TABLE 12
CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS LABORATORY LIQUID EFFLUENT

Parameter (Units)	Number of Samples	Value[1]			
		Minimum	Maximum	Average	Permit Limit[2]
Discharge Permit Requirements (Reference (3))					
Intake Point 001					
Flow (MGD)	Continuous[3]	0.0	2.01	1.73	Monitor
pH (SU)	51	7.0	8.3	----	Monitor
Total Suspended Solids (mg/l)	51	1.1	398	17	Monitor
Total Copper (mg/l)	27	<0.003	0.013	<0.005	Monitor
Discharge Point 002					
Flow (MGD)	Continuous[3]	0.007	2.7	1.4	Monitor
pH (SU)	53	6.9	11.8	----	6.5-8.5[4]
Temperature (°F)	Continuous[3]	33	82	56	90
Total Suspended Solids (mg/l)	53	1.2	213	11.6	Monitor
Total Suspended Solids, Net (mg/l)	53	0	34	1	40
Total Dissolved Solids (mg/l)	52	95	3310	355	Monitor
Oil & Grease (mg/l)	53	<5.0	<6.2	<5.0	15
Total Copper (mg/l)	27	<0.004	0.194	<0.016	Monitor
Copper, Net (lbs/day)	27	0.000	0.131	0.05	Monitor
Discharge Point 03A					
Flow (MGD)	15	0.0007	0.0108	0.0043	Monitor
pH (SU)	4	7.2	7.6	----	6.5-8.5
Oil & Grease (mg/l)	4	<5.0	<5.0	<5.0	15
Total Suspended Solids (mg/l)	4	<2.0	4.6	3.1	Monitor
Thallium (µg/l)	4	<0.5	<0.5	<0.5	25
Discharge Point 03B					
Flow (MGD)	Continuous[3]	0.0	1.1	0.40	Monitor
pH (SU)	51	7.0	8.3	----	6.5-8.5[4]
Temperature (°F)	Continuous[3]	35	76	54	90
Oil & Grease (mg/l)	12	<5.0	<5.0	<5.0	15
Total Suspended Solids, Net (mg/l)	12	-13	4.4	-1	40
Total Copper (mg/l)	27	<0.003	0.016	<0.006	Monitor
Copper, Net (lbs/day)	27	0	0.051	0.009	Monitor

Notes for Table 12 are on page 36

TABLE 12 (continued)
CHEMICAL CONSTITUENTS AND TEMPERATURE IN KNOLLS LABORATORY LIQUID EFFLUENT

Parameter (Units)	Number of Samples	Value[1]			
		Minimum	Maximum	Average	Permit Limit[2]
Discharge Point 03D					
Flow (MGD)	Continuous[3]	0.0078	1.4400	0.1228	Monitor
pH (SU)	52	7.0	8.2	----	6.5-8.5[4]
Temperature (°F)	Continuous[3]	32	82	55	90
Oil & Grease (mg/l)	12	<5.0	<5.0	<5.0	15
Total Suspended Solids (mg/l)	12	1.7	11	5.0	Monitor
Total Copper (mg/l)	27	<0.003	0.013	<0.006	Monitor
Copper, Net (lbs/day)	27	0	0.008	0.002	Monitor
Discharge Point 03E					
Flow (MGD)	13	0.0001	0.0014	0.00030	Monitor
pH (SU)	4	7.2	7.9	----	6.5-8.5
Oil & Grease (mg/l)	4	<5.0	<5.0	<5.0	15
Total Suspended Solids (mg/l)	4	<1.0	8.3	<3.7	Monitor
Discharge Point 001, 002, 03B and 03D					
Copper, Net Loading (lbs/day)	27	0.0	0.2	0.1	1.1

Notes:
1. A value preceded by "<" is less than the RL. Average values preceded by "<" contain at least one "less than reporting limit value" in the average calculation.
2. NYSDEC SPDES Permit (Reference (3)).
3. The number of continuous monitoring days may differ slightly due to shutdown during maintenance activities.
4. If intake pH (Outfall 001) is greater than or equal to 8.2, the upper pH limit is increased to 9.0, but in no case can the effluent pH exceed intake pH by more than 0.5 SU.

TABLE 13
CHEMICAL CONSTITUENTS IN MOHAWK RIVER WATER

Parameter (Units)	Number of Samples Upstream/ Downstream	Value						Standard[1]
		Mohawk River Upstream (Outfall 001)			Mohawk River Downstream			
		Minimum	Maximum	Average	Minimum	Maximum	Average	
Total Dissolved Solids (mg/l)[2]	51/0	15	1620	228	----	----	----	500
Chloride (mg/l)[2]	5/5	25.6	37.3	30.9	25.1	80.6	40.8	250

Notes:

1. NYS Quality Standards (Reference (1)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.
2. Voluntary parameter.

TABLE 14
CHEMICAL CONSTITUENTS IN WEST BOUNDARY STREAM AND MIDLINE STREAM

Parameter (Units)	Number of Samples West Boundary Stream / Midline Stream	Value[1]						Standard / Guidance Value[2]
		West Boundary Stream (Outfall 004)			Midline Stream (Outfall 005)			
		Minimum	Maximum	Average	Minimum	Maximum	Average	
Flow (Estimated (GPD))[3]	4/5	14,000	101,000	55,000	6,700	86,000	51,000	Monitor[4]
pH (SU)	4/5	7.3	7.5	----	7.2	7.9	----	6.5-8.5[4]
Total Suspended Solids (mg/l)	4/5	1.1	18.4	11	9.2	33.8	18.4	Monitor[4]
Oil & Grease (mg/l)	4/5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	15[4]
Chemical Oxygen Demand (mg/l)	4/5	8	233	71	6	27	14	Monitor[4]
Chloride (mg/l)[5]	4/5	486	2,770	1110	472	1,330	930	250
Thallium (µg/l)	4/0	<0.5	<0.5	<0.5	----	----	----	25[6]
Volatile Organic Compounds (µg/l)[5][7]	4/5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	Note (8)

Notes:

1. A value preceded by “<” is less than the RL. Average values preceded by “<” contain at least one “less than reporting limit value” in the average calculation.
2. NYS Quality Standards and Guidance Values (Reference (4)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. The West Boundary and Midline Streams are tributaries to the Mohawk River, which is a Class A water.
3. Flow is estimated by measuring stream depth, width, and velocity. Flow is intermittent and is measured only when samples are collected.
4. Permit limits as required by NYSDEC SPDES permit (Reference (3)).
5. Voluntary parameter.
6. NYSDEC SPDES Permit Action Level.
7. EPA method 601 was utilized to analyze for VOCs listed in Table 25. All results were less than the RL of 1 µg/l.
8. Water quality standards and guidance values differ depending upon the specific parameter. The standards/guidance values range from 0.07 to 50 µg/l.

TABLE 15
CHEMICAL CONSTITUENTS AND TEMPERATURE IN EAST BOUNDARY STREAM

Parameter (Units)	**Number of Samples Upstream / Downstream**	**Value(1)**						**Standard / Guidance Value(2)**
		East Boundary Stream Upstream			**East Boundary Stream Downstream (Outfall 006)**			
		Minimum	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**	
Flow (Estimated (GPD))(3)	1/4	1,683	1,683	1,683	87,000	390,000	180,000	Monitor(4)
pH (SU)	1/5	7.3	7.3	----	7.1	8.1	----	6.5-8.5(4)
Temperature (°F)	1/5	64	64	64	41	69	59	No Standard
Dissolved Oxygen (mg/l)	1/1	5.2	5.2	5.2	7.1	7.1	7.1	Note (5)
Specific Conductance (µmhos/cm)	1/1	1,521	1,521	1,521	1,243	1,243	1,243	No Standard
Volatile Organic Compounds (µg/l)(6)	1/5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	Note (7)
Oil & Grease (mg/l)	0/5	----	----	----	<5.0	<5.0	<5.0	15(4)
Total Suspended Solids (mg/l)	0/4	----	----	----	<1	30.3	<10.2	Monitor(4)
Chemical Oxygen Demand (mg/l)	0/4	----	----	----	8	17	14	Monitor(4)
Chloride (mg/l)(8)	0/4	----	----	----	508.0	1150.0	753	250

Notes:

1. A value preceded by "<" is less than the RL. Average values preceded by "<" contain at least one "less than reporting limit value" in the average calculation.
2. NYS Quality Standards and Guidance Values (Reference (4)) for Class A Waters: source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. The East Boundary Stream is tributary to the Mohawk River, which is a Class A water.
3. Flow is intermittent and is estimated by measuring stream depth, width, and velocity or by volume collected over a time period. Flow is measured only when samples are collected.
4. Permit limit as required by NYSDEC SPDES permit (Reference (3)) for the downstream location.
5. For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l, and at no time shall the Dissolved Oxygen (DO) concentration be less than 4.0 mg/l.
6. EPA method 601 was used to analyze for VOCs listed in Table 25. All results were less than the RL of 1 µg/l.
7. Water quality standards and guidance values differ depending upon the specific parameter. The standards/guidance values range between 0.07 and 50 µg/l.
8. Voluntary parameter.

Radiological: The average radioactivity concentrations in the sanitary sewage effluent to the Town of Niskayuna POTW are shown in Table 16. Only strontium-90 and naturally occurring uranium were detected in the quarterly effluent composite samples. The concentration of strontium-90 is at levels typically found in surface water from historical atmospheric weapons testing. The radioactivity concentrations in the sanitary sewage effluent quarterly composite samples were less than one percent of the DOE derived concentration guide (DCG), Reference (5), as required by the Outside Users Agreement (Reference (2)).

TABLE 16
KNOLLS LABORATORY SANITARY SEWAGE EFFLUENT DISCHARGED TO THE TOWN OF NISKAYUNA PUBLICLY OWNED TREATMENT WORKS: QUARTERLY COMPOSITE SAMPLE RADIOACTIVITY RESULTS

Radionuclide	Quarterly Composite Sample Average Radioactivity Concentration (pCi/l)(1)	DOE Order 5400.5 DCG (pCi/l)	Percent of DCG
Cs-137	<0.33 ± 0.09	3,000	<0.01
Sr-90	<0.12 ± 0.08	1,000	<0.01
Co-60	<0.33 ± 0.10	5,000	<0.01
H-3	<85.62 ± 7.06	2,000,000	<0.01
Total Uranium	<0.46 ± 0.13	500(2)	<0.09
		Total Percentage(3)	<0.13

Notes:

1. Average values preceded by “<” contain at least one less than decision level concentration (DLC) value in the average. The (±) value provides the 95% confidence interval for the average value.
2. The DCG for total uranium is based on U-234.
3. The radioactivity standard for the Town of Niskayuna Sanitary Sewer System corresponds to one percent of the derived concentration guide in DOE Order 5400.5 for the mixture of radionuclides present (Reference (2)).

The radioactivity concentrations in Knolls Laboratory liquid effluent are shown in Table 17. The average concentrations are all well below the DOE Derived Concentration Standard (DCS). The amount of each radionuclide released from the Knolls Laboratory in liquid effluent is shown in Table 18.

The total radioactivity released from each outfall/source is as follows: Outfall 002, 374.2 µCi; Outfall 03A, 17.5 µCi; Outfall 03D, 43.5 µCi; Outfall 03E, 0.4 µCi; Outfall 004, 15.2 µCi, and River Bank Seepage, 9.6 µCi for a total of 460.4 µCi (or 4.60×10^{-4} Ci). The radioactivity was contained in approximately 2.67×10^{9} liters of water released from the Knolls Laboratory. The annual average radioactivity concentration in that effluent, prior to entering the Mohawk River water, corresponds to less than 0.1 percent of the DOE DCS, Reference (6), for the mixture of radionuclides present.

