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Commissioner

Interim Report on the Radon Investigation at the Niagara Landfill

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March 20, 1996

Introduction

The Niagara Landfill is located in the Town of Tonawanda, Erie County (Figure 1). The landfill is no longer accepting waste and is being prepared for closure. As part of closure operations, 6 NYCRR Part 360 requires a landfill gas venting system to be installed. This venting system will direct the methane and other gases produced in the landfill to be pumped into either a flare or a small power plant where the methane will be mixed with air and burned to produce electricity. At present, the system is venting passively to the atmosphere.

The Niagara Landfill is one of the four properties designated as the Tonawanda Site by the United States Department of Energy (DOE) for purposes of consideration in the DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). The landfill contains about 117,000 cubic yards of contaminated soil containing among other radionuclides, radium-226 (Ra-226). Concerns have been raised about the radon produced by the decay of the Ra-226 and its effect on the concentration of radon released from the landfill through the venting system. This report provides a summary of the sampling done to date by the Bureau of Pesticides & Radiation in addressing this concern.

Background

History of Site

The site was an operating landfill in 1978 when Part 360 went into effect. Niagara Landfill, a subsidiary of Browning-Ferris Industries (BFI), operated the facility under NYSDEC Permit No. 9-1464-00147/00001-0. The land itself is owned by Seaway Industrial Development, Inc. The landfill ceased accepting waste in 1993. The site is comprised of approximately 100 acres located in an industrialized area in northwestern Tonawanda, New York. In 1974, uranium ore residues processed during Manhattan Engineering District (MED) project were excavated from the Ashland 1 Site, which is adjacent to the Niagara Landfill, and relocated onto the Niagara Landfill Site in three areas identified as Sites A, B, and C (See Figure 2). Area A is the largest, covering about 10 acres. A fourth area, Area D, also contains MED waste. It is continuous with an area of contamination on the Ashland 1 site.

FUSRAP Material at the Niagara Landfill

The DOE has estimated that there are 91,100 cubic yards of FUSRAP material in areas A and D and another 25,900 cubic yards of FUSRAP material in areas B and C. At some point in time, the 2 acres in Areas B and C were covered with about 20 - 40 feet of refuse.

The United States Department of Energy has performed a remedial investigation on these sites. The Table below summarizes the results of radiological sampling of the contaminated areas. (*Remedial Investigation Report For The Tonawanda Site*, Volume 1, Figure 7-4).

Radionuclide	Min Conc pCi/g	Max Conc pCi/g	Ave Conc pCi/g	Std Dev pCi/g
U-238	0.8	52.0	9.5	8.1
Ra-226	0.4	72.0	5.2	8.6
Th-232	0.4	21.0	1.5	1.7
Th-230	0.3	880.0	83.8	163.8

Gas Extraction System

To control methane concentrations in the landfill and to control odors, DEC's regulations require that the gasses generated in the landfill be vented. Major closure requirements

applicable to the Niagara Landfill gas extraction system are found in 6 NYCRR Part 360 Solid Waste Management Facilities:

> Subdivision 360-2.15(e) Landfill gas control. Landfill gas control systems must be designed to prevent the migration of concentrated amounts of landfill gases off-site. Gas venting systems are necessary for all landfills upon closure and must be designed and constructed in accordance with the requirements of subsection 360-2.13(p) of this Subpart. These systems must prevent the accumulation of gas at greater than 25 percent of the lower explosive limit in structures on-site and off-site; prevent damage to vegetation both on the final cover and off-site; and control objectionable odors due to any gas emissions.
>
> Paragraph 360-2.13(p)(1) Materials required. Gas venting layers must consist of venting pipes with risers installed within the gas venting layer.
>
> Subdivision 360-2.15(g) Gas Control using flares. All gas control systems which utilize flares must be designed in accordance with any applicable requirements of Parts 201 and 212 of this Title.

