AREVA Inc.

Mount Athos Road Facility


# Decommissioning of Selected Sections of the Former Waste Water Line

November 2011

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# Table of Contents

# List of Figures

# List of Tables

# 1 Executive Summary

Over the operating history of the Mount Athos Road (MAR) facility an underground/under plant waste water piping system (sometimes referred to as the "hot acid line") was used to carry low activity waste water from sinks, showers and drains to a pair of 1,000 gallon retention/dilution tanks. Water was then sampled and discharged to the wet weather stream when in conformance with the NRC effluent limitations at the time know as MPC for maximum permissible concentration.

This report describes the historic use of the piping system, the sections replaced or removed over the site history, results of soil sample analyses and a quantification of the remaining SNM as uranium in the remaining sections of pipe.

Based on the characterization of the piping system there remains detectible uranium contamination in sections of the pipe and some areas with residues containing low concentrations of residual uranium. Based on the length of the remaining pipe and results of characterization the system has about **12.5** grams of uranium and **0.5** grams of uranium-235. This value is much less than the 350g U-235 limit described in 10 CFR150 and is consistent with the by-product license.

Since further remediation would require extensive excavation of the building foundation and the fact that the residue remaining is compliant with the possession limit of the license, further remediation will be delayed until the final site decommissioning. Note that there is no planned end date.

This report is part of the decommissioning record and must be maintained for future reference.

## 1.1 Introduction

The Mount Athos Road facility was constructed in the late 1960's for the purpose of manufacturing commercial nuclear reactor fuel. The facility performed pelletization from 1975 to 1982. After 1982 the process was ceased and pellet fabrication was outsourced. The former waste water line was used from the initial operation, the period of pelletizing and later during general fuel production processes. The pipes are made of Vulcathene, a co-polymer polypropylene with 3% carbon black, which has a high resistance to chemical attack and is therefore well suited for carrying aggressive chemicals and liquids found in chemical plants and laboratory waste. The pipe was installed as part of the initial construction and was capable of handling acids with radioactivity and has been commonly referred to as the "**hot acid line**". The pipe was used for discharging water from acid solution rinse tanks in the parts cleaning process, from the demineralizers and was used for low concentration uranium in wash waters from sinks and showers.

The pipe lays anywhere from about 3 feet below the foundation to approximately 10 feet below the ground surface. The pipe ran the length of the fuel plant with multiple extensions, most of which were never used, and drained into two 1,000 gallon retention tanks. The pipe was used to drain water from change room sinks, showers, and metrology laboratory sinks with the potential to be slightly contaminated with low enriched uranium. For a portion of the operation period, water from the pellet grinders was centrifuged and flocculated to remove uranium and discharged through the piping system. The pipe handled slightly contaminated

water which was collected in retention tanks and was eventually discharged to the "wet weather" stream. This water eventually meandered to the James River some 1,100 feet away. After these discharges ceased, the pipe was flushed with water to remove any sludge build up. Sections of the system continued to be used for industrial waste water from the component cleaning processes for several years, which likely cleaned any uranium deposits or contamination that remained in these sections from its operation period.

The area commonly known as the wet weather stream was decommissioned in 1998. The NRC formally approved the release for unrestricted use of this area on April 3, 2000. The wet weather stream was remediated to less than 30 pCi/g total uranium average. The wet weather stream is the only true decommissioning project since the area was released by the NRC for unrestricted use. Figure 1 depicts the sections of waste water pipe that have been removed over time.

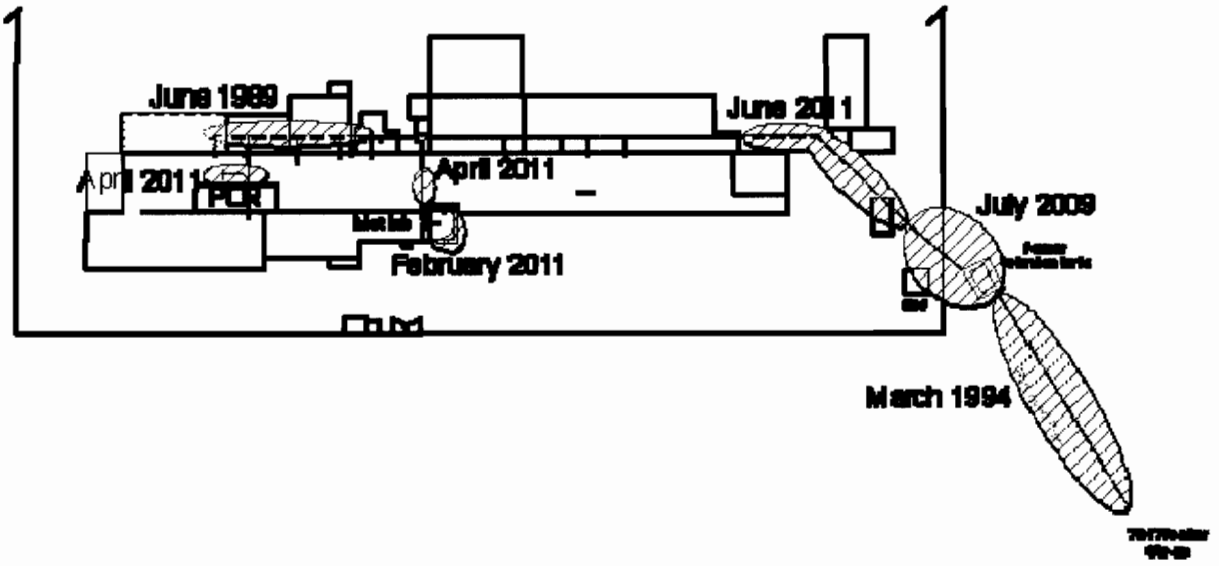


Figure 1 Waste Water Line Removal and Characterization Project over Time

# 2 References

2.1 Legacy Acid Line Removal Plan, June 2009

2.2 Decommissioning Plan, January 2011

2.3 Uranium Contamination of the Wet Weather Stream From CNFD Liquid Effluent Discharges, November 1, 1984

# 3 Pipe Removal Projects

During and after the operational period of the fuel plant, several projects were undertaken to replace or remove sections of the waste water line. The following sections describe the significant projects related to the waste water line. The discharges to the wet weather stream from the pipe system and the remediation of the wet weather stream are not addressed in this report.

During the operational period of the piping system two retention/dilution tanks were in service to collect waste water and, if necessary, dilute the water before being discharged to the wet weather stream. At some undetermined time, one of two retention tanks was removed and used in another application on site. The remaining tank was removed as described in section 3.3.

## 3.1 Pipe Replacement 1986

In 1986, a section approximately 50 feet long of the Vulcathene waste water line was excavated and replaced with a polyethylene section after a noticeable increase in volume of waste water being collected at the retention tanks. This increase was due to groundwater infiltration caused by differential settling of the fill dirt used during the initial building construction. The location of the pipe replacement is shown in Figure 2. Survey records associated with the project, if any, were not found.

