APPENDIX 1

RADON TESTING DETAILS

URS-39400093.20201

Facility Radon Testing Plan for CWM Buildings in Model City, NY

prepared for

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by

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1. Introduction

This report presents a Facility Radon Testing Plan to characterize indoor radon (Rn-222) levels in buildings at the CWM Chemical Services, LLC (CWM) facility in Model City, New York. The report summarizes properties of individual buildings to be tested, including their occupancy, uses, size, and the numbers and types of radon samples required to characterize their indoor radon levels.

1.1 Background and Purpose

The CWM Site, located at 1550 Balmer Road in Model City, NY, lies on the boundary between the towns of Lewiston and Porter in Niagara County in Western New York. The site contains the Model City Treatment, Storage, and Disposal Facility (TSDF), which is permitted (EPA ID No. NYD049836679) for liquid, solid, and semi-solid organic and inorganic hazardous waste and industrial non-hazardous waste. The TSDF includes an aqueous wastewater treatment system and facilities for waste stabilization, secure landfilling, and storage and disposal of wastes under the Resource Conservation and Recovery Act (RCRA) and Toxic Substances Control Act (TSCA). The TSDF operations date back to 1971.

Before commercial TSDF operations, the Site was owned by the U.S. Government (early 1940s through the mid 1960s). The Site constituted part of the Lake Ontario Ordinance Works, which conducted explosives/propellant research, detonation of explosives, and research and waste storage related to the Manhattan Project. Although extensive remedial actions at the site have since removed residual radiological contaminants from the previous U.S. Government activities, CWM has agreed to conduct additional radiological characterization of the site to assure protection of human health and the environment.

The state permit under which CWM operates its Model City facility requires that CWM conduct a Building Interior Survey to investigate radon levels inside all facility buildings [Part 373 Permit, Module II – Corrective Action Requirements, (J)(1)(b)]. This report constitutes the Facility Radon Testing Plan to fulfill the radon investigation requirements of the Building Interior Survey.

1.2 Technical Approach and Scope

This Facility Radon Testing Plan evaluates current radon measurement technologies to select the radon testing duration and method that are best suited to determining the radon levels in CWM buildings. Technical guidance is also reviewed for selecting the optimal sampler placement, density, and sensitivity. The buildings at the CWM Site are then identified and characterized for selecting those that should be tested for indoor radon levels. The last section of the Plan proposes the radon sampler configuration, placement methods and locations, retrieval, and data analysis.

The technical approach proposed in this Facility Radon Testing Plan is consistent with U.S. Environmental Protection Agency (EPA) guidance for indoor radon characterization,[1,2] including that aimed at schools and other large buildings,[3,4] and with EPA measurement device protocols.[5] It is also based on general[6] and specific[7] guidance from the New York State Department of Health (DOH), which recommended the sampling density and indicated that the radon tests need not be performed on garden-storage-type sheds or office trailers on blocks.

2. Radon Measurement Methods

Technical guidance from EPA and other agencies helps define the best sampling duration, radon measurement method, sampling locations, sampling density, and sensitivity requirements. This section summarizes the guidance and recommends the best radon testing parameters for the CWM Site.

2.1 Radon Sampling Time and Duration

The time period over which radon should be sampled depends on the purpose of the sampling. Indoor radon levels vary naturally from, hour to hour, day to day, and season to season, depending on the succession of changes in building ventilation, weather, and other factors. For diagnosing radon responses to heating, ventilating, and air conditioning (HVAC) cycles, grab samples or continuous radon monitors are best because they can detect radon variations on the same time scale as the HVAC cycles. For rapidly screening building radon levels for a real estate transaction, 2- to 4-day charcoal canister samplers, short-term electrets, or similar integrating devices are often best because they average over diurnal, HVAC, and occupancy cycles but give a rapid enough result for decisions about a sale. For determining low-level radon risks or the need for building remediation, long-term tests are best because they average over cycles in building operations, weather, and possibly seasons.

Radon is generally measured in units of its concentration in air (pico-Curies of radon per Liter of air, or pCi/L), or less-commonly by the concentration of its decay products (working levels, or WL). The threshold for recommending remedial actions to reduce indoor radon levels is 4 pCi/L, averaged over a one-year period,[1-2] and the same threshold is applied to schools and other large buildings.[3-4] Short-term follow-up testing is recommended by EPA for homes over 8 pCi/L to reduce health risks to occupants.[1] Without administrative or risk-related urgency, however, EPA recommends long-term (annual-average) testing because it demonstrates more accurately whether a home is above or below the 4 pCi/L threshold, particularly if it is close (i.e., 4.1 pCi/L vs. 3.9 pCi/L).