BFI had originally designed the gas extraction system to cover the entire landfill. At DEC's recommendation, BFI deleted from the original plans four wells that would have been located near the contaminated soil. Thus, none of the wells in the gas extraction system collect gas directly from the FUSRAP material. Increasing the distance between the FUSRAP waste and the gas collection wells increases the time it takes the radon to reach the wells. This causes more radon to decay in the waste before reaching the well.

Sampling Plan

The Niagara Landfill has 34 methane extraction wells. In order to estimate the potential radon release from the landfill, a plan was developed for sampling the radon at the well head of 6 wells. The wells were selected such that 3 wells were near FUSRAP material (wells 15, 24 and 35) and 3 wells were further away from FUSRAP material (wells 4, 10 and 21). The attached map (Figure 3) shows the location of each of the 34 gas wells, with the 6 sampled wells marked.

Each well head has a sample port. At present, each well head is venting directly to the atmosphere. On February 7, 1996, one day prior to sampling, the open vent on each of the 6 wells to be sampled was capped and the methane was directed to the gas

collection system (still under natural pressure only). This was done to ensure that samples taken would contain only landfill gas, with no mixing with clean air.

To take a sample, first the sample port was connected to the input port of the Lucas cell. Then a 5 liter/minute air pump was connected to the output port of the Lucas cell. Air was pumped from the sample port into the Lucas cell to the air pump to the outside air. This was done for five minutes to flush all of the clean air out of the Lucas cell and replace it with landfill gas.

After sampling, the Lucas cells were returned to Albany for analysis. A minimum of four hours between sampling and analysis is required to allow for equilibration. Since the travel time from Buffalo to Albany is about 6 hours, this was not a problem. In Albany, on February 8, 1996, each Lucas cell was analyzed for radon concentration. The Lucas cells were then sent to the Bureau's contract lab, Thermo NUtech, by overnight mail for a second analysis.

Results of Analysis

Each of the samples was analyzed by both the Bureau and the contract lab. The following table gives the analysis results of both (decay corrected to the time the gasses were extracted from the wells):

Well No.	Bureau's Analysis (pCi/l)	Contract Lab's Analysis (pCi/l)
4#	118	111
10#	89	228
15*	87	83
21#	193	299
24*	151	135
35*	180	181

* Near FUSRAP material
# Away from FUSRAP material

The results of the Bureau and the Contract Lab show good agreement except for wells 10 and 21. The Bureau believes some of the discrepancy is due to the contract laboratory's larger detector (Thermo NUtech is capable of counting Lucas cells that are larger than the Bureau's). The contract lab's photomultiplyer tube has a diameter of approximately 5 inches.

For reproducible results, it may be critical to place the Bureau's 2 1/4-inch diameter Lucas cells precisely in the center of the detector. The Bureau's detector (and photomultiplyer tube) is smaller and more closely matches the diameter of our Lucas cells.

Discussion

The results range from 83 pCi/l to 299 pCi/l. There is no pattern in the data indicating that a high concentration of radon is being collected from the FUSRAP wastes. In fact, the highest concentration is found one of the wells selected to be further away from the FUSRAP material, and the lowest concentration is found in a well selected because it was close to the FUSRAP waste. Thus, it is likely that most of the vented radon originates in the solid waste itself, the soil used for cover, and the soil beneath the waste.

The average concentration of radium-226 in the FUSRAP waste is estimated to be about 5 pCi/g, based on the DOE sampling results cited above. Eisenbud reported the concentration of radium measured in soils and rocks as ranging from 0.20 pCi/g to 1.02 pCi/g, with soil at an average of 0.73 pCi/g[1].

