.8	4.7
8/24/2022	<MDC	1.6	16.6	4.7
8/30/2022	5.5	1.6	22.5	4.7
9/6/2022	3.9	1.6	21.4	4.7
9/13/2022	2.0	1.6	24.8	4.7
9/20/2022	<MDC	1.6	13.5	4.7
9/28/2022	3.8	1.6	16.4	4.7
10/4/2022	2.1	1.6	12.2	4.7
10/11/2022	4.6	1.6	28.2	4.7
10/19/2022	1.6	1.6	8.7	4.7
10/25/2022	5.3	1.6	18.6	4.7
11/1/2022	6.2	1.6	19.7	4.7
11/9/2022	7.0	1.6	27.3	4.7
11/15/2022	<MDC	1.6	9.0	4.7
11/23/2022	7.6	1.6	27.8	4.7
11/29/2022	4.8	1.6	25.6	4.7
12/7/2022	6.0	1.6	28.9	4.7
12/13/2022	7.7	1.6	41.6	4.7
12/20/2022	4.6	1.6	15.2	4.7
12/27/2022	5.8	1.6	26.9	4.7

Table E.9 Air Monitoring Gross Alpha/Beta Results for Background Location (Marion)
Results are in femtocuries per cubic meter (fCi/m³)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Marion Office				
1/3/2022	4.8	1.5	36.8	4.5
1/10/2022	7.2	1.5	44.6	4.5
1/18/2022	3.9	1.5	41.9	4.5
1/25/2022	4.2	1.5	30.2	4.5
1/31/2022	7.2	1.5	35.8	4.5
2/7/2022	3.8	1.5	32.1	4.5
2/14/2022	4.0	1.5	28.6	4.5
2/22/2022	3.1	1.5	24.7	4.5
3/1/2022	4.1	1.5	25.6	4.5
3/7/2022	5.8	1.5	40.6	4.5
3/14/2022	3.1	1.5	28.2	4.5
3/21/2022	2.4	1.5	18.9	4.5
3/29/2022	2.1	1.5	15.2	4.5
4/4/2022	2.1	1.5	13.4	4.5
4/11/2022	2.7	1.5	13.4	4.5
4/18/2022	2.1	1.5	14.0	4.5
4/25/2022	2.8	1.5	17.3	4.5
5/3/2022	4.3	1.5	19.4	4.5
5/9/2022	<MDC	1.5	9.8	4.5
5/16/2022	4.1	1.5	23.8	4.5
5/24/2022	3.1	1.5	17.6	4.5
5/31/2022	2.8	1.5	15.4	4.5
6/6/2022	1.9	1.5	18.6	4.5
6/13/2022	2.3	1.5	20.5	4.5
6/21/2022	4.2	1.5	20.1	4.5

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
Marion Office				
6/27/2022	2.2	1.5	19.5	4.5
7/5/2022	1.8	1.5	20.6	4.5
7/11/2022	2.5	1.5	17.5	4.5
7/19/2022	3.7	1.5	27.0	4.5
7/26/2022	4.1	1.5	27.5	4.5
8/1/2022	2.2	1.5	16.5	4.5
8/9/2022	<MDC	1.5	11.8	4.5
8/16/2022	2.8	1.5	28.0	4.5
8/23/2022	3.3	1.5	29.3	4.5
8/31/2022	6.7	1.5	31.7	4.5
9/6/2022	4.6	1.5	22.6	4.5
9/12/2022	2.2	1.5	26.4	4.5
9/19/2022	<MDC	1.5	34.3	4.5
9/26/2022	4.3	1.5	22.3	4.5
10/3/2022	2.9	1.5	15.5	4.5
10/11/2022	5.3	1.5	29.5	4.5
10/24/2022	3.6	1.5	27.2	4.5
10/31/2022	6.7	1.5	24.1	4.5
11/7/2022	9.3	1.5	40.8	4.5
11/14/2022	4.7	1.5	17.3	4.5
11/21/2022	6.1	1.5	24.9	4.5
11/28/2022	5.6	1.5	23.7	4.5
12/6/2022	5.5	1.5	33.3	4.5
12/13/2022	8.0	1.5	45.8	4.5
12/20/2022	6.4	1.5	21.1	4.5
12/27/2022	3.7	1.5	24.4	4.5