TABLE 17
RADIOACTIVITY CONCENTRATIONS IN KNOLLS LABORATORY LIQUID EFFLUENT

Sample Point / Parameter	Number of Samples	Radioactivity Concentration (pCi/l)(1)				Percent of DCS
		Minimum	Maximum	Average	DOE-STD-1196-2011 DCS(2)	
Outfall 002						
Gross Alpha	12	0.79 ± 1.17	3.78 ± 2.81	<1.46 ± 0.53	140	<1.04
Gross Beta	12	<0.70	3.78 ± 2.81	<2.14 ± 0.61	1,100	<0.19
Sr-90	12	<0.08	0.34 ± 0.15	<0.17 ± 0.05	1,100	<0.02
Cs-137	12	<0.10	<0.12	<0.11 ± 0.01	3,000	<0.01
H-3	12	<83.78	<95.45	<89.19 ± 2.22	1,900,000	<0.01
Outfall 03A						
Gross Alpha	12	<3.34	<13.20	<7.71 ± 2.12	140	<5.51
Gross Beta	12	<5.52	26.00 ± 9.30	<11.13 ± 3.80	1,100	<1.01
Sr-90	12	0.75 ± 0.17	3.10 ± 0.33	2.01 ± 0.54	1,100	0.18
Cs-137(3)	4	<0.12	<0.12	<0.12 ± 0.01	3,000	<0.01
Outfall 03B						
Gross Alpha(3)	4	<0.33	<0.90	<0.56 ± 0.41	140	<0.40
Gross Beta(3)	4	1.00 ± 0.94	1.76 ± 1.02	<1.37 ± 0.61	1,100	<0.12
Outfall 03D						
Gross Alpha	12	<0.51	<2.43	<0.94 ± 0.33	140	<0.67
Gross Beta	12	1.07 ± 0.95	6.09 ± 4.14	<2.29 ± 0.81	1,100	<0.21
Sr-90	12	<0.08	0.47 ± 0.28	<0.15 ± 0.07	1,100	<0.01
Cs-137(3)	4	<0.10	<0.12	<0.11 ± 0.02	3,000	<0.01
Outfall 03E						
Gross Alpha	12	<2.77	46.37 ± 50.29	<12.18 ± 7.52	140	<8.70
Gross Beta	12	5.55 ± 4.83	27.22 ± 12.85	<12.12 ± 3.97	1,100	<1.10
Sr-90	12	<0.09	0.92 ± 0.22	<0.42 ± 0.17	1,100	<0.04
Cs-137(3)	4	<0.12	<0.13	<0.12 ± 0.01	3,000	<0.01
Outfall 004						
Gross Alpha(4)	11	<2.74	29.00 ± 28.99	<7.08 ± 5.06	140	<5.06
Gross Beta(4)	11	<3.13	21.20 ± 11.39	<7.72 ± 3.50	1,100	<0.70
Sr-90(4)	11	<0.08	0.58 ± 0.17	<0.27 ± 0.14	1,100	<0.02
Cs-137(4)	11	<0.12	0.46 ± 0.09	<0.16 ± 0.07	3,000	<0.01
Outfall 005						
Gross Alpha(3)(4)	4	<3.19	12.01 ± 11.15	<6.42 ± 6.63	140	<4.58
Gross Beta(3)(4)	4	<4.80	11.75 ± 9.34	<7.55 ± 4.71	1,100	<0.69
Sr-90(3)(4)	4	0.14 ± 0.11	0.21 ± 0.11	0.19 ± 0.05	1,100	0.02
Cs-137(3)(4)	4	<0.12	<0.12	<0.12 ± 0.01	3,000	<0.01
Outfall 006						
Gross Alpha(3)(4)	4	3.94 ± 5.84	<6.12	<4.95 ± 1.74	140	<3.54
Gross Beta(3)(4)	4	<2.93	11.17 ± 9.25	<8.10 ± 5.79	1,100	<0.74
Sr-90(3)(4)	4	0.10 ± 0.11	0.20 ± 0.12	0.15 ± 0.07	1,100	0.01
Cs-137(3)(4)	4	<0.12	<0.13	<0.12 ± 0.01	3,000	<0.01

Notes for Table 17 are on page 41.

TABLE 17 (continued)
RADIOACTIVITY CONCENTRATIONS IN KNOLLS LABORATORY LIQUID EFFLUENT

Sample Point / Parameter	Number of Samples	Radioactivity Concentration (pCi/l)(1)				Percent of DCS
		Minimum	Maximum	Average	DOE–STD-1196-2011 DCS(2)	
River Bank Seepage						
Gross Alpha(4)	2	8.70 ± 10.12	10.00 ± 11.00	9.35 ± 8.26	140	6.68
Gross Beta(4)	2	4.98 ± 4.95	7.10 ± 4.80	6.04 ± 13.47	1,100	0.55
Sr-90(4)	2	0.36 ± 0.25	2.42 ± 1.12	1.39 ± 13.06	1,100	0.13
Cs-137(4)	2	<0.22	<3.47	<1.84 ± 20.66	3,000	<0.06
West Landfill Stream						
Gross Alpha(3)(4)	3	<0.59	11.39 ± 5.52	<4.25 ± 15.37	140	<3.04
Gross Beta(3)(4)	3	2.34 ± 1.42	24.05 ± 4.28	11.09 ± 28.45	1,100	1.01
Sr-90 (3)(4)	1	0.13 ± 0.11	0.13 ± 0.11	0.13 ± 0.11	1,100	0.01
Cs-137 (3)(4)	1	0.38 ± 0.10	0.38 ± 0.10	0.38 ± 0.10	3,000	0.01
Upper East Boundary Stream						
Gross Alpha(3)(4)	4	<3.55	<8.29	<6.22 ± 3.70	140	<4.44
Gross Beta(3)(4)	4	5.73 ± 4.40	23.20 ± 7.45	<11.11 ± 12.93	1,100	<1.01
Sr-90(3)(4)	4	<0.09	0.31 ± 0.14	<0.18 ± 0.16	1,100	<0.02
Cs-137(3)(4)	4	<0.12	<0.14	<0.13 ± 0.01	3,000	<0.01
Upper West Boundary Stream (background for comparison)						
Gross Alpha(4)	12	<1.09	4.80 ± 5.01	<2.05 ± 0.64	140	<1.47
Gross Beta(4)	12	2.10 ± 1.30	5.41 ± 1.92	<3.62 ± 0.67	1,100	<0.33
Sr-90(4)	12	<0.08	0.22 ± 0.12	<0.15 ± 0.03	1,100	<0.01
Cs-137(4)	12	<0.12	<0.13	<0.12 ± 0.01	3,000	<0.01
H-3(4)	12	<83.56	<95.09	<89.12 ± 2.26	1,900,000	<0.01
Site Service Water (background for comparison)						
Gross Alpha	12	<0.15	1.95 ± 1.59	<1.08 ± 0.31	140	<0.77
Gross Beta	12	<0.57	2.84 ± 1.51	<1.55 ± 0.52	1,100	<0.14
Sr-90	12	<0.08	0.17 ± 0.12	<0.09 ± 0.02	1,100	<0.01
Cs-137	12	<0.12	<0.28	<0.15 ± 0.04	3,000	<0.01
H-3	12	<83.60	<94.78	<88.96 ± 2.21	1,900,000	<0.01
Mohawk River Cooling water (background for comparison)						
Gross Alpha	12	<0.42	1.63 ± 1.32	<0.78 ± 0.23	140	<0.56
Gross Beta	12	0.70 ± 0.81	2.56 ± 2.38	<1.61 ± 0.39	1,100	<0.15
Sr-90	12	<0.07	0.16 ± 0.12	<0.09 ± 0.02	1,100	<0.01
Cs-137	12	<0.12	<0.13	<0.12 ± 0.01	3,000	<0.01
H-3	12	<83.79	<95.14	<89.29 ± 2.25	1,900,000	<0.01

Notes:

1. A value preceded by "<" is less than the DLC. Average values preceded by "<" contain at least one value that is less than the DLC. The (±) value provides the 95% confidence interval for the value.
2. The DCS for gross alpha and gross beta radioactivity is based on the most restrictive radionuclide possibly present in measurable quantities as a result of Knolls Laboratory operations.
3. Monthly samples are composited and analyzed quarterly.
4. Samples may not be obtained every month due to dry or frozen conditions.

TABLE 18
KNOLLS LABORATORY RADIOACTIVITY RELEASED IN LIQUID EFFLUENT

Radionuclide	Release (Ci)[(1)(2)]	Half-life
Sr-90	1.64E-04	28.78 years
Y-90	1.64E-04	2.67 days
Cs-137	1.32E-04	30.07 years
Fission and Activation Products (Half-life > 3 hr)	4.60E-04	

Notes:
1. The totals include results that were less than or equal to the DLC.
2. Slight rounding differences occur when summing individual values.

AIRBORNE EFFLUENT MONITORING

Sources

Nonradiological: The principal source of industrial air emissions is the Knolls Laboratory steam-generating heating boiler system. The Knolls Laboratory heating boilers are comprised of three stationary combustion units that primarily combust natural gas with ultra-low sulfur distillate fuel oil used as a backup fuel. The by-products from the combustion of fuel associated with the operation of this source are released through individual elevated stacks. Another stationary combustion source is the ASGTF that is comprised of two natural gas-fired water heaters (East and West) that exhaust through a common stack. Both gas-fired water heaters are in layup and have not been operated since 2010 and 2002, respectively.

Other operations at the Knolls Laboratory that can result in air emissions include the carpenter shop, metalwork operations, belt grinders, welding, nonradiological laboratory hoods, mobile air compressors, non-road engines, and emergency power generating stationary internal combustion engines. These sources of air emissions at the Knolls Laboratory meet the criteria for exempt and trivial sources under the NYSDEC air regulations and are not required to have air permits or registrations.

Radiological: Laboratory operations capable of generating airborne radioactivity are serviced by controlled exhaust systems that discharge through stacks. To minimize radioactivity content, the exhaust air is passed through appropriate air cleaning devices, such as high efficiency particulate air (HEPA) filters and activated carbon adsorbers, prior to release. Potential diffuse sources are also evaluated and may include emissions from resuspension of contaminated soil, D&D activities, and fugitive building emissions.

Effluent Monitoring

Nonradiological: The Knolls Laboratory originally had two nonradiological air emission permits, one for the heating boilers and one for the ASGTF. The two permits were consolidated into a single permit ASFP (Mod 2) in December 2009. In January 2010, the Knolls Laboratory was granted a modification ASFP (Mod 4), as listed in Table 6, to consolidate the reporting dates for certain regulatory submittals listed in the permit. The air permit currently limits CO and SO2 emissions from the heating boilers based on fuel usage. Under the terms of the permit, direct emission monitoring from combust installations listed in the permit is not required. The ASGTF has no emission limits. The quantities of pollutants released are estimated based on the quantity and type of fuel burned multiplied by the appropriate EPA approved emission factors. The NYS emission standards for stationary combustion installations are listed in Reference (7).

The NYSDEC regulations do not require air emission permits for exempt and trivial activities. In general, exempt and trivial activities do not require emissions monitoring; although some activities may require monitoring of run times, installation and maintenance of air quality control equipment, or limiting source material usage to maintain their exempt status.

Radiological: Airborne effluents from the main radiological emission points are continuously sampled for particulate radioactivity with particulate filter samplers and with activated charcoal cartridge samplers where iodine or antimony may be present. Exhaust systems servicing major facilities are also continuously monitored for particulate, iodine, and noble gas radioactivity. The monitors continuously record radioactivity levels in the effluents and are equipped with alarm functions to provide an alert should an abnormal level occur. Other minor radiological emission points are evaluated for the potential for release and monitored on a periodic basis, as necessary, to confirm their low emissions.

Effluent Analyses

Radiological: Particulate filters and activated charcoal cartridges are changed and analyzed on a routine basis. Particulate filters are analyzed by direct counting for gross alpha and beta radioactivity using a sensitive low-background gas proportional counting system. The system provides DLCs for alpha and beta radioactivity of approximately 1×10^{-15} μCi/ml and 5×10^{-15} μCi/ml, respectively. The activated charcoal cartridges are analyzed for iodine-131 and antimony-125 by gamma spectrometry, which provides DLCs of approximately 2×10^{-14} μCi/ml and 1×10^{-13} μCi/ml, respectively. Noble gas radioactivity released is calculated based on integration of recorded data from a continuous noble gas monitor.

