

**Advanced Sampling and Analysis of Tritium Facilities,
SW-13/1B Building at Mound Plant using *TRUPRO*SM**

Amendment Report

PREPARED FOR

BWXT of OHIO, Inc

BY

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1.0 SUMMARY

The objective of the Mound Tritium Facilities Project was to deploy and evaluate a concrete sampling and profiling tool developed by *New Millennium Nuclear Technologies* (NMNT; Dallas, Texas, USA). This sampling and profiling technology was deployed by NMNT for the U.S. Department of Energy Mound Environmental Management Project (DOE-MEMP) Office and BWXT of Ohio Inc.

The DOE is in the process of D&D for many of its nuclear facilities throughout the United States. These facilities must be dismantled and the demolition waste sized into manageable pieces for handling and disposal. The facilities undergoing D&D are typically chemically and/or radiologically contaminated. To facilitate this work, DOE requires a tool capable of profiling the bulk building materials to depth. Operating requirements for the tool include simple and economical operation, the capability of operating in ambient temperatures, and must be safe for workers.

BWXT of Ohio is engaged in the closure of Mound Plant Site by 2006. Acceleration of the pace of cleanup at the site will require a program of effective and focused action - one that is paramount to a safe and economically viable site closure. Pre-demolition surveys and decontamination of contaminated facilities are of the utmost importance to allow effective segregation of concrete building rubble and for recycling of the non-contaminated concrete and steel. This document describes how NMNT can maximize the stockpile of uncontaminated recyclable concrete and steel from the demolition of Mound concrete buildings by utilizing *TRUPROSM* Profiling System Equipment (US Patent #60/371971), our patented technology for Transuranic Profiling. The results acquired in the SW-13/1B area at the DOE's Mound site using *TRUPROSM* will be compared against traditional sampling and analysis of concrete previously acquired in the same area.

NMNT's concrete sampling and profiling tools provide a superior approach to concrete or bulk material sampling and analysis when compared to traditional methods of concrete sampling using a coring machine. The specialized concrete profiling drilling technology has four major components: a drill with a specialized cutting and sampling head, hollow shank drill bits, sample collection units and a vacuum pump. The equipment in conjunction with portable radiometric instruments produces a profile of radiological or chemical contamination of the material sampled for study. The drill head is used under hammer action to penetrate hard surfaces, which causes the bulk material to be pulverized as the drill travels through the radioactive media thereby efficiently transmitting to the sampling unit a representative sample of bulk material. The profiling equipment sequentially collects all material from the hole with no secondary waste by-products. The bulk material samples are retrieved by use of a specially designed, two-stage vacuum sample retrieval unit that prevents cross contamination of the clean retrieved samples. No circulation medium is required with this profiling process; therefore, the only by-product from drilling is the sample.

There is a need to detect tritium at depth within the building material matrix in real time to allow for immediate response to contamination and increased worker safety awareness. The accepted

method for detecting tritium is Liquid Scintillation Counting (LSC) of field swipes or digestion of sub-sampled cores. This method takes place in a counting laboratory that is removed from the area of measure and often backlogged with work. This baseline methodology removes sub-sampled cores from the contamination area, which causes delays in turn-around time from minutes to hours or even days and weeks. The downtime associated with these delays reduces productivity, increases costs, and, most importantly, delays worker awareness of the area contamination.

The data quality, quantity, and representativeness may be used to produce an activity profile from the hot spot surface into the bulk building material. The activity data obtained during the profiling process is reduced and transferred to building drawings as part of a detailed report of the radiological problem. This activity profile may then be expanded to ultimately characterize the facility and expedite waste segregation and facility closure at a reduced cost and risk.

2.0 PROFILING OBJECTIVES

TRUPROSM was deployed in support of the Department of Energy (DOE) EM-50 Advanced Technology Program to accomplish subsurface concrete sampling and characterization using hammer drilling with particulate and tritium capture with profiling in depth at Mound site in Ohio. The technology had been previously demonstrated and deployed by the EM-50 D&D Large-Scale Demonstration and Deployment Project. Radioactive material characterization and remediation of various nuclear processing facilities to be decommissioned at the DOE-MEMP in Ohio was assessed for the presence of radionuclides throughout the concrete floor and subsurface matrices. By using the rapid profiling approach, activity and volume reduction of various segregated waste streams was achieved that lead ultimately to a basis for controlled disposal and release of concrete and so avoid the costs and risk associated with excavation and achieve final site closure commensurate with the site owner, stakeholder, and Nuclear Regulatory Commission (NRC) requirements. Several issues resolved by using *TRUPROSM* are as follows:

- Provides a proven procedure to characterize contaminants of concern in the slabs, sumps, trenches and subsurface soils for release by an approved waste disposal route and allows for leaving uncontaminated buildings and underground concrete and soil as an option in the overall decommissioning plan.
- Reinforces the case to leave buildings and uncontaminated concrete in place by proving material is clean at depth or proves the release case for disposal of contaminated concrete.
- Enhances the ability to decontaminate and segregate some of the high volume foundations, sump and trench backfill material and minimize the volumes of contaminated concrete to be crushed and sent to a low-level radioactive waste site.
- Provides detailed information on the extent of contamination by complementing existing surveys to determine where more surveying/sampling needs to be conducted.

- Provides a better understanding of the activity, volume and cost information needed to evaluate the amount of decontamination and handling prior to releasing any concrete which is the key to determining which decommissioning route is the most cost-effective for MEMP.
- Provides a protocol for demolition, disposal and removal of material by eliminating historical unknowns through the ability to sample inaccessible areas of the building matrix.

Profiling the concrete floor and subsurface material of SW-13/1B Building to depth included the following desired capabilities and design features of the equipment:

- Removes samples of concrete using a specialized tungsten carbide drilling technology.
- Measures contaminants of concern concentrations within and beneath building structures including sumps, bedrock, trenches and floors.
- Collects of all concrete particulate from sampling operations into specialized filter units.
- Powered by commonly available electric power.
- Removes one-inch depths of potentially contaminated concrete from predetermined sampling points sequentially from depths of one-inch to three feet.
- Produces representative samples in a powdered form for optimal counting efficiency by a portable Beta Scout LSC system or gamma spectrometer.

2.1 Advantages of *TRUPRO*SM

*TRUPRO*SM concrete sampling and profiling technology has the demonstrated ability to precisely profile and characterize concrete floors and subsurface material in SW-13/1B Building and locate, at depth in near real time, tritium contamination of consequence throughout the concrete building matrix at positions sampled.