Radon testing at the CWM Site is recommended to occur over an approximate 4-month period beginning in October, 2005. This recommendation is based on the lack of any evidence of risk-related urgency for completing the tests, the precision and accuracy advantages of averaging over a relatively long period, and the worst-case nature of testing during the winter months in New York. Indoor radon levels are expected to be highest during the winter because of reduced ventilation through windows and other sources of outdoor air. Outdoor radon levels are normally about 0.4 pCi/L, compared to average US indoor levels of about 1.3 pCi/L.[1]

The recommended 4-month period may be shortened or extended for the convenience of CWM Site operations. Longer sampling periods, up to a year, are more representative of the annual-average conditions in CWM buildings; however they could expose the samplers to greater risk of loss or damage. Shorter sampling periods, as little as 3 months, are still conservative in representing mostly winter months; however, they are slightly less representative of an annual cycle. Sampling intervals of 3 months or less are deemed short-term by EPA, and are subject to closed-building sampling conditions,[1] which could potentially constrain building operations. Furthermore, short-term tests have a higher probability of requiring follow-up testing to determine whether the annual-average level is actually above or below the 4 pCi/L threshold.

2.2 Radon Test Method

The alpha track method was selected for measuring the indoor radon levels at the CWM Site. It was selected from the 15 different radon measurement methods recognized by EPA[5] based on its capability for long-term integrated measurements, its minimal interference by radiation from other (non-radon) sources, and its robustness in the industrial environment.

The 15 radon test methods recognized by EPA include four grab-sampling methods (GS, GC, GB, and GW) that are limited to very-short-term sampling; two continuous methods (CR and CW) that focus on repetitive measurements over minute- to hour-time scales; five sampling methods (ES, AC, LS, SC, and PB) that are limited to short-term sampling periods up to several days; and one method (RP) that integrates over longer time periods but is more costly than passive long-term sampling methods. The remaining three methods AT, UT, and EL were considered in greater detail because they potentially offer cost-competitive, long-term integrated radon measurements.

The Alpha Track (AT) method uses a piece of plastic or film in a small container to register alpha-particle damage tracks from radon and its decay products. The container entrance is covered by a filter to reject entry of outside radon decay products and other alpha emitters. At the end of testing, the container is re-sealed for return to the laboratory for analysis. Analysis consists of etching the plastic or film detector to enhance the damage tracks and then counting the tracks in a pre-determined area using a microscope or optical reader. The radon concentration is calculated from the number of tracks per unit area using empirical calibrations. Typical exposure times are 3 to 12 months.

Unfiltered Track detectors (UT) use a similar plastic or film to register alpha particle damage tracks, but the UT detectors lack the entrance filter to remove external radon decay products and other alpha emitters. While processed and calibrated similarly to AT detectors, the UT detectors have a greater dependence on the equilibrium ratio between radon concentrations and decay-product concentrations. EPA currently recommends that UT detectors not be used when equilibrium fractions are less than 0.35 or greater than 0.60 unless calibration factors are specially adjusted. Because of the unknown equilibrium states in the industrial settings of the CWM Site, the use of UT detectors was rejected.

Long-term electret ion chambers (EL) utilize an electrostatically-charged disk detector (electret) situated in a small container (ion chamber). During the measurement period, radon diffuses through a filter-covered opening in the chamber and causes, along with its decay products, a decreased voltage charge on the electret. A calibration factor relates the measured voltage drop to the radon concentration. Specially-designed electrets are suitable for long-term measurements over 1- to 12-month periods.

URS's experience suggests that electret samplers are less robust for an industrial environment such as the CWM Site than alpha track detectors because of the sensitivity of electrets to other types of radiation (beta and gamma) that could potentially occur unpredictably at the CWM Site from variations in natural background and from proximity to materials with slightly-elevated levels of naturally-occurring radioactive materials. The Alpha Track detectors are therefore recommended as the method of choice for the CWM Site radon testing.

2.3 Radon Sampling Density

Radon samplers will be deployed at an approximate density of one sampler for every 2,000 square feet of area in each building. This density corresponds to that recommended by the New York Department of Health for schools and other large buildings,[6] and was applied to each building to determine its minimum

number of samplers. A minimum of one sampler was applied to small buildings with less than 2,000 square feet.