Assessment

Nonradiological: The heating boiler operations at the Knolls Laboratory are "capped," or limited, to the following conditions under the ASFP (Mod 4) issued by NYSDEC:

1. A maximum heat input of 162.4 billion British Thermal Units (BTUs) during any 12-month period;
2. The quantity of fuel used during any 12-month period shall not exceed 159.2 million standard cubic feet (SCF) of natural gas or 1.16 million gallons of distillate fuel oil or any combination of the two, not to exceed condition 1 above;
3. Annual emissions of the following contaminants are capped as follows:

   CO – 13,370 pounds per year

   SO_2 – 82,360 pounds per year;
4. The sulfur content of any fuel oil burned shall not exceed 0.5 percent by weight, and the fuel oil must conform to the specifications for distillate fuel oil per American Society for Testing and Materials (ASTM) D396-78, as amended; and
5. The annual capping period will run from the first working day in September to the first working day in September of the following year with the Annual Capping Certification due by September 30 each year.

The ASGTF hot water heater operations are not capped under the ASFP (Mod 4). Fuel oil supplier certification statements and/or applicable fuel oil analyses for distillate fuel oil are maintained to confirm that the fuel oil burned in the Knolls Laboratory heating boilers contained less than

0.5 percent sulfur by weight and conforms to the ASTM Standards for distillate fuel oil. Semi-annual reports demonstrating compliance with the fuel oil sulfur limitation are sent to both the EPA and NYSDEC. Under current NYSDEC regulations, the sulfur content of fuel oil is limited to 0.0015 percent sulfur by weight. Although the EPA and the ASFP require the combustion of fuel oil with a sulfur content of less than 0.5 percent sulfur, the Knolls Laboratory complies with the more stringent NYSDEC regulatory requirement that fuel oils contain no more than 0.0015 percent sulfur by weight.

Compliance with the capping requirements is determined by calculations using fuel usage records each year and submittal of an annual capping certification statement to NYSDEC. Although the emissions from the operation of Air Emission Point EP-00030, ASTGF, are not capped, the emissions from this facility are included in the capping certification for information.

During 2022, the Knolls Laboratory heating boilers continued to operate within the capped operating and emission limits established by NYSDEC in the Knolls Laboratory's ASFP and as gas-fired boilers under 40 CFR 63 Subpart JJJJJJ – National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers located at Area Sources of Hazardous Air Pollutants.

Radiological: The radioactivity released in airborne effluent during 2022 is shown in Table 19. The point source airborne radioactivity was contained in a total air exhaust volume of 1.46×10^{12} liters. The average radioactivity concentration in the exhaust air was well below the applicable standards listed in Reference (6). The diffuse source emissions are calculated using EPA approved methods. The radioactivity concentration for 2022 at the nearest Knolls Laboratory boundary, based on the annual diffusion parameters, averaged less than 0.01 percent of the DOE DCS, Reference (6), for the mixture of radionuclides present. Airborne effluent monitoring data are reported as required by EPA regulations in Reference (8).

TABLE 19
KNOLLS LABORATORY RADIOACTIVITY RELEASED IN AIRBORNE EFFLUENT

Radionuclide	Point Source Release Ci(1)	Diffuse Source Release Ci	Total Release Ci(2)	Half-life
H-3	6.57E-08	0.00E+00	6.57E-08	12.32 years
Kr-85	4.56E-02	0.00E+00	4.56E-02	10.76 years
Sr-90	2.42E-06	4.29E-06	6.71E-06	28.8 years
Y-90	2.42E-06	4.29E-06	6.71E-06	2.67 days
Cs-137	2.42E-06	4.56E-06	6.97E-06	30.07 years
Co-60	1.06E-07	2.97E-07	4.03E-07	5.271 years
Eu-152	0.00E+00	1.29E-08	1.29E-08	13.54 years
Total Fission and Activation Products (Half-life>3 hr)	4.56E-02	1.34E-05	4.56E-02	
U-234	5.33E-07	1.20E-09	5.34E-07	2.46E05 years
U-235	8.95E-09	2.97E-08	3.87E-08	7.04E08 years
U-236	1.66E-09	4.96E-12	1.66E-09	2.34E07 years
U-238	1.28E-11	3.52E-13	1.32E-11	4.47E09 years
Total Uranium	5.44E-07	3.06E-08	5.75E-07	
Pu-238	7.46E-08	6.77E-08	1.42E-07	87.7 years
Pu-239	8.40E-11	2.68E-07	2.68E-07	2.41E04 years
Pu-240	0.00E+00	6.70E-08	6.70E-08	6.56E03 years
Pu-241	0.00E+00	4.09E-11	4.09E-11	14.29 years
Pu-242	0.00E+00	2.02E-15	2.02E-15	3.75E05 years
Total Plutonium (Alpha)	7.47E-08	4.03E-07	4.77E-07	
Am-241	7.33E-17	6.69E-08	6.69E-08	432.7 years

Note:
1. With the exception of Kr-85, the totals include results that were less than or equal to the DLC.
2. Slight rounding differences occur when summing individual values.

ENVIRONMENTAL MONITORING

Scope

Nonradiological: The Knolls Laboratory nonradiological environmental monitoring program consists of routine surface water and groundwater sampling. Surface water is sampled for water quality at the following locations: Mohawk River upstream and downstream from the Knolls Laboratory outfalls, the Midline Stream near the point of entry to the Mohawk River, the West Boundary Stream, and the East Boundary Stream upstream and downstream of the closed landfill. The West Boundary Stream sample point is on Knolls Laboratory property, prior to where the stream enters the General Electric Global Research Center property. The West Boundary Stream eventually meets the Mohawk River upstream from the Knolls Laboratory. Required analytical surface water parameters were discussed earlier in this report and more details are provided in the following pages. Stream sample points are shown in Figure 2.

The Knolls Laboratory contains a permanently capped landfill that covers an area of approximately 3.7 acres on the east side of the site. The landfill was officially closed in October 1993. The groundwater and surface water surrounding the closed landfill are routinely monitored and the results are reported to NYSDEC in compliance with Reference (9). An annual landfill inspection was conducted and no degradation in the cap was identified. Routine landfill maintenance was performed to ensure continued integrity of the landfill cap and associated cover. In accordance with a NYSDEC-approved RCRA Corrective Action groundwater monitoring plan, quarterly groundwater monitoring is performed at the D3-D6 Area and G1-D4 Alleyway to assess the effectiveness of soil remediation projects. The results of the groundwater monitoring are reported to NYSDEC annually. Groundwater is also monitored by other groundwater monitoring wells located throughout the Knolls Laboratory. Knolls Laboratory groundwater data are discussed separately later in this report.

Radiological: The Knolls Laboratory radiological environmental monitoring program includes: a) the routine collection and analysis of samples of Mohawk River water, sediment, and fish; surface water streams; groundwater; and local municipal waters; and b) the continuous sampling of air at stations located in the predominant upwind and downwind directions from the Knolls Laboratory.

Mohawk River water and bottom sediment samples are collected for radioactivity analyses at locations upstream and downstream from the main Knolls Laboratory outfall as shown in Figure 3. Samples are collected during each of three (3) calendar quarters; ice coverage and/or winter weather prevents sampling during the first calendar quarter. A Birge-Ekman dredge, which samples an area of approximately 15 cm x 15 cm to an average depth of 2.5 cm, is used for the collection of sediment samples. In addition, bottom feeding fish and recreational sport fish are collected from the Mohawk River upstream and downstream from the main Knolls Laboratory outfall for gamma spectrometry and radiochemical analyses.

Surface water is also sampled monthly for radioactivity at the Midline Stream near the point of entry to the Mohawk River, the West Boundary Stream, the East Boundary Stream upstream and downstream of the closed landfill, and the West Landfill Stream. Groundwater wells are sampled annually for radioactivity and are discussed separately in the Groundwater Monitoring section of this report.

The municipal water systems servicing the area surrounding the Knolls Laboratory are those of Schenectady, Niskayuna, and Latham/Colonie, New York. Supply wells for the Schenectady and Niskayuna systems are located upstream and downstream, respectively, from the Knolls Laboratory. Although there is no direct mechanism for Knolls Laboratory effluent to enter the water supplies, samples are collected monthly from the Schenectady and Niskayuna municipal water systems. A monthly sample is also collected from the Latham/Colonie municipal water system that obtains its water from the Mohawk River. Monthly samples are composited quarterly and analyzed for radioactivity.

Environmental air samplers are operated in the predominant upwind and ten downwind locations around the entire perimeter of the Knolls Laboratory to measure normal background airborne radioactivity, and to confirm that Knolls Laboratory effluents have no measurable effect on normal background airborne radioactivity levels.

Analyses

Nonradiological: The water samples collected from the Mohawk River and the three main surface water streams are analyzed for the constituents listed in Tables 13, 14, and 15. The analyses were performed in accordance with 40 CFR Part 136 utilizing the procedures provided in Standard Methods, Reference (10), or other EPA approved methods.

Radiological: The individual quarterly samples of Mohawk River water and quarterly composite samples of Schenectady, Niskayuna, and Latham/Colonie municipal waters are analyzed for gross alpha and gross beta radioactivity. The stream samples are analyzed for gross alpha and gross beta radioactivity, and for other radionuclides as appropriate. The methods used are described in the Effluent Analyses portion of the Liquid Effluent Monitoring section of this report.

The Mohawk River sediment samples are analyzed for uranium and plutonium alpha radioactivity by chemical extraction with subsequent direct counting on an alpha spectrometry system, for gross beta radioactivity by direct counting of a dried sample, and for cesium-137 and other gamma emitting radionuclides by gamma spectrometry. Seven samples from the second quarter sample set collected at locations upstream, opposite, and downstream from the main Knolls Laboratory outfall (i.e., Outfall 002) are also analyzed for strontium-90 by chemical extraction and gross beta counting. The downstream samples for strontium-90 analyses are selected from locations that previous monitoring had indicated would be locations of highest concentrations.

Edible portions of the fish collected from the Mohawk River are analyzed for gamma emitting radionuclides with a high purity germanium spectrometer system, for strontium-90 by chemical extraction and beta counting, and for plutonium by chemical separation followed by alpha spectrometry.

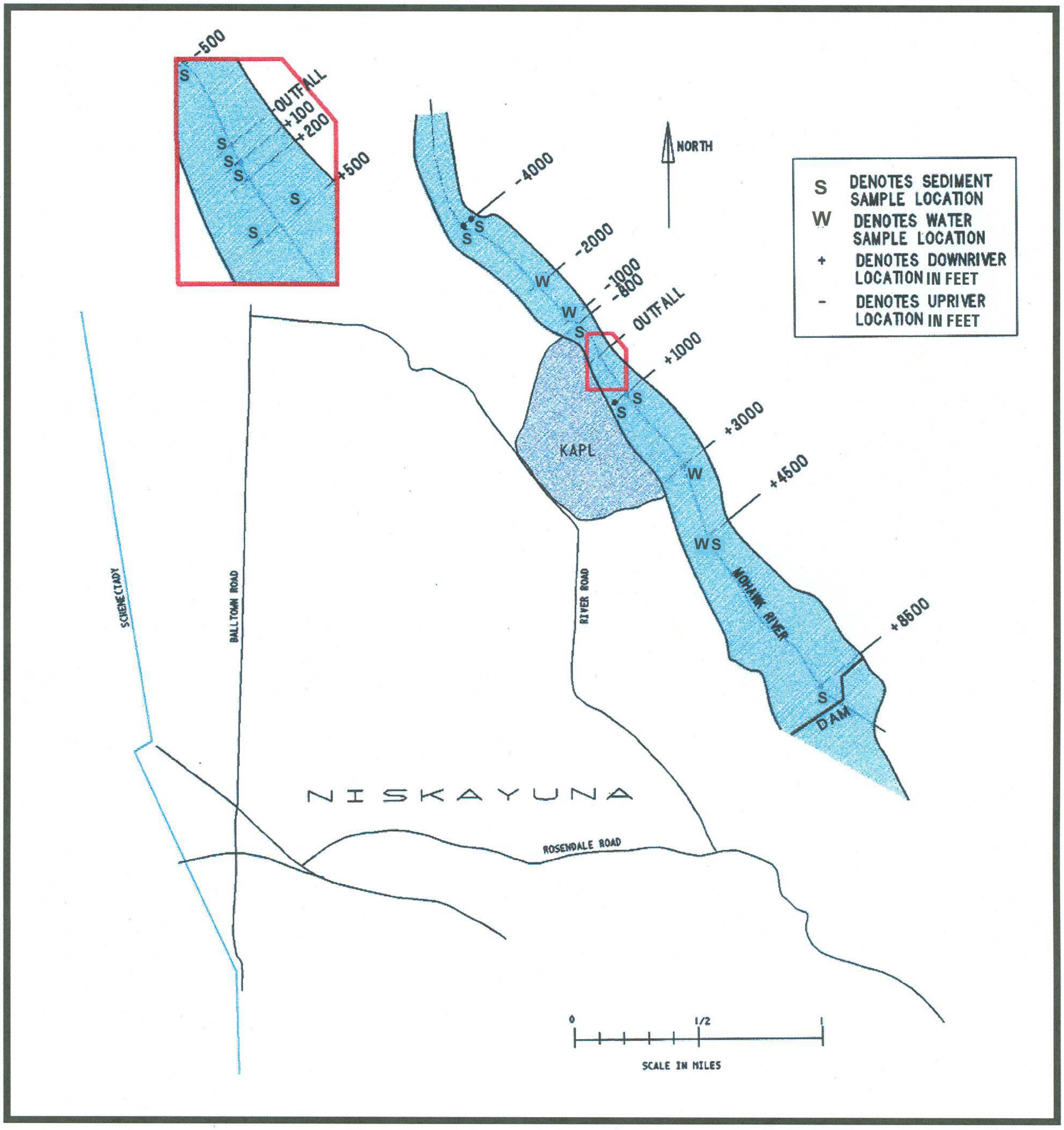

FIGURE 3
KNOLLS LABORATORY, NISKAYUNA, NEW YORK
MOHAWK RIVER SAMPLING LOCATIONS

The environmental air sample filters are changed on a routine basis and analyzed by direct counting for gross alpha and gross beta radioactivity using the method described in the Effluent Analyses of the Airborne Effluent Monitoring section of this report.