This concrete sampling and profiling technology also produces higher quality, more representative samples than the baseline tool in less time, so that the radioanalysis is more reliable.

In addition, this concrete sampling and profiling technology has more sampling tolerance and depth resolution than the baseline tool with significantly less chance of cross contamination of samples than the wet or dry operated baseline tool.

The concrete sampling and profiling technology is also much faster at producing samples from the concrete in a form that can be analyzed within ten minutes by the calibrated for tritium Beta Scout Liquid Scintillation Counter within the sampling area.

The biggest difference between the improved concrete sampling and profiling technology and the baseline technology is the approach to sample acquisition and use of portable radioanalytical measuring equipment. *TRUPROSM* concrete sampling and profiling technology employs a heavy-duty 110V hammer action drill that rapidly penetrates the concrete surface to a precise predetermined depth. The dust generated is immediately extracted away from the specialized tungsten carbide drill bit and collected in an inline filter unit for radioanalysis. The sample is in dust form and is therefore easier to place in the correct geometry for calculation of the matrix activity. The baseline coring technology is neither as precise nor as fast as the concrete profiling technology and the core still needs to be sub-sampled in the laboratory, which is removed from the area of sampling and often backlogged with work. The current method, being removed from the contamination area, inherently causes delays in turn-around time from tens of minutes to hours. The downtime associated with these delays reduces productivity, increases costs, and most importantly, delays worker awareness of the area.

3.0 *TRUPROSM* METHODOLOGY

3.1 Sample Collection

There is a need to detect tritium at depth within the building material matrix in real time to allow for immediate response to contamination and increased worker safety awareness. The accepted method for detecting tritium is liquid scintillation counting of field swipes or digestion of sub-sampled cores. This baseline methodology takes place in a counting laboratory that is removed from the area of measure and often backlogged with work, which causes delays in turn-around time from minutes to hours or even days and weeks. The downtime associated with these delays reduces productivity, increases costs, and most importantly, delays worker awareness of the area of contamination.

By utilizing the *TRUPROSM* profiling equipment, concrete powder samples were removed from the concrete slab with a hammer action drill at 20 predetermined areas of SW-13/1B Building and 2 additional holes. The concrete profiling technology was set up to take samples of the concrete adjacent to where previous cores had been taken.

Table 1 summarizes the samples collected and analyzed. Figure 1 shows the sampling locations in building SW1B.

3.1.1 Sampling of 15 of the 20 holes

NMNT collected samples of concrete particulate from 15 of the 20 holes in one-inch increments to a total depth of 4 inches. The holes sampled were numbered 1 to 14 and number 18. In some cases it was not possible to obtain samples at 1-inch increments to a total depth of 4 inches because the drill bit went straight through a void or to the bottom of the trenches or sumps. The undersurface of the concrete slab was not at a uniform depth and varied considerably between 3 and 4.5 inches.

For holes 5 and 8, only 3 samples were collected at 1-inch increments to a total depth of 3 inches. For hole 9, the first 3 samples were collected at 1-inch increments to a total depth of 3

inches, the fourth sample was a composite sample collected at a depth of 3 to 7 inches and the fifth sample was a composite sample collected at a depth of 7 to 12 inches. For hole 12, the first 3 samples were collected at 1-inch increments to a total depth of 3 inches; the fourth sample was a composite sample collected at a depth of 3 to 8 inches. For hole 13, the first 3 samples were collected at 1-inch increments to a total depth of 3 inches; the fourth sample was a composite sample collected at a depth of 3 to 8 inches.

Since it was suspected that there might be higher tritium activity around holes 5 and 18, two additional holes, 5A and 18A, were drilled. For hole 5A, the first 3 samples were collected at 1-inch increments to a total depth of 3 inches, the fourth sample was a composite sample collected at a depth of 3 to 17 inches. For hole 18A, the first sample collected was from multiple surface points taken at a depth of 1/16 inch to obtain a representative sample. This sample was the mastic covering the concrete slab. Samples 2 to 5 were at 1-inch increments to a total depth of 4 inches.

3.1.2 Sampling of 3 Special Tritium Holes

For 3 of the 20 holes, fugitive tritium was collected in the form of tritiated water (HTO) vapor during drilling of the top 2 inches of sample. These holes were numbered 15, 16 and 17. For these 3 “Special Tritium Holes”, the top 2 inches of concrete powder were collected as one composite sample. Concrete samples were collected from the two bottom one-inch increments to a total depth of 4 inches. Fugitive HTO vapor from all of, or a known representative percentage of, the sampling pump exhaust stream was collected in two inline water traps, traps 1 and 2. A background HTO vapor collection and analysis of room air in the vicinity of Special Tritium Holes was also performed.

3.1.3 Sampling of 2 Special Deep Holes

For 2 of the 20 holes, “Special Deep Holes” numbered 19 and 20, *NMNT* collected samples of concrete or sand particulate from each hole. Initially, 17 to 20 samples were to be collected from each hole at 1-inch increments but during the sampling it was found that the undersurface of the concrete slab was not at a uniform depth.

For hole 19, eight samples were collected at 1-inch increments to a total depth of 8 inches. Sample nine was a composite sample collected at a depth of 8 to 13 inches and sample ten was a composite sample collected at a depth of 13 to 17 inches. After the 17 inches there was a metal plate so hole 19A, an offset of hole 19, was drilled. A composite sample was collected to a depth of 12 inches. It was suspected that there might be some sand so a third hole, 19C was drilled in close proximity to hole 19. Three samples were collected to a total depth of 12 inches. The first sample was a composite collected from 1 to 6 inches, the second sample was sand collected from 6 to 8 inches depth and the third sample was a composite sample at a depth of 8 to 12 inches.

For hole 20, seven samples were collected at 1-inch increments to a total depth of 7 inches. Samples 8 to 11 were composite samples collected at a depth of 8 to 13 inches, 13 to 16 inches, 16 to 18 inches and 18 to 21 inches respectively. Sample numbers 11 to 25 were taken at 1-inch increments to a total depth of 35 inches.