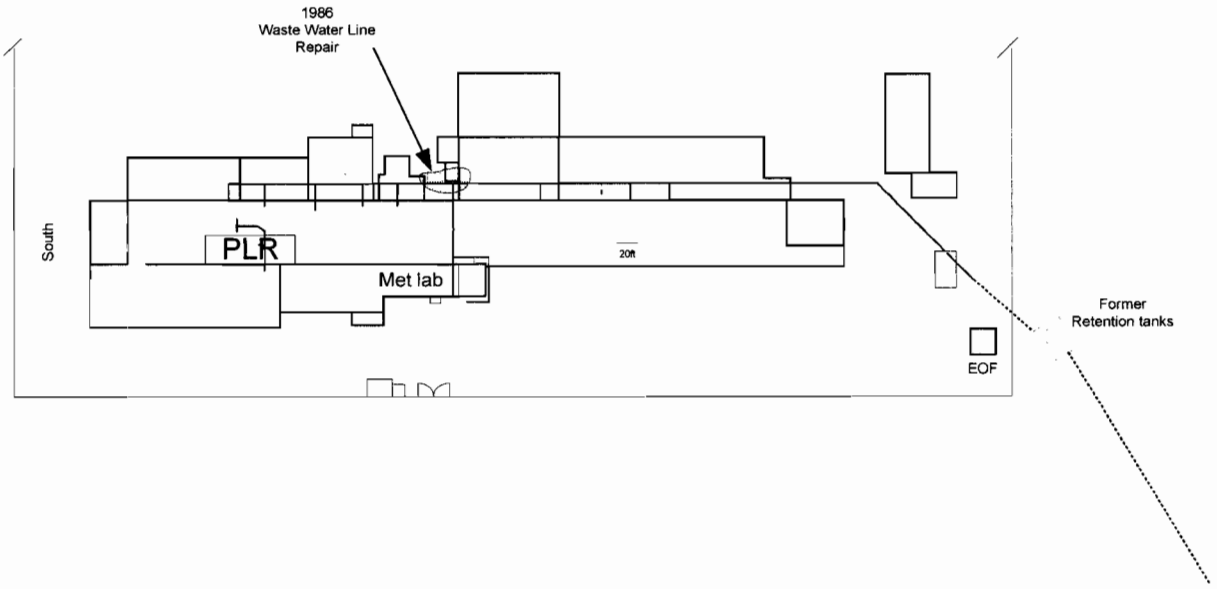


Figure 2 1986 Waste Water Line Repair

## 3.2 June 1989 Pipe Removal

On June 27, 1989, 175 feet (including cleanout sections) of the 4 inch diameter Vulcathene waste water line was excavated prior to construction of building additions (Figure 3). As part of the project, 15 soil samples were collected along the pipe excavation and analyzed for isotopic uranium and VOCs, according to the report. Results of the radiological analysis were not found in the decommissioning file, so a definitive determination of the radiological status cannot be made. The project file did not have any information which would indicate that the pipe leaked or that there was contamination in the soil around the removed pipe.

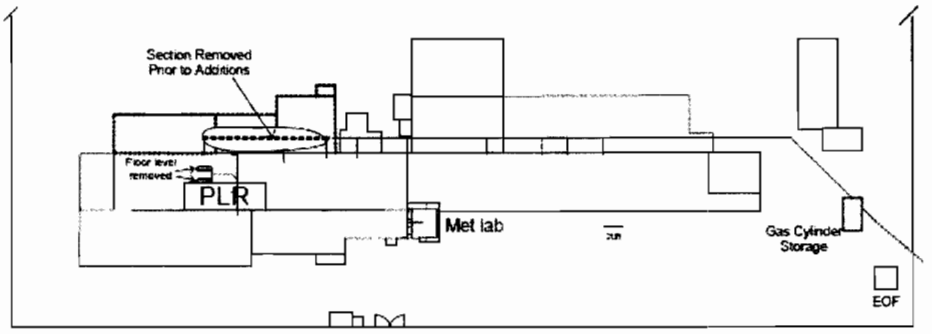


Figure 3 1989 Waste Water Line Removal

## 3.3March 1994 Pipe Removal

In March 1994 records indicate that the waste water pipe from the retention tanks to the Wet Weather stream was removed. Partial documentation of the project is provided in reference 2.1, however characterization or soil sample results have not been available to date. Figure 1 and Figure 2 show the section of pipe removed during this project starting at the former retention tanks to the terminus at the wet weather stream.

## 3.4July 2009 North Pipe and Retention Tank Removal

As part of AREVA's global commitment to environmental excellence a plan, reference 2.1, was put in place and executed to confirm that sections of the waste water line were removed and to remove the section of pipe from the gas bottle storage shed to the retention tank system. To confirm that the 1994 pipe excavation (Figure 1) had taken place, an exploratory excavation was dug at the capped end of the waste water line. The bedding sand was located and no pipe was found as expected. Three additional cross sections of the piping path were excavated and the bedding sand bed was identified and it was confirmed that the pipe had been removed. Gamma Spectroscopy results from the previously removed section of piping are shown in Table 1.

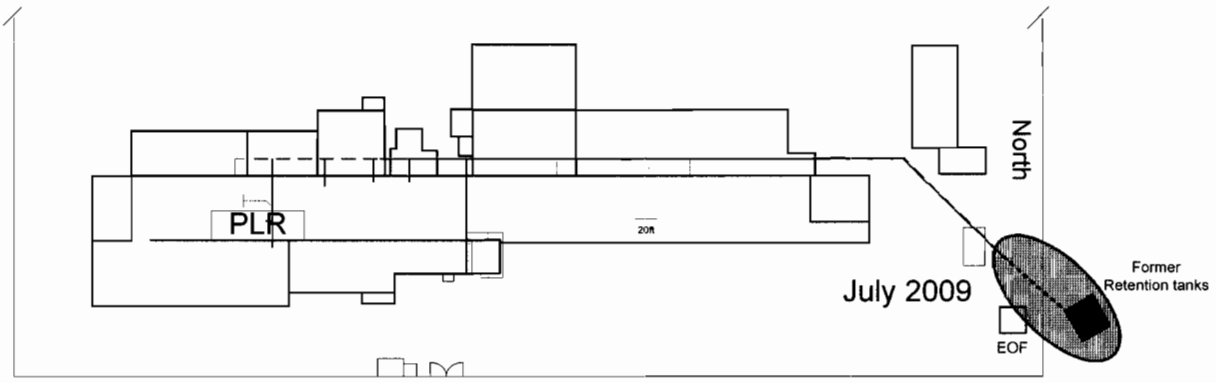


Figure 4 Depiction of the Waste Water Line with July 2009 Removed Sections Highlighted