The sampling density criteria are applied to all CWM Site buildings, even including those that are not frequently occupied. Although sampling of seldom-occupied buildings exceeds the New York guidance for schools,[6] it is consistent with CWM's Part 573 New York Permit, which requires radon testing of all site buildings. The only buildings excluded from radon testing are those such as garden storage sheds or office trailers that have no foundations but are set on concrete blocks or similar supports. The New York Department of Health has concurred with this exclusion.[7]

2.4 Location of Radon Samplers

General guidance for selecting locations to deploy any kind of radon sampler in any type of building is given by both New York DOH[6] and EPA.[5] Their guidance is generally consistent. New York DOH indicates that testing should include all frequently occupied spaces that are in contact with the ground or directly above crawl spaces or unoccupied basements. Based on the occupancy consideration, the samplers allocated for a building should be placed in the most commonly-occupied area(s) if the building has multiple work areas.

The following location criteria are summarized from the EPA and New York DOH guidance, which seeks to locate the samplers in the breathing zone of a residential environment:

Location Guidelines for Radon Samplers

- Near the interior of the room (at least 1 foot from walls)
- Between 2 feet and 8 feet above the floor
- Away from drafts (HVAC vents, doors, windows)

Figure 1. Location Guidelines for Radon Samplers.

Additional criteria, such as avoiding heat sources, water sources, direct sunlight, and high humidity, are aimed at charcoal canister samplers whose efficiency changes with temperature and humidity. They are not included above because temperature and humidity changes are relatively unimportant for alpha track detectors.

The deployment location should provide adequate space for undisturbed hosting of the sampler throughout the sampling interval. They may be placed on file cabinets, exposed shelves, or similar surfaces, but should not become covered by papers or other objects that could hinder the diffusion of radon to the sampler entrance. They may also be suspended by a durable string tied to an overlying support. They are sufficiently robust that small bumps will not affect their performance.

The above location guidelines are adapted to the CWM Site to accomplish the sampling objective: to obtain radon measurements that are representative of the occupants' breathing zone. For example, vented laboratory hoods and associated air inlets will also be avoided as though they were HVAC vents. In a few buildings that are highly ventilated by outdoor air for temperature or other engineering controls, avoiding ventilation drafts is neither possible nor necessary unless they also contain less-ventilated areas that are also occupied. Other adaptations may also be made as required to implement the radon testing plan.

Exceptions to the above guidelines will be noted at the time of sampler deployment and/or collection for inclusion in the radon measurement report.

Experience has shown that long-term radon samplers are least-disturbed when accompanied with an explanatory note about their purpose and retrieval time frame. The alpha track detectors will be deployed with an accompanying, visible notice that is designed to not cover any sampler openings. The text of the notice will be similar to the following example (Figure 2).

Long-Term Radon Sampler

This sampler measures radon, as required by CWM's Part 373 New York Permit.
Please do not disturb it. It will be retrieved by approximately February, 2006.
Contact Stephen Rydzyk (754-0325) regarding removal, obstruction, alteration, damage, or misuse.

Figure 2. Explanatory Label to be Attached to Radon Samplers.

2.5 Radon Sampler Analysis and Sensitivity

The alpha track radon samplers will be retrieved and returned for laboratory analysis according to the supplier's directions. The samplers will be deployed for sufficient time and analyzed over sufficient area that they are capable of detecting radon concentrations at least as low as 0.4 pCi/L, which is the approximate outdoor radon concentration quoted by EPA.[1] The specification quoted by Landauer Inc. for their standard sensitivity alpha track radon sampler is 30 pCi/L days based on a 90-day exposure. This corresponds to a detection limit of approximately 0.33 pCi/L, or for a 120-day exposure, approximately 0.25 pCi/L.

3. CWM Building Characterization

All buildings at the CWM Site were identified by the CWM Site engineer, who also provided information on the building sizes and foundation/construction categories. The list of buildings was analyzed and used to select the radon sampling density for each building.

Table 1 lists the buildings in which radon testing will be performed. The list does not include garden storage sheds or office trailers that have no foundations but are set on concrete blocks or similar supports because they do not require radon sampling.[7]

As suggested by New York guidance for indoor air sampling,[8] a pre-sampling characterization inspection was performed for each building in Tables 1 and 2. The inspection was intended to identify features or conditions that could affect or interfere with radon testing. It was performed on September 13-14, 2005 by Stephen Rydzyk (CWM Site Engineer, Model City, NY), Bryan Pell (URS Corporation, Buffalo, NY), and Kirk Nielson (URS Corporation, Salt Lake City, UT).