Soil Gas

In 1989, the New York State Department of Health published Influence of Surficial Soil and Bedrock on Indoor Radon in New York State Homes. In this report, the results of a large number of measurements of radon in soil gas were published. These measurements were made to investigate the relationship between radon concentration in soil gas and in homes. The radon in soil gas was measured as follows:

1. A PVC pipe was driven into the ground to the depth where the measurement was to be made.

2. The soil inside the pipe was removed.

3. A detector (for long term measurements, an alpha track detector was used) was placed at the bottom of the pipe.

4. The pipe was sealed just above the detector.

5. After the required exposure time, usually about 3 months, the detector was retrieved and analyzed.

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[1] Eisenbud, Merril, *Environmental Radioactivity from Natural, Industrial, and Military Sources* (Academic Press, Inc., 1987), p. 131

This technique allowed the detector to be exposed to the soil gas without any dilution of the radon by outside air. The measurements were made in 4 areas of the state, Long Island, Orange County, Onondaga County and Erie County. Soil gas radon concentrations ranged from tens to thousands of pCi/l. The average concentrations in each of the areas ranged from hundreds to 1400 pCi/l. This is shown in the following table:

Area	Radon Concentration pCi/l	Standard Deviation pCi/l
Long Island	254	110
Orange County	550	424
Onondaga County	1402	1011
Erie County	395	425

Dose Calculations

The Bureau has estimated the concentration of radon in the air at the boundary of the landfill, based on the results of this sampling and a set of conservative assumptions about the release of the gas and mixing with the surrounding air. For this calculation, it was assumed that the concentration of radon in all of the vent exhausts is 100 pCi/l (other assumptions used in the calculation are explained in Attachment 1). The boundary concentration resulting from a vent concentration of 100 pCi/l is 0.0017 pCi/l. To estimate the site boundary concentrations for higher vent concentrations, the result can be linearly scaled. For example, if all wells were exhausting radon at 300 pCi/l, the estimated boundary concentration would be 0.0042 pCi/l.

This estimate of radon concentration at the site boundary can be compared to the ambient concentration of radon in air. According to Eisenbud[2], the average concentration of naturally occurring radon in outdoor air is normally in the range of 0.1 to 0.5 pCi/l.

This estimated concentration can be compared to the concentrations in Table II, Section 380-11.7 of Part 380, to estimate the radiation dose a person could receive from breathing this concentration of radon continually. For inert gases such as radon, the concentration in Table II is that concentration of the gas that would deliver a radiation dose of 100 millirems per year

[2] Ibid., p. 139.

(mrem/yr) to a person who breathed that air constantly, 24 hours a day, every day of the year. Using the applicable Table II concentration for radon-222 (1 E-10 µCi/ml or 0.1 pCi/l), we can estimate the radiation dose a person would receive if he or she continually breathed the air at the boundary of the landfill. For a vent concentration of 100 pCi/l, that dose is about 2 mrem/yr. If all the wells were venting at 300 pCi/l, the resulting dose to an individual breathing this gas directly and continually would be about 6 mrem/yr.

The actual concentration to which anyone off site will be exposed will be at least an order of magnitude lower, due to the conservative assumptions used in the calculation and the additional mixing with the air that will occur as the radon moves away from the landfill.

Possible Effects of Active Venting

BFI has obtained the necessary DEC permits for an active landfill gas collection system and flare. When the active system is in operation, blowers will pull the landfill gas through the wells and a system of pipelines, to the flare. Actively removing the gasses from the landfill could have an effect on the concentration of radon in the extracted gasses. By actively removing the gas from the landfill, the system may extract some radon that would otherwise have decayed within the landfill. This could increase the concentration of radon in the extracted gas. It is also possible that the active extraction process will draw out more methane than radon (methane is lighter than radon), or increase the mix of air in the extracted gases, and the concentration of radon will be lower. The only way to determine the effect of the active system is to measure the radon in the pipeline upstream of the flare.

The Department plans to take such measurements as soon as possible after the active system has been put into operation and the system has stabilized. We understand that stabilizing the system will take a few weeks.

Conclusions

1. The concentrations of radon measured in this study are consistent with those that have been measured in soil gas. Based on these results, there is no basis for concluding that the radon in the landfill gas is significantly higher than it would be if there were no FUSRAP material in the landfill.

2. The projected off-site dose from the current radon emissions is less than 1 mrem/yr.

3. There is no adverse effect on the environment from the emission of radon from the landfill.

4. The blower and flare should be put into operation and the inflowing gas should be sampled to determine the radon concentrations in the actively extracted gas.