Assessment

Nonradiological: The results of the analyses of Mohawk River water for chemical quality are summarized in Table 13. Results of routine analyses in the West Boundary Stream and Midline Stream are summarized in Table 14, and results for the East Boundary Stream are summarized in Table 15. Analyzed parameters were generally below the NYS standards for Class A waters for the section of the Mohawk River that borders the Knolls Laboratory. The surface water database shows that there is no water quality degradation attributable to the Knolls Laboratory.

Current Knolls Laboratory Operations

The Midline Stream has the potential to be influenced by runoff from the east side of the Knolls Laboratory. The West Boundary Stream captures runoff from an on-site road. Therefore, the Knolls Laboratory SPDES Permit requires the stormwater for these areas to be monitored. Additional voluntary monitoring is also performed and is presented in Tables 13, 14, and 15. The State water quality standard for chloride was exceeded in West Boundary Stream, Midline Stream, and East Boundary Stream. The high chloride results for all streams were attributed to winter road salting and snow/ice removal operations.

Voluntary surface water monitoring is also performed for other parameters at these locations to supplement the regulatory required SPDES and landfill post-closure monitoring activities. The data from samples analyzed during 2022 continued to indicate there is no adverse impact from current Knolls Laboratory operations on the Mohawk River or the closed landfill on the surrounding surface water streams. Instances where surface water standards or guidance values have been exceeded are discussed below.

Surface Water near the Closed Landfill

The former Knolls Laboratory landfill (permanently closed and capped in 1993) is bordered by the East Boundary Stream, the West Landfill Stream (which is frequently dry), and the Mohawk River to the north. Sample data for the East Boundary Stream is presented in Table 15. The East Boundary Stream upstream and downstream locations were sampled as part of the landfill post-closure monitoring activities.

The Mohawk River and East Boundary Stream data, as previously discussed, do not indicate any measurable impact from the former landfill.

Radiological: Results of the radioactivity analyses performed on samples of Mohawk River and municipal waters are summarized in Table 20. The results for the gross alpha and gross beta radioactivity concentrations show no significant difference between river water samples upstream and downstream from the Knolls Laboratory or in Schenectady, Niskayuna, and Latham/Colonie municipal waters.

The results of radioactivity measurements for gross beta, strontium-90, cesium-137, plutonium, and uranium in Mohawk River bottom sediment samples are summarized in Table 21. The 2022 data shows no significant differences between upstream and downstream radioactivity concentrations for gross beta, strontium-90, cesium-137, plutonium, and uranium. Historically, slightly higher concentrations of radioactivity have occasionally been measured in samples collected from locations within one thousand feet downstream from the main Knolls Laboratory outfall. This localized concentration of radioactivity is attributed to operations conducted prior to 1964, when the facility was subject to applicable Federal regulations and State and local agreements through the Mohawk River Advisory Committee that permitted limited amounts of radioactivity to be released to the Mohawk River. These low levels of radioactivity in the river sediment do not present a health risk since the radioactivity is deposited as bottom sediment, which is not subject to becoming airborne and is unlikely to interact with the aquatic environment. Additional detail regarding the low level of radioactivity in the Mohawk River is discussed in the Special Mohawk River Surveys section, later in this report.

The results of the detailed gamma spectrum analyses performed on Mohawk River bottom sediment samples also indicated the expected low levels of potassium-40 and daughters of uranium and thorium. The potassium-40 and daughters of uranium and thorium are naturally-occurring radionuclides. No detectable cobalt-60 was found in any of the samples. However, localized low levels of cobalt-60, attributable to operations prior to 1964, have been observed occasionally in past river sediment samples.

The analytical results for the fish collected from the Mohawk River are summarized in Tables 22 and 23. The results indicate the presence of naturally occurring potassium-40. The results of sensitive analyses for strontium-90 and plutonium indicate essentially no detectable strontium-90 or plutonium in either upstream or downstream fish. The measured concentrations of radioactivity indicate no effect from Knolls Laboratory operations. In addition, the results of a detailed biological survey (Reference (11)) confirm that the low levels of radioactivity in the Mohawk River bottom sediment near the main Knolls Laboratory outfall (Outfall 002) are not taken up and propagated through the food chain.

The analytical results for the environmental air samples for 2022 indicate that there were no significant differences between the average upwind and downwind radioactivity concentrations. The average upwind gross alpha and gross beta radioactivity concentrations were 1.1×10^{-15} μCi/ml and 1.8×10^{-14} μCi/ml, respectively. The average downwind gross alpha and gross beta radioactivity concentrations were 1.1×10^{-15} μCi/ml and 1.8×10^{-14} μCi/ml, respectively.

TABLE 20
RESULTS OF MONITORING MOHAWK RIVER WATER AND MUNICIPAL WATER

Location and Source of Water Sample	Number of Samples	Radioactivity Concentration (pCi/l)(1,2,3)						
		Gross Alpha Values				Gross Beta Values		
		Minimum	Maximum	Average		Minimum	Maximum	Average
Mohawk River								
Upstream	6	<0.50	<0.98	<0.74 ± 0.22		1.11 ± 0.95	2.60 ± 1.06	1.95 ± 0.52
Downstream	6	<0.54	<1.00	<0.73 ± 0.21		1.29 ± 0.93	2.60 ± 0.99	1.91 ± 0.56
Municipal Water								
Schenectady Municipal Water(4)	4	<0.57	1.03 ± 1.25	<0.80 ± 0.30		1.35 ± 0.96	2.81 ± 1.22	2.25 ± 1.06
Niskayuna Municipal Water(4)	4	<0.60	<1.20	<0.90 ± 0.54		1.75 ± 1.03	3.21 ± 1.34	2.49 ± 0.96
Latham/Colonie Municipal Water(4)	4	<0.34	<0.65	<0.48 ± 0.24		0.67 ± 0.86	2.68 ± 1.09	1.60 ± 1.58

Notes:
1. The (±) value for average values provides the 95% confidence interval for the average value. The lowest possible value for any parameter is zero.
2. A value preceded by "<" is less than the DLC for that sample and parameter.
3. Average values preceded by "<" contain at least one value that is less than the DLC.
4. Monthly samples are composited and analyzed quarterly.

TABLE 21
RESULTS OF ANALYSES OF MOHAWK RIVER SEDIMENT FOR RADIOACTIVITY

Number of Samples and Type of Results	Radioactivity Concentration (pCi/g, dry weight)(1) (2)		
	Area Sampled Relative to Effluent Point		
	Upstream	Opposite	Downstream
Gross Beta Concentration			
Number of samples	12	3	24
Average Concentration(3)	23.40 ± 4.40	25.47 ± 27.48	25.06 ± 3.70
Minimum Concentration	16.30 ± 2.26	18.20 ± 2.45	14.90 ± 2.21
Maximum Concentration	37.68 ± 6.96	38.20 ± 6.88	42.58 ± 7.32
Sr-90 Concentration			
Number of samples	4	1	2
Average Concentration(3)	0.07 ± 0.03	0.06 ± 0.01	0.08 ± 0.28
Minimum Concentration	0.05 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
Maximum Concentration	0.10 ± 0.02	0.06 ± 0.01	0.10 ± 0.02
Cs-137 Concentration			
Number of samples	12	3	24
Average Concentration(3)	<0.03 ± 0.01	0.02 ± 0.01	<0.03 ± 0.01
Minimum Concentration	<0.02	0.01 ± 0.01	<0.01
Maximum Concentration	0.08 ± 0.03	<0.02	0.09 ± 0.03
Plutonium Concentration(4)			
Number of samples	12	3	24
Average Concentration(3)	<0.03 ± 0.01	<0.03 ± 0.03	<0.02 ± 0.01
Minimum Concentration	<0.01	<0.02	<0.01
Maximum Concentration	<0.07	<0.04	<0.06
Uranium Concentration(5)			
Number of samples	12	3	24
Average Concentration(3)	0.73 ± 0.11	0.59 ± 0.32	<0.70 ± 0.11
Minimum Concentration	0.48 ± 0.03	0.49 ± 0.06	0.40 ± 0.03
Maximum Concentration	1.08 ± 0.05	0.73 ± 0.04	1.18 ± 0.06

Notes:

1. The sediment is sampled to a depth of approximately 2.5 cm.
2. The (±) values for minimum and maximum concentrations represent the statistical uncertainty at two standard deviations. A value preceded by “<” is less than the DLC.
3. The (±) values for average concentrations provide the 95% confidence interval for the average value. Average values preceded by “<” contain at least one value that is less than the DLC.
4. Plutonium concentration values are the sum of results for Pu-238, Pu-239, and Pu-240. Minimum and maximum concentrations preceded by “<” include at least one radionuclide concentration that is less than the DLC in the sum of the radionuclides.
5. Uranium concentration values are the sum of results for U-234, U-235, and U-238. Minimum and maximum concentrations preceded by “<” include at least one radionuclide concentration that is less than the DLC in the sum of the radionuclides.

TABLE 22
GAMMA SPECTROMETRY RESULTS FOR MOHAWK RIVER FISH

Sample Location(2)	Fish Type	Number of Samples	Radioactivity Concentrations (pCi/g, wet weight)(1)			
			K-40		Cs-137	
			Maximum	Average(3)	Maximum	Average(3)
Upstream	Carp White Sucker	2	3.09 ± 0.26	2.81 ± 3.61	<0.01	<0.01 ± 0.01
Upstream	Smallmouth Bass Northern Pike	3	3.11 ± 0.26	2.83 ± 0.61	<0.01	<0.01 ± 0.01
Downstream	Carp White Sucker	3	3.17 ± 0.27	3.01 ± 0.43	<0.01	<0.01 ± 0.01
Downstream	Walleye Smallmouth Bass	2	3.48 ± 0.28	3.35 ± 1.66	<0.01	<0.01 ± 0.01

Notes:

1. A value preceded by "<" is less than the DLC for that sample and parameter. The (±) value provides the statistical uncertainty at the 95% confidence interval.
2. Upstream samples were obtained above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upstream respectively, from the Knolls Laboratory Outfall 002). Downstream samples were obtained between the Knolls Laboratory Outfall 002 and Lock 7.
3. Average values preceded by "<" contain at least one value that is less than the DLC.