Table 1 Gamma Spectroscopy Results (pCi/g) for the North Pipe

Date Collected: June 4, 2009

| Nuclide | Field ID: 1 Lab ID: 0906241-1 (pCi/g) ± 2σ | Field ID: 2 Lab ID: 0906241-2 (pCi/g) ± 2σ | Field ID: 3 Lab ID: 0906241-3 (pCi/g) ± 2σ | Field ID: 4 Lab ID: 0906241-4 (pCi/g) ± 2σ | Field ID: 5 Lab ID: 0906241-5 (pCi/g) ± 2σ |
|---|---|---|---|---|---|
| Ac-228 | < MDC | <MDC | 0.98 ± 0.34 | 1.06 ± 0.33 | <MDC |
| Bi-212 | <MDC | 0.46 ± 0.17 | 1.8 ± 1.0 | <MDC | <MDC |
| Bi-214 | <MDC | 0.46 ± 0.17 | 0.85 ± 0.25 | 0.52 ± 0.21 | 0.52 ± 0.22 |
| K-40 | 9.9 ± 2.2 | 14.7 ± 2.8 | 14.6 ± 3.1 | 20.0 ± 3.7 | 14.2 ± 2.8 |
| Pb-212 | 1.01 ± 0.21 | 0.35 ± 0.12 | 1.30 ± 0.27 | 1.11 ± 0.25 | 0.50 ± 0.16 |
| Pb-214 | 0.99 ± 0.20 | 0.40 ± 0.14 | 0.64 ± 0.18 | 0.79 ± 0.20 | 0.36 ± 0.14 |
| Th-234 | <MDC | <MDC | 2.1 ± 1.0 | <MDC | <MDC |
| Tl-208 | 0.30 ± 0.11 | 0.116 ± 0.074 | 0.46 ± 0.14 | 0.57 ± 0.15 | <MDC |
| Co-56 | <MDC | <MDC | <MDC | <MDC | <MDC |
| Nuclide | Field ID: 6 Lab ID: 0906241-6 (pCi/g) ± 2σ | Field ID: 7 Lab ID: 0906241-7 (pCi/g) ± 2σ | Field ID: 8 Lab ID: 0906241-8 (pCi/g) ± 2σ | Field ID: 9 Lab ID: 0906241-9 (pCi/g) ± 2σ | Field ID: 10 Lab ID: 0906241-10 (pCi/g) ± 2σ |
| Ac-228 | 0.88 ± 0.31 | <MDC | 0.95 ± 0.37 | 0.43 ± 0.30 | <MDC |
| Bi-212 | <MDC | <MDC | <MDC | <MDC | <MDC |
| Bi-214 | 0.75 ± 0.25 | <MDC | 0.78 ± 0.29 | <MDC | <MDC |
| K-40 | 11.4 ± 2.6 | 15.3 ± 2.9 | 11.0 ± 2.8 | 13.7 ± 2.7 | 14.6 ± 3.0 |
| Pb-212 | 0.81 ± 0.22 | 0.39 ± 0.15 | 1.05 ± 0.26 | 0.32 ± 0.15 | 0.51 ± 0.17 |
| Pb-214 | 0.66 ± 0.19 | 0.28 ± 0.13 | 0.72 ± 0.21 | 0.32 ± 0.14 | 0.38 ± 0.15 |
| Th-234 | 1.9 ± 1.1 | <MDC | <MDC | <MDC | <MDC |
| Tl-208 | 0.32 ± 0.12 | <MDC | 0.33 ± 0.14 | 0.137 ± 0.080 | <MDC |
| Co-56 | <MDC | <MDC | 0.28 ± 0.19 | <MDC | <MDC |
| Nuclide | Field ID: 11 Lab ID: 0906241-11 (pCi/g) ± 2σ | Field ID: 12 Lab ID: 0906241-12 (pCi/g) ± 2σ | Field ID: 13 Lab ID: 0906241-13 (pCi/g) ± 2σ | Field ID: 14 Lab ID: 0906241-14 (pCi/g) ± 2σ | Field ID: 15 Lab ID: 0906241-15 (pCi/g) ± 2σ |
| Ac-228 | <MDC | 0.44 ± 0.29 | 0.92 ± 0.41 | 0.83 ± 0.31 | 1.53 ± 0.43 |
| Bi-212 | <MDC | 1.42 ± 0.91 | <MDC | <MDC | <MDC |
| Bi-214 | 0.36 ± 0.19 | 0.28 ± 0.17 | 0.78 ± 0.28 | 0.92 ± 0.28 | 1.02 ± 0.31 |
| K-40 | 16.0 ± 3.0 | 12.6 ± 2.6 | 9.9 ± 2.6 | 10.5 ± 2.6 | 17.2 ± 3.5 |
| Pb-212 | 0.46 ± 0.15 | 0.23 ± 0.14 | 1.13 ± 0.26 | 1.21 ± 0.27 | 1.78 ± 0.35 |
| Pb-214 | 0.58 ± 0.16 | 0.43 ± 0.17 | 0.94 ± 0.24 | 0.86 ± 0.23 | 0.93 ± 0.25 |
| Th-234 | 1.44 ± 0.86 | <MDC | <MDC | <MDC | <MDC |
| Tl-208 | 0.25 ± 0.10 | <MDC | 0.38 ± 0.15 | 0.37 ± 0.13 | 0.67 ± 0.19 |
| Co-56 | <MDC | <MDC | <MDC | <MDC | <MDC |
| Nuclide | Field ID: 16 Lab ID: 0906241-16 (pCi/g) ± 2σ | | | | |
| All <MDC | | | | | |

Results of the analysis are consistent with background concentrations of radioactive material.

In July 2009, the section of the waste water line from the former retention tanks to just before the gas bottle storage area was excavated (Figure 4). The internal sections of the pipe had detectable alpha and beta/gamma contamination, most likely from uranium and beta/gamma from by-product material. In addition to the removal of the pipe, the remaining 1,000 gallon retention tank was removed and the contaminated sections packaged and disposed as LLRW. Sample results for Total Uranium are shown in Table 2, and Gamma Spectroscopy results are shown in Table 3. The soil results are consistent with background concentrations of radioactive material. A series of photographs is also available that documents the project progress. These photos are maintained in electronic format in the decommissioning files.

Table 2 Total Uranium Results for the North Pipe

| **Sample ID** | **Date Collected** | **Result (µg/kg)** | **pCi/g[1]** |
|---|---|---|---|
| S-100709-1 | 10/07/2009 | 2,000 | 4 |
| S-100709-2 | 10/07/2009 | 590 | 1.2 |
| S-100709-3 | 10/07/2009 | 1,300 | 2.6 |
| S-102209-1 | 10/22/2009 | 1,300 | 2.6 |
| S-102209-2 | 10/22/2009 | 540 | 1.2 |
| S-102209-3 | 10/22/2009 | 1,100 | 2.2 |
| S-102209-4 | 10/22/2009 | 1,100 | 2.2 |
| S-102209-5 | 10/22/2009 | 600 | 1.2 |
| S-102209-6 | 10/22/2009 | 700 | 1.4 |
| S-102209-7 | 10/22/2009 | 1,200 | 2.4 |
| S-102209-8 | 10/22/2009 | 800 | 4 |
| S-102209-9 | 10/22/2009 | 1,100 | 1.2 |