Future Actions

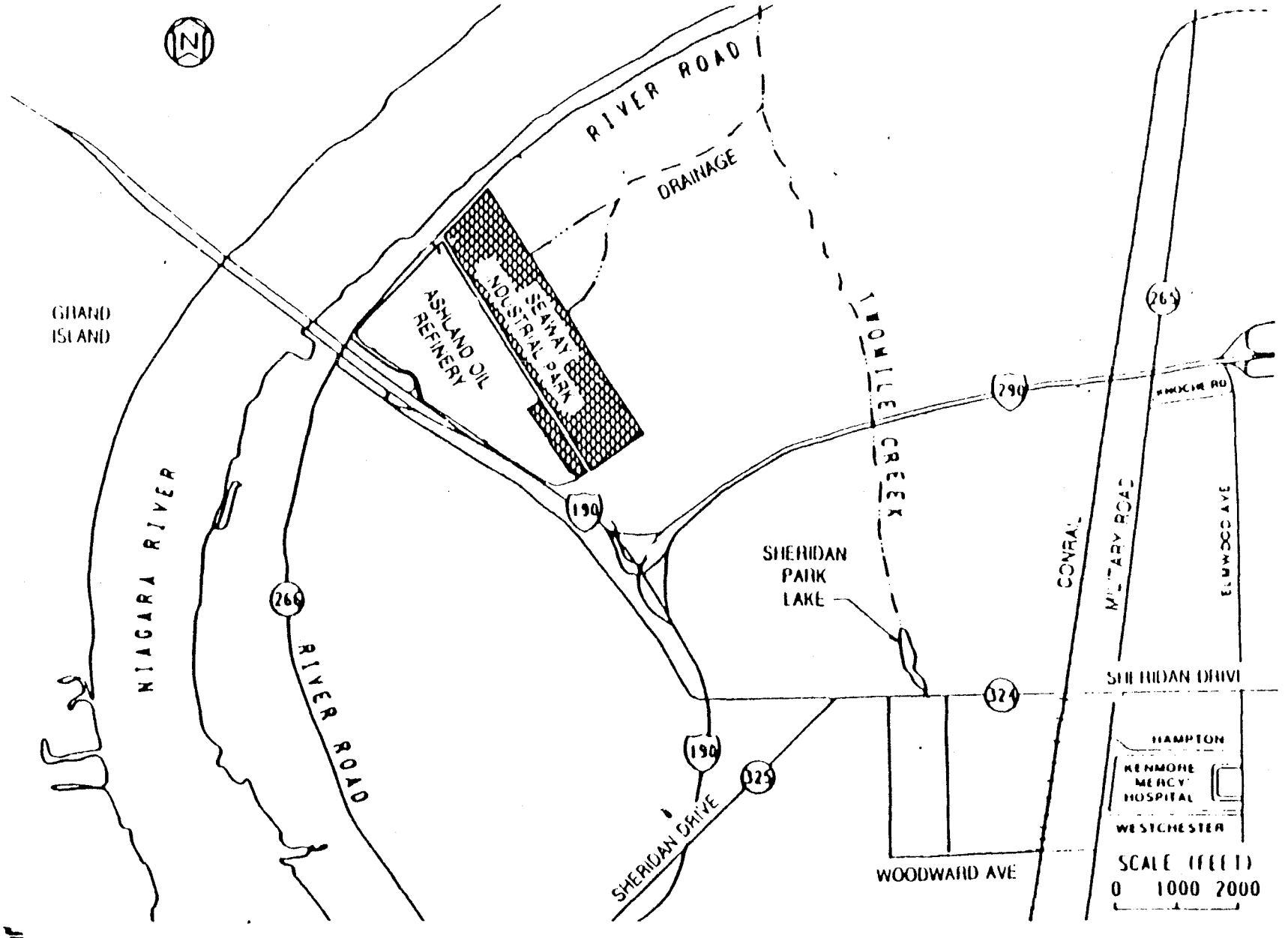
The following additional work would be useful to confirm the above conclusions:

- Measurements of radon gas concentrations from other landfill venting systems. To be valid for comparisons, both the landfill and its venting system should be similar to the Niagara Landfill. There may not be many such landfills in New York State.