Mr. Rydzyk, who had previously generated the list of buildings, areas, and foundation properties, took the URS staff to each building, explained its operations, and estimated its typical occupancy rate. Mr. Pell checked the exterior and interior gamma radiation levels for each building using a gamma radiation MicroR Meter (Model 12S, Ludlum Measurements, Inc., Sweetwater, TX). The calibration sheet for the meter is shown in Appendix A. The presence or absence of significant indoor radon sources was estimated from any potential excess of indoor gamma radiation compared to exterior background radiation. Dr. Nielson visually assessed the building leakage potential from cracks and openings, and took photographs of prospective locations for deploying the radon samplers.

In addition to the building identity, Table 1 lists estimates by the CWM Site engineer of the building size (square feet), foundation level (above grade or below grade), floor level (above grade or below grade) and material (wood or concrete), and crawl space (yes or no). The other columns in Table 1 list information determined for the buildings during the pre-sampling inspection, as described in the next section.

Table 1. CWM Site Buildings, Properties, and Sample Locations.

Bld	Building Name	Area[a]	Fnd.[b]	Floor[c]		CS[d]	Src[e]	Vnt[f]	Occ[g]	OG[h]	IG[i]	Smp[j]	Samp. Loc.[k]
1	Guardhouse	150	BG	AG	Conc	N	N	L	2	2	4.5	1	shelf by phone
2	Scalehouse	720	BG	AG	Wood	Y	N	T	1	5	5	2	over cabinets
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	3	NE Cabinets
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	4	NW Cabinets
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	5	Lunch Rm
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	6	SE Conf Rm
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	7	SW Conf Rm
4	Administration Building	11,760	BG	AG	Wood	Y	N	T	30	2	2	8	Velma Office
5	SLF 7/11 Leachate Collection Building	550	BG	BG	Conc	N	N	M	0	4	2	9	tank support post
6	SLF 7 Lift Station Building	170	BG	BG	Conc	N	N	M	0	4	4	10	on control box
7	SLF 10 Leachate Collection Building	550	BG	BG	Conc	N	N	M	0	3	3	11	tank support post
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	12	SW ramp wall
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	13	S Rm SE Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	14	S Rm 3rd E Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	15	W end N Rm Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	16	N Rm Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	17	N Rm 2nd E Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	30	18	N Rm 2nd N Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	19	Office wall
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	20	S Rm W 1 Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	21	S Rm W 2 Pillar
8	PCB Warehouse	22,500	BG	AG	Conc	N	U	L	0.2	5	5	22	N Entr Rm W end
9	GWES South of PCB Warehouse	225	BG	AG	Conc	N	N	T	0	3	3	23	On control box
12	Old Scalehouse Building	900	BG	AG	Conc	N	N	T	0	2	3	24	File cabinet
13	Transportation Garage	4,200	BG	AG	Conc	N	N	L	0	3	3	25	by Drill Press
14	Old Truckwash Building	1,120	BG	AG	Conc	N	N	L	0	3	3	26	Light on left
15	Emergency Response Garage/Safety Room	2,460	BG	AG	Conc	N	N	L	0.4	3	3	27	On railing
15	Emergency Response Garage/Safety Room	2,460	BG	AG	Conc	N	N	L	0.4	3	3	28	Shelf or table