1 – Based on specific activity of 2E6 pCi/g for 4% enriched uranium

Table 3 Gamma Spectroscopy Results (pCi/g) for the North Pipe

| Nuclide | Field ID: 1 Lab ID: S-100709-1 **(pCi/g) ± 2σ** | Field ID: 2 Lab ID: S-100709-2 **(pCi/g) ± 2σ** | Field ID: 3 Lab ID: S-102209-3 **(pCi/g) ± 2σ** | Field ID: 4 Lab ID: S-102209-4 **(pCi/g) ± 2σ** | Field ID: 5 Lab ID: S-102209-5 **(pCi/g) ± 2σ** |
|---|---|---|---|---|---|
| Al-26 | <MDC | <MDC | <MDC | <MDC | <MDC |
| Ac-228 | 0.82 ± 0.57 | 0.35 ± 0.45 | <MDC | <MDC | 0.78 ± 0.39 |
| Bi-214 | 0.86 ± 0.37 | 0.51 ± 0.29 | 0.67 ± 0.35 | 0.92 ± 0.38 | 0.61 ± 0.32 |
| K-40 | 12.0 ± 3.3 | 11.4 ± 3.1 | 16.5 ± 4.1 | 12.4 ± 3.8 | 12.1 ± 3.4 |
| Pb-212 | 0.91 ± 0.37 | <MDC | 0.78 ± 0.30 | 0.82 ± 0.30 | 0.63 ± 0.26 |
| Pb-214 | 0.93 ± 0.31 | <MDC | 0.67 ± 0.28 | 1.04 ± 0.31 | 0.46 ± 0.27 |
| Tl-208 | 0.41 ± 0.20 | <MDC | 0.34 ± 0.17 | 0.31 ± 0.20 | 0.20 ± 0.13 |
| Ra-226 | 1.16 ± 0.32 | 0.45 ± 0.23 | 0.88 ± 0.29 | 1.34 ± 0.34 | 0.67 ± 0.27 |

Table 3 Continued

| Nuclide | Field ID: 6 Lab ID: S-102209-6 (pCi/g) ± 2σ | Field ID: 7 Lab ID: S-102209-7 (pCi/g) ± 2σ | Field ID: 8 Lab ID: S-102209-8 (pCi/g) ± 2σ | Field ID: 9 Lab ID: S-102209-9 (pCi/g) ± 2σ |
|---|---|---|---|---|
| Al-26 | 0.060 ± 0.070 | <MDC | <MDC | <MDC |
| Ac-228 | <MDC | 1.34 ± 0.69 | 1.06 ± 0.58 | 1.24 ± 0.68 |
| Bi-214 | <MDC | 0.91 ± 0.43 | 0.84 ± 0.35 | 0.74 ± 0.34 |
| K-40 | 12.3 ± 3.4 | 10.8 ± 3.4 | 10.4 ± 3.1 | 7.3 ± 2.7 |
| Pb-212 | <MDC | 1.45 ± 0.43 | 1.09 ± 0.34 | 0.91 ± 0.30 |
| Pb-214 | <MDC | 1.20 ± 0.40 | 0.91 ± 0.30 | 0.86 ± 0.29 |
| Tl-208 | <MDC | 0.40 ± 0.23 | 0.28 ± 0.16 | 0.35 ± 0.19 |
| Ra-226 | <MDC | 1.38 ± 0.39 | 1.16 ± 0.31 | 1.09 ± 0.31 |

The retention tank area was partially demolished in order to remove the short sections of pipe imbedded within the concrete. The imbedded pipes were disposed with the other radioactive waste generated. Areas of the retention tank concrete base that supported the retention tanks had several pockets of detectable contamination. These areas were removed and disposed as LLRW. Figure 5 shows the retention tanks support structure demolished during the remediation.

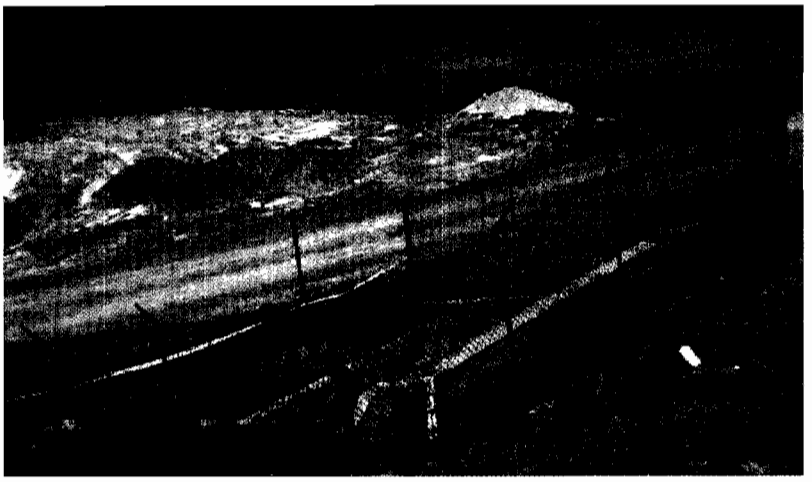

Figure 5 Retention Tank Area

## 3.5February 2011 Outside Area around Met Lab Pipe Removal and Characterization

Excavation of the Metrology Lab drain pipe began on February 15, 2011 and was completed on February 17, 2011.

First, a drain pipe was removed to access the waste water line (Figure 6).

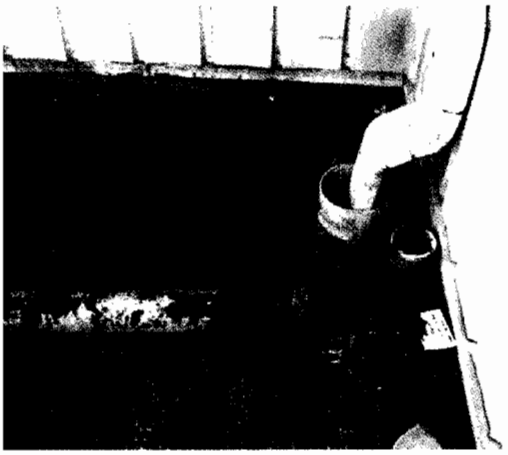

Figure 6 Photo of Drain Pipe Removed to Access Waste Water Line

A long section of pipe (approximately 32 feet) adjacent to the north side of the building and a short section of pipe (approximately 20 feet) along the front (east side) of the building were removed (Figure 7). The total length of pipe removed was approximately 52 feet.