3.2 Sample Analysis

Samples were analyzed for tritium using a portable Liquid Scintillation Counter that was calibrated using a tritium standard. A known mass of each incremental depth dust sample was weighed out on a calibrated balance. 2 mls of distilled water and 2 mls of Instagel LSC cocktail were added to a 20 mls LSC vial and shaken thoroughly to evenly disperse the concrete dust throughout the volume of LSC cocktail. The dusts were homogeneously distributed throughout the matrix to present the best sample geometry. The dusts constituted a mass of very fine particulate minimizing self-absorption of any activity present. Each sample was placed in the counting chamber of the tritium calibrated Beta Scout and analyzed for tritium activity for 10 minutes. 0.1g to 0.25g was all that was needed for the portable liquid scintillation counter; the rest of the concrete dust was produced for the onsite laboratory to compare the activity profile results. The tritium standard was counted after every few samples to ensure that it was within the criteria. Tritium analyses on only the top 4 increments were performed. Tritium losses as HTO vapor during sampling and practicality of deep sampling of varying matrices were documented.

Gamma spectrometry was performed using a Sodium Iodide detector housed in a modular portable 3-inch walled lead shield in conjunction with gamma analysis software installed on a Dell laptop.

The activity data produced by the calibrated radiometric instruments was assessed for quality, quantity, and representativeness which were then used to produce an activity profile from the hot spot surface into the bulk building material. The activity data obtained during the profiling process was reduced and transferred to building drawings as part of a detailed report of the radiological problem. This activity profile was then expanded to ultimately characterize the facility and expedite waste segregation and facility closure at a reduced cost and risk.

There was a discrepancy between *NMNT's* and BWXTs initial tritium laboratory results. Initially *NMNT* calculated the efficiency using an unquenched tritium standard which resulted in a higher efficiency and lower tritium results. However, BWXT supplied *NMNT* with a tritiated water standard which was used to calculate the efficiency of the detectors. *NMNT* recalculated the tritium results based on the efficiency of the new calibration geometry for each of the Liquid Scintillation Detectors that was used for analysis.

3.2.1 Analysis of the 15 holes

NMNT provided tritium (H-3) analysis for the 4 one-inch sample increments for the 15 holes numbered 1 to 14, 18, 5A and 18A with the exception of holes 5 and 8 where 3 samples were analyzed. Duplicate samples were also analyzed at random. The remaining samples from the 1-inch increments were delivered to BWXTO in individual plastic containers.

3.2.2 Analysis of the 3 Special Tritium Holes

Tritium analysis was performed on the 3 concrete samples and the tritiated water collected in the traps from holes 15, 16 and 17. The tritiated water was analyzed using the LSC. A 2ml sample was taken from each trap for the analysis. The remainder of collected powder in individual plastic containers and HTO (in polymer bottles) was delivered to BWXTO for potential analysis.

3.2.3 Analysis of 2 Special Deep Holes

Tritium analysis was performed on the four 1-inch increment samples for holes 19 and 20 and the composite sample collected from hole 19C at a depth of 1 to 6 inches.

Gamma analysis was performed on various samples collected from hole 20. These were samples 5 to 19 and sample number 25. Analogues of the samples to be analyzed were prepared by adding a known amount of a 12 peak, 10-nuclide gamma source on a similar quantity of cement known to be uncontaminated. The analogues were used to calibrate the NaI detector with regards to both energy and efficiency. Bulk samples of the dust generated were accurately weighed into capped securitainers and placed directly onto the detector head.

The remaining samples were delivered to BWXTO in individual plastic containers.

4.0 RESULTS

4.1 Visual Inspection of Concrete Samples

The concrete dusts acquired in the first inch of depth of each sampling point were fine brown dusts with a small fraction of larger and blacker aggregate material. Dusts collected deeper into the concrete matrix were composed equally of both the light and dark material. Material retrieved from the trenches and sumps was fine sand and the building subsurface bedrock samples varied from a fine particulate to a fine grit and gravel due to the varying composition and density of the limestone bedrock layering. Further analysis of the average ratio of cementitious to aggregate material content of the concrete would be advisable. Tritium contamination on normalized samples whose content is predominantly aggregate material could bias the results low as there is very little diffusion of tritium into aggregate material.

4.2 Tritium Results for 15 Holes

The results in Table 2 show the tritium activity per sample analyzed the total activity per hole and the average activity per hole for samples 1 through 14, 18, 5A and 18A. Figure 2 shows the distribution of tritium at various points sampled in Room SW1B at the 1-inch depth. The general trend for most of the holes is that the highest tritium activity was in the first inch of the sample as shown in figure 3. The samples at the 4-inch depth for holes 4 and 11 and sample at 3-inch depth for hole 8 were analyzed in duplicate. The results were in agreement. For hole 12, the sample at 3 to 8 inches depth and hole 13, the sample at 3 to 12 inch depth, the results are reported as the limit of detection, which is 0.59 nCi/g. These results were below the background level in these 2 cases. The highest activity was in the mastic sample 18A.

4.3 Tritium Results for Special Tritium Holes

The results in Table 3 show the tritium activity per sample analyzed the total activity per hole and the average activity per hole. The general trend is that the highest tritium activity was in the first two 1-inch samples.

Tritium analyses on the tritium water bubblers for the bulk incremental special tritium sample holes 15, 16, and 17 are shown in Table 3A. These results indicate that significantly less tritium was found in trap 2 than trap 1 for holes 15, 16 and 17. Table 3B shows the tritium activity in the sample collected from the first 2 inches from holes 15, 16 and 17. The total activity in the solid samples and the total activity in the water were used to calculate the percent of tritium in each media as shown in Table 3C. These results show that between 14 to 28% tritium was lost to the atmosphere.

Decreased flow rate and vacuum would decrease the removal efficiency of particulate from the sampling point at depth so the traps are the optimum engineered solution to entrapment of fugitive tritium without affecting the sampling technologies performance.

However the cumulative concentration of volatilized fugitive tritium from the concrete matrix onto the internal inaccessible surfaces of the filter housing and vacuum pump, require that the off gas be scrubbed through a series of water traps to ensure containment of residual tritium from numerous sampling point operations.

4.3 Tritium Results for Special Deep Holes

The results in Table 4 show the tritium activity per sample analyzed the total activity per hole and the average activity per hole.

4.4 Gamma Spectrometry Results for Hole 20

Figure 2 shows the radionuclide gamma profile for each 1-inch increment up to 35 inches in depth. Gamma analyses of deep sample hole 20's bulk incremental inch samples from the fifth inch incremental sample to a depth of 35 inches into the subsurface bedrock of SW-13/1B Building indicate that, in general, the majority of the activity is contained in the concrete building matrix subsurface slab to 19 inches in depth.

Figure 3 shows that at the 19-inch concrete interface the total activity is reduced significantly and below the 19 inch level the predominant radionuclide is Pb-210.