Bld	Building Name	Area[a]	Fnd.[b]	Floor[c]		CS[d]	Src[e]	Vnt[f]	Occ[g]	OG[h]	IG[i]	Smp[j]	Samp. Loc.[k]
17	Laboratory	4,200	BG	AG	Conc	N	N	T	5	3	3	29	West Lab, over shelves
17	Laboratory	4,200	BG	AG	Conc	N	N	T	5	3	3	30	East lab, over book shelves
19	Block Bldg North of Lab	72	BG	AG	Conc	N	N	M	0	2		31	
20	Maintenance Building	1,428	BG	AG	Conc	N	N	M	2	3	3	32	on Locker
21	Maintenance Pump Repair Building	910	BG	AG	Conc	N	N	L	1	3	3	33	Inner room, front of shelf
22	Transformer Operations Building	2,200	BG	AG	Conc	N	N	M	0.2	3	3	34	On post bracket
23	Storage Building North of TO Bldg	240	BG	AG	Conc	N	N	M	0	3	3	35	
24	Boiler Room North American	525	BG	AG	Conc	N	N	M	0.2	3	3	36	On control box
25	Boiler Room Clever Brooks	490	BG	AG	Conc	N	N	L	0.2	3	3	37	On control box
26	Main Compressor Room	294	BG	AG	Conc	N	N	V	0	3	3	38	On electrical box
27	Joy Air Compressor Room/Storgae Room	490	BG	AG	Conc	N	N	L	0	3	3	39	Shelf front
28	Training/Lunch Rooms	2,220	BG	AG	Conc	N	N	T	2	4	4	40	Lunch Rm on vending machine
28	Training/Lunch Rooms	2,220	BG	AG	Conc	N	N	T	2	4	4	41	
29	Water Treatment Building (WWT)	1,250	BG	AG	Conc	N	N	L	1	3	3	42	On valve
31	Electrical Building across from WWT	252	BG	AG	Conc	N	N	M	0	3	6	43	On control panel
32	A/T Building	6,000	BG	AG	Conc	N	N	M	1	5	5	44	On control panel
32	A/T Building	6,000	BG	AG	Conc	N	N	M	1	5	5	45	Foreman office file cabinet
32	A/T Building	6,000	BG	AG	Conc	N	N	M	24	5	5	46	On pillar
32	A/T Building	6,000	BG	AG	Conc	N	N	M	24	5	5	47	Control Panel
32	A/T Building	6,000	BG	AG	Conc	N	N	M	24	5	5	48	Process area pillar
33	Clarifier Building	510	BG	AG	Conc	N	N	T	0	3	3	49	On power box
39	Block Building West of A/T	200	BG	AG	Conc	N	N	L	0	3	3	50	On control box
40	Arc Furnace Building	2,500	BG	AG	Conc	N	N	L	0	3	3	51	
41	T-8001 Collection Building	400	BG	BG	Conc	N	N	V	0	3	3	52	On control box
42	SLF 3 GWES Building	170	BG	AG	Conc	N	N	L	0	3	3	53	On control box
43	Building North of Lagoons	170	BG	AG	Conc	N	N	L	0	3	3	54	On control box
44	BW02s GWES Building	224	AG	AG	Conc	N	N	M	0	3	3	55	On tank/pipe
45	SLF 12 GWES Building	224	AG	AG	Conc	N	N	L	0	3	3	56	On tank/pipe
46	SLF 12 Lift Station	572	BG	BG	Conc	N	N	L	0	3	3	57	On tank or rails

Bld	Building Name	Area[a]	Fnd.[b]	Floor[c]		CS[d]	Src[e]	Vnt[f]	Occ[g]	OG[h]	IG[i]	Smp[j]	Samp. Loc.[k]
47	RMU-1 O/W Seperator Building	3,300	BG	BG	Conc	N	N	M	0	3	3	58	On scaffold
47	RMU-1 O/W Seperator Building	3,300	BG	BG	Conc	N	N	M	0	3	3	59	On scaffold
48	RMU-1 Lift Station	270	BG	BG	Conc	N	N	M	0	4	4	60	on Tank
49	Pump Shed in Leachate Tank Farm	168	AG	AG	Conc	N	N	M	0	3	3	61	On pipe
50	Block Bldg West of Leachate Tank Farm	72	BG	AG	Conc	N	N	L	0	3	3	62	On control box
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	63	Lab on control box
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	64	Office on file cabinet
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	65	On drum puncture unit
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	66	On center string
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	67	Far wall
51	Drum Warehouse	24,030	BG	AG	Conc	N	U	L	9	3	3	68	Right wall
54	Fire Water Tank Block Building	440	BG	AG	Conc	N	N	L	0	3	3	69	On wall box
55	Heavy Equipment Garage/Offices	7,200	BG	AG	Conc	N	N	L	3	2	2	70	On south wall beam
55	Heavy Equipment Garage/Offices	7,200	BG	AG	Conc	N	N	L	3	2	2	71	On north wall cabinet
55	Heavy Equipment Garage/Offices	7,200	BG	AG	Conc	N	N	L	3	2	2	72	Upstairs shelf front
55	Heavy Equipment Garage/Offices	7,200	BG	AG	Conc	N	N	L	3	2	2	73	Office shelf
56	Stabilization Facility Northern Expansion	9,375	BG	AG	Conc	N	N	V	4	3	3	74	Therm Box
56	Stabilization Facility Northern Expansion	9,375	BG	AG	Conc	N	N	V	4	3	3	75	N Conduit
56	Stabilization Facility Northern Expansion	9,375	BG	AG	Conc	N	N	V	4	3	3	76	West wall
56	Stabilization Facility Northern Expansion	9,375	BG	AG	Conc	N	N	V	4	3	3	77	South railing
57	Stabilization Facility Macro/SCTR Areas	14,775	BG	BG	Conc	N	U	L	3	2	2	78	Power Box
57	Stabilization Facility Macro/SCTR Areas	14,775	BG	BG	Conc	N	U	L	3	2	2	79	Center post
57	Stabilization Facility Macro/SCTR Areas	14,775	BG	BG	Conc	N	U	L	3	2	2	80	Downstairs office shelf front
57	Stabilization Facility Macro/SCTR Areas	14,775	BG	BG	Conc	N	U	L	3	2	2	81	Upstairs kitchen
57	Stabilization Facility Macro/SCTR Areas	14,775	BG	BG	Conc	N	U	L	3	2	20	82	East wall box
65	SLF 1-6 Pretreat Building	441	BG	AG	Conc	N	N	L	0	3	3	83	Elec box right
66	SLF 1-6 Lift Station	624	BG	BG	Conc	N	N	M	0	3	3	84	On railing
67	SLF 1-6 Control Room Building	60	BG	AG	Conc	N	N	T	0	3	3	85	Cabinet wall
69	SLF 1-11 O/W Separator Building	1,010	BG	BG	Conc	N	N	M	0	3	3	86	Power box