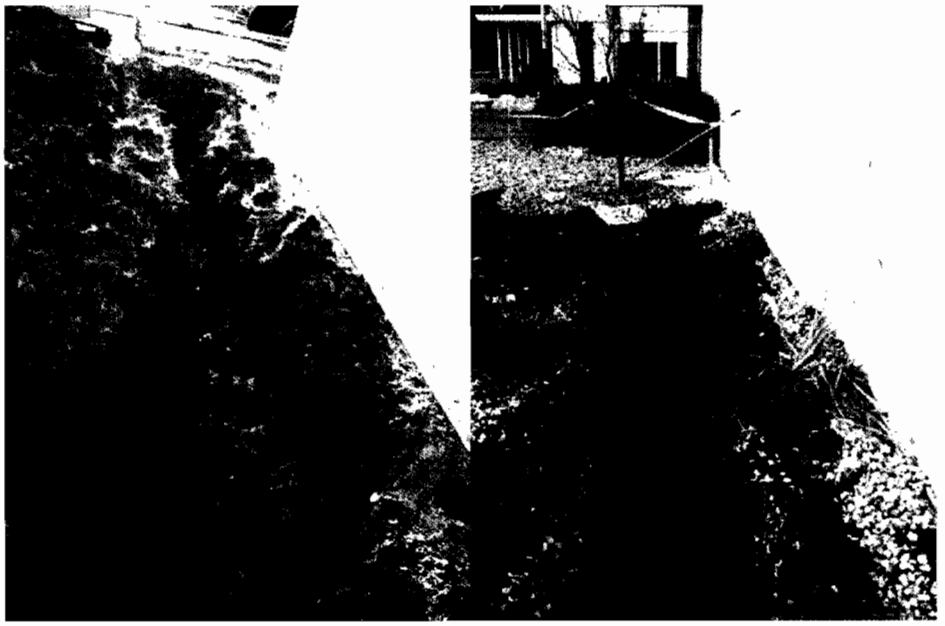

Figure 7 Photo of North (left) and East (right) Side of Building after Pipe Removal

The main entrance line to the building and other lines were capped after excavation. Figure 8 shows the main exit line capped after pipe removal. The other lines were capped the same way as shown below. There were a total of six lines capped, and their locations are shown in Figure 10.

Figure 8 Main Exit Line Capped after Pipe Removal

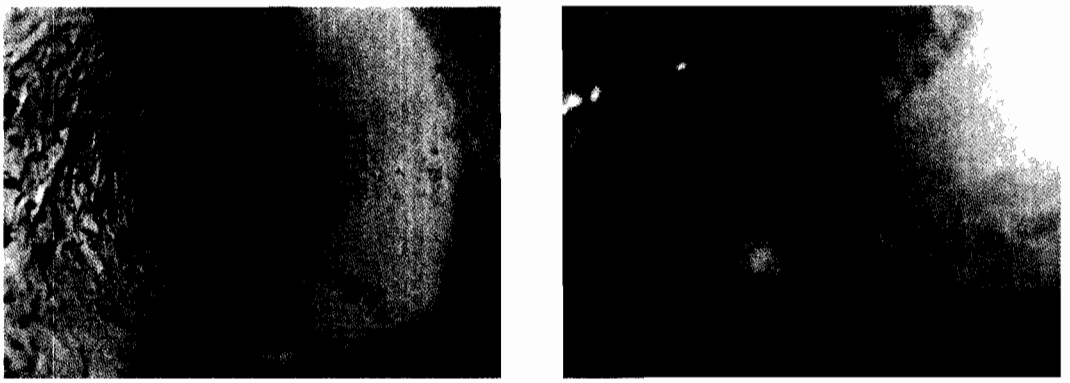

Figure 9 Photos inside Met Lab Drain Lines Exiting from East Side of Building

After the removal of the pipe sections, soil samples were taken from seven locations shown in Figure 10. Sections of both pipes were removed and from these, two dozen ~1cm samples were retrieved. These pipe samples and a composite of the seven soil samples were sent to ALS laboratory for analysis. Gross alpha and beta surveys were also taken on sections of the pipe.

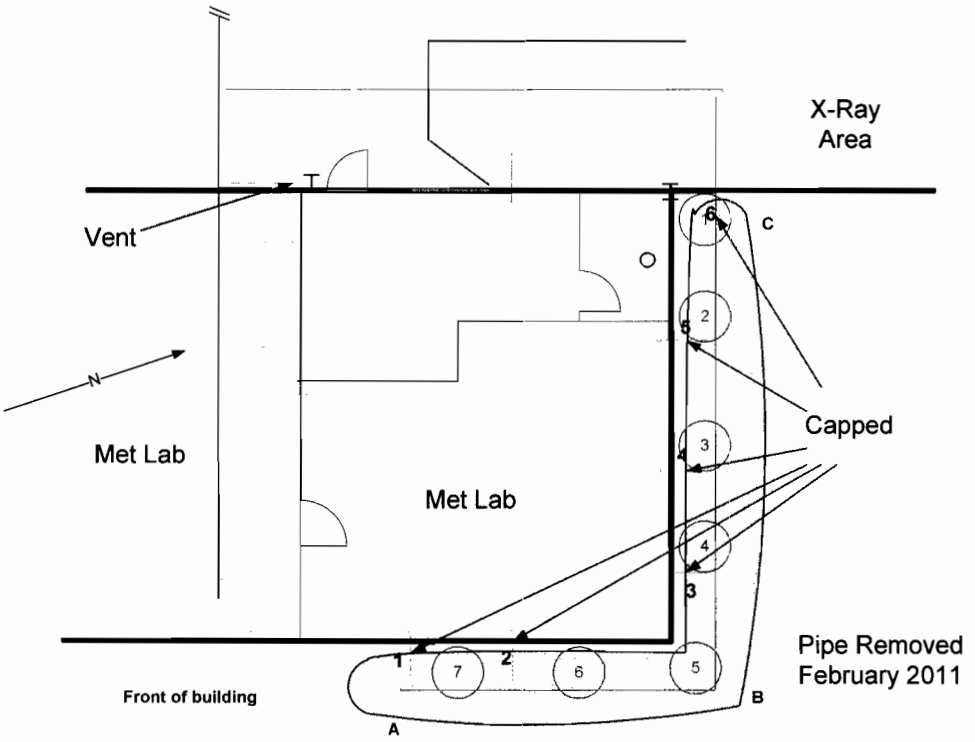


Figure 10 Location of the Seven Soil Samples (pink) and the Six Capped Lines from the Met Lab Drain Excavation

One soil composite sample, one solid sample from a short pipe, and one solid sample from a long pipe were collected on February 16, 2011. These three samples were tested for total Uranium (Table 4) and gross alpha and beta concentrations (Table 5). The composite soil sample was consistent with background radioactivity. The data for the residue inside the Long Pipe is somewhat anomalous and attributed to potential heterogeneity of the sample. Total uranium shown in Table 4 if converted to alpha activity is about 90 pCi/g, where the radioactivity analysis indicated 1.42 pCi/g. The short pipe compares favorably between total uranium and gross alpha activity.