TABLE 23
RADIOCHEMICAL ANALYSIS RESULTS FOR MOHAWK RIVER FISH

Sample Location(1)	Fish Type	Radioactivity Concentration (pCi/g wet weight)(2)	
		Sr-90	Plutonium(3)
Upstream	Smallmouth Bass	0.003 ± 0.004	<0.009
Upstream	Walleye	<0.003	<0.001
Upstream	Carp	0.003 ± 0.003	<0.002
Downstream	Smallmouth Bass	<0.003	<0.022
Downstream	Walleye	<0.002	<0.001
Downstream	Carp	<0.003	<0.001

Notes:

1. Upstream samples were obtained above Lock 8 and below Lock 9. (Lock 8 and Lock 9 are located approximately 9 miles and 14 miles, upstream respectively, from the Knolls Laboratory Outfall 002). Downstream samples were obtained between the Knolls Laboratory Outfall 002 and Lock 7.
2. A value preceded by "<" is less than the DLC for that sample and parameter. The (±) value provides the statistical uncertainty at the 95% confidence interval.
3. Plutonium concentration values are the sum of results for Pu-238, Pu-239, and Pu-240.

Special Mohawk River Surveys

The Knolls Laboratory conducted an extensive sediment and biological sampling program of the Mohawk River during the summer of 1992 and again during the summer of 2002. These sampling programs were performed to update information on the quantity and distribution of radioactivity in the river sediment attributable to Knolls Laboratory operations prior to 1964 and to demonstrate that the residual radioactivity has no adverse effect on human health or the environment. Samples included numerous sediment core samples and various samples of fish, macrophyton, periphyton, plankton, benthic macroinvertebrates, and water. NYSDEC participated in the 2002 survey by observing the Knolls Laboratory sampling on the Mohawk River and splitting select core samples for independent analysis. The Knolls Laboratory also conducted a special sampling program consisting of only sediment core samples in 1980 (Reference 11).

In 2019, DOE-EM collected sediment core samples in locations adjacent to and downstream of the Knolls Laboratory. Results from this survey were published in Reference (12). Based on the results, DOE-EM concluded that current data is consistent with previously collected survey data, and existing residual radioactivity in the Mohawk River sediment has not migrated further downstream.

The results of the 1992 and 2002 sampling programs, as discussed in References (13) and (14), respectively, show that the distribution of residual radioactivity in the Mohawk River sediment in the vicinity of the Knolls Laboratory is well understood. The majority of radioactivity present is confined to an area along the south side of the Mohawk River, which extends from the Knolls Laboratory Outfall 002 to 1,000 feet downstream. The radioactivity generally is located at least 8 inches below the top of the sediment surface. Radioactivity concentrations above background levels are also detectable further downstream; however, the concentrations are lower, and the radioactivity is located even deeper in the sediment.

Comparison of the 2002 sediment sampling results with those from 1992 and to those obtained from the similar survey done in 1980 shows that the 2002 results are similar to the 1992 results, though generally are lower than the 1980 results. The residual radioactivity remains deeper in the sediment than when surveyed in 1980, due to deposition of new sediment in the outfall area. Additionally, the NYSDEC split sample results for the 2002 survey were in very good agreement with the Knolls Laboratory sample results.

A comparison was made between the total amount of residual radioactivity of Knolls Laboratory origin estimated to be present in the sediment above the Lock 7 dam for the 1980, 1992, and 2002 surveys. Though below the results from 1980 (with correction for radioactive decay), the 2002 survey results are not significantly different than the results obtained in 1992. The total radioactivity of Knolls Laboratory origin present in the sediment above the Lock 7 dam is considered to be the same as estimated from the 1992 study: less than 0.65 Ci, of which 90% is attributable to cesium-137 and strontium-90 (and its short-lived daughter product yttrium-90). For perspective, the total radioactivity of Knolls Laboratory origin present in the sediment is less than 10% of the naturally occurring radioactivity found in the sediment in the same region.

The results of the fish and other biological sampling conducted show no detectable radioactivity of Knolls Laboratory origin above weapons testing fallout levels in any biological sample. These results continue to demonstrate that the residual radioactivity in the sediment is not being taken up in the food chain.

A radiological assessment of the residual radioactivity in the sediment concludes that, even using very conservative assumptions and hypothetical scenarios, no measurable dose to a member of the public would result, even if all of the radioactivity in the sediment were released back into the river water. The major conclusion of the radiological assessment is that the radioactivity of Knolls Laboratory origin continues to have no adverse effect on human health or the environment.

RADIATION MONITORING

The purpose of the environmental radiation monitoring program is to measure the ambient radiation levels around the Knolls Laboratory to confirm that operations have not altered the natural radiation background levels at the Knolls Laboratory perimeter. The sources of radiation at the Knolls Laboratory are from small specimens of irradiated and non-irradiated materials, radioactive waste management facilities, and residual radioactivity remaining in facilities from historical operations.

Scope

Environmental radiation levels were monitored at the perimeter of the Knolls Laboratory with a network of standard DT-702/PD lithium fluoride TLDs. The sixteen locations of the Knolls Laboratory perimeter TLD monitors are shown in Figure 2. Two temporary perimeter TLD locations (T18 and T19) were added to monitor the relocation of the SPRU project TRU waste temporary storage on November 27, 2018, at the start of the first quarter 2019 monitoring period.

Control TLD monitors were also posted at remote off-site locations to measure the natural background levels typical of the surrounding area. All TLD monitors were posted for quarterly exposure periods.

Analyses

The environmental TLDs were calibrated to a cesium-137 standard source. The TLD radiation exposures were measured quarterly utilizing an automated TLD readout system, which was calibrated prior to the processing of the TLDs.

Assessment

The results for the Knolls Laboratory perimeter and off-site radiation monitoring locations are summarized in Table 24. With the exception of monitoring locations 5, 16, and T18, the total annual exposures for each perimeter location are within the expected distribution of the off-site measurements at the 95% confidence interval. Perimeter monitoring locations 5, 16, and T18 are located close to the SPRU Disposition Project (SPRU DP) temporary storage area established for managing TRU waste from the SPRU DP, which results in slightly elevated radiation levels at these locations. Other locations such as T19 are slightly elevated for the same reason, but fall within the 95% confidence interval of the off-site locations. Conservative calculations show that the radiation exposure to the nearest off-site neighbor in the same direction would not be discernable from natural background radiation. As a result, Knolls Laboratory operations in 2022 have had no significant effect on off-site radiation levels beyond the Knolls Laboratory perimeter.

TABLE 24
PERIMETER AND OFF-SITE RADIATION MONITORING RESULTS, KNOLLS LABORATORY

Monitoring Location[1]	Total Annual Exposure[2] (millirem)
1	69 ± 1
2	65 ± 2
3	67 ± 2
4	74 ± 2
5	83 ± 1
6	72 ± 2
7	73 ± 2
8	71 ± 1
9	66 ± 2
10	64 ± 2
11	69 ± 2
12	65 ± 1
13	64 ± 1
14	65 ± 2
15	72 ± 1
16	85 ± 3
T18	112 ± 2
T19	77 ± 2
Off-Site Locations	63 ± 19[3]

Notes:
1. See Figure 2 for perimeter monitoring locations.
2. The (±) values for individual locations provide the 95% confidence interval for the exposure due to random uncertainty.
3. Approximately 95% of off-site natural background measurements are expected to be within this range.

GROUNDWATER MONITORING

Scope

The Knolls Laboratory groundwater monitoring program includes routine monitoring of the closed Knolls Laboratory landfill, monitoring of localized areas as part of the RCRA Corrective Action program, and voluntary monitoring across the site.

Groundwater from 33 monitoring wells was sampled and analyzed for chemical quality and/or radioactivity in 2022. Sampling and analysis of 16 groundwater monitoring wells and water from two catch basins is required by State regulations. Five wells (NTH-1A, NTH-2A, NTH-5A, W-11, and W-12) are associated with post-closure landfill groundwater monitoring Eleven wells (MW-40, MW-44R, MW-45, MW-46, MW-47R, MW-48, MW-49, MW-50, MW-51, MW-52, and SW-10) and two catch basins (CBR 002-248 and CBR 002-260) are monitored to assess the effectiveness of soil remediation projects performed in the D3-D6 Area, the former D3/D4 Yard, and the G1-D4 Alleyway. The remaining groundwater monitoring wells were voluntarily monitored by the Knolls Laboratory. The locations of the Knolls Laboratory monitoring wells and the location of the D3-D6 Area, the former D3/D4 Yard, and the G1-D4 Alleyway are shown on Figure 2. The locations of the D3-D6 Area, the former D3/D4 Yard, and the G1-D4 Alleyway monitoring wells and catch basins are shown on Figure 4.

Sources

Nonradiological: Generally, groundwater underlying the Knolls Laboratory is contained in highly impermeable and nonporous soil and bedrock. As a consequence, there is only slight movement of the water, generally believed to be toward the northeast, toward the Mohawk River. Due to the impermeable and nonporous nature of the soil and bedrock, there is no commercial or public development of the groundwater in the vicinity of the Knolls Laboratory. Groundwater contaminants can be introduced through two possible routes. The first route, surface recharging, carries atmospheric contaminants such as acid rain and airborne radioactivity from natural and manmade sources (such as past nuclear weapons testing), and surface contaminants from operational and historical land use (such as de-icing compounds, fertilizers, and pesticides). The second route is leaching of shallow nonradioactive buried wastes in the closed Knolls Laboratory landfill and other burial areas in the vicinity of the landfill where small amounts of waste chemicals from laboratory operations were buried many years ago, consistent with common industrial practices at the time.

Radiological: In some areas of the Knolls Laboratory, the soil contains low levels of radioactivity from operations that commenced in the 1950s that is detectable above background levels. This has resulted in low levels of radioactivity in some of the on-site groundwater wells.

Analyses

Nonradiological: As part of the NYSDEC-approved Knolls Laboratory Landfill Post-Closure Monitoring Program, Reference (9), the Knolls Laboratory monitors five overburden wells; one upgradient (NTH-1A) and four downgradient wells (NTH-2A, NTH-5A, W-11, and W-12). The parameters monitored under the revised monitoring plan (approved by NYSDEC in 2018) allow for adequate groundwater quality assessment based on the large historical database. During 2022, the landfill wells were sampled once, in accordance with Reference (9).

The D3-D6 Area, the former D3/D4 Yard, and the G1-D4 Alleyway post-remediation groundwater monitoring program consists of eleven wells (MW-40, MW-44R, MW-45, MW-46, MW-47R, MW-48, MW-49, MW-50, MW-51, MW-52, and SW-10) and four inlet sample locations from two catch basins (CBR 002-248; inlet samples A, B, and C and CBR 002-260; inlet sample A) that are monitored quarterly to assess the effectiveness of soil remediation projects in these areas. The soil remediation projects were performed in accordance with State regulatory agency approved plans and entailed the removal of soil and debris containing VOCs.

Knolls Laboratory performs voluntary monitoring of select groundwater monitoring wells annually. The selection of wells and parameter groups is based on the historical groundwater monitoring program results, site operational history, well locations, and subsurface hydrogeological information. Table 25 lists the specific analyses for each chemical parameter group (field parameters, metals, and VOCs) for the landfill and voluntary groundwater monitoring programs.

All field parameters except for turbidity are measured in the field using procedures provided in Standard Methods, Reference (10), or other EPA approved methods for analyzing chemical parameters. The vendor analytical laboratory is NYS Environmental Laboratory Approval Program (ELAP) certified in potable water analyses and wastewater chemical analyses.

Radiological: The groundwater well samples are analyzed by the Knolls Laboratory for radiological parameters using the methods described in the Effluent Analyses section of this report.

TABLE 25
GROUNDWATER MONITORING PARAMETERS

MONITORING PARAMETER GROUPS		
FIELD	**METALS[1]**	**VOLATILE ORGANIC COMPOUNDS**
Static Water Level Specific Conductance Temperature pH Turbidity[2]	Aluminum Antimony Arsenic Barium Beryllium Boron Cadmium Calcium Chromium (total and hexavalent) Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Selenium Silver Sodium Thallium Zinc	EPA 601: Chloromethane Bromomethane Dichlorodifluoromethane Vinyl Chloride Chloroethane Methylene Chloride Trichlorofluoromethane 1,1-Dichloroethane 1,1-Dichloroethene trans-1,2-Dichloroethene cis-1,2-Dichloroethene Chloroform 1,2-Dichloroethane 1,1,1-Trichloroethane Carbon Tetrachloride Bromodichloromethane 1,2-Dichloropropane trans-1,3-Dichloropropene Trichloroethene Dibromochloromethane 1,1,2-Trichloroethane cis-1,3-Dichloropropene Bromoform 1,1,2,2-Tetrachloroethane Tetrachloroethene Chlorobenzene p-Dichlorobenzene m-Dichlorobenzene o-Dichlorobenzene EPA 602:[3] Benzene Toluene Ethylbenzene Xylenes

Notes:
1. Analysis of metals (unfiltered and filtered) is performed voluntarily and only in the Land Area Wells.
2. Measured in the laboratory and only for the Land Area Wells.
3. EPA 602 parameters not required at the Landfill Wells.