Bld	Building Name	Area[a]	Fnd.[b]	Floor[c]		CS[d]	Src[e]	Vnt[f]	Occ[g]	OG[h]	IG[i]	Smp[j]	Samp. Loc.[k]
70	Water Inlet Building	300	BG	AG	Conc	N	N	T	0	5	5	87	On valve
72	Locker Building	3,000	BG	AG	Conc	N	N	T	40	5	3	88	Locker top
72	Locker Building	3,000	BG	AG	Conc	N	N	T	40	5	3	89	Threshold top
73	SLF 1-6 Electrical Block Building	100	BG	AG	Conc	N	N	M	0	3	3	90	Far wall panel

[a] Building floor area (square feet).
[b] Building foundation (AG = above grade; BG = below grade).
[c] Building floor (AG = above grade; BG = below grade; Conc = concrete floor; Wood = wood floor).
[d] Building has a crawl space? (Y = yes; N = no).
[e] Potential radon sources observed in the building? (Y = yes; N = no; U = undetermined).
[f] Building Ventilation (T = tight, < 0.5 ach; M = medium, ~1 ach; L = leaky, > 2 ach; V = mechanically ventilated).
[g] Building occupancy (person hours per day; 0 indicates less than 1 hour/week).
[h] Outdoor gamma radiation exposure rate (uR/hour).
[i] Indoor gamma radiation exposure rate (uR/hour).
[j] Proposed radon sample number.
[k] Proposed radon sample location.

4. Radon Testing Plan and Data Analysis

The following radon testing plan summarizes the procedures that will be followed for determining the radon levels in the buildings at the CWM Site. The plan addresses the configuration of the radon samplers, how and where they are deployed, how they are retrieved, and how their analytical data will be evaluated.

4.1 Sampler Configuration

Radon samplers are to be obtained from Landauer Inc., Glenwood, IL, and will consist of their Radtrak, standard sensitivity (30 pCi/L days), thoron-filtered samplers. The samplers are provided in cylindrical containers of a few centimeters diameter, as illustrated in Figure 2. The cylinders are closed on all surfaces except the top face (as illustrated), which contains nine holes that allow radon gas to diffuse into the container. The explanatory notice (Figure 2) will be attached to the samplers by taping around the curved surface of the sampler and attaching to the notice at both ends of the tape, as illustrated in Figure 4.

Figure 3. Illustration of a Radtrak Radon Sampler Provided by Landauer Inc.

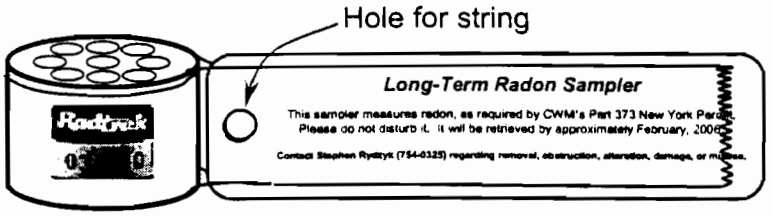

Figure 4. Attachment of the Notice to the Radtrak Radon Sampler.