Table 4 Total Uranium (µg/kg) for Soil and Solid Samples from Met Lab Drain Excavation

| Sample ID | Total Uranium (µg/kg) |
|---|---|
| Soil Composite | 1,000 |
| Short Pipe | 6,900 |
| Long Pipe | 47,000 |

Table 5 Gross Alpha/Beta Concentration (pCi/g) for Soil and Solid Samples from Met Lab Drain Excavation

| Field ID | Gross Alpha Concentration (pCi/g) ± 2σ | Gross Beta Concentration (pCi/g) ± 2σ |
|---|---|---|
| Soil Composite | 1.38 ± 0.55 | 1.95 ± 0.57 |
| Short Pipe | 20.8 ± 3.7 | 6.2 ± 1.3 |
| Long Pipe | 1.42 ± 0.48 | 0.73 ± 0.33 |

## 3.6 April 2011 Pellet Loading Room to S-2 Building Pipe Removal and Characterization

In April 20011 concrete sections of the floor outside the pellet loading room (PLR) were measured, cut, and removed. This area was selected for remediation/characterization because of its proximity to the uranium handling areas and was considered to be the pipe section with the highest probability of contamination or residues. Figure 7 shows the dimensions and location of the removed concrete sections. A trench was dug and sections totally about 62 feet of the PLR pipe were removed. The PLR pipe had beige debris inside with a powdery sandy-clay consistency that can be seen mostly filling the pipe in Figure 11.

Figure 11 Black PLR Pipe with Debris (left) and White Elbow Pipe with Debris (right)

Five soil samples as depicted in

Figure **12** were composited into one sample and three pipe samples were collected from the PLR trench and pipe. Gross alpha and beta analysis was performed on the samples, and the results are presented in Table 6. The UPC Soil sample was a composite of the five sampling locations indicated in Figure 12 below.

The sandy clay-like residue inside the UPC pipe (Figure 11) was tested for gross alpha/beta activity by ALS Environmental. That data is presented in Table 6 as "UPC Line Debris." Frisking surveys of the material did not indicate that the pipe fill material was contaminated. A sample of the residue was collected and sent to the Chemistry and Materials Center (CMC) for radiological and chemical analysis. The radiological analysis was performed by gamma spectroscopy. This analysis did not identify radioactive material above background levels. In addition to the radiological analysis, the sample was analyzed for its chemical constituents. Sample results indicate that the material is mostly comprised of Calcite

($CaCO_3$) and Quartz (SiO). The sample was 31 percent Calcite and 67 percent Quartz. Based on these results it has been concluded that sand was poured into the pipe at some point in the past to fill the pipe.

Table 6 Gross Alpha/Beta Concentrations (pCi/g) of Soil and Solid Samples for Area between PLR and S-2 Building

| Field ID | Gross Alpha Concentration (pCi/g) ± 2σ | Gross Beta Concentration (pCi/g) ± 2σ |
|---|---|---|
| UPC Line Debris | 260 ± 43 | 100 ± 17 |
| UPC Soil | 3.0 ± 1.2 | 2.24 ± 0.85 |
| PLR North/South Pipe | 66 ± 11 | 18.5 ± 3.3 |
| PLR East/West Pipe | 125 ± 20 | 30.7 ± 5.3 |

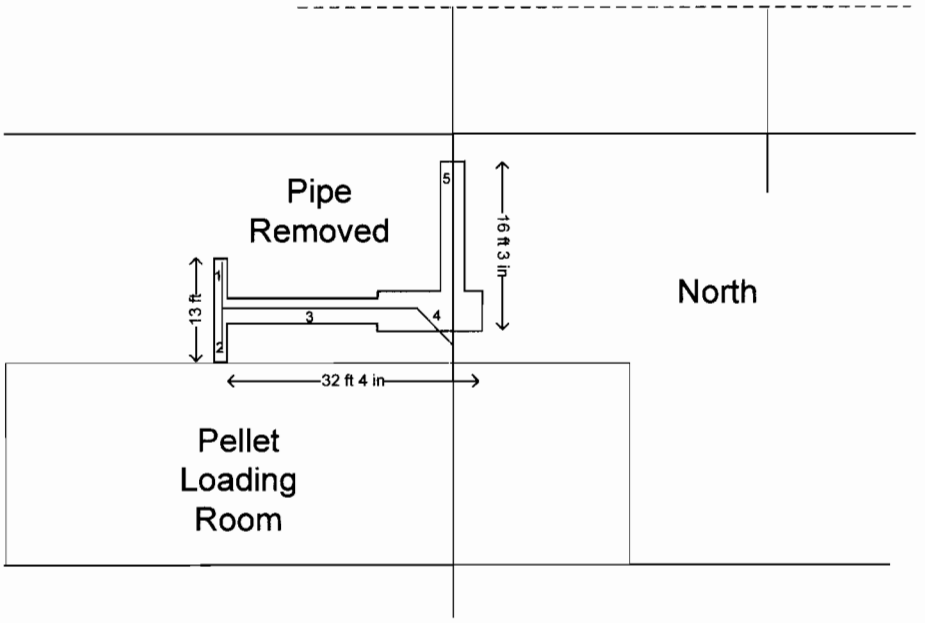


Figure 12 Pellet Loading Room to S2 area Pipe Removal and Sampling

## 3.7 April 2011 Metrology Lab to Grid Area Pipe Removal and Characterization

Concrete sections of the floor were measured, cut, and removed. Figure 13 below shows the dimensions and location of the removed pipe sections. A trench was dug (Figure 14) to expose the pipe, and sections totaling approximately 18 feet of the Met Lab pipe were removed. The east Met Lab pipe and the pipe that exited the Met Lab were clear of debris as shown in Figure 15.

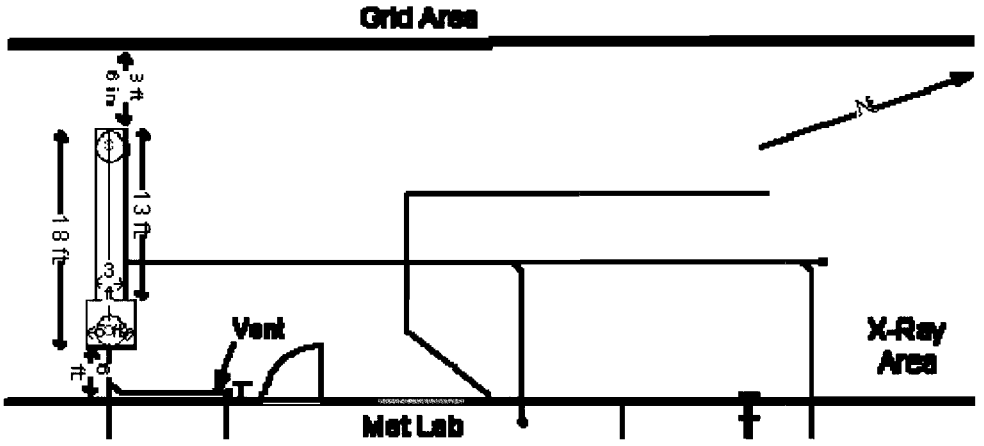


Figure 13 Met lab to Grid Area Excavation

Figure 14 Trench Dug between Metrology Lab and Grid Area after Pipe Removal

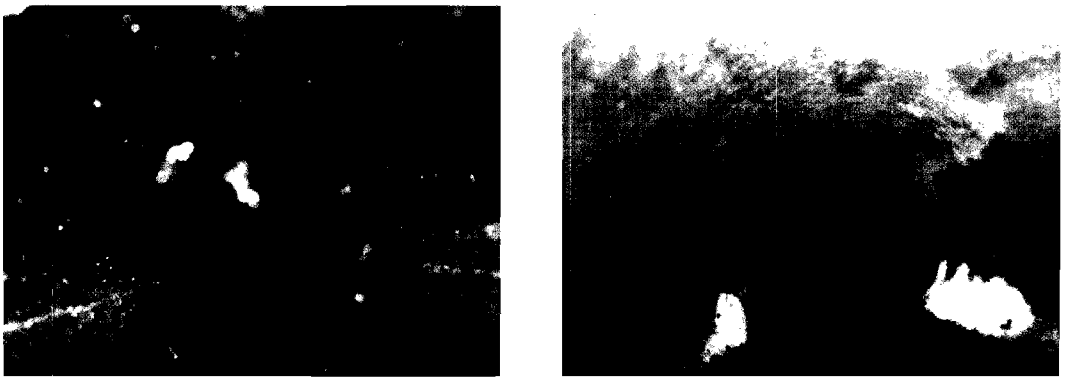

Figure 15 Met Lab Pipe Going into Met Lab (left) and the East Met Lab Pipe (right)