Assessment

Nonradiological: Tables 26, 27, and 28 summarize the 2022 nonradiological groundwater monitoring results for the landfill and voluntary monitoring wells. Generally, the majority of analytical results are indicative of natural groundwater quality. Most variations in the data are attributable to natural water quality, variability in laboratory results at or near the RL, or interference associated with groundwater turbidity. The turbidity is the result of natural particulate materials entering the well from the surrounding clay and silt-rich geologic materials. Turbid water samples commonly show elevated metal results that are caused by particle mineralogy and are not indicative of dissolved, mobile metals. Tables 29 and 30 summarize the 2022 quarterly monitoring of the D3-D6 Area, the former D3/D4 Yard, and the G1-D4 Alleyway.

All monitoring results are compared to the NYS groundwater standards provided in 6 NYCRR Part 703 for class GA groundwater (Reference (1)). If no standard is provided, then the results are compared to the Guidance Values provided in the NYS Technical and Operational Guidance Series (TOGS) (1.1.1) Water Quality Standards and Guidance Values (Reference (4)).

Landfill

The Knolls Laboratory Landfill well results are presented in Table 26. Specific conductance and pH were consistent with past monitoring results. Overall results of field parameters for the landfill wells are within representative ranges typical of the landfill area per Reference (15). VOCs were not detected at or above the RL in any of the monitored Landfill wells.

Land Area

The Land Area data (Table 27) show natural water quality variations, the turbidity/elevated metal relationship, and road salting effects. Specific conductance and pH were consistent with past monitoring results. Toxic metal results from all wells are less than the corresponding groundwater standard and are attributable to natural water quality. VOCs were not detected at or above the RL or the applicable groundwater standard in any of the monitored Land Area wells, with the exception of well W-4. Only one VOC was detected in W-4, and its concentration is below the applicable groundwater standard. Well W-4 was resampled during the 2nd quarter 2022 to evaluate the detected VOC and VOCs were not detected. The presence of VOCs in W-4 is consistent with historical detections.

Hillside

The Hillside groundwater monitoring consists of field parameters and VOC analysis. The field parameter data is consistent with the effects of natural groundwater compositional variations (Table 28). VOCs were not detected at or above the RL at any Hillside well locations. An investigation of the Hillside revealed that the VOCs are mostly restricted to porous backfill associated with building foundations and utility lines, and are not migrating through indigenous soils.

Lower Level

The Lower Level wells are installed in bedrock and are sampled for field parameters and VOCs. Field analysis data is shown in Table 28. The field data shows the effects of natural groundwater compositional variations. The data is generally consistent with that reported previously. VOCs were not detected at or above the RL at any Lower Level well locations.

D3-D6 Area, Former D3/D4 Yard, and G1-D4 Alleyway

The D3-D6 Area, former D3/D4 Yard, and G1-D4 Alleyway monitoring wells and catch basin inlet monitoring locations are situated adjacent to and within areas subject to past soil remediation (Figure 4). The monitoring consists of VOC analysis. VOCs were detected in samples collected from six of the eleven monitoring wells at concentrations above applicable groundwater standards. These VOCs are localized to the area adjacent to Buildings D3 and D6 and were not detected in downgradient or sidegradient monitoring wells. A summary of the detected VOCs is provided in Table 29.

VOCs were detected in samples collected from the four catch basin inlets at concentrations that do not exceed the applicable groundwater standards. The VOC detections are sporadic in occurrence. The VOCs detected in the catch basin inlets are consistent with those detected in monitoring wells adjacent to Buildings D3 and D6. The presence of VOCs in the storm drain inlets shows there is some in-leakage of adjacent groundwater into the storm drain system. A summary of the detected VOCs is provided in Table 30.

Radiological: Results of the groundwater monitoring for radioactivity are summarized in Table 31. Well KH-17 was not sampled based on temporary access constraints and assessed benefits of obtaining the sample during the sampling period. Some wells had slightly higher gross beta and/or gross alpha radioactivity than the background wells. This is attributed to slightly higher levels of dissolved naturally occurring uranium, thorium, and their respective daughter products. Naturally occurring potassium-40 would also contribute to the gross beta radioactivity. Strontium-90 was detected above background levels in several wells. Strontium-90 and its daughter product, yttrium-90, also contribute to the gross beta radioactivity. All gross alpha, gross beta, and strontium-90 results were generally within the range of previously reported values. The maximum concentration of strontium-90, which has the most restrictive DCS of any radionuclide measured in any well, was detected in well KH-21. The KH-21 strontium-90 concentration was less than one percent of the DOE DCS (Reference (6)).

Conclusion

The overall conclusion of the groundwater monitoring program is that previous operations and waste disposal practices have resulted in some small, measurable effects on the groundwater quality in localized areas of the Knolls Laboratory. Based on upstream and downstream monitoring of the Mohawk River, there is no detectable effect on river water quality as a result of past or current Knolls Laboratory operations. The groundwater is limited in quantity and is not used as a drinking water supply. In addition, the Knolls Laboratory is not located over any principal or primary bedrock or overburden aquifers. Therefore, the groundwater associated with the Knolls Laboratory does not pose any threat to public health.

TABLE 26
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LANDFILL WELLS

Well	Sample Date	Parameter				
		Water Level Elevation (ft)(1)	Temperature (°C)	pH (SU)	Specific Conductance (μmhos/cm)	VOCs(2) (μg/l)
NTH-1A(3)	05/02/22	319.61	8.4	6.3	658	<1.0
NTH-2A	05/02/22	233.61	7.7	7.1	805	<1.0
NTH-5A	05/02/22	268.12	8.5	6.5	456	<1.0
NTH-5A QA Duplicate	05/02/22	NM	NM	NM	NM	<1.0
W-11	05/02/22	257.94	7.4	7.2	1121	<1.0
W-12	05/02/22	240.69	7.2	7.2	598	<1.0
STANDARD/GUIDANCE VALUE(4)		Note (5)	Note (5)	6.0 – 9.0(6)	Note (5)	Note (7)

Notes:

NM Not Measured

1. The latest site-wide topological mapping project results were used for the groundwater elevation calculations.
2. See Table 25 for a listing of the VOCs. Landfill wells are analyzed for VOCs only using EPA Method 601. A value preceded by “<” is less than the RL.
3. Up-gradient well.
4. NYS Quality Standards and Guidance Values (References (1) and (4)).
5. No standard or guidance value available.
6. Per the NYSDEC-approved Post-Closure Landfill Monitoring Plan, the acceptable pH range is 6.0 – 9.0.
7. Standards/Guidance Values vary between 0.4 μg/l and 50 μg/l.

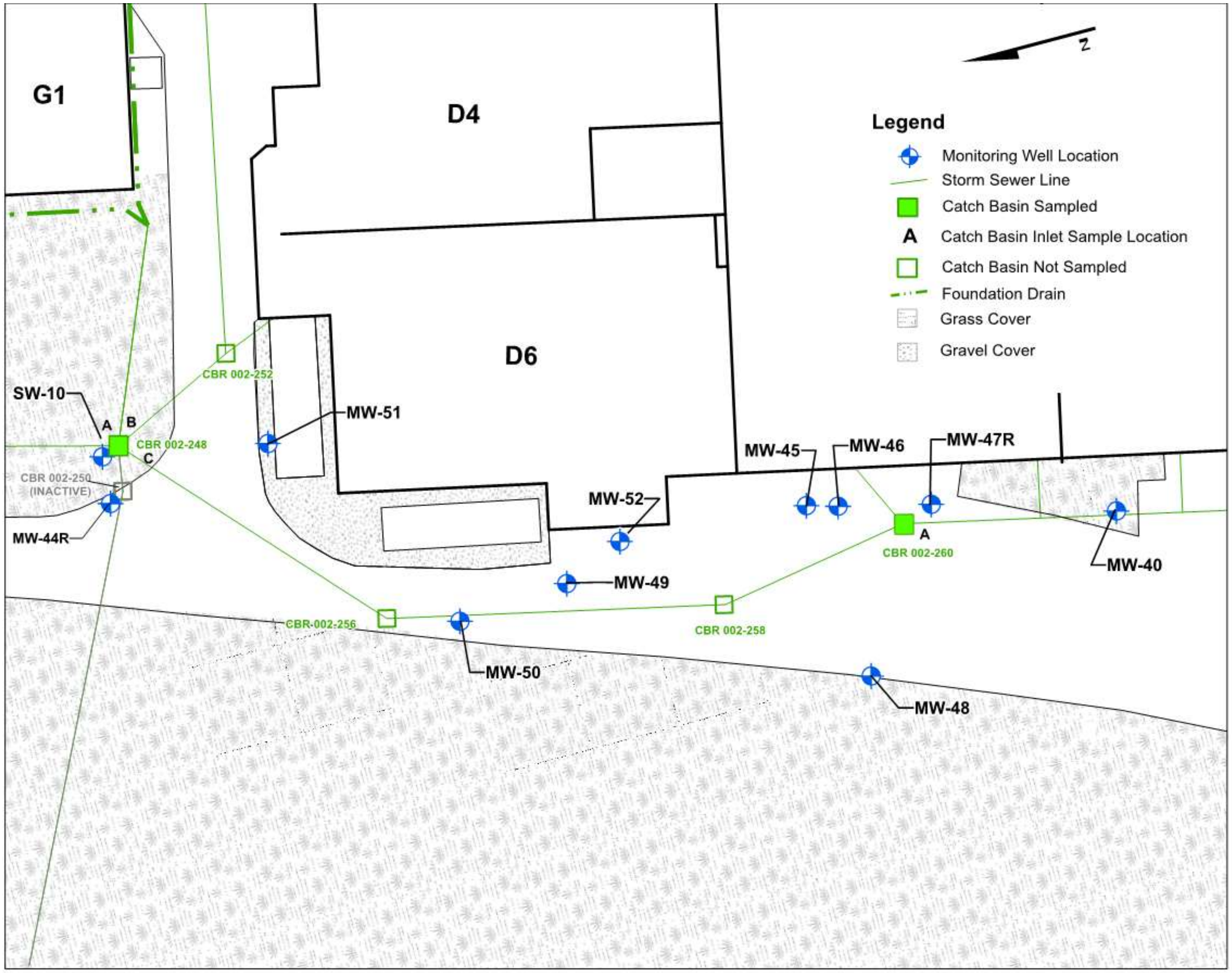

FIGURE 4

KNOLLS LABORATORY, NISKAYUNA, NEW YORK
D3-D6 AREA, FORMER D3/D4 YARD, AND G1-D4 ALLEYWAY
MONITORING LOCATIONS

TABLE 27
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS

Well	Sample Date	Parameter[1]										
		Field Parameters						Metals[2]				
		Water Level Elevation (ft)	Temperature (°C)	pH (SU)	Specific Conductance (μmhos/cm)	Turbidity (ntu)		Aluminum (mg/l)	Antimony (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Beryllium (mg/l)
KH-2	05/02/22	323.36	10.5	6.7	6,883	45		0.192 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.463 / 0.475	<0.005 / <0.005
MW-3	05/02/22	320.20	7.9	6.2	2,374	13		0.134 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.088 / 0.090	<0.005 / <0.005
W-1	05/02/22	319.08	11.5	6.8	6,985	3.3		<0.100 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.339 / 0.366	<0.005 / <0.005
W-4	05/02/22	282.20	8.1	6.8	1,404	1300		0.550 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.079 / 0.060	<0.005 / <0.005
W-4, Duplicate	05/02/22	NA	NA	NA	NA	1200		0.534 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.077 / 0.060	<0.005 / <0.005
W-8	05/02/22	300.86	10.4	7.1	505	16		<0.100 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.136 / 0.135	<0.005 / <0.005
W-10	05/02/22	287.46	8.7	7.1	992	4.9		<0.100 / <0.100	<0.060 / <0.060	<0.005 / <0.005	0.036 / 0.037	<0.005 / <0.005
STANDARD/GUIDANCE VALUE[3]		Note (4)	Note (4)	6.5 - 8.5	Note (4)	5		Note (4)	0.003	0.025	1	0.003[5]

Notes for Table 27 are on page 68.