Table E.10 Air Monitoring Gross Alpha/Beta Results for Background Location (West Chicago)
Results are in femtocuries per cubic meter (fCi/m³)

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
West Chicago				
1/12/2022	3.6	1.6	37.0	4.6
1/19/2022	3.7	1.6	37.5	4.6
1/26/2022	4.3	1.6	32.7	4.6
2/1/2022	2.7	1.6	36.4	4.6
2/8/2022	5.8	1.6	47.7	4.6
2/15/2022	3.4	1.6	24.3	4.6
2/22/2022	3.1	1.6	27.8	4.6
3/2/2022	3.4	1.6	33.3	4.6
3/8/2022	3.5	1.6	26.4	4.6
3/15/2022	3.0	1.6	26.4	4.6
3/22/2022	2.9	1.6	27.2	4.6
3/29/2022	<MDC	1.6	15.0	4.6
4/5/2022	2.7	1.6	10.5	4.6
4/12/2022	1.7	1.6	9.1	4.6
4/19/2022	<MDC	1.6	9.6	4.6
4/26/2022	2.6	1.6	7.1	4.6
5/3/2022	2.8	1.6	12.4	4.6
5/10/2022	3.3	1.6	11.8	4.6
5/16/2022	3.6	1.6	23.5	4.6
5/24/2022	2.5	1.6	10.5	4.6
5/31/2022	2.0	1.6	13.8	4.6
6/7/2022	2.2	1.6	15.6	4.6
6/13/2022	2.3	1.6	15.7	4.6
6/21/2022	2.8	1.6	20.2	4.6

Location	Alpha		Beta	
Date	Result	MDC	Result	MDC
West Chicago				
6/28/2022	2.7	1.6	17.4	4.6
7/5/2022	3.8	1.6	22.4	4.6
7/11/2022	3.5	1.6	17.9	4.6
7/25/2022	3.9	1.6	21.3	4.6
8/2/2022	2.2	1.6	17.5	4.6
8/8/2022	2.4	1.6	16.8	4.6
8/16/2022	2.0	1.6	16.9	4.6
8/23/2022	1.9	1.6	26.9	4.6
8/29/2022	6.3	1.6	27.1	4.6
9/6/2022	3.8	1.6	20.8	4.6
9/13/2022	3.9	1.6	23.2	4.6
9/20/2022	7.5	1.6	29.0	4.6
9/27/2022	3.0	1.6	17.6	4.6
10/4/2022	2.2	1.6	12.1	4.6
10/11/2022	8.9	1.6	26.1	4.6
10/19/2022	5.6	1.6	16.0	4.6
10/25/2022	7.1	1.6	37.3	4.6
11/9/2022	4.5	1.6	31.4	4.6
11/18/2022	2.2	1.6	17.0	4.6
11/22/2022	8.2	1.6	40.9	4.6
11/29/2022	8.3	1.6	53.8	4.6
12/7/2022	6.6	1.6	38.4	4.6
12/13/2022	5.5	1.6	30.7	4.6
12/20/2022	3.4	1.6	23.9	4.6

Table E.11 Summary of Ambient Gamma Results for Background Location

Location	Quarter 1 mR/quarter	Quarter 2 mR/quarter	Quarter 3 mR/quarter	Quarter 4 mR/quarter	Annual exposure mR/year
KC-01	12.8	9.2	10.7	8.3	41.1
KC-02	12.7		8.4	8.3	39.2
KC-03	8.6	9.5	7.7	10.1	35.9
KC-04	9.6	8.4	11.6	11.8	41.5
KC-05	10.1	7.2	11.8	11.2	40.4
KC-06	9.3	6.0	11.3	8.9	35.4
KC-07			11.5	11.3	45.7
KC-08		8.4	9.3	10.3	37.4
KC-09	8.3	7.7	8.9	9.1	34.0
KC-10		7.6	12.2	10.8	40.8
KC-11	11.9	11.5	11.4	10.8	45.6
KC-12	11.3	10.6	11.4	9.7	43.1
KC-13	8.6	8.2	12.0		38.4
KC-14	10.7	10.6	10.0	8.5	39.8
KC-15	10.6	7.0	9.3	9.1	36.0

Blanks in the table indicate that dosimeters were missing at the end of the quarter.
Annual Exposure column based on averages of all available data.
Quarter length is estimated to be 91.25 days.

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