5.0 Conclusions and Recommendations

Based on the samples evaluated, the following conclusions and recommendations could be made:

- There was significantly high tritium contamination within the concrete slab at the points sampled.

- Based on the bubbler results for the 3 special tritium holes where known historical tritium contamination was present, all fugitive tritium was entrapped in traps 1 and 2 of the bubbler system ensuring no release of fugitive tritium to the working area.
- A more detailed and extensive sampling and analysis regime is needed to prove adjacent areas and subsurface bedrock is free of tritium contamination or contaminants of concern.
- The concrete sampling and profiling technology produced higher quality, more representative samples than the baseline tool in less time, so that the radioanalysis was more reliable.
- Confidence is greatly increased in radiological safety and in D&D operations by having a more resolute understanding of previous historical unknowns.
- The concrete sampling and profiling technology in conjunction with the Beta Scout LSC and gamma spectrometer reduced, by orders of magnitude, the downtime associated with sample analysis delays. Thus, the improved technology increases productivity, decreases costs, and most importantly, significantly improves worker awareness of the area for a safe and concerned radiation worker.
- The sampling and profiling technology can be used in the acquisition of samples to prove that a bulk building material is clear for free release or reuse in real time, that bulk building material waste streams can be radiologically fingerprinted to depth and so enhance the ability to decontaminate the material more efficiently and effectively and thus segregate radwaste streams saving considerable time and money.
- Sampling and profiling to depths of more than 40 inches at this site was relatively straightforward and can be used in the acquisition of incremental samples to prove that building subsurface material is clear for free release or reuse in real time, saving considerable time and money and enhancing D&D strategy.

Table 1: Summary of Samples Collected and Analyzed

Sample Number	Depth (in)	Analysis	Sample Number	Depth (in)	Analysis	Sample Number	Depth (in)	Analysis
1/1	1	Tritium	10/3	3	Tritium	20/7	7	Gamma
2/1	1	Tritium	10/4	4	Tritium	20/8	8 to 13	Gamma
2/2	2	Tritium	11/1	1	Tritium	20/9	13 to 16	Gamma
2/3	3	Tritium	11/2	2	Tritium	20/10	16 to 18	Gamma
2/4	4	Tritium	11/3	3	Tritium	20/11	21	Gamma
3/1	1	Tritium	11/4	4	Tritium	20/12	22	Gamma
3/2	2	Tritium	12/1	1	Tritium	20/13	23	Gamma
3/3	3	Tritium	12/2	2	Tritium	20/14	24	Gamma
3/4	4	Tritium	12/3	3	Tritium	20/15	25	Gamma
4/1	1	Tritium	12/4	3 to 8	Tritium	20/16	26	Gamma
4/2	2	Tritium	13/1	1	Tritium	20/17	27	Gamma
4/3	3	Tritium	13/2	2	Tritium	20/18	28	Gamma
4/4	4	Tritium	13/3	3	Tritium	20/19	29	Gamma
5/1	1	Tritium	13/4	3 to 10	Tritium	20/20	30	NA
5/2	2	Tritium	14/1	1	Tritium	20/21	31	NA
5/3	3	Tritium	14/2	2	Tritium	20/22	32	NA
5A/1	1	Tritium	14/3	3	Tritium	20/23	33	NA
5A/2	2	Tritium	14/4	4	Tritium	20/24	34	NA
5A/3	3	Tritium	18/1	1	Tritium	20/25	35	Gamma
5A/4	3 to 17	Tritium	18/2	2	Tritium	19A/1	1 to 12	NA
6/1	1	Tritium	18/3	3	Tritium	15/1	2	Tritium
6/2	2	Tritium	18/4	4	Tritium	15/2	3	Tritium
6/3	3	Tritium	19/1	1	Tritium	15/3	4	Tritium
6/4	4	Tritium	19/2	2	Tritium	16/1	2	Tritium
7/1	1	Tritium	19/3	3	Tritium	16/2	3	Tritium
7/2	2	Tritium	19/4	4	Tritium	16/3	4	Tritium
7/3	3	Tritium	19/5	5	NA	17/1	2	Tritium
7/4	4	Tritium	19/6	6	NA	17/2	3	Tritium
8/1	1	Tritium	19/7	7	NA	17/3	4	Tritium
8/2	2	Tritium	19/8	8	NA	18A/1	mastic	Tritium
8/3	3	Tritium	19/9	8 to 13	NA	18A/2	1	Tritium
9/1	1	Tritium	19/10	13 to 17	NA	18A/3	2	Tritium
9/2	2	Tritium	20/1	1	Tritium	18A/4	3	Tritium
9/3	3	Tritium	20/2	2	Tritium	18A/5	4	Tritium
9/4	3 to 7	Tritium	20/3	3	Tritium	19C/1	1 to 6	Tritium
9/5	7 to 12	Tritium	20/4	4	Tritium	19C/2	sand	NA
10/1	1	Tritium	20/5	5	Gamma	19C/3	8 to 12	NA
10/2	2	Tritium	20/6	6	Gamma			
Tritiated Water Samples								
Background	3000 ml	Tritium	16/1 trap 1	2900	Tritium	17/1 trap 1	3000	Tritium
15/1 trap 1	2400	Tritium	16/2 trap 2	2900	Tritium	17/2 trap 2	2900	Tritium
15/2 trap 2	3400	Tritium						

Table 2: Tritium Results for the 15 Holes

Hole Number	Depth (in)	nCi/g	Total nCi/g per hole	Average nCi/g per hole
1	1	149.020	363.186	90.797
1	2	63.221		
1	3	60.378		
1	4	90.567		
2	1	38.610	171.910	42.978
2	2	38.133		
2	3	63.556		
2	4	31.611		
3	1	117.578	242.226	60.557
3	2	57.200		
3	3	43.615		
3	4	23.833		
4	1	123.139	244.081	56.633
4	2	56.406		
4	3	25.876		
4	4	21.110		
4 duplicate	4	17.550		
5	1	156.619	257.152	85.717
5	2	48.100		
5	3	52.433		
5A	1	53.820	186.627	46.657
5A	2	57.576		
5A	3	74.646		
5A	4	0.585		
6	1	57.953	121.174	30.294
6	2	15.805		
6	3	24.837		
6	4	22.579		

Table 2 Cont.