TABLE 27 (continued)
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS

Well	Sample Date	Metals[1,2]									
		Boron (mg/l)	Cadmium (mg/l)	Calcium (mg/l)	Chromium (mg/l)	Chromium, VI (mg/l)[6]	Copper (mg/l)	Iron (mg/l)	Lead (mg/l)	Magnesium (mg/l)	Manganese (mg/l)
KH-2	05/02/22	<0.050 / <0.050	<0.005 / <0.005	471 / 508	<0.005 / <0.005	<0.02	<0.005 / <0.005	0.400 / 0.088	<0.005 / <0.005	148 / 152	1.97 / 1.84
MW-3	05/02/22	<0.050 / <0.050	<0.005 / <0.005	205 / 284	<0.005 / <0.005	<0.02	<0.005 / <0.005	0.412 / <0.050	<0.005 / <0.005	46.8 / 49.8	0.176 / 0.122
W-1	05/02/22	0.063 / 0.053	<0.005 / <0.005	425 / 475	<0.005 / <0.005	<0.02	<0.005 / <0.005	0.284 / 0.128	<0.005 / <0.005	120 / 131	0.141 / 0.134
W-4	05/02/22	0.068 / <0.050	<0.005 / <0.005	136 / 128	<0.005 / <0.005	<0.02	0.007 / <0.005	2.24 / 0.139	0.008 / <0.005	41.0 / 40.3	0.506 / 0.160
W-4, Duplicate	05/02/22	0.065 / 0.053	<0.005 / <0.005	134 / 133	<0.005 / <0.005	<0.02	0.008 / <0.005	2.11 / 0.118	0.007 / <0.005	40.4 / 40.8	0.508 / 0.169
W-8	05/02/22	0.248 / 0.205	<0.005 / <0.005	47.1 / 46.4	<0.005 / <0.005	<0.02	<0.005 / <0.005	0.218 / 0.177	<0.005 / <0.005	13.9 / 13.9	0.074 / 0.062
W-10	05/02/22	0.081 / 0.063	<0.005 / <0.005	92.8 / 108	<0.005 / <0.005	<0.02	<0.005 / <0.005	0.101 / <0.050	<0.005 / <0.005	31.2 / 35.8	0.066 / 0.054
STANDARDS/GUIDANCE VALUES[3]		1	0.005	Note (4)	0.05	0.05	0.2	0.3[7]	0.025	35[5]	0.3[7]

Notes for Table 27 are on page 68.

TABLE 27 (continued)
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF LAND AREA WELLS

Well	Sample Date	Metals[1,2]								Organics
		Mercury (mg/l)	Nickel (mg/l)	Potassium (mg/l)	Selenium (mg/l)	Silver (mg/l)	Sodium (mg/l)	Thallium (mg/l)	Zinc (mg/l)	VOCs (µg/l)
KH-2	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	102 / 107	<0.005 / <0.005	<0.010 / <0.010	739 / 776	0.012 / 0.010	0.092 / 0.082	<1.0
MW-3	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	0.927 / 1.07	<0.005 / <0.005	<0.010 / <0.010	192 / 269	<0.010 / <0.010	<0.010 / <0.010	<1.0
W-1	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	12.5 / 15.0	<0.005 / <0.005	<0.010 / <0.010	754 / 838	<0.010 / <0.010	0.014 / <0.010	<1.0
W-4	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	2.67 / 2.79	<0.005 / <0.005	<0.010 / <0.010	103 / 103	<0.010 / <0.010	0.012 / <0.010	1.1; cis-1,2-Dichloroethene
W-4, Duplicate	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	2.64 / 2.68	<0.005 / <0.005	<0.010 / <0.010	119 / 125	0.011 / <0.010	0.012 / <0.010	<1.0
W-4, Resample	06/28/22	NA	NA	NA	NA	NA	NA	NA	NA	<1.0
W-8	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	3.66 / 3.83	<0.005 / <0.005	<0.010 / <0.010	46.6 / 48.4	<0.010 / <0.010	<0.010 / <0.010	<1.0
W-10	05/02/22	<0.0002 / <0.0002	<0.020 / <0.020	4.07 / 4.43	<0.005 / <0.005	<0.010 / <0.010	73.8 / 68.0	<0.010 / <0.010	<0.010 / <0.010	<1.0
STANDARD/GUIDANCE VALUE[3]		0.0007	0.10	Note (4)	0.010	0.05	20	0.0005[5]	2.0[5]	Note (8)

Notes:

NA Not Applicable.
1. A value preceded by “<” is less than the RL.
2. Unfiltered / Filtered results.
3. Water Quality Standards, 6 NYCRR 703.5 (Reference (1)).
4. No groundwater standard or guidance value available.
5. NYSDEC, Division of Water TOGS (1.1.1), (Reference (4)).
6. Hexavalent chromium results are unfiltered, per Standard Method 3500Cr-D.
7. Combined concentration of iron and manganese shall not exceed 0.5 mg/l per 6 NYCRR 703.
8. See Table 25 for the complete list of VOCs that were analyzed. Standards/Guidance values vary between 0.4 µg/l and 50 µg/l.

TABLE 28
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF HILLSIDE AREA AND LOWER LEVEL WELLS

Locations	Sample Date	Water Level Elevation (ft)	Temperature (°C)	pH (SU)	Specific Conductance (µmhos/cm)	Volatile Organic Compounds (µg/l)(1)(2)
Hillside Area						
B-6	06/28/22	322.53	17.7	7.1	5,020	<1.0
SW-10	06/28/22	327.37	16.9	7.0	3,910	<1.0
SW-10 (Duplicate)	06/28/22	NA	NA	NA	NA	<1.0
B-16	05/03/22	269.3	9.0	6.9	2,713	<1.0
KH-6	07/05/22	313.49	13.9	7.0	843	<1.0
KH-9S	06/28/22	324.07	15.8	6.9	7,557	<1.0
KH-18	05/03/22	281.53	11.9	6.7	1,129	<1.0
Lower Level						
KH-19	05/03/22	237.12	13.0	8.8	1,140	<1.0
KH-21	05/03/22	242.38	11.3	6.6	8,869	<1.0
KH-22	05/03/22	223.19	10.5	6.8	3,695	1.4(2); Chloroform
KH-23	05/03/22	242.87	10.7	7.1	4,033	<1.0
KH-23 (Duplicate)	05/03/22	NA	NA	NA	NA	<1.0

Notes:

NA Not Applicable.

1. See Table 25 for the complete list of VOCs that were analyzed. A value preceded by "<" is less than the RL. The results for those parameters not listed in this table were all less than the RL.
2. Samples were analyzed for 52 volatile organic compounds. Chloroform was detected in the May 3, 2022 sample from KH-22 at a concentration of 1.4 J µg/L. The chloroform result is less than the Reference (1) standard of 7 µg/L. Chloroform, a trihalomethane, may be associated with chlorinated site service water. All other values were less than the RL.

TABLE 29
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF D3-D6 AREA, FORMER D3/D4 YARD, AND G1-D4 ALLEYWAY, DETECTED VOLATILE ORGANIC COMPOUNDS

Well	Sample Date	Volatile Organic Compounds (1, 2)			
		trans-1,2-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)
MW-45	3/29/22	<1.0	3.6	9.7	3.2
	6/22/22	<1.0	2.0	7.3	2.0
	9/7/22	<1.0	11	27	8.6
	11/17/22	1.6	5.5	4.2	3.0
MW-46	3/29/22	<1.0	1.8	34	4.4
	6/22/22	<1.0	0.33 J	25	3.3
	9/7/22	<1.0	0.48 J	14 J	1.4 J
	11/17/22	<1.0	6.0	170	10
MW-46 Duplicate	3/29/22	<1.0	2.0	33	4.4
	6/22/22	<1.0	0.26 J	23	2.7
	9/7/22	0.34 J	11 J	81 J	16 J
	11/17/22	<1.0	5.1	130	8.3
MW-47R	3/29/22	<1.0	3.4	47	1.9
	6/22/22	<1.0	3.3	36	1.8
	9/7/22	<1.0	5.3	46	2.7
	11/16/22	<1.0	4.6	39	2.4
Standards (3)		5	5	5	5

Notes for Table 29 are provided on Page 71.

TABLE 29 (continued)
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING OF D3-D6 AREA, FORMER D3/D4 YARD, AND G1-D4 ALLEYWAY, DETECTED VOLATILE ORGANIC COMPOUNDS

Well	Sample Date	Volatile Organic Compounds (1, 2)			
		trans-1,2-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)
MW-49	3/29/22	<1.0	1.9	2.7	0.70 J
	6/22/22	<1.0	3.8	4.7	1.4
	9/7/22	<1.0	5.6	8.4	1.7
	11/16/22	<1.0	1.9	0.87 J	0.68 J
MW-51	3/30/22	<1.0	1.2	5.1	0.92 J
	6/23/22	<1.0	3.5	9.7	1.8
	9/8/22	<1.0	6.2	16	2.7
	11/16/22	<1.0	4.3	12	2.5
MW-52	3/29/22	<1.0	2.7	22	2.9
	6/22/22	<1.0	1.4	25	2.0
	9/7/22	<1.0	12	41	9.5
	11/16/22	<1.0	4.7	22	4.6
Standards (3)		5	5	5	5

Notes:

J The associated result is less than the RL but greater than or equal to the method detection limit and the concentration is an approximate value.

1. A value preceded by "<" is less than the RL.
2. Samples were analyzed for 52 volatile organic compounds. Chloroform was detected in the March 29, 2022, June 22, 2022, and September 7, 2022 samples from MW-52 at a concentrations of 0.54 J µg/L, 0.95 J µg/L, and 0.47 J µg/L, respectively. The chloroform results are less than the Reference (1) standard of 7 µg/L. Chloroform, a trihalomethane, may be associated with chlorinated site service water.
3. Water Quality Standards, 6 NYCRR 703.5 (Reference (1)).

TABLE 30
RESULTS OF KNOLLS LABORATORY CATCH BASIN MONITORING OF D3-D6 AREA, FORMER D3/D4 YARD, AND G1-D4 ALLEYWAY DETECTED VOLATILE ORGANIC COMPOUNDS

Catch Basin	Sample Date	Volatile Organic Compounds (1, 2)		
		cis-1,2-Dichloroethene (µg/L)	Tetrachloroethene (µg/L)	Trichloroethene (µg/L)
CBR-002-248-A	3/30/22	0.85 J	<1.0	3.2
	6/23/22	0.90 J	<1.0	3.2
	9/8/22	0.82 J	<1.0	2.5
	11/17/22	0.57 J	<1.0	1.8
CBR-002-248-A Duplicate	3/30/22	0.84 J	<1.0	2.8
	6/23/22	0.88 J	<1.0	3.1
	9/8/22	0.73 J	<1.0	2.3
	11/17/22	0.55 J	<1.0	1.8
CBR-002-248-B	3/30/22	0.47 J	0.46 J	0.97 J
	6/23/22	0.71 J	0.57 J	1.2
	11/17/22	0.41 J	0.33 J	0.70 J
CBR-002-248-C	3/30/22	0.55 J	0.45 J	0.78 J
	6/23/22	0.68 J	0.49 J	1.1
CBR-002-260-A	3/30/22	0.23 J	<1.0	<1.0
	6/23/22	0.31 J	<1.0	<1.0
Standards (3)		5	5	5

Notes:

J The associated result is less than the RL but greater than or equal to the method detection limit and the concentration is an approximate value.

1. A value preceded by "<" is less than the RL; <1.0 J indicates the result is less than the RL and the RL is estimated.
2. Samples were analyzed for 52 volatile organic compounds. Combinations of trihalomethanes (THMs) (bromodichloromethane, bromoform, chloroform, and dibromochloromethane) were detected in the September 8, 2022 catch basin inlet sample, CBR-002-248-B, at concentrations of 2.1 µg/L, 0.74 J µg/L, 1.5 µg/L, and 2.6 µg/L, respectively, which are less than the Reference (1) standards and Reference (4) guidance values of 50 µg/L, 50 µg/L ,7 µg/L, and 50 µg/L, respectively. THMs may be associated with chlorinated site service water.
3. Water Quality Standards, 6 NYCRR 703.5 (Reference (1)).