- Long-term measurements of radon gas (using alpha track detectors) at the Niagara Landfill, when the active venting system is in operation. The number of wells samples should be increased to a minimum of 12.

- Radon sampling of the inflow to the flare.

FIGURE 1



LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

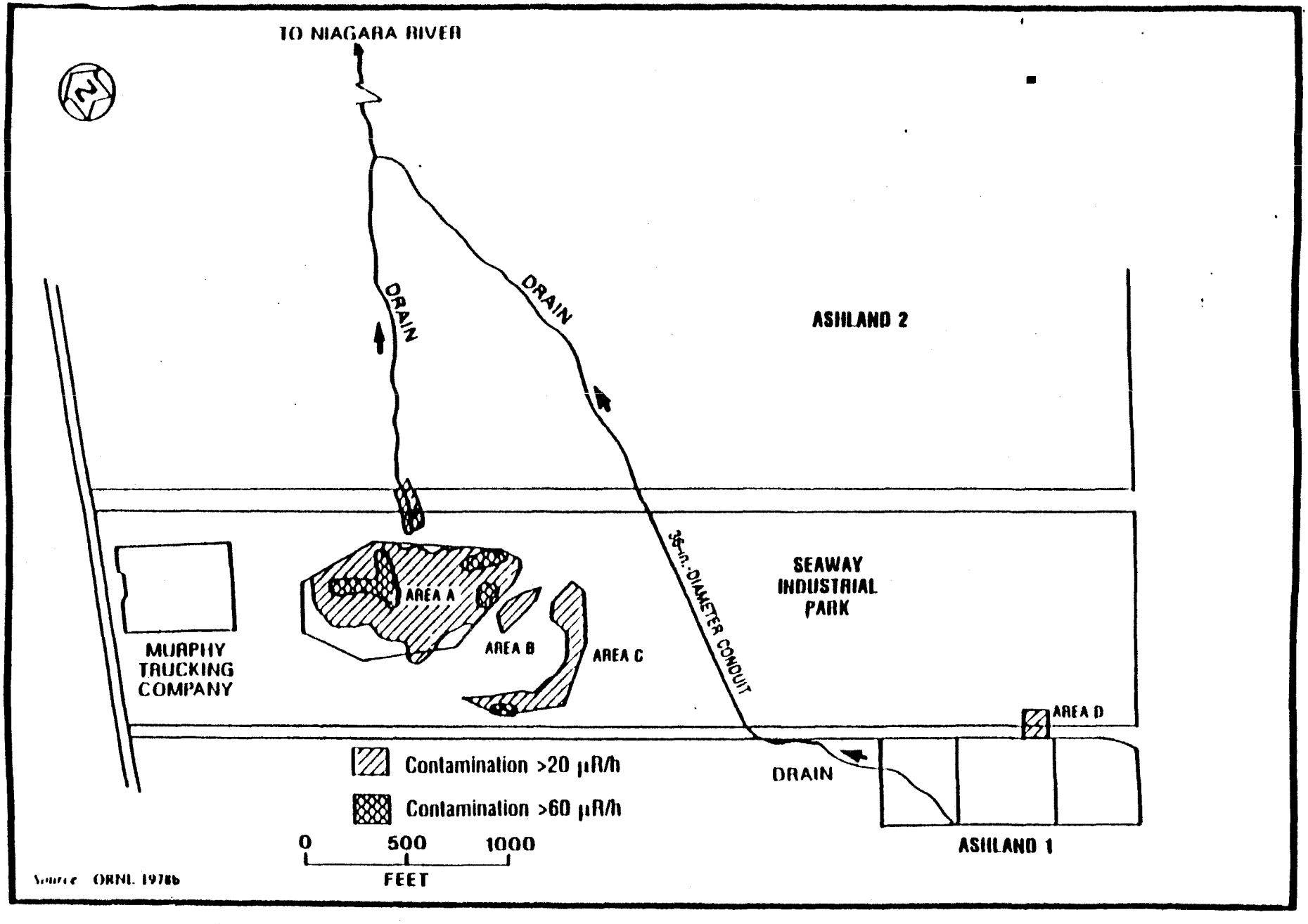
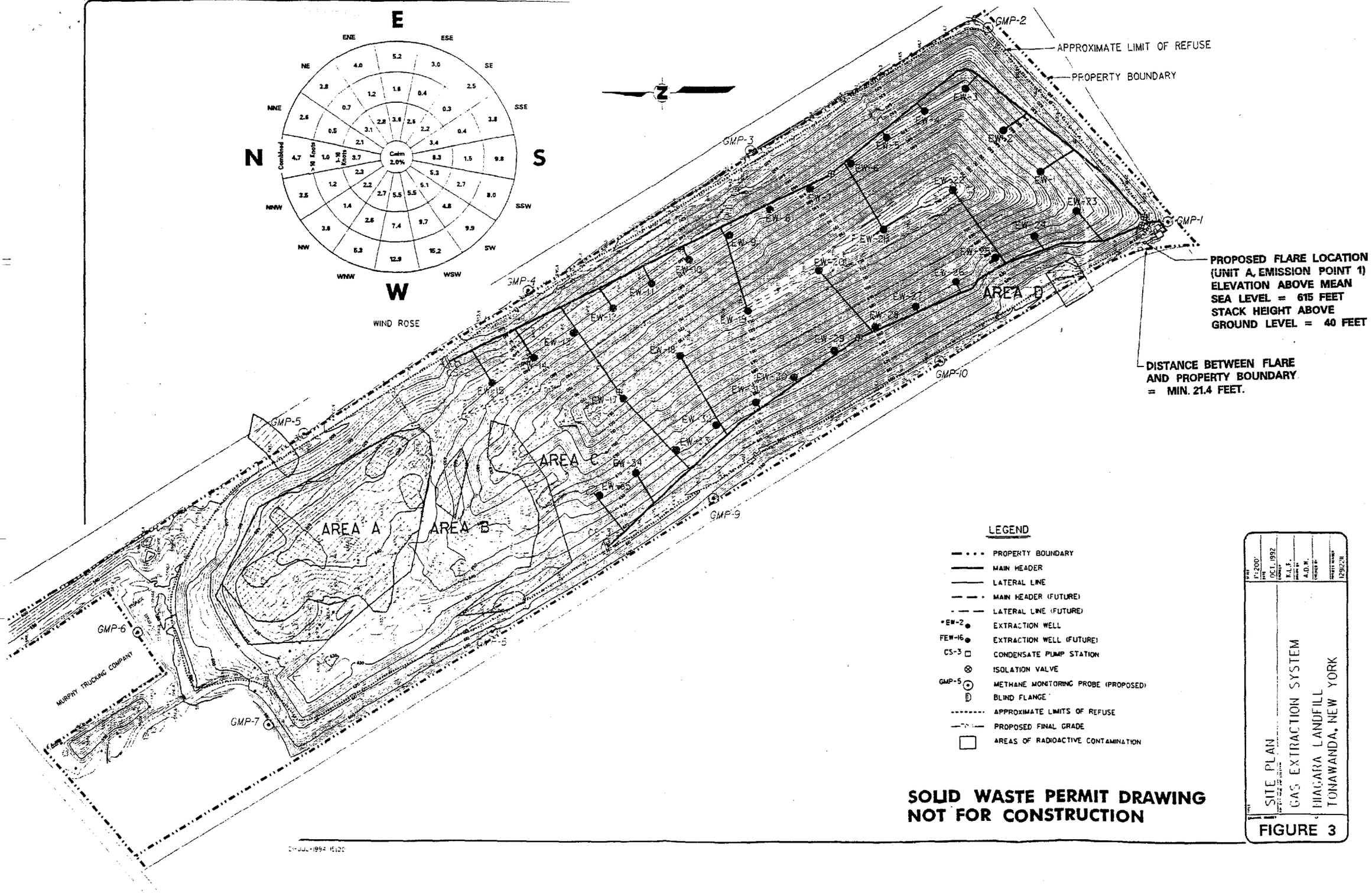