Hole Number	Depth (in)	nCi/g	Total nCi/g per hole	Average nCi/g per hole
7	1	57.881	114.830	28.708
7	2	21.450		
7	3	16.683		
7	4	18.816		
8	1	95.330	167.696	55.899
8	2	26.455		
8	3	45.911		
8 duplicate	3	49.335		
9	1	45.045	168.345	33.669
9	2	90.767		
9	3	18.590		
9	3 to 7	3.218		
9	7 to 12	10.725		
10	1	129.415	220.233	55.058
10	2	38.133		
10	3	29.353		
10	4	23.332		
11	1	158.500	256.190	64.048
11	2	19.890		
11	3	31.836		
11	4	45.964		
11 duplicate	4	39.287		
12	1	45.283	187.656	62.552
12	2	59.583		
12	3	82.790		
12	3 to 8	<0.59		
13	1	87.389	124.013	41.338
13	2	20.735		
13	3	15.889		
13	3 to 12	<0.59		
14	1	185.083	275.879	68.970
14	2	40.040		
14	3	15.210		
14	4	35.546		

Table 2 Cont.

Hole Number	Depth (in)	nCi/g	Total nCi/g per hole	Average nCi/g per hole
18	1	425.425	626.203	156.551
18	2	62.468		
18	3	69.995		
18	4	68.490		
18A (mastic)	(1/16)	1305.851	2362.025	472.405
18A	1	418.582		
18A	2	243.100		
18A	3	298.155		
18A	4	96.337		

Table 3: Special Tritium Holes Results

Hole Number	Depth (in)	nCi/g	Total nCi/g per hole	Average nCi/g per hole
15	2	203.605	510.549	170.183
15	3	128.057		
15	4	178.374		
16	2	181.935	357.519	119.173
16	3	151.989		
16	3 to 6	23.595		
17	2	385.348	845.57	281.856
17	3	298.155		
17	4	162.067		

Table 3A: Tritium in Bubbler System

Hole No.	Trap No.	Time (Sec)	Total Volume (l)	Total tritium (nCi)
15/1	trap 1	44	2.4	173.807
15/2	trap 2	44	3.4	49.245
16/1	trap 1	31	2.9	546.044
16/2	trap 2	31	2.9	21.002
17/1	trap 1	65	3.0	912.488
17/2	trap 2	65	2.9	63.005
Background	NA	600	3.0	43.452

Table 3B: Total Tritium Collected (powder) in the first 2 inch Sample

Hole No.	Total sample (g)	HTO loss to air (nCi/g)	Sample Activity (nCi/g)
15	6.55	34.054	203.605
16	7.76	73.073	181.935
17	8.63	111.273	385.348

Table 3C: Percent Tritium in Soil and Bubbler

Hole No.	Total tritium in Solids and Water (nCi/g)	% Tritium loss	% in Solids
15	237.659	14.329	85.671
16	255.008	28.655	71.345
17	496.621	22.406	77.594

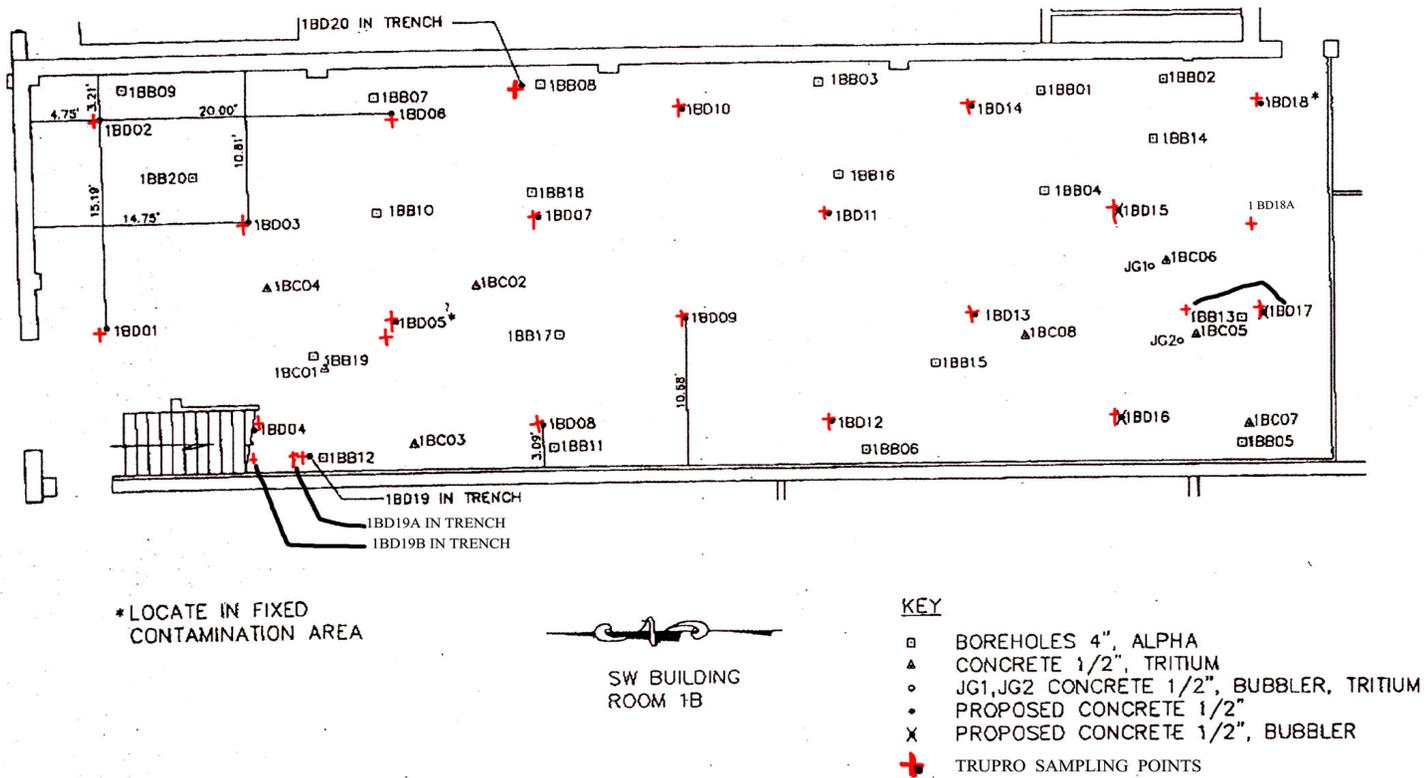
Table 4: Tritium Results of the 2 Deep Holes