4.2 Sampler Placement

A total of 90 radon samplers will be placed in the 52 buildings identified by the first column of Table 1. The samplers, identified sequentially by the location numbers in the next-to-last column in Table 1, will be placed in the locations described by the last column in Table 1 or in a suitable alternative determined at the time of sampler deployment. A Detector Log, furnished by Landauer Inc. or a similar one prepared by the URS sampling technician, will be used to record the sampler deployment details (Figure 5).

RADON TEST DETECTOR LOG

Company
Address

Landauer, Inc.
2 Science Road
Glenwood, IL 60425-1586

Phone
Contact
Account #

Detector Number	Starting Date			Ending Date			Detector Location/Comments
	Mo	Day	Yr	Mo	Day	Yr	

Return original copy with detectors. Retain copy for your records.

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Figure 5. Example of a Landauer Radon Test Detector Log.

The deployment of each radon sampler will involve the following procedure. The sampling technician will (a) open the mylar shipping bag for one detector; (b) tape the detector to a notice tag; (c) record the sampler ID number (from the sampler) on the Detector Log; (d) record the starting date on the detector log; (e) record the location number and description on the Detector Log; (f) place the tagged detector in its sampling location; and (g) retain the opened detector bag and the detector seal for use upon sampler retrieval. If the detector is to be hung from an overlying support, rather than placed on a horizontal surface, the sampling technician will punch a hole in the notice tag, attach a string to the tag, and hang the detector in the desired location as part of step (f). The detector may also be attached to a surface with tape as long as the sampler inlet holes are not covered. The location description will indicate which samplers are hung and any other pertinent description of the deployment conditions.

In addition to deploying samples in each of the 90 locations listed in Table 1, nine field duplicate samples (10 % of the number of sampling locations) will be deployed alongside their counterparts (generally within about 15 cm). Each field duplicate sample will be entered on the Detector Log as a separate sample from its mate, and its identity will be described in terms of an offset distance from its predecessor. The sample should not be directly identified as a field duplicate; but should be identifiable to the sampling technician and data analyst from the building number, location number, and offset distance.

Five field blank samples (5 % of the number of sampling locations) will be retained sealed in their original shipping bags and not deployed. The five sealed bags will be stored in a clean environment along with the opened bags from the 99 samplers that were deployed.

Site personnel will make occasional inspections of the sampling sites to verify that the detectors are undisturbed from their intended locations and are not covered by papers or otherwise obstructed by materials that could limit their access to the building atmosphere.

4.3 Sampler Retrieval

At the end of the sampling period, approximately 4 months after sampler deployment, each sampler will be retrieved. Sampler retrieval from each of the 90 locations will consist of (a) verifying from the Detector Log (Figure 5) that the correct sampler number is being retrieved; (b) removing the notice tag from the detector and removing any loose dust or dirt from the entrance face of the detector; (c) removing the round seal from the detector bag and affixing it to the detector's entrance face; (d) record the retrieval date and any additional comments on the Detector Log; (e) seal the detector into its mylar shipping bag according to Landauer instructions; and (f) accumulate all other detectors being retrieved and shipping them, with a copy of the Detector Log, to Landauer for analysis.

Each of the five field-blank samples will be prepared for return by (a) opening its bag, (b) affixing the round seal to the detector face; (c) entering the retrieval date and a location description on the Detector Log; (d) entering a deployment date on the detector log that corresponds to the dates of deployment of the other 99 detectors; (e) entering fictitious building and location numbers on the detector log (locations 100 through 104); (f) re-sealing the detector into its mylar shipping bag according to Landauer instructions; and (g) combining the field blank detectors with the other retrieved samples for shipment to Landauer for laboratory analysis. The location names, numbers, and descriptions used for the five field blank samples should be logged in URS records such that the sampling technician and data analyst will recognize them as field blanks, but so that the laboratory will not know from the Detector Log that they are field blanks.

4.4 Radon Data Analysis

The radon concentrations reported by Landauer from their analysis of each of the 104 samplers returned to them will be reported as required by the CWM Part 373 Permit. Results (in pCi/L) for each of the 90 sampling locations will be reported in tabular format as they are listed above in Table 1. The results from the 14 quality assurance samples will be analyzed to determine the average agreement with duplicate analyses and the average field blank radon concentration on the unexposed detectors.