On April 7, 2011 one composite soil sample comprised of two samples as shown in Figure 13 and one solid sample from the Met Lab Pipe were collected. Results of the analysis are shown in Table 5. Gross alpha and beta analysis on both the soil and solid

samples are consistent with background radioactivity concentrations. The very low concentration of radioactivity in the pipe is likely due to a period of time where the line was used for laboratory water discharges effectively rinsing the line and the historic limited use of the met lab for radioactive material.

Table 7 Gross Alpha/Beta Concentrations (pCi/g) of Soil and Solid Samples for Area between Metrology Lab and Grid Area

| Field ID | Gross Alpha Concentration (pCi/g) ± 2σ | Gross Beta Concentration (pCi/g) ± 2σ |
|---|---|---|
| Met Lab Soil | 2.09 ± 0.76 | 1.68 ± 0.58 |
| Met Lab Pipe | 1.44 ± 0.53 | 0.55 ± 0.35 |

## 3.8June 2011 North Pipe Removal

The remaining pipe outside the building footprint was removed in June 2011 as shown in Figure 16 and Figure 17 following the relocation of the cylinder storage area.

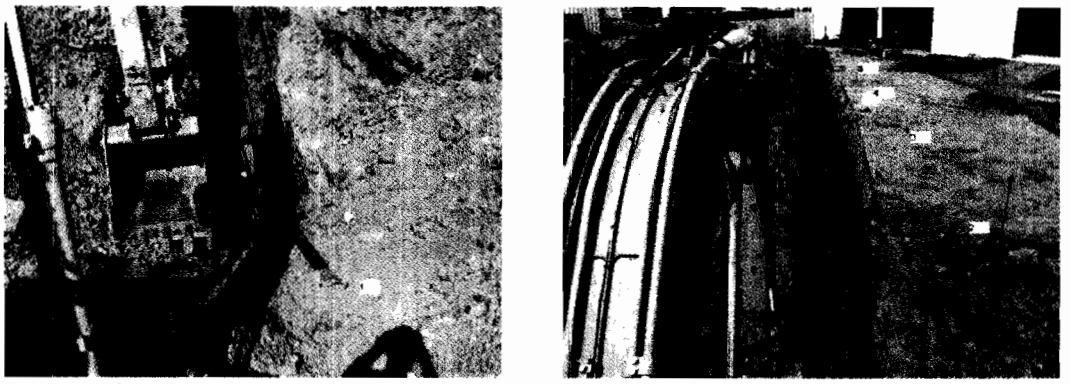

Figure 16 June 2011 North Pipe Removal Sample Locations

Figure 16 shows pictures of the excavation with some of the sample locations. A full set of pictures is saved in the decommissioning file.

Table 8 provides the sample results of the eleven soil sample collected along the pipe excavation. Sample 11 is slightly higher than background concentration levels and likely due to cross contamination from the pipe removal when water from the pipe leaked during the removal. This concentration is well below the project decision level of 30 pCi/g. The Nuclear Regulatory Commission (NRC) split sample with AREVA and one of their samples was about 90 pCi/g. The anomaly is likely due to the heterogeneity of the split sample. It was noted during a subsequent NRC inspection that the Derived Concentration Guideline Limits (DCGL) for uranium at a similar facility were calculated to be about 500 pCi/g. Although each site has specific factors that influence the DCGL, it is reasonable to expect that the actual DCGL will be greater than 30 pCi/g. Additionally, it's clear that the average concentration is much less than 30 pCi/g. No additional action is planned for this area and records will be maintained in the decommissioning file for use when the site is ultimately decommissioned at some undetermined future time.

Table 8 North Pipe Excavation Soil Sample Results

| Sample Location | Gross Alpha Concentration (pCi/g) ± 2σ | Gross Beta Concentration (pCi/g) ± 2σ |
|---|---|---|
| North Location 1 | 4.2 ± 1.3 | 2.97±0.90 |
| North Location 2 | 3.2±1.0 | 2.49±0.66 |
| North Location 3 | 3.7±1.2 | 2.93±0.82 |
| North Location 4 | 1.51±0.62 | 1.91±0.58 |
| North Location 5 | 1.99±0.81 | 2.31±0.72 |
| North Location 6 | 1.82±0.75 | 2.90±0.80 |
| North Location 7 | 3.16±0.97 | 3.33±0.80 |
| North Location 8 | 11.0±2.5 | 9.3±1.9 |
| North Location 9 | 6.3±1.6 | 5.1±1.2 |
| North Location 9 DUP | 5.3±1.4 | 5.0±1.1 |
| North Location 10 | 2.69±0.87 | 2.86±0.72 |
| North Location 11 | 19.6±3.7 | 17.9±3.1 |

| Sample | Gross Alpha Concentration (pCi/g) ± 2σ | Gross Beta Concentration (pCi/g) ± 2σ |
|---|---|---|
| Pipe Sludge 1 | 276 ± 44 | 113 ± 18 |
| Pipe Sludge 2 | 194 ± 31 | 79 ± 13 |