Hole Number	Depth (in)	nCi/g	Total nCi/g per hole	Average nCi/g per hole
19	1	85.586	215.083	53.771
19	2	42.471		
19	3	39.836		
19	4	47.190		
19C	1 to 6	164.450	164.450	164.450
20	1	40.040	448.117	112.029
20	2	31.460		
20	3	29.804		
20	4	346.813		

Table 5: Gamma Activity with Depth of the Concrete Slab of SW-13/1B for Hole Number 20

Area	Nuclide	Am-241	Pb-210	Bi-207	U-235	Cs-137	Ra-226	Bi-214	Ac-228	TOTAL
Sample ID	Depth (in)	Activity (pCi/g)								
20-5	5	1.122E+02	2.548E+03	2.648E+02	4.870E+02	1.805E+02	8.017E+03	5.318E+02	6.896E+02	1.283E+04
20-6	6	9.46E+01	7.57E+03	1.09E+02	2.34E+02	8.44E+01	3.85E+03	2.18E+02	4.76E+02	1.263E+04
20-7	7	8.90E+01	7.09E+03	4.81E+01	9.41E+01	4.27E+01	1.55E+03	9.64E+01	2.20E+02	9.231E+03
20-8	8	8.459E+03	5.738E+04	2.279E+04	4.178E+04	1.880E+04	6.878E+05	4.581E+04	8.715E+04	9.700E+05
20-9	14	2.560E+02	1.965E+03	5.902E+02	1.281E+03	4.358E+02	2.109E+04	1.186E+03	2.287E+03	2.909E+04
20-10	17	1.612E+02	3.704E+03	3.534E+02	8.049E+02	2.829E+02	1.325E+04	7.100E+02	1.423E+03	2.069E+04
20-11	19	8.298E+01	-3.010E+01	3.084E+02	4.202E+02	2.561E+02	6.917E+03	6.195E+02	1.092E+03	9.667E+03
20-12	22	1.700E+02	1.510E+04	1.017E+02	1.842E+02	8.793E+01	3.032E+03	2.036E+02	4.143E+02	1.929E+04
20-13	23	1.700E+02	1.510E+04	1.017E+02	1.842E+02	8.793E+01	3.032E+03	2.036E+02	4.143E+02	1.929E+04
20-14	24	1.084E+02	5.138E+03	1.188E+02	2.751E+02	7.942E+01	4.529E+03	2.384E+02	4.755E+02	1.096E+04
20-15	25	3.619E+01	2.200E+03	4.645E+01	1.028E+02	3.679E+01	1.692E+03	9.299E+01	1.787E+02	4.386E+03
20-16	26	3.619E+01	2.200E+03	4.645E+01	1.028E+02	3.679E+01	1.692E+03	9.299E+01	1.787E+02	4.386E+03
20-17	27	5.945E+01	6.526E+03	2.661E+01	3.713E+01	2.302E+01	6.112E+02	5.313E+01	9.570E+01	7.432E+03
20-18	28	7.992E+00	9.779E+02	7.118E+00	1.374E+01	7.935E+00	2.262E+02	1.395E+01	2.983E+01	1.285E+03
20-19	29	1.219E+01	2.328E+03	1.174E+01	2.612E+01	1.146E+01	4.299E+02	2.324E+01	4.520E+01	2.888E+03
20-25	35	9.000E+01	7.307E+03	3.486E+01	5.827E+01	3.552E+01	9.592E+02	6.970E+01	1.490E+02	8.703E+03
LOD (pCi/g)		9.07E-02	1.59E+00	2.68E-02	4.48E-02	2.55E-02	7.37E-01	5.39E-02	8.59E-02	