The 9 field duplicate samples will be compared with their counterparts to compute a coefficient of variation (*COV*) as[5]:

$$COV_i = 100 \frac{\sqrt{2(R_i - R_{d,i})^2}}{R_i + R_{d,i}}$$

where COV_i = coefficient of variation for pair i (%),
R_i = measured radon level (pCi/L), and
$R_{d,i}$ = duplicate radon measurement (pCi./L).

A precision of $COV_i < 10\%$ for measured radon levels above 4 pCi/L indicates satisfactory performance, with somewhat greater variations expected for lower levels because of the smaller number of tracks on which the lower levels are based.

The 5 field blank values will be directly averaged to determine the magnitude of any systematic blank value that should be considered for subtraction from all of the 99 other measurements. Ideally, the five field blank values, or at least their mean, should be near zero.

5. Literature References

(1) U.S. Environmental Protection Agency, A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon, Washington DC: US EPA Indoor Environments Division, *EPA 402-K-02-006*, May 2004.

(2) U.S. Environmental Protection Agency, Technical Support Document for the 1992 Citizen's Guide to Radon, Washington DC: US EPA, *EPA 400-R-92-011*, May 1992.

(3) U.S. Environmental Protection Agency, Building Air Quality: A Guide for Building Owners and Facility Managers, Washington DC: US EPA, *EPA 402-F-91-102*, December 1991.

(4) U.S. Environmental Protection Agency, Radon in Schools (2nd Ed.), Washington DC: US EPA, *EPA 402-F-94-009*, October 1994.

(5) U.S. Environmental Protection Agency, Indoor Radon and Radon Decay Product Measurement Device Protocols, Washington DC: US EPA, EPA Office of Air and Radiation, *EPA 402-R-92-004*, July 1992.

(6) New York State Education Department and Department of Health, Guidance for Radon Measurement in Schools and Large Buildings, November 2003.

(7) Gavitt, Stephen M., CWM Building Survey, NY Department of Health memo to Jill Banaszak, September 14, 2005.

(8) New York State Department of Health, Indoor Air Sampling and Analysis Guidance, Division of Environmental Health Assessment, Center for Environmental Health, February 1, 2005.

Appendix A

Gamma Radiation Meter Calibration

INSTRUMENT CALIBRATION

CAL# 11377
Prev. 9894

health physics instruments
330 D South Kellogg Ave, Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY:	EQUIPMENT NO.	DATE:
URS		September 23, 2004
MFG.:	**MODEL:**	**DATE DUE:**
Ludlum	12S	September 23, 2005
SERIAL NUMBER:	**BATTERIES:**	**DETECTOR:**
11095	Two D cell	N/A

CALIBRATION DATA :

Source	Type	Cal Constant		Due Date	Source	Type	Cal Constant		Due Date
CS1:	CS137		mR/h @ 1 m	5/05	S:	Ra-226	1.929	mR/h @ 1 m	5/05
CS2:	CS137		mR/h @ 1 m	5/05	W:	Ra-226	0.128	mR/h @ 1 m	5/05
CS1-1:	CS137		mR/h @ 1 m	5/05	N1:	Cf252		mrem/h@ 1 m	Assay 1/91
CS1-2:	CS137		mR/h @ 1 m	5/05	N2:	Cf252		mrem/h@ 1 m	Assay 1/99
CS1-3:	CS137		mR/h @ 1 m	5/05	Pulser:	Model: MP2	Serial No.:	001	7/05

Source	Distance	Exposure	Scale Readings					
	cm	µR/h	X 1000	X 100	X 10	X 1		
W	25.2	2000	2,000					
	46.2	600	700					
	80.0	200		200				
	146.0	60		70				
	292.1	15			13			
	461.8	6			6			
		Background			4	O/S		

BAROMETER mmHg:	TEMPERATURE °C	AM 241
761	27	Yes

COMMENTS:

CPM ranges set electronically. Background subtracted from all readings. ( ) indicates reading as found. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☑ Instrument OK

CALIBRATION BY: RON GODDEN	DATE	CHECKED BY: JOHN S. HANOLOSER, JR.	DATE
Ron Godden	9-27-04	JSH	9-27-04

HPI FORM ZACFORM 2/96