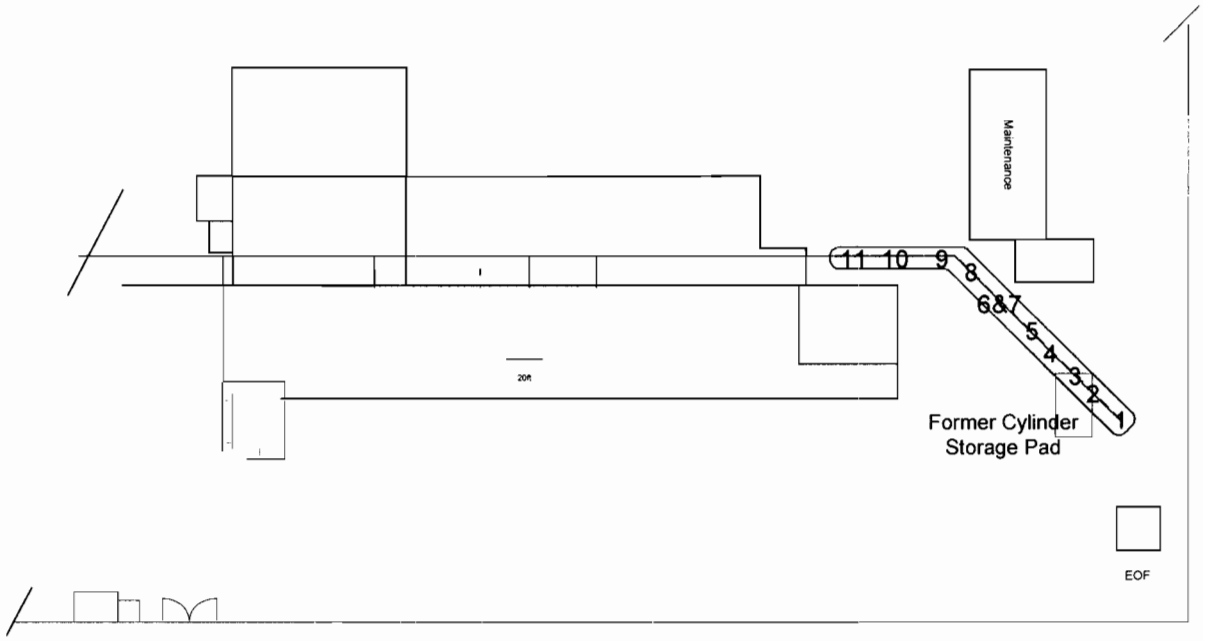


Figure 17 June 2011 North Pipe Removal and Sample Location

# 4 SNM in Remaining Pipe System

Based on the characterization of the piping system there remains detectible uranium contamination in sections of the former waste water pipe and some areas with residues containing low concentrations of residual uranium. The remaining pipe was separated into 3 units for the purpose of characterization and quantifying the residual uranium as shown in Figure 18.

## 4.1 South Plant Pipe Sections Remaining

Based on the samples and surveys from the south plant pipe and the remaining 70 foot section of the pipe, the amount of remaining uranium was calculated to be about 1 g U and 0.04 g $^{235}$U.

**Calculations:**

Pipe Sludge Sample Results:

Activity Concentration =260 pCi/g alpha (conservatively assume that all alpha activity is uranium)

Specific activity (SA) for 4% U = 2E6 pCi/g-U

Mass concentration = Activity Concentration /SA = 260pCi /g-sludge /2E6 pCi/g – U

= 1.3E-4 g-U/g-sludge

Sludge present (linear) = 10 g/inch (conservative)

Length of Pipe = 70 ft (840 in)

Total sludge = linear concentration x length = 10g/in x 840 in = 8,400 g

U = Concentration x mass of sludge = 1.3E-4g-U/g-sludge x 8,400g = **1.1 g U**

$^{235}$U = g U x 4% = **0.04 g $^{235}$U**

## 4.2 Met Lab Area Pipe Sections Remaining

Based on the samples and surveys from the Met Lab Area pipe and the remaining 145 foot section of the pipe the amount of remaining uranium was calculated to be about 0.5 g U and 0.02 g $^{235}$U.

**Calculations:**

Pipe Sludge Sample Results:

| | |
|---|---|
| Short Pipe | 6,900 µg-U/kg |
| Long Pipe | 47,000 µg-U/kg |
| Average | 26,950 µg-U/kg (0.000027g-U/g-sludge) |

Sludge present (linear) = 10 g/inch (conservative)

Length of Pipe = 145 ft (1,740 in)

Total sludge = linear concentration x length = 10g/in x 1,740 in = 17,400 g

U = Concentration x mass of sludge = 0.000027g-U/g-sludge x 17,400g = **0.5 g U**

$^{235}U$ = g U x 4% = **0.02 g $^{235}U$**

## 4.3North Plant Pipe Sections Remaining

Based on the samples and surveys from the north plant pipe and the remaining 540 foot section of the pipe the amount of remaining uranium was calculated to be about 43 g U and 2 g $^{235}U$.

Calculations:

Pipe Sludge Sample Results:

| | |
|---|---|
| Pipe Sludge 1 | 269 pCi/g |
| Pipe Sludge 2 | 276 pCi/g |
| Average | 272.5 pCi/g |

Specific activity (SA) for 4% U = 2E6 pCi/g-U

Mass concentration = Activity Concentration /SA = 272.5 pCi /g-sludge /2E6 pCi/g – U

= 1.36E-4 g-U/g-sludge

Sludge present (linear) = 12.3 g/inch

Length of Pipe = 540 ft (6,480 in)

Total sludge = linear concentration x length = 12.3g/in x 6,480 in = 79,700 g

U = Concentration x mass of sludge = 1.36E-4g-U/g-sludge x 79,700g = **10.9 g U**

$^{235}U$ = g U x 4% = **0.43 g $^{235}U$**

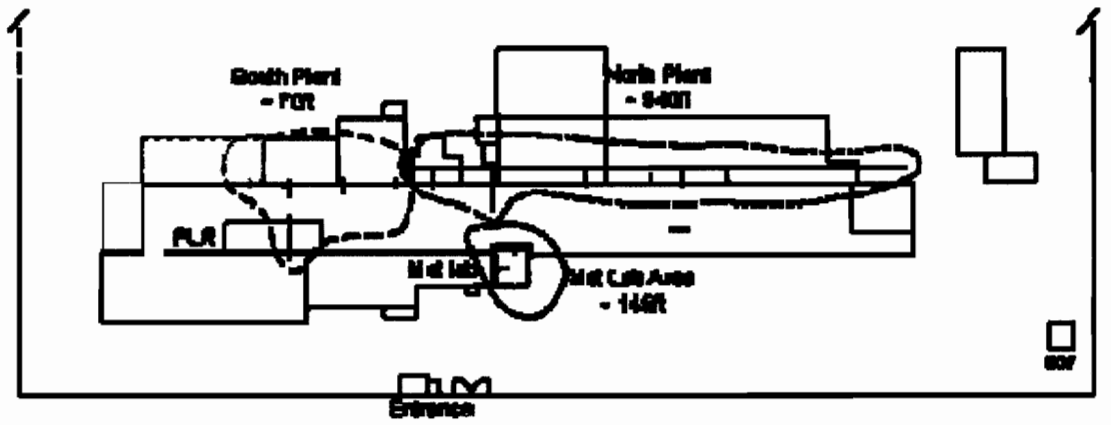


Figure 18 Pipe Areas Remaining

Summing the 3 areas, the system has about 12.5 grams of uranium and 0.5 grams of uranium-235. This value is much less than the 350g $^{235}U$ limit described in 10 CFR150 and is consistent with the by-product license authorization.

Table 9 Residual Uranium Estimation

| Pipe Section | Grams uranium | Grams $^{235}U$ |
|---|---|---|
| South Plan | 1.1 | 0.04 |
| Met Lab | 0.5 | 0.02 |
| North Plant | 10.9 | 0.43 |
| **Sum** | **12.5** | **0.5** |