Figure 1: TRUPROSM Sampling Locations Within Room 1B of The SW Building



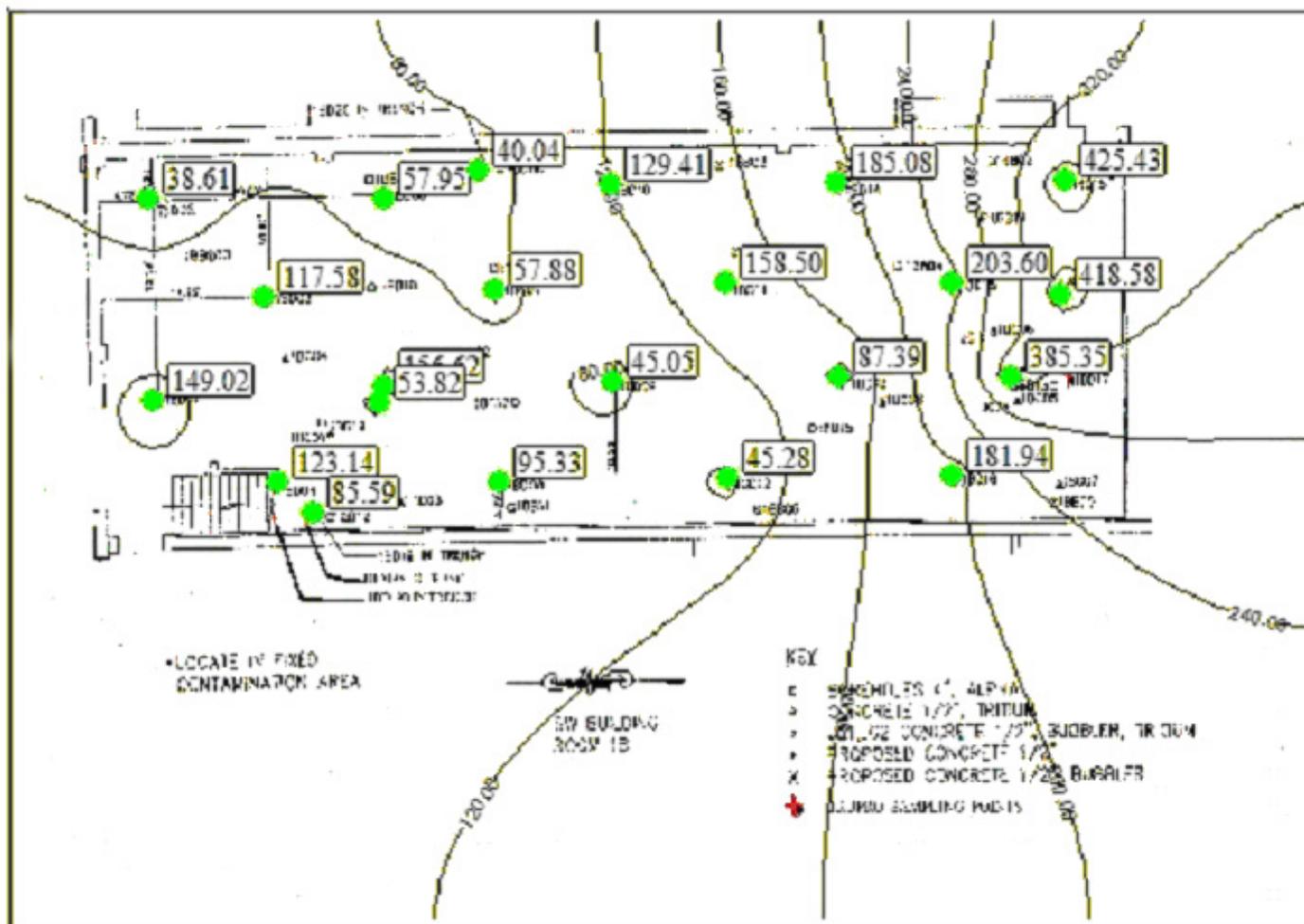
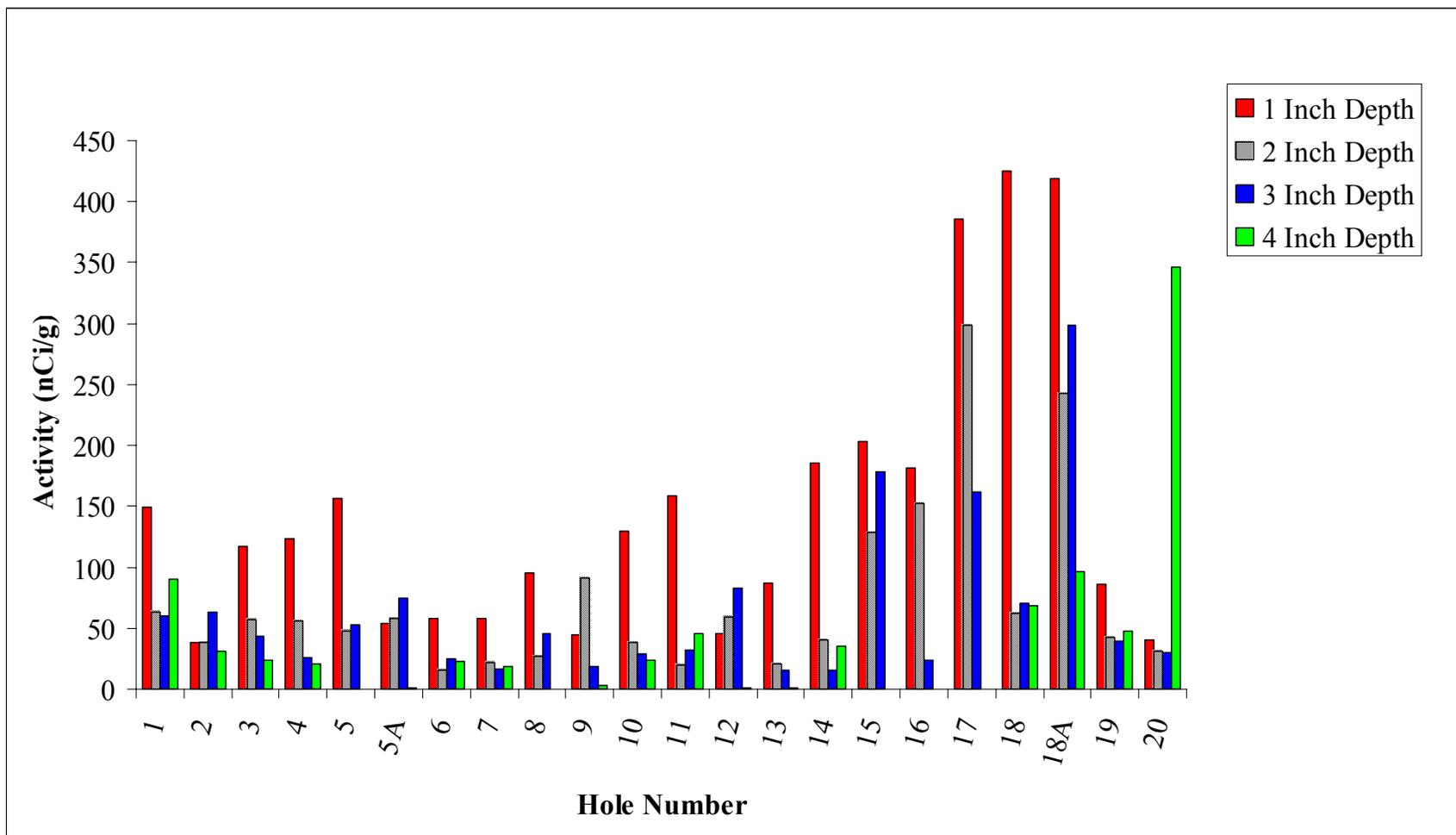