FIGURE 2 AREAS OF RADIOACTIVE CONTAMINATION AT SEAWAY INDUSTRIAL PARK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ENE
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N
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NNW
SSW
NW
SW
WNW
WSW
W
Combined
> 10 Knots
1-10 Knots
Calm
2.0%
WIND ROSE
N
GMP-1
GMP-2
GMP-3
GMP-4
GMP-5
GMP-6
GMP-7
GMP-9
GMP-10
APPROXIMATE LIMIT OF REFUSE
PROPERTY BOUNDARY
PROPOSED FLARE LOCATION
(UNIT A, EMISSION POINT 1)
ELEVATION ABOVE MEAN
SEA LEVEL = 615 FEET
STACK HEIGHT ABOVE
GROUND LEVEL = 40 FEET
DISTANCE BETWEEN FLARE
AND PROPERTY BOUNDARY
= MIN. 21.4 FEET.
AREA A
AREA B
AREA C
AREA D
MURPHY TRUCKING COMPANY
LEGEND
PROPERTY BOUNDARY
MAIN HEADER
LATERAL LINE
MAIN HEADER (FUTURE)
LATERAL LINE (FUTURE)
EXTRACTION WELL
EXTRACTION WELL (FUTURE)
CONDENSATE PUMP STATION
ISOLATION VALVE
METHANE MONITORING PROBE (PROPOSED)
BLIND FLANGE
APPROXIMATE LIMITS OF REFUSE
PROPOSED FINAL GRADE
AREAS OF RADIOACTIVE CONTAMINATION
SOLID WASTE PERMIT DRAWING
NOT FOR CONSTRUCTION
SITE PLAN
GAS EXTRACTION SYSTEM
NIAGARA LANDFILL
TONAWANDA, NEW YORK
1"=200'
OCT. 1992
K.L.F.
A.D.K.
FIGURE 3

Attachment 1
Calculation of Radon Concentrations at the Site Boundary
Niagara Landfill, Tonawanda NY

Assumptions:

Concentration of radon in vent exhaust is 100 pCi/l.
Based on measurements of vent gas.

Exhaust velocity of vents is 1 m/sec.
Based on observation of vent exhaust.

Vertical mixing distance is 10 m.
Based on height of landfill over surrounding area. When standing on the leeward side of hill, the wind is coming up the hill. This indicates a large convection cell on the order of the size of the hill. 10 m is about one third the height of the hill. Therefore, 10 m is conservative.

Wind is 10 miles/hr from west.
Based on Wind Rose data.

Length of Landfill perpendicular to flow is 800 m.
Based on perpendicular to Wind Rose most likely wind direction.

1. Amount of radon being released:

Each pipe is a 6" diameter pipe. There are 34 pipes spread throughout the landfill.

Area of pipe = .0182 m^2

Amount of radon released per pipe =
(.0182 m^2)(1 m/sec)(100 pCi/l)(1000 l/m^3) = 1.82×10^3 pCi/sec.

Total amount of radon released =
(34 pipes)(1.82×10^3 pCi/sec/pipe) = 6.2×10^4 pCi/sec.

2. Volume of air in which it is mixed.

Perpendicular length = 800 m.
Mixing height = 10 m.
Wind Velocity = 10 miles/hr. = 4.47 m/sec.

Volume of air = (800 m)(10 m)(4.47 m/sec) = 3.6×10^4 m^3/sec.

3. Concentration at Site Boundary

$$Rn(concentration) = \frac{6.2 \times 10^4 pCi/sec}{(3.6 \times 10^4 m^3/sec)(10^3 l/m^3)} = .0017 pCi/l$$

Performed by: [redacted] Date: 3/18/96
Reviewed by: [redacted] Date: 3/18/96