TABLE 31
RESULTS OF KNOLLS LABORATORY GROUNDWATER MONITORING FOR RADIOACTIVITY

Location Month Sampled		Radioactivity Concentrations[1,2]					
		Gross Alpha	Gross Beta	Sr-90	Cs-137		H-3
		pCi/l					$x10^2$ pCi/l
Landfill Area							
May	NTH-1A	<0.69	<2.37	0.27 ± 0.20	<0.30		<0.92
	NTH-2A	3.56 ± 3.29	14.20 ± 4.75	0.41 ± 0.23	<0.24		<0.91
	NTH-5A	2.79 ± 2.58	2.63 ± 3.39	<0.15	<0.24		<0.91
	W-11	<1.53	6.57 ± 4.20	0.22 ± 0.21	<0.17		<0.91
	W-12	<1.68	4.68 ± 4.03	0.39 ± 0.24	<0.19		<0.92
Land Area							
May	W-4	<1.53	5.73 ± 4.04	<0.16	<0.36		<0.91
	W-8	2.92 ± 2.70	6.56 ± 3.85	<0.14	<0.13		<0.91
	W-10	2.54 ± 3.83	20.20 ± 5.57	<0.16	<0.25		<0.91
	MW-3	<2.18	3.61 ± 4.06	0.37 ± 0.24	<0.18		<0.91
Hillside Area							
May/June/July	B-6	<2.67	6.24 ± 4.12	<0.34	<0.14		<0.91
	B-16	3.38 ± 5.10	6.07 ± 3.88	0.26 ± 0.21	<0.40		<0.86
	KH-6	<1.08	<2.46	0.20 ± 0.21	<0.25		<0.91
	KH-9S	8.49 ± 12.78	9.15 ± 5.85	0.31 ± 0.24	<0.24		<0.91
	KH-18	1.82 ± 2.75	4.03 ± 3.31	0.28 ± 0.22	<0.17		<0.91
	SW-10	5.78 ± 7.01	8.91 ± 4.09	0.53 ± 0.24	<0.19		<0.86
Lower Level							
May	KH-19	<0.93	<2.42	<0.16	<0.11		<0.91
	KH-20	<1.13	<2.44	<0.15	<0.17		<0.86
	KH-21	1.99 ± 2.41	<2.29	1.77 ± 0.39	<0.15		<0.86
	KH-22	<3.10	12.60 ± 5.56	0.98 ± 0.29	<0.11		<0.86
	KH-23	8.46 ± 7.82	9.44 ± 4.18	0.31 ± 0.25	<0.24		<0.86
Background Wells – for comparison							
May	W-1	<4.44	5.75 ± 5.18	<0.16	<0.30		<0.91
	KH-2	<3.68	5.69 ± 4.89	0.20 ± 0.19	<0.14		<0.91
	KH-3S	30.80 ± 18.09	15.00 ± 5.93	0.27 ± 0.22	<0.29		<0.91

Notes:

1. A value preceded by "<" is less than the DLC for that sample and parameter. The (±) value represents the statistical uncertainty at the 95% confidence interval.
2. The lowest possible value for any parameter is zero.

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CONTROL OF CHEMICALLY HAZARDOUS SUBSTANCES AND SOLID WASTE

Sources

Chemicals are not manufactured at the Knolls Laboratory. Minimal quantities of hazardous wastes do result from the necessary use of chemicals in Knolls Laboratory operations. To ensure the safe use of chemicals and disposal of the resulting wastes, the Knolls Laboratory maintains a hazardous waste control program. Hazardous wastes are disposed of through permitted off-site treatment and disposal facilities.

Chemical Control Program

The control program minimizes the quantity of waste material generated, ensures safe usage and storage of the materials at the Knolls Laboratory, and provides for proper disposal of the wastes by vendors that operate under permits issued by Federal and State agencies.

A principal part of the waste minimization program is the control of the acquisition of hazardous substances for use at the Knolls Laboratory. Purchase requests for chemicals are reviewed to ensure that the materials are actually necessary for Knolls Laboratory operations, the amount ordered is not excessive, and that methods for proper disposal are in place before the material is ordered. Hazardous substance storage controls include as a minimum: labeling, providing revetments as appropriate, segregation based on compatibility, limiting storage volumes, and providing weather protection as appropriate. When required, large volumes of chemicals and petroleum products are stored in accordance with the NYS Chemical Bulk Storage regulations (Reference (16)) and the Petroleum Bulk Storage (PBS) regulations (Reference (17)). The Knolls Laboratory did not store any chemicals in quantities that are subject to the Chemical Bulk Storage regulations during 2022.

Additionally, many hazardous substances have been replaced by nonhazardous substitutes. The Knolls Laboratory stresses the "Know-Before-Do" principle. To this end, facility personnel must identify ways to minimize waste prior to purchasing new chemicals or performing a waste generating process. The Knolls Laboratory also evaluates the hazardous waste that is generated and determines if additional waste minimization can be achieved.

All personnel working at the Knolls Laboratory are provided with general information on the Knolls Laboratory policies for the procurement, use, and disposal of hazardous substances. For individuals who use hazardous substances in operations, specific training is provided to ensure that they are knowledgeable of safe handling techniques and emergency response procedures. After chemicals are used and no longer needed, they are accumulated in designated staging and storage areas where they are segregated and packaged for shipment. Waste is temporarily stored only as necessary to accumulate sufficient volumes for shipment to a waste disposal vendor. Hazardous and mixed (radioactive and hazardous) waste storage facilities are operated at the Knolls Laboratory under a permit obtained from NYSDEC. The Knolls Laboratory has an inspection program to verify routinely that hazardous substances are properly stored and controlled in accordance with approved procedures.

In addition, the Knolls Laboratory hazardous waste control program is subject to on-site inspection. EPA conducted a hazardous waste management inspection during 2022.

Chemical Disposal

Hazardous waste is managed in compliance with RCRA. Generated waste is transported by vendors to treatment, storage, and disposal facilities for final disposition. The transportation vendors and the treatment, storage, and disposal facilities operate under permits issued by the cognizant Federal and State regulatory agencies. The Knolls Laboratory requires the disposal facilities to provide itemized written verification that the waste was actually received. During 2022, the Knolls Laboratory shipped approximately 20 tons of RCRA and NYS hazardous waste off-site for disposal. This included approximately 1.4 tons of mixed waste and 18.6 tons of hazardous waste. The Knolls Laboratory reduces the potential environmental impact of the waste by selecting the ultimate disposal methods that minimize or eliminate future environmental effects.

Nonhazardous chemical waste is also sent off-site for disposal. The transportation vendors and the treatment, storage, and disposal facilities are typically the same as those used for hazardous waste disposal. These facilities also operate under permits issued by the cognizant Federal and State regulatory agencies. The Knolls Laboratory requires the disposal facility to provide itemized written verification that the waste was actually received. During 2022, approximately 47.3 tons of nonhazardous chemical and medical waste were sent for off-site disposal via incineration, wastewater treatment, chemical treatment, or land disposal from the Knolls Laboratory.

Solid Waste Disposal/Recycling

During 2022, approximately 1,410 tons of nonhazardous solid waste were generated from such waste streams as office and cafeteria trash, construction and demolition debris, and classified scrap paper. From these waste streams, the Knolls Laboratory recycles materials such as unclassified office paper, glass, plastic, tin, aluminum, newspapers, magazines, corrugated cardboard, asphalt, computers, wood, precious metals, used oil, lead/lead acid batteries, scrap metal, concrete, universal waste (e.g., light bulbs, batteries, thermostats), printer cartridges, and cafeteria grease. In 2022, approximately 724 tons of these materials were recycled from the Knolls Laboratory.

CONTROL OF RADIOACTIVE MATERIALS AND RADIOACTIVE WASTE

Sources

Operation of the Knolls Laboratory results in the generation of various types of radioactive materials and wastes. Low level radioactive solid waste materials that require disposal include filters, metal scrap, rags, resin, paper, and plastic materials.

Control Program

Detailed procedures are used for handling, packaging, transportation, and disposal of radioactive waste at a government operated or licensed disposal site. Internal reviews are made prior to the shipment of any radioactive material from the Knolls Laboratory to ensure that the material is properly identified, surveyed, and packaged in accordance with Federal requirements.

The volume of radioactive waste is minimized through the use of special work procedures that limit the amount of materials that become contaminated during work on radioactive systems and components. Radioactive liquid waste is collected in an absorbed form prior to shipment to an approved disposal facility. All radioactive wastes are prepared and shipped in accordance with written procedures to meet the applicable DOT regulations given in Reference (18). The waste packages also comply with all applicable requirements of the NRC, the DOE, and the disposal sites.

Disposal/Recycling

The shipments of low level radioactive solid wastes were made by authorized common carriers to disposal sites located outside NYS. During 2022, approximately 132.6 cubic meters (173.4 cubic yards) of low level radioactive waste containing approximately 19.7 Curies (Ci) of radioactivity were shipped from the Knolls Laboratory for disposal, a volumetric decrease from the 285.4 cubic meters (373.3 cubic yards) containing 11.2 Ci shipped in 2021. The decrease in volume from 2021 to 2022 comes from a decrease in total inventory.

CONTROL OF MIXED WASTES

Sources

Waste that is both radioactive and chemically hazardous is regulated under both the AEA and RCRA as “mixed waste.” Also, per NYSDEC, certain TSCA regulated PCB waste is also considered a hazardous waste. Operations at the Knolls Laboratory, in support of research and development for the design and operation of naval nuclear propulsion plants, resulted in the generation of a small quantity of mixed wastes. These wastes included laboratory chemicals, oils, equipment, and debris.

Control Program

Mixed wastes were managed in accordance with the Knolls Laboratory RCRA permit, the FFCA of 1992, and the Knolls Laboratory Mixed Waste STP. The Mixed Waste STP is updated annually, if required, and provided to NYSDEC. The Knolls Laboratory takes aggressive action to minimize the creation of mixed waste by reducing the commingling of radioactive and hazardous materials and avoiding the use of hazardous substances where technically acceptable. The amount of generated mixed waste was also minimized through the use of detailed work procedures and worker training.

Storage and Disposal

Mixed wastes were accumulated in designated regulated and permitted storage areas. The wastes were packaged for storage and shipment to off-site treatment facilities in accordance with the Knolls Laboratory Mixed Waste STP. In 2022, there were three shipments totaling approximately 1.4 tons of various mixed wastes to treatment and disposal facilities.

RADIATION DOSE ASSESSMENT

The effluent and environmental monitoring results show that radioactivity present in liquid and gaseous effluents from 2022 operations at the Knolls Laboratory, including DOE-EM activities for the NNPP had no measurable effect on normal background radioactivity levels. Therefore, any radiation doses from the Knolls Laboratory, including DOE-EM activities, operations to off-site individuals were too small to be measured and must be calculated using conservative methods. Estimates of the radiation dose to the maximally exposed individual in the vicinity of the Knolls Laboratory, including DOE-EM activities, and the collective dose to the population residing in the 80 kilometer (50 mile) radius assessment area are summarized later in this report in the Radiation Dose Assessment and Methodology section.

The results show that the estimated doses were less than 0.1 percent of that permitted by the radiation protection standards of the DOE listed in Reference (19), and that the estimated dose to the population residing within 80 kilometers (50 miles) of the Knolls Laboratory was less than 0.001 percent of the natural background radiation dose to the population. In addition, the estimated doses were less than one percent of that permitted by the NRC numerical guide listed in Reference (20) for whole-body dose, demonstrating that doses are ALARA. The dose attributed to radioactive air emissions from the Knolls Laboratory was less than one percent of the EPA standard in Reference (8).

The collective radiation dose to the public along the travel route from outgoing Knolls Laboratory shipments of radioactive materials during 2022 was calculated using data given by the NRC in Reference (21). Based on the type and number of shipments made, the collective annual radiation dose to the public along the transportation routes, including transportation workers, was less than one person-rem. This is less than 0.001 percent of the dose received by the same population from natural background radiation.

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