Figure 2: One inch Depth Tritium Activity (nCi/g) Distribution

Figure 3: Tritium Activity in Relation to Hole Number and Depth



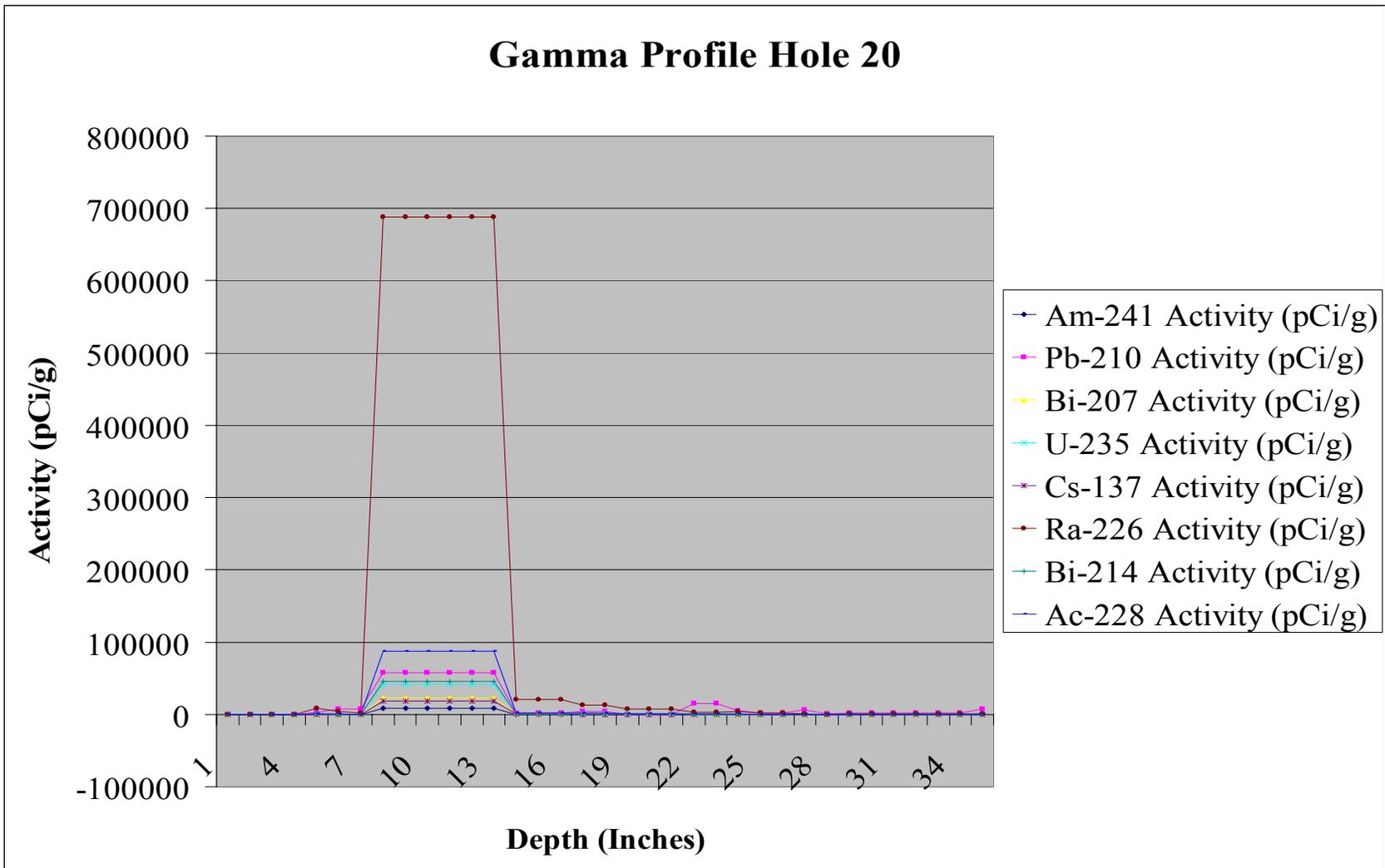


Figure 4: Hole 20 Gamma Activity Profile from 5 in. to 35-in. Depth

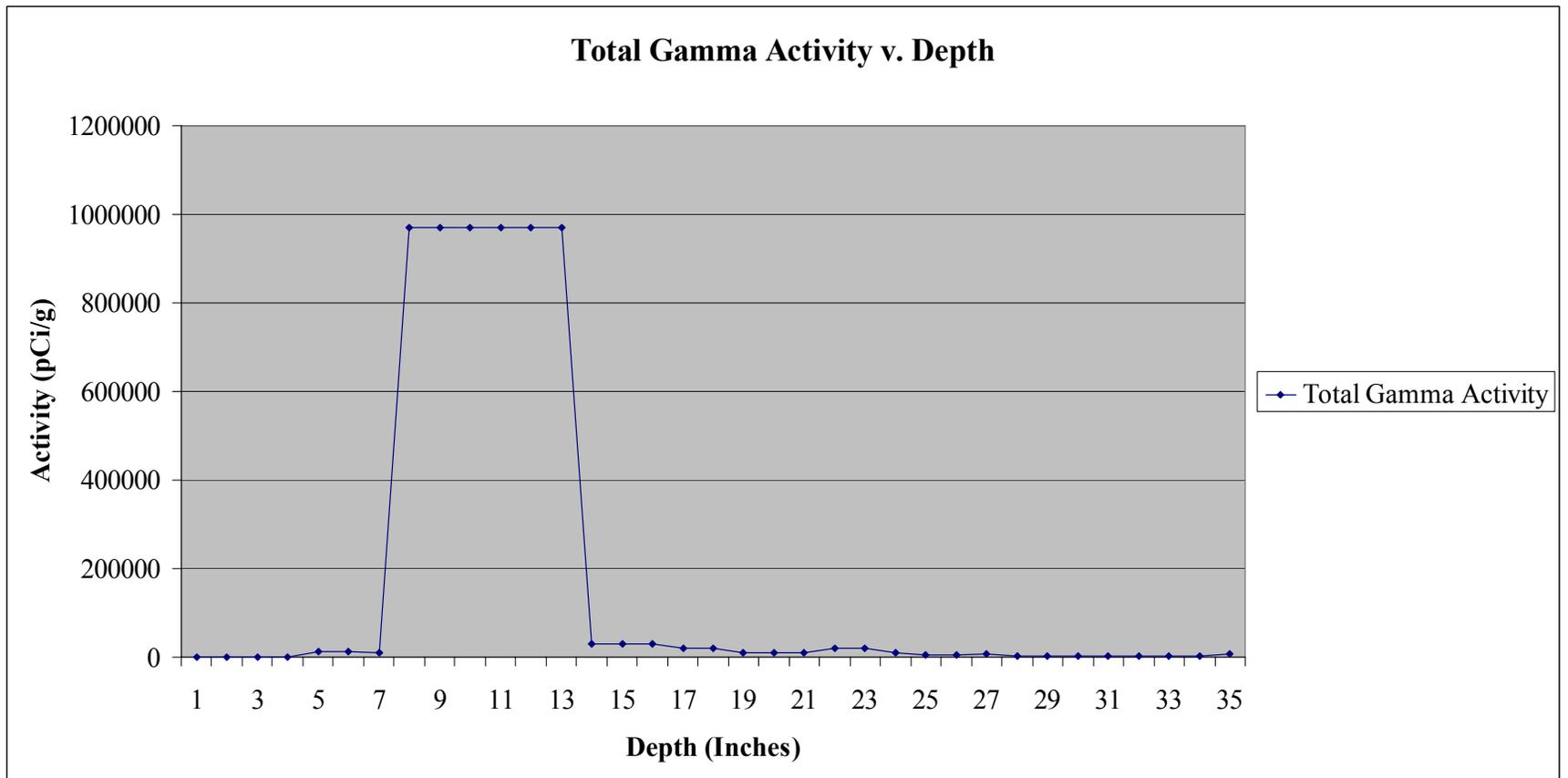


Figure 5: Hole 20 Total Gamma Activity Profile from 5 in. to 35-